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REPORT ON SEVENTH INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY,

HELD IN LONDON IN AUGUST, 1891:

AND ON THE LATEST DEVELOPMENTS OF SANITATION AND SANITARY WORK IN EUROPE.

Presented to both Houses of Parliament by His Excellency's Command.

INTRODUCTORY ABSTRACT

TO REPORT ON CONGRESS OF HYGIENE, AND ON SANITARY WORK IN EUROPE,

(Parliamentary Paper, No. 160, 1891,)

BY A. MAULT.

As my Report is necessarily very long, and treats of a great number of topics, I have judged it to be desirable to prepare the following Abstract of matters referred to in it in a form that will serve as an Index to those who are interested in any special subject that was considered at the Congress, or that came under my observation.

(The numbers refer to paragraphs of the Report.)

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To the Honourable the President and to the Members of the Central Board of Health.

Gentlemen,

Delegation to Congress.

Collection of information.

1. I have the honour to present to you the following Report of my mission to England as Delegate of the Tasmanian Government to the Seventh International Congress of Hygiene and Demography, and to request you to forward it to the Government for its information as to the fulfilment of the commission it entrusted to me. In accordance with your instructions I took advantage of my visit to England to obtain all information that could be collected in the time at my disposal on the latest developments of Sanitary science and practice in Europe. To do this in the most efficient and useful manner, I selected, in addition to London, the following places as most fairly representative of different sewerage systems in use, and as exemplifying the best methods of sanitary administration:—Acton, Aldershot, Birmingham, Coventry, Croydon, Ealing, Eastbourne, Glasgow, Liverpool, Manchester, Marseilles, Paris, Rochdale, Sheffield, Southampton, and Warrington. I also obtained as precise information as possible as regards other places I was unable to visit.

Progress Report.

Information for other Colonies.

2. On the 20th of August I had the honour to forward a short Progress Report to the Hon. the Chief Secretary. I have to request that that Report be taken as introductory to this. Mention was made in it of my proceedings at Melbourne and Adelaide with respect to the offer of my services to the Governments of the other Colonies. Since it was written I received from Sir John Forrest, the Premier of Western Australia, a request that, in accordance with the above-mentioned offer, I should obtain for the Central Board of Health of that Colony information with respect to recent improvements or developments of the dry-earth system. I replied by promising to obtain all information in my power, and have done so accordingly.

I. THE CONGRESS.

Organisation of Congress.

3. The Congress was virtually the eighth of the series (though called the seventh) of International Congresses of Hygiene and Demography that have been held in various capitals of Europe. Each of these Congresses has been more important in its proceedings and results than its predecessor. At an early stage in the preparations made for this one in London, it became evident that its scope would be so large, and the matters to be discussed so numerous, that special arrangements would have to be made for the conduct of its business. It was accordingly divided into the two great divisions—Hygiene and Demography—and the Division of Hygiene was subdivided into nine sections, each having an organisation and officers of its own, and meeting separately, the first and last meetings of the Congress being the only general ones. The sections in the Division of Hygiene were—

Preventive Medicine.
Bacteriology.
Relation of the Diseases of Animals to those of Man.
Hygiene of Infancy and Childhood.
Chemistry and Physics in relation to Hygiene.
Architecture in relation to Hygiene.
Engineering in relation to Hygiene.
Naval and Military Hygiene.
State Hygiene.

The Division of Demography comprised Demography in general, Health Statistics, and Industrial Hygiene. Some arrangements of the kind were evidently necessary, but it was quite impracticable to fix definite limits. The 2nd, 3rd, 4th, and 8th sections of the Hygiene Division were practically definite enough; but the other sections, especially the 1st, 5th, and 9th taken together, and the 6th, 7th, and 9th, and Industrial Hygiene taken together so overlapped each other in regard to subject-matter as to render it difficult to determine to what section certain topics belonged.

Work of Congress.

4. Altogether 273 papers were submitted to the Congress, of which 163 were by Delegates from Great Britain, 24 by Delegates from each of the countries of France and Germany respectively, 12 by Delegates from Austria-Hungary, eight by those from India and the United States respectively, six by those from Italy, four by those from Belgium and Holland respectively, three by those from Canada, Denmark, Egypt, and Spain respectively, and two by those from Australia, Roumania, Russia, and Switzerland respectively. As many of these papers are very important, and contain the latest information on subjects of vital interest to medical men, engineers, municipal authorities, and all concerned in protecting the public health, together with the opinions thereupon of some of the most eminent men of the day, I have added in the first Appendix to this Report a list of the documents. I have at present copies of some of them, and hope soon to have copies of all, and shall be glad to lend them for perusal to any who may apply for them. It is inevitable that such papers should vary very much in value. A Congress affords opportunities, that are not neglected by "faddists," to air their views, and the determination of the Organizing Committee to allow fair discussion on all matters necessitated that such opportunity should not be denied. In effect, the discussion arising from the reading of papers containing erroneous views often afforded as much instruction as that arising from the enunciation of undisputed truth.

Appendix I.

Engineering Section.

Work of Engineering Section.

5. I have mentioned in my Progress Report that, as the meetings of the various sections were held at the same time, I could only attend those of the Engineering Section, including the excursions made in connection therewith. As the practical work seen on these excursions was illustrative of the application of principles to sanitary purposes comparable with other applications which I saw in my inspection of work in other towns, I will postpone to a later part of this Report my record of and my remarks upon all this work, and will here content myself with giving an account of the actual proceedings of the Section while in session. This will be best done, not by following the order of the papers as read, but by grouping them according to subjects. I must further premise that the work of the Section was naturally limited to the consideration of matters brought before it, and, consequently, many important details connected with sanitation were not discussed. In the following Report I will do my best, though no formal votes were taken in the Section, to faithfully give an impartial appreciation of the general results of discussions, and not one based on my own opinions. I will also limit myself to subjects of practical importance to a Colony like Tasmania.

Scope of practical work of Session.

6. The practical work of the Engineering Section may be divided under the following heads:—Sewage Removal, Sewage Disposal, Sub-soil Drainage, Water Supply, and Treatment of House and Town Refuse.

Sewage Collection and Removal.

Sewage removal

7. With respect to Sewage Removal, the universal opinion of all the Delegates, not only in the Engineering Section, but in all others where the matter was mentioned, was in favour of water carriage in underground sewers, wherever such method of removal was possible. This principle was accepted as axiomatic, and discussion only took place with regard to methods or modifications of it, and as to details of construction necessary to secure perfect working.

With the exception of some of the principal French and Italian Delegates, there was a general consensus of opinion in favour of the 'Separate' system of sewerage—the collection of house sewage, including rain-water from roofs and courtyards, by means of drains connected with sewers serving as far as practicable only for the conveyance of such sewage, and leaving the rain-water falling on streets, roads, and lands to be conveyed by the simplest means possible to the watercourses naturally draining the district. The French and Italians, on the other hand, approved of the Parisian method of sending "*tout a l'égout*"—everything to the sewer—including storm water, street sweepings, and road scrapings. This system has the insuperable drawbacks of necessitating the building of immense sewers, the treatment, where treatment is necessary, of enormous quantities of sewage at the outfalls, and the manual and mechanical cleansing of sewers—that is, the taking out of them, by manual labour, the sand and solid matter deposited in them. The increased size of sewer required was thus put by Mr. Middleton in his paper:—

"Under the conditions which exist in this country, the proportion which the sewage matter at its maximum bears to the storm-water at its maximum is probably about 1 to 25, while in tropical countries this proportion is greatly exceeded, while the duration of the rainfall is much concentrated, and the length of the time during which there is no rain is correspondingly increased. Assuming the above figures to be correct, sewers to carry storm-water must be 25 times larger than where sewage only is to be transported; these dimensions must be much increased when the rainfall is tropical; and these same sewers will in time of drought be almost empty, the rate of delivery in them will be very slow, and they will become foul to an excess, and must be dangerous to health, especially under tropical conditions of great heat and long periods of continued drought."

The cost of the immense sewers required would, in places where the sewage has to be purified before discharge, be further aggravated by the fact that such treatment cannot now be permitted in the immediate neighbourhood of towns, and consequently great lengths of outfall sewers are required. Another imperfection of the *tout à l'égout* system is that in heavy rain storms it is impossible to treat all the sewage arriving at the outfall either by irrigation or chemical treatment, and it has usually to be passed directly into the outfall river without purification. At Reims, to avoid this, large reservoirs have been constructed to receive these exceptional quantities of sewage. These reservoirs are simply dug in the earth and planted with poplars. In ordinary weather they are covered with grass and herbs. In wet weather they receive the excess sewage, which is left to be absorbed by the ground, which absorption is said to be done without causing a nuisance.

Mr. Middleton thus sums up his case in favour of the separate system :—

"The advantages which the separate system offers appear to be :—(1.) The use of very small sewers. (2.) A fair amount of regularity in the sewage passing through the sewers, which will not vary greatly either in quantity or quality, and which will at certain known times in every day carry a known maximum and minimum of sewage. (3.) The gradients can be arranged to give a minimum rate of flow which shall not allow of deposit. (4.) Where pumping has to be employed, the volume to be pumped is reduced to a regular diurnal unit, as against a quantity which may vary in the proportion of from 1 to 25 or more according to the rainfall, and which necessitates the use of pumping machinery, tanks, and other appliances calculated to deal with the larger quantity. (5.) The comparatively small alteration of level of the sewage matter in the sewers, and the fact that the variation in the rate of flow would be reduced and the average rate made higher, should tend to prevent pressure from the evolution of gases, and should shorten the time of delivery—and therefore that in which fermentation can take place—and should tend to health. (6.) The heavier matter, such as road scrapings, coaldust, &c., is not passed into the sewers, but into the water-courses, and the former should, therefore, be maintained free from deposit with great facility. (7.) From the small size of the sewers and the comparatively regular flow of sewage in them, they offer great facilities for more thorough and regular ventilation than has been hitherto found possible in the larger sewers."

Earth and pail closets, and closed cess-pit systems.

8. With reference to the modifications of the separate system that are based upon the separation of the more solid fæcal part of the house sewage from the rest, what has been above reported will show that the opinion of the Congress was opposed to their adoption, except when the want of water made the use of water-closets impracticable. As regards earth-closets, it was pointed out that they fail, because their proper use cannot be secured in the circumstances where their proper use is of the utmost consequence—in the poorer quarters of towns. Mr. Baldwin Latham, in his paper on "Sanitation in India," gave instances of this. Furthermore, with respect to earth-closets, pail-closets, and closed cesspits, their use does not simplify, but rather complicates, the question of sewage collection and disposal; for sewers to remove the liquid fæcal matter and house slops are just as necessary as if the solid fæcal matter were not separated, and the purification of the sewage is just as difficult.

Earth closets.

Pail closets.

The same reasons that militate against the adoption of the "earth" system tell equally as regards the pail system, which differs from the former only in the use of a chemical disinfectant or deodorant instead of earth—or in the use of no deodorant at all.

The use of both these systems is allowed in England in some places, and under certain regulations. The most usual of these is that the closets must be placed outside the dwelling-house.

Liernur's system.

Pagliani's system.

The professedly hermetically-closed cesspit system, such as that of Liernur, is not used in England. M. Sijmon, of Rotterdam, spoke of the success of Liernur's system at Amsterdam as regards the houses in which it was used ; but other speakers denied this, and spoke of the stench connected with the discharge, transport, and utilization of the fæcal matter. Professor Pagliani, Director of Public Health in Rome, described another system that he advocated. It consists of a closed receptacle partly filled with peat, as a filtering medium, placed on the line of drain from the house, so as to retain all the solid part of the sewage and allow only the liquid part to get to the sewer in the street. The peat is to be in such quantity that the upper part can be kept dry, so as to allow the action of the air. Means are taken to prevent the washing away of the peat, which is turned over from time to time ; and the receptacle is emptied and the manure carted away at long intervals. The Professor said that experience had shown the successful working of this plan, and he claimed that its use greatly lessened the required size of drains and sewers ; that the peat retained all the solid portion of the sewage, and absorbed a large quantity of the dissolved portion that was of manurial value; that, consequently, the resulting manure was good, and also that the effluent sewage is deprived of most of its putrescible constituents. I know from my own experience in dealing with the sewage of Paris from 1872 to 1876 the great use that may be made of peat—especially peat charcoal—and the great amount of ammonia it can absorb, and therefore think some modification of Professor Pagliani's system might be used with advantage for treating the sewage from country houses or small villages in the colonies.

Sewer construction.

9. In nearly all the papers in which sewer construction was alluded to, the best material to use was considered to be, and it is hardly necessary to mention it, glazed earthenware or vitrified brick. But in connexion with my paper on the drainage of Zeehan—where it was impracticable to use earthenware pipes—a very long and interesting discussion took place as to the use of the material—sheet iron—I had selected in the stead of stoneware. Theoretical doubts were expressed by some

who had had no experience in the use of the material, but all who had used it gave testimony as to its durability, the City engineers of Edinburgh, Glasgow, and Liverpool mentioning instances of its undeteriorated condition after long use—up to 40 years. Another engineer stated that he found sewage, with the grease and soap it contained, acted as a preservative to wrought iron pipes, which would have soon rusted through if used to convey clean water. The President of the Section also concurred, but thought care should be taken in case of sewage from chemical factories.

Size of drains.

10. With respect to another point connected with construction—the size of drains—comparatively little was said, but the general impression made was rather in favour of smaller than of larger drains than are now being used. In the architectural section a paper was read on this subject by Mr. Lawford, under the title "Four-inch drains *versus* six-inch drains." He put his case thus:—

"Taking, as an example, the case of an ordinary sized town house, with an average of 10 inhabitants, and allowing 30 gallons of waste water or liquid matter to be discharged per head per day, the total volume would be 300 gallons per day, and of this amount at least one-half must be reckoned as being discharged in six hours, this giving 25 gallons per hour as the maximum flow to be provided for. To this amount must be added the rainfall from the roof and areas which, as a rule in the case of town houses, is taken into the sewer. The superficial area to be dealt with under this heading varies from 1000 to 10,000 square feet; taking 6000 square feet, which is considerably in excess of the average, and allowing for 1¼ inches of rainfall per hour (thus providing for the heaviest thunderstorms), the total volume of rainfall to be dealt with would be 3900 gallons per hour. The maximum hourly discharge of sewage and rainfall combined would therefore be 3925 gallons, or 65·4 gallons per minute, and a four-inch pipe will discharge this amount when running full at the very flat gradient of 1 in 207·36, the velocity produced being 2·02 feet per second, which is barely sufficient to make a drain self-cleansing.

"As the conditions on which these figures are based are only likely to occur once or twice a year, if at all (*i.e.*, during an exceptionally severe thunderstorm), it is evident that without special arrangements for flushing, even a four-inch drain can scarcely be made absolutely self-cleansing, more particularly as the usual gradient is from 1 in 40 to 1 in 60 with a consequent increase of discharging capacity.

"The author therefore considers that under ordinary circumstances a four-inch drain is ample for an average-sized house, and that a six-inch drain is too large to be kept free from deposit, more particularly as the majority of the pipes discharging into it are three inches or less in diameter. Baths, lavatories, and sinks never have waste pipes exceeding two inches internal diameter, and it is the exception to find more than one appliance being discharged at a time. The question therefore naturally arises, 'How can a two-inch pipe possibly flush and cleanse a pipe nine times its own sectional area?'

"The soil pipe is the only pipe of larger size which ever discharges at full bore, and the amount discharged at one time (two or three gallons at the most) is insufficient to make a four-inch horizontal drain run even half full for more than a few feet."

Methods of lifting sewage.

11. In comparatively few places can sewage be properly disposed of without lifting it from lower to higher levels, and the best methods of doing this were treated of in some papers. Where very large quantities has to be lifted at one station, direct acting pumps immediately driven by steam power are perhaps the best to use; but where the quantity is smaller, or where it has to be lifted at different stations, the best means for lifting it is by air pressure supplied from one central station. Water pressure has sometimes been used instead, but the inelasticity of water renders its use precarious, as it gives rise to continual accidents. Mr. Middleton sums up the matter thus:—

"The separate system appears to offer many advantages for the collection of sewage in very flat districts, in receivers of limited capacity, placed at comparatively short distances apart, whence it may be discharged or pumped to a higher level by steam power or by water or air pressure supplied from a central station. It is thought that the use of air is most advantageous for this purpose, as very much smaller pipes can be used for its transmission than is possible when water is employed as the motive power; a speed of 60 feet per second being quite admissible when air is used, while three feet per second would be about the limit for water, and there is no shock with the first-mentioned form of power, while there is considerable shock with the second. The efficiency obtained with the use of compressed air is considerable, and might, it is thought, be greatly increased by its more careful and scientific employment, both as regards the construction of receivers, the height of the lift;—in the compressing machinery, by the reduction of waste space, and in heating, and by the expansive use of the air.

"Where water is used as the motive power, space must be provided in the sewers or watercourses for the exhaust water, while the air may be discharged into the sewer without taking up useful space, and may serve to ventilate it. On the other hand, this air, which has been in intimate contact with sewage matter (presumably, however, little fermented) may be discharged into the streets through some opening, and may become a source of danger."

I shall, further on, be able to give accounts of practical applications of these means.

12. While considering the relative advantage of the *tout à l'égout* system, and that of separating the storm-water from the rest of the sewage (see § 7, *ante*), I have remarked on the necessity entailed by the former to have manual or mechanical means of taking out of the sewers the sand, grit, and heavy mud washed in from the roads. This is what used to be done in England, and is what is being done at all places on the Continent where the system is in vogue, and the system is being there rapidly extended. It necessitates that numbers of men should live and labour under loathsome and unwholesome conditions. It is not an economical system, as it would surely be better not to put this heavy material into the sewers at some expense, and then to be put to still

greater expense to take it out again. The system also necessitates that all main sewers should be large enough for men to work in them. This is not only expensive to construct, but the size of the sewers makes it impracticable to properly flush them, except at great expense; whereas in the separate system not only is the necessity for flushing much less, but the means for effecting it much more efficacious and much less costly. One of the greatest recent developments of sanitation in Great Britain is in connection with sewer and drain cleansing and flushing, and I shall hereafter give full details concerning this work.

13. There is still to be considered, in connection with the subject of the proper removal of sewage, the question of the means by which it may be effected without permitting any unpleasant or unwholesome emanations from it to enter houses or affect the atmosphere of towns—the question of sewer and drain ventilation. The necessity of carrying out this ventilation was recognised when sewerage first became general, and attempts were made to do it by all sorts of contrivances. When first the pressure of vapour and gas in the sewers was found to overcome the action of syphon and other traps, and force the bad air into the houses, the pressure was relieved by allowing the sewer manholes to have grated coverings opening into the streets. When any sudden lowering of atmospheric pressure takes place—for instance, before rain, or on damp evenings—sewer air and vapour expand and rise out of the gratings, and causing, if the sewers are foul, a pestilential smell. To obviate this many expedients were tried. The best was to ventilate the sewers by allowing the street gratings to be down-cast shafts only for the air, and to make special up-cast shafts reaching above the roofs of houses. Where this is properly done it may be made pretty effectual. Sewer ventilation.

Other expedients are thus described by Mr. Read in the paper on Sewer Ventilation read in the Section :—

"The favourite recommendation by newspaper correspondents has always been to connect to a factory chimney, on the assumption that it will entirely clear a whole system of sewers, and cremate the gases. Factory chimneys are usually confined to one quarter of a town, and although velocities from 500 feet to 2000 feet per minute can be obtained by connecting to them—and in some towns costly stacks 100 feet high have been specially erected for the purpose—their effect upon ordinary sewers is only local, and very limited in extent ; so that it is like shooting at a sparrow with a 100-ton gun.

"'*Keeling's Destructor.*'—The most recent apparatus for ventilating sewers by artificial means is 'Keeling's patent sewer gas destructor,' an arrangement of lamp column with a 6-inch connexion from the sewer for passing sewer air through an atmospheric gas-burner fixed in the base of the column, the outlet being about 10 feet above ground, under an ordinary street gas-lamp, placed at the top of the column ; a consumption of coal gas from 6 cubic feet to 10 cubic feet per hour is required to keep them burning, and produces a heat of about 600° F. at the burner, and about 100° F. at the outlet, where the velocity is about 200 feet per minute, or equal to about 40 cubic feet per minute of air extracted.

"The advantages claimed for this apparatus are that sewer gas is entirely cremated, and that one destructor will suffice to ventilate fabulous lengths of 12-inch sewer, variously stated, or inferred, as somewhere between 1000 yards and 9 miles ; but no such distances can be affected by any such apparatus if a fan or a factory chimney of 10 times the power cannot do it."

All these expedients for sewage ventilation were based upon theoretical data, or misunderstood and misinterpreted natural phenomena: such, for example, as that water had a tendency to run down hill, so air had a tendency to do the reverse. It was assumed that sewer ventilation was exactly analogous to mine ventilation, though a little thought would have shown how totally different were the conditions in which the work had to be effected. In a mine all air has to enter by one opening, pass along all workings by being confined to one channel, as it may be called, by bratticing, &c. until it comes out by the upcast shaft where the force of its current may be assisted—it having thus but one entrance and one exit. Similar arrangement cannot be made with sewers with their numerous ramifications; and as to assisting the current at the exit, Mr. Read says :—"Any attempt to draw air through a sewer will not be felt at a greater distance than 400 yards, and only under very favourable conditions will the distance exceed 100 or 200 yards. This was conclusively proved in 1858 by Sir J. Bazalgette and Col. Heywood, by experiments on a large scale with a furnace at the Westminster Clock Tower." But the real conditions in which the ventilation of sewers was to be done were not experimentally examined till quite recently. As Mr. Santo-Crimp, to whom the profession is indebted for the first really practical examination of these conditions, says in the paper he communicated to the Section :—

"There is probably no subject in connection with sanitary science regarding which more has been written, but fewer experiments made, than the ventilation of sewers. The question is undoubtedly one of extreme difficulty, as the conditions vary in almost every sewer, and one would therefore have thought that writers would have at least made an attempt to ascertain the actual conditions prevailing before proposing methods that would in all likelihood fail in consequence of their being designed upon wrong principles. In nearly every paper or work on the subject examined by the author, the writer has assumed that temperature is practically the only agent causing movements of sewer-air, an assumption greatly wanting in basis, as we shall see later on.

"As a result of this assumption, it has been widely believed that sewer-air constantly passes from the lower parts of a drainage system to the higher, to the discomfort of the inhabitants of the higher parts of the district sewered. As a matter of fact, the sewer-air as often passes downhill as the reverse way.

"Having constructed some works in connection with the ventilation of sewers, which were designed in accordance with the views then prevailing, the author was disappointed with the results, and he determined to undertake an extended series of observations on the movements of sewer-air. This he did during the year 1888, and the results were communicated to the Institution of Civil Engineers, and may be found in Vol. XCVII."

The following is Mr. Read's account of these experiments:—

"*Wimbledon.*—More recently, in 1887-8, Mr. Santo Crimp, at Wimbledon, had 600 yards of 12-inch sewer trapped off at the lower end, an opening 28 inches area was made at the street level, just above the trap, and a 6-inch opening at the upper end, all other known openings being closed. There was 100 feet difference of level between the two openings, and a fan attached to the upper one drew air from the sewer at the rate of 300 cubic feet per minute for 14 hours, and during the same period the sewer-air continuously discharged itself from the lower opening 600 yards away at a velocity of 42 lineal feet to 104 lineal feet per minute, thus showing that one or more accidental openings must have existed, and that the friction of the flow of sewage, and the effect of the wind, was sufficient to bring the sewer-air down to the lower opening, in spite of the powerful fan at work at the upper end.

"On removing the fan the 6-inch pipe was carried up a building 25 feet high, and anemometers attached to the lower opening showed that during 1888 the air current was down-hill at that point on 273 days and up-hill on 97 days."

Mr. Santo Crimp made the following remarks:—

"These experiments had not been continued very long before the author found that for all practicable purposes the wind was the only agent producing movements of sewer-air that could be measured by an anemometer. Not only were experiments made in ordinary sewers, but also in surface-water sewers, at a time when they contained no water, and precisely the same results were obtained as in the sewers proper. Having, therefore, ascertained the true cause of the movements of sewer-air, their direction and strength could, after some little experience, be fairly well foretold, so far as the experimental sewer was concerned, for when northerly winds prevailed the sewer-air travelled up hill, and when southerly winds were experienced the sewer-air passed down hill. In other sewers that were being experimented upon at the same time the opposite conditions prevailed; and this is easily explained, for in passing over a town the course of the wind is broken up and deflected, and it will affect the openings upon the sewers in different ways, in some cases inducing currents out of them, in others passing down into the sewers and driving out the sewer-air elsewhere.

"On taking charge of a part of the enormous main drainage system of the metropolis, the author soon found opportunities of ascertaining the conditions prevailing, and he found that they were identical with those in the smaller sews at Wimbledon; light air and calms mean stagnation in the sewers, whilst brisk winds cause rapid movements of the sewer-air. Of course, an abnormal rise of temperature due to the admission into the sewers of hot liquids will produce a local disturbance, but this in no wise affects the main question."

As later on I shall have to record and make observations on sewer and drain ventilation as I have seen it in operation, I will content myself with giving the following extract from Mr. Read's practical conclusion:—

"*True Ventilation.*—Nearly all attempts to maintain a constant current of air flowing in one direction have failed, because they have not been in harmony with the forces at work within and without the sewers. The streets are the only places where municipal authorities are free to ventilate sewers as they please; therefore, the gratings at the street level have always been more numerous than shafts above the houses; and as long as this is the case, no constant current of air inwards at the street gratings can be maintained. There can be no true ventilation without a system of both inlets and outlets; the street gratings should be comparatively small to always act as inlets, and the outlets should always be above the roofs of the houses, and much more numerous than the inlets. It is necessary, therefore, in order to give a strong initial velocity at the inlets, and to localise the ventilation, that the street grating inlets should not exceed 30 or 36 square inches area, placed from 60 to 100 yards apart, and that the outlets should be distributed over these lengths in such numbers of 4-inch or 6-inch shafts that the sum of their sectional areas, between each pair of inlets, shall exceed the sectional area of the sewer as much as possible."

Sewage Disposal.

Sewage disposal.

14. In relation to the vital question of Sewage Disposal there was, of course, no divergence of opinion as to the necessity of preventing all discharge of unpurified sewage into freshwater streams. As to the best means of purification there was considerable discussion. As I shall have to go fully into this matter in connection with my visits to places where various methods are practised, I shall content myself here to note the proceedings of the Engineering Section with reference to places I did not see, and with reference to the general scientific principles that demand attention.

River pollution.

15. Everywhere the river upon which a town is situated is taken to be not only the source of its water supply, but also, naturally, the outfall of its sewage. If there be no sewers the rainwater and slops normally flow to the river, and when sewers are built they are made to run in the same direction. Consequently, in all inland towns sewage disposal is connected with river pollution. In one of the first papers read in the Section, Professor Robinson called attention to this connexion, and in relation to means of preventing pollution he went largely into the question of the application of sewage to the land, calling attention to the conditions necessary to the success of such application; his opinion being that when an area of porous land can be obtained sufficiently large to enable the sewage of about 100 persons to be applied *intermittently,* good agricultural pursuits will ensue. With respect to the real purification of the sewage, he called attention to the fact that the micro-organisms perform an important function in sewage filtration, and that the action of an earth filter is not mechanical, but partly chemical and partly biological. The destruction of the organic impurities in sewage was shown to be brought about by a process of active fermentation or decomposition (termed nitrification) caused by bacteria. A question of great practical importance in connection with both sewage disposal and water supply is whether any of these organisms can escape

destruction. The conclusion that is arrived at by the American investigators in the report of the State Board of Health, Massachusetts, is that the belief that bacteria cannot survive to pass through sand filters is fallacious, although the great bulk are destroyed. It follows from what has been said that in the disposal of sewage upon land or in filtering impure water, the necessity arises for exercising great care. Experiments upon sewage filtration have been made by Mr. Hiram Mills, C.E., of the Lawrence Experimental Station in America, which confirm the view that nitrification ceases if the filtration is not conducted intermittently. Also, that sewage effluents that have been passed through sand filters covered with soil, in which nitrification took place, resulted in the destruction of bacteria, and that the effluents from such filters were not favourable to the support of bacteria. This is due to the fact that the free and albumenoid ammonias in such effluents, being the residue of a much larger amount that has been destroyed, are much less able to support bacterial life than fresh organic substances containing the same amount of free and albumenoid ammonia. Dr. Sedgwick has also found that some especially hardy bacterial organisms could live to pass through five feet of coarse sand filters worked intermittently; and although the large bulk of organisms are destroyed by filtration, some do pass in filters composed of sand alone. When the filters are of fine sand, however, and covered with soil, the bacteria appear to be all nitrified.

Self-purification of rivers.

In further connection with the matter, Professor Percy Frankland communicated to the section a paper on the present state of our knowledge concerning the self-purification of rivers. The object of the paper was to show that the manifest purification of any river during its flow was due entirely to sedimentation, both as regards chemical and biological aspects. The Professor said :—

"Some years ago, I undertook a series of experiments to further test this point in connection with the Thames, which has always been regarded by some as a river possessed of most remarkable self-purifying power, and which undoubtedly often does reach London after a long flow through a cultivated and fairly populated district, in a surprisingly pure state. The experiments in question consisted in taking samples of the water flowing in the river at different points on the same day, with a view to establishing whether on the whole the chemical quality of the water was improved or deteriorated during the course of its long flow. Thus, on one day, samples were taken at Oxford, Reading, Windsor, and Hampton ; on another day at Chertsey and at Hampton ; and on three different occasions samples were collected both at Windsor and at Hampton on the same day. The results of analysis on these various samples are recorded in the accompanying table, and clearly indicate that the chemical quality of the water undergoes slight but almost continuous deterioration in flowing from Oxford to Hampton. It must be remembered that this deterioration is in spite of a very large increase in the volume of the water, a large proportion of which gains access to the river from springs in the chalk, and is of the very highest purity.

"In the above experiments I purposely limited the scope of my inquiry to the dissolved organic matter so as to avoid the complications arising from the suspended matters, concerning the removal of which by sedimentation there is no dispute. On this account all the above samples were filtered through Swedish paper before analysis. Indeed, it cannot be too strongly pointed out that unless the questions of dissolved and suspended matters are kept wholly distinct in these investigations, no reliance whatever can be placed upon the results."

The table above referred to contained analyses of the solids in solution, carbon, nitrogen, chlorine, &c., in the water taken as above described. As far as the Thames is concerned, it may be thus summarised as regards observations taken in November, 1883, the parts being 100,000ths.

Date.	Place.	Total Solids (in solution).	Total combined Nitrogen.
Nov. 4th, 1883	Above Oxford..........	30·28	0·217
" "	Below Oxford............	31·04	0·224
" "	Above Reading..........	33·32	0·286
" "	Above Windsor..........	31·80	0·258
" "	At Hampton.............	30·52	0·252
Nov. 17th, 1883	Just above Staines......	32·40	0·233
" "	Just below Staines......	31·12	0·244

Observations were also taken at Windsor and Hampton, in January, 1884, and an average struck of all the observations above Windsor and at Hampton, with the result that the total solids diminish from 33·55 to 32·13, and the total combined nitrogen augments from 0·295 to 0·304. The Professor thereupon proceeded to say :—

"From the analytical table it will be seen that the idea of any striking destruction of organic matter during the river's flow receives no sort of support from my experiments, the evidence is in fact wholly opposed to any such supposition."

After referring to experiments in Germany, he went on :—

"A careful study, therefore, of these most recent investigations leads us to the inevitable conclusion that sedimentation is the main cause of any self-purification in river water, of any rapid oxidation of dissolved organic matter there is still no reliable evidence, although of course dilution, which frequently takes place on the largest scale, as in the case of the Thames, without being suspected until made the subject of a most careful scrutiny, will produce a superficial appearance of such a result.

"This removal of microbes by sedimentation during the flow of a river is unquestionably of great hygienic importance, and of much greater hygienic importance than the alleged oxidation of dissolved organic matter, which in itself can have no power of communicating zymotic disease ; it is, however, a process which cannot be relied upon as furnishing any guarantee that harmful microbes, turned into a stream at a given point, will no longer be present in the water at any point lower down.

"From the numerous experiments which have been made on the vitality of pathogenic microbes in water, there can be no doubt that many forms which might have subsisted as above indicated would remain alive for long periods of time, and be carried down uninjured when the river was next in flood. Indeed, recent experiments of Lortet ("The Pathogenic Bacteria of the Mud of the Lake of Geneva," Centralblatt für Bakteriologie, IX., 709) have shown that such deposits formed in lakes actually, and not unfrequently, contain pathogenic forms in a state of vitality.

"We must not allow, therefore, this sedimentation of microbes to cause us to relax our protective measures to exclude contamination from our streams, but, on the contrary, bacteriological research clearly indicates, on the one hand, the value and importance of purifying by the very best available means all dangerous liquids, such as sewage, before admission into rivers, and, on the other hand, to submit the water drawn from streams for town supply to the most careful subsidence and filtration through sand before delivery."

The reading of this paper gave place to a very lively discussion. In common with many others I objected to the manner in which the experiments had been conducted, and questioned the accuracy of the conclusion deduced. It was pointed out that, as far as the experiments were concerned, the samples of water having been taken from various points at the same time, their analyses shewed only the constituents of various waters at a particular date, and not the changes that were taking place in the same water in consequence of its flowing down the river, and being subjected to atmospheric and other influences—for instance, that the water taken on the 4th November, 1883, above Oxford could have no relation with water taken the same day and hour at Reading, Windsor, and Hampton, respectively 30, 60, and 80 miles lower down the river. That what ought to have been done should have been, as far as possible, to have followed a given volume of water—say by floating down it in a boat going at the same rate as its current—taking samples at given distances apart, as well as at places where sewage was entering; further, that the consideration of the matters in suspension ought not to have been eliminated, seeing that their sedimentation is a slow process, and the analyses show that sometimes the total solids in solution augment in quantity when the circumstances seem to show that this augmentation is due to matters dissolved out of the suspended matter, and consequently that such augmentation is no proof that organic matter is not being destroyed as well as being precipitated or deposited. It was furthermore shown how illogical it was to draw conclusions from averages struck with respect to matters that had no interconnexion, such as the various samples of waters taken in the experiments; but that, on the other hand, the analyses of samples taken with some sort of inter-connexion, however imperfect, showed that an amelioration of the water was taking place in its downward course. Thus, for instance, the water in the Thames on the 4th November contained at Reading, where a great inflow of sewage takes place, 0·286 part of combined nitrogen in 100,000 parts of water; lower down, at Windsor, it only contained 0·258 part, and though there it received further pollution it only contained 0·252 part at Hampton. Generally speaking, the views of Professor Percy Frankland on the inability of rivers to purify themselves apart from sedimentation were not accepted by either engineers or chemists in the Section; but that does not take away from the value of his remarks as to the necessity of taking every precaution with respect to the purity of water introduced into towns for human consumption, and as to the danger of allowing imperfectly purified sewage waters to be run into freshwater rivers.

16. Very interesting accounts of the sewage farm of the city of Reims were given by Dr. Henri Henrot, Mayor of the City, and by Mons. A. Bonna, Secretary of the Sewage Company of Paris, the Company which owns most of the farm and has a lease of the sewage. Reims has a population of about 100,000. The mean daily quantity of sewage is about 36,000 tons (8,000,000 gallons), one-third of which gets to the farm by gravitation, and the rest has to be pumped—engines of 110 horse-power being used for this work. The city gives the use of 396 acres of land, and the Company has bought 1051 acres more, for the purposes of the farm. All this land can be irrigated, except 136 acres. The land is permeable to the depth of about 7 feet, and is composed of 80 per cent. of carbonate of lime, 15 of silicious sand, and 5 of clay, with a little soil. Its surface is well adapted by gentle slopes for irrigation purposes. The irrigation is applied by open trenches and furrows, movable galvanized iron sluice-plates being used to stop and turn water in the furrows. The trenches and furrows are so arranged as to avoid the submersion of the soil, and to permit the sewage to circulate as much as possible without touching the plants. The ground is deeply cultivated and trenched by special steam ploughs, the quick and powerful action of which disintegrates and consequently aerates the soil better than the slow action of ploughs drawn by horses or oxen. The irrigation trenches and furrows are, however, made with special ploughs drawn by animals. Part of the sewage is very rich—that arriving by gravitation—as it is largely composed of the water used in the wool-scouring establishments. The usual quantity of sewage that such land in France is thought capable of purifying is 16,000 tons an acre for each year, = 3½ million gallons; but the quantity used at Reims does not average 11,000 tons a year. The effluent waters are collected in open canals cut down to the impermeable bed—that is, to the level of the ground water of the district, and are delivered into the river in a clear condition. To get fall for this, two water-mills had to be purchased and their dams removed. The principal crop grown is sugar beet, 618 acres of this root having been grown in 1890. Crops of this sort—that is, crops requiring hoeing and earthing up—are preferred to all others for irrigation purposes, as these operations ensure the breaking up of the surface crust that is formed by the sewage water, aerate the soil, and permit large quantities of the water to be used by maintaining the permeability of the soil. In winter, such crops being off the ground, it can be irrigated all over, and can be occasionally surface-ploughed. Taking the farm generally, a disposition of crops has to be made that will permit the

sewage being diverted from particular crops at the time when irrigation would be detrimental. Thus, the beet-root crops must be left to ripen in September and October, and the sewage employed elsewhere.

The result of the farming in 1890—the first entire year—was a little over 18 tons to the acre. This yield was expected to augment in 1891 to 24 tons to the acre, 692 acres being sown. The yield of cereal crops in 1890 was:—Wheat, 40 bushels to the acre; rye, 44 bushels to the acre; oats, 54 bushels to the acre. To counteract the tendency of sewage irrigation to render wheat crops liable to be laid by rain, a little phosphate was used. The green crops were heavy. In lucerne, which is specially adapted to the chalky soil, three cuttings produced 8 tons of dry fodder to the acre from 32 tons of green. Italian rye produced 36 tons to the acre; the crop was consumed green, being too heavy to dry. It is not intended to continue this crop, as the exuberant growth renders the stalks too strong and hard. Of common meadow hay, 4 tons (dry) to the acre were got from two cuttings. This crop was only grown on poor land, which is being levelled and improved.

The Company intends consuming all its produce—the beet and potato crops in a distillery, which is nearly ready for work; and the pulp from the distillery, the dry and green crops, in three stock farms. For the future it will more especially confine itself to this part of the operations, for the result of the farming has enabled it to let to an agricultural company the irrigated lands, and this company will take the risks of the cultivating processes. The rent to be paid by it to the Sewage Company will be—

£	s.	d.		
1	12	6	the acre	for the first year
2	9	0	„	for the second year
3	5	0	„	for eight succeeding years
3	13	0	„	for ten succeeding years
4	1	6	„	for sixteen years remaining

till the end of the Sewage Company's concession. These rents will yield a good return to the Sewage Company for its outlay.

17. Other methods of sewage treatment were dealt with in the Section, but the principal discussions on this subject took place in the Chemical and Physical Section, where Dr. André read a paper recommending the use of manganate and sulphuric acid for purifying London sewage; and Dr. J. C. Thresh (London) read a paper entitled "An Outline of the various Chemical Processes for Filtering Sewage," of which the following is a summary:—The deleterious organic matters contained in sewage may be divided into two classes—those held in solution and those held in suspension. The latter, again, may be divided into living organisms and dead organic matter. The various processes which have been devised for the removal of these impurities may be classified as follows:—(1.) Subsidence, with complete rest, or by passing through large tanks with a very slow but continuous flow. (2.) Filtration through screens or filter-beds of gravel, sand, cinders, &c. (3.) Percolation through materials exerting some chemical or catalyptic action on the organic matter—such as animal charcoal, metallic iron, polarite, magnetic carbide, or other compounds of iron, manganese, &c. (4.) Precipitation by addition of chemicals capable of combining with certain of the organic constituents with the formation of insoluble compounds, such as the soluble salts of iron, aluminium, zinc, &c., hydrate of lime. (5.) Precipitation, &c., by electrolytic treatment, as in Webster's process. (6.) Destruction of the organic matter by oxidizing agents, as by the addition of permanganates and acid. (7.) Sterilization, where destruction of all micro-organisms is chiefly aimed at, as in the Amines process, or by the addition of chlorinated lime, carbolic acids, and other antiseptics and disinfectants to retard or prevent putrefactive changes. (8.) Nitrification, the oxidation of the organic matter by organisms in the surface soil by intermittent percolation of the sewage through specially prepared land. (9.) Utilization of the organic matter as food for growing crops—broad irrigation. No one of these processes, unless it be the last, is capable of giving satisfactory results; but the extent to which the purification should be carried depends chiefly upon the way in which the effluent is to be disposed of. Where it can be cast with safety into the sea or into a large tidal river purification need not be so complete as where it must flow into a stream or river which a few miles further down furnishes the water supply to other towns or villages. In the latter case it is absolutely necessary that the sewage should be so treated as to deprive it of all specific organisms, and of the largest possible proportion of both suspended and dissolved organic matters. To effect this a combination of two or more of the above processes must be resorted to. The combination to be adopted varies according to circumstances, depending chiefly upon the character of the sewage, the position of the town, and the mode in which the effluent is finally to be disposed of. Chemical methods of sewage purification.

18. The influence of irrigation on health was frequently discussed in the Section, and also in other sections, not only in relation to sewage farms, but also to irrigation in general. In regard to the latter, in India it has been found necessary to establish belts of unirrigated land round cantonments, towns, and villages. In the paper read by Mr. R. F. Grantham in the Engineering Section, the following statements were made regarding the effects of irrigation in India—statements corroborated by Drs. Simpson and Thornton, of the Indian Medical Service, and General Maclagan in the discussion which followed:— Effect of irrigation on health.

"These works have unquestionably conferred immense benefits upon the soil, the climate, and the welfare of the people in preserving them from the effects of drought, but at the same time they have produced serious insanitary conditions. Colonel Baird Smith, in his work on *Italian Irrigation*, makes frequent references to the unhealthiness and depopulation by malarious influences in that country. Three kinds of irrigation have been practised there for three different states of cultivation ; the ordinary periodical flooding ; marcite, or winter flooding, when the land is under flood for a certain period ; and irrigation for rice cultivation. The first was carried on without prejudice to health, inasmuch as the water simply flowed over the land and passed off; the second was practised during the winter when the temperature was low and the evaporation small, and the water completely covered the land so that no harm ensued; but the third, that used for rice cultivation, was held to be so injurious to health owing to the stagnation of the water upon the fields, that laws were passed restricting the limits of such cultivation to three or four miles from the outskirts of any town.

"It appears that the evils attending irrigation in India are due to interference by the canals with the natural drainage of the country, and to over-saturation of the soil, resulting in the formation of marshes. Inquiries were made to ascertain to what extent the health of the populations living in the irrigated districts suffered, but it was found impossible to obtain statistics of their previous condition for comparison. It was determined, therefore, to rely on the evidence to be obtained as to the enlargement of the spleen—a certain consequence of malarial diseases. Investigations were made, and it was recommended that, as in the plains of Lombardy, great cities and military cantonments should be protected by zones round them, of from at least three to at most five miles radius, being kept free from irrigation.

"It has also been stated on high authority that malarial fever is by far the principal cause of disease and death in India. In 1864 it was reported that the whole area irrigated by the western Jumna Canal required thorough drainage, and that 60,000 acres were effected by a 'reh' efflorescence. The mortality from fever over the area watered by this canal was so terrible that the cantonment of Karnal had to be abandoned. Again, in 1867, it was reported that from 61 to 80 per cent. of the residents were suffering from spleen disease. Dr. Thornton, C.S.I., from whose paper to the Society of Arts, in 1888, I have derived much information, goes on to say that, since his paper was written, 'a system of surface drainage is being carried out; but surface drainage, though valuable and important, merely provides an outlet for surface waters, and is no remedy for excess subsoil water resulting from constant irrigation added to the natural rainfall. The proper remedy is subsoil drainage; but subsoil drainage has not yet been attempted.'"

Effect of sewage on food grown on irrigated land.

19. With reference to the same subject, but in connexion with sewage irrigation, Dr. Carpenter, the chief medical officer of the Croydon Sanitary authority, declared, in the Chemical and Physical Section that the experience of the past 31 years of sewage irrigation on the Beddington Sewage Farm proved the following five propositions:—"1. That the judicious application of sewage in close proximity to dwelling-houses does not depreciate the health of the inhabitants. 2. That the judicious application of sewage to land will satisfactorily cleanse the effluent water and fit it for discharge into any ordinary rivulet or watercourse. 3. That vegetables from fields continuously irrigated by sewage are satisfactory food for man and beast, and that animals fed mainly on sewage-grown crops are as healthy as animals fed on ordinary agricultural produce. 4. The germs which spread infectious disease are not capable of reproduction on properly cultivated sewage farms, the chemical and vital conditions of the surface of the soil being contrary to their further development. 5. In order to produce the results described in Proposition 4, it is requisite that the sewage be kept near the surface, moving over the land rather than through it in a downward direction. It must be kept within the influence of vegetable root fibrils and of the humus of the soil, and under-drainage is not a necessity." I shall hereinafter give a description of the Croydon Sewage Farming.

Influence of Subsoil on Health.

Sub-soil water and drainage.

20. The influence of subsoil water and subsoil drainage on health—especially upon the production and propagation of diphtheria—was a subject that received a great deal of attention, not only in the Engineering Section, but in many other sections of the Congress. The necessity for draining the subsoil was insisted on by Don Pedro Garcia Faria and Mr. R. Grantham, in the Engineering Section, by Mr. Blaxhill, Architect to the London County Council, and others in the Architectural Section. But the marked connexion between diphtheria and cognate diseases, and the "tidal" movements of "ground water," first noticed, I believe, by Pettenkofer of Munich, produced some remarkable papers and discussions. In the Engineering Section they were begun by a paper by Mr. Baldwin Latham on "The Influence of Ground Water upon Health." He remarked that—

"There is a seasonable fluctuation in the waters in the ground, and, as a rule, these waters are lowest in the autumn and early winter, and highest in the spring or early summer, but in some years the period of both low and high water varies as, for example, the low water of last season did not take place till February of this year (1891).

"It is also known that the artificial lowering of the subsoil waters of a district has produced the same effects upon the health as occur when a general lowering of the ground water arises naturally from drought.

"The actual drying of the ground is a condition which is favourable to the general good health in this country, and this circumstance often masks, in the general death-rate, the potential influence of certain diseases, so that the general health of a district appears to be good while at the time it may suffer intensely from a certain class of disease of which low ground water is the indicator. When, however, the conditions become extremely intense, and the ground water exceptionally low, the influences at work affect the death-rates as a whole. On the other hand, in periods of excessive rain with high ground water, the conditions are usually favourable to health, and all places in which the ground waters are of an uniform level . . . are usually healthy.

"It is known that the measure of the effect of the ground water is most marked in districts which draw their water supply from the ground, and amongst that section of the inhabitants who use such water for dietic and other purposes, especially in the case of young children and teetotallers.

"The unhealthy time after the period of excessive low water is that when the first rain begins to percolate through the soil, just as if it washed out matters which had been specially prepared or were retained in the dark recesses of the soil, into the water, or by driving out the ground air specially charged with the poison of disease. It is by no means uncommon both in this and other countries to find that particular epidemic outbreaks which have become rife at a low-water period can be traced to particular rainfalls. In this country since we have the registration of deaths, those quarters of the year when percolation has first commenced after periods of exceptionally low water are, without exception, the most unhealthy seasons that have been recorded. . . .

"There is no doubt that the sanitary condition of the district greatly influences the results of the movements of the ground water, and the greater the amount of disturbance, or the number of disturbances of the ground water in the course of the season in insanitary districts, the greater and more marked the influence upon health until the period arrives when the soil has been washed free from its impurities, and the waters have accumulated in the ground.

"Certain diseases have their allotted seasons and conditions favourable for their development and spread, and there are a number of diseases usually most rife when the ground waters are low, such as enteric fever, cholera, small-pox, diphtheria, and others.

"The state of low ground water as being a condition accompanying epidemics of typhoid fever is a matter of constant observation, and it is a well authenticated fact that all epidemics of this disease in this country have occurred in periods only of low water, or when immediately following a very low state of the ground water. Ground water influences both small-pox and diphtheria in a most marked manner, but in directly opposite ways, so that when one of these diseases is present the other is absent. Small-pox is accompanied or preceded by intense dryness of the ground, while diphtheria occurs only when the condition of the ground is one of continued dampness. The year 1871 was a very fatal year from small-pox in this country, and in that year the percolation experiments showed that the ground was intensely dry. . . . Since September, 1885, there have been no deaths recorded from small-pox in Croydon, but diphtheria has been very prevalent during the whole of that period, and the ground has been in a constant state of dampness."

In the discussion which followed, it was insisted that the sanitary condition of a district was not deteriorated by the lowering of the level of the ground water as a determining cause in itself, but by the effect such lowering had upon the germs contained in the soil; that where the soil is uncontaminated, drying it improves the sanitary condition of the place; but that, where it contains germs, those germs are stationary because the ground water in which they are is stagnant. When, by lowering its level, the ground water begins to flow towards wells, it carries the germs with it, and by the use of the well-water the germs get introduced into the human system. M. Maignein, a French engineer, related a case in which this action appeared to be demonstrated.

In the discussions that took place in other Sections, the same view seemed also to be universally taken, with the additional point that probably the pathogenic germs were torpid while in the stagnant water, and that when the level of water was lowered the germs were exposed to the action of the air which replaced the water in the interstices of the soil, and were vivified before being carried to wells, or drawn into the air by evaporation.

In the Section of Preventive Medicine much discussion also took place which it is out of my province to notice, except in so far as it related to effects causable or preventible by sanitary works. Mr. M. A. Adams, F.R.C.S., read a paper on the "Relationship between the occurrence of Diphtheria and the movements of Sub-soil Water," in which he pointed out the "tidal" action, usually annual, of this water, in a manner similar to that described by Mr. B. Latham. The conclusions he arrives at are that the organisms of diphtheria inhabit soil polluted with organic matter, and that, subject to suitable conditions of environment, they live there, being liable to displacement, and that there are certain agents of dispersal that drive them out of the soil and cause epidemics. Dr. Seaton mentioned the case of a village quite near London, which enjoyed complete immunity from diphtheria and from any disorder that could be confounded with diphtheria. Here a new system of sewerage was constructed, with a remarkable result that a severe outbreak of diphtheria immediately occurred. *Post hoc*, or *propter hoc?* The inhabitants accused the drainage system, and Dr. Seaton allowed that the disturbance of the soil might have led to the freeing of the germs. This, however, he said, opened up an admirable field for enquiry. Dr. Seaton concluded by saying that there is a strong ground for urging on Government the necessity of a systematic and comprehensive inquiry into the causes of diphtheria, including in such inquiry the places known to be free from the disease, and taking into consideration the results of previous investigations as to the carriage of infection by milk, its relation to dirt, dampness, and insanitary surroundings.

Dr. Abbott, Secretary to the State Board of Health, Massachusetts, gave the following account of an inquiry directed to be made by his Board in 1889:—

"In a city in which diphtheria was epidemic, 100 houses were selected for examination and inspection. A recent and quite severe epidemic had prevailed, in which there had been 174 deaths from diphtheria in the course of the year 1889. Fifty houses were selected in which cases of diphtheria were known to have occurred within 12 months prior to the time of inspection; 50 other houses were selected in which it was known that no cases of diphtheria had occurred during the previous five years. In general terms, the houses of the latter class were as nearly identical with the former in their location, construction, and the social condition of their inmates, as possible. On inspection, the actual sanitary condition of these houses was found to differ but little in the two classes. Defects of plumbing, want of proper traps, leaks in drain pipes, and other similar defects were found about equally in the two. Not one of the 100 houses had special provision for ventilation. In one point only did there appear to be a marked difference in the two classes, and that was in the ratio of damp cellars. In the houses in which diphtheria had existed, the ratio of damp cellars was as eight to five when compared to the houses of the other class. I believe this is in accord with the observations of others to the effect that where diphtheria has once been introduced from without, it finds in dampness a congenial soil for its propagation."

Water Supply.

Sources of supply.

21. The question of water supply was repeatedly considered in the Section. Mr. Binnie, Engineer-in-Chief of the London County Council, read a paper chiefly insisting on the necessity of obtaining water for large cities from gathering grounds in uncultivated and uninhabited mountain regions, citing the examples of most of the great English, Scottish, and Irish Municipal authorities, with the exception of London. This may probably be taken as an indication of the water policy of the metropolis in the near future.

In connection with the water supply of towns in general, and London in particular, Dr. Willoughby pointed out that the water companies of the metropolis and surrounding towns are drawing from the land a greater volume of water than is being naturally stored for river, &c. supply—a statement that is proved by the fact that the surface level of the deep well-water in the London basin has been lowered 20 feet in the last 20 years. As this basin, though containing a large supply of water, has by no means an inexhaustible one, he advises that London and all towns similarly situated, should draw most of their water from either mountain districts having a heavy rainfall, or from districts in which the underground store of water is running to waste.

Professor Percy Frankland pointed out the necessity of testing the quantity of magnesia in water derived from dolomite countries. In the Bacteriological Section he read a paper on the Hygienic Value of the Bacteriological Examination of Water, in which he insisted upon the limitation of the quantitative method of such examination to the solution of problems concerning the purification of water by filtration, precipitation, and other processes in which the water can be submitted to examination immediately after treatment. Applied in this manner, the quantitative method has, he said, yielded the most important information as to the removal of microbes from water by processes of purification, both natural and artificial, and as to how such processes can be rendered more efficient. Dr. Macweeney, of Dublin, had also a paper on the same subject; and other papers on cognate subjects will be found catalogued in Appendix I.

Purification of water.

22. One of the most striking advances that have been made in recent years with respect to sanitation in connection with water supply is the attention that is now paid to the removal of micro-organisms, as well as other organic and chemical impurities.

In relation to such purification, Dr. W. Anderson described the results obtained by the use of his revolving filters:—

"The apparatus consists of a cylinder, supported horizontally on two hollow trunnions, of which one serves for the entrance and the other for the exit of the water. The cylinder contains a certain quantity of metallic iron, in the form either of cast-iron borings, or, preferably, of scrap iron, such as punchings from boiler plates. The cylinder is kept in continuous but slow rotation by any suitable means, the iron being continually lifted up and showered down through the passing water by a series of shelves or scoops fixed inside the shell of the cylinder. By this means the water, as it flows through, is brought thoroughly into contact with the charge of iron, which, in addition, by its constant motion and rubbing against itself and the sides of the cylinder, is kept always clean and active. Simple contrivances for preventing the iron from being carried out of the cylinder, or piled up at the outlet end, and for distributing the current of water over the whole area of the cylinder are also furnished, but need not be described.

"The water as it leaves the cylinder appears to have undergone only one change of any importance, viz., a quantity of iron, ranging from one-tenth to one-fifth of a grain to the gallon has been taken up, and to get rid of this the water has to be aerated either by blowing in air, or by merely allowing it to flow along a shallow open trough; in both cases repose in a settling reservoir is necessary. After a few hours—from two to six in most cases, much less in some—the greater part of the iron will have subsided to the bottom of the settling tank, usually as loose flakes of iron peroxide associated with organic matter and other impurities, and the water is then ready for filtration. In most cases a rapid passage through a shallow layer of sand is all that is required to separate the iron, which remains as a fine layer on the surface of the sand, while the water issues from the filter free from iron, greatly ameliorated as regards organic matter, and practically deprived of microbes.

"The revolving purifier was invented by the author in 1884–5, to meet the difficulties which arose in the working of the "spongy-iron" filters at the Antwerp waterworks. These filters, which consisted of a mixture of "spongy iron" and gravel, choked up gradually and became almost inactive, after working for three years very satisfactorily as regards the purification of the water. They were replaced by the revolving purifiers, which have been in operation there ever since with most satisfactory results."

Tables were given showing that the mean purification obtained by the process was the removal of 63 per cent. of the organic impurities and 99 per cent. of the microbes contained in the water; and this not in laboratory experiments, but in connection with the regular supply of town waterworks in France, England, India, and South America.

Mr. P. S. Wales, Medical Director, United States Navy, communicated a paper to show that mechanical filtration can be done on the largest scale; and that it has advantages over the filter-bed system in uniformity of action, rapidity in cleansing, protection from light and floating particles in the air, and the inability of lower organisms to secure a footing, greater surety of a steady supply, freedom from freezing, the non-renewal of filtering beds, the non-disturbance of them by local rains, and the ability to wash the filtering medium with filtered water.

In connection with the filtration of water, Herr W. Kummel, Engineer, of Altona, related the history of the outbreak of typhus in that city in February of this year—an outbreak that he said had been attributed by the local doctors to the use of the water passing through the waterworks filters. But the consideration of the whole of the circumstances seemed to show, not that typhus germs were introduced or rendered active by the filtering operations, but that the filtering operations as conducted at Altona failed to remove the germs existing in the unfiltered water.

A paper on the cooling of water in hot climates by means of cooling-pits was communicated by Professor Oelwein, of Vienna.

23. With reference to the distribution of water, M. Bechmann, Chief Engineer of the Waterworks of Paris, described the double system of pipes which, in that city, separately distributed the drinking water and the water used for manufacturing and municipal purposes. Where there is an unlimited supply of perfectly pure water there was not the same need of a double system of pipes as in cases where there is a comparatively small supply of pure water accompanied with a larger supply of inferior water. But at Paris, even if all the water were equally good there would still be a great advantage in keeping the two services distinct, as the house service can be rendered perfectly regular when independent of the public service, but not otherwise; for where there are very high houses in streets where there are public fountains, fire-plugs, street-watering stand-pipes, &c., when various orifices are simultaneously opened the upper floors of the houses are left without pressure. With respect to this double service, M. Bechmann confessed that, besides its increased cost, it had the inconvenience of being liable to be misapplied; that the water intended only for manufacturing and sanitary purposes was sure to be used for human consumption; and he therefore proposed that in all cases of double distribution the drinking water only should be allowed to be introduced into dwellings. *Distribution of water.*

Mr. W. Matthews, the Waterworks Engineer of Southampton, read a paper on the double water supply of that town. In consequence of the failure of an attempt made before 1852 to obtain a supply by boring in the chalk, a bore hole of 1300 feet, made at a cost of £20,000, remaining unproductive, a supply was taken from the River Itchen. This supply becoming more and more unsatisfactory, entirely new works were established in 1888, drawing the supply from wells sunk in the chalk eight miles away, in connexion with which use was made of some of the old high-level reservoirs. The old source of supply was not discontinued, but only diverted. As, at the same time, it became necessary to renew the trunk and other mains, it occurred to Mr. Matthews to establish a second supply for sanitary purposes, making use of the old pipe lines and the low-level reservoirs. A large portion of the town now has a separate supply, for sanitary purposes, of water which costs nothing for pumping, and a consequent saving is effected in the pumping and softening of the domestic supply. As the renewal of mains becomes necessary, so the dual supply is extended by allowing the old pipe lines to remain in and connecting them to the secondary system. In dry weather the drainage from the common is inadequate for the sanitary supply, and is augmented by pumping from the deep well to the extent of nearly 100,000 gallons per day. Pumping is effected by means of a pair of hydraulic engines driving a set of well pumps. Power is derived from the high pressure main to the town where it passes near the well. The water is conveyed to and from the engines by a by-pass fitted with valves; admitted at a pressure of 20 lbs. to the square inch, it works the engines and is exhausted through the by-pass into the main at a pressure of 5 lbs., the only effect being that the head of water in the trunk main is lowered by the difference of 20 lbs. — 5 lbs. = 15 lbs., and no water is lost. The secondary supply is used exclusively for public sanitary purposes, and no service pipes or other house connections with the system are permitted to be made.

In further connexion with the distributive service of waterworks, Herr G. Oesten, of Berlin, related a case of the introduction of extraneous pollution into the pipes of a high-pressure service, showing that when the current of such a service is very strong it may act as a sort of injector and draw into the pipe matter that can enter in the direction of the current.

24. A very interesting discussion on the whole question of water supply took place, in which the authors of the various papers took part, and also Professors Robinson and Percy Frankland, and Dr. Odling and others; and the general outcome of it was altogether condemnatory of the intermittent system as distinguished from the constant supply; that, in regard to double distribution, its cost made it impossible of general adoption; that, with respect to filtration, it was not to be depended upon in the case of polluted water without constant watchfulness. In this discussion Dr. Percy Frankland instanced the well-known outbreak of typhoid fever at Lausen. He said that the excreta of a man suffering from typhoid was proved to have entered into the stream of a valley, and this was proved to have infected a stream two miles distant, and apparently in no way connected with the first stream. Experiments were made, a large quantity of salt was dissolved in the first stream; in a very short time the amount of chlorine in the second stream greatly increased. A quantity of fine flour was mixed with the water of stream No. 1; this, however, did not pass through to stream No. 2. I confess that I agree with the members of the Royal Commission on the sanitary condition of Melbourne, as expressed in their report, that the results of these experiments *Effects of purifying processes.*

by no means prove the transmission of the infection from one valley to the other, as the transmission of chlorine is a totally different matter from the transmission of pathogenic germs. Dr. Frankland then spoke of the purification of water, and stated that he knew of no system of purification that can be absolutely relied upon except boiling.

Treatment of Town Refuse.

Disposal of town refuse.

25. The question of the proper disposal of town refuse, other than sewage, received a great deal of attention in the Engineering Section, but as I had not only the advantage of hearing and discussing the papers read at the Congress, but also of further discussion with their authors at places where various systems were being carried out, I think it will be better to reserve all remarks until I fully treat the subject in a later portion of this report. The principal papers communicated to the Section were by Mr. C. Jones, Town Surveyor, Ealing, on Refuse and Refuse Destructors; by Mr. M'Callum, Borough Engineer of Blackburn, on the Refuse Destructor in that town; by Dr. Wegl, of Berlin, on the Removal of Street Offal and Refuse in large Towns; by Herr Meyer, Director of Streets and Sewers, Copenhagen, on Experiments made there in the Burning of House Refuse; by Mr. G. W. Laws, City Engineer of Newcastle-on-Tyne, on Refuse-burning; and by Dr. Miller Bruce, on "How best to dispose of the Refuse of large Towns."

ARCHITECTURAL SECTION.

Hygiene of Towns.

26. In the Architectural Section there were some very interesting papers read and discussions held on matters connected with the Hygiene of towns and of buildings. A matter of vital importance as regards the health of towns is the provision of sufficient open spaces within them. The Earl of Meath, an Alderman of the London County Council, read a paper on behalf of the Public Gardens Association, in which regret was expressed that in all large towns greater care had not been taken to preserve even the smallest open spaces that had once been public property—a regret that should serve as a warning to colonial towns. Great stress was laid on the fact that it was better to have many comparatively small open spaces rather than one or two large ones, and upon the desirability of connecting such open spaces with one another by wide boulevards planted with trees and shrubs; and that in all towns there should be a fixed minimum of open space proportionate to population, and that the urban authorities should not be satisfied till this minimum had been exceeded. The minimum proposed was not mentioned, but Herr F. Stübben, City Architect of Cologne, in his paper, mentioned that a minimum of 5 per cent. of the area of the town proper should be reserved for public parks, another 5 per cent. for planting trees in streets and open spaces, and the remaining 90 per cent. should give 60 per cent. to dwellings and 30 per cent. to streets. These figures are not taken at random, but are based upon the plans of German cities, and will be acted upon in the extension of Cologne.

A long discussion took place on both papers, in the course of which Dr. Gould, of the United States Labour Department, Washington, cited statistics which showed that London held the twentieth position with regard to its open spaces, measured in the number of inhabitants to each acre. Vienna had a population of 473 to each acre of open space, Paris 495, Brussels 637, while London had 694. The Earl of Meath appeared to be in favour of small instead of large spaces. He found that London took higher rank when the larger parks were left out of the reckoning. Without the great parks, London had a population of 909 to each acre; but Philadelphia, which had a population of over 1,000,000, and had only 340 to each acre of open space on the average, had 17,641 to each acre when its greatest park was left out, and Vienna would have 3300 to each acre with one great park left out.

Smoke nuisance.

27. In the Section of Chemistry and Physics, attention was paid to another matter of great importance—the purity of the air of towns as affected by hygrometric and other conditions, and especially by smoke. The most important paper on the subject was contributed by the Manchester Field Naturalists Society (Dr. Bailey, Dr. Cohen, Dr. Hartog, and Dr. Tatham).

A general and systematic investigation is being made of the composition of the air of Manchester in the different parts of the city. Special attention is being paid to the following points:—(*a*) the differences of composition in the air of thinly and densely populated areas; (*b*) the relation between atmospheric impurity and prevalent sickness and mortality; (*c*) the extent to which smoke and noxious vapours are due to factories and dwelling-houses respectively; (*d*) the character of the air during the prevalence of fog.

The committee has devised a simple method for the estimation of the sulphurous and sulphuric acid in the air. It has been shown by its aid that during fog the proportion of sulphurous acid present in the atmosphere is enormously increased. The ratio of the minimum to the maximum amount found is as 1 to 26, the latter figure corresponding to a very foggy day.

Analyses of snow on successive days showed that during a three days' fog rather more than 1½ cwt. of sulphuric acid per square mile was deposited in the centre; at an outlying station 1 cwt. of sulphuric acid and 13 cwt. of blacks per square mile was carried down during the same time. The solid deposits on leaves of shrubs have also been analysed, and the results amply explain the difficulty experienced in growing plants and trees in town. A series of observations on the clearness of the air, and on daylight intensity is also being made.

28. With respect to the sanitary construction of houses, a large part of the time of the Architectural Section was occupied in discussing the subject. One of the most important papers relative to the building of ordinary dwelling-houses was by Mr. H. H. Statham on "Some Insanitary Superstitions in House Building." The scope of the paper may be judged from the following extract:— Hygiene of dwellings.

"For many generations the orthodox manner of making a house floor has been to lay wooden joists from wall to wall with boards nailed down above, and a lath-and-plaster ceiling beneath, the space between being an unseen cavern for the accumulation of whatever dirt and decaying matter can find its way in. What the results may be I once saw in the worst form in a case where the boards of an East End schoolroom were taken up to ascertain the condition of the joists. The space between those joists was filled nearly to the top with a festering mass of dirt and dust, over which the children had been daily collected. Such a floor would not be allowed in a modern London board school, but it is the accepted floor for a dwelling-house; and though the conditions of a well-kept dwelling-house do not encourage such an accumulation as this, I believe the tenants of the best kept London house which has been inhabited for any length of time would be disagreeably surprised at the amount of dirt they would find under their flooring boards if they looked for it. The old-fashioned system of ceiling up to the under side of the flooring boards and leaving the joists visible is far more sanitary; the drawback is that it is unsightly, and that it does not shut out sound sufficiently. Double flooring boards with felt between would get over the latter objection to some extent; but what I wish to recommend is the general adoption of solid floors of iron and concrete with a wood block or plain parquet floor on them, for the average town dwelling-house. . . . . . The whole tribe of things called 'skirtings' and 'casings' are superstitions of the same kind, for providing dark inaccessible places where no cleansing hand can ever come. Baths and watercloset basins are surrounded with those foolish fences of joinery; whited sepulchres, which indeed appear neat outwardly, but within they are full of—no one knows what, for no one ever looks. Let both watercloset and bath stand open to inspection all round, instead of being cased in. In the matter of the bath, the money spent on panelled casing and 'polished baywood or mahogany top' would go far to render the bath itself a neat and presentable piece of furniture.

"This system of ornamental casing is carried out again in the wooden skirtings which are fixed at the base of the walls of each room. Skirtings may be considered necessary for three reasons—for appearance, for a stop to the plastering, and to prevent chairs and other articles of furniture knocking against and injuring the paper and plaster. But they should be in a solid thickness of wood of no greater projection from the plaster surface than is necessary for their practical object. Unfortunately, it is considered necessary that the larger and more dignified a room is the larger moulding and the greater projection the skirting should have. As we are not going to the expense of putting down moulded timber three inches thick round the room, a moulding of the desired projection is fixed on the top and a piece of inch-and-a-quarter wood fixed between that and the floor, with a nice hollow space behind. The result is often rendered audible by the scuttering and scrambling of the mice, who are enjoying their gambols in the private corridors which we have obligingly provided for them.

"Casings for pipes are, no doubt, necessary, and are generally specified to be screwed on, so as to be removable when required. They never are removed, or the space behind seen, except when something is wrong with the pipe. They should be hinged, and made with button fasteners, so that they can be opened every day without any trouble. Among other drawbacks, they form a private lift or elevator for the cockroach, who is fond of warmth, and is enticed to ascend along the line of the hot-water pipes. The cockroach is bad enough in the kitchen, but a good deal worse in the bedroom; it is hardly worth while to afford him the luxury of a private passage, heated with hot water, to the upper floors."

There is not much novelty in these suggestions, but they are given as showing what is now the practice in all public buildings where sanitary conditions are studied.

Mr. T. Blashill, the Superintending Architect of London County Council, read a paper on the "Control of the Construction of Dwelling-houses," in which he laid down that the chief structural conditions of a habitable building which are recognised as being necessary for its healthy occupation are these:—

1. It must stand upon a site the subsoil of which is naturally dry, or is properly drained and free from impurity; and effective means must be taken to prevent the admission of air from the soil into the building.
2. The building materials—particularly the bricks, the mortar, and the plaster of the walls—must be of good quality, so that neither moisture nor impure air can be admitted through them into the building, and means must be taken to prevent the moisture from the ground rising up the walls.
3. All parts of the building, and not merely those parts which are actually inhabited, must be properly ventilated and lighted, the habitable rooms being of sufficient size, and particularly of sufficient height.
4. Provision must be made for the removal of refuse, whether solid or liquid, from the building, and from its near neighbourhood, before the refuse begins to pollute the air.

In the discussion which followed, the first and second of these conditions were especially insisted on as being those usually neglected. In connexion with the same conditions, Professor E. Trélat, of Paris, read a paper on the "Hygienic Composition of the Walls of Dwellings," in which there was a critical examination of the composition, &c. of the walls of houses, and their hygienic functions, defined to be (1st) to protect the interior from variations of temperature, and (2nd) to be impenetrable to infectious influences arising from the vital condition of the occupants.

Where it is absolutely necessary to build in marshy land, some practical suggestions may be obtained from a paper by Herr P. J. H. Cuypers, of Amsterdam, on "Pile Foundations in Marshy Land, and the Exclusion of Damp from Buildings."

Dwellings at low-rentals.

29. There were many papers read with special reference to the housing of the working classes, both by the cottage system and the block system, and treating the matter both from the hygienic and financial points of view. The first of these papers was by M. Charles Lucas, architect, of Paris, on the "Hygiene of Groups of Dwellings at Low Rentals," which was illustrated with examples taken from existing types. M. E. Cacheux followed with one on the "Principal Causes of the Insanitary Condition of Tenement Houses in Paris." In Mr. Rowland Plumbe's paper on "Cottage Homes for the Industrial Classes of the Metropolis," particulars were given of a village of such homes now being built. Dr. Sykes, in his paper on "Block Dwellings," specially insisted on the necessity of leaving open spaces around such dwellings.

In the long discussions that followed the reading of all these papers, the principal matters dwelt on were the necessity of giving sufficient light in such dwellings, of avoiding overcrowding in them, and of controlling their height, and there was an evident preponderance of opinion in favour of separate cottage homes when practicable.

In the Section of State Hygiene, a paper by Mr. S. M. Burroughs, on "The Housing of the Poorer Classes," was chiefly devoted to shewing how the difficulties of satisfactorily doing this could be overcome by the State taking over the railways, and granting free passes on them to suburban dwellers.

Common Lodging-houses.

30. A very interesting and useful paper on the subject of "Common Lodging Houses" was read by Mr. Gordon Smith. All who have experience in administering sanitary laws know what a difficult subject this is to deal with. The laws which regulate them do not define what they regulate. Mr Smith says :—

"In the absence of any complete statutory interpretation of the term, I will first explain that a common lodging-house is, in a certain limited sense, a sort of inn or hotel resorted to by certain of the very poor for temporary residential purposes, in which sleeping accommodation is provided in common, in one or several rooms, and where those who resort to it cater for themselves, as regards food, and ordinarily use one kitchen in common. On several occasions efforts have been made to define with precision what constitutes a common lodging-house. For example, so along ago as 1853—that is, within two years of the passing of the first Common Lodging Houses Act—the law officers of the Crown, on being consulted as to the meaning of the term, advised as follows :—'It may be difficult to give a precise definition of the term "common lodging-house," but, looking to the preamble and general provisions of the Act, it appears to us to have reference to that class of lodging-houses in which persons of the poorer class are received for short periods, and, though strangers to one another, are allowed to inhabit one common room. We are of opinion that it does not include hotels, inns, public-houses, or lodgings let to the upper and middle classes'; and they further explained, with regard to that part of the above definition which refers to the persons inhabiting a common lodging-house being 'strangers to one another' that their 'obvious intention was to distinguish lodgers promiscuously brought together from members of one family or household.' When asked the further question whether lodging-houses, otherwise coming within the definition, but let for a week or longer period, would, from the latter circumstance, be excluded from the operation of the Act controlling such houses, the law officers observed :—'We are of opinion that the period of letting is unimportant in determining whether a lodging-house comes under the Act now in question.'

"More recently it has been held that evidence that hawkers, itinerant picture-frame makers, chair-makers, musicians, bone-gatherers, and persons suspected of begging, resorted to a house for lodgings, and had their meals in the kitchen at the same table, paying sixpence per night each, is sufficient to establish that the house is a common lodging-house requiring to be registered under the Public Health Act, 1875. It will thus be seen that the question as to what is a common lodging-house depends, not so much upon the precise definition of the term, as the consideration whether the circumstances of its occupation are such as involve supervision by the sanitary authority in order that its general cleanliness, ventilation, good ordering, &c., may be secured."

In London, in 1889, the average number of people who slept every night in common lodging-houses was 34,000. Some of the houses are certified to receive as many as 430 lodgers. Some in Manchester, Liverpool, and Leeds are certified for numbers varying from 640 to 822. If Mr. Smith's requirement of 300 cubic feet of air space for each lodger is carried out in the last case, the sleeping accommodation is about 250,000 feet. Mr. Smith's other requirements are that each common lodging-house should—

"comprise an adequate day-room for each sex, fitted with a fireplace and range suitable for the cooking of the lodgers' food, also a sufficient scullery or wash-house. Likewise dormitories for each sex, furnished with single bedsteads, bedding, &c. Lavatories, separate from the dormitories, are also necessary; and suitable and sufficient closet accommodation. In addition to the separate dormitory accommodation for each sex, cubicles or separate rooms have to be provided for married couples, for, be it remembered, that any man and woman applying for such accommodation—and the Act of Parliament imposes no duty on the keeper of a common lodging-house in regard to the family relationship of the lodgers—may be received as such in a common lodging-house. In some few common lodging-houses a separate reading room has been provided, but this is comparatively exceptional. In several I have noticed that lockers are provided, in which those lodgers who may be regarded as regular customers can, for a trifling extra fee per week, leave their property with a certain amount of safety.

"A few instances have come under my notice in which buildings have been specially erected as common lodging-houses, but these are comparatively rare. More frequently the common lodging-house is a capacious dwelling-house which has ceased to serve its original purpose, owing to entire change in the character of the neighbourhood, and which has been altered and adapted to serve its new purpose; but more often it is a warehouse or factory that has been altered and adapted to the purpose. These latter are generally the best kind of building for the purpose, as they usually have large rooms capable of fair light and ventilation."

31. With reference to Public Buildings, Mr. Lennox Browne, F.R.C.S., read an important paper on the Sanitation of Theatres, which it is nearly impossible to satisfactorily condense without the use of the drawings by Mr. Turner with which it was illustrated. Its object was to point out that while urban authorities have seen that all manner of precautions are taken to protect the public from danger from fire, such authorities seem to— Theatres.

"have completely ignored the far more important subject of the health, not only of the actors and actresses, but also of the general public. I say 'more important' advisedly, as there is ample evidence to show that the time when fires are most liable to occur in theatres, is not when the house is full, but within two or three hours after the audience and company have left the building; whereas if the sanitary arrangements are faulty, the danger is a constant one; and this danger to health, while affecting the audience, must much more affect those employed behind the scenes, because they are compelled to be in the theatre for much longer periods, both for acting and rehearsals, and are there all the week round. Moreover, it is behind the scenes that insanitary conditions are to be found in their most objectionable form."

32. A very great deal of attention was given in the Architectural Section to the construction of both permanent and temporary Isolation Hospitals and of Asylums. Isolation Hospital Buildings.

Dr. Thorne Thorne, F.R.S., of the Local Government Board, read a paper on "English Isolation Hospitals," in the course of which he drew attention to the great growth in England of the provision by sanitary authorities, and at the cost of the localities, of hospitals for the isolation of first cases of infectious diseases with a view to the prevention of epidemics. At least 400 sanitary authorities now possessed such hospitals, and since 1879, when the author prepared his official report on this subject, about £450,000 had been expended for this purpose. With the single exception of smallpox, there was no evidence that the aggregation of the infectious sick in reasonable numbers constituted any danger to the outside public, whereas, on the other hand, isolation in hospitals had again and again prevented diffusion of infection. But success depended on the proper construction and administration of these hospitals. An unoccupied zone of 40 feet should surround the hospital buildings,—each disease should be treated in a building aërially distinct from any other,—the wards should have means of cross-ventilation,—and in allotting a space of some 2000 cubic feet per bed care should be taken to give at least 12 feet of wall space to each bed; for it was on a level with the patient's lungs and mouth that it was so essential to secure wholesomeness of air breathed. As a rule, one bed per 1000 of the population sufficed for the current permanent requirements, and no district should be content unless a few cases of two different diseases in both sexes could be simultaneously isolated. Much depended for success on the character of the hospital. Unless they are reasonably attractive in style, and well designed for purposes of recovery, that immediate isolation which is above all things necessary is not attained. It is not the poor man who, when suffering from infectious disease, constitutes the greatest danger to the community. It is such as the milk-vendors', the drapers', the publicans' family—namely, those who, through their wares and otherwise, tend to scatter infection that are above all a public danger; and they must be attracted by a building where there is reasonable comfort and the best chances of recovery.

The paper was illustrated by plans of the Heathcote Isolation Hospital, Leamington, prepared by Mr. K. D. Young, who also read a paper on its construction and arrangement. The following are the principal constructional details of the isolation wards:—

"The isolation block is divided into two equal parts by a wall, and the arrangements on one side of the wall are an exact counterpart of those on the other side, the entrance to one side being on the east, and that to the other side to the west. Each half of the building, therefore, contains a large ward for three beds, two small wards for one bed each, a nurses' duty room, and a water-closet and slop-sink. These rooms communicate with each other by way of an open verandah, roofed over at the top, but quite open in front.

"Each large ward is 36ft. long by 18ft. wide, the smaller wards being 18ft. by 12ft., and all are 12ft. high. The allowance of floor space is 216ft. per bed, and of cubic space 2592ft. per bed. The large wards are lighted by three windows at each end, the smaller ones by one window on each side, being in the proportion of one square foot of window surface to about 65ft. of cubic space. The windows, which form the principal means of ventilation, are divided into two parts by a transom which is fixed about 1ft. 6in. down from the head of the frame. Below the transom are ordinary double-hung sashes, provided with a deep bottom-rail and cill-board which permits of the lower sash being raised and a current of air admitted in a vertical direction between the two sashes, at the same time preventing free access of air at the cill level. Above the transom is a "hopper light," hung on hinges at the bottom to fall inwards, and provided with glazed cheeks at the sides to prevent down draughts. In addition to the windows, openings are made at the floor level behind each bed, and provided with Elliston's radiator ventilators; there is also an extraction flue in each ward carried up alongside the smoke flue, from which it is separated by iron plates. The inlet to the flue is at the ceiling level, and a Bunsen burner is provided with a view to produce an upward current when the fire is lighted. The wards are each provided with a Boyd's hygiastic ventilating grate; these grates have at the back of the fire an air chamber which is supplied with fresh air from the outside. The air being warmed by contact with the heated fire-brick back of the stove, passes into the room through a grating above the fireplace.

"The walls of the ward are lined to a height of 5ft. with tinted glazed bricks, above which they are plastered and distempered. The floors are laid with yellow deal in 3-ft. widths, ploughed and tongued. The vertical angles of the walls, the horizontal angles at the junction of floors and walls and of walls and ceilings are all rounded, so also are all the angles of door panels and of the windows. No recessed mouldings are used anywhere."

The Rev. C. E. Few, Vicar of Seal, Sevenoaks, read a paper recommending the construction of small local isolation hospitals, instead of one large one for a whole district.

Professor Duchaussoy communicated a paper on Hospital Tents and Huts, describing the hospitals of the *Association des Dames Françaises*.

A long discussion took place on all these papers, the prevalent opinion being that the better arrangement was to have one isolation hospital for each district; that wooden hospitals were to be avoided, but where unavoidable they should be burnt after use; that tent treatment was preferable in summer.

In connexion with Smallpox Hospitals, there was a paper read in the Section of Preventive Medicines by Surgeon-General Bostock, in which, after detailing the facts as to the known spread of smallpox round smallpox hospitals, the arrangements made by the Metropolitan Asylums Board for the establishment and organisation of Floating Hospitals and their transport service were detailed.

Asylums for the Insane.

33. The construction of, and arrangements for, Asylums for the Insane were the subject of two papers by Mr. Hine, of Nottingham, and Dr. Greene, of Northampton. In both papers the necessity of having plenty of sunlight was insisted on. One of the chief points of constructional detail in Mr. Hine's paper was in connexion with ventilation. He said—

"After long consideration, and some years of experience, I have come to the conclusion that the right system is one of air warmed over hot water or steam-pipes, and propelled into the wards by a fan, through underground trunks, and vertical flues in the walls communicating with all the rooms, and a similar system of extraction flues, by which the vitiated air is expelled.

"It must be understood that I do not advocate air warmed by fire heat,—a method which may seriously deteriorate its quality, a result not to be feared by warming over steam batteries, which plan has the further advantage of allowing the temperature to be quickly raised or lowered in any particular ward by a simple arrangement of pipes and valves.

"I cannot attempt to describe my system in detail, but will merely call attention to a few important points :—

"The air which is propelled into the building must be drawn from a situation untainted by obnoxious surroundings.

"The trunks and flues must be carefully calculated in proportion to the size of each room. Many failures in ventilation are due to ignorance or neglect of this.

"Separate trunks for day and night service should be arranged, with simple shutter-valves for closing the one and opening the other at morning and night.

"The extraction flues should communicate with upcast shafts of some height, say in towers, to carry well away the vitiated air.

"The fresh warmed air should enter the rooms near the top, and the vitiated air be withdrawn near the floor ; experience having taught us that this is right ; for, if the positions of inlets and outlets were reversed, some deleterious gases would not readily ascend to escape at the top, while the warm air, entering at the bottom, would quickly ascend and pass out without mixing thoroughly with the surrounding atmosphere, as it must do if driven in at the top, and be allowed to spread over the whole surface of room, gradually falling as more air is forced in above it, and vitiated air extracted below.

"When ventilation is required without heat, the fan may be used to drive in air at its normal temperature, the stagnant atmosphere in the rooms being of necessity displaced either through the extraction flues or the open windows.

"One great advantage of this system is that heat can only be obtained in conjunction with ventilation, which is not always the case with steam or hot-water pipes *in* the wards, where a close stuffy heat is generally the result.

"I cannot better illustrate the results of this system than by quoting from a recent report of the Superintendent of the Nottingham Borough Asylum, where I have lately introduced it in the new male annexe:—

"'So efficiently has the heating been done, that a temperature of 60 deg. has been easily maintained throughout the wards without the aid of any fires, and this when the thermometer outside registered 10 deg. of frost. The dormitories and single rooms are just as easily warmed at night.

"'Those who are acquainted with the working of an asylum will readily imagine the immense comfort of being able to do without fires in the wards. There is no crowding round the fireplaces, and no quarrelling for the best seats, but the patients sit scattered about at the windows and at the tables, just as in summer. It was expected that there would be some grumbling at first at the absence of fires, but, strange to say, I don't think I heard a single complaint. Another great advantage this system of heating has over most others is the entire absence from the rooms of all pipes and other heating surfaces.

"'The ventilation is also equally successful. It is very observable in the dormitories and single rooms; the air in these appears to be almost as pure in the morning when the patients get up as in the evening when they go to bed.'"

Dr. Greene only allows 1080 cubic feet of space for each patient, of which 600 cubic feet are allotted to the dormotory, and 480 to the day-room, the superficial spaces being respectively 50 and 40 square feet. He has, consequently, to provide ventilation, to renew the air four or five times an hour. The chief constructional points he insisted on were :—

"The inner walls should be plastered throughout, or, preferably, covered with Portland or Parian cement. It is not on æsthetic grounds only that I insist on this, but for sanitary reasons also. The joints of brickwork can never be made perfectly smooth. Dust collects in the grooves and irregularities, and dust too often means disease. A skirting-board implies that there is a space at its back for collecting dust and dirt, and for affording a pleasant playground for rats and mice. It should be abolished, and a strip of wood about 2 in. wide and 1 in. thick nailed to the floor close to the wall.

"The space between the foundation walls should be filled in, and a thick layer of concrete should rise to within $1\frac{1}{2}$ in. of the floor level. On this concrete, wood blocks should be laid, a thick layer of Stockholm tar being placed next the concrete. By these means neither damp, sewer-gas, nor vermin can get under the floor. It is also warm, and the tread is noiseless,—important points in asylums and hospitals.

"The favourite kind of window at present is the ordinary double-hung sash-window. Why it should be the favourite is not easy to see.

"In asylums it has to be blocked both top and bottom, merely allowing an opening of about 4 in. or 5 in. The consequence is that the amount of air admitted is insufficient in warm weather. Further, it is most difficult to keep clean. Dirt accumulates between the sash and the frame, and the cords are constantly breaking. A modification of the French casement is much to be preferred. The upper part should be an oblong swivel, or hinged fanlight, and the lower divided at its centre by a strong mullion, the sections being fitted with sashes moving on central pivots. An asylum needs abundance of light, and the windows should be more numerous, perhaps, than in any other building. Unfortunately, the amount of glass necessary for light is apt to make the wards somewhat cold in winter. It would be very desirable to have all the windows double, and in this case the inner window might be on the double-hung sash principle. No blocks would be necessary, and ventilation, without draught, would be easily maintained. Wherever practicable the windows should be placed opposite to each other, and the width of the room should rarely exceed 25 feet, or perflation is likely to be imperfect. The upper panels of the doors should be, almost without exception, of strong plate-glass, and the lower panels of open ironwork, fitted in some cases with light wooden shutters.

"The staircases are almost invariably of stone. In most asylums they are too narrow, and the risers too high."

General Matters connected with Sanitary Administration.

34. In addition to what may be considered as more or less engineering and structural aspects of Hygiene, many other matters connected with the administrative duties fulfilled by the Central Board of Health were considered and debated at the Congress. In the following observations upon them I shall avoid any purely medical subjects, and, at the same time, by treating every subject as far as possible under a separate heading, give to every reader of this Report the opportunity of passing by matters of no interest to him, or of knowing where he may obtain further information on those that he may wish to study in the light of the latest scientific developments of them.

35. Nearly every civilized State has, by passing laws for the conservation of the public health, accepted the principle of State intervention in the matter. At the Congress, though the general principle was accepted that the State should only intervene by undertaking such functions as it cannot without detriment to the common weal refuse to undertake, several special propositions were made. As far as the prevention of disease is concerned, existing legislative measures are almost exclusively devoted to precautions against those of infectious or contagious character. In the Section of Preventive Medicine Dr. Squire proposed that consumption and other tuberculous diseases should be also the subject of legislation so far as acquired tubercle is concerned. Professor A. Corradi, of Pavia, communicated a paper on the same subject to the Section of State Hygiene. In the same section the duty of the State with regard to the enforcement of the Contagious Disease Acts was discussed from divergent points of view in papers by Dr. Holroyde, Medical Officer of Health for the garrison town of Chatham, and by Dr. J. B. Nevins, President of the Medical Association for the repeal of the Acts.

State intervention in Health matters.

Pulmonary diseases.

Contagious Diseases Acts.

The desirability of the State undertaking scientific investigations into the origin and causes of disease was the subject of papers in the same section by Dr. Tomkins, of Leicester, and Dr. Wright, and international measures for the prevention of food adulteration were advocated by Dr. Van Hamel Roos, of Amsterdam.

Scientific investigations.

Food adulteration.

With respect to the question of State control over dwelling-houses, especially the homes of the working classes, Mr. Henry Rutherford, barrister-at-law, urged the compulsory sanitary registration of all dwelling-houses in regard to drainage and water supply—no house being allowed to be tenanted until certificated after examination by a qualified officer. Another paper on the subject was read by Dr. Elgin Gould, of Washington. He dwelt on the rapid growth of American cities, the evil results of which fell chiefly on the poorer classes. He described the condition of things which existed amongst these classes in Washington, and which resulted in a death-rate amongst them of 1 in 33. Then the various reforms which had been instituted were described, resulting in a death-rate of 24 per 1000, and amongst children under one year of age the death-rate fell from 49 to 40 per 1000.

A long discussion followed, in which numerous difficulties were pointed out in the way of getting legislation to effect such objects. But Dr. Gould, in reply, stated that most of the difficulties mentioned had been solved in the United States, and suggested a study of the sanitary legislation of the State and City of New York.

Dr. Danford Thomas read a paper on "State Control of the Sale of Poison." In the year 1889, 15,025 persons died of violent deaths, and of this number 636 died of the effect of poison; 376 from accidental or negligent use of poison, including the following substances:—Arsenic, mercury, lead, copper, caustic acids (carbolic and other), turpentine, opium, morphia, paraffin, iodine, oil of almonds, Prussic acid, cocaine, antipyrine, &c. These records did not include a vast number of cases which recovered, and which were not recorded. Many of these poisons were contained in patent medicines. The great facility with which both these and even crude drugs could be obtained was alluded to. He would increase the first list of poisons, and suggested that they should be sold in blue bottles properly labelled, and not sold to any person under 16 years of age. It was an extraordinary fact that the Japanese and other nations were ahead of us in this respect,

Sale of poisons.

having laboratories for the analysis of patent and secret remedies, and adequate legislation. He would make all proprietary medicines really patent; would abolish licences to sell them; and would confine the sale to chemists and druggists only.

In the discussion which followed, Dr. Littlejohn, of Edinburgh, referred to the great ease with which laudanum could be purchased. He had taken 10 or 12 little phials out of the pockets of suicides.

Mr. Carnegie (President of the Pharmaceutical Society) cordially agreed with Dr. Thomas's conclusions in the interests of the public. He pointed out the inconsistency of placing restrictions on chemists selling certain articles, yet a huckster in the street could sell the same thing mixed with a little treacle and water.

It was moved by Dr. Danford Thomas, and seconded by Dr. Littlejohn, "That in the opinion of the International Congress of Hygiene and Demography, it is essential, in the public interests, that the existing law regulating the sale of poisons should be amended, and greater restrictions placed on the sale of poisons, and this especially in Great Britain and her Colonies."

This resolution was carried.

Local Boards of Health.

36. The constitution, powers, and duties of Local Boards of Health were often referred to, and were the subject of two papers in the Section of State Hygiene; one by Mr. Gainsford Bruce, Q.C., M.P., and the other by Dr. Simon, of Breslau. In his opening address Lord Basing, the President of the Section, mentioned that during the short period of 20 years in which Local Boards had been working under the control of the Local Government Board, the death-rate of England had diminished one-seventh.

Quarantine.

37. A great deal of discussion took place in the Sections of Preventive Medicine and of State Hygiene on the subject of Quarantine. In the former section, a paper on "The Mode of Preventing the Spread of Epidemic Disease from one Country to another" was read by Surgeon-General Cunningham, M.D., C.S.I., in which he described Quarantine as a method "powerful for evil, but powerless to do good"; Medical Inspection, as better, but which "cannot be credited with the arrest of epidemics"; and Sanitary Improvements as "the best and only efficient means of checking epidemic disease proved by experience."

Dr. Lawson, Inspector-General of Hospitals, followed with a paper on "The Communicability of Cholera from Country to Country," in which he combatted the idea that personal communication was the chief factor in the dissemination of the disease, and gave details of a great number of outbreaks, which he held to prove that "the efficient factor is air borne, and active on sea as well as on land whenever it meets with the necessary conditions to develop it." He, therefore, held that it "cannot be excluded from any country by general quarantine. All that can be done is by hygienic measures to improve the health of the population, and to remove the conditions which favour the formation of foci."

Dr. Ashburton Thompson, of Sydney, then read a paper on "Australasian Quarantine," giving an account of the proceedings of the Intercolonial Sanitary Conference of 1884, whose unanimous resolutions in favour of limited quarantine were accepted by all the Australasian Governments, and have ever since been faithfully carried out by that of New South Wales. He maintained that the system had proved successful.

In the discussion which followed, ten English and Indian medical experts, three French, two Dutch, one American, and one South American took part, and the opinion was almost entirely against quarantine.

Surgeon-General Cunningham summed up briefly. The general condemnation of the quarantine system left him, he said, very little to say. Quarantine could only be logical if it could be proved that diffusibility of disease was commensurate with increased facility of inter-travel. All history showed the opposite. Steamboats and railways had not increased the spread of cholera; our growing communication with India—the home of cholera—had not increased it: the theory of quarantine was as wrong as its practice was faulty.

Dr. Thompson also summed up for his side of the question, protesting "against cholera and English and Indian local conditions being spoken of as though they confirmed the whole matter," apparently forgetting that in the case of small-pox preventive measures are proved to be much more efficacious than any known preventive measures against cholera—and small-pox is virtually the disease whose introduction Australian quarantine is relied on to prevent. In subsequent correspondence he reclaims that the discussion on the question should be confined "to gentlemen of practical experience in executing quarantine measures." As quarantine is now practically discontinued in England and India, this is virtually an appeal from the opinion of the highest medical authorities in the world to the authorities who are actually carrying out the condemned system.

In the Section of State Hygiene, Dr. Montizambert, Superintendent of the Canadian Quarantine Service, cummunicated a paper on Modern Quarantine in Canada and the United States, the chief value of which consisted in the description of the appliances used for the disinfection of ships. These appliances consist of an apparatus for applying a mercuric chloride drench to all parts of the woodwork of a ship and replacing the bilgewater with the solution; of steam apparatus for disinfecting the bedding, clothing, &c.; and a sulphur dioxide fumigating apparatus for disinfecting the contents of the hold, &c. No description was given of the means of disinfecting such portion of the cargo (*e.g.*, rags for paper making) as may require special disinfection.

Dr. V. Vignard read a paper on "Quarantine and Medical Inspection," in which he urged that the two should be combined in one system, of which disinfection should be the essential characteristic.

Dr. Stopford Taylor, Medical Officer of Health, of Liverpool, read a paper on the "Medical Supervision of the Mercantile Marine," in which he urged the repeal of the quarantine laws, and the handing over of all sanitary work connected with shipping to the control of local sanitary authorities.

In the discussion which followed, Dr. Feraud, Director of the French Naval Medical Service, explained that Dr. Vignard's opinion was personal and not official. He himself was evidently in favour of modified quarantine. The Medical Officers of Health of Newcastle, Hull, and Sunderland, agreed with Dr. Taylor that local sanitary work, with corresponding sanitary work on board ships, were far better than quarantine. The question of hygiene on board ship was also considered in the Section of Naval and Military Hygiene.

38. The compulsory notification of infectious diseases gave rise to a long, but, as will be seen, very one-sided discussion in the Section of State Hygiene. It was based on two papers, the first by Dr. Boobyer, Medical Officer of Health of Notingham; and the second by Mr. D. Biddle, M.R.C.S.E. Dr. Boobyer, after giving a history of compulsory notification before the passing of the English Act of 1889, showed that such notification was a failure when it was to be made only by the householder; and, except in cases where no medical man is in attendance, all varieties of practice in different towns have led up to the notification by the medical attendant to the sanitary authority. He claimed that, both with respect to diseases dependent for their propagation upon personal contagion, and to those arising in connexion with the insanitary conditions, notification simply imparts to the sanitary authorities information necessary to enable them to exercise those powers with which the earlier Public Health Acts had already invested them. He further held that, from the scientific point of view, compulsory notification, and even isolation, are the necessary outcome of evolution as applied to preventive medicine. He illustrated the fruits of prompt notification, and the want of it, by the behaviour of smallpox in Leicester and Sheffield in 1887-8. In the former town, where notification was compulsory, there were but few cases, thanks to immediate isolation and other measures; in the latter town, where it was not compulsory, there were thousands of cases.

Notification of Infectious Disease.

Mr. Biddle's paper—"Should compulsory notification be made general?"—was devoted to show that the question should be answered in the negative. He claimed that statistics showed that *notifiable diseases* had increased in towns that were under the dual system of notification by both medical attendant and householder, apparently thinking that notification in some unexplained manner increased not only the number of *known* cases, but the prevalence of the diseases themselves. He held, further, that the system is dishonouring to the profession; that it leads to a prolongation of the time which elapses between the onset of illness and the doctor's first visit, and to hasty diagnosis, so that the information imparted to the sanitary authority is often incorrect and misleading, and "friction" often results.

The subject was further illustrated by a paper by Dr. S. Cameron, Medical Officer of Leeds, on an outbreak of Typhus in that town.

In the discussion which followed the reading of these three papers,—

Dr. Sergeant, Medical Officer of Health, County of Lancashire, said he had had a great deal of experience in the working of the Notification Act, and it all went in favour of the value of the Act. He thought dual notification was preferable. He commented on the fact that the opposition came not so much from the public as from the medical profession, which was greatly to be regretted. The Act had been adopted voluntarily in 75 per cent. of Lancashire. He objected to the title of "informer" being applied to medical men any more than a vendor of inflammable liquids, who had to notify the fact that he had such on his premises, could be called an informer.

Dr. Hewitt (Minnesota) claimed to represent one of the largest States in America, and there a similar Act had been in force for eight years. It became law at a request of the people. Before this Act was passed, out of a population of 600,000 there were 1200 deaths from diphtheria per annum. Now (after eight years of the Act) the population was double (nearly a million and a half), and the annual deaths from diphtheria were only 761.

Dr. Parkes (Medical Officer of Health, Chelsea) referred to the subject of erysipelas and "continued" fever. He thought the list of diseases required careful revision.

Mr. Shirley Murphy (Medical Officer of Health, County of London) said that a prompt notification of disease was of great value in enabling medical officers of health to ascertain the source and stop the supply of any infected material such as milk. He wished to emphasise the great value of the Notification Act, both for the safety of the public, and also as a means for obtaining material for future investigation.

Dr. Willoughby, of London, would like to ask Mr. Biddle to explain how the notification of disease could possibly hinder measures being taken to prevent its spread?

Dr. Atkinson spoke against dual notification by both doctor and householder, as distinguished from notification by one of these.

Dr. Covernton, of Montreal, gave some facts from his experience in Canada. He spoke at length of the regulations now in force in his Province. These worked well and without friction, though they were more stringent there than in many other places. The result was that epidemic diseases were becoming rapidly stamped out.

Dr. Berdoe (District Medical Officer of Bethnal Green) spoke to having seen scarlatina in the homes of the poor, with six to eight families under the same roof, and the parents would not part with their children. Since the Act had come in no friction whatever had occurred. On the contrary, a poor man regarded it as a blessing to have a case of fever in his house, for not only did he get his child looked after at a good hospital, but his house was thoroughly overhauled and put into order.

Dr. Drysdale, Dr. Harvey Littlejohn, Dr. Ewing (one of the chief medical officers of New York), and others took part in the discussion.

Dr. Cameron, in replying, regretted certain parts of Mr. Biddle's paper, and alluding to that gentleman's statistics, said there was not enough detail as to the existence of fever hospitals, how inspection is carried out, and other particulars which would greatly influence the conclusion.

Dr. Boobyer, in replying, mentioned that in the nine years during which notification had been in force scarlatina had considerably diminished.

Mr. Biddle said that his chief objection was to the medical man being made the notifier; this work more properly belonged to the householder. He supported the single as against the dual system. He only opposed the dual notification, and his statistics had, he was afraid, been misunderstood.

The meeting was very crowded, and much interest was manifested in the proceedings. Finally the following resolutions were put:—

Proposed by Councillor Dr. Lowe, Leeds, seconded by Dr. Spottiswoode Cameron, Medical Officer of Health of Leeds: "That notification of infectious diseases in all countries should be compulsory." Carried with loud applause, only five voting against.

Proposed by Dr. A. J. Martin, of Paris, seconded by Dr. Tivant, Monaco: "That it is desirable that the notification of infectious maladies should be made by the doctor."

Proposed by Dr. Currie, New Brunswick, seconded by Dr. Fartell, Halifax, Nova Scotia, and carried: "That in the opinion of this Section notification of infectious diseases should be made compulsory on the medical attendant and householder in whose house the disease occurs."

It thus appears that there is an almost unanimous consensus of opinion in the medical profession as represented at the Congress in favour of compulsory notification.

Disinfection.

39. Papers on the use of Disinfectants and on the means employed in testing them were read in the Section of Preventive Medicine by Professor Pistor, of Berlin; in that of Bacteriology by Dr. Behrings, of Berlin, Professor Max Grueber, of Vienna, and Professor Hueppe, of Prague; and in that of Chemistry by Mr. Sreatfield and Dr. Moody.

Burial.

Cremation.

40. Two well known champions of totally opposite views on the subject of the disposal of the dead, Sir Henry Thompson, F.R.C.S., and Mr. Seymour Haden, F.R.C.S., communicated papers to the Section of State Hygiene. Sir H. Thompson began by assuming the accuracy of the following statement:—"That the bodies of those who have died of any, or almost any, of the diseases generally known as zymotic, are charged with elements which have the property of communicating the same diseases to the bodies of living persons if brought into contact with them, it may be by inoculation, or by food admixture." He showed that the Registrar-General recorded annually about 70,000 deaths from these diseases in England, so that this question of the disposal of the dead was one of vital importance to the living. "The question is not the management of infectious disease during life—which has been well studied—but the best method of arresting its progress at death, so that the remains shall not be injurious to the survivors. Experience in the past has demonstrated that all methods of dealing with the dead body which have for their object its conservation entire when loaded with contagious elements largely disseminate them, and have often occasioned fresh outbreaks, especially in periods of epidemic visitation. The universally prevalent watercourses beneath the surface of the soil, both natural and artificial, offer innumerable channels for the transit of such elements." He acknowledged that dangers from this source were less than they used to be, but their existence in any situation is only a question of degree. He criticised Mr. Seymour Haden's method of dealing with the dead from infectious diseases as impracticable, and therefore urged, in the public interest, that everybody dying of such disease should be disinfected and rendered incapable of transmitting it. This can only be done really efficiently by heat, by the process known as "cremation," the best methods of which he described. He referred to the legal and criminal aspects of the question as connected with the determination of the cause of death, and called attention to the defects in the English system of ascertaining such cause, and stated that three per cent of all cases of death are uncertified by anyone. He proposed that fully qualified medical men should be appointed to determine the cause of death in every case, each to have charge of a certain district, so that no burial could take place without a certificate. Sir Henry Thompson invited the members to inspect the Crematorium at Woking.

Burial in earth.

On the other side, Mr. Seymour Haden propounded—(1.) That the natural destination of all organised bodies that have lived and that die on the earth's surface, is the earth. (2.) That the evils which the cremationists declare to be inseparable from the principle of interment are independent of that principle, and are of our own creation. (3.) That the source of these evils is to be found, not in the burial of the dead, but in the unreasoning sentiment which prompts us to keep them unburied as long as possible, and then to bury them in such a way that the earth can have no access to them.

(4.) That the principle of burial supposes the resolution of the body by the agency of the earth to which we commit it, and that the earth is competent to effect that resolution, and to effect it innocuously. (5.) That to seek to prevent the beneficient agency of the earth by enclosing the dead in inperishable coffins, brick graves and vaults, is in the highest degree irrational, since it engages us in a vain resistance to an inevitable dispensation, and has led us to accumulate in our midst a vast store of human remains in every stage and condition of decay. (6.) That the remedy for such evils is not in cremation, but in a sensible recognition of, and a timely submission to a well-defined law of nature, and in legislative action to enforce the provisions of that law." He therefore proposed that cremation, which he declared unnecessary, and, in a medico-legal sense, dangerous, should, as a measure of public safety, be declared a misdemeanour; that the whole subject of burial should be dealt with by a law containing the following provisions:—Burial within the earth as the only legal mode of disposing of a dead body, limitation of time beyond which it should be illegal to keep a dead body unburied, and the illegality of strong coffins, brick graves and vaults, and all contrivances having for their effect the retarding of the resolution of the body by the earth.

M. Caffard and Dr. Brouardel, both of Paris, also read papers on cremation.

In the animated discussion which followed, nearly all the speakers were in favour of cremation, and at the end of it the following Resolution was carried with only four dissentients, in a very crowded meeting:—"That the cremation of the dead is a rational and hygienic procedure which is especially called for where death occurs from contagious disease." Resolutions were also passed in favour of removing legal disabilities to the adoption of cremation, and for its use on battlefields.

41. In the Section of State Hygiene a paper was read by Mr. A. E. Fletcher, Chief Inspector under the Alkali Acts—the Acts under which action is taken in respect to most noxious trades—with respect to the working of the last amended Act, that of 1881. "There are now 1034 works registered under it, of which 133 only are alkali works. Only those processes of manufacture come under the Act which are specially named in the schedule appended to it. This has led to strange anomalies, owing to the constant change and development of chemical processes, and it is much to be desired that a more general Noxious Gases Regulation Act should be adopted, whereby all works, where certain noxious gases are generated, should be brought under its control. These noxious gases form but a short list, namely, chlorine and its acid compounds, the acid compounds of fluorine, nitrogen, and sulphur, including sulphuretted hydrogen. To these may be added metallic fumes containing lead, antimony, arsenic, or zinc. An Act for regulating all works liable to discharge any of the foregoing substances would not require amendment from time to time, as must be necessary when the specific processes of manufacture are named, since these are ever changing. Some even would think it better to make no attempt to enumerate the gases to be considered noxious, and to enact simply that, in the case of every manufacturing process from which a noxious gas may be thrown off, the manufacturer should use the best practicable means for preventing the escape of such gas into the atmosphere. For the purpose of such an Act a noxious gas might be defined as 'a gas which gives offence, and is the subject of complaint to the local authority on the part of ten neighbouring ratepayers.'" **Noxious Trades.**

Dr. Abbott (of Boston) in discussing this paper stated the laws in the State of Massachusetts against the emission of noxious gases were amongst the oldest they had, dating back as far as 1697. They had, however, little to do with alkali works, the principal works they had to deal with being those for artificial manures.

42. The subjects of food poisoning, especially in connection with the diseased condition of animals slaughtered for food, and of the infection of meat, milk, and other comestibles, occupied a great deal of attention. In the section treating of the relation of the Diseases of Animals to those of Man, Dr. Ballard read a paper on Meat and Milk Infections, especially with relation to fourteen cases of "meat poisoning" reported to the Medical Department of the Local Government Board. This paper was illustrated with photographic slides by Dr. Klein. Of the fourteen cases, nine were in connection with fresh or salt pork, one veal, one beef, two butcher's meat (kind not stated), and one tinned salmon; and Dr. Ballard thinks this is no unfair representation of the relative frequency with which swine's flesh is connected with such cases of induced disease. The explanation seems to be that such flesh is rich in the gelatinous food in which air-borne micro-organisms thrive. Dr. Ballard's practical conclusion is that, as the micro-organism attacks the food either before or after being eaten, cleanliness and sufficiency of cooking are the grand precautions to take. He said— **Food.**

"But if we do eat ham or bacon, cold or warm, it is a proper precaution to avoid them if not duly cooked throughout. The people who chiefly got pneumonia in Middlesbrough were a class who habitually only warmed the bacon they ate by slightly toasting it before a fire; they did not heat it sufficiently to kill any micro-organism; and the hotel hams (indeed, hams cooked at home too) are rarely thoroughly cooked. But the grand precaution of all is the very commonplace one signified by the word cleanliness. Every factory where pork is converted into brawn or hams ought to be so arranged that light and a draught of air can penetrate freely everywhere; there should be no corners where refuse matter can lodge and become a centre for the cultivation of morbid micro-organisms in filth; the rise of ground air should be obviated by cement under the pavement or flooring; and the place should be kept scrupulously clean and free from incursions of sewer air or putrid emanations of any kind. Kitchens, and above all pantries and places where food is stored in hotels, public refreshment rooms, or pastrycooks' premises, and in private houses, should be similarly cared for. It should be held to be part of the business of conservators of public health to see that these rules are observed, as well as the business of every master or mistress of a family."

In the same Section, Dr. V. C. Vaughan, of the United States Army, read a paper on the "Infection of Meat and Milk;" Dr. Ostertag, of Berlin, on the "Regulation of the Milk Supply with relation to transmissible Disease;" Dr. Vacher, of Birkenhead, on the "Inspection of Meat;" Professor Bang, of Copenhagen, Professor M'Fadyean, and Dr. S. Woodhead on the "Transmission of Tuberculosis by Meat and Milk of Tuberculous Animals;" Professor Perroncito, of Turin, on "Communication of Disease from Animal to Man;" and Professor Klein, on "Cases of Scarlet Fever brought about by milk from Cows suffering from an infectious udder disease." In the rather warm discussions that took place on all these papers, one point united all suffrages—the necessity of constant, proper inspection to insure the prevention of the issue of diseased food for human consumption, and to secure the utmost cleanliness in dairies, slaughter-houses, and all places where food is stored or prepared.

In the same section, Dr. B. Carsten related the measures that had been successful in stamping out trichinosis in the Netherlands. I have also pleasure in recording that Professor Crookshank, in his paper on "Actinomycosis," bore warm testimony to the observations on this disease made by Mr. A. Park, of Hobart.

In the Chemical Section, Dr. Otto Hehner communicated a paper on "The Antiseptic Treatment of Food," and Mr. Goodfellow one on "Recent Hygienic Improvements in the Manufacture of Bread."

In the Bacteriological Section, the eminent President, Sir Joseph Lister, made the comforting statement that mutton was always free from tubercle, so that there is absolute safety in its consumption so far as tuberculosis is concerned.

School Hygiene.

Physical and mental condition of children in Schools.

43. It has been already mentioned that a Section of the Congress was entirely devoted to the Hygiene of Infancy, Childhood, and School Life, and a great amount of useful work was done in it. In the first place, as to the relation that should exist between the physical and mental condition of children and their education, many papers were read, the most important one being by Dr. Warner on "The Scientific Observation and Study of Children in Schools, and the Classes into which they may be grouped." The same gentleman also read a paper on another branch of the subject in the Division of Demography. The observations were taken for a Joint Committee of the British Medical Association and the Charity Organisation Society, and 50,027 children were examined in 106 schools. Dr. Warner's Report is based upon viewing each child while still, and also while performing some simple action. "The children being drawn up in ranks, a standard at a time, or in groups of about forty, the observer can view each individual. It is convenient to fix the child's eyes while he is under observation by asking each in turn to look at an object held up [the doctor used a shilling at the end of a pencil]. The trained observer can read off the physiognomy of the individual features and their parts, the facial action and expression, the eye movements, the balance of the head and body, &c., as quickly as a printed line. The children are then requested to hold out their hands straight, the action being shown them momentarily; the action and balance are noted as a further indication of the condition of the nerve system. Finally, the palate is inspected in each case. At each stage children presenting deviations from the normal are asked to wait with the teacher. Any cases not picked out may now be presented by the teacher. The selected cases are kept; the rest are dismissed to the class-room. Each of the selected cases is then reviewed individually, and the schedule form is filled in. . . . . The teachers' reports of mental status are filled in by them afterwards. In this method a fairly uniform standard of observation can be maintained. A tape measure for the head circumference is useful. Occasionally some detailed inquiries may be made, or some brief mental examination conducted with the teacher may be desirable; but, as a rule, no question was asked of the child." The result of the examination was that 40,851 of the 50,027 children were passed as well made, with nerve system well acting, and as average or bright at school-work. The rest were reported on in eleven groups—not groups of distinct children, but of conditions, many of the conditions being correlated. Thus, in the group of 2003 children described as of "low nutrition" a high degree of correlation existed, as co-existing with it there were "defects in development" in 1459 of them; "abnormal nerve-signs" in 1233; both these conditions together in 793; and "dull in school" in 797. It was not intended to represent children as exceptional from an educational point of view because some defect was present. Analysis of the various defects shows them to be of different importance. This subject was treated in a paper communicated to the Division of Demography. The general scope of Dr. Warner's paper was to shew the desirability of having a physical as well as a mental examination of children in schools, with the view of ascertaining what modified and adapted education should be given to those shewn to need it.

The paper gave rise to considerable discussion, in which much information was given respecting "auxiliary schools." Dr. Shuttleworth was sure that there were numbers of children requiring special attention and special means of instruction. The London School Board had established three such schools, and three years ago such schools had been established in Germany, Norway, and Denmark. He had visited the schools in Christiana and Bergen, where only three hours of instruction is given in the day, where every teacher has charge of only ten children, where a certain number are, after a year or two, able to go back to the ordinary schools, and where others are entirely instructed up to the standard of confirmation, the passport into Norwegian civil life. These results were so important that they should not be neglected in England, where the class of children for whom such treatment was necessary, when they did not get it, often sank down even into the criminal class. Dr. Peeke Richards, of Hanwell Asylum, testified that the tendency was for these children to graduate to either the workhouse or the asylum when left without special training. Dr. Foster, of Vienna, and Dr. Jacobi, of New York, pointed out that if strong and feeble were schooled together, the whole standard of education must be lowered—a condition of things almost of graver consequence to the strong than to the weak. After much confirmatory speaking, the following Resolution was carried:—"That, as according to the returns prepared by Dr. Warner on the feeble-minded, epileptic &c., it would appear that an appreciable number of children, though not imbecile, are more or less defectively developed in brain and body, for their training and education special arrangements are necessary, and, in the absence of such arrangements, there is great probability of grave moral and mental deterioration."

In connection with the same subject, and in the same Section, there were papers by Dr. Shuttleworth on the "Care of the Mentally feeble as distinguished from the Imbecile Child;" by Dr. Beach, on the "Care and Treatment of Epileptic, Feeble-minded, and Imbecile Children;" by four German Professors on "A proposed Method of collective Investigation into the Condition of Feeble-minded Children;" and special papers by experts with respect to the Hygiene of Speech, Sight, and Hearing, and on the Education of the Blind and of Deaf Mutes.

Overwork, &c. in Schools.

44. The converse of the above subject of the relation of the physical and mental condition of children to their education, namely, the relation of their education to their physical and mental condition was also considered. Dr. Sturges, Physician to the Hospital for Sick Children, read a paper on the "Physical indications of Injurious Schooling," which was devoted to directing the attention of teachers to nervous disorder in children—especially in girls—due to circumstances of school life, such as overwork, punishments, examinations, &c. An account of "An Experiment concerning over-pressure of Brain" was read by Professor Burgerstein, of Vienna. One hundred and sixty-two children in two classes of girls of from 11 to 12 years of age, and two of boys varying from 12 to 13 years of age, were taken to demonstrate the fluctuation of brain power in children during one hour's occupation with a familiar subject. The subject was arithmetic, in simple addition and simple multiplication. The children worked at them for 10 minutes, then were allowed five minutes' rest. This was repeated four times, making up the hour. During the hour about 135,000 figures were dealt with, and 6500 mistakes made. During the first working period of 10 minutes about 31,000 figures were dealt with, and 1250 mistakes made;

during the second	35,000	,,	1700	,,
,, third	34,000	,,	1950	,,
,, fourth	35,000	,,	1600	,,

It will be seen that in the first period 23 per cent. of the work was done and 19 per cent. of the mistakes made; in the second, 26 per cent. of work to 26 per cent. of mistakes; in the third, 25 per cent of work and 30 per cent. of mistakes; and in the fourth, 26 per cent. of work to less than 25 per cent. of mistakes. The Professor argued, from the manifest inferiority of the work in the third period, that children of the ages stated become fatigued in three-quarters of an hour; that organic material is gradually exhausted, diminishing the power of work to a certain point in the third quarter of the hour, returning with renewed force in the fourth: and he therefore proposed resolutions, which were carried, recommending, first, that further researches should be made into the question of mental overpressure in schools; and, secondly, that until such researches were made, it was desirable to limit school lessons on a particular subject to three-quarters of an hour.

Physical Education.

45. The important subject of Physical Education received a great deal of attention, and it may safely be said that the paper on the subject by Mr. White, Chairman of the London School Board's Committee, on Physical Education, was the most successful contribution to the Congress from a popular point of view, as it was practically illustrated with respect to each detail referred to by a number of children from one of the Board schools, under Miss Harrison. Mr. White restricted the use of physical education to the securing of the best conditions for mental effort by promoting the best physical conditions; to the instruction which leads to uniform and harmonious development of the whole body of the individual child, with due regard to his physical idiosyncrasies, or any accidental or abnormal characteristics which makes him differ from the ordinary normal child. The conditions with which school instruction limit the possibility of physical education, such as time and place, were considered, and it was recommended that short exercises should be given not near meal times but in the middle of mental exercises. The advantages attending it were pointed out not only in regard to hygiene, but also in regard to school discipline and other matters. The conditions of its being successfully taught were explained, as regards the nature of exercises, the dress most suitable—musical accompaniment being discouraged except in infant schools. Hints for typical lessons were given, and the principle laid down that they should embrace one or more movements for each part of the body—first simple, then more complicated. The use of apparatus is deprecated. The length of time necessary and desirable should be sufficient to afford recreation and relief from the intellectual labour of the preceding and following lessons, but should not be so long or of such a character as to produce fatigue. Weak pupils may require individual attention, and the teacher ought to know enough physiology and anatomy as to be able to judiciously bestow such attention. The Education Department has recognised Physical Education for the first time in the 1891 Code of Regulations, Article 12*f*, providing that "in making up the minimum time constituting an attendance may be reckoned time occupied by instruction in suitable physical exercises

and military drill." Mr. White's views as regards school physical education may be summed up as aiming not at localising muscular effort over a limited region, but to generalise it by distributing it over a large number of muscles at the same time: not to induce fatigue, but to bring all the functions into activity. "Its aim in school is hygienic, and not to promote skill."

Dr. Broman, of London, read a paper on "Physical Exercise in the School—a part of the School Hygiene;" Sir P. Magnus on "Manual Training in its relation to Health;" and there were other papers incidentally connected with the subject.

In the general discussion which followed, illustrations were given of foreign systems—especially the Swedish—and great stress was laid on the undesirability of adding to school hours by tasks to be prepared at home.

General School Hygiene.

46. Subjects in connexion with the General Hygiene of Schools were treated by Dr. Shelley, Medical Officer to Haileybury, who read a paper on "Epidemics in Schools," and Dr. Malcolm Morris. In the Section of State Hygiene, Dr. Newsholme read a paper on the "Teaching of the Laws of Health of Schools."

Training of Architects.

47. The subject of the necessity of special education in sanitary matters being undergone by all those who have to undertake the administration of sanitary matters, or the carrying out of sanitary work, received much attention. In the Section of State Hygiene, a paper by Mr. W. H. Seth-Smith, President of the Society of Architects, on "The Statutory Education and Registration of Architects" was followed by a discussion and the passing of a Resolution affirming the desirability of such statutory examination and registration. When this came to the knowledge of the Section of Architecture, a protest was entered against the action of the Section of State Hygiene, and no further action was taken in the matter.

Sanitary Inspectors.

A paper was read on the "Education, Training, and Status of Sanitary Inspectors," and the Annual Report of the Council of the Association of Sanitary Inspectors of Great Britain was read, and a discussion held on the quality of the education necessary for Inspectors, and the kind of examination that should be held before certificates of competence were given.

Very important action was taken in reference to the trade that has more to do than any other with domestic hygiene. The Plumbers' Company of London—one of the great City Guilds—has for some years been devoting much time, money, and attention to the subject of improving the practical education of the workmen connected with the trade both in London and the country generally. Advantage was taken of the meeting of Congress to hold a special meeting to further this object. The meeting was a large one, and among those present were representatives from the following towns in England and Wales:—Birmingham, Bradford, Brighton, Bristol, Cardiff, Hull, Leeds, Leicester, Lincoln, Liverpool, Manchester, Newcastle, Nottingham, Plymouth, Sheffield, Southampton, Swansea. Scotland—Aberdeen, Dumfries, Dundee, Edinburgh, Glasgow, Inverness. Ireland—Belfast, Cork, and Dublin.

Sir Douglas Galton presided, and the Master of the Plumbers' Company (Mr. W. H. Bishop) read a short report he had prepared on the subject, in which he referred to the efforts made by the Company to extend among workmen a technical knowledge of the art of plumbing by the registration of qualified men. It was now about seven years since this work had been begun, and at the present time there were 950 persons engaged in the chief towns of the United Kindom and Ireland in assisting to carry out the objects of the movement. The movement had, however, now reached a position when it was felt that it was necessary to give some legislative encouragement to it, and the Court of the Plumbers' Company had drawn up a draft Bill which they considered should be presented to Parliament during the next session, for the purpose of carrying out the proper education and registration of plumbers in the United Kingdom.

The Right Hon. J. Boyd, Lord Provost of Edinburgh, then moved the following Resolution:—

"That this special meeting of the International Congress of Hygiene, assembled to consider the necessity for securing the greater sanitary efficiency of the plumbers' work and drainage of dwelling-houses and other buildings, desires to record its opinion that an organised and efficient system of registration of qualified plumbers is essential to the protection and preservation of the health of the community, and that such a system having been established in the chief cities and towns of Great Britain and Ireland by the protection of the Worshipful Company of Plumbers, London, and the plumbers and sanitary authorities of those places, the time has now arrived when application should be made to Parliament for powers enabling a council of competent jurisdiction and authority to take measures for systematically promoting technical education among plumbers in all parts of the United Kingdom, and regulating the practice of those plumbers who are enrolled as registered plumbers."

His Lordship said it was generally admitted that there was a great need for dealing with such an important subject as the registration and education of plumbers in a manner which had not been before attempted. In seeking to bring this about, the Plumbers' Company had done an immense amount of good, and had given the public the benefit of their experience.

Mr. Bailie Crawford (Chairman of the Health Committee of the Corporation of Glasgow), in seconding the Resolution, remarked that in Scotland the title of the subject was really understood to be plumbing reform. His connexion with the movement was as the Chairman of the Health Committee of the Corporation of Glasgow, and he had some short time ago attended a conference composed of practical men in the trade; and bearing in mind the fact that Scotchmen were held to be a hard-headed race, who were not given to imaginary views, he considered that the unanimous approval of the movement which was given at that conference was a compliment to the Plumbers Company, and proof of the practical character of the scheme.

The chief representatives of all the other cities supported the resolution, which was carried with but one dissentient voice.

In the report prepared by Mr. Bishop, and above mentioned, particulars are given of the course of instruction for plumbers formulated by the representatives of the plumbers' craft, acting in concert with leading educational authorities, and so arranged as to secure the teaching of scientific principles in a manner intelligible to ordinary apprentices, and useful to plumbers in their everyday work. The course includes instruction in those parts of the different branches of physical and chemical science which have a direct bearing upon plumbing and drainage works. By means of a suitably graded syllabus, divided into three parts, a continuous and progressive course of study is provided, in combination with technical instruction and workshop practice. Examinations correspond with the three stages of instruction, and the candidates passing the third or final examination are arranged in three classes :—Honours, first-class, and ordinary. Those passing in the ordinary class are eligible for certificates of registration as journeymen, and those passing in either first-class or honours are eligible for certificates of registration as masters. Candidates for certificates as masters are required to be acquainted with special subjects in hydraulics, heat, and sanitation in the final course, and those candidates only who satisfy the examiners in these subjects are entitled to honours. To encourage the highest efficiency of craftsmanship combined with scientific knowledge, the Worshipful Company of Plumbers, under special conditions, confer the freedom of the Company upon plumbers passing the final examination in honours. The educational system includes special classes, lectures, and demonstrations for those qualifying themselves as teachers of plumbers' classes.

Anthrax.

48. The liability to certain diseases of persons following certain callings was the subject of two papers, one by Professor Chauveau, of Paris, and one by M. Duguid, F.R.C.V.S., both being on Anthrax, under its various names and forms of Charbon, Miltzbrand, Woolsorters' Disease, &c. Preventive measures, especially as regards animals, such as protective inoculation, were recommended to be undertaken and enforced by legislation.

Influence of occupation on health.

49. The larger subject of the influence of occupation on life and health was exhaustively considered in the Division of Demography. Two papers—one by Dr. Ogle, of London, and the other by Dr. Bertillon, of Paris—were read. Tables of comparative mortality were given of men from 25 to 65 years of age, not only as regards all causes, but as regards particular diseases which may be supposed to especially affect people following certain occupations. The effect on mortality of the following causes are shown—(1.) Working in a cramped attitude, and especially in one that interferes with the action of the thoracic organs. (2.) Overwork, and especially sudden muscular efforts and strains. (3.) Dealing with noxious substances, such as lead, phosphorus, mercury, infected hides, &c. (4.) Working in ill-ventilated and over-heated rooms. (5.) Alcoholic excess. (6.) Liability to accident. And (7.) Exposure to inhalation of dust of various kinds. Of course, the tables cannot be given here, but I may illustrate those of Dr. Ogle by saying that if in the three years ending 1883 equal numbers of living persons following different occupations had been taken, it would have been found that, for every 100 clergymen who died, 202 doctors, 300 filemakers, and 397 servant men employed in inns, would have died : that for every 100 fishermen, who work in the open air, who died of phthisis and diseases of the respiratory organs, 217 drapers, who work in confined air, and 317 printers, who work in highly vitiated air, would have died : that for the same number of fishermen the following numbers of people who work in dust-laden air would have died—bakers, 201 ; cotton-workers, 274 ; cutlers, 384 ; earthenware-makers, 565 ; Cornish miners, 580.

Alcoholism.

50. The effects of Alcoholism on Public Health were also considered in the Section of Preventive Medicine, in papers written by Mr. J. G. Phillips, of London, and Professor Westergaard, of Copenhagen. A very long discussion ensued, in which most of the leading physicians present took part. The extreme view was propounded by Dr. N. Kerr, who urged the prohibition of even the limited use of intoxicants; their exclusion from social, political, and sacred functions; their being scheduled as poisons under the Pharmacy Acts; and the prevention of their manufacture. He found no supporters, the general view being that further legislation was required with respect to habitual drunkards and the prevention of the sale of liquor to children.

Effect of sanitary work.

51. A great many illustrations were given throughout the Congress of the wonderful effect of sanitary work in Great Britain. More was made of this by the foreign delegates than even by the British ones, and warm tributes of admiration were paid to the example set to the rest of the world. The whole of Sir Joseph Fayrer's opening address in the Section of Preventive Medicine may be said to have been a history of the effect of preventive measures on public health—the mortality in England having declined from 42 in the 1000 in the decade 1681–90 to about 18 in the decade 1881–90. Perhaps the most striking statements made were, that compulsory vaccination had diminished the death-rate from smallpox from 57.2 in 1840 to 6·5 in 1880 in the 100,000; and drainage work had brought down the mortality from typhoid fever from 39 in 1869 to 17 in 1890 in the 100,000.

The beneficial effect of sanitation is not only shown in general improvement, but is especially marked in particular cases. For instance, the death-rate in the maternity hospitals of European countries has been reduced by the use of antiseptics from 34 in 1000 cases to 5 only.

General use and influence of the Congress.

52. There were many other subjects treated, which a glance at Appendix I. will show well deserving of attention, but which I do not find sufficiently in my province or my capacity to treat; but, as I have already said, I gladly hold the information I have at the disposal of those who wish to make use of it.

53. I believe the Congress fulfilled the intentions of those who organised it, and that it has been and will of be immense use in promoting the object it was intended to fulfil—not only to enlarge sanitary science, but to diffuse it—and so secure the greatest blessing to the commonweal—the public health. As the Prince of Wales well said at the opening meeting—"But my hope is that the work of this Congress may not be limited to the influence which it may exercise on sanitary authorities. It will have a still better influence if it will teach all people, in all classes of society, how much everyone may do for the improvement of the sanitary conditions among which he has to live. I say distinctly 'all classes,' for although the heaviest penalties of insanitary arrangements fall on the poor, who are themselves least able to prevent or bear them, yet no class is free from their dangers or sufficiently careful to avert them. Where could one find a family which has not, in some of its members, suffered from typhoid fever, or diphtheria, or other of those illnesses which are especially called 'preventible diseases?'. Where is there a family in which it might not be asked, 'if preventible, why not prevented?'"

II.—SANITARY WORK AND ADMINISTRATION.

54. As I have already done in regard to the actual work of the Congress, so I propose, in giving an account of the present condition and methods of sanitary work and administration in the places I visited, to arrange what I have to say under headings having reference to the various subjects treated rather than to the order of time at which my visits occurred, or of the towns and cities inspected. Some of the subjects to be thus treated have been already referred to as having been considered at the Congress; in such cases what will be further said will usually be in the way of practical illustration of what was necessarily, in the papers read, and in the discussions that followed, the enunciation of scientific principles. But I shall also have to treat of matters that were either only incidentally, or not at all, mentioned at the meetings in London. During these visits of inspection I determined that I would see and consider everything without prejudice, and with the view, not of fortifying preconceived opinions, but of learning whether they ought to be modified in consequence of new developments of science.

Sewerage, or Sewage Collection.

55. Everywhere, the methods adopted for collecting the sewage of towns have a great deal to do with the question of its ultimate disposal, for on the methods of collection depend the uniformity or otherwise both of the quantity and quality of the sewage. The sewerage system adopted in a place is often the result, not of the deliberate judgment of the engineers of to-day, but of their having to make the best of the works constructed at a time when town drainage was but little understood. This was especially the case in London, where the incorporation into the sewers of the old water-courses such as the Fleet Ditch, the Ranelagh, and others, virtually rendered impossible the adoption of the system of separating the rain-water from the sewage proper. One consequence of this has been that every year more and more money has had to be spent in providing storm-water overflows, which now after every shower of rain have to relieve the congested sewers by discharging part of their contents directly into the Thames without any treatment. Another consequence has been the greatly increased cost of sewers, as their dimensions are naturally so much greater than those of sewers that have only to convey sewage. This is especially to be remarked at Paris, where the street sewers are of enormous size, varying from 14′ 6″ × 16′ 8″ to 6′ 7″ × 3′ 3″, and where up to the end of 1888 nearly 550 miles in length of these sewers had been built. Many of these sewers have a comparatively flat bottom in which is a narrow channel for the ordinary flow of sewage, and a rail is laid on each side of this channel on which run the waggons used for carrying off the solids (sand, &c.) washed in from the roadways—which solids are sometimes caught by automatically-working waggons and mud-boats, and sometimes loaded into ordinary waggons by men. In some parts of Paris large perforated metal buckets are placed at the outfall into the sewers of the drains from the street gratings, for the purpose of catching the sand and rubbish washed in. There is always a man-hole where these recipients are placed, and they are emptied as often as needed by being drawn up by a small portable winch which is taken round for the purpose.

Storm-water not separated from Sewage.

London.

Paris.

Separate system.

56. In speaking of the Separate system, it must be always understood that the complete separation of rain-water from sewage is in every case practically impossible, and consequently provision must be made for receiving into the sewers such rain-water as cannot be separated—for instance, the rain-water falling on paved surfaces such as house-yards that are drained by grated catch-pits, as such catch-pits receive a great deal of house-sewage and slops. The proportion that such rain-water bears to the sewage, of course, varies very much in accordance with the density of population in the town to be drained. But, as in designing sewers provision should be made for not only the present population of a district, but for the population that will in all probability occupy it in a more

Sewer capacity.

or less near future, the sewers are usually made to suffice for such increased population. In Europe, engineers have usually constructed sewers large enough to carry four times more than the sewage of the eventual population calculated upon—that is, to carry a given quantity of sewage together with three times that quantity of rain-water. Thus, Sir Joseph Bazalgatte designed the London sewers to carry a daily quantity of 106,000,000 gallons of sewage and 324,000,000 gallons of rain-water; and the works now being carried out at Marseilles provide for 21,000,000 gallons of sewage and 68,000,000 gallons of rain-water a day. This provision also agrees with that proposed to the Victorian Royal Commission by Mr. Thwaites for the sewers of Melbourne—his figures being 42,000,000 gallons of sewage and 120,000,000 gallons of rainfall a day. It appears that in America it sometimes happens that no provision is made in the sewers to carry off any rain-water. In London, and other towns where rain-water cannot now be separated from the rest of the sewage, each proprietor is called on to provide the means of conveying what falls on his property to the sewers: for instance, the house-drainage regulations of the Vestry of St. Martin's-in-the-Fields, Westminster, enact that "No rain-water pipe will be allowed to deliver on to the footways or roadway; water from the roofs, bay windows, cornices, &c. must be taken into the system of house drainage." On the other hand, where the separate system is adopted and the quantity of sewage to be carried is lessened as much as possible, the rain-water from buildings is sent into the street gutters so as to form part of the road-drainage, and not of the house-drainage. Thus, at Southampton a by-law provides that all rain-water shall be conveyed from roofs, cornices, and other parts of buildings to the channel in the road by means of iron troughs or pipes.

Construction and accessories of Sewers.

57. Very much greater attention is now being paid everywhere to the methods of construction of sewers, and to the means for enabling them to be properly inspected, cleansed, and ventilated. Great improvements have been made in the manufacture of materials and appliances, and a great number of new apparatus, some of especial value, have been invented and introduced. Most of these I shall have to notice in connexion with house-drainage rather than with systems of sewerage.

Inspection of Sewers. Man-holes.

58. One matter to which great attention is being paid is the proper inspection of sewers. Where formerly man-holes were few and far between, now they are placed so as to virtually command the whole of the public sewers—even those constructed of earthenware pipes. For instance, in the contract work just commenced for the sewerage of Marseilles, on a length of about 121 miles of outfall and collector sewers there are 2020 man-holes—about one in every hundred yards. This is about the usual provision. These man-holes are sometimes altogether closed with air-tight doors, but oftener have covers with air-holes to serve as inlets for fresh air to ventilate the sewers. Where this is done care should be taken that they cannot become outlets for foul air, as used to frequently occur, and at Adelaide to such an extent as, until remedied, to greatly undo the good done by the sewerage works. At Sheffield and elsewhere, the man-hole covers with air-holes are also fitted with dirt-boxes to catch the gravel and sand from the street that would otherwise fall into the sewers.

Ventilation of Sewers.

59. The principles that underlie the proper ventilation of sewers have been already referred to in a former part of this Report. But underlying those principles themselves is the fact that the measure of the necessity that a sewer has to be ventilated is equally the measure of the faultiness in some respect or other of the sewerage system of which it forms a part. The faultiness of a sewer that requires much ventilation will probably consist in either the excess of its dimensions, the feebleness of its gradient, the imperfection of its construction, or in the insufficient quantity of water used as the vehicle for carrying off its sewage. Any of these imperfections will cause such a stagnation in the flow of the sewage as will have for result a fermentation and disengagement of noxious gas, and the more or less this occurs the more or less will be the need for sewer ventilation. Apart from this disengagement of gas from putrefying sewage, there is disagreeable smell from fresh sewage that ought to be hindered from giving offence, and to do this sewers should be ventilated on the principles above referred to. These principles are not yet put into practice in many places. The following details came under my observation :—

Croydon.

At Croydon there were, at varying intervals along the roads and streets, six and eight-inch ventilating pipes taken from the sewers and carried up the trees forming the avenues, and up the house-sides. There are also isolated columns about 25 feet high, where other support for the pipes was unattainable. Most of these ventilators seemed to be placed close by man-holes, as if to remedy the nuisance that had actually been caused by the escape of bad smells from the sewer openings. In a paper read by Mr. Walker, the Borough Engineer, at the meeting of the Association of Sanitary Engineers held at Croydon in July, 1890, he described the various methods of sewer ventilation which had been tried there. Up to 1876 the man-hole openings were furnished with charcoal trays through which the sewer-air had to pass before it reached the air-holes in the covers. The charcoal soon lost its filtering power, and four men were constantly employed changing and reburning it. The system was then discontinued. Since then, the town has been an open field for every inventor who had a nostrum for sewer ventilation. The best results obtained from any of the schemes tried were those from one of Keeling's Destructors, having all the recent patented improvements in it, and these best results were not equal to those obtained without any special apparatus. The Keeling Destructor was placed on high ground at the head of a nine-inch sewer, in which, by burning eight cubic feet of gas an hour, it seems to have induced a current of about 1180 yards an hour: in the ordinary ventilating pipes, without any apparatus or any consumption of gas, the average current induced was about 1430 yards an hour. It is not stated in either case how far the influence of this ventilation was felt. I did not see that in any case any precautions were taken to prevent the upcast ventilating pipe from becoming—say, in a high wind—a downcast pipe, with the effect of blowing the sewer-air out of the man-hole openings.

Liverpool. In the year 1872, at Liverpool the Health Committee of the Corporation expended more than £10,000, in fixing about 1000 "Archimedean screw ventilators," six inches in diameter, on the branch sewers from court-yards in the more densely inhabited parts of the city. They do not seem to have done much good, and, as Drs. Parkes and Sanderson reported that notwithstanding their mechanical efficiency "they exercise no practical influence in preventing the escape of sewer-air into the streets and houses," no new ones are fixed. A great many of the houses in these court-yards have been demolished in connexion with the sanitary improvements of the city, railway extensions, &c., so that now only about 880 of the screw ventilators are left, and their maintenance costs about five shillings a year each. There are at Liverpool over 250 miles of brick main outfall and collector sewers, discharging into the Mersey by ten outlets, which are tide-locked every tide. These sewers are ventilated by grids or openings in man-hole covers at every 80 yards of their length on a system begun in 1873 by the then Engineer to the City, Mr. G. F. Deacon. Each of these ventilators has a clear opening of at least 63 square inches, and over 200 miles of the sewers have been thus ventilated, as well as a considerable part of the 267 miles of pipe sewers. The grids and openings in the man-hole covers must act as both inlets and outlets, as no other means of outlet for sewer-air are provided, but their size and frequency should, under ordinary circumstances, be sufficient to secure ventilation without nuisance.

Paris. At Paris means are taken to prevent the using of rain-water pipes from roofs to ventilate the sewers, as each one communicating with a sewer has to be fitted with a flap valve to hinder the air of the sewer from rising into the pipe.

Flushing of Sewers. 60. Insomuch as sewers, as distinguished from drains, do not usually need to be flushed out at frequent and regularly recurring intervals, it is not now very usual to employ automatic means to secure this flushing. In fact, the more general the automatic flushing of drains becomes, the less will there be of necessity to flush sewers at all, except at rare intervals. In the large towns it is now almost universally the practice to perform this service by tank-carts when necessary. At Birmingham they have a number these, varying in capacity from 1800 gallons to 330 gallons, and a continually increasing quantity of water is being employed for flushing purposes. During 1890 more than fourteen million gallons were used, and during the first three months (winter) of 1891 about four and a half million gallons were used.

Birmingham.

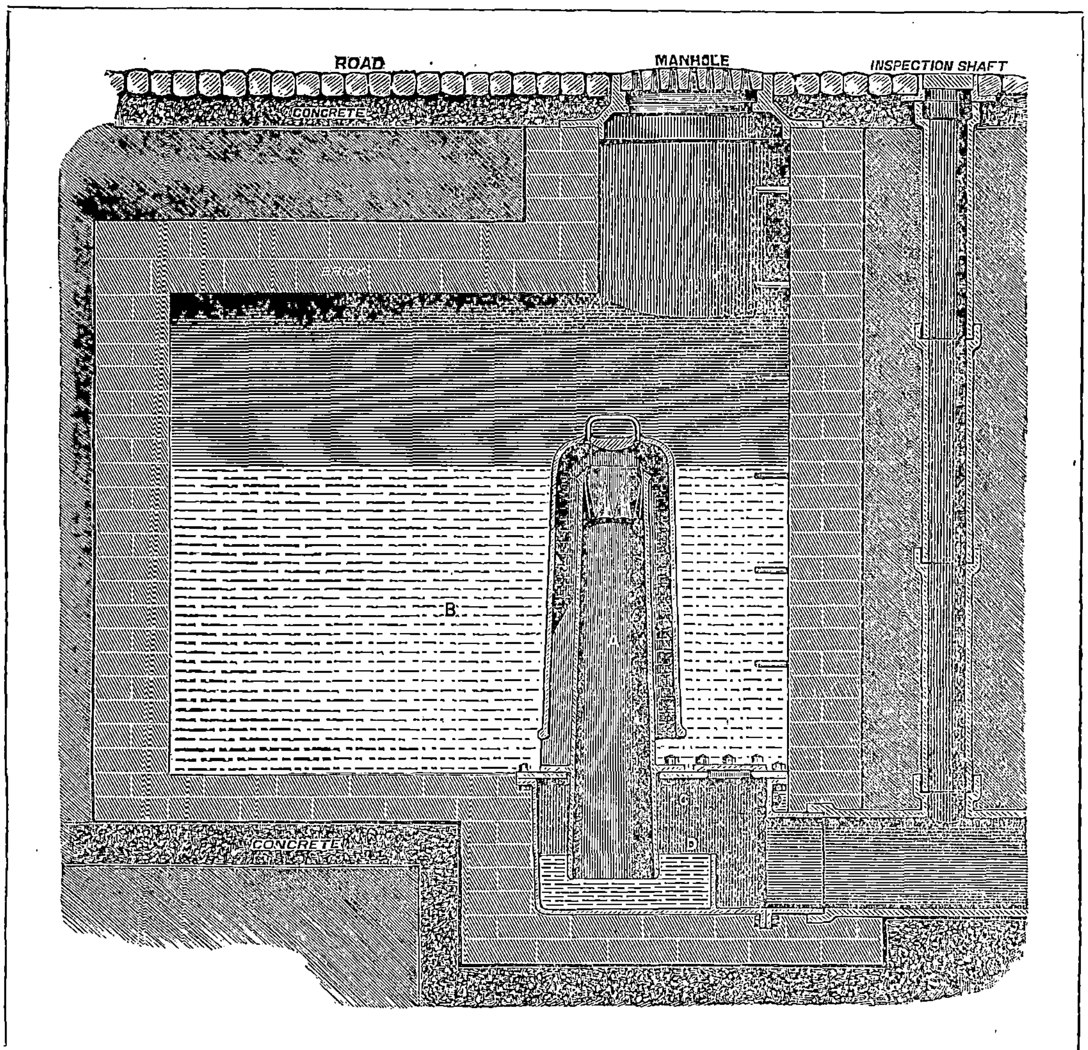
Liverpool. At Liverpool the Corporation have a regular service for the periodical flushing of the smaller sewers and house-drains, every one of which is thus cleansed twice a year; those serving public institutions are flushed at intervals varying from a fortnight to three months.

Marseilles. In the large towns in France the flushing is usually done by having flushing-chambers built in connexion with the sewers. Thus, in the sewer system of Marseilles provision is made for constructing nearly 800 of these chambers, capable of holding from 880 to 2200 gallons each.

Croydon. In some of the smaller towns automatic flushing apparatus is still used in connexion with the sewers. At Croydon there are 40 tanks built in concrete, and capable of holding from two to three thousand gallons each, and fitted with automatic apparatus to act once a day; and thirteen iron tipping tanks holding about 100 gallons each, and acting four times a day. In other parts of the town there are 85 flushing-stations in the shape of man-holes near the water-mains, and used by attaching hose to the fire plugs. Where there are no available water-mains, water is carted to the man-holes in special flushing vans. Mr. Walker, the Borough Engineer, says: "Taking working expenses, to pump, supply, and deliver the water into account, the cost of a flush from an automatic tank is less than that of a flush from a water van."

At Eastbourne, tanks with automatic flushing apparatus were also in use. In fact, it would be difficult to name any important place in the United Kingdom where they are not used either in connexion with public sewers or private drains.

Self-acting flushing apparatus. 61. There are various arrangements in use of automatic apparatus for this flushing. That which I most frequently saw in use, and which appeared to work with perfect regularity and certainty, was Stone's new patent "Field's" self-acting flushing syphon, as made by Stone and Co., of Deptford, London. The engraving on the opposite page illustrates in section the construction, method of placing, and action of this apparatus, as applied to public sewers. A brick or concrete tank of the desired capacity is built where necessary—in the drawing it is shown at the head of a pipe sewer. In this tank the syphon (A) is fixed. The syphon is an annular one, consisting of a double pipe, one being inside the other, and the outer one being the shorter limb, or inlet, and the inner the longer limb, or discharge. This syphon is fixed upon the top plate of a trapping-box (C), placed at the bottom of the tank, and the discharge limb of the syphon passes through this top plate to plunge about half an inch into the water of the trapping-box—and the height of this water is regulated by the weir (D). The water used for flushing is delivered into the tank (B) by a tap which is regulated so as deliver the necessary quantity of water in the time at which it is arranged to periodically flush. Thus, if the tank be of 1000 gallons capacity, and it be determined to flush the sewer once a day, the conduit tap is opened sufficiently to give a dribble that will amount to



1000 gallons in the twenty-four hours. The action is as follows :—While the water is rising in the tank no discharge can take place, but when it has risen to the level of the top of the longer limb it, of course, would begin to overflow, but the patent lip of peculiar form fitted at the top of this limb causes it to accumulate there until it reaches a certain point, when it starts off with a rush, and the corrugations in the lip dividing the water into several streams makes it displace a large quantity of the air in the discharge limb, and the syphon action is thus started. As the waterway in both parts of (A) is very great, the whole of the water in (B) is almost instantaneously discharged, with correspondingly vigorous action in the sewer. When the tank is discharged, the whole operation recommences with the slow filling of it again.

The great advantage of this apparatus in comparison with others consists in its not needing a small separate syphon or air-pipe to start the syphon action in the larger one—the action being started by the arrangement of the lip. I shall have to speak of adaptations of it to flushing in connexion with house-drainage, trough closets, &c. And for its water supply, any source can be taken advantage of—even the sewage itself.

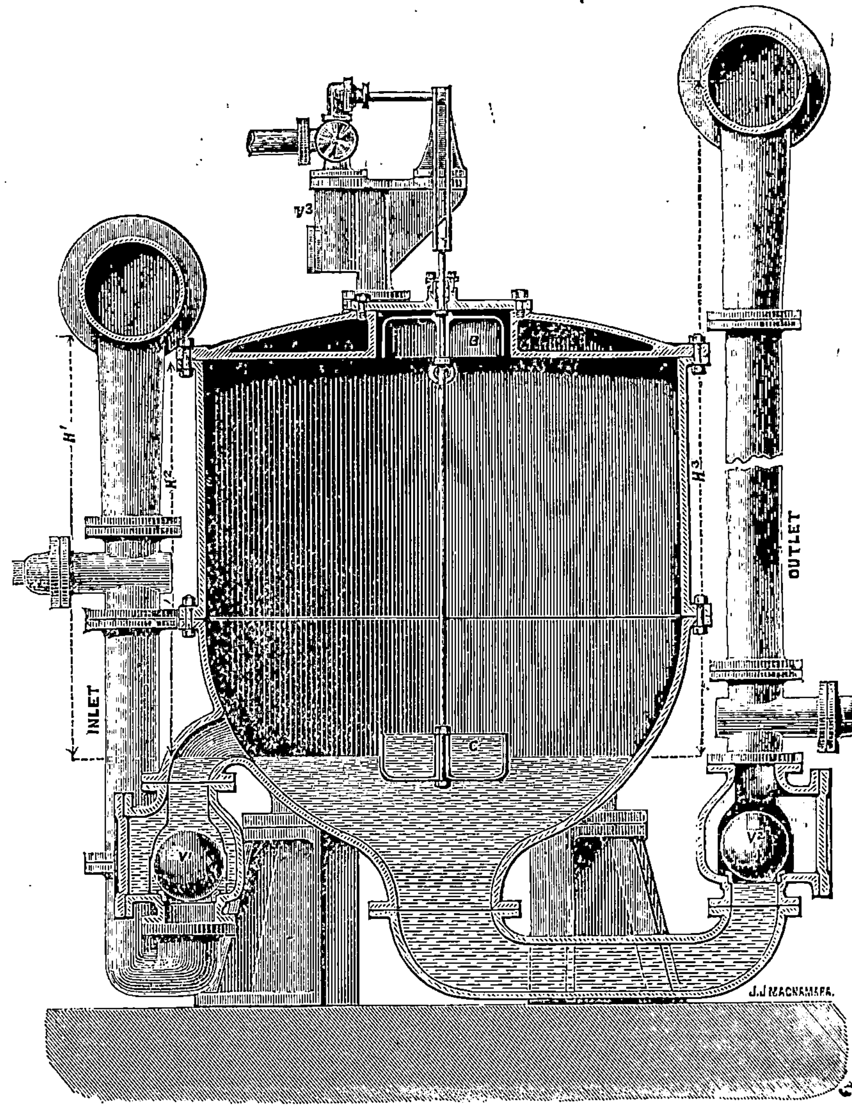
62. There are very few towns in which sewage can be disposed of entirely by gravitation, except at the cost of the construction of very deep sewers in those places where natural undulations of the surface intervene so as to form more or less distinctly separate drainage basins. The question of sewage-lifting or pumping is therefore a very important one; and it is so not only in places where it must be done to secure an outfall—for instance, in London, where many parts are actually below high-water level—but also in places where it offers an alternative worth considering to the construction of costly sewerage works. And it is in connexion with this matter that within the last ten or twelve years the greatest improvements have been introduced in both principles and appliances. These improvements are so great and of such a character and nature that they are probably destined to revolutionize the sewerage systems of the future. They are the invention of Mr. Isaac Shone, of the firm of Shone & Ault, engineers, of Great George-street, Westminster, and are known as the Shone Hydro-Pneumatic System. Their main feature consists in the raising of sewage and other liquid and semi-liquid substances by means of compressed air applied directly in machines that work automatically—applied directly, that is, the compressed air acts immediately upon the liquid, and is not used to work pumps or other machines for lifting it. The air used is

Sewage-lifting or pumping.

Shone's Hydro-pneumatic System.

compressed by steam power, and this steam power is being obtained more and more usually every day by utilizing the fires of refuse destructor furnaces for heating the necessary boilers. In a subsequent part of this Report it will be seen that in some places by this utilization the compressing of the air is done without entailing any special outlay whatever, except that upon the prime cost of the machines.

With the help of the accompanying drawing, showing in section one of Shone's "ejectors," the method of action of the system will be readily understood. The ejector is supposed to be placed in a brick chamber built under the roadway at the point on the line of the sewer where it is desired to lift the sewage from one level to another. The sewer is shown in section on the left hand side, and from it an iron pipe marked "inlet" delivers the sewage by gravitation into the ejector, which consequently must be placed sufficiently below the level of the sewer to allow the sewage to rise to the top as high as the bell marked (B), and to do this it raises the ball valve (v^1) on the inlet pipe. The bell (B) and the cup (C) are both fixed on a spindle, the rising and falling of which works the slide-valve of the automatic gearing connected with the compressed air main. The slide-valve box is marked (v^3), and the compressed air pipe is shown coming into it from the left. When the sewage rises in the ejector up to the bell (B), the atmospheric air in the bell is enclosed, and as the sewage still rises it raises the bell and its spindle sufficiently to shift the slide-valve and allow the compressed air to pass through the opened ports on to the surface of the sewage in the ejector. The amount of compression given to this air is, of course, dependent on the duty it has to do, so if it be necessary to lift the sewage a considerable height, or to force it along a considerable length of main, a corresponding degree of compression has to be given. Immediately the compressed air acts on the surface of the sewage, the pressure shuts down the inlet valve (v^1)—preventing the sewage from returning into the sewer—and opens the outlet valve (v^2), and forces all the contents of the ejector through the outlet main. When the level of the sewage is thus reduced below the level of the cup (C), the weight of the liquid therein is sufficient to pull down the spindle and reverse the action of the slide-valve. This first cuts off the supply of compressed air, and then allows that in the ejector to exhaust down to atmospheric pressure. The weight of the sewage in the outlet pipe then closes down valve (v^2), and that of the sewage in the inlet pipe opens valve (v^1), and the whole operation recommences, and continues as long as there is sewage to flow and compressed air to act.



The inventors call attention to the following points:—First, that the compressed air is not admitted to the ejector until it is full; secondly, that the air is not allowed to exhaust until the ejector is emptied down to the discharge level. In consequence of these actions the sewage is dealt with just as it flows from the sewers, whether it be at the maximum or minimum rate, and so far as the action of the ejector is concerned it matters not how much the difference of the two rates of flow may be. Again, an important source of loss in using compressed air—namely, the frictional and clearance losses of a pumping machine—is obviated in the ejector, since there are no cylinders or pistons with their connexions, for the machine itself is the cylinder and the air the piston—a frictionless piston. The total friction is therefore infinitesimally small, and the liability to derangement of parts and to accidents equally so. Furthermore, the parts coming into contact with the sewage have no dressed surfaces such as cylinders and pistons, &c. of pumps must have, and which get rapidly corroded and used by the action of the sewage with its solid and liquid constituents, road detritus, &c. In the ejector there is nothing but the hard skin of the castings coated with Dr. Angus Smith's composition, upon which these constituents have no effect. The only tooled surfaces are those in connection with the automatic slide-valve, which makes only one short movement of a few inches for each discharge of the ejector, however large, say 1000 gallons; and they are, besides, only in contact with the compressed air and not with the sewage. The outlet being at the bottom of the ejector, all the solids, sludge, grit, and other matters brought down the sewer are discharged, and so no screening or straining of the sewage is necessary. The action of the ejector in suddenly discharging a large quantity of sewage has all the effect of a powerful flusher, and so no other flushing apparatus is needed lower down the sewers into which it discharges. And, lastly, it forms a complete and absolute severance between the sewers below it and the drains above, so that it effectually bars all passage of sewer gas.

63. In connexion with the raising of sewage these ejectors may be used either for simply lifting the sewage from a lower level sewer to a higher level one, or for forcing the sewage to its outfall through an iron main that takes the place of a much larger outfall sewer, and acts independently of gravitation. The adoption of one or the other of these courses is a matter to be decided upon with respect to every place after due consideration of circumstances, conditions, and comparative cost. Take, for example, the case of the sewerage of a town built on an alluvial flat, on a river side, or on the sea shore, with but little difference of level between the land and the water. The system to be adopted would depend greatly on the permissibility or otherwise of more or less numerous outfalls, and the conditions of such permissibility as regards purification, &c., the relative cost of having one or more outfalls, the relative cost of the construction of large sewers with slight falls in deep cuttings as compared with small sewers in shallow cuttings, aided by ejectors where necessary, and the relative working cost of repairs and flushing the large sewers compared with the repairs and expenses of the small ones and ejectors. In all probability it would be found that where one ejector was necessary, especially if at a distance from the air-compressing station, the multiplication of ejectors would not add proportionately to the cost, and one of the great advantages of the Shone system could be realized in the avoidance of large sewers with sluggish currents of sewage.

64. I saw at Eastbourne an example of the use of the ejectors as appliances for lifting sewage from lower to higher level sewers. The town has a population varying from 35,000 in winter to about 80,000 occasionally in summer. All the houses have water-closets. A sewerage system, designed by Mr. Wallis, the then Borough Engineer, was carried out in 1865 with an outfall into the sea at low-water mark at Langney Point, about 2½ miles from the town, and where the set of tides is such that under any conditions the sewage is carried out to sea, so that the Bay of Eastbourne is kept free of contamination. When I saw it there were no traces of sewage on the beach, though a stiff breeze was blowing in. Of course at high water the outfall sewer—which has only a slight gradient—was tide-locked right up to the town, and, consequently, the sewer was continually being silted up so that its cleansing was a continued source of expense and of nuisance. In 1881 the town had grown so much that the sewerage was insufficient as regards the outfall, as well as growing more and more offensive. Mr. Wallis therefore remedied matters by the adoption of the Shone system. At about a mile and a quarter from its outfall a penstock was fixed in the sewer to shut off the tidal water, and under the road close by was built a chamber to contain three 600 gallon ejectors. The inlet to these ejectors brings the sewage from the town side of the penstock in the outfall sewer, and the outlet discharges it over the top of the penstock into the tidal side of the sewer. The average daily discharge of the ejectors is about 2½ million gallons, equal to over 70 gallons a day from 35,000 persons; but in wet weather the discharge is over 4 millions gallons a day: and for the last ten years the whole of the sewage of Eastbourne has been thus disposed of. Mr. C. Tomes, the present Borough Surveyor, says, writing in 1889 of the ejectors:—"During the eight years in which they have been in operation they have been working continuously, and we have never had a stoppage or breakdown of any sort, and they have not given the slightest cause for complaint."

Shone's ejectors at Eastbourne.

The compressed air for these ejectors was supplied from a pair of Sturgeon's trunk compressors, worked together or alternately with steam from two 10-horse power Kesterton boilers, worked alternately—the air pressure being maintained at from 11 to 14 lbs. pressure. The engine station is about 300 yards from the ejector station, to which the compressed air is conveyed through a six-inch iron main, and a four-inch main is continued to supply the compressed air to three other ejector stations, where five ejectors raise the sewage from parts of the town (and important parts of the town) lying too low for drainage by gravitation into the main outfall sewers. These ejectors have been added to the sewerage system at various times since 1881, and thus illustrate the adaptability of the Shone system to meet the growing wants of an increasing town. To serve them some two miles of compressed air mains are used, and the Chairman of the Drainage Committee of the Borough says, in an official report:—

"The air pipes are laid under the streets, and we have never had the least trouble with them, and the observations taken from time to time show that the loss by leakage and friction is practically nil. The ejectors and the automatic gear are strong and simple in construction, and they work in their chambers under the streets noiselessly and innocuously, and need little or no repair or personal attendance."

The cost of these works was about £9000. They may be said to have obviated the necessity of duplicating the main outfall sewer, which cost the Duke of Devonshire about £40,000. The annual cost of working was about £450, but the Corporation are building destructors for burning the town refuse, the heat from which will be utilized to produce the steam required for air-compressing, and the working cost will thus be greatly diminished.

Shone's ejectors at Henley.

65. The sewerage of the town of Henley furnishes an example of the application of Shone's system, not only in the collection of sewage, but in its discharge without the use of a large outfall sewer, and altogether independently of gravitation. The town stands on the western bank of the Thames, about 65 miles above London, on alluvial gravel overlying chalk. This subsoil, like all similar formation in the valley of the Thames, is full of water. The town has a fixed population of about 6000, rising to double that number at the holding of the celebrated regatta. After the establishment of a Local Board of Health whose drainage operations polluted the river, the Thames Conservancy obtained an injunction compelling the Board to cut off all sewage drains communicating with the river. This rendered the condition of the town so intolerable that the inhabitants petitioned the Local Government Board to hold an inquiry. The inquiry was held, and, as a result of it, the Sanitary Authority received an order to immediately provide a proper system of sewerage. In compliance with that order the Local Board consulted Mr. Baldwin Latham, who prepared for them three schemes, all on the gravitating system, with steam pumping of the sewage, so as to raise it to a level permitting its purification by irrigation-filtration before discharge into the river. In each scheme the collecting sewers varied from nine to fifteen inches in diameter, and the outfall sewer discharged into a tank sewer 4 ft. 6 in. in diameter, and 1000 feet long, "which was intended to hold the sewage at night, or at any time when the pumping machinery was stopped." It was proposed to adopt one of these schemes in which the tank sewer was to be laid at an average depth of 21 feet below the surface, and 15 feet below the ground water level; and $3\frac{1}{2}$ acres of ground, about half-a-mile from the centre of the town, were to be obtained for treating the sewage, which would have to be lifted 22 feet. Mr. Latham's estimate of the cost of the works, exclusive of land, was £19,700, and the yearly charges £1976. A competent judge has estimated that by the time the works were actually completed and made watertight at such a depth in land so charged with springs, they would have cost many thousands of pounds in excess of the above estimate. The land also in such proximity to the town would have been very costly.

Before the land was purchased it was determined to invite Mr. Shone to prepare a scheme based on his hydro-pneumatic system. This was done, and the scheme has been carried out, after it had been approved by the Local Government Board. The town is divided into four drainage districts. At the lowest convenient point in each district an ejector station is built under the public road to hold two 150-gallon ejectors—one to be always in use, and one in reserve. The collecting sewers in each of these districts are made of stoneware pipes, only seven inches in diameter, which dimension is found to be quite sufficient, as the sewers have a good fall. They converge in each district to the ejector station, and their depth in the lowest parts is about seven feet. The house drains are only five inches in diameter. The outfall works are in a wood about a mile and a half from the town, and have an elevation of 160 feet *above* the ejectors. An iron discharge pipe, beginning at the ejector most distant from the outfall, with a diameter of five inches, increasing one inch in diameter as it receives branch pipes from the other ejectors in turn, carries the sewage driven up by the compressed air to an intermediate ejector station half way up the hill towards the outfall, where three similar ejectors receive and force it up the other half. The object of having these intermediate ejectors is to divide the lift in order to work with a lower pressure of air, economy in working being greater with low pressure air than with high. The compressing station is installed at the outfall, with duplicate compressors, engines, and boilers, one set only being in use at a time. The boilers are 30 horse-power, working to a pressure of 60 lbs. to the inch, and the air is compressed to 35 lbs. From the receiver the compressed air is sent to the intermediate ejectors through a four-inch iron pipe, and thence to the collecting ejectors through three-inch pipes. The total cost of the works, including purchase and preparation of the land, legal charges, &c., was a little under £19,000, and the yearly working expenses about £500. It will thus be seen that, notwithstanding the greater distance of the outfall, and the considerable height to which the sewage is lifted, the *actual* cost of the work, and of the yearly cost of working, are considerably below Mr. B. Latham's *estimated* cost, the difference meaning more than a shilling in the pound in the yearly sewerage rate. And not only is greater economy obtained, but greater efficiency, and the sewage outfall is removed from the immediate neighbourhood of the town to a distant position, where it can incommode no one, even in case of carelessness.

Shone's ejectors at Southampton.

66. But it is not only in connexion with the lifting and transmission of ordinary sewage that Shone's ejectors are useful and utilised; they are equally so in connexion with the lifting and transmission of the sludge resulting from precipitating processes for the purification of sewage, and of the contents of the pails collected in towns where there are no water-closets. At Southampton the sewage is clarified in precipitating tanks situated about a mile from the town yard, where the refuse destructor is placed, and where the street sweepings are deposited, as hereinafter described in connexion with sewage disposal. The compressed air mains are laid from the engines in this yard to

the Shone's ejector at the precipitating tanks, and the ejector forces the sludge back to the town yard through a 4-inch cast-iron pipe. (See plan at page 39.) The Southampton Corporation have a contract, which has now been in operation for some years, for supplying compressed air and taking the sludge from the tanks of the Shirley Local Board of Health, which are situated $2\frac{1}{2}$ miles from the works. The sludge and air mains could not be laid for this outlying service without several very sharp curves, and it was confidently predicted that the system could not work under these conditions. These predictions have been quite falsified, as the mains have worked without any failure.

At Warrington the sewage of one district of the borough is raised by Shone's ejectors, working as ordinarily used; but in the greater part of the town the houses have no water-closets, movable pails being used and collected by the corporation workmen. These pails used to be carted out to the manure manufactory at Longford, causing not only a great nuisance as the "conservancy carts"—as with alliterative euphonism they are called—passed along the streets, but also very heavy expense. To avoid this, two central depôts have been built—details of the working of which are hereafter given—and the pail contents are forced thence by ejectors to Longford, a distance of about two miles. By this arrangement about £1200 a year have been saved in the cost of carting alone. Shone's ejectors at Warrington.

67. To sum up my observations upon the Shone system, I may say that every sanitary engineer whom I met who had had practical experience of it was perfectly satisfied with its working, not only as efficient when dealing with small quantities in little districts and in exceptional circumstances, but as being capable of application to efficiently and economically collect and discharge the sewage of the largest cities.

Sewage Disposal.

68. The situation of a town has naturally a great deal to do with the method adopted to get rid of its sewage. The usual methods may be described under four heads:— Various methods.

Discharge without any treatment into the sea or river.
Discharge after clarification by chemicals (precipitation process).
Discharge after purification by earth filtration (irrigation).
Treatment of solid fæcal matter separately from liquid.

In the last three methods two of them are sometimes combined; thus, irrigation is often employed after partial purification by precipitation, and, in the places where solid fæcal matter is collected separately, the liquid sewage still requires dealing with in some way.

Discharge without Treatment.

69. The case of Eastbourne has already been mentioned as one where the set of currents permit the discharge of the sewage into the sea without any ill effect on the adjoining beaches. At Marseilles similar circumstances as regards currents have decided the choice of the position of the outfall, which has in addition the advantage of being in a rocky sterile place, uninhabited and uninhabitable. Eastbourne. Marseilles.

At Liverpool the whole of the sewage is sent into the Mersey without any treatment. The ten outfall sewers already mentioned deliver it at intervals all along the river frontage of the city and docks, and no complaint appears to be made of any nuisance arising therefrom. The range of the tides is large, that of lowest neaps being 12 ft. 9 in., that of highest springs being 33 ft. 5 in., and the assumed mean range being 23 feet. This great tidal action, without doubt, prevents any offensive deposit taking place at the outfalls. The Bootle and Toxteth Park sanitary authorities also discharge their sewage without treatment into the Mersey immediately below and above the city, and any offensive matter found on the beaches in their districts may most probably be attributed to their own action; but I was told that no great nuisance is found to exist. The population of the city of Liverpool is about 520,000; probably the adjoining townships have a population of at least 180,000 more. The sewage of this population of 700,000 can only represent an infinitesimal ratio to the enormous body of water represented by a range of 23 feet in the Mersey at Liverpool, ebbing and flowing every tide, and consequently the dilution, as effected by such tidal action, must be very complete; and, seeing that the water is sea-water, and not used for domestic purposes, is quite satisfactory from a sanitary point of view. Liverpool.

Generally speaking, it may be said that, with the exception of Southampton, every town and city in Great Britain situated on the seashore discharges its sewage without purification into the sea. The Corporation of Dublin, in May and June of the current year, appointed a committee to enquire into the methods of sewage disposal adopted at seaside towns; and the committee obtained information from the 26 largest of such towns, and, with the exception above noted, all discharged their sewage into the sea without treatment. This may not be the best method of dealing with sewage in the abstract, but Mr. Spencer Harty, the City Engineer, nevertheless recommends its adoption in Dublin, on the ground that all other systems involve a much larger expenditure for a less satisfactory result. All seaside towns.

Clarification by Precipitation.

70. London is, practically speaking, entirely a water-closet town, and the greater part of the sewage is discharged into the Thames at Barking and Crossness after treatment; but during rain London.

storms a great deal is discharged directly into the Thames by storm overflows situated all along the course of the sewers. I visited the works at Barking in company with many members of the Congress, and the system adopted there was explained to us by Mr. A. Binnie, Chief Engineer of the London County Council. The mean daily quantity of sewage received—being that of all London north of the Thames—is about 105 million gallons. Some of this arrives by gravitation from the higher parts of the metropolis; that from the lower districts has to be pumped from the low level into the high level sewers at the Grosvenor and Abbey Mills pumping stations, some miles above Barking. All this sewage is brought by three main sewers, nine feet in diameter, which, at the entry to the works, run side by side. At this point there is on each sewer a chamber containing two suspended L shaped cages or gratings for catching all the larger floating matters brought by the sewage. These cages are placed one after the other, one being always in place while the other is lifted and cleaned. The chambers are flat-bottomed, and, when a cage is in place, the horizontal limb of the L rests on the bottom; when the cage is lifted the horizontal limb is level with a platform on to which the arrested matters are raked. This platform is at a higher level than the top platform of a Fryer's Destructor, in which the matters are burnt, as hereinafter described. At these chambers the smell is the usual heavy nauseous odour of town sewage—a matter of no great importance at Barking, as close alongside are the Beckton Gas Works, perhaps the largest establishment of the kind in the world. The material stopped by the cages seemed to be chiefly vegetable—orange-peel, potato-parings, sticks, corks, rags, &c.—no solid fæcal matter being visible.

Just beyond the catch-gratings the chemical treatment of the sewage begins. The first process is the addition of lime. There are large sheds in which the lime is prepared. It is intended to add four grains of lime in *solution* to each gallon of sewage (about a quarter of a ton to each million gallons); but when we were there only two grains were being added, and part of this not in solution, but in the form of milk of lime, the works being still incomplete. The lime is prepared by being slaked and then mixed with sewage in revolving machines until it forms milk of lime, which is run into the sewers. Nothing is done with sulphuric acid or otherwise to retain any ammonia, and, the sewage being fresh, I did not notice by the smell that any was being disengaged by the mixture of the lime.

The sewage thus charged with lime flows on for two or three hundred yards, by which time it is supposed to be sufficiently well mixed. It then passes through other sheds where a solution of proto-sulphate of iron (green vitriol) is added in the proportion of one grain to the gallon of sewage; and it then flows on to the precipitating tanks.

These tanks are thirteen in number, but only five were being used. They are from 880 to 1360 feet in length, 30 feet in breath, arched over, and they are filled with sewage to a depth of 9 feet. In them the sewage, which in the sewers travels at the rate of 150 feet a minute, flows on at the rate of only two feet in the minute, and is consequently sufficiently stagnant to allow of precipitation taking place, so that by the time it has reached the far end of the tank the top water is supposed to be clear enough to be discharged into the river. At the time we were there it was by no means clear, and the smell from the overflow chamber was the same in nature, and nearly the same in strength, as that from the grating chambers at the entrance to the works. In due order the sewage is turned off from each tank in turn, and by a series of sluices opening from the top downwards, the water is drawn off as it gets clear by precipitation. When the water is all drawn off men are sent into the tank with besoms to sweep the sludge into a sewer that runs under it for its whole length. The clear water is run into reservoirs, whence it is discharged into the Thames on the ebb tide.

The sludge from the precipitating tanks is pumped into reservoirs, where it subsides for 12 hours—the water from it being sent back into the sewers for treatment with the sewage. The sludge, still containing nine parts of water to one of solid matter, is then pumped into steamers specially built for the purpose, each of about 1000 tons capacity. It is taken about 50 miles down the river to the Barrow Deeps, a place approved by the Admiralty and the Thames Conservancy, where it is distributed over a length of eight or ten miles, in what is practically the open sea. About 19,000 tons of this sludge are thus disposed of every week. Every effort made to induce farmers to take it has proved quite fruitless, though works were undertaken to press the sludge into dry cakes.

When we saw the works they were, as above mentioned, still incomplete, and consequently were not working normally. The impression they produced upon me was that the machinery used was good, but that the arrangements for tank cleaning and sludge removal left much to be desired.

The effluent water has been tested, with the result that the chemists advised that in hot weather it should be further treated with permanganic acid as an oxidising and deodorant agent. This is done, though we did not see the process; and in 1887 there were 2173 tons of manganate of soda and 865 tons of sulphuric acid used for the purpose. The quantity used to the gallon of sewage is not mentioned, but at Leicester from one to one and a quarter grains of the manganate to three-quarters of a grain of the acid was found sufficient.

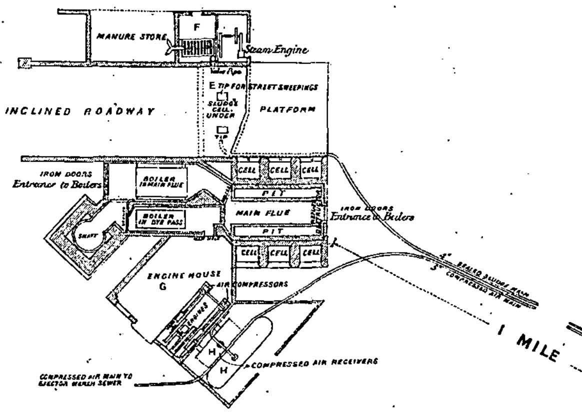
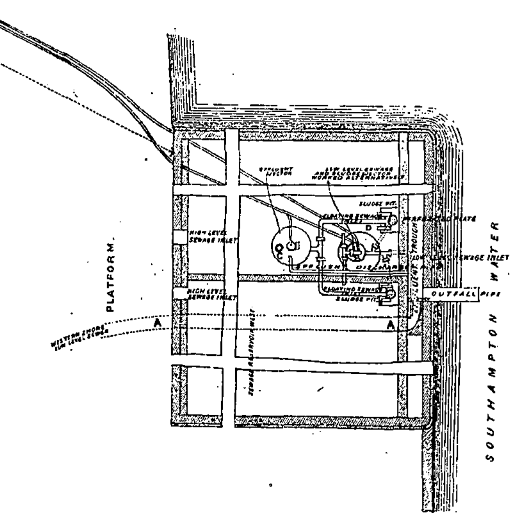
In their report on the whole matter, Sir B. Baker and Mr. Binnie advise the continuance of the system, not as being perfect, but as being adaptable to any system that the advance of science may show to be the best. More than £525,000 have been spent at the Barking works. Speaking of the sludge, they say—

"It is a black offensive fluid, but is not, so far as we have been able to learn, injurious to the health of the men employed in its manipulation at Barking and Crossness, or on board the sludge ships which

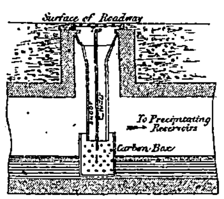
CORPORATION OF SOUTHAMPTON.

SEWAGE CLARIFICATION & HOUSE REFUSE DISPOSAL WORKS.

W. B. G. BENNETT, *Engineer.*

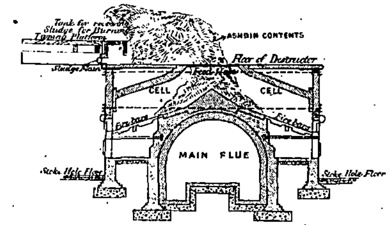



PLAN.



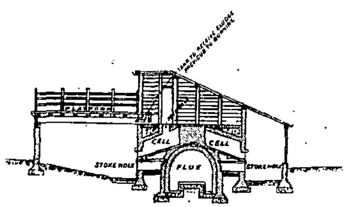
CARBON BOX AND SHOOT

Scale 4 Feet = 1 Inch

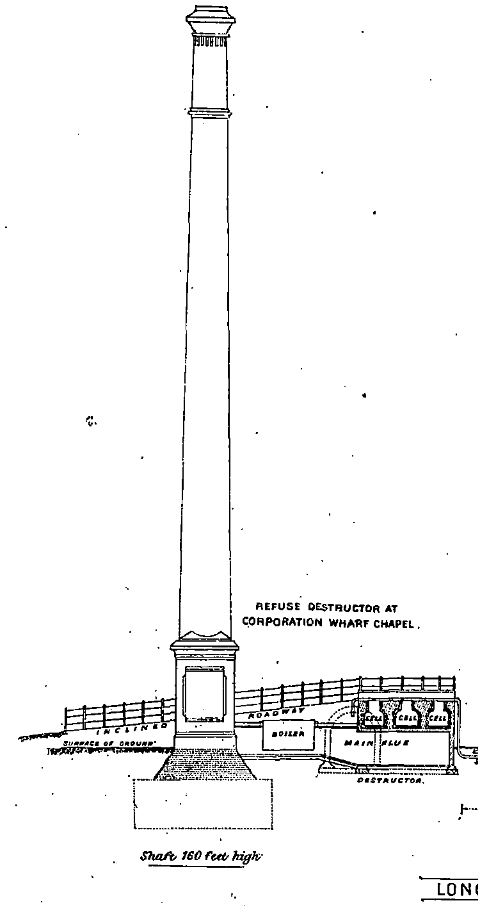
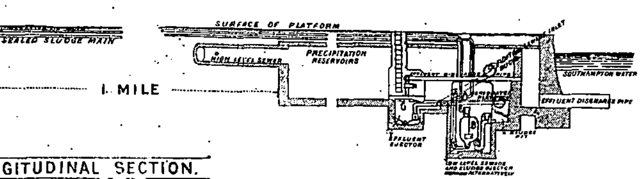


CROSS SECTION OF REFUSE DESTRUCTOR.

Scale 8 Feet = 1 Inch



SECTION

Shaft 160 feet high

LONGITUDINAL SECTION.

convey it to sea. As far as we can ascertain from the result of the working at Barking, the cost of the present treatment is about 27*s.* 9*d.* per million gallons, of which about 9*s.* is due to the cost of manipulating and pumping the sludge from the stores into the ships, and conveying it 50 miles down the river. . . . As to the disposal of the sludge by transporting it to the sea in ships, we are of opinion that, as the cost, including loading charges after precipitation, is under 9*d.* a ton, the method cannot be considered an expensive one; and as to the effect of the sewage on the sea into which it is discharged, we have satisfied ourselves that no evil influence of the slightest degree can be detected, and from a sanitary point of view this part of the proceedings is beyond question the most effectual. . . . Already we notice a marked improvement in the cleanliness of the foreshore in the immediate neighbourhood of the Barking outfall, which was formerly covered with black fœtid mud, but which is now gradually returning to its original state of a gravelly foreshore, on which grow green algæ of the usual type, characteristic of the foreshore of the Thames in its cleaner parts. . . . Practically, therefore, the sewage might be said to be taken to the sea, but instead of being discharged in a crude condition at one point it would be dealt with in two portions, the least offensive part—that is, the clarified sewage—being discharged some distance up the estuary, and the more offensive part, namely the sludge, being deposited many miles out at sea. Of course the latter alternative involves an increase of working expenses, and a saving in capital expenditure. Assuming the annual charges, including interest, to be the same with any two schemes, and the efficiency equal, we should prefer that scheme in which the capital expenditure was the least, because working expenses may be modified as experience is gained and improved methods introduced; but a mistake as regards capital expenditure cannot be remedied except by additional expenditure."

71. Southampton is also a water-closet town. Its population is over 60,000, and there are about 12,000 houses. Part of the sewage is sent directly into Southampton water without treatment; part of it is partially treated in dry weather on a small sewage farm at St. Denys, which does not pay working expenses; but by far the greater part is treated in the following manner at the town quay, where there are two precipitating tanks worked alternately. The accompanying plans, for which I am indebted to Mr. Bennett, the Borough Surveyor, will greatly facilitate the understanding of the following description. About 50 yards before the main sewer reaches the precipitating tanks there is an ordinary man-hole, near which the corporation have a small cottage which is used as a store for ferozone, the precipitant used. In this store a quantity of it is damped with clean water, to which is added one pound of sulphuric acid to the hundredweight of ferozone. In the man-hole a perforated box is slung down into the sewer so that the bottom of it is always in the stream of sewage. This box is filled about three times a day by means of a shoot, the man in charge looking from time to time to see how the varying quantity of sewage is washing away the ferozone. To prevent it from caking on the top of the box a pipe and tap at the top of the man-hole send a small driblet of water continually upon the precipitant. The box is so arranged as regards the perforations in it that the flowing sewage washes out of it a sufficient quantity of the preparation to effect clarification; and in the flow of fifty yards to the tanks the whole is thoroughly mixed together. **Southampton.**

Each tank is 100 feet long, 60 feet wide, and 10 feet deep at its lowest part, and is arched over. In each there is a floating sewage inlet, consisting of a pipe connected with a 700-gallon Shone's ejector, similar to those before described, and fixed to a buoy which allows the pipe to rise and fall with the level of the water in the tank, keeping its mouth, which is protected by a perforated plate, always a few inches below the surface to hinder the entrance of floating matter. In about two hours the water is clear enough to discharge. The samples I saw taken were quite clear; and I saw the samples taken by the man in charge for several preceding days, and they were all equally clear, notwithstanding that on some of them there had been considerable rain. As soon as the top water is quite clear to a certain depth a valve is opened admitting the effluent into the ejector, whence it is at once discharged into the tideway about 200 yards out from the quay. I examined the foreshore in the neighbourhood and found it quite clean. A supplementary sewage outlet is provided in each tank for discharging the effluent by gravitation when the tide is low enough.

The above-mentioned precipitant, ferozone, is thus composed, according to an analysis by Sir Henry Roscoe:— **Ferozone.**

Ferrous sulphate	26·64
Aluminium sulphate	2·19
Calcium sulphate	3·30
Magnesium sulphate	5·17
Combined water	8·20
Moisture	24·14
Silica	11·35
Magnetic oxide of iron	19·01
	100·00

Dr. Arthur Angell, the County Analyst for Hampshire, speaks thus of it:—

"Ferozone contains a large proportion of ferrous iron salts, and for that reason alone cannot fail to be a powerful chemical disinfectant; further than this, however, it contains salts of alumina and of magnesia, both of which assist as decolorants and precipitants. The remaining part of ferozone is made up principally of very finely divided porous magnetic oxide of iron, and this serves both as a further oxidising agent and as a weighting material, which accelerates the subsidence of the suspended matter, and keeps the sludge down as it accumulates at the bottom of the tank.

"The insoluble portion of the ferozone is composed of finely-powdered polarite—the newly-invented material, to which the filter-beds containing it owe their very remarkable oxidising powers; this powder, therefore, keeps the sludge sweet during subsequent disposal, either by pressing or drying, or by both; and thus a part of the process, which is so offensive at sewage works where lime forms one of the ingredients used, is carried on without committing a nuisance."

I was not able to obtain an analysis of the effluent water, but I give one in connexion with Acton, where the same precipitating material is used, which shows that its action is very satisfactory. Besides, Southampton Water, into which the effluent is discharged, is a large arm of the sea, and therefore does not demand, with respect to water sent into it, that chemical purity which should be required in the case of a river that is, or might be, the source of water supply for human consumption.

When all the water has been drawn off from the precipitating tank, the buoy resting on the floor of the tank keeps the mouth of the discharge pipe sufficiently high to prevent the entrance of the precipitated sludge. The floor is sufficiently dished to allow almost all this sludge to flow to the outlet valves leading to a 360-gallon Shone's Ejector; but sometimes the man in charge has to go down and use a squeegee to thoroughly clean the bottom. The ejector sends the sludge through about a mile of four-inch iron pipes to the manure works at the Corporation Wharf. Neither the full nor the empty tank smelt offensively. A pressure of 40 lbs. on the square inch is required to work the sludge ejector; one of 10 lbs. is sufficient for the other.

The works at the Corporation Wharf are in a part of the town surrounded by dwelling-houses, a circumstance that should necessitate the avoiding of all operations causing nuisance. I therefore think it is a pity that the manure-making operations were not provided for elsewhere. But this is a detail that does not affect the question of the success of the system adopted, as what is done at the Corporation Wharf could be at least equally well done anywhere else. The works consist of a destructor, hereinafter described, which produces the steam power necessary to work the air-compressors for the ejectors and a variety of other machinery; and around them are the stables, refuse-yards, &c., and hither is brought all the town street-sweepings. The four-inch pipes from the tanks can be discharged into a cell, whence the sludge can be drawn as required for mixing with street-sweepings, &c. in an incorporator, whence again conveyors and elevators can load it into trollies. But none of this work was being thus done when I was there. Square bays or stanks were formed with road-sweepings for walls and floor. They were nearly filled with sludge, taken to them in turn in wooden shoots from the delivery pipe. The work was being carelessly done, and caused some offence; but this might have been avoided by doing the work under sheds that would keep the street-sweepings dry, and by immediately covering the sludge with dry sweepings or with dust from the destructor. After a short time the sludge and sweepings are all mixed together by hand labour, and form a manure containing about 25 or 30 per cent. of solid matter, which can be carted about without losing its liquid part. In this condition it is taken away as fast as made, at the price of 2*s*. 6*d*. the ton in the works. Most of it seems to go to the orchards and market gardens in the Channel Islands, where its fertilising properties are highly appreciated. In consequence of this ready sale, the burning of the sludge in the destructor, which was formerly successfully done, has been discontinued.

The yearly cost of labour and chemicals at both the works—the precipitating tanks and the manure-mixing yard—is £308. The sewage disposal works cost £3000 (exclusive of the destructor, which is virtually self-supporting, as will hereafter appear). If 10 per cent. upon this amount be taken for interest, sinking fund, and repairs, the total yearly cost will be £608,—an amount that is more than covered by sales of manure, which reach nearly £700 a year. Of the £308 expended, less than half was paid for the chemicals used for precipitation, being less than one farthing for each thousand gallons of sewage clarified.

Acton. 72. At Acton, a large and increasing suburb of London, the whole of the houses have water-closets, and the sewage is also purified with ferozone. But the methods employed are quite different from those at Southampton. The ferozone is mixed with water in a mill and added to the incoming sewage through small perforated pipes, about 8 grains to the gallon being used. The sewage then passes over tumbling weirs into one or other of three open tanks, where it is allowed time—two hours—to settle. The water is then discharged by floating outlet-pipes taking the water from the top—partly directly into a creek of the Thames—and partly through filter-beds, where it is further purified by filtration through sand and polarite. The unfiltered effluent was clear, with a slightly yellowish tinge. From analyses made by Dr. E. Frankland, the precipitation process reduces the suspended matters in the sewage from 240·80 parts in 100,000 to 5·92 parts, and of the dissolved organic matters present in the crude sewage ninety per cent. were removed. The Thames Conservancy Commissioners consequently allow its discharge without filtration. The filtered effluent was perfectly bright and colourless. Analyses by Sir H. Roscoe show it to contain four parts of free ammonia and 64 parts of chlorine in a million, and on being kept a long time it shows no traces of putrefactive change. There is virtually no smell about the works to show that any sewage treatment is going on. The filters only require every day the usual top scraping of the sand, as the intermittent use of two permits the polarite to recharge itself with oxygen, and so to work for an indefinitely long time. The filters are composed of a top layer of nine inches of sand, then ten inches of polarite and sand mixed in equal parts, then, in order, six inches of sand, four inches of fine gravel, and four inches of shingle, in which the agricultural drains are bedded that carry the filtered water away.

The filtering medium above mentioned—polarite—contains, according to Sir H. Roscoe's analysis— Polarite.

Magnetic oxide of iron	53·85
Alumina	5·68
Magnesia	7·55
Water, with a trace of carbon	5·41
Silica	25·50
Lime	2·01
	100·00

The following Report is by Mr. J. Carter Bell, the County Analyst of Cheshire:—

"I enclose the analyses of the crude sewage and also of the effluent. These samples I took myself from the Acton Sewage Works on Saturday, August 30th, 1890.

	Parts per 100,000. Sewage.	Effluent.
"Total solid matter at 212° F.	361	76
"Suspended matter	306	Nil.
" Ditto mineral matter	190	"
" Ditto organic matter	116	"
"Total solids in solution	55	76
"Ditto mineral ditto	35	49
"Ditto organic ditto	20	27
"Chlorine	5	6
"Oxygen required for 15 minutes	1·28	·04
" Ditto ditto 3 hours	2·55	·24
"Free ammonia	6·40	·22
"Albumenoid ammonia	·70	·035

"The effluent was flowing exactly like clear spring water, and when the sample was put into the bottle there was not the slightest odour of any kind, and it would have been impossible for any one to have said, judging by the appearance, that it was not good drinking water. The analysis also shows that the reduction of the putrescent matter has been very great, and that such an effluent as this may be run into any stream with perfect safety. I am surprised to find that after more than three years' working the filter beds can produce such a good effluent."

The sludge from the precipitating tanks flows into a sludge-pit, whence it is first pumped into a rotatory agitator, where more ferozone is added; then it is filter-pressed, and the cakes sold at 6*s*. 6*d*. a ton, or thoroughly dried and ground and sold in sacks at 30*s*. a ton. There is not much of the latter made, and there did not seem much sale for either, there being a large quantity of cake on the ground. I could get no analysis of it, but do not think it can be rich, as the pressing process squeezes about 80 per cent. of water from it—5 tons of sludge usually making one ton of cake. In all probability the richest manurial constituents of the sludge are in a state of solution, so the result of the squeezing will be the removal of the best part of the manure. This best part is simply thrown back into the sewer to be treated over again. In other words, after all the processes have been performed to concentrate the really valuable part of the sewage, the greater and the better part of the resulting concentrated manure is thrown back to be diluted over again. On the other hand, where sludge is treated as at Southampton or Birmingham, all its manurial value is retained. I could get no returns as to the yearly cost of the Acton Works.

73. Ealing is a suburb of London, with a population of less than 30,000. The whole of the houses have water-closets. The sewage works are constructed on about three acres of land bought for the purpose, and the portions now used for sewage disposal consist of tanks, engines and machinery, mixing sheds, destructors, and fume cremators. Part of the works were built nearly 30 years ago, and they have been added to as found necessary to meet the growing requirements of the rapidly increasing population, which numbered only 5500 when the original tanks were built. The chemical process adopted consists of a modification of the lime process, clay and sulphate of alumina being also used; the dosage given being 10¼ grains of lime, 11½ grains of clay, and 2 grains of sulphate of alumina to each gallon of sewage. The lime is made into milk of lime in one of Scott's mixers, and is, with the clay similarly prepared, run into the main inlet sewer, and is thoroughly mixed with the sewage in its course to the first tank. The solution of sulphate of alumina is not added until partial clarification has taken place. The sewage then passes through two more tanks one after the other. During its passage it is aerated as much as possible by passing over tumbling weirs and a water-wheel which its current keeps in motion. Mr. Jones, the engineer to the Ealing Board, and the designer and administrator of the works, lays great stress upon the oxidation produced by the exposure of the sewage to air secured by these falls, and upon the comparatively large size of his tanks. These tanks are so arranged and so worked that the sewage, after receiving its dosage of chemicals, has a run—most of the time at a slow pace in large reservoirs—of about quarter of a mile before reaching the final tumbling weir at the head of the outlet sewer that conveys the effluent water to the Thames. Provision is made for diverting part of the sewage in case of necessity by a storm overflow. Ealing.

A pronounced sewage smell accompanies the whole process and pervades the works. The effluent water retains some of this, and is not very clear. At the time of the visit paid by members of the Congress to the works, Mr. Jones said that he did not profess to send clear water into the Thames, and did not think it right to spend money to obtain an unnecessary degree of purity, especially as the Thames Conservancy Commissioners were satisfied. I have no doubt from what I observed at my visit that if the circumstances of Ealing were different—if it were a large town on a small river, instead of being a small town on a large river—some further purification of the effluent would be required before its discharge would be permitted.

The subsiding and effluent water tanks are open to the air, and are in sets of three, two of which are in use while the third is being cleansed. When the water is drawn out of the one being cleansed, the sludge is swept into a drain leading into a sludge well, whence it is raised by a chain-pump and delivered into drying-basins. These drying-basins are in sheds, and are made with sides of three-inch deals placed edgeways one upon another to the height of four or five feet, and held in place by stakes driven into the ground. The bottom and sides are lined with a layer of street sweepings or house refuse, which are also spread over the top of the sludge when the tank or basin is full. Part of the water from the sludge percolates through the sides, and is returned for treatment into the sewer. After the sludge and refuse have remained in a basin some days, they are mixed up together and loaded into small trucks that run on a tramway leading to the destructors (Fryer's) to the platform, over which they are raised by a mechanical lift. The stuff must still contain a very large proportion of water, but it is nevertheless all burnt into clinkers, which are used for road-making, concrete, &c., no other fuel than sludge and refuse being used in the destructors. The dust from the dust chamber of the destructors is sold for manure. The other products of the combustion (the fumes) are taken through a cremator invented by Mr. Jones, wherein they pass over the clear glead of a coal or coke fire to destroy all their noxious constituents before they are allowed to discharge into the high chimney shaft. The heat from the cremator and destructors is utilised to produce all the steam required for the establishment.

I was not able to obtain the cost of this system of sewage disposal.

Sheffield.

74. Sheffield has a population of over 300,000, by far the greater part of whom use common privies, only 3500 of the houses out of 60,000 having water-closets. The natural outlet for the drainage of the town is the River Don, a comparatively small stream, and into it the sewage, amounting to about ten million gallons a day in dry weather, is discharged after purification by Mr. Alsing's lime process. The sewage works occupy over seven acres of a small property of 23 acres bought for the purpose by the Corporation at Wincobank, on the outskirts of the town. The other 16 acres are meadow lands, and there are only a few metal works and cottages in the neighbourhood. The works, similar in principle to those carried out for 15 or 20 years by Mr. Alsing at Bradford, are capable of treating nearly double the present quantity of dry-weather sewage. In heavy rain the sewage is discharged directly into the river without treatment; and the sewage from midnight to six o'clock in the morning is also allowed to pass without purification, as its character is held to be far less noxious then than during the day.

The sewage by day is first strained through gratings that retain the larger floating matters brought down by it. It is then allowed to be at comparative rest in large catch-pits, where the heavier suspended material is naturally deposited. Milk of lime is then added in varying quantities, but averaging a dosage of about a ton of lime to the million gallons. Two sewers then take the sewage to the precipitating tanks and filters, which are in duplicate, and which are arranged as follows:—The tanks and filters are altogether over 600 feet long and 100 feet broad, and are divided longitudinally into 15 compartments, each 40 feet long, and laterally into seven divisions. The sewage flows into the upper one of these divisions, a channel about six feet wide, from which sluices admit it into the next division, a precipitating tank 40 feet wide, with a floor rapidly sloping away from the channel, and at the lower end a valve with floating arms, so as to take only top water, is placed, and also another fixed valve for sludge. When this precipitating tank is full the sluice from the channel is closed, and that one leading into the next tank opened, and so on all along the line. The sewage in the full tank is allowed to stand 20 minutes, by which time the top water is clear. The valve with floating arms is then opened, and the clear water drawn off into a trough about four feet wide, whence it overflows upon a weir about 20 feet wide, having four or five drops of three inches each for the purpose of aerating the water. At the lower end of the weir is a narrow channel, about four feet deep, adjoining the filter, and communicating with the bottom of it by pigeon-holes through the separating wall. The filter is an upward one, filled with coke, the effluent water flowing off from the top of which was quite colourless and clear. The coke lasts about six months, and is then taken out, dried, and is used as fuel for steam production, being mixed with a little fresh coal. The time taken by the whole process from the entry of the sewage into the works to its discharge into the river is about two hours.

The only analyses I could obtain of Sheffield sewage before and after treatment cannot be said to shew the usual results, as the raw sewage was taken at a time when the accumulated silt in old sewers was being admitted in such quantities as to raise the matters in suspension to about 20 times the ordinary dosage. But, speaking generally, it may be taken that the precipitating process removes about half the quantity of organic matter that the raw sewage holds in solution, and almost all the matters it holds in suspension, and that the filtering operation removes about one-sixth more of the organic matters in solution. I believe that the filtering would be much more perfect if the filters were downward acting, as the coke would then be aerated after every operation, and so recover its oxidising power. As it is I should be afraid that the effluent, however bright it might appear would still be liable to further putrefactive action itself, and to set up such action in the river into which it is discharged. The lime process has had to be discontinued at other places on this account.

The sludge is not removed from the precipitating tanks after every operation, but only once a day. The sludge-valve above mentioned being opened, the sludge flows into a sludge drain running under the trough at the top of the tumbling weir above described. This drain takes it to a sludge-well whence it is lifted by centrifugal pumps and discharged into settling ponds, where it is kept for some time—the water draining from it running back into the sewage channel. It is then drawn off into drying-basins till it is dry enough to cast out upon the manure heap. This manure heap was very large. There does not seem to be any demand for it, and its disposal will soon be a matter of urgent necessity and considerable difficulty.

At the manhole on the inlet of the sewer from the town into the works there was the usual smell of sewage. There was a faint ammoniacal smell at the place where the lime admixture was taking place; and there was an offensive smell where the mud was being moved.

The works cost £32,000, exclusive of land. The yearly working expenses are about £4500.

75. The city of Glasgow contains a population of 565,714, and with its suburbs, 662,000. At midsummer this year there were 780 common privies and 4000 pail closets; all the population not served by these conveniences being served by water-closets. The whole of the sewage is at present sent directly into the Clyde without any treatment, and the condition of the river is such as to require immediate remedy. The Corporation is about to commence works to be designed by Mr. Alsing, of Sheffield, for the purification of the sewage of the eastern part of the city—that situated the farthest up the Clyde valley—containing a population of 168,000 persons in an area of a little more than 2000 acres. This determination has been arrived at after the matter had been relegated to a committee, who visited and inspected various large towns, including London and Paris, and who recommended that if precipitation were decided on, works built on a plan similar to those at Sheffield would be best suited for the purpose. "The chemical agent need not be the same. That can be determined from time to time as experience and discovery may dictate, without affecting the plan of the works." The committee recognised that one great difficulty in connexion with the system was the disposal of the sludge—calculated to be 70 or 80 tons a day when partly dried. To meet this difficulty the officers of the cleansing department recommended that a branch line of railway should be constructed to the works, which should also be made the depôt for the house and street refuse of the district; that as much as possible of the sludge should be mixed with the drier part of the "manurial refuse," and sold as top-dressing to farmers; and that the rest should be sent off with the unsaleable refuse to improve moss land in the neighbourhood. As the various railway companies are bound to carry this any distance under 12 miles for sixpence a ton, there appears no cheaper way of disposing of it. Glasgow.

Sewage Clarification by Precipitation, followed by Irrigation.

76. At Coventry, where nearly all the houses have water-closets, the sewage of a population of over 50,000, amounting to about 2,250,000 gallons a day, is professedly treated at the sewage works by the sulphate of alumina process, supplemented by irrigation; but on the day I inspected them some of the sewage was being sent directly into the River Sherbourne without treatment. On entering the works the sewage is first strained through one of Baldwin Latham's revolving screens, which consists of a wheel about 10 feet in diameter, the tambour of which is filled with cast-iron close grating. The periphery of the wheel is about two feet wide, and carried on spokes of that width, which are also filled in with similar gratings, upon which at the periphery end boxes are fixed which in revolving carry up water to wash these latter gratings—the tambour gratings being washed with jets of water playing upon them from the back. The spoke gratings carry up the solid matters stopped by the tambour gratings, and let them drop into a box fixed at the level of the wheel axle, whence a creeper delivers them on to the floor of the works. After being thus strained there are added to the sewage quantities of sulphate of alumina first, and lime afterwards, varied to suit its changing conditions, but which are said to average 9 cwt. of sulphate of alumina and 6½ cwt. of lime to the million gallons; and all are thoroughly stirred up together in a mixing well. The sewage then passes into the settling tanks, of which there are eight, each of which is used in order. The top water is run off by a drain on to a small farm of eight acres, which is intermittently irrigated. The land is thoroughly drained with pipe drains laid from five to seven feet deep and 15 feet apart, with manholes for inspection of water level and for aeration of the soil. The land is cropped with Italian rye grass. I could get no analysis of the effluent water. It is evident that this little farm is quite inadequate to deal in any way with such a volume of sewage as that of Coventry, as over 400,000 tons of sewage would have to be applied to each acre of the land every year if all the sewage were sent on,—a quantity which is twenty or thirty times too much. Coventry.

The settling tanks are in turn emptied twice a week and the sludge swept into sludge tanks, whence it passes through Johnson's filter presses, which reduce the bulk from 460 tons to 100 tons; the effluent water is returned to the sewer for treatment, and the pressed cake is, when there are customers for it, sold as manure. The remarks I have made regarding sludge-pressing at Acton are equally applicable here.

The works bear evidence of the changes and additions that have from time to time been made in the system of sewage treatment, and the distribution of engines and boilers must be a costly arrangement to work. The working expenses of the establishment for the year ending 25th March, 1891, amounted—exclusive of interest on loans and sinking fund—to £3536, and the receipts for manure sold, cottage rent, &c., £206. It is not surprising that the Corporation are making inquiries as to the best system to adopt in the place of the existing one.

Birmingham.

77. The city of Birmingham, for sewage disposal purposes, forms part of the Birmingham, Tame, and Rea Drainage District, which contains an area of over 47,000 acres, with a population of about 650,000 people. The city itself contains an area of 8420 acres, with a population of about 450,000 people; but as the outlet for its sewage was also that for the surrounding district, a joint Drainage Board was formed for the treatment of the whole sewage. The houses are still chiefly served with movable pails, of which there are still in the city proper over 35,000 remaining, with about 7000 old-fashioned privies with ashpits. Both these kinds of conveniences are being replaced with water-closets at the rate at present of about 3000 a year, and every encouragement is given to expedite the change.

Precipitation works.

The sewage of the whole district amounts to about twenty million gallons a day in dry weather, and is all treated together, first by precipitation with lime at the Saltley works, and then the effluent water is used for irrigating about 850 acres of land lower down the valley. At the Saltley works provision is made of storm overflows to divert the superabundant water in rainy weather. The quantity of lime mixed with the sewage is about half-a-ton to each million gallons. From the mixing-sheds the sewage runs into one of four large settling tanks. These tanks are arranged in two sets of two each, each set being used for a fortnight, in which time they get sufficiently full of sediment deposited by the almost stagnant sewage they contain, for the overflow that takes off the partly clarified top-water is so wide as not to produce a perceptible current in the tanks. This

Irrigation farm.

partly clarified water flows by gravitation to the irrigation farm at Tyburn, and its volume is sufficient to give a yearly dose of over 35,000 tons of sewage to the acre—an enormous quantity. The nature of the land is favourable for sewage purification, its surface not requiring much preparation, and its subsoil being gravel and sand, varying in thickness from six to ten feet. The main sewage carriers are open brick troughs, leading from the sewer, or conduit from Saltley, to various centres on the farm, whence secondary earthen carriers lead to the ordinary flooding carriers, which distribute the sewage over the land. The land is thoroughly drained to a minimum depth of 4 ft. 6 in. by three and four-inch agricultural pipes placed from half to three-quarters of a chain apart, discharging into main drains of socket pipes of 9 in. and upwards in diameter, which in turn discharge into the outfall channels. The water in these discharge channels was quite clear. I got no analysis of it, but its purity apparently satisfies the very jealous riparian proprietors lower down the stream. All ordinary agricultural crops are grown on the land.

Sludge disposal.

The sludge from the precipitating tanks, one of which is cleaned out every week, partly flows and is partly swept or scraped towards a sludge-well, whence it is raised by bucket-dredgers and pumps, and delivered sufficiently high into wooden troughing to flow by gravitation to all parts of the Saltley farm, which contains about 270 acres, and the troughing and its supports are movable, so that every part can be served in turn. The sludge, amounting on an average to 4000 tons a week, contains 90 per cent. of water, and is run on to the land, a sort of basin being made to receive it by throwing up a little bank of soil all round the plot. About an acre a week is covered by this sludge, which is allowed to lie a fortnight, during which time the earth beneath and the air above absorb so much of its moisture as to allow of it being turned over and trenched into the ground by spade husbandry. The crops grown are partly market garden produce, and partly agricultural. Beet, cabbages, cauliflowers, celery, corn, &c. were all looking very well. In dry weather this farm can also be irrigated. After three or four years another dressing of sludge can be applied. The treatment of sludge on this farm and at the tanks caused an offensive smell. On the irrigation farm there was a perceptible smell of sewage, which was not very pronounced at the time I visited it.

Cost, &c.

Both farms are worked rather for stock and dairy purposes than for the sale of the agricultural produce, nearly the whole of which is consumed on the premises for feeding purposes; and over 300 acres are in pasture. The land and works cost over £400,000, three per cent. upon which would represent an annual rent of £12,000—about £10 an acre on the two farms. The other expenses were, in the year 1885, the last of which I have an account, £11,500 at the Saltley works, and £22,800 at the Tyburn farm, making the whole expense of the system £46,300. During the year the farm returns were £20,000, of which about £5000 were received for agricultural produce and pasturing of cattle, £4500 for milk, and £10,500 for stock, making the deficit to be paid out of rates, £26,300. But as part of the capital raised on loan has to be repaid each year until the loans are extinguished, the actual amount of rates paid in 1885 for sewage treatment was £33,000, being under fourpence in the pound on the rateable value of the district.

Nightsoil.

The nightsoil collected from the pail closets and privies is treated at three stations in various parts of the city, and by the City Authorities, quite independently of the Drainage District Board above referred to. The quantity of this nightsoil is very great. During the fifteen months ending the 31st of March last about 2,400,000 pails were emptied at, and 145,000 loads of privy ashpit contents removed to, these stations. Part of this quantity is mixed with street sweepings, and sent away as manure in canal barges to farmers in the country. The rest, after receiving a little sulphuric acid to fix the ammonia, is partially dried into manure in steam jacketted cylinders with revolving scrapers, the steam being generated by the heat of the destructors hereinafter described. The fumes are carried up a very high shaft, and precautions are taken to prevent offensive smells, which, however, are not altogether successful. I was unable to procure the cost of this disposal of nightsoil, as the work is carried on in connexion with the destruction of refuse, &c.

Sewage Clarification by Irrigation only.

78. The sewage of the town of Croydon is clarified on the broad or surface irrigation system on two farms—one at Beddington and the other at South Norwood. The operations on both are conducted in the same manner, but the following description more particularly applies to the South Norwood farm, which I visited with Mr. Walker, the Borough Engineer, on the 15th September. The area whose sewage is treated on this farm is about 2400 acres, having a population of about 16,000, all living in houses having water-closets; and the sewage amounts to about 500,000 gallons a day in dry weather, rising sometimes to 3,000,000 gallons a day in wet weather, all of which is dealt with on the farm without regard to the injury the crops may thereby sustain. The purification of the sewage is thus made the main object—the commercial success of the farm is only a secondary one. The area of the land is about 110 acres, of which 106 can be irrigated—74 by gravitation, the rest by pumping. The soil, about ten inches in depth, overlies a strong brick clay quite impermeable to sewage. It is not drained except in part, where shallow drains are laid to drain the ground more quickly when the sewage is turned off. The sewers deliver the sewage into one or other of two straining-tanks, which are alternately emptied about every five days, the sludge and solids being lifted out with dredger-buckets into settling-tanks made of planks, where it drains for four or five days, and is mixed with burnt house refuse and used to fill up low places on the farm, or as manure on the parts not irrigated. No lime or other chemical means of precipitation are used in these tanks, the sludge from which amounts to only 1300 cubic yards a year.

Croydon.

South Norwood farm.

The land is divided into irrigation plots, varying from 80 to 140 yards wide each, and arranged in sets of three, each one slightly below the other. Each set of three has a bringing-on carrier-drain at the top and an effluent drain at the bottom, and between each of the three there is a catchwater drain that serves as a bringing-on carrier to the plot below it. Each plot slopes evenly down from the bringing-on carrier, the water from which is led on to its surface by numerous little openings so that it may spread over all the plot. At the bottom of the plot the water is collected by the catchwater drain, which serves as bringing-on carrier to the next plot, where the same process takes place, and is then again repeated on the third plot of the set. By this means the water is more evenly distributed than if the whole width of the three plots was irrigated from the openings in the top bringing-on carrier, as the water has always a tendency to make channels for itself, and this tendency is corrected by the intermediate catchwater drains. The only crop grown is rye-grass, and the theory of broad irrigation is that the sewage moving over the land rather than through it, is purified by being kept within the influence of the root fibrils of the grass and of the humus of the soil,—the chemical and vital conditions of the surface of the soil thus occupied being obnoxious to the development of disease germs. All the sewage is exposed to this surface influence for a flow of at least 250 yards, which it takes about four hours to accomplish. The effluent water was clear, and is admitted into the streams of the country; but, from analyses kindly sent me by Mr. Walker of the effluent water from Beddington, its quality appears to greatly vary from time to time. There are six analyses of the effluent water from two outlets—four taken in July and two in September. In all the samples the quantity of chlorine is about four grains in a gallon, while the free ammonia varies from between 0·85 and 1·50 part in a million in the July samples to 7·25 parts in a million in the September samples.

Irrigation plots.

The yearly cost of the process is, for rent, interest, and repayment of capital, £2070; working expenses, £1100; total, £3170. From this must be deducted £1250, receipts from crops sold, leaving a balance of £1920 to be provided by a rate of $5\frac{1}{8}$*d.* in the pound on the rateable value of the district served. The yearly quantity of sewage applied to each acre is about 12,000 tons, of which about 80 per cent. flows off as effluent, and 20 per cent. is evaporated or absorbed by the vegetation. At Beddington the yearly quantity of sewage is about 14,000 tons to the acre.

79. The city of Paris contains a population of nearly $2\frac{1}{2}$ millions, and its sewage is of a very exceptional character when compared with that of an English town. This is principally owing to the fact that in Paris much more water is used for public services—such as street-scavengering and watering, public fountains, &c.—and less for domestic purposes than in England. The sewerage system is professedly the *tout à l'égout*, but this is by no means yet attained, especially with respect to the more solid part of the fæcal matters. There are about 130,000 privies of all sorts, of which only one-tenth are water-closets, the rest being thus divided: 65,000 privies, with cesspools in masonry, each holding from 10 to 40 cubic yards, placed underground (usually under the houses), and emptied by the manure companies with their steam pumps, &c.; 18,000 movable receptacles, and 34,000 movable receptacles with straining arrangement that allows the liquid contents to run into the sewers while the solid are removed, as are the other movable receptacles, by the manure companies. It will be seen that thus not one-fifth of the fæcal matter gets into the sewers. The consequence of all this is that the sewage of Paris is a very "weak" one. From analyses given me by M. Dutoit, Conducteur Principal at the works at Clichy, it contains only 2·95 grains of organic matter in solution in a gallon, as compared with 4·83 grains in the average of English Sewage given by the Rivers Purification Commissioners in their Report on the Mersey and Ribble Basins; and 1·94 grains of ammonia, as compared with 4·69; 0·36 grains of organic nitrogen, as compared with 1·54 grains; and 5·39 grains of chlorine, as compared with 7·46 in English sewage. This feeble dosage must always be remembered when considering the results of the sewage treatment.

Paris.

There are two main outfalls of the Paris sewage—one at Clichy, and the other at St. Ouen—and it is all sent into the Seine without treatment, except the comparatively small quantity purified by irrigation-filtration on the plain of Gennevilliers. This plain is admirably adapted for the purpose, being a flat haugh of gravel and sand on three sides surrounded by the Seine, and standing about 13 to 15 feet above it. The whole soil is so permeable that the level of the river is practically the level of the subsoil water. The Clichy main outfall sewer brings down in ordinary weather about 80 million gallons of sewage a day, of which nearly 19 million gallons are pumped across the river to Gennevilliers. The Municipality of Paris has there a small farm of about 15 acres on which it began irrigation, and showed such results that, when neighbouring proprietors were offered sewage free of charge, they were not slack in taking advantage of it, so that to-day very nearly 2000 acres are irrigated, over 30 miles of main conduits having been constructed to convey the sewage all over the plain. From the main conduits carrier drains take the sewage on to the various properties, and on them it is distributed, so far as I saw, by open furrow drains about three or four feet apart, and not all over the surface—and thus the edible parts of the vegetables grown do not come into actual contact with the sewage. The cultivation was almost exclusively that of orchards, vineyards, and market gardens, and the trees, vines, and vegetable crops looked in beautiful condition. The land requires no subsoil drainage, being all permeable enough to drain naturally into the river; but there are cross drains from half to three-quarters of a mile apart, and 13 or 14 feet deep, that take off a little more than a quarter of the water that is put on the land. The quantity that is put on every year is about 16,000 tons to the acre, equal to a rainfall of over 150 inches. The effluent water is beautifully bright, and is used as drinking water by the people. A gentleman who was with me tasted it, and said that it was very slightly saline. The analysis given me by M. Dutoit showed that the irrigation-filtration had made the following changes in the water:—

The quantity of lime in solution in it	was augmented from	13·16	to	21·28	grains in a gallon.
,, of sulphate of magnesia ...	,, ,,	6·44	to	7·49	,,
,, of chlorine	was diminished from	5·39	to	4·97	,,
,, of organic matter in solution	,, ,,	2·95	to	0·09	,,
,, of free ammmonia...........	,, ,,	1·60	to	0·00	,,
,, of albumenoid ammonia ...	,, ,,	0·34	to	0·00	,,
,, of nitric acid	was augmented from	0·36	to	1·435	,,

The augmentation in the quantities of lime and magnesia are due to the character of the soil. The quantity of chlorine and nitric acid may account for the slightly saline taste of the water, the augmentation in the quantity of the nitric acid showing the oxidising effect of the air and, perhaps, the nitrification of organic matter by the action of the germs contained in the sewage. The effect of the irrigation-filtration on the germs is shown by the analyses to have diminished their number from 13,800,000 in the cubic centimetre of the sewage to 1584 in the same quantity of effluent water.

There is a considerable population living on the plain, and the irrigation work has had no bad effect on their health; neither has the drinking of the effluent water. The works are considered to be so successful that Parliamentary powers have been granted to the Municipality to acquire a greatly increased area of land further down the river valley; and the intention is to treat the whole of the sewage of Paris on the same system as at Gennevilliers, and to transform all privies into water-closets, and thus do away with the nuisances accompanying the collection of nightsoil in Paris and its treatment at Bondy and elsewhere. What the extent of the nuisance thus caused at present may be judged from the fact that 3000 tons of nightsoil have to be collected and treated every day. In connexion with the cost to the Municipality of Paris of one or other system of treatment of the sewage and fæcal matter, I have no materials upon which to base an estimate; but it is well known that, in consequence of the irrigation works, the value of land at Gennevilliers has very greatly increased.

Adelaide.

80. At Adelaide the sewage is purified on a sewage farm of about 480 acres by either direct filtration through earth, or by irrigation-filtration. On arrival at the farm the outfall sewer discharges itself in a shed where are fixed two consecutive iron gratings acting as strainers, and which retain the larger floating matters brought down. The sewage then passes through one or other of two revolving screens made on the same principle as Baldwin Latham's machine, which I have already described (§ 76). These screens are worked by an hydraulic engine driven by the pressure derived from the waterworks mains. The material stopped by the gratings and screens is carted away and used on the farm. It amounts to about two loads a day, and the smell from it was very bad, as was also the smell generally pervading the shed. When irrigation is not going on the sewage is sent on to the filter-beds; and there is a bye-wash also that can send the storm-

Filter-beds.

waters directly on to them without straining. The filter-beds have an area of about 70,000 square yards. They are formed of a layer of engine clinkers laid about six feet below the surface, and in which agricultural drains are laid about seven yards apart for taking off the filtered sewage. The soil is filled up over these with ridges and furrows about three feet wide and two feet six inches deep, except the ridge over the drain-pipe, which is six feet wide. The sewage is conducted into these furrows, and has six feet of earth to pass through at least to reach the drain. The filtering capacity of the earth is said to be five gallons a day to each cubic yard, which is equal to about three quarters of a million gallons for the whole bed. No crops are now grown on the filter-bed ridges, but the silt deposited in the furrows is removed from time to time, stacked on the broader ridges, and when partially dry sold to farmers at ten shillings a ton. The effluent filtered water is described as pretty clear and slightly yellow, and is carried off by a drain to the general outfall.

The filter-beds were not in use at the time of my visit. I am indebted to Mr. Bayer, Sanitary Engineer to the Government of South Australia, for the following analysis, made by Mr. G. Goyder, jun., Government Analyst, of the "Mixed Effluent from pipes in Filter-beds caught before entering Effluent Drain" on the 14th July, 1890:—

Total solids........................	241·70	parts in 100,000
Ammonia, free and saline	0·2138	„
„ albumenoid	0·1206	„
Nitrogen as nitrates	1·583	„
Chlorine	52·50	„

Another sample of the effluent taken from a different pipe on the same day did not differ much from the above. I have not been furnished with any analysis of the unfiltered sewage of Adelaide, but presume that it is similar in quality to that of ordinary English towns with water-closets. If so, the above analysis shows that, as far as organic impurities are concerned, the filters are effecting a very satisfactory purification,—more than nine-tenths of the ammonia being got rid of. The most remarkable feature is the large quantity of chlorine, which is probably washed out of the soil—the whole farm having probably been, at no very distant time in the past, a salt-marsh; but the analyses of the soil given me do not furnish the quantity of chlorine present. This is to be regretted, as the chlorine in the effluent is about ten times the quantity usually present in fresh sewage.

The soil taken out of the trenches, and sold as manure, contains:—

Insoluble silicate and sand	61·80	per cent.
Organic matter and combined water ...	21·18	„
Alumina	5·20	„
Moisture, 212° Fahrenheit	3·93	„
Iron oxide......................................	2·56	„
Lime	2·23	„
Phosphoric acid	0·73	„

with smaller quantities of potash, sulphuric acid, magnesia, and soda, in the order named. The quantity of organic matter is probably eight or ten times greater than in the soil naturally.

Irrigation.

On the irrigation farm there are about 450 acres available, and this area is divided into large fields. The soil is chiefly sand, gravel, and light loam, with, according to the before-mentioned analyses made by Mr. Goyder of the upper six feet in depth of it, a mean of 81·33 per cent. of insoluble silicate and sand; 5·55 per cent. of iron oxide; 4·70 per cent. of alumina; 1·28 per cent of lime; with about $2\frac{1}{4}$ per cent. of water, and very small quantities of magnesia, potash, and soda, in the order named. As before-mentioned, no chlorine is given as being present. There is probably over 2 per cent. of organic matter and combined water. The sewage is taken on to the land in cement carriers, and distributed to the various fields in wooden (red deal) troughs, and then sent over the surface in the usual way. Though said to be "broad" irrigation, it is not so in the sense understood by that description at Croydon, but is rather irrigation-filtration similar to that practised at Gennevilliers. There is no thorough-drainage of the land, but only a main outlet drain with one or two branches for the whole 450 acres of the farm. This drain is laid about five feet deep, and the soil is so permeable that it has reduced the level of the ground water all over the place to that depth from the surface. The maximum quantity of sewage applied to the land is 5000 tons a year to each acre, equal to a rainfall of nearly 50 inches. Though in winter most of the sewage is diverted from the farm to the filter-beds, in summer there is not enough for the farm, so part of the effluent water has to be pumped over again to irrigate some portion of the land under crop. The principal crops grown are lucerne and mangolds, with prairie grass and cocksfoot for grazing purposes—a good business being done in taking in horses and cattle for grazing, each horse being charged for at four shillings a week. A good deal of ensilage is also made, and cattle, sheep, and pigs are fattened for sale. There used to be a large business done in milk and dairy produce, but dairy farming had to be discontinued in consequence of a popular outcry that it was disseminating disease. In the case of garden produce, care is taken to keep the sewage from actual contact with the plant above ground; and with respect to fodder for cattle, the sewage is applied at an early stage in the growth, and the cut lucerne I examined had no smell of it.

The following is an analysis of the effluent and sub-soil water from the farm, according to a sample taken on the 14th July, 1890—being one of Mr. Goyder's analyses:—

Total solids	201·60	in 100,000
Ammonia, free and saline	0·2914	„
„ albumenoid	0·1092	„
Nitrogen as nitrates	1·472	„
Chlorine	70·50	„

This would make it appear, when compared with the analysis of the effluent from the filter-beds, that the action of the filter-beds is quite as efficacious as that of irrigation-filtration. The quantity of chlorine is again remarkable.

The influence that irrigation with sewage is having upon the soil of the farm is shewn by the following analyses taken in December, last year, which also shew that, as was to be expected, the influence is greatest at the surface, and diminishes in descending:—

	2 feet	4 feet	6 feet
Depth from surface at which soil was taken	2 feet	4 feet	6 feet
Percentage of organic matter in soil	4·69	2·78	2·35
„ phosphoric acid „	0·13	0·09	0·07
„ sulphuric acid „	0·15	0·11	0·01

It will be interesting to have from year to year further analyses of the soil from these depths, to see the progressive action of this influence. And if, as suggested, chlorine is being washed out of the soil, its dosage should also be given.

The published accounts of the working of the farm for the year ending 30th June last show a loss of £583 on the year's transactions. Among the expenses is charged a sum of £282 for rent of land. If instead of rent a low rate of interest had been charged on the cost of acquisition and preparation of the land and the construction of the irrigating works, the loss would have probably been about £800.

Treatment of Solid Fæcal Matter separately.

Manchester.

81. At Manchester, with a population of about 400,000 (the old city), the sewers deliver their contents—including the drainage from over 20,000 water-closets—into the Irwell and its tributaries without any treatment. A scheme is prepared and is in course of fulfilment to take the whole of the sewage some miles down the river, and there treat it with the sulphate of alumina or other chemical process and filtration, and it is proposed to transform all the privies into water-closets. In the meantime the contents of the existing privies have to be collected and dealt with. These include nearly 7000 old-fashioned privies with ashpits, and 69,000 movable pail closets, and from them about 175,000 loads of nightsoil were collected last year. The greater part of this is sent to the Water-street works, and thence by railway to the Carrington Moss farm, or sold to farmers. The rest is taken to the Holt Town works, where about 300 tons are received every night. The pails are emptied into enclosed tanks, precautions being taken to prevent the smell of the operation from escaping into the open air. The pails are then washed, and the washings disinfected and precipitated by ferozone, and the mud therefrom dried. The nightsoil from the tanks is sent into the "concentrators"—steam-heated jacketted cylinders—each holding a charge of two tons. Ten gallons of sulphuric acid are added to each charge to fix the ammonia. The whole is kept in motion by revolving machinery for five hours. At the end of this period the soil comes out in the shape of a comparatively dry poudrette, dosing, 4 per cent. of ammonia and 8 per cent. of phosphoric acid—if necessary, dried blood and phosphates being added to keep up the dosage. This manure is sold at £3 a ton, and nearly £19,000 worth of it was taken away last year. The fumes from the drying manure are drawn out of the concentrators, washed in a tower with water sprays, and then burnt by being passed through the fires of the destructors that are also established at the Holt Town works.

Concentrated manure works at Holt Town.

Nightsoil farm at Carrington.

At the Carrington Moss farm, of the 1093 acres belonging to the city, about one-half is let, and the other half kept in hand for disposal of the nightsoil—344 acres of it being already reclaimed and farmed. Last year over 42,000 tons of nightsoil were received by railway. There is a special siding for this traffic, to which a narrow-guage line runs from the farm, and at which the railway trucks are discharged into the smaller waggons running on the farm line. Twopence a ton is paid for this discharging service.

In its natural state Carrington Moss is a peat bog with about 16 feet in depth of peat, so soft that after the thin crust of heather that must be removed to cultivate the ground is taken off it is impossible to take horses upon it for some years. It is deeply drained, and then light moveable rails with temporary junctions are placed leading from the farm railways across the land to be manured. For the first time of manuring a top-dressing of 300 tons to the acre is put on, and every two years thereafter another top-dressing is applied in continually diminishing quantities. The first and some of the subsequent dressings have to be dug in by spade husbandry, and, as may well be imagined, the spreading out and digging in of a coating of about 2¼ inches thick of nightsoil over great surfaces is an operation attended with no very pleasant odours. Nightsoil is utilised even for road-making; all the farm roads are made with it mixed with ashes, and, when once set, their surfaces are hard and durable. Of the 344 acres cultivated last year, 86 were old cultivated moss, 116 had been twice cropped, and 142 once cropped. The average yield to the acre was—of oats, 50 bushels of 45 lbs. and 2 tons of straw; of hay, 3 tons; of swedes, 36¾ tons; and of potatoes, 9 tons.

Yearly cost.

The total yearly expenditure of the "Nightsoil Department" at Water-street and Holt Town, and at the Carrington Estate, for the year ending 31st March, 1890, was £134,798; and the total receipts were £72,758, leaving a balance of £62,040 to be provided for out of the rates—a sum that would require a rate of 6¼*d.* in the pound to raise. It may be noted that the Authorities make the "sanitary pails" at the Holt Town Works, and that one-sixth of them have to be renewed, and one-third of them repaired, every year. The pails are made of steel and galvanised after being made, and weigh 25½ lbs. each, and cost nearly 4*s.* 4*d.* each. The air-tight covers weigh 16½ lbs. each, and cost 4*s.* 10¾*d.* each—2*s.* 1*d.* of this being for the india-rubber caulking. One cover serves for five or six pails. Mr. Whiley, the Superintendent of this department, estimates that if all the privies and pail closets in the city were transformed into water-closets at a cost of £4 15*s.* each, and the cost of such transformation, and of the water required to supply the closets, charged to the rates, together with provision for the gradual extinction of the cost of transformation, the amount so chargeable to the rates would be less than half that of the deficit of £62,000 now charged as the net cost of the pail system.

82. The sewage collection system of Warrington (53,000 inhabitants) has already been described in connexion with the use of Shone's ejectors. The number of pails in use is 7500. They are made out of petroleum casks, each cask being cut into two, and re-made to a smaller size than a half-cask, with new hoops and fittings, at a total cost of 3*s.* 4*d.* a pail. To each five or six pails there is an air-tight lid that costs 11*s.* complete. They are collected by day, and at least once a week, but in some special cases oftener. The professedly air-tight character of the covers notwithstanding, there are still complaints made of smell escaping from the "conservancy carts." No ashes or dry earth are allowed to be put into the pails. At the depôt in the town they are emptied, washed, and sprinkled within with carbolic powder in sufficient quantity to cover the surfaces. **Warrington. Pails.**

The emptying and washing of the pails is done in an inner shed within the large shed of the depôt. This inner shed is enclosed on two sides and open on the other two, and is covered over with an inverted hopper-shaped roof, from the top of which a fan, driven by a gas-engine, draws the air and forces it into the chimney shaft of the works, which is 120 feet high. This arrangement does not obviate all offensive smell. In the tank in which the night-soil is emptied is a sort of "dolly," worked mechanically, for breaking up the paper, &c. From this tank it passes into another covered one, where it is kept for a day before being sent as previously described by a Shone's ejector through a six-inch pipe to the Longford works, more than a mile away.

Longford is a little outside Warrington, and the ejector main delivers the nightsoil into raised covered tanks, whence it passes by gravitation into the condensers, 90lbs. of sulphuric acid being added to each thousand gallons of nightsoil. The condensers are steam cylinders with tubes through them, through which tubes the soil passes, and is therein partly dried, the vapour from the drying being drawn off and condensed, and the condensed water discharged as innocuous. From the condensers the soil passes into vacuum drying-pans, where it is further dessicated, and is then stacked for sale as manure. Some of the manure is still further dried, ground into powder, and sold in sacks at £6 5*s.* a ton. The whole process is accompanied with offensive smells. At these works about 144 tons of soil are treated, and 13 tons of manure produced, every week. The total sales of manure last year were over £1500. The cost of the system cannot well be ascertained, as proceedings connected with the scavenging department are also carried on at the depôts and works, but probably the yearly expenditure, apart from interest and sinking fund on cost of works, is about £3500, and the receipts about £1780. **Longford works.**

83. Rochdale, the town where Alderman Taylor, whom I had the pleasure of seeing, originated his celebrated "Pail system," has a population of 71,500. There are in the town about 400 water-closets and 12,600 pail-closets. There is a sewage farm to treat the contents of the sewers, but I did not see it at work, as the sewage was being diverted in order to effect repairs to the outfall sewer. The farm and works thereupon have cost £38,000. The expense of working it last year, exclusive of rent or interest and sinking fund on the above amount, was £1090, and the receipts £465, so that the farm is worked at a great loss. **Rochdale.**

The works for treating the contents of the pails are situated within half a mile of the centre of the town. The pails, which are similar to those in use at Warrington, but with different covers, are collected once a week and removed in specially designed vans, each holding 24 pails. Each pail thus removed is replaced at the same time by a cleansed one, having in it a small quantity of deodorant. The town is divided into six districts radiating round the works, and one of them is dealt with every day of the week. Every privy in the town is numbered, and the carters are furnished with "van lists" shewing the street or streets to be visited on each round, the number of each house to be called at, and the number of each pail to be collected. These are all printed beforehand, the districts being subdivided into groups of houses sufficient in number to provide a load for the van. The weekly emptying of every pail is thus secured. Nearly 9000 tons of excreta were thus collected last year. The removal is still accompanied by offensive smells in the streets. On arriving at the works, the vans, after being weighed, are taken into a shed, the doors of which are kept closed as much as possible. The pails, on removal from the vans, are raised by a hydraulic lift to a higher floor, where they are emptied into tanks and then returned to the lower floor to be washed and deodorized; the vans also being served so after every journey. **Manure works.**

The excreta in the tanks is mixed with sulphuric acid, in the proportion of 24 lbs. of acid to the ton, to fix the ammonia. It is then run into the narrower end of one of Haresceugh's patent revolving cylinders. These are 12 feet long and not truly cylindrical, the diameter varying from 6 feet at the narrower end to 6 feet 6 inches at the wider. They revolve each one on four friction rollers. Through these cylinders all the smoke and hot air from specially constructed furnaces pass, after having heated the boilers which provide the steam for the engines that make the cylinders revolve and do the other mechanical work of the establishment. The revolution of the cylinders agitates the excreta, and so exposes fresh surfaces to the hot air blowing through them. The charge of a cylinder is three and a-half tons; and in about $11\frac{1}{2}$ hours this is reduced to nearly five and a-half hundredweights of a material very like hard clay. This is taken out of the cylinders and further dried on a floor formed of iron plates, under which passes the hot air that has been blown through the cylinders. The hot air charged with the moisture derived from the excreta in the cylinders is then passed through condensers to remove this moisture, after which it is blown through a special furnace, from which it passes up the main chimney shaft, which is 250 feet high.

The manure, when dried to 10 or 12 per cent. of moisture, is taken from the drying floors and ground in a pug-mill, and then sold in sacks. It is certainly a valuable manure, containing, according to an analysis made in 1884 by Dr. Voelcker and confirmed by subsequent analyses, about 7 per cent. of nitrogen, chiefly in the form of ammonia ; 1·62 per cent. of soluble and 2·29 per cent. of insoluble phosphoric acid ; and 2·96 per cent. of potash. This, at the usual valuation, would make the manure worth £7 6*s.* a ton, and it is sold for £6.

As in the accounts of the collection of the refuse the expenses in connexion with nightsoil and ashes are taken together, it is impossible to exactly fix the cost of the process of making the manure. But if half the cost of collection be referred to the nightsoil, its collection would cost £3644 ; the cost of manufacture is £3721, making the total yearly cost £7365. The sales of manure produced £3040 last year, leaving the total net cost £4323, which had to be provided out of the rates, being equal to a rate of nearly 4½*d.* in the pound.

Purification by Electrolysis.

Mr. Webster's process.

84. I had not any opportunity of seeing Mr. Webster's process of purifying sewage by electric action actually at work. It has been experimented with on a large scale at the Crossness outfall of the London sewers. The process is based upon the oxidation of the organic matter in the sewage by the electric current acting on iron plates placed in the shoots leading from the sewage to the settling-tanks, and so arranged that all the sewage comes into contact with the plates. The quantity of sewage operated on in each experiment was about 20,000 gallons, and subsequently, according to Professor Threlfall, of Sydney, 1,000,000 gallons a day. According to Sir H. Roscoe's analysis the effluent from the settling-tanks has lost from 57 to 87 per cent. of the albumenoid ammonia contained in the sewage—an amount of purification that is surpassed by the Ferozone process as practised in bulk at Acton and Southampton. The inventor calculates that the cost of a complete plant, with engines in duplicate, for treating 1,000,000 gallons a day, would be from £6000 to £7000, and the daily expenses 12 cwt. coal and the wages of four men. This does not include the cost of getting rid of the sludge. The above figures would represent, on the same calculation with respect to the capital as that hereinbefore taken for Southhampton, a yearly outlay of £1320, being more than double that expended at that town for the same work. Therefore, as far as my present knowledge goes, I should not recommend the adoption of purification by electrolysis in the present state of the development of the system.

I take it, as far as suspended matters in the sewage are concerned, that they are deposited in the tanks by the precipitation and precipitating action of the iron dissolved from the electrodes, and that this iron also gives off oxygen to the organic matter in solution with which it comes in contact. The salts of iron in the ferozone have just the same action, and, for a given quantity of effect, produce it at a far less cost.

Collection and Disposal of Town and House Refuse.

85. Almost, if not quite, as important as the collection and disposal of sewage is the collection and disposal of the street, yard, and house refuse of towns. Unless the proper performance of the former be supplemented by the proper performance of the latter, the sanitation of a town is, at least, partially neglected ; and during this visit to England I have been more than ever struck by the fact that the places where sanitary work has had the greatest influence in diminishing the occurrence of, and mortality from, preventable diseases are the cities where most attention is paid to the regular carrying out of the scavenging service, not only in the public streets but also in private yards.

Scavenging.

86. A past-master in sanitary science and work, Sir R. Rawlinson, at the annual meeting of the Association of Municipal and Sanitary Engineers, held at Stratford-on-Avon in 1885, said :—

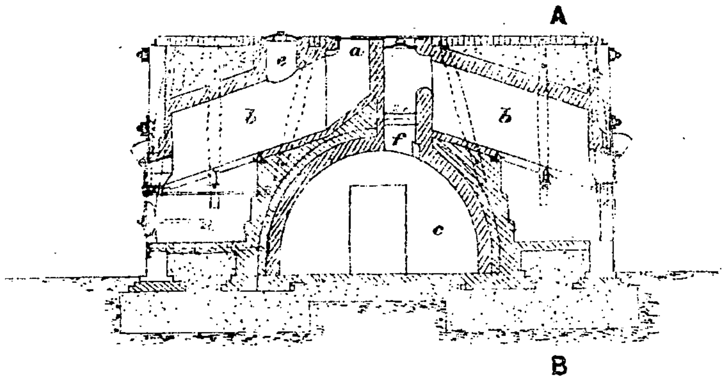
"There is one thing I wish to say to the governing people of Stratford, and that is that the foundation of all sanitary science is *scavenging* ; and if I were asked what is the most important feature of all sanitary science, I would again repeat—scavenging. Your sewers, your drains, your water supply, are all secondary considerations if scavenging is neglected. There should be no private vested interests in effete matter, as it should be removed by public scavengers from the premises of every individual, every manufactory, and every other place at the cost of the general body, and the cost should be paid out of the general district rate. I say this most earnestly and most advisedly. It is being contended against by some Local Boards, the members of which say that they do not see why they should cleanse private establishments. But I know why this should be done : it is because if you leave it to private individuals it becomes the source of serious evil. And I say, as a last word to the people here, mature your scavenging arrangements and make them perfect ; do not let them to any contractor . . . . The most economical way is for the Corporation or Local Board to do the work themselves under their own management."

This is what is now being done by nearly every sanitary authority.

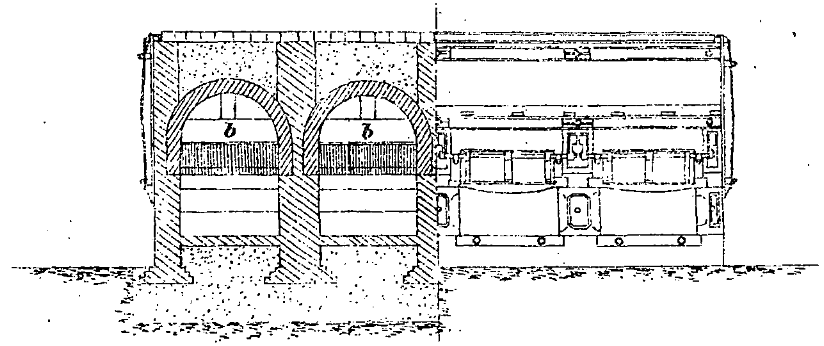
At Manchester the principal streets are swept daily and others twice or three times a week, chiefly by machines, which commence work at midnight, and will do about 30,000 square yards a day. The men who are employed at hand-sweeping begin to work at two o'clock in the morning, and sweep about 3000 square yards a day. There is a "swilling gang" also constantly employed in the court-yards. All the courts I saw were paved, but some of them in Ancoats were in a bad and dirty condition. There is also a special gang for cleansing street gullies. Some part of the street sweepings is sold to the farmers, but the greater part is taken to "tips" on lands purchased for the purpose, and which require filling up ; but in wet weather the mud is left to drain in depôt-yards in the city, and, when dry, removed to the "tips." The markets and slaughter-yards are

FRYERS DESTRUCTOR.

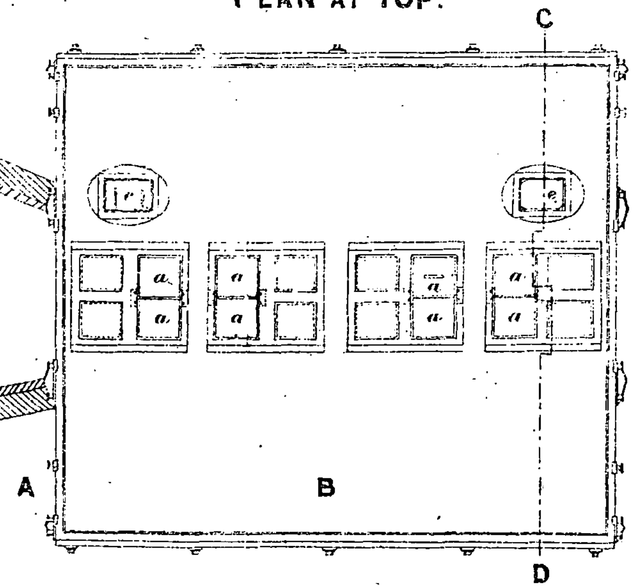
SECTION ON C.D.



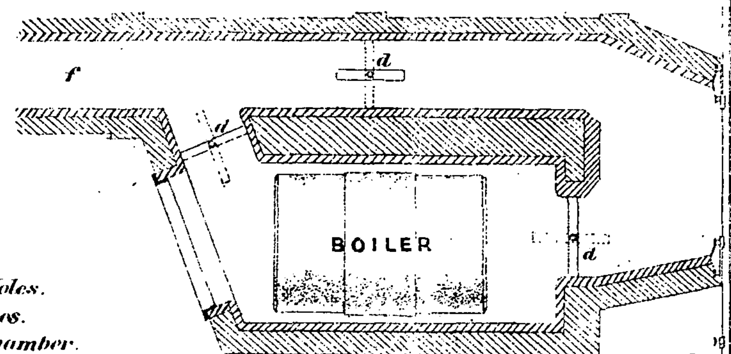
SECTION ON A.B. ELEVATION.



PLAN AT TOP.



SECTIONAL PLAN OF FLUES.



a. a. Feed Holes.
b. b. Furnaces.
c. Dust Chamber.
d. d. Dampers.
e. e. Mattress Holes.
f. f. Flues.

cleansed daily, and, in a large city like Manchester, enough garbage of different sorts is gathered to make it worth while to specially treat them separately for the extraction of fish oil, animal fat oil, &c., the residue being used to enrich the manure made as before described.

At Liverpool the system of scavenging is yet more complete than at Manchester, the court-yards and passages being all regularly swept. Of the street sweepings some 3000 tons are used as binding on newly macadamized roads. 24,000 tons (including garbage from markets) are sold as manure, and 120,000 tons sent out to sea. Refuse was first sent to sea in 1880 in consequence of the growing difficulty to otherwise deal with it. A steam hopper barge was built capable of carrying 380 cubic yards of refuse, and in 1884 another was added. Probably a third will be required, notwithstanding that destructors for refuse will also be used. These hopper barges take the refuse outside the bar of the Mersey, where, at 22 miles from the landing stage, there are 117,000 acres with a minimum depth of 90 feet, an area on which it will take about 30 years for the present yearly quantity of about 160,000 tons (including house refuse) sent out, to make a difference of one inch in the depth. About seven per cent. of the street watering in Liverpool is done with sea water.

At Glasgow also the system is very complete, and comprises the cleansing of all common court-yards. The sweeping machine service begins at half-past ten o'clock P.M., and continues all night. The street sweepings are treated with the house refuse, and what are not sold as manure are used for raising and reclaiming the peat moss farm belonging to the city. There are, in the principal streets, bins fixed about 40 yards apart, for the reception of the manure gathered by boys from the roadways during the day. These are low inconspicuous boxes, very unlike the pillar boxes used in London for the same purpose, which are apt to be mistaken for street post office boxes.

At Southampton all the street sweepings, except the part that is required for binding for newly macadamized roads, is used as a drying and absorbing material to be mixed with the sludge from the sewage tanks, consequently its disposal not only costs nothing, but actually brings in a small return to help in paying the cost of collection.

At Paris, in ordinary times, the street sweepings are not carted from the streets, but swept into the gutters, whence they are flushed into the sewers, with the consequence, before described, of having special arrangements to clean the sand and gravel out of the sewers again.

House Refuse.

87. In London the greater part of the house refuse is collected by the contractors for scavenging, and treated in the dust-yards together with the street sweepings; the treatment consisting chiefly in screening out the breeze and ashes, which are sold to brickmakers, and in making a compost of the residue, which is sold as manure. These processes create considerable nuisances in the neighbourhoods where they are carried on, and are the cause of many complaints. This has led to the introduction at Whitechapel, at Letts's Wharf, where the refuse of the city is dealt with, and at Chelsea where that part of Westminster and Kensington is treated, of means to get rid of part at least of the nuisance by the action of fire. London.

88. At Letts's Wharf there is a destructor of ten cells which burns the paper and dry rubbish collected from the shops and warehouses, and the refuse material from the houses after the ashes, cinders, and anything else worth picking out, have been sorted out by the women employed for the purpose. Destructors.

As there will be frequent occasion to refer to destructors in this part of my Report, and as those patented by Mr. Fryer, of the firm of Manlove, Alliott, and Fryer, of Nottingham, will be the kind meant unless otherwise specified, the following account of them will assist in understanding their action. The illustration given of it is copied from Mr. Codrington's Report to the Local Government Board, dated December, 1887. Since that date various improvements have been made, but the general principle is the same. There is a group of furnaces, called cells, marked *b*, each about 9 feet, by 5 feet, by 3 feet 6 inches in height to the crown of the fire-brick arch. It will be noticed that the furnace has a considerable slope downwards from the back to the front. The fire-bars are 5 feet in length, and behind them is a fire-brick hearth 4 feet in length. Behind the hearth a wall, the end of which is visible on Section A B, divides the flue from the refuse feeding place, the flue *f* going downwards into the main flue *c*, and the feeding-place sloping up to the opening, *a*, for the admission of the refuse. The main flue under the hearth is now made larger than shewn to act as a dust chamber. Over some of the furnaces there is placed another and larger opening *e*, over the hottest part of the fire, for the admission of condemned meat, infected mattrasses, and other large objects. The furnace doors are the full width of the cell, and are hung on hinges to open upwards, and have balance weights. Every part exposed to fire is either of iron or fire-brick, and the whole structure is tied together with iron rods and stays. The cells are usually placed back to back with one feeding door *a* to each pair. A group of four cells measures about 14 feet by 24 feet, and a group of six, 21 feet by 24 feet, and so on proportionately. They are usually built with a road on an inclined plane so that the refuse carts may be tipped on the top, close to the feeding doors; but at Letts's Wharf a lift has to be used to raise the shop refuse, and the house refuse is carried up in buckets by men. The feed-openings are kept filled with refuse which slides forward on the sloping hearth, and is partially dried by the heat given out by the fire below and reverberated by the furnace arch. It is helped forward by pushing from above or raking from below till it reaches the fire-grate, where it burns until only a hard clinker is left, which is raked out at given intervals through the furnace door. The hot gases, or a portion of them, are usually utilized by being carried through a multitubular boiler to produce the steam necessary to work the machinery of the establishment. They are then sent up a high shaft; a dust chamber being built to prevent noxious dust being also carried up, as it would cause a nuisance by falling round the works. A great inconvenience was also found to be caused by the draught of the chimney stack carrying up burnt paper which fell in quantities all round the wharf. This is now stopped by a grating.

The clinker is removed every two hours. It is loosened from the fire-bars and lifted over the burning cinders with suitable tools, and raked out of the fire with any other part of the completely burnt refuse. The fire is then again spread evenly over the grate, and dry refuse raked forward from the back sufficient to cover the glead with a thickness of about four inches. When the refuse is wet, less is put on; and if too much is ever put on the fire will become dead and black. Thin layers are put on at intervals of twenty minutes, but the fire is left undisturbed for the last half-hour before clinkering. The art of firing is to keep the bars evenly covered with a clear bright fire about nine inches thick. There should be enough refuse kept over the feed-door to prevent the admission of cold air, and always enough on the back hearth ready to be raked forward for burning.

The Letts's Wharf and Whitechapel destructors burn from 31 to 32 tons of refuse a week in each cell. The temperature in the dust-chamber at Whitechapel ranges from 410° to 540° Fahrenheit—amply sufficient to destroy all germs from the refuse. At Letts's Wharf no use is made of the clinkers.

Chelsea.

89. At the Chelsea Works more is done with the refuse. They are situated at the Salopian Wharf, and belong to the Refuse Disposal Company, who are working Messrs. Stanley and Russell's patented process, the object of which is to save and utilize as much of the refuse as possible, and that by means which get rid of the insanitary part of the arrangements usually made to deal with the material,—the men, women, and boys employed being protected from the dust and dirt of the ordinary scavenger's yard. By an ingeniously mounted set of three large cylinder screens with progressively smaller meshes, and by the centrifugal action of a large turntable, all the component parts of the refuse are either automatically separated from each other, or are brought in front of boys who can pick out what is wanted; and, at a particular point in the process, the paper—of which there are large quantities—is blown by a powerful draught into a receptacle where it is disinfected by heat. The general divisions of the separated materials are paper, rags, bags, &c., saved for paper-making; straw, boxes, sticks, coal, and cinders, for heating purposes; tin and iron, sold for scrap; bones, whole bottles, broken glass, sold to manufacturers; stones, vegetable refuse, animal refuse, rubbish, broken crockery, &c., ground under edge-runners and sold as manure; and breeze, &c., sent to the brick-yards. The fuel found is sufficient to raise steam for all the machinery, including that for paper-making, and that for working the dynamos for the electric lighting of the establishment; and some is mixed with breeze, tar, &c. for making artificial fuel, which fetches a good price. The greatest novelty in the Chelsea establishment is the paper-making,—all the paper-making materials found in the refuse being pulped in three beaters, and then made into brown casing-paper.

The Company has expended about £16,000 on the works. They give evidence, in parts, of their experimental character, and, should the same system be carried out elsewhere, no doubt a better installation would produce even better results than those obtained at Chelsea. I am not in a position to speak of these results financially, but, from a sanitary point of view, they show a great advance on the old methods of refuse treatment.

Southampton.

90. At Southampton the house refuse is collected by the town scavengers and is all destroyed in the destructors. I was much struck with the heating power of these destructors, as the great bulk of the fuel supplied to them seemed so little calculated to give out any heat. As it was the middle of summer a great portion of the ash-bin contents seemed to be fresh vegetable matter—such as cabbage-leaves and stalks, pea and bean pods, and fruit and potato parings—with, especially as regards the bins from the poorer class of houses, but little intermixture of dry ashes; and yet the heating power developed was very great, as 25 tons of the refuse are sufficient to supply the day's requirement of steam. About 60 loads of house refuse are collected daily in tumbril carts, which, going up an inclined plane, deliver it on the top of the destructor. (See plan at page 39.) This has six cells, and the products of combustion pass through a 30 horse-power multitubular boiler in the main flue to a brick chimney-shaft 160 feet high. There is also a bye-pass, in which a smaller boiler is placed, to enable the work to be continued during repairs. There is a great draught in the chimney, but no obnoxious fumes have been noticed. There is no dust chamber. The steam generated is used to drive a pair of engines of 31·5 indicated horse-power for compressing the air for the Shone's ejectors already referred to, and also working the dynamos that now furnish the electric lighting of the works, and are intended to light the municipal buildings, &c., the dynamos being sufficiently powerful to feed lamps of 30,000 candle power. There is also a six horse-power machine for manure mixing, and the machines for chaff-cutting, &c., and clinker-grinding.

The clinkers amount to from 15 to 20 per cent. of the refuse burnt. They are ground and used to make mortar when required for building purposes, and, at other times, concrete or artificial stone, four parts of ground clinker being used to one of Portland cement. I saw steps of this artificial stone that had been some years in use, and had still sharp unworn arrises. The principal use made for it is for paving-flags for footpaths. I saw a street of which one footpath was paved with these at about a third of the cost of the pavement on the other side, which was of Swanage stone. Both had been laid down together, some years ago, to test their relative durability. The artificial stone was wearing as well as the other, and had the additional advantage of not becoming "greasy" in damp weather.

91. At Birmingham there are three stations in different parts of the city to which the house and other refuse is taken, and at which there are destructors and boilers having 37 cells and furnaces. I visited the principal station in Montague-street. Here the contents of the ash-bins are carried by an elevator into a revolving screen, which separates the fine ashes and dust, which are used to mix with nightsoil, as before described. The more offensive part of the residue is burned in destructors designed by Mr. Pearce, of Bradford. Each of these is 7 ft. 4 in. by 5 ft. 4 in., and 3 ft. high in the middle to the crown of the arch. The whole of the bottom is occupied by fire-bars, which slope upwards from the fire-door about nine inches in their length. The whole of the back is occupied by a pigeon-holed fire-brick wall, which gets red-hot, and so presents a large heated surface to the vapours arising from the combustion of the refuse, which have to pass through the pigeon-holes on their way to the chimney. Behind this wall is a dust chamber 1 ft. 6 in. wide, through which the vapours also pass. This chamber goes to the bottom of the ash-pit under the fire-bars, from which it is separated by a dry wall, removable when the dust is cleared out. An opening with a damper leads from the chamber to the flue, which, in turn, communicates with a chimney stack 260 feet high, which also serves for the boilers. The fumes from the nightsoil dryers, mentioned in § 77 of this Report, are taken by pipes into these furnaces. The furnaces are fed with refuse sometimes by the fire-door, but principally by a feed-door on the top, like those of Fryer's destructors, and the firing and clinkering is done in the same way. Not much use seemed to be made of the clinkers, except for road pitching. Birmingham.

But by far the greater part of the screened refuse is burnt in the furnaces of eleven multitubular boilers, which generate the steam for driving part of the machinery of the establishment and for heating the nightsoil dryers above referred to. These furnaces are fitted with patent lifting and moving self-clinkering fire-bars, to prevent the clinkers forming in large cakes and to keep the air-spaces clear. The play of these bars can be regulated to suit the condition of the refuse, or it can be stopped entirely, and this stoppage is, I believe, the usual state of affairs. But, when in use, the effect is to work the clinker to the back, where it falls over the end of the fire-grate into the ash-pit.

92. At Manchester the best of the screened refuse is burnt in Lancashire boiler furnaces, and the worst in destructors. These are very simple in construction, being arranged in groups of four, back to back, each being 8 ft. 6 in. by 4 ft. 3 in. by 6 ft. 3 in. in height. The fire-bars slope upwards 1 in 6 from the fire-door, and are 5 feet long, the rest of the bottom being occupied by a hearth separated by a low wall from a descending flue leading to the chimney. The refuse is fed into an opening over the middle of the furnace without any previous drying. Great care is taken to ensure regularity in the feeding and clinkering, so that the majority of the fires of each group may always be burning well, and so secure a sufficiently high temperature in the common flue to destroy the fumes coming from any newly charged cell. The clinkering is done every hour and a half. Each cell burns about 28½ tons a week, and produces a large quantity of clinker, most of which is ground and used for mortar-making, more than 6600 tons of mortar having been made last year. The fine dust from the flues is mixed with carbolic acid and made into disinfecting powder. Manchester.

Mr. Codrington reports that the average temperature of these furnaces was found to be 625° Fahrenheit. Now, by excluding air as much as possible from the furnaces and keeping up the combustion of the aqueous vapour from the concentrators described in § 81 of this Report, not only are the noxious fumes of the vapour destroyed, but the temperature in the furnaces raised to 1200° or 1500° Fahrenheit. When this aqueous vapour is not available it is replaced by a steam-jet. The heat is utilized to raise steam for engines and for heating the above-mentioned concentrators.

93. At Ealing the dust-bin refuse is partly mixed with the sewage sludge, as before described in § 73 of this Report, and partly burned in a destructor of four cells, in the manner mentioned. The cremator alluded to in the description cited has a fire-grate 6 ft. 6 in. long by 4 ft. wide in a furnace with a fire-brick reverberatory arch, having projecting rings of fire-brick, which deflect the gases coming from the destructor cells and force them down on the surface of a coke fire, which is always kept with a clear glead. A heat, said to vary from 1000° to 1500° Fahrenheit, is always kept up. There is an arrangement of air-holes to control the admission of air to the cremator, and also to the flues bringing the gases, so as to give enough to secure their combustion. The heat from the cremator, as well as from the destructor, is utilized for steam production. The use of the cremator has put an end to all the local complaints of nuisances arising from the smoke of the destructor. Ealing.

94. At Warrington the house refuse is burned in the cells of a Fryer's destructor fitted with Perrett's patent furnace, the fire-bars being very deep, very close together, and the lower edge kept immersed in water. By this arrangement they are kept cool, their durability prolonged, their original shape preserved, and the width of the air spaces between the bars kept constant. The low temperature at which the bars are kept prevents the clinkers from adhering. Air at a low pressure is admitted above the surface of the water. The heat is used to produce steam in three multitubular boilers for the drying processes described above in § 82. Large quantities of clinkers are produced and used for road-making, concrete, &c. Warrington.

Glasgow. 95. Glasgow is divided for refuse collecting purposes into seven districts, and each district into six subdivisions, each subdivision being attended to once a week, except those in the central division, which are attended to twice a week. The ash-pits are emptied by night, and the dry shop and warehouse rubbish collected by day. The whole of the matters collected are sent to one or other of three stations called "Despatch Works." The last constructed of these I was taken over. Advantage is taken of the conformation of the ground to allow the carts bringing the refuse to deliver it on what is virtually the second floor of the sheds, the first floor being occupied by the machinery, and the ground floor with the furnaces and railway lines. The carts are weighed on entrance and then tipped on the upper floor, traps through which deliver the refuse upon revolving screens, which are slightly conical, and which deliver what will not pass the screen meshes on to an endless travelling band, from which one boy picks out the straw and vegetable refuse generally, which he drops down a shoot into a railway waggon placed below to receive them. Another picks out old iron, tin ;—and so forth. What is not worth while picking out is carried on and dropped at the feeding-doors of the destructor cells, the clinkers from which are used for road-making, &c. The screenings from the larger meshed screen are principally cinders, and are carried by another endless web to the boiler furnaces, of which they furnish the only fuel used. The screenings from the fine meshed screens are in like manner carried to the mixing tanks, where the nightsoil of the remaining privies in the city is treated and then sold to farmers as manure. The foul air from these mixing tanks is drawn out by a fan and forced through special flues opening under the fire-bars of the destructor furnaces The chimney shaft is 240 feet high, and there are dust-flues, gratings to stop burnt paper, &c. The total refuse, including street sweepings, last year amounted to about 780 tons a day, or 244,000 tons a year, of which about 140,000 were sold after treatment to farmers, and the rest disposed of as "unsaleable refuse" or burnt.

House Sanitation: Drainage.

96. Of late years more and more attention has been paid to the means of rendering every house taken by itself as infection-proof as possible, whatever may be the state and condition of the general system of sewerage with which it is connected. One of the chief means devised to this end is the ventilated disconnecting chamber. This is a small inspection chamber, usually about three feet long by about two feet wide, built in brick on the line of the drain leading to the common sewer at a point at or below that at which the last of the branch drains from the house joins it. The accompanying drawing, taken from a full-sized model in the Parkes Museum, of House Drainage arrangements, as elaborated by Professor Corfield and Mr. Rogers Field, shews the usual manner of construction of this chamber and other features connected with drains. The main house-drain is marked BB (in the model it is a six-inch drain), and on it there is an interception trap AA on a junction pipe, the upper arm of which has an inspection pipe 1A, closed with a Stanford-jointed stopper, which, when taken out, permits the inspection of the six-inch drain and the removal of any obstacle sticking in it beyond the interception trap. The chamber Y is lined with white glazed bricks, and the drains running through it are made of half pipes only, so that the drainage is visible. The chamber is covered with a movable air-tight iron door. It is ventilated by a four-inch pipe CC leading to an air inlet DD, which is made in any convenient position in an adjoining wall, and the entrance grating to which is also guarded with a light mica valve to prevent the exit of air. This ventilating pipe forms the short arm of a ventilating syphon. In the chamber the branch drain from the trapped gully X joins the main house drain N, the junction being also in half pipes. The gully X receives the down waste pipe W from the bath, which pipe is continued upwards as a ventilator, the waste being fixed to the bath with the screw plug V, having under it a lead trap U with a clearing-screw. The gully also receives the waste from the lavatory through the pipes S, R, and the hopper Q, and also a rain-water pipe T. The main house drain N is continued to receive the water-closet soil-pipe C, the junction between the lead and earthenware pipe being made with a metal thimble L with a cement joint M on one end and a solder joint J on the other. The soil-pipe is continued upwards by the same sized pipe A, which becomes the longer arm of the ventilating syphon and is connected with C by the astragal joint H. The branch soil-pipes E have two-inch antisyphonage air-pipes B and D, with a brass ferrule K to join the lead to the earthenware trap F and a solder joint to connect with the lead trap G. Parts of the drain O are bedded *on* concrete, and parts P are embedded *in* it, to shew the practice in bad ground and under houses.

Disconnexion of drainage from sewers.

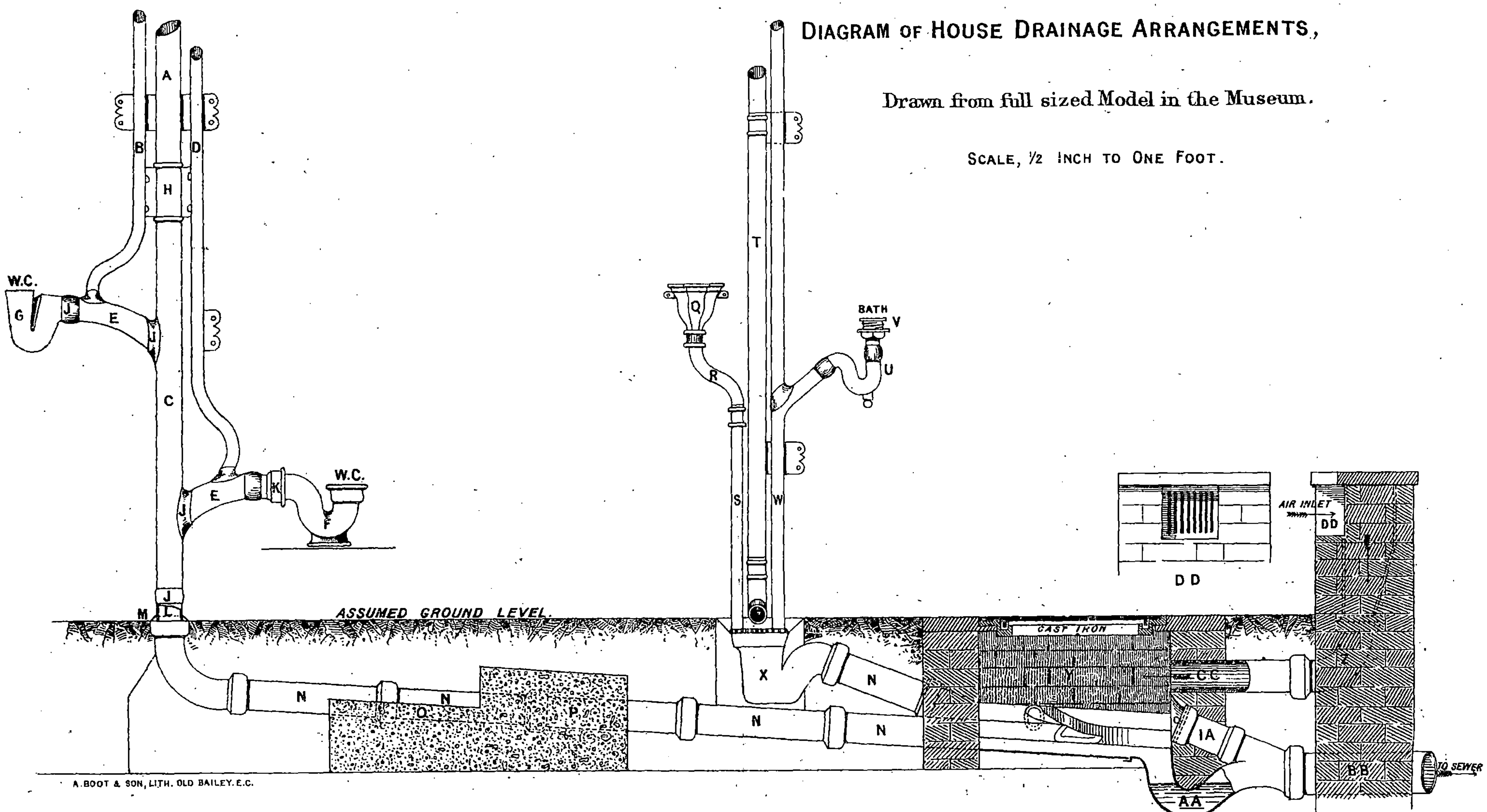
The illustration on page 55 shews the arrangement of an intercepting chamber as constructed by Messrs. Broad and Co. of Paddington, with their white enamelled channel-blocks or halfpipes, junctions, and bends. Of course, any number of junctions coming in at any angle can be arranged for ; and it will always be found advantageous to make the intercepting chamber, if possible, the point of union of all the drains of a dwelling-house.

Size of drains. 97. There is some divergence of practice as regards the size of pipes allowed for house-drains; the authorities of Birmingham and other places fixing four inches in diameter as the minimum, and many others six inches as the minimum, if there be water-closets. I know of no instance in England where the maximum diameter is also fixed, but in Paris both maximum and minimum are regulated, being $6\frac{1}{2}$ inches and $3\frac{1}{4}$ inches. In Paris also the minimum gradient of 1 in 33 is fixed, with a proviso that the administration will, if necessary, allow less inclination, but on the condition that there is provided special means of periodical flushing.

Diagram of House Drainage Arrangements,

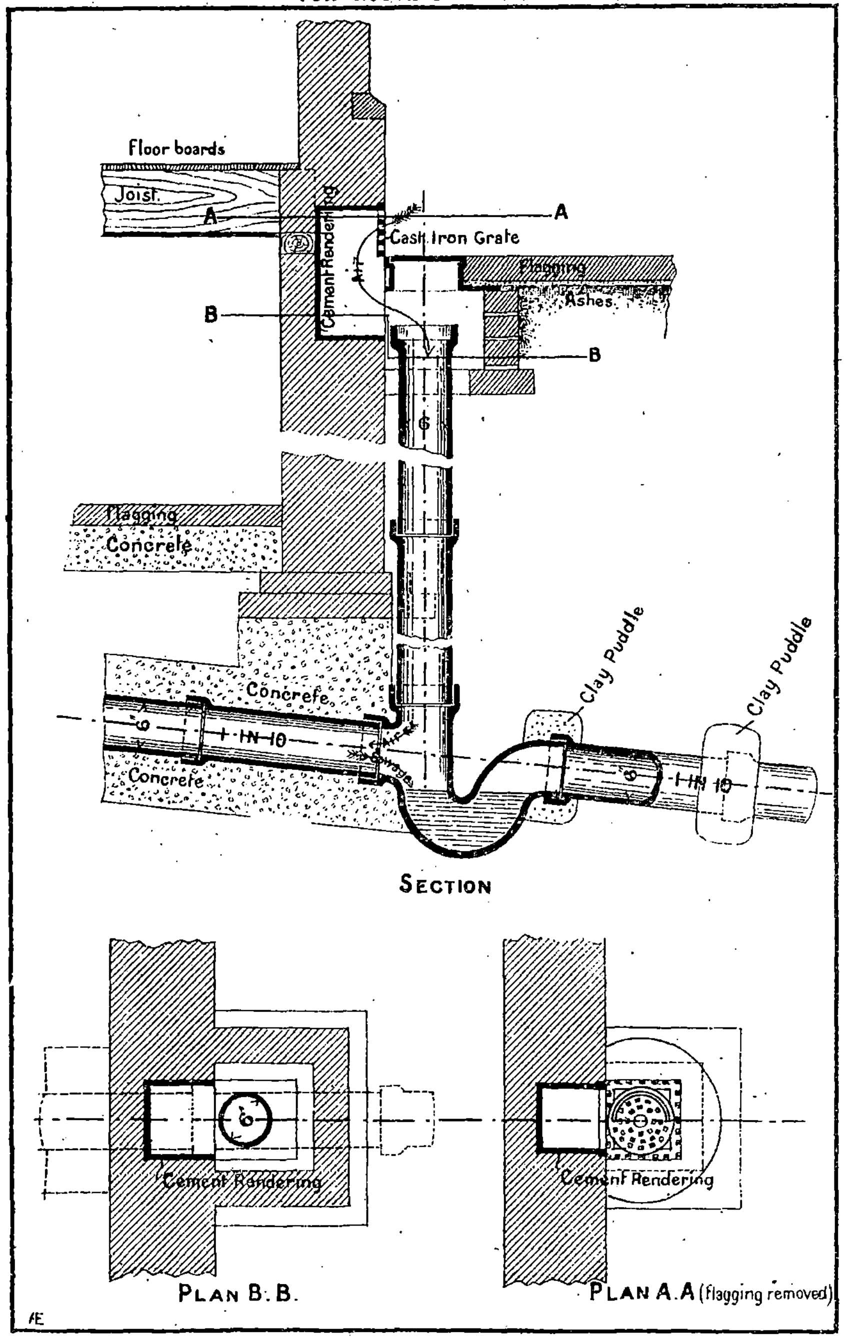
Drawn from full sized Model in the Museum.

Scale, ½ Inch to One Foot.

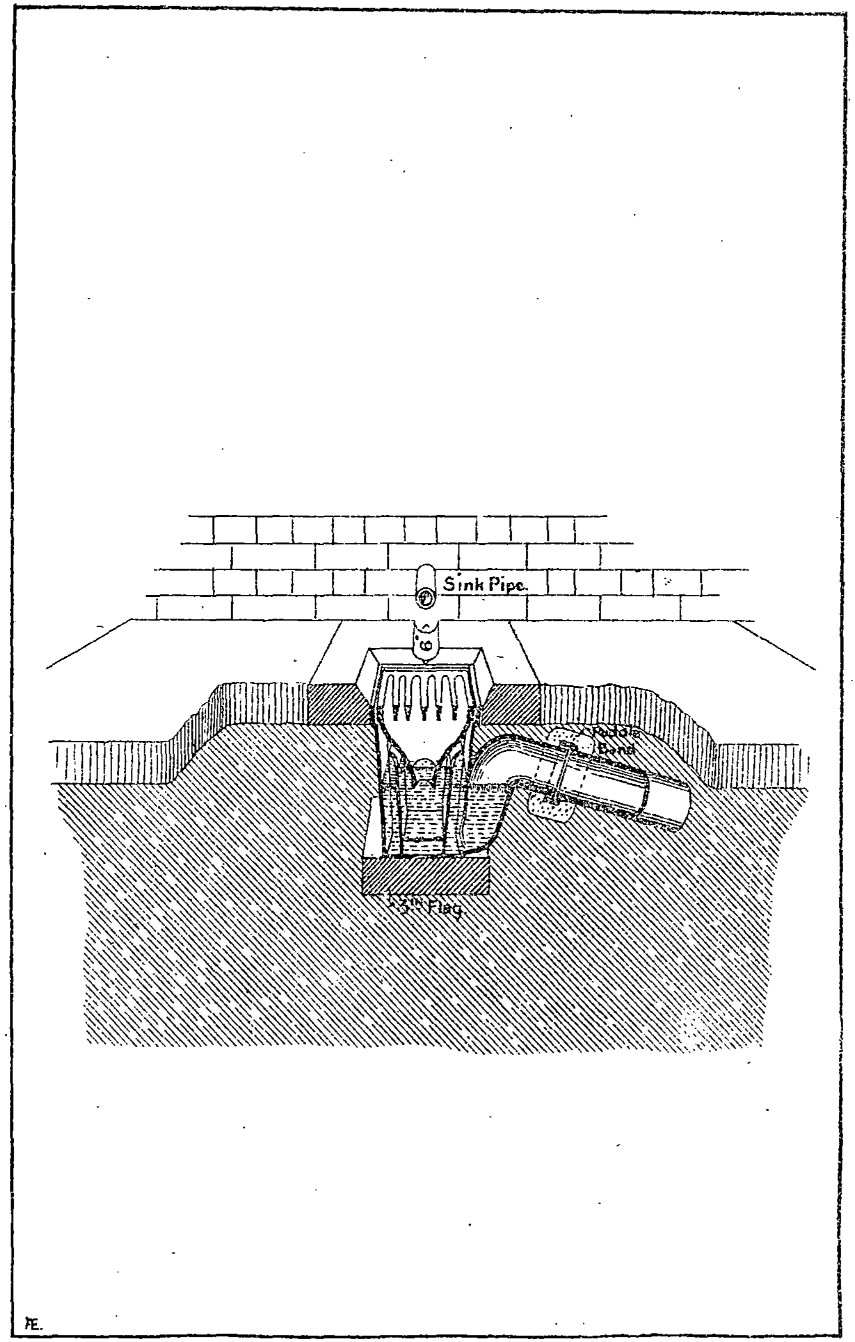


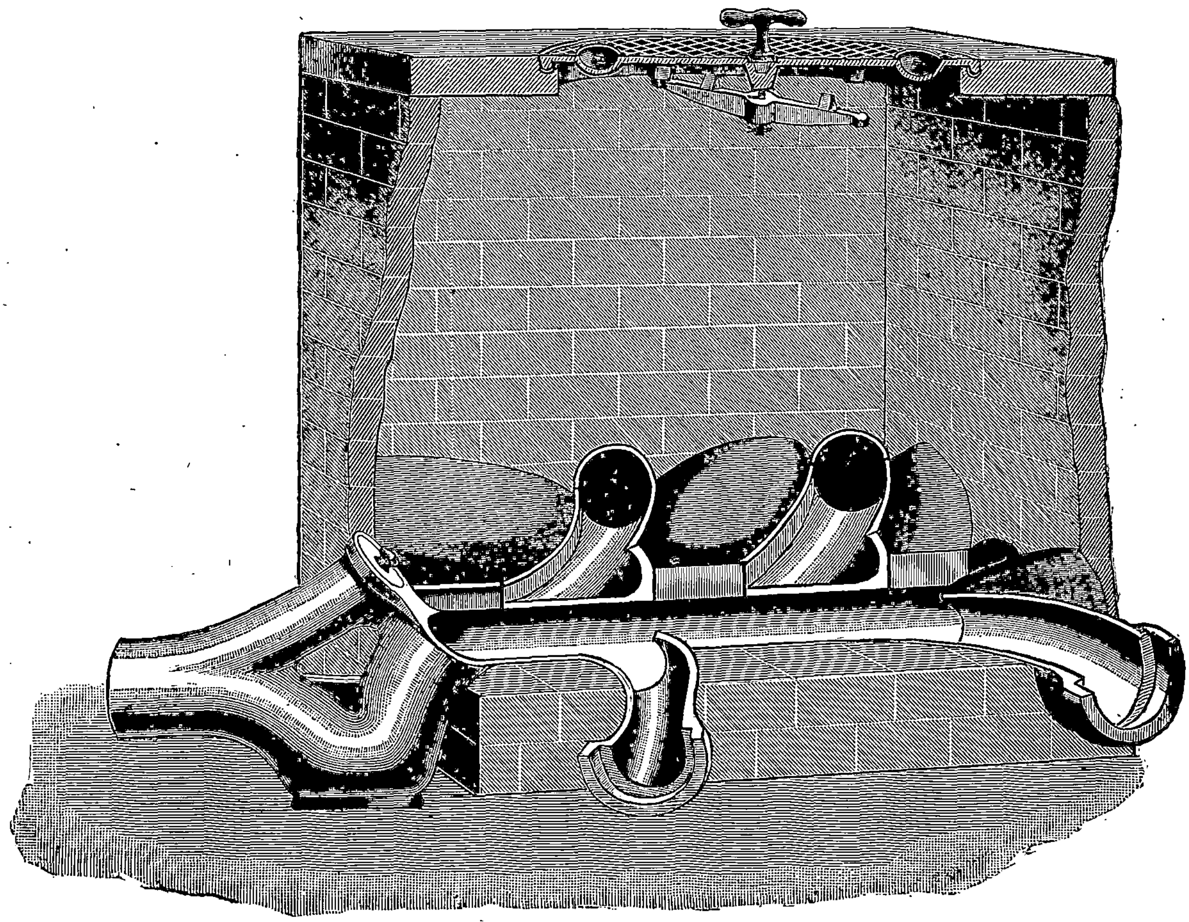
A Ventilating Shaft.
B 2in. Air Pipe (Anti-Siphonage).
C 4in. Drawn Lead Soil Pipe, 10lb. lead.
D 2in. Air Pipe (Anti-Siphonage).
E 4in. Lead Branches for Closets.
F Earthenware Closet Trap.
G Anti D Trap.
H Astragal Joint.
J Wiped Solder Joints.
K Brass Ferrule for jointing Earthenware Trap to Lead.
L Brass or Copper Thimble for connecting Stoneware Bend to Lead Soil Pipe.
M Cement Joint (in Section).
N 4in. Drain Pipes jointed with Cement.
O Two Feet of Pipe bedded on 6in. Concrete.
P Two Feet of Pipe bedded in 6in. Concrete.
Q Hopper Head (Galvanized Iron) for Lavatory Waste.
R 6in. Set-off do. do.
S 3ft. Length do. do.
T 6ft. Length 3in. do. Rain Water Pipe and Shoe
U Lead P Trap with Cleaning Screw.
V Plug Waste for Bath.
W Bath Waste Pipe with Ventilating Pipe above.
X Trapped Gully.
Y Disconnecting Chamber lined with White Glazed Bricks with Benchings rendered in Cement and rith Glazed Channels.
Z 4in. Easy Bend.
AA Intercepting Trap with Inspection Arm—IA
BB 6in. Drain Pipe to Sewer.
CC 4in. Ventilating Pipe connecting with Air Inlet—DD
DD Front View of Air Inlet shewing 9in. grating.

DISCONNECTING SYPHON & COVER.
FOR HOUSE DRAINAGE.



TRAPPED YARD GULLY.





98. Nearly all sanitary authorities discourage the practice of laying drains below house-floors, the usual bye-law providing that the builder " shall not lay any such drain so as to pass under any building except where any other mode of construction may be impracticable, and in that case he shall cause such drain to be laid in the ground so that there shall be a distance equal at the least to the full diameter of the drain between its top at its highest point and the surface of the ground under such building. He shall also cause such drain to be laid in a straight line for the whole distance under such building, and shall cause the drain to be completely embedded in and covered with good and solid concrete at least six inches thick all round. He shall also cause adequate means of ventilation to be provided in connexion with such drain at each end of such portion thereof as is beneath such building." The accompanying plan shows the method adopted by Mr. Wike, the borough engineer at Sheffield, for effecting this ventilation, and at the same time making an arrangement to act as an intercepting chamber. **Drains under houses.**

99. Every sanitary authority requires, by bye-law, that every drain communicating with a public sewer shall be provided with a sufficient trap—but so far as I know there is in England no definition of what is a sufficient trap. Doultons, Broad, and other good pipe manufacturers make intercepting traps with a water-seal of three inches, but many are made with much less. In Paris the regulations require at least $2\frac{3}{4}$ inches. **Drain-traps.**

100. Another requirement of all Local Boards of Health is the proper ventilation of all house-drains. Usually one of two plans is allowed: that generally adopted is shown on the plan of the model house-drainage at page 54, in which the air enters by the short-arm of a syphon into the intercepting chamber, and goes out by the long-arm, which is often a continuation of the soil-pipe; and the other is a reversal of this, the short inlet arm being placed at the end of the drain, and the long outlet arm going up from the intercepting chamber. Naturally, the greater the difference is between the length of the two arms the more perfect the ventilation will be when not affected by wind; the Local Government Model Bye-laws require a minimum difference of 10 feet in the length of the two arms. A too powerful draught is to be deprecated, as it will blow out the water-seal of the traps; it will be quite sufficient if the longer arm be ended with a cowl turning away from the wind. The opening of the inlet for fresh air should be at least equal in effective area to that of the cross section of the largest drains to be ventilated, and the outlet continuation of the soil-pipe at least 4 inches in diameter. The inlet should be guarded with a mica valve to prevent back draft. **Ventilation.**

101. Almost all these matters, and others referring to the subsoil drainage of the sites of houses, the construction, materials, connexions, &c., of house-drains, are treated of in the Model **Model Bye-laws.**

Bye-laws issued by the Local Government Board, which Bye-laws have been very universally adopted by all Local Boards of Health in England.

Rate upon water-closet drain connexions.

102. In one respect there is a great difference in practice between England and France, though the sanitary authorities of the latter profess to be equally desirous with those of the former to encourage the sending quickly out of the building all the noxious matters connected with human occupation. In England everyone has the right to send, under proper supervision, all the sewage produced in a house into a public sewer. In France the same right exists in regard to ordinary house slops, but, with regard to water-closet sewage, an annual payment has to be made before it is allowed to pass into the sewers. This is altogether distinct from the charge for water. At Paris a charge is made of 25*s.* a year for each water-closet or filtering-closet—a rate that produces over £40,000 a year, and would produce over £150,000 were all the privies turned into water-closets. At Marseilles it is intended to vary the payment from 16*s.* a year for houses valued at £20 a year and under, to £8 a year for houses valued at £800 a year and above, with intermediate rates for intermediate valuations. These rates are expected to produce £45,000 a year.

Drain-testing.

103. There is a growing practice among sanitary authorities in England to forbid the occupation of new houses until the proper construction and ventilation of their drainage has been examined and tested. This is usually done by the smoke-test, but at Eastbourne water under pressure is also used. At Glasgow there is a permanent staff of five smoke-testers constantly employed on this service and on that of testing old drains; and in the Act of 1890, conferring further powers on the sanitary authorities of the city, one of these further powers is that of entering after notice on premises for the purpose of applying the smoke-test to the drains—"and if the drains be found defective, the owner of the premises shall be bound, immediately on an order to that effect being given by the Police Commissioners, to carry out all necessary operations for removing defects of structure, or doing such acts as may be requisite to prevent risk to health, and, failing compliance with such order, the Police Commissioners may execute the work, and recover the expense thereof as damages from the owner." No new houses are occupied until this testing has been done; and it is done at every house in which fever occurs.

Certificates of sanitary condition of houses.

At Eastbourne, the authorities have gone a step further. A register is kept of the sanitary condition of the houses; and, at the request of the proprietor, and after a special examination made, a certificate is given of the sanitary condition; and further periodical examinations are made to see that the condition of the premises warrants the continuance of the certificate. No charge is made for such certificates, which, it will be remembered, some of the hygienists at the Congress desired to make it compulsory for owners to obtain before letting any dwelling-house. During the sittings of Congress there was also a lively discussion on the subject in the columns of the London morning papers. In the Eastbourne Register there are columns for entering the names of the owner, occupier, and builder of the house, its position, and, if a new one, the Register number of the plan deposited before it was built, the position and character of the drains and their outfall, and of their traps. Then come the date and details of the first inspection, with a description of the water supply, dust-bin, water-closets, drain connexions and traps, the nature of the test applied, and remarks on the results of the inspection, all signed by the officer who made it. As an example of how the work is done, I give the following extract of actual entries relating to a house:—

"Condition as found.—*Date of Inspection*, 1890, June 18.

"*Water Supply.*—Water for all purposes drawn from a cistern placed in the roof, and from one continuous pipe.

"*Dust-bin.*—Brick, built under the back steps close to the house, reached from back road.

"*Water-closets.*—Pan-closet apparatus and D trap on first floor—bad form of W.C. for servants.

"*Drains and Traps.* (The disconnecting trap is mentioned in the other part of the Register.)—Gully-trap in front area receiving bath and pantry waste; also in back area receiving scullery waste. Traps bad form.

"*Remarks.*—No test made. Closet apparatus in very foul state. Waste-pipe of wash-basin connected direct to the soil-pipe. Rainwater-pipe connected to the soil-pipe. Flushing power to the closets insufficient. A written report sent to owners' agents, Messrs. ———

"See Letter Book, page 641.

"(Signed) WALTER GRANT.

"Amended Condition.—*Date of Inspection*, 1891, May 15th, July 15th.

"*Water Supply.*—One cistern for domestic uses—supplies hot-water cistern; another for water-closets only. A draw-tap at scullery sink direct from public main.

"*Dust-bin.*—Portable iron dust-bin provided, reached from back road.

"*Water-closets.*—Bramah apparatus on first floor. Improved basin fixed in servants' W.C. at rear.

"*Drains and Traps.*—Stoneware gully traps in front and back areas for waste and surface water.

"*Test applied.*—Water and smoke-rocket.

"*Remarks.*—Drain relaid, tested with water 15th May, 1891, sound and satisfactory sanitary arrangements.—(Initialed.) W.G. Soil-pipe and branches thereto tested with rockets 15th July, found sound; premises in satisfactory sanitary condition.

"(Signed) WALTER GRANT.

"Note.—The front area drainage passes under the floor—'disconnected' at its junction with the main house-drain.

"Certificate issued, 16th July, 1891."

The following is the form of the Certificate:—

"BOROUGH OF (L.S.) EASTBOURNE.

"Registered No.

"CERTIFICATE of Satisfactory Sanitary Condition of House Property known as within the said Borough of Eastbourne.

"I HEREBY certify that, on the day of 189 , the above-named premises were duly and properly examined and inspected, and the drains tested, and that the said premises were found to be at that date in a satisfactory sanitary condition.

"Dated this day of 189 .

" , *Inspector of Nuisances.*

"*N.B.—This Certificate will be withdrawn if at any time upon inspection the sanitary arrangements are found in a faulty condition or badly kept.*"

The great value of such a certificate to an incoming tenant is the assurance it gives that the buried and hidden work of the builder and plumber, which no amount of superficial examination, however carefully made, can really determine the character of, has been properly done, as it is upon this work that much of the healthiness or otherwise of the house depends.

Subsoil drainage.

104. Nearly all local sanitary authorities have adopted the model Bye-law No. 60 relating to subsoil drainage of the sites of new houses, and in some districts provision is made for carrying out Dr. Ballard's recommendation that the whole site of a house should be covered with an impervious layer of concrete. The 25th section of the Public Health Amendment Act, 1890, enacts that "it shall not be lawful to erect a new building on any ground which has been filled up with any matter impregnated with fæcal, animal, or vegetable matter, or upon which any such matter has been deposited, unless and until such matter shall have been properly removed by excavation or otherwise, or shall have been rendered or have become innocuous." Many Local Boards had anticipated this enactment by their Bye-laws. The want of such legislative provision has already had to be regretted on several occasions in these colonies.

In the very valuable and interesting work on the Medical Organization, Hygiene, and Demography of Denmark, prepared for and presented to the International Congress by the Danish Government, there are admirable proofs of the care now being exercised in sanitary matters in that country, especially in Copenhagen. There are beautiful maps that have been prepared by the Sanitary Society of Denmark, partly with Government aid, of the subsoil of the city, one being taken at four feet below the surface, and one at nine feet, and the varying heights of the subsoil water are noted. On these maps are distinguished the bad artificial soil, good artificial soil, sand, and clay, and building regulations have to be made accordingly. Unfortunately there is a considerable area of the bad artificial soil, for, as the city increased, its fortifications forced the builders to create land by reclamation from the sea. "Unfortunately for health," the report says, "the material used during centuries for filling in these grounds was about as bad as it could be. Offal, sewage, rubbish from houses, streets, and yards, were emptied by the careless inhabitants on to the low-lying meadows which stretched along the Sound, or were thrown into the water itself. The area thus filled in became in time the building grounds of succeeding generations, and the people of to-day are still suffering from these proceedings."

Plans of new houses.

105. The legislative provision for the depositing with the Local Sanitary Authority, and approval by it, of plans for all new buildings before beginning to build has been productive of much good, both in Great Britain and in America. As an example of the good effects of this legislation, I may quote the following passage from one of the recent yearly reports of Dr. Fenton, Medical Officer of Health of Coventry. After giving the number of plans examined by the City Surveyor and himself, he goes on:—

"Of these 256 were passed as presented, 26 were passed after suggested improvements were made, and 22 were rejected finally. The latter were principally stables and sheds proposed to be erected at the rear of houses situated in densely built, over-crowded neighbourhoods. The erection of buildings in such situations is extremely objectionable, as it cuts off the already too scanty supply of fresh air and light, and as they are generally put up for the purpose of keeping animals, a serious addition is made to the pollution of the atmosphere. Large numbers of such erections have been made in the district, many without plans being passed, on the plea of their being of a temporary nature. They cannot be too strongly condemned. I have examined 120 new dwellings recently completed, and found them satisfactory."

In New York the law on the subject was passed in 1881, and in the Annual Report of the Board of Health for last year the Chief Inspector, Mr. Collins, charged with the administration of the Act, reporting to Dr. Ewing, the Sanitary Superintendent, says:—

"From the outset the work of enforcing this law has been beset with difficulties and serious responsibilities. The first experienced was in securing proper plans and specifications, much of which still continues. The task of examining and determining from plans and specifications that the plumbing of the more than 2600 houses annually built in this city is properly provided for and described, is anything but easy, but, added to this, questions arising with numerous architects, builders, and plumbers in the execution of the work, require to be examined and decided. Neither is it easy to secure from builders and plumbers of this large number of houses absolute compliance with approved plans and specifications, and work absolutely free from defects of material, workmanship, and system. In the enforcement of this law other difficulties arose. . . . . Old builders and plumbers had to be guided into new ways. For years there was a constant struggle against defective plumbing, and covering of pipes without inspection. Numerous open joints were found, many made with putty. Every ruse was employed to deceive. One builder erecting a block of houses even opened the entire roadway in front of them, and closed it without laying a pipe, to give the impression that sewer connexions had been properly made, when, in fact, the houses had been sewered by a box drain laid through the cellars. Dummy vent-pipes were also frequently discovered, but every such discovery led to the arrest and conviction of the offender. Defective plumbing was obliged to be perfected without regard to the expense imposed, and unscrupulous builders and plumbers at last began to realize, though slowly, that it was more expensive to violate the law than to comply with it. In this manner work went on, until in 1887 material began to show more defects than the workmanship, the iron pipes used at the time being of the kind designated in the trade as "light." The rules governing plumbing were, in consequence, amended to require the grade of pipe known as "extra heavy." The next important improvement was suggested by the difficulty of examining in detail each of the almost innumerable joints of iron pipes used in new buildings. It consisted of the application of the pressure test to all iron pipes after they had been put in place, the test being made by charging the pipes from front wall to roof, after all openings have been carefully plugged, with water or air, the exact pressure allowed being ten pounds to the square inch. This test is now invariably insisted on, and no work is passed until after the test has shewn it to be perfect. The value of this, and the wisdom of requiring it, have been often demonstrated in the past year, for its use allows neither defective pipe nor defective jointing to escape undetected."

Most of the cities and towns in England have local Acts which give them special powers with respect to buildings. In many cases there are special Building Acts; and in others the sanitary authorities, while adopting the model Bye-laws in principle as far as they affect building, add thereto other provisions—for instance, with regard to the strength and description of materials—and thus make a complete set of regulations for controlling every department of construction as effectually as a Building Act. Some of these sets of Bye-laws are very clearly set forth: those of Sheffield being illustrated with diagrams fully explaining the objects and terms of the regulations, and in addition contain detailed suggestions and particulars setting forth the requirements of the Council in cases where works are subject to its approval or to that of the Borough Surveyor. For an example, I give the following with respect to the plans required to be deposited before beginning any new building, as the requirements set forth are similar in character to those of most other sanitary authorities:—

The plan shall show or give particulars on the following points:—

(i.) Character of intended water supply for domestic and other purposes; specify water-closets to have cistern supply, and if there be any well on the premises show its position, and figure in the distance from the nearest drain.

(ii.) Full particulars as to lines and position of all intended drains (in red), their sizes, fall, and depth, as described more particularly under the instructions with reference to house drainage, together with full particulars as to any existing drains (in black) proposed to be utilized in connexion with the intended new drainage, and show position of disconnecting traps and ventilating pipes, reflux and screw-down valves.

(iii.) Show rain-water drains in blue colour with sizes and fall; also position of rain-water cistern and overflow (if any).

(iv.) Specify all gullies to be of the Highway Department pattern.

(v.) Specify all manure pits to be constructed water-tight in manner before mentioned.

(vi.) Describe paving of yard, and specify character of foundation for paving, which should consist of *six inches* of hard rubbish or lime concrete, as the Borough Surveyor may require.

(vii.) Show how causeway is to be paved, and figure in width.

(viii.) If any internal water-closet specify that the soil-pipe is to be carried up full bore above the eaves of roof or above all dormer windows.

(ix.) Figure on the thickness of all external and cellar walls, also of cellar area walls and their projections on to the causeway.

(x.) Show and figure on the dimensions of all proposed pilasters, cornices, or other projections.

(xi.) Describe proposed mode of constructing all floors and cellar-walls (if any) and all foundations.

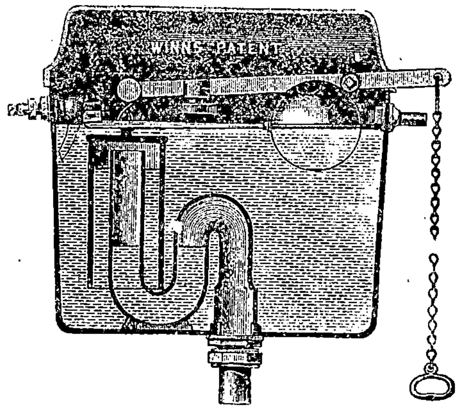
(xii.) In the case of factories and workshops give probable number of hands to be employed, and of each sex. Describe the proposed ventilating arrangements, &c.

(xiii.) The section shall show the intended level of the lowest floor above Ordnance datum, and also the street and yard levels.

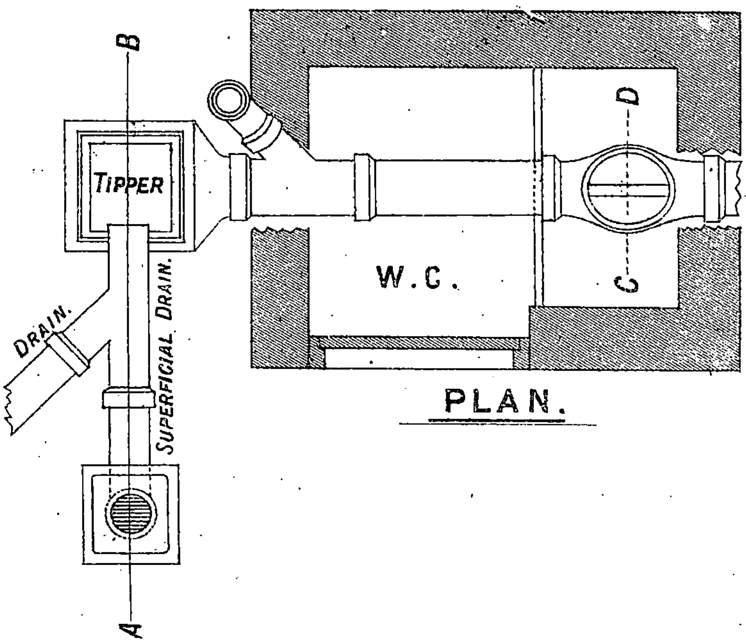
There are similarly given "suggestions and particulars" with reference to every part of the construction. For instance, in connection with the above-mentioned gullies (see drawing at page 55):—

"The gully grates and traps to be used for house drainage purposes are to be of the same construction and principle as those specified for streets—viz., side outlet, double trapped, with removable sludge-boxes and hoppered gratings. It is recommended that in size they be not less than ten inches by seven inches, top outside measure. It is also recommended that a deep form of construction—viz., one in which the water-line is not less than 18 inches below the surface—be adopted for yards and exposed positions, as giving more security from frost in winter."

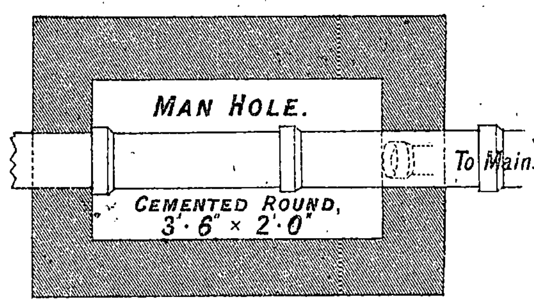
In all places plans for new buildings, &c. are approved subject to the builder giving such notices as are needful for the proper inspection of his work during construction. For instance, at Warrington, at the time of the official notification to a builder of the approval of his plans he is furnished with a sheet containing four forms of notice to the Borough Surveyor: the first being notice of intention to begin the building; the second that the drains are laid ready for inspection before being covered in; the third that the foundations are ready for inspection; and the fourth that the house is completed and ready for inspection before occupation. Each notice is separated from the next by

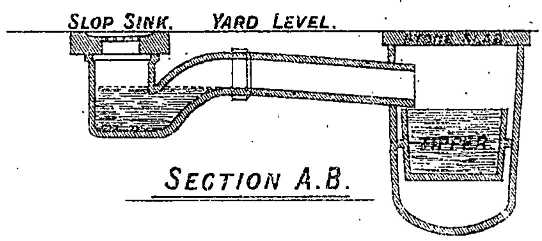


SYPHON CISTERN.

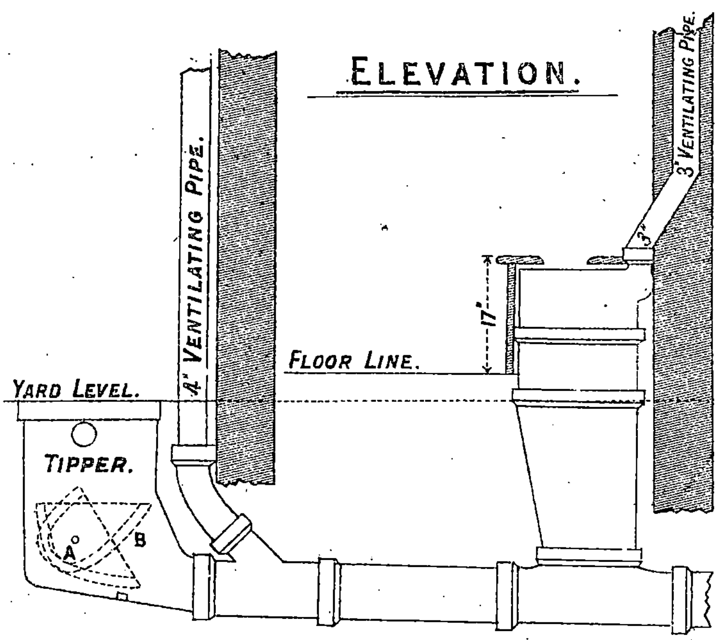


PLAN.

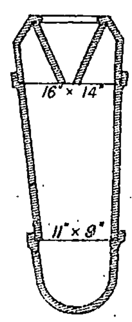




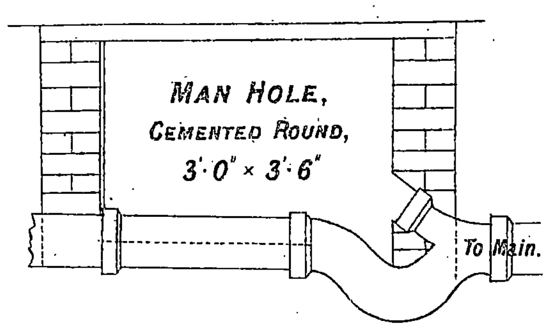
SECTION A.B.



ELEVATION.



SECTION C.D.



perforations so as to be easily separated, and bears the official register number of the plan passed, and also at the foot contains abstracts of the regulations relating to the subject of the notice. The builder has consequently nothing to do but fill in the place and date, and sign his name, before sending it to the Town Surveyor.

106. The insistance by sanitary authorities upon having good workmanship and good materials, a proper system of drainage, plumbing, and ventilation, and an economical and at the same time effective use of water, have given a great impulse to the introduction of new appliances and apparatus, some of great value. Many Local Boards of Health have what is in effect a sanitary museum, showing the systems they will permit, and sometimes also those they will not permit to be used. The collection of apparatus at Birmingham was particularly good and complete. The regulations with respect to the relative position in regard to the house of both internal and external water-closets, their ventilation, lighting, and general arrangements are usually in accordance with those prescribed by the Model Bye-laws, and the apparatus usually is specified to be subject to the approval of the sanitary authority. The best that I saw were fitted in well-lighted closets, having windows opening to the external air, tiled floors, and walls lined with tiles or Parian or other hard cement. The basins were placed on the floor without any casing round them, so that the floors were all visible and all washable, and the seat was hung on hinges to a rail supported by small brackets. The basins and traps were in one piece, and glazed inside and out, and made to be visible, and of a form easily flushed; the trapping, ventilation, &c. being as before described. The water supply was from syphon cisterns, giving a fixed quantity of water very rapidly, and all by one pull of the handle. All the leading manufacturers make apparatus of this sort. Of the syphon cisterns there are various sorts, and their action will be understood by the accompanying illustration of one of the best known. The cistern is made to hold the required quantity of water for one flushing, usually two or three gallons, the ball-tap shutting off the supply when the quantity has entered. The long arm of the syphon passes down through the bottom of the cistern to the basin to be flushed; the short arm is entirely within the cistern, and is bent upwards again. The bent-up part is enclosed in a larger tube open at the bottom and closed at the top with a movable airtight lid attached to the lever worked by the handle. When there is no water in the cistern there is enough left in the bend of the shorter limb to prevent the passage of air, consequently as the water rises in the cistern the air imprisoned in the tube prevents the water rising in it to the height necessary to overflow into the pipe; but when the cap is raised by pulling the handle the air escapes, the water rises and overflows, and the syphoning action is established, and, the handle being immediately released, continues until the cistern is emptied. Therefore exactly the arranged quantity of water is used for each flush. It will be seen that there are no valves except the ball-tap to get out of order. Water-closets.

107. For places in which there is a limited water supply, or where the house occupiers cannot be trusted to properly use ordinary water-closets, Dr. Alfred Hill, Medical Officer of Health of Birmingham, has introduced and recommends the use of the "waste-water closet." The accompanying plan shows a single one of these closets; it will be readily seen that the system is, at least, equally applicable to a number grouped together,—for instance, to serve a number of houses in a court yard. An ordinary privy is built on the line of the house drain. Immediately under the seat an upright junction on the drain receives a glazed stoneware taper pipe that in turn receives another of the ordinary size of the opening in the seat. Immediately under the seat two shelving pieces are placed, reducing the opening to a slit 2½ inches wide, running from back to front, to hinder the throwing down into the drain of large objects likely to choke it. All this arrangement is shown on the plan, elevation, and section CD. Between the closet and the house and at a place on the drain where it may receive all the drainage from the sink, gully trap, and other receptacles of slops, rain, and waste water, a "tipper" is placed as shown in a chamber in such a manner as to catch all the sewage and water. The tipper, which may be made of any size, is so hung on trunnions excentrically as to rest horizontally until about full, when the weight of the water tips it over, and then when it is empty it again becomes horizontal. The volume of water thus tipped out flushes out the drain under the closet. Between the closet and the sewer the drain runs through a man-hole with a syphon and inspection branch—one of the pipes through the man-hole being also a capped pipe admitting inspection. Waste-water closets.

Dr. Hill claims for this closet arrangement that it is—

"cheap, simple, and easy of construction, not readily put out of order, requiring little or no attention, and exempt from the serious drawback of becoming useless through freezing in the severest and most protracted cold weather . . . . It requires neither basins nor cisterns, nor even a special water supply. One of the very strong claims to acceptance of this form of closet consists in the fact that it is actuated entirely and automatically by the waste water of the premises, no special water supply being required, and consequently no increase in the volume of sewage resulting, and no additional work being thrown upon the sewage farm. It dispenses with moveable fittings of every kind, and cannot be obstructed or broken except by acts of wilful damage, and if so obstructed or broken it admits of easy repair."

The great default of the system is that the flushing is not applied where it is most needed—on the shelving pieces just under the seat. However little excrement may remain on the surface of these pieces it will become as offensive, and sometimes as dangerous to health, as the basin of a dirty unflushed ordinary water-closet. A superior modification of the same principle seems to me to be Duckett's "Automatic Slop-water Closet," as used at Burnley. The arrangement of the drains and Burnley system.

the tipper is the same, but there is no slit with shelving pieces, the oval pan or pipe below the seat being 15in. by 10in., and dropping into the water of a syphon trap—water which is always there, as it is renewed by every flush. The drawback to this system is that continual inspection is required to prevent the drains being choked with big objects wilfully and mischievously put down the seat—but a cleansing inspection is also required for Dr. Hill's closets.

Trough closets.

108. Very great improvements have been made in the arrangements, method of action, and fittings of trough closets, so that they are now, in my opinion, the best form of water-closet to use where groups of closets are needed, especially in a climate where the freezing of water is not a contingency to be provided against. The accompanying drawings show a set of the closets made entirely in stoneware except the flushing tank and the seats. The flushing-tank is made to contain any needed quantity of water, and may be set to discharge at any fixed interval, each flushing driving out the water and soil contained in the trough and replacing them with clean water; its action is similar to that of the one described on page 33 of this Report. The seats may be fixed at any wished-for interval apart, and can be readily separated from each other by partitions. The water supply and frequency of flushing cannot be interfered with by the occupiers of the closets, and, consequently, the economy of water is probably greater than with the waste-water closets. With these children, for play or mischief, and their elders for sanitary purposes, may turn on the sink tap to see the frequent flushing action of the tipper—a waste of water impossible with the automatic syphon.

Earth-closets and privies.

109. The regulations usually adopted for the construction and use of earth-closets, pail-closets, and privies are those of the Model Bye-laws. In the southern and midland towns of England they are not much used, and, as a rule, the occupiers using them have to make arrangements for the removal and disposal of the nightsoil, and the usual method adopted is to bury the matter in gardens and fields. But in London, under the Public Health Act of this year, every sanitary authority is bound to make arrangements for the due cleansing out and emptying at proper periods of the earth-closets, &c. in its district. In the northern towns, where their use is more general, nearly every sanitary authority which provides for the disposal of the nightsoil objects to the use of earth, ashes, or such deodorants, as adding to the quantity of matter to be removed and treated, and impoverishing the resulting manure. It was only in connexion with hospitals in the south that I saw the earth system really in use, and there, in the fever wards, the excreta were not allowed to be sent into the sewers, but were burnt in cremators. The accompanying plan of the privies and ash receptacles as constructed at Warrington shows the arrangement usually adopted in northern towns. At some places in Denmark the use of powdered peat in the closet-pails is compulsory. If the peat be carbonized or torrified it is an excellent deodorant and disinfectant.

Ashpits.

110. The arrangements for ash-pits are also controlled by the Model Bye-laws. Everywhere the system is coming more and more into vogue to have only moveable ash-bins; in the north these are very frequently half kerosene casks, with additional hoops and handles. Care is taken that the ash-bin shall be placed under cover, so as to keep the contents dry, as shewn on the Warrington plan.

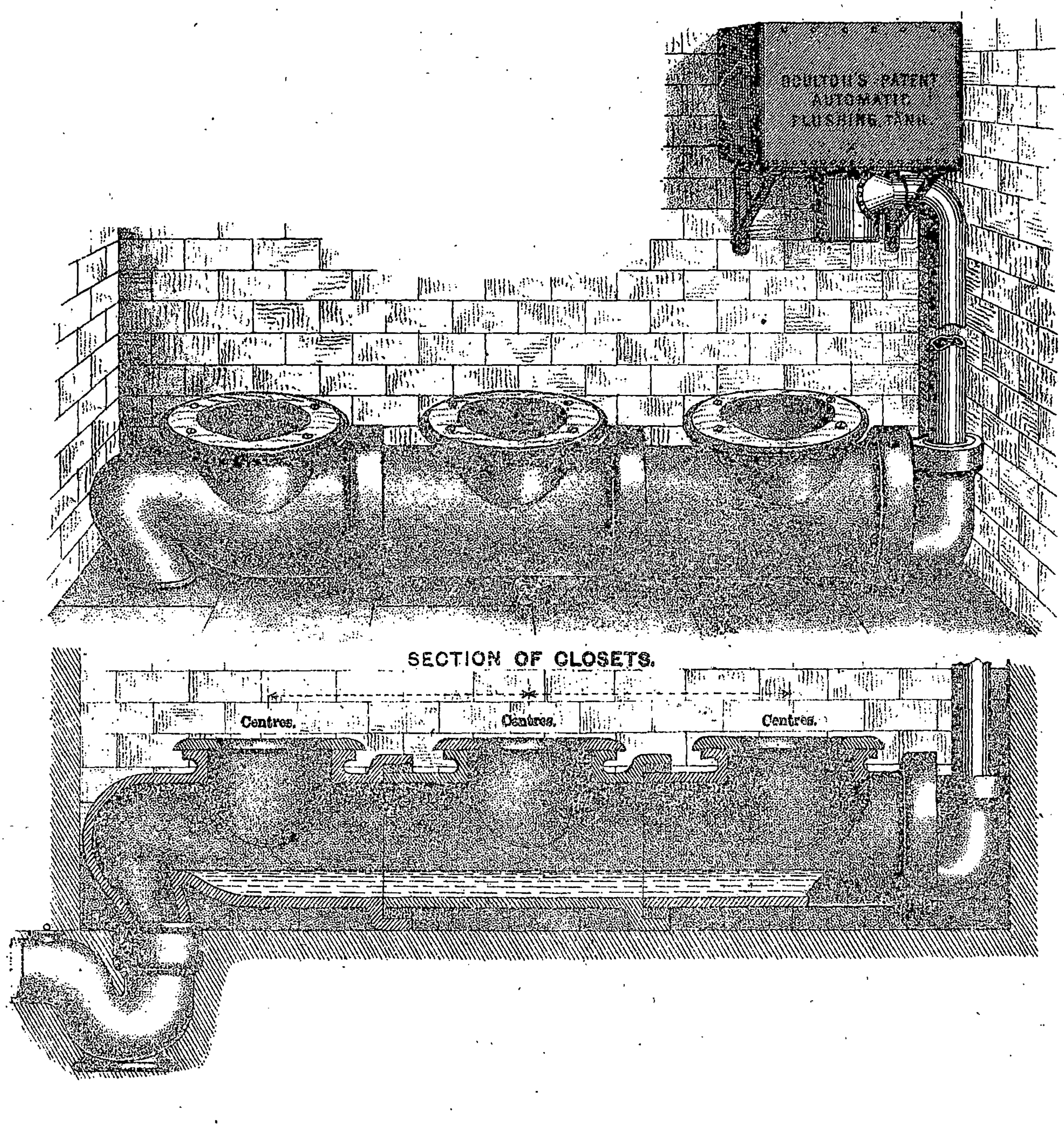
Unhealthy old houses.

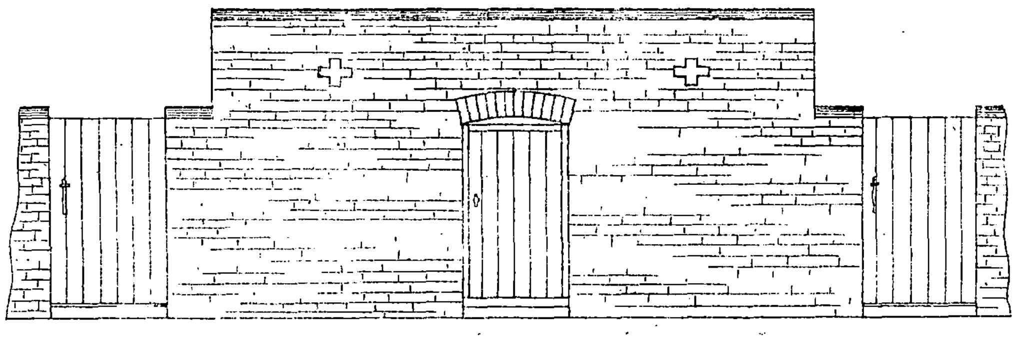
111. It is not only with respect to the sanitary provisions necessary to make the new houses added to towns and cities healthy abodes for their inmates, but also with the far more difficult task of trying, in the case of old houses, to remedy all the evils arising from defective original construction, from decay and dilapidation, and from years—perhaps even centuries—of improper usages, especially in regard to the disposal of sewage, offal, and excrementitious matters, that sanitary authorities have to occupy themselves. The annual reports of the officers of the various authorities are full of details of the work thus done. In the best organised districts continual and periodical inspections are made. In the older and larger towns the difficulties to be surmounted are especially great, the number of notices for the remedying of "nuisances" arising from what may be considered structural defects amounting usually to about one-seventh or one-eighth of the total number of houses in the place—"nuisances," that is, in the sense of the Public Health Acts, including any house in such a state as to be injurious to health. And some of these nuisances are almost irremediable. For instance, the Medical Officer of Health of Coventry, in summing up the results of a general inspection made this year of about 11,500 houses in that city, says:

"The most striking feature of this record is the large number of houses situated in courts, and so built that through ventilation is impossible, being either back to back, or, what is much the same, one-sided. In no less than 3149 cases light and air can enter from one side only. Many of these houses are some centuries old, with low ceilings, low and small windows and doorways, and are so closely crowded together that the amount of open space in the yard is frequently less than the area covered by the houses. I have often pointed out in previous reports how injurious to health this mode of house construction is. It constitutes the weakest point in the sanitation of the city, and is one which has hitherto remained untouched, and now requires the most vigorous attention."

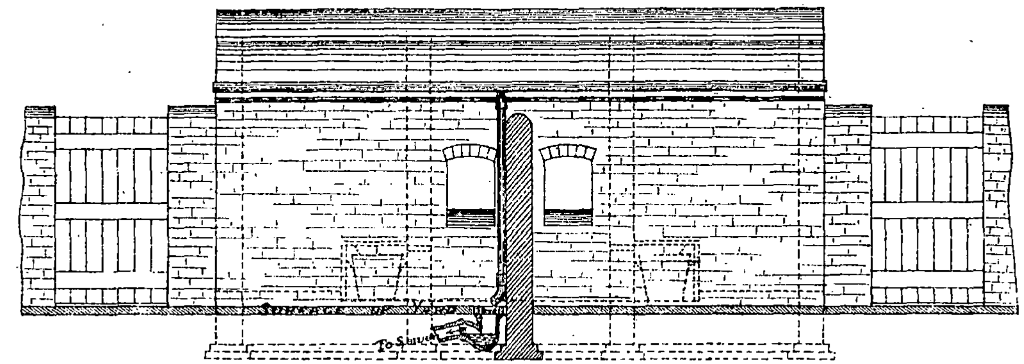
It is perhaps in Glasgow that the most persistent efforts have been made in dealing with all the insanitary conditions of the poorer class of houses. Under local Acts the sanitary authority has peculiar powers. All houses of not more than three rooms, or not exceeding 3000 cubic feet in

TROUGH CLOSETS.

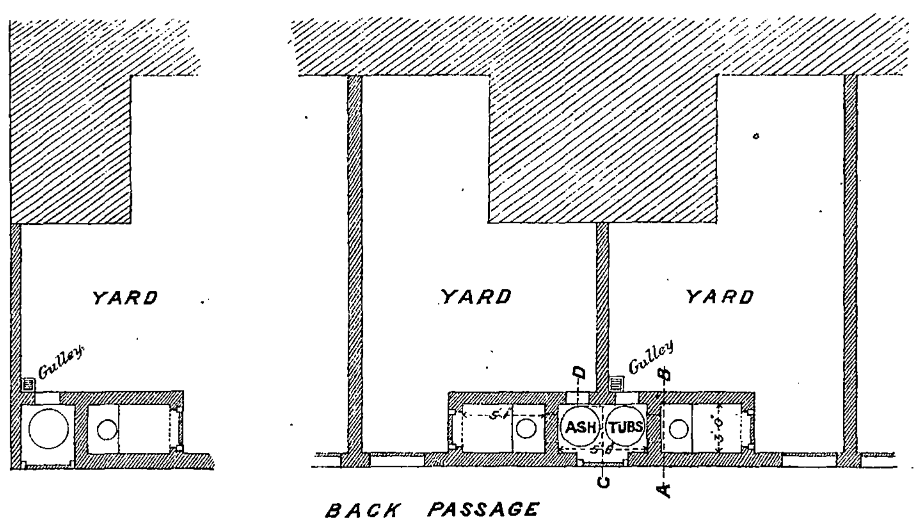




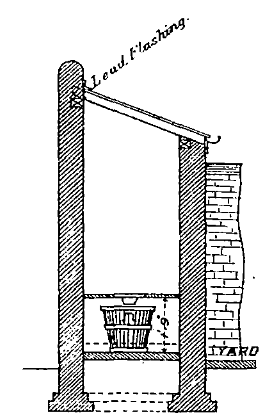
Elevation to Passage.



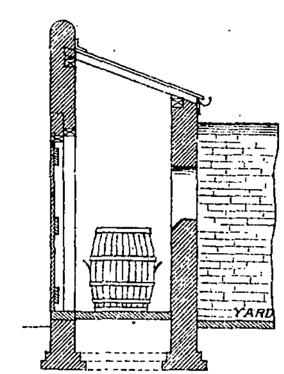
Elevation to Yards.



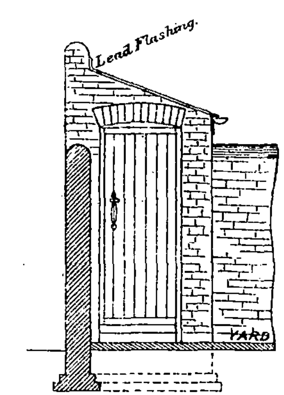
Plans of Single and Double Closets



Section on Line A.B.



Section on Line C.D.



Side Elevation.

contents, may be measured; and the total contents, with the number of inmates allowed—being one adult or two children under ten years of age for every 400 cubic feet—stamped on a tin ticket, is affixed on the outer door. These are the well-known "ticketed houses" of Glasgow, which contains 24,000 of them. They may be visited by the Inspector by night as well as by day, and the occupier is liable to fine for every breach of the regulations, especially with respect to overcrowding. About one-eighth of the whole population of the city live in these ticketed houses.

112. Dr. Russell, the Medical Officer of the City of Glasgow, whose sanitary services, so highly prized and so deservedly celebrated all over the world, need no praise from me, has probably done more than anyone else, not only to call attention to the evils of overcrowding, but, in his own district, to prevent it. The constant relation of density of population to mortality had been clearly shewn by Dr. Farr, the eminent statistician—I suppose that for the future we shall say "the eminent demographer." He took the 631 registration districts of England and Wales, and found that their death-rate, varying for the decennium 1861–1870 from 13 to 33 in the 1000 living, when compared with the density of their population gave the following results when arranged in five groups:— **Overcrowding.**

1.	A mortality of	14 to 16	to the 1000 occurred with	a population of	86	to the square mile.
2.	„	17 to 19	„	„	172	„
3.	„	20 to 22	„	„	255	„
4.	„	23 to 25	„	„	1128	„
5.	„	26 and upwards	„	„	3399	„

It will be noticed that though the mortality always increases with the increase of density of population, the ratio of increase is far greater in the latter than in the former. Allowing for this difference of ratio he made a series of calculations in relation to over 500 districts, and found that in only one group was there a difference of one in the thousand between his calculated mortality and that actually recorded; in all the other groups the difference never exceeded 0·12 in the 1000. Observations of this sort are of general rather than particular practical value. What can you do to sensibly relieve the density of the population of a whole district? It is affected by influences not only beyond our control, but which we would not wish to interfere with if we could—for the increase in density of population is a sure sign of increase of prosperity.

But Dr. Russell saw what was within the sphere of practical control, and he addressed himself to controlling that. The general outcome of the influence of density of population upon mortality is the sum of the influence it exercises on each individual of the population; and the influence on each individual in a large district is not equal, but varies with the density of his immediate surroundings. These immediate surroundings are amenable to control, so Dr. Russell set to work to ascertain what they were among the people whose health was entrusted to his keeping. The density of population as established by the returns of a whole district is to a certain extent fictitious, as it is affected by unoccupied areas, such as public parks, wide streets, &c.; and though these circumstances ought not to be overlooked, as they have a great bearing on the health of a population, they may give an erroneous idea of the actual surroundings of an individual. But the house he lives in, and still more the room he lives in, gives an unmistakeable idea of the real conditions in which he lives, especially if taken in connexion with the circumstances alluded to above. And though you cannot much affect a whole district if taken together, you can greatly affect the condition of a room if taken separately, and by affecting the condition of rooms the condition of houses is affected, and through the houses that of the whole district. **Glasgow.**

This is how Dr. Russell has worked. His system is a model of the use to be made of statistics in sanitary matters. I take the following examples from his vital statistics for 1886. The mean death-rates given refer to the years 1880-1-2. The city contained in 1881 a population of 511,520, on an area of 6111 acres, giving a density of 84 persons to the acre. The mean number of rooms in each house was 2·322: the mean number of persons occupying each room 2·040. Of the whole number of houses in the city, 30 per cent. had only one room, 44 per cent. two rooms, 21 per cent. three or four rooms, and 5 per cent. five rooms or more. The mean death-rate of all ages was 25·2 in the 1000 living; of children under five years 82·1 in the 1000 living; of all ages from infectious diseases 3·43; from consumption and acute lung diseases 8·8, both in the 1000 living; and of 1000 children born 148 died in their first year. All these "means" Dr. Russell calls "standards" for comparison in his entire administration:—thus, the standard density is 84 persons to the acre, the standard of house accommodation is 2·322 rooms to a house, or 2322 rooms in 1000 houses; the standard of occupancy is 2·04 persons to each room, and so on with regard to the percentage of large and small houses, and the death-rate in the 1000 with relation to age and cause. And these standards, and others referring to other conditions, are applied to every district in the city, and their interconnexion, as shewn by this application, proves the utility of making them objects of inquiry and action. Glasgow is divided into 24 districts, and these standards are applied to each of them, and shew, almost without exception, that amelioration in the condition of each circumstance is accompanied by amelioration in the duration of life, and that deterioration in the circumstances is followed by deterioration in life power. The following table sets this forth with relation to one of the best and one of the worst of the districts. There is one better, and one worse, but all the others range between those given below, and without exception their position in the order of healthiness depends upon the degree to which they are better or worse than the "standard." The districts are subdivisions of the old registration districts:—

Circumstances.	Standard of City.	Amelioration. District 17.	Deterioration. District 6.
Density—Persons to the acre	84	43	155
Mean number of rooms in each house	2·322	3·883	1·830
,, ,, persons occupying each room	2·040	1·299	2·627
Percentage of houses of only 1 room	30·0	7·5	53·0
,, ,, ,, 2 rooms	44·0	37·0	33·0
,, ,, ,, 3 or 4 rooms	21·0	34·5	13·0
,, ,, ,, 5 or more rooms	5·0	21·0	1·0
Consequences.			
Mean death-rate at all ages in 1000 living	25·2	17·2	37·8
,, ,, under 5 years of age living	82·1	54·0	128·5
,, ,, under 1 year of 1000 born	148·0	114·0	203·0
,, ,, all ages, infectious diseases, in 1000 living	3·43	1·91	3·81
,, ,, all ages, consumption and acute lung diseases, ditto	8·80	5·06	15·79

Among the above "*Circumstances*" the dominant factor appears to be the number of persons occupying each room. The average size of the rooms varies from a mean of 930 cubic feet in the oldest houses, mostly "ticketed," to 1340 in the new best-class houses for artisans. If we take the districts showing the widest departure from the above standard of occupancy, two to a room, or, to avoid fractions, say 2000 to 1000 rooms, we find that in Glasgow there are two districts in which there are less than 1500 to 1000 rooms, and seven districts in which there are more than 2500 persons to 1000 rooms :

In the former the mean death-rate, all ages, is 16·7 ; in the latter 30·7, in 1000 living.
,, ,, ,, under 1 year, is 112; in the latter 173, in 1000 born.
,, ,, ,, from infectious diseases, 1·73; in the latter 4·25, in 1000 living.
,, ,, ,, from consumption and lung diseases, is 5·10, ; in the latter 11·38, in 1000 living.

Among the "*Consequences*" it is not surprising to find that the quantity of air space given to each individual during the night and all other times while at home should tell with especial force upon the death-rates from consumption and acute lung diseases. While the effects of what may be called outdoor sanitation are chiefly marked in connexion with typhoid fever and malarial diseases, those of indoor sanitation, though marked enough in connexion with fever, are not so striking as in connexion with the great decrease in the death-rates from the great scourges of Glasgow—consumption and lung diseases—34 per cent. of all the deaths registered being attributed to them, as compared with about 10 per cent. in England and Wales.

Houses unfit for habitation.

113. The condition of some houses is so bad that, after all the efforts made by sanitary authorities, the only real remedy is demolition. The Public Health Acts gave powers to Local Boards to prevent the occupation of such houses, but the remedy took some time to apply. In many of the larger cities the Torrens' and Cross's Acts, the Artizans and Labourers Dwellings Acts, and special legislation, had empowered the authorities to deal with the worst classes of house property in their districts.

In London the work that was done under the Artizans and Labourers' Act, though it had a beneficial effect from a sanitary point of view, was so expensive, especially as immense sums had to be paid for compensation, that it not only compelled the Board to stay its hand, but had a deterrent effect on many other sanitary authorities. The Metropolitan Board of Works was held bound to provide for the disturbed artizan population in the old sites, and so land that was worth from £50,000 to £100,000 an acre had to be devoted to the building of tenement houses. Thus, in London the problem of housing the poor seems as far from solution as ever. Living in the town means paying a high rent; living in the country means, even with railways, walking every day some miles to and from work.

At Liverpool an immense amount of demolition has been done under the Liverpool Sanitary Amendment Act of 1864. Last year, Dr. Stopford Taylor, the eminent Medical Officer of Health for the City and Port, made reports under that Act dealing with 688 houses, and the Grand Jury, after hearing evidence and seeing the premises, made presentments that the houses should be demolished accordingly as unfit for human habitation. "The houses were situated back to back, either in courts from seven to eleven feet wide, or immediately abutting on such courts, and could not be ventilated; sunlight never entered them, and for years they had been notorious for a high death-rate." For years this work has been going on, and though these demolitions carried on for sanitary purposes and those necessitated by railway extension have actually diminished the population of the city by 35,000 in the decennium, it is still the most densely peopled place in England, notwithstanding its 733 acres of docks and quays.

At Glasgow also a special Act was obtained in 1871, and under its provisions more than a million and a half of money has been spent in the purchase and demolition of insanitary houses. The closes and wynds of High-street and Bridgegate were notorious as the filthiest and most unhealthy dens in the United Kingdom. They have been swept away, and a great portion of the sites they occupied is to be left unoccupied by dwelling-houses. On the other hand, public and private properties in healthier parts of the city have been built upon under the control of the sanitary authorities, so that within the last twenty years more than a third of the whole population of Glasgow has been re-housed—a feat unparalleled in sanitary work. And though the working classes of Glasgow are still so fond of living in single and double-roomed houses as to lower Dr. Russell's "standard" house from one of 2·322 rooms in 1881 to one of 2·259 rooms in 1891, and to increase the standard of occupancy from 2·040 persons to a room in 1881 to 2·054 in 1891, yet it is probable that, thanks to this great and improved reconstruction of houses, the "standard" air space for each individual has risen from about 500 cubic feet in 1881 to over 600 cubic feet in 1891.

The Birmingham Corporation also spent over £1,000,000 in buying land and building houses under the provisions of the Artizans and Labourers' Dwellings Act, 1875, and the effect has been to make what was a nest of narrow streets and courts into a busy commercial quarter, as well as to greatly benefit the health of the city, the death-rate in the district dealt with falling from 53·2 to 21·3 in the 1000.

114. Great facilities have been given to all sanitary authorities by the Housing of the Working Classes Act, 1890, to follow the example set by Liverpool, Birmingham, and Glasgow. The first part of the Act relates to unhealthy areas in towns, with or without reference to the particular matter which gives its name to the Act. Power is given to Local Boards of Health or other sanitary authorities, after representation made by Officers of Health, who are bound to make such representations whenever they see cause, that any houses or alleys are unfit for human habitation, or the narrowness, closeness, and bad arrangement, or the bad condition of streets and houses, or the want of light, air, ventilation, or proper conveniences or any sanitary defects, or any one or more of them are dangerous to health, to make an improvement scheme for the place so represented; and after due publicity, the Local Government Board may, after local inquiry by one of its officers, make a provisional order for carrying out the scheme, which, when approved by Parliament, is embodied in an Act. In London this improvement scheme must be accompanied with provision for accommodating as many of the working classes as the scheme displaces. In the country this provision need not be made. The Local Authority may raise funds by loans or rates to carry out an approved scheme, may acquire additional lands for building purposes, and may sell or let for building purposes lands acquired. Five years are allowed for completing an improvement scheme, after which the Local Government Board may do the work. If the Medical Officer makes default in representing unhealthy areas, twelve ratepayers may intervene and make the representation. Housing of the Working Classes Act, 1890, (53 & 54 Vict. ch. 70). Unhealthy areas.

115. The second part of the Act makes it the duty of the Medical Officer of Health to represent to the Local Board any dwelling-house which appears to him to be in a state so dangerous or injurious to health as to be unfit for human habitation. Any four householders may complain to the Officer of Health, who is bound to make examination of the locality complained of. Local Boards are given three months to act, after which the Local Government Board can intervene. Local Boards are also to make periodical inspections for themselves. When an order has been made for closing a house the occupier is liable to a penalty if he continues occupation; and, on the other hand, the expenses of his removal may be paid by the Local Board and recovered from the owner. The owner may undertake to do the work necessary to make the house fit for habitation, and if he neglect to do so within reasonable time the Local Board may order its demolition and recoup themselves for the expenses incurred by selling the materials. There are also provisions for protecting persons having only life interest in property. This part of the Act also applies to buildings which, though not themselves unfit for habitation, are from their position obstructive to the ventilation or proper sanitary condition of other houses, or prevent the carrying out of necessary measures of improvement in a neighbourhood. Unhealthy dwellings. Obstructive buildings.

There are details as to methods by which compensation is to be assessed, the arbitrator taking into consideration the condition of the property and the expense that would necessarily have to be incurred in putting it into a habitable state, and such like points affecting value—which, moreover, is not to be based on the exaggerated rental that may have been obtained from overcrowding. These provisions are probably the most useful of all in the Act, as it is well known that the enormous and unjust compensation that the authorities of London, Liverpool, and Birmingham had to pay for the property they took did more than anything else to render all previous legislation on the subject quite a dead letter so far as the country generally was concerned. Provision is made for loans, &c. as in the first part of the Act.

116. Under the third part of the Act Local Boards may provide lodging-houses for the working classes, lodgings being taken to mean separate houses or cottages, as well as groups of tenements, and may include a garden not to be more than half an acre in extent nor £3 in yearly value. They may acquire or build such lodgings, and fit up and furnish them, and must retain the management and control of them in their own hands. The financing of these lodging-houses is duly provided for in manner similar to that of the preceding parts. Furthermore, the Public Works Loan Commissioners are by this Act empowered to advance money for the purpose of providing or improving these lodging-houses to companies or individual landowners; and railway, gas, and water companies may make exceptionally favourable rates for the occupiers of such Lodging-houses for the working classes.

lodging-houses. And public companies generally may build such houses for their workmen, notwithstanding any provision in their Acts or charters to the contrary.

The Act, with necessary alterations to make it workable, is applied also to Scotland and Ireland. Parts one and two are compulsory on all urban authorities; part three may be adopted by both urban and rural authorities.

117. The Act had not been long in force in England at the time of my visit. The only sanitary authorities in whose districts I observed that use had been made of it were the Local Boards of Health of the Cities of Birmingham and of Coventry, and of the Town of Southampton. At Coventry the Medical Officer of Health had under its provisions "reported 74 houses as unfit for habitation. Of these 19 were closed, 8 demolished, 14 improved and re-opened; in 16 cases the owners had promised to make each pair of back-to-back houses into a single one; and in 17 cases nothing had been effected. At Birmingham and Southampton notices had also been issued and acted on, and at the latter place the Medical Officer had reported in favour of adopting Part Three of the Act.

Common lodging-houses.

118. The complaint made in the Congress, that there is no interpretation of what is meant by a common lodging-house in any of the Acts of Parliament referring to them, is unfounded as far as Glasgow is concerned, for in the Police (Amendment) Act of 1890 it is declared that the words shall "mean a house or part thereof in which any person is lodged by the night at a rate not exceeding sixpence per night for each person, whether the same be payable nightly or weekly, or at any period not longer than a fortnight, and shall include any place where emigrants are lodged, and all boarding-houses for seamen, irrespective of the rate charged for lodgings or boarding." The regulations affecting common lodging-houses are usually those contained in the Model Bye-laws. At Liverpool the space required for each lodger in a registered house is 300 cubic feet, or if the room is used by day as well as night, 350 cubic feet. At Coventry the space is 350 cubic feet, and at Southampton 400. At Warrington it is also 400 cubic feet, with a proviso that if there be no fireplace the space shall be 500 cubic feet. The Model Bye-laws also provide for regulations for houses let in lodgings of a class above the common lodging-house. And in the city of New York all tenement houses—that is, all houses occupied by more than two families—are subject to continual inspection, and more than a million of the inhabitants of that city live in such houses.

It is in connexion with lodging-houses for the working classes that in some cities more good is being done in the way of the healthy housing of the working classes than in any other way. Mr. P. Fyfe, Sanitary Inspector of Glasgow, says in his Report for last year—"The increase of large and well appointed lodging-houses is becoming very marked in various parts of the City. In proportion, the smaller and poorly appointed lodgings are disappearing; many still remain, but I look on their extinction as a matter of time. The capital which is being at present put into these large and well appointed workmen's 'homes' is certain to reap its reward by drawing many men to them who can have little comfort and home life in small and ill-regulated houses in the Central District." And at Coventry, Dr. Fenton, in his report this year, calls attention both to the good effect of this class of lodging-house, and to the large returns proper expenditure of capital in them is sure to gain.

Water Supply.

Water supply.

119. There is an obligation upon every householder to have a proper supply of water—not necessarily from water-works. As a rule the water supply of most of the larger cities and towns in England is in the hands of the Corporate authorities, whose Officers of Health furnish monthly analyses showing its comparative purity. As water rates are only collected from houses actually

Wells.

supplied, there is often much difficulty experienced in effecting the closing of polluted wells, especially after the decision of the magistrates in the Birmingham case in 1888, when they held that not only pollution must be proved, which is practicable, but also that the pollution has been injurious to health, which it is often impracticable to prove to the satisfaction of magistrates, as every one suffering from disease may have been exposed to all kinds of noxious influences as well as bad water.

Streets and Courts.

New streets.

120. The general regulations usually adopted with regard to new streets are based upon those contained in the Model Bye-laws. In the case in which the proprietor of building land intends to dedicate the streets on it to the public, the Sheffield sanitary authority requires that the street shall be made and sewered in the same manner as the public streets, and in conformity with the specification to that end prepared by the Borough Surveyor. The Public Health Acts Amendment of last year empowers Local Boards to make Bye-laws for the provision, in connexion with new streets, of secondary means of access where necessary for the purpose of the removal of house-refuse and other matters.

Wood-paving.

121. In all the more important cities more and more use is continually being made of wood-paving in the streets. In new streets they are laid on a concrete foundation, but in old streets the

existing foundation is made use of. The blocks now being used are chiefly of yellow deal nine inches long, three inches wide, and six inches deep, laid with the fibres standing vertically, with the heading joints as close as the blocks will lie, and the transverse joints half an inch in thickness. The usual way of securing uniformity in the width of these joints all across the street is to place half-inch battens between every rank of blocks, the battens being withdrawn when the grouting is being done. Mr. Mason, the surveyor to the district of St. Martin's-in-the-Fields in London has improved upon this method by using studs like common cut nails with heads each projecting exactly half an inch. Boys drive three of these into one side of each block—two being towards the bottom and one towards the top—and the projection secures the even width of the joint all across the work, holds it solid till it is grouted in, and then acts as a dowel tying the work together. He took me to see the work in progress of the repavement of the Haymarket. When the old paving-stones are removed, the foundation is rounded evenly and carefully to give eight inches of rise in the 51 feet of width of the carriage-way, and the surface is then floated over with a thin coat of cement made of five parts of sharp sand to one of Portland cement. When this is set, the blocks are laid with half-bond, the side channel being paved with them laid in lines parallel to the curb. The whole work is then grouted in with thin mortar made of one part of Portland cement to three of sharp sand. The present contract price for the blocks delivered at the work is £6 a thousand, and the cost of the pavement complete about six shillings a square yard.

I have given all these details not only to describe a good pavement, easily constructed and kept clean, and giving great relief to dwellers in streets by its freedom from noise and from dust, but one that offers an opportunity for utilising our stores of wood. And this not only in Tasmania, but in Europe. In England yellow deal is taken as under all circumstances the best at present in the market, its superiority in the matter of fibre more than compensating for its inferiority in the matter of hardness and durability. English oak is hard enough and durable enough, but it wears so as to become very slippery in damp weather, and so requires continual sanding and gravelling. Jarrah from Western Australia has been introduced into the London market, and is now eagerly sought. Mr. Mason told me he could not get any, the Lambeth authorities having just bought for £11,000 all that there was in stock. Its present price is £11 15*s.* a thousand delivered on the work. What is required is a hard fibrous wood that can be seasoned without splitting, and that is sawn carefully and squarely to dimensions. If the above price is maintained, and £2 a ton for freight and 8*s.* a ton charges in London be allowed, the price free on board here would be equal to about 11*s.* a hundred feet Tasmanian measurement. Mr. Mason assured me he would willingly give Tasmanian woods a fair trial, and I hope to give him an opportunity of so doing.

122. In nearly every town visited I was taken by the sanitary inspectors to see some of the worst quarters in the town in order that I might judge as to the difficulties that had still to be contended with; and, in comparing them with places that had evidently once been similar but had been successfully dealt with, to estimate the good that had been, and could still be, effected with the means at disposal. Some towns that I had well known I found very greatly improved, especially in the condition of their court-yards—the portion of a town that is the crucial test of sanitary work. Where the court-yards were in the best condition that condition was more due to the fact that they were well paved than to any other detail of the sanitary work that had been done; for good paving not only makes it easy to keep a yard clean, but makes it possible to keep the houses in it clean—an almost absolute impossibility in wet weather in an unpaved yard. Another noticeable point in these quarters of large towns is the physical as well as moral effect of low public-houses on their immediate neighbourhood. This was especially observable in Glasgow, where the numerous drinking-shops seemingly had no sanitary conveniences, and where consequently every obscure corner of the court behind them showed permanent signs to both sight and smell of the use that was made of them. Court-yards.

Special Hygiene: Schools.

123. The great development given by recent legislation to education has caused a corresponding increase in the number of schools in Great Britain. As these new schools have mostly been built during a time when hygienic construction was well understood, and when, on the whole, fairly satisfactory regulations in regard to accommodation, light, ventilation, and conveniences were enforced, the result has been that a great improvement has taken place, especially in London and the larger cities. But as full information respecting them is easily obtainable, I shall limit myself to noticing what has been done elsewhere, especially in matters that also came under special discussion at the Congress. English Schools.

I have already noticed the great advance that sanitary science has made in Denmark. This is very remarkable in connexion with school hygiene. In 1884 a Government commission reported on sanitary matters in connexion with education, and their report contains interesting and useful information of a nature that I do not think has been so completely obtained in any other country. With respect to 30,000 children taken from all classes of schools, and varying in age from 6 to 17 years, information as to health was obtained. The diseases especially noted were scrofula, anemia, nervous diseases, headache, bleeding from the nose, chronic stomach, lung, heart, and other diseases, and deformities of the spine. The two first-named and habitual headache comprised three-fourths of all the sickness noted. In the boys' schools on an average 29 per cent., and in the girls' schools 41 per cent. of the children were out of health. With regard to the former, 18 per cent. were ill Danish Schools. Health of school children.

on entering the school at 6 years of age, and the percentage gradually increased, with a slight pause between the 10th and 11th year, up to 31 per cent. at the 12th year; then a slight decrease took place to 27 per cent. at the age of 15; and after that a rapid increase to 34 per cent. at 17. In the girls' schools the increase is more rapid, rising from 25 per cent. at 6 years of age to 51 per cent. at 13, and then decreasing to 42 per cent. at 15, when they leave school. This rise and fall was found to be a constant phenomenon as it was borne out on more extended observations, and also by those made in Sweden at the same time. The difference between the state of health of town and country children is strikingly small; but there is a little more difference between that of the richer and poorer children to the disadvantage of the latter, except in the higher schools, where, perhaps, brain pressure tells against the health.

Sight.

The examination as to short sightedness gave the same result as elsewhere—it increased with the increase of study, and in the highest class in the upper schools the proportion of shortsighted pupils reached 45 per cent.

Hearing.

The Commission did not make investigations as regards deafness; but some made later in some parish schools in Copenhagen shewed that scarcely half the children examined—580—had quite normal hearing.

School-hours.

The daily working hours of school children, not including those occupied in singing lessons and gymnastics, but reckoning the time employed in preparing lessons at home and on lessons outside the school curriculum, averaged $4\frac{1}{2}$ hours at 6 years of age, and gradually and continuously increased to over $7\frac{1}{2}$ hours at 15 years, in girls' schools; and from $4\frac{1}{4}$ hours at 6 years of age to $9\frac{1}{2}$ hours at 18 years in boys' schools.

Physical development.

With regard to growth, the average height of boys and girls was found to be the same from 6 to 10 years of age; at 11 years the average height of the boys was more than $\frac{3}{4}$ of an inch greater than that of the girls, who came up to the boys again at 12, surpassed them by more than an inch at 13, and by more than $\frac{3}{4}$ of an inch at 14, but from that age again fell behind them,—the average height of a Danish boy of 16 years being found to be a little over 5 feet $4\frac{1}{2}$ inches, and that of a girl of the same age about $1\frac{1}{4}$ inch less. From 6 to 11 years of age the boys were found to be, on an average, a little heavier than the girls; from 12 to 14 years the girls were heavier than the boys; both were the same weight at 15; and after that age the boys were heavier,—the average weight of a boy of 16 years being found to be 117 lbs., and that of a girl $4\frac{1}{2}$ lbs. less. As a rule, both in regard to height and weight, living in town or country made no difference, but the condition of the parents did—the children of the richer being more developed at every age. In a very interesting examination made by M. Hansen, Director of the Deaf and Dumb Institution in Copenhagen, it was shewn that children do not grow regularly all the year round, but that increase in height chiefly takes place from April to June, while the principal increase in weight occurs from June to December, so that, except in the periods stated, growth is very small.

Physical education.

Gymnastics are compulsory in all boys' schools, but only facultative in girls' schools. Handiwork—*slojd*—especially wood-carving and easy carpenter's work, has been of late years introduced in some schools; but the instruction is given by school teachers especially trained, and not by artizans. Danish *slojd* differs a little from the well known Swedish, and great attention is paid to position of the body in working—especially in regard to chest contraction.

Sanitation and sanitary arrangements.

A short course of instruction in hygiene has been introduced into all teachers' training schools, but there is as yet no proper system of school inspection as to sanitary condition and conveniences. But as regards schools built since the Commissioners' Report was published, they have mostly been built in accordance with the recommendations contained in it; the principal features are an allowance of 14 square feet of floor space to each child, with a minimum height of ceilings of 10 feet, and window lights equal to one sixth of the floor area—which seems to me to be a very small allowance of light.

Food Supply.

Bread.

124. Bakehouse registration, inspection, and regulation is carried out on lines similar to those set forth in our ordinary Local Board of Health Bye-laws; and in the performance of their duties the Inspectors find the same kinds of evils to remedy as here—dilapidated bakehouses, with floors, etc. in a condition impossible to keep clean; fowls and animals kept in, or in places immediately adjoining, them, bad water used, and such like. At Birmingham every baker is obliged to have the bakehouse regulations posted up in a conspicuous place within it; and this obligation has had a good effect.

Milk.

125. In England and Scotland the hygienic control of the milk supply is chiefly under the "Dairies, Cowsheds, and Milkshops Order of 1885," an Order made by the Privy Council under the provisions of the Contagious Diseases (Animals) Act of 1878, and addressed to all the various sanitary authorities of the two countries. This Order makes it unlawful to carry on business as a purveyor of milk without registration. The trades of butter or cheese-making are not interfered with, nor the selling of small quantities of milk to neighbours or workmen. No building is to be newly occupied as a dairy or milk-shed without a month's notice to the local authorities, and the satisfying of them as to lighting, ventilation, air-space, cleansing, drainage, and water supply; and existing buildings must not continue to be so occupied if, in regard to all these matters, they are not in the state necessary and proper, (*a*) for the health and good condition of the cattle therein; and (*b*) for the cleanliness of milk-vessels used therein for containing milk for sale; and (*c*) for the protection of the milk therein against infection or contamination. No person suffering from a

dangerous infectious disorder, or having recently been in contact with a person so suffering, is to milk the cows, handle the vessels, or assist in the milking or the storage or distribution of the milk. Privies are not to communicate with or be ventilated into dairies; nor are dairies to be used as sleeping apartments. Swine are not to be kept in cowsheds. The milk of any diseased cow is not to be mixed with other milk, nor be sold or used for human food under any conditions, nor be sold or used for food of any animal unless and until it has been boiled. And local authorities are empowered to make regulations to carry out the Order in their Districts. Most local authorities have done so, and their regulations usually provide for the whitewashing of dairies twice a year; the frequent—usually daily—washing of the floor; the exclusion from them of any drain-openings; their proper lighting; and their thorough ventilation. With respect to cowsheds, the regulations provide usually for their being properly paved, drained, supplied with water, and ventilated, and their being swept and cleaned twice a-day, and their being whitewashed twice a-year. There are also regulations for the regular inspection of the cattle, and the protection of milk from infection. There seems a great divergence of opinion on the subject of the air-space necessary for a cow. At Birmingham and Coventry the requirement of the regulations is 800 cubic feet. At Liverpool and Warrington the floor-space allowed would not give this cubic space unless the cowsheds were over 20 feet high. At Birmingham the lighting-space is to equal one-twentieth of the floor-space, and the ventilation inlets and outlets 54 square inches for each cow. In the Glasgow Police Act Amendment of 1890 there is a very necessary provision to the effect that if, in the opinion of the medical officers, the outbreak or spread of any infectious disease is attributable to milk supplied from any dairy, the dairy-keeper must furnish, on application, lists of all his customers. Under the Infectious Diseases (Prevention) Act of 1890, in the above case the sale of milk from the dairy would be stopped.

The dairy produce from Denmark brings the highest price paid in the London market, and no wonder, if the same precautions are generally taken with regard to quality of food, cleanliness, and care of milk as are exercised in connexion with the Copenhagen Milk Supply Association—the Company that supplies the metropolis with the greater portion of its milk—the rest of the milk being also "controlled." Every cow is inspected every fourteen days by a veterinary surgeon. Milk intended for infants' food, for which a small additional price is charged, is drawn from particular cows which are limited to a special diet, from which all roots, except carrots, and all oilcake are excluded. The feeding of other cows is also controlled. Great precautions are taken with respect to the milking; cleanliness of hands and dress—the latter being put on only at milking time—is insisted on; and every farmer must have a Lawrence cooler, and a stock of ice always on hand proportionate to the number of his milch kine, so that the milk on leaving the farm shall not exceed 41° Fahrenheit in temperature. On arriving at the milk store in town it is tested, and then filtered through special gravel and canvas upward filters. It is said to be quite astonishing to see the quantity of disgusting dirt thus got rid of. Four kinds of milk are sold—cream, infants' milk, sweet milk, and half-skimmed milk—the former two in clear glass bottles, the latter from large tin cans that the man who goes round with cannot tamper with. The milk is drawn off from the cans by a tap that communicates with a perforated pipe inside that reaches to the top of the cans, the perforations being so graduated as to insure that the milk drawn off by the tap is a mixture of the top, middle, and bottom milk in the can, and thus the first customer served gets as rich a quality as the last. In case of infectious disease breaking out in any of the work-people's families, the person in question is suspended from work, but receives full wages, and thus all temptation to conceal such cases is obviated. During 1890, 120 cows were withdrawn on account of tuberculosis out of the 4284 cows kept by the 49 contracting farmers: of these, three cases were tuberculosis of the udder; 337 cows were temporarily withdrawn for other diseases, the most frequent being sore teats. The supply was suspended from two farms on account of cattle disease, and from one on account of scarlet fever.

In New York the powers conferred on the milk inspectors are very great, and, as usually is the case under democratic institutions, very summarily exercised. The city is divided into seven districts, each of which has an inspector who is always accompanied by one of the sanitary police as a witness, and who every three weeks is shifted from district to district. He is provided with a tested lactometer, vessels for holding milk, stoppers and seals for them, books, forms, &c. Twice a month inspection is made at the railway stations and wharves of the milk as it enters the city. The rest of the inspector's time is occupied at the milk-sellers' shops. The procedure is as follows:—The inspector enters the shop and asks the questions required by law, and necessary to fill up the forms in his inspection book; and under the heading in it of "Remarks" he notes the condition of the shop and milk vessels, whether there is a dipper in the milk-can, and also the marks on the can denoting the dairy from which it comes. He then thoroughly mixes the milk to be examined, pours a sample of it into the tin vessel he uses for examining it, and takes its temperature, and notes the reading of the lactometer. If the milk stands below 100° of the lactometer at a calculated temperature of 60° Fahrenheit—and he has a ready formula for making this calculation—he warms or cools the milk to exactly 60°, and notes the lactometer reading. If this reading be then below 100°, and if the appearance and taste also indicate that the milk has been watered, two samples are taken and duly sealed and marked for verification. One of these is for the City Analyst, the other is handed to the milk-seller. *The milk is then taken and poured out into the gutter*—a sort of Jedburgh justice that very effectually prevents any of it being taken for human consumption, or any profit coming from it into the milkman's pocket. When the report of the analysis is received, the Chief Analyst, in council with the Attorney and Sanitary Superintendent, determines whether or not the dealer shall be arrested. Last year there were 299 arrests made, and 3705 quarts of milk destroyed, and 7400 dollars of fines imposed. As these all shew a considerable diminution from 1889, the prompt method of dealing seems to be effectual in preventing adulteration. If the milk has only been skimmed it is not destroyed, but the dealer is proceeded against. Of the adulterations, 63 per cent. were by the addition of water, 23 per cent. by the abstraction of cream, 13 per cent. by both adding water and abstracting cream, and one per cent. by adding antiseptics. The sanitary authorities are advocating the introduction of a system of controlled milk-selling somewhat on the lines of the Danish system.

Meat.

126. The slaughtering of cattle and sale of meat are in England usually regulated under bye-laws formed upon the Model Bye-laws of the Local Government Board. The establishment of public abattoirs is getting more and more into favour; but the visitor from Tasmania may well be surprised at the backwardness of many even of the larger communities with respect to this important sanitary provision. While Hobart and Launceston and some of the smaller towns of the colony have for years had public abattoirs, the City of Birmingham is just building one, and many other large towns are still only debating upon the matter. The butchering of animals is usually done in the lower and more densely inhabited parts of towns, and adds to the unwholesomeness of districts already unhealthy enough. I saw in several towns I visited that while the general condition of the place was evidently the result of careful cleansing and supervision, the private slaughter-houses of the butchers were in a disgraceful state. This is not only bad for the neighbourhood in which they stand, but the meat slaughtered and dressed in such circumstances must be deteriorated.

In nearly all towns there is a regular system of meat inspection under the control of the sanitary authorities. The inspectors are usually practical butchers, a veterinary surgeon being called in when cases are going to be taken into Court. There is a singular provision at Birmingham in connexion with this inspection. The Health Committee employ three inspectors for examining meat, fish, and game. The butchers and fishmongers of the city submit a number of names to the Committee, who from them select six, and from these six three are selected to act in each disputed case with the three inspectors as jury or arbitrators, the Medical Officer of Health being virtually umpire. This arrangement is seldom called into action—not once last year. In Copenhagen every animal slaughtered is examined by veterinary surgeons, who stamp the meat as first class or second class. In London, Glasgow, and Liverpool condemned carcases and meat are treated in tanks containing a solution of picric acid and protosulphate of iron. At Birmingham they are burnt in special retorts at the gasworks. At Manchester and other places having destructors, they are disposed of in them. At Edinburgh they are boiled down, except in case of animals suffering from anthrax, when the carcases are burnt. Special care is taken in case of tuberculosis, especially in some of the larger towns. In New York during the last five years the disease has been entirely confined to cows, not a single bull or steer suffering from it having been slaughtered. In Copenhagen last year nearly 4½ per cent. of the cattle slaughtered were found suffering from it, and their carcases had to be destroyed; but no distinction is made in the statistics to shew whether they were steers or cows. In this last-named city particular inspection is carried out with regard to sausage-makers' establishments.

Food analysis, &c.

127. The analysts appointed by the various health authorities are doing a very important work in connexion with the prevention of adulteration. This is shewn by comparing the percentage of adulteration detailed in recent reports with that given in those of a few years ago. At Birmingham from 15 to 20 years ago from 40 to 60 per cent. only of the articles analysed were found to be genuine. For the last few years the percentage has been from 85 to 90 of genuine. The diminution of falsification has not been regular: every few years some new method seems to have been discovered that tempted dishonest traders to try again to sell adulterated food, and this "try-on" has sent up the percentage of the falsified. Milk with water, butter with margarine and fat, coffee with chicory, beer with salt, and lard with cotton seed oil, seem to be the chief articles that are tampered with in England. At Liverpool the samples for analysis are not only taken from ordinary dealers who sell food to be consumed at the purchasers' homes, but also from restaurants and eating-houses where it is being sold for immediate consumption. Glasgow seems to be the only city in Britain where much attention is paid to the condition of fruit and vegetables offered for sale, and there last year not quite 6000 lbs. weight were destroyed. At New York during the same period over 1,000,000 lbs. weight were seized and condemned.

Re-greening vegetables.

When at Glasgow my attention was called to the action the city authorities were taking in reference to a matter cognate to the above—the adulteration of tinned vegetables by the process for re-greening them. The noticing of the superior colour of fresh vegetables that have been boiled in copper vessels as compared with the colour of those boiled in tin or iron, led to the introduction of a process for improving the colour of those hermetically sealed in tins by Appert's method. This method has introduced a very important industry into France, where a trade of nearly £2,000,000 a year is done in preparing and preserving by it vegetables—chiefly peas and French beans. The process for improving the colour of these vegetables consists in plunging them, while fresh, for from 5 to 15 minutes in a boiling solution of sulphate of copper, of strength varying according to the nature of the vegetable, but still more according to the practice of the individual manufacturer. The wide range of variation in this practice was shewn by the results of analyses made in 1881, at the instance of the French Government, when from 8 to 27 parts of salts of copper in 100,000 were found. The dangerous nature of this practice was soon seen, and in 1853 the use of copper vessels or of salts of copper in the preparation of preserved vegetables was forbidden in Paris, and in 1860 in all France. This resolution was adopted on the report of a scientific commission named by the Government to enquire into the whole matter. The summing up of the Report was—"Although the quantities extracted from the samples analysed have not appeared in general sufficient to produce serious accidents, the presence of a highly poisonous substance in these food-stuffs, in proportions without fixed limit, creates a risk which cannot be disregarded, and which the Administration ought not to permit."

Immediately on the passing of the decree prohibiting this re-greening, the manufacturers commenced to agitate for its repeal, on the plea that it was ruining an industry employing over 20,000 persons. The central government, and the governments of the departments where the preserving was done, appointed commission after commission to enquire into the matter, and during their inquiries the law became virtually inoperative. But England, Germany, and the United States passed laws generally dealing with the matter. In France the commissions all reported against sanctioning "*reverdissage.*" The commissions included such honoured names as Pasteur and Bussy. The latter asks—"Can the Administration which, in the interests of foreign trade and the health of children, pushes its foresight so far as to interdict the use of poisonous paints in colouring toys, sanction the staining of an ordinary article of food with sulphate of copper?" The number of commissions appointed seem to shew that the Governments were anxious to be afforded some pretext for withdrawing the decree of prohibition. That pretext was afforded it at last by a report presented on the 15th of April last year, and three days after the decree was rescinded. A committee was named by the magistrates of Glasgow to report on all these proceedings, and Dr. Russell was its Chairman. Its report sets forth the whole history of the agitation, and gives a critical account of the report of the commission of last year, shewing that its recommendation was the outcome of the form the manufacturers' agitation had taken—"That re-greening for export should be permitted, but *not for home use.*" The trade is therefore to have two labels, one for home use marking the ungreened vegetables as "*legumes au naturel,*" and the other for export, whereon the principal customers for adulterated food are complimented by having their nationality associated with the poisoned articles—"*petits pois*" or "*haricots,*" as the case may be, "*a l'anglaise.*"

I believe that in all these colonies no special legislation is necessary in order to countervail this failure on the part of the Government of France to fulfil the duties that—as its own scientific men had so admirably shewn—it owed to its neighbours. In this colony the 32nd Section of the Public Health Act, 1885, is explicit on the subject, and I take it that after notice had been given to importers and vendors that *petits pois* and *haricots*, unless marked "*au naturel,*" are coloured and stained with a "material so as to render the article injurious to health," the sale of them would render the vendor liable to the penalties imposed by the Section cited, as absence of knowledge could not be pleaded under the 34th Section of the Act cited. A similar course was adopted in Massachusetts. In the Nineteenth Annual Report to the State Board of Health, dated January, 1888, the Secretary says:—

> "The following articles of food named in the Report of the Food Analyst deserve special attention. Canned vegetables (chiefly beans and peas).—A considerable portion of these articles is imported from France, mainly from Paris and Bordeaux, and, as will be seen from the Report, two-thirds of the samples examined were found to be adulterated with copper, which had evidently been introduced for the purpose of imparting to these vegetables a bright green colour like that of the same kinds of food when used in the fresh state. Such sale being evidently in violation of the Statutes, the parties selling them were notified that the sale was deemed to be made contrary to the law of 1882. The limitation of the quantity of poisonous colours in articles of food is, to say the least, a matter of doubtful propriety, especially when the preparation of such forms of adulteration is conducted by irresponsible parties outside of the State, and, as in this case, outside of the Country."

SMOKE.

128. In the manufacturing towns great efforts are made to improve the condition of the atmosphere by the prevention, as far as possible, of the smoke nuisance. The authorities are naturally desirous, while safe-guarding the public health, to do as little as possible to interfere with the staple industries of their districts. But every year, with the developments of science, more and more can be done to diminish the nuisance, and this progress is marked by the variation in the local regulations, which are getting more and more stringent, without becoming correspondingly more oppressive and restrictive of trade. Thus, at Manchester a few years ago four minutes in each half-hour were allowed for the emission of black smoke from factory chimneys; now the allowance is limited to one minute in the thirty. Gas engines for the smaller, and Siemen's furnaces for the larger motive powers required are also effectuating a great improvement. And the matter is not one of comfort and cleanliness only, but one greatly affecting the public health—telling chiefly upon the death-rate from diseases of the respiratory organs. The yearly death-rate from these diseases in the various counties in England increases and diminishes in proportion to the smokiness of the air, and varies from 4381 in the million living in smoky Cheshire and Lancashire, and almost as many in London, to only 2835 in the million living in Sussex, Hampshire, and Berkshire, and but a few more in Hertfordshire, Buckinghamshire, Oxfordshire, and the fenny counties of Northampton, Huntingdon, Bedford, and Cambridge; and gradually mounting from this rate to that, as the counties become more and more smoky in their air. Dr. Hill, of Birmingham, says in one of his reports—"The purity of the atmosphere is so important a point to strive after that a continued

Smoke prevention.

vigilance to prevent the discharge of more smoke into it than is absolutely necessary is highly desirable, the more so as it is well recognised that sooty and other particles, besides being prejudicial to the respiratory organs and delicate goods, form a nucleus for the atmospheric watery vapours, thus producing the greater prevalence of fogs in manufacturing towns than in the rural districts."

Burial.

Burial of the dead.

129. I found that the opinions of officers of health, and other sanitary authorities, was being more and more confirmed in favour of cremation. Arrangements have been made at Glasgow and Leicester for thus disposing of the dead, and the public mind is gradually becoming more familiarised with an idea that was formerly regarded with false sentiment and prejudice. Dr. Hill, in one of his recent reports, after quoting Sir Henry Thompson's arguments in favour of cremation, says—"I fully endorse these views, and strongly feel the responsibility of continuing a system after its dangers have been pointed out, and a remedy for them indicated."

Wakes.

At Glasgow, under the special Act of last year, it is illegal to take the body of any person who has died of an infectious disease in any hospital from the hospital, except for immediate burial by being carried directly to a cemetery and there buried. Another section of the same Act sets forth that—"It shall not be lawful to hold any wake over the body of any person who has died of any infectious disease, and the occupier of any house or premises who permits or suffers any such wake to take place in such house or premises, and every person who knowingly attends or takes part in such wake, shall be liable to a penalty not exceeding forty shillings." The necessity for such legislation is shewn by a case mentioned by Dr. Stopford Taylor, Medical Officer of Health, Liverpool, in his yearly Report for 1887, when 51 persons suffering from typhus were taken to hospital from a neighbourhood where a wake had been held on a man who had died of that disease—the patients, or some of their connexions, having taken part in the wake.

Prevention of Disease.

Notification of infectious disease.

130. By one of the provisions of the Infectious Disease (Notification) Act, 1889, sanitary authorities were given the option of adopting it in their districts, and nearly all have so adopted it. Under the 3rd Section, when any infectious disease occurs in a house the head of the family, and also the medical man in attendance, are to notify the fact to the Medical Officer of Health of the district in which the house is situated. Section 6 limits the operation of the Act to the following infectious diseases:—"Smallpox, cholera, diphtheria, membranous croup, erysipelas, the disease known as scarlatina or scarlet fever, and the fevers known by any of the following names:—Typhus, typhoid, enteric, relapsing, continued, or puerperal." Some officers of health regret that measles and whooping cough, or, at least, measles, were not included in the diseases to be notified, as they had been in the voluntary notification that had been established in many places. Under the Act the sanitary authority has to pay to the medical practitioner a fee of half-a-crown for every case notified if it be one in his private practice, and of one shilling if he notifies it as occurring in his practice as medical officer of any public body or institution. There is a penalty for failing to notify.

The effect of thus making notification compulsory was at once notable. Even where a voluntary system had been established many medical practitioners had held aloof, and the proportion of deaths to notified cases shewed how very imperfectly notification was performed. Officers of health, therefore, had to greatly rely on their inspectors' discoveries of cases when going their rounds. The number of notifications immediately increased on the adoption of the Act. At Liverpool it came into force on the 1st September, 1890. For the eight months ending 31st August only 1914 cases had been notified, though an epidemic of scarlatina had begun in June; for the remaining four months of the year 2688 cases were reported.

As far as I could learn the practical working of the Act was not accompanied with any of the friction that was anticipated, medical practitioners accepting and loyally carrying out its provisions. They were, as a rule, all specially informed when the Act would come into force, and furnished with the necessary forms of notification. At Liverpool, where every house in which infectious disease occurs is inspected and disinfected, medical practitioners were offered a supplementary and optional form to be filled up in cases where they desired to avoid the inspector's visit and would themselves fulfil his duties. This form was decided on after communication with the local Medical Institution as representing the profession. It is appended to the ordinary notification, and is in this form:—"Please state—1. Whether the patient is properly isolated, or fit for removal to hospital? 2. The date for disinfection. 3. The names of children, if any, who attend school, and what school? 4. If any sanitary defect is supposed to exist? 5. If any other matter requires attention?"

It has been found much more difficult to get the notification done by the heads of families, to all of whom personally it was of course impracticable to send information as to the adoption of the law, though public notification was generally made. Dr. Fenton, Medical Officer of Health of Coventry, gives the following illustration of the effects following compliance and non-compliance with the law in connexion with an outbreak of scarlet fever that occurred in November, 1890, at Earlsdon, an outlying part of the city:—

"On the 24th of that month two children were taken ill of scarlet fever. In one instance a doctor was called in, who reported the case. The child was removed to hospital forthwith, and no further illness took place in that house. In the other family medical aid was not at first sought, and no attempt at isolation was made. The other children from the house continued to attend school, and laundry work was taken into the house. On the 3rd of December a second child became ill, and on the 7th a third. A doctor was then called in, and the cases were reported and removed to the hospital, but not before five children in the family, and thirteen in other families, had been infected. Occurring in an isolated neighbourhood like Earlsdon, it was possible to trace the incidence of the disease from house to house in a manner that is impossible in the crowded city. All the cases were removed to hospital, the school was closed for three weeks, disinfectants were supplied, and disinfection of houses, bedding, and clothing was freely done, with the desired result, Earldon being soon free from the disease. But the effect of disobeying the law in this instance caused the city the expense of having to support eighteen persons in hospital for a period of from six to eight weeks."

All Medical Officers of Health seem to be agreed that the strict carrying out of the compulsory attendance clauses of the Elementary Education Act has had the tendency of aiding in the spread of infectious diseases, especially measles and scarlet fever. On the one hand, parents, especially the more ignorant among them, have a wholesome dread of the visits of the school attendance officer, and, on the other, the loss arising from diminished school attendance at present falls on the teachers. This is very hard upon the latter, especially when schools are closed on account of epidemics; and yet this closing has been proved to be about the only successful means of staying the spread of an epidemic among children. I was shown returns of the rapid extension of measles upon the opening of schools after the midsummer holidays, its subsidence during a period of closure, its re-extension upon an untimely re-opening, and its re-subsidence upon reclosure, all so marked as to render the conclusion as to cause and effect a certainty. In many towns information is sent by the Medical Officers of Health to the school teachers as to infectious diseases occurring in the families of pupils; and reciprocally by school teachers to the Officers of Health as to any children not attending school on account of illness. Much useful information is thus obtained. In schools.

In New York children exposed to contagious diseases are excluded from the schools they are attending. A notification is sent to the master of the school to the effect that the attendance at school of the children whose names are given, who are in contact with contagion of scarlet fever, or whatever the disease may be, exposes the other scholars to danger, and brings the master within the purview of the law prohibiting the exposure of children to such risks.

In the Glasgow Act of 1890 there is a section imposing a penalty upon any one washing or exposing in a wash-house or drying-ground, used in common, any bedding, clothing, or other articles that have been exposed to infection, and upon any one selling, pawning, or giving such articles.

131. In New York pulmonary tuberculosis is regarded by the sanitary authorities as a disease that can be directly communicated from one person to another, and the medical sanitary inspectors take as much, or more, precaution against its spread as they do in relation to ordinary zymotic diseases. "Rules to be observed for the prevention of the spread of consumption" are printed and distributed everywhere, and especially among the families connected with those who are known to be suffering from it. The action taken in connection with the disease is based upon the Report of Drs. Biggs, Prudden, and Loomis, Pathologists to the Health Department, who sum up their Report, dated May, 1889, by saying— Consumption.

"We desire to especially emphasize the following facts:—

1st. That tuberculosis is a distinctly preventible disease;
2nd. That it is not directly inherited; and
3rd. That it is acquired by the direct transmission of the tubercle bacillus from the sick to the healthy, usually by means of the dried and pulverised sputum floating as dust in the air.

"The measures, then, which are suggested for the prevention of the spread of tuberculosis are:—

1st. The security of the public against tubercular meat and milk, attained by a system of rigid official inspection of cattle;
2nd. The dissemination among the people of the knowledge that every tubercular person may be a source of actual danger to his associates if the discharges from the lungs are not immediately destroyed or rendered harmless; and
3rd. The careful disinfection of rooms and hospital wards that are occupied or have been occupied by phthisical patients."

132. The very great increase in the death-rate from cancer that has marked the returns in recent years has caused a corresponding amount of attention to be devoted to this disease. So far this does not seem to have produced any practical result. In his report for last year, Dr. Stopford Taylor shows that in Liverpool the mortality from it is chiefly among women; that the actual number in his returns has increased from 166 in 1869 to 334 in 1890; the percentage of deaths from it to total deaths has increased from 1·1 to 2·3; and the death-rate from it among 1000 living has increased from 0·34 to 0·54. He says, "Year by year this disease claims more and more victims; and though increased knowledge and correct diagnosis may add somewhat to the number, yet the yearly increase in the deaths from this disease requires some other explanation than it is possible at present to give. The number of deaths (334) was the largest ever recorded." Cancer.

133. The rate of infant mortality in a community is acknowledged to be a good test of its general sanitary condition. A very large part of this mortality is caused by such zymotic diseases as measles, scarlet fever, diphtheria, and whooping-cough. The very large mortality from infantile diarrhœa four years ago induced the Local Government Board to send one of its medical inspectors, Infant mortality.

Dr. Ballard, to some of the larger towns to examine on the spot into the conditions which, in addition to high temperature, tend to produce the disease especially among children under five years of age. He was assisted by the Medical Officers of Health of the various places wherein his enquiries were held. His report has been made, and has given a fresh stimulus to sanitary work in connexion with drainage and cleansing. His opinion is "that the essential cause of diarrhœa resides ordinarily in the superficial layers of the earth, where it is intimately associated with the life processes of some micro-organism not yet detected." His practical suggestions to sanitary authorities consequently are chiefly relative to the necessity of the speedy removal from habitations and their neighbourhood of all sewage and refuse, the drying of the subsoil, the making of house sites and yards impermeable, the free ventilation of yards as well as houses. He also refers to food precautions, particularly with regard to milk and stale fruit. These suggestions are being acted on.

The connexion between the staple industry of a place, as affecting the employment of women away from their homes, and infant mortality, has often been insisted on. The Officer of Health at Coventry gives a confirmation of this in noting the great fall in the death-rate of children that accompanied the change of the staple trade of the city from the manufacture of ribbons, which employed women in factories, to the making of bicycles—a trade wherein women are not employed.

Vaccination and Vaccine Lymph.

Vaccination in England.

134. In England the vaccination arrangements are under the control of the parish authorities, and not of the municipal or sanitary. Some of the Medical Officers of Health give in their yearly reports statistics on the subject obtained from the parish officers. So far as I could learn, most of the vaccination of infants is done from arm to arm, and among sanitary officers no persistent effort is made to encourage re-vaccination of adults.

Army Vaccine Institute, Aldershot.

In the English army vaccination and re-vaccination are now, I believe, exclusively performed with calf lymph. The Army Vaccine Institute is at Aldershot, and under the superintendence of Professor Smith, and from it prepared lymph is sent to all the stations of the army at home and abroad. The lymph is obtained from weaned calves carefully selected and examined. On entering the establishment their age, sex, colour, weight, and girth are registered; and the weight and girth are noted on their leaving. In another register there are entered a number and notes to identify each calf and the date of vaccination, the source of the lymph used for the vaccination, the number of insertions and how many of them were successful, the amount of lymph collected and method of its preservation, the number of hours after vaccination that the lymph was taken, and the disposal of it. Each recipient of it has to make a Return to the Institute of the number of primary vaccinations and re-vaccinations performed, distinguishing the successful from the unsuccessful, so that the results obtained from each calf may be known. In collecting the lymph, not only the clear exudation, but the crust of the pustule is also taken, and the whole thoroughly mixed in a mortar with glycerine till it becomes an opaque pulp coloured with the triturated crust. The pulp for home use is collected on ivory points in the usual way, which in turn are wrapped in tinfoil. That for sending to a distance is dropped into a hollow ground out of the middle of a little glass plate $1\frac{1}{2}$ inches square; another plate of the same size is placed over it, and the edges of the two are fixed together by being dipped into melted wax. The plates are then wrapped in tinfoil and kept in an ice chamber till sent away. The lymph is taken 120 hours after the vaccination of the calf. I have to thank Professor Smith very heartily for his great courtesy and kindness when I visited the Institute, and for all the information he gave me.

French Vaccine Institute, Paris.

135. At Aldershot I had the pleasure of meeting Dr. Saint-Yves Ménard, the Director of the French Vaccine Institute, who was good enough to invite me to inspect the establishment at Paris and the method of operation both in regard to the culture and collection of lymph and the performance of the national vaccination system, and who was prodigal of kindness and attention during my visit.

The Institute is at No. 8, Rue Ballu, in Paris, and, though not large, is well fitted up for the purpose, and the whole of the apparatus and instruments, from the pivoted-balance operating table, to which the calf can be securely strapped while still standing, to the vaccinator's pocket-case of instruments and accessories, are admirably well contrived and made. The calves are all specially chosen cow calves of from six to eight months' age, weaned, and feeding on hay and bran. They are kept in clean, well ventilated stalls, with cement floors, glazed tile-covered walls and enamelled iron fittings, so as to prevent all lodgment of infective dirt. The inoculation is made on the right side on the lower half of the thoracic-abdominal region, which is selected as presenting a large plane surface readily got at, and easily kept clean. The calf is strapped down on its left side, the place is washed with soap and water, then shaved and washed with borax water. A great number of superficial scarifications are made with the lancet, and the lymph inserted is taken from the precedingly vaccinated calf that gave the finest eruption. The lymph is collected from the fourth day up to the sixth day at latest after the operation. For immediate use the pustule is squeezed with a flat-bladed pincer till the lymph exudes. For use at a distance it is collected with a specially prepared scraper, that gathers up the crust as well as the pale lemon-coloured lymph. This is mixed as in England, with chemically pure glycerine, which renders the animal matter imputrescible. The mixing machinery is a very perfect piece of mechanism, ensuring the perfect trituration of the crust.

The pulp is put into slightly tumescent glass tubes and hermetically sealed with the blowpipe. It is of the same colour and consistence as that issued by the Aldershot Institute. About 400 calves are used every year, and each one yields, if necessary, enough lymph for 4000 vaccinations.

There is no law of compulsory vaccination in France, but the vaccination of infants has become so much the custom in the larger towns that it is almost universally practised. Besides, vaccination and re-vaccination are among the obligatory regulations of so many institutions that, in large towns at least, vaccination of the entire population is fairly well secured. Every child must go to school, but no unvaccinated child will be admitted into school, and every child ten years old at school must be re-vaccinated. Service in the army is obligatory, and every soldier entering the army must be re-vaccinated. Every patient admitted into a hospital, whatever illness or accident may be the cause of his admission, is re-vaccinated unless his condition quite precludes the safety of the operation. This particular regulation has been in force for some years, and was introduced after one or two cases in which patients admitted for other complaints developed into smallpox which swept the wards. Policemen, railway servants, and the workmen of most public companies have to be vaccinated. There is thus at Paris but little need of compulsory vaccination of infants.

Dr. Saint-Yves Ménard, and his colleague, Dr. Chambon, are the heads also of the civic vaccination service, and with their staff perform about 40,000 vaccinations a year. Every one of these vaccinations is performed directly from the calf. Some of the staff are always at the Institute, and there great numbers of parents of the middle classes take their infants; but when the rich classes desire that the vaccination should be done at their houses, the calf is taken there for the purpose. There are a number of special carriages for the transport of the animals, and, when the operation is to be performed in an apartment, on one of the upper floors of one of the vast houses in Paris, it is amusing to see how the vaccinating staff is prepared for all emergencies; there being not only a sort of sedan chair arrangement for carrying the calf up, but canvas carpet covers to lay down to insure against all accidents. Vaccinations performed with such paraphernalia and under such circumstances cost a pretty little fee, the payment of which is an evidence of zealous faith in Dr. Jenner.

But by far the greater part of the vaccinations are performed at the public offices and institutions. Every week in every one of the twenty arrondissements of Paris vaccination is performed for all comers, either at the Mairie or some other large building. Not only is the operation gratuitous, but poor parents are allowed a sum of about three shillings to pay for the loss of time caused by their bringing back the child on the eighth day for verification of the success of the vaccination of the week before.

Dr. Ménard took me with him to the weekly vaccination at the Mairie of the XI. Arrondissement on the 23rd of September. We arrived at the place a short time before the staff, and while waiting for them we saw not only mothers and infants coming in, but troops of children of all ages. Soon the calf was brought in a low set covered carriage, the back of which when let down formed an easy inclined plane for the animal. It was quite at home with its attendant, and seemed to know what was expected of it. The last week's children treated it as an acquaintance, and there was not the least difficulty in getting it into the vaccinating room. This was a large place with a low platform on two sides, ordinarily used for meetings such as school examinations. The last week's children to be inspected only were on one side—the mothers uncovering the arms, as the doctor rapidly examined those evidently successfully vaccinated, and passed them to an assistant who recorded the fact and gave the certificate for the little bonus. The doubtful cases and the clearly unsuccessful ones took a little longer time, and the latter were sent to the other side of the room among the children come for vaccination.

These children, after being examined to see if they were in good health, were sent up with their mothers in small batches on to the platform, where the calf was quietly standing in the sight of all. The flat-bladed pincer of which I have spoken was fixed on a line of pustules, and was making the lymph exude. On a little bench close by, which was covered with a white napkin, was a small dish containing a weak solution of oxycyanurate of mercury (1 part to 1500 of water), and four or five vaccinating instruments which have a sharp pointed steel arrow-shaped blade about three quarters of an inch long, screwed into a handle. Meanwhile the mothers had bared both arms of the children, and were taking them one by one to the doctor, who stood in a good light and within reach of the little bench, on which the assistant with the calf placed the prickers when he had charged their points by making them touch the exuding lymph. The doctor made two slight punctures on each arm and handed the instrument to another assistant, who dipped it into the mercurial solution, which thoroughly disinfects it without injuring the steel, dried it, and handed it back to the first assistant to be re-charged with lymph. The whole of the operations are thus performed. No two children are vaccinated with the same instrument until it has been disinfected and re-charged with lymph from the calf, and, consequently, there can be no accidental inoculation of blood or matter of any kind from one child to another: and, as the whole operation is performed *coram populo*, they see that this is so. I was interested to see how the habits and feelings—the weaknesses, if one chooses to call them so—of the people were considered in the matter. For instance, boys were vaccinated with two punctures, one above the other on each arm; girls, to whom in after life the cicatrices might be considered a disfigurement when in full dress with short sleeves, had the punctures side by side, and so high up that any sleeve would cover them. The punctures made were in all cases very slight, most of the children not crying during the operation, and those who did cry, often doing so before they were touched. The work was done with astonishing rapidity.

The punctures were usually covered with a bandage of air-tight material, to be removed the next day, but which in the meantime keeps the place from the action of the air and the matters floating in it, and from being irritated by the clothes. There were about a hundred of the previous week's children and another hundred of first appearances. This was more than usual at the season, for, as a rule, nearly all children in France are vaccinated between April and July—May being the favourite month.

New York.

136. In New York as great attention is paid to re-vaccination as to primary vaccination, and calf lymph only is used. The Health Department has an organised corps of physicians, eight in number, who are known as Permanent Inspectors of Vaccination. In the spring and autumn of each year as many more physicians as may be required to make a house-to-house visitation of the whole city are appointed as Temporary Inspectors of Vaccination. It is the specific duty of all this staff to offer during this visitation free vaccination to all persons needing it. With regard to public schools, no pupil is allowed to attend, nor can any teacher be employed, unless properly vaccinated; and it is a condition precedent to the admission, employment, or attendance of a pupil or teacher, that the master of the school be furnished with a proper certificate from a qualified doctor of such vaccination. The Board of Health is empowered to send qualified agents to examine, vaccinate, or re-vaccinate all pupils who require it, and the master is bound to co-operate with the agent of the Board; and no pupil who refuses to be re-vaccinated either by the agent or at home by the family doctor is allowed to attend any school until the requirement is fully complied with. In accordance with this regulation pupils of the various schools are vaccinated by special inspectors, who visit the schools during teaching hours and vaccinate all pupils, except some good reason for non-vaccination be presented by the teacher, parent, or pupil. The lymph used is produced by the "Vaccine Laboratory" of the Department, from which surplus lymph is also sold to the medical profession. In regard to primary vaccination very strict supervision is made. Every such vaccination is verified and reported on by an inspector who is not the one who performed the operation. The condition of the population in relation to vaccination is every year becoming better. In 1890 there were performed 30,329 primary vaccinations, as against 26,336 in 1889; and 61,718 re-vaccinations, as against 48,206 in 1889,—showing an increase of 17,505 in all. These numbers are irrespective of the vaccinations performed by private medical practitioners. As the number of births in the city, after deducting the deaths of children under one year of age, was 28,962 in the year 1890, it will be seen that the above numbers are very remarkable, and that the children of New York are rapidly securing immunity from smallpox. There were only five cases of it in the city during the year, and they were all imported by ships from other places. The total cost of the Vaccination Department for the year was 19,110 dollars, making the cost of each operation a little under 9*d*. The lymph is chiefly collected on quill slips; some ivory points being used, and also a few tubes. Only cow calves are selected for cultivating the lymph. Each one is kept under conditions of the most scrupulous cleanliness, is examined by the Departmental Veterinarian, and unless it shows normal vesicles it is not used for charging points.

Disinfection.

In the sick room.

137. Nearly all sanitary authorities issue suggestions and directions as to the precautions to be taken in houses in which cases of infectious diseases occur. A short time ago the Society of Medical Officers of Health agreed upon some general suggestions to be recommended to all, and these suggestions have in many cases been adopted. On the whole they agree with the directions that have been issued in Tasmania from time to time by Dr. Hall, the Central Board of Health, and Dr. Giblin (the Medical Officer of Hobart). There is one point on which very great stress is laid—the removal of the patient to a hospital, or his complete isolation at home. The disinfectant generally recommended in England, as here, for use in the sick room is green copperas. In France sulphate of copper is recommended in solutions of two strengths, one being made with 3500 grains of the sulphate to the gallon, and the other with 840 grains to the gallon; the former being used for disinfecting the dejections, soiled linen, &c., and the latter for washing the hands and steeping the unsoiled linen, &c. In all cases supplies of disinfectants are given gratuitously. The French authorities also recommend the attendants on the sick to frequently rinse their mouths with water that has been boiled.

Disinfection of houses.

138. When a case of infectious disease has been notified to the medical officer he usually instructs the inspector to report on the premises on which it has occurred. These inspections are often very thorough, as the inspector has usually to fill up the columns in his report book, which make it necessary to examine the place in detail:—"General condition of the house; state of cellars; water supply; back windows and doors; state of privies and of ashpits; condition of yard; drains; sinks; animals; number of habitable rooms; number of inmates; work required to be done; when work finished; whether reported on; Remarks"—I quote all these from a form given me—have to be written down. After the removal of a patient, or on his recovery if treated at home, the house is thoroughly disinfected. To this end, a notice is served on the *owner* requiring him within three days to do the work set forth in the schedule of the notice. This schedule usually gives directions "to strip the paper from off the walls and ceilings, and burn it immediately; to cleanse the painted surfaces, wash the walls and ceilings with a solution of caustic soda, and lime-wash the walls and ceilings of house, cellars, privies, and entries." In nearly every district the

authorities keep a staff of men for doing the above work, and fumigating with sulphurous gas, gratuitously for the poor, and on payment of actual expenses by the rich.

In Paris the service of disinfection is gratuitously performed, and is very carefully organised. For house-disinfection two men always go together, being carried to the place to be disinfected, together with their implements and material, in the vehicle that is to take away the bedding, &c. that requires disinfection by heat. The implements and material comprise everything they are likely to want—sulphur in pound packets, and pieces of sheet iron, bags of sand and bricks to make a safe place in the room whereon to burn it, and some methylated spirit, matches, and fire-lighters to help in setting it on fire; canvas bags containing long canvas blouses buttoning round the wrists and neck and covering all the clothes of the men while they are at work; a measuring rod, a ladder seven feet long, a pot of paste with a brush, two wooden buckets each holding 2¼ gallons (10 litres), four whitewash brushes and two bass brooms, and a quantity of paper such as old newspapers;—then sulphate of copper in pound packets, a litre of a strong solution of corrosive sublimate, and a guaging glass holding one-tenth part of a litre. The strong solution of corrosive sublimate is formed by taking ten per cent. by weight of the sublimate in powder, five per cent. of chlorhydrate of ammonia, and 85 per cent. of water. It is coloured blue to distinguish it from other liquids, and so prevent accidents; and when used it is diluted by putting the measuring-glass above mentioned full of it to the ten-litre bucket full of water—and thus the solution actually used contains one part of corrosive sublimate in a thousand.

On arriving at the house the men put on their blouses, prepare ten litres of the strong solution of sulphate of copper mentioned in §137; they then measure the room to be disinfected, so that they may know how much sulphur to burn—the quantity prescribed being about two ounces to every cubic yard of space. They next spread out on the floor or on the tables all objects that could not from their nature be removed for disinfection by heat, and then block up all openings, carefully caulking all joints by pasting over them strips of paper. They proceed then with the sand, bricks, and sheet iron to make a safe place in the middle of the floor for burning the sulphur; the proper quantity of this is put upon it, moistened with methylated spirit, and a fire-lighter is lighted and placed on it. The door is then locked by the men as they retire, and is also securely caulked outside with paper and paste. They take the strong solution of sulphate of copper they have made, and with it disinfect the privies, sinks, and drains, leaving a little that they dilute into the weak solution, and therein wash their hands. They then take off the blouses, which are replaced in the canvas bags and sent off to the disinfecting-station.

On the morrow they return to the place and open the door and windows; they again disinfect the privies, &c., outside the chamber. They then prepare two bucketfuls of the weaker solution of corrosive sublimate, and with the whitewash brushes and brooms dash the solution over the floor, walls, and ceiling of the chamber, and over everything it contains, taking care to thoroughly wash the frame of the bed, the floor round it, and the night-stool.

There is also an organized corps of disinfectors under the Health Department of New York, and their services are rendered gratuitously to the public. For fumigation sulphur-dioxide is used, but for ordinary disinfection bromine is recommended. It is used in a solution of one pound in 200 gallons of water; and from a series of experiments made last year by the chemical staff of the Department, it ranks, at this strength, in effectiveness as a germicide after corrosive sublimate and carbolic acid, but before permanganate of potash, chloride of lime, proto-sulphate of iron, sulphate of zinc, and other common disinfectants. It also seems to have lost all disagreeable smell—the smell, in fact, that gave it its name—for the analysts say of it—"Attention should be drawn to the effectiveness of bromine as a disinfectant for ordinary domestic uses. In addition to its marked power as a germicide, it possesses the advantages of cheapness and great effectiveness as a deodorant, nor does it substitute another unpleasant smell for the one destroyed, as is the case with carbolic acid. In solution of the strength given a gallon costs less than half a cent.' It was first brought into use by this Department 1887 as a deoderant of the earth exposed throughout the city by the excavations made for the subways." It ought therefore to be very useful whenever large quantities of polluted earth have to be moved, as is often the case with sewerage and other sanitary works.

139. Nearly every urban sanitary authority has a disinfecting-station at which all articles, such as bedding and clothing, that have been subjected to infection, may be disinfected. Some of these establishments are remarkably well fitted up, and do much effective work. At Glasgow half an acre of land adjoining the Belvidere Isolation Hospital is occupied as a disinfecting-station; and there is a large washing establishment, as well as hot-air and steam stoves. The clothes of the poor are, as a rule, taken there while the house is being cleansed and disinfected, and are washed, dried, and returned before evening. There is also a cremator for straw taken out of mattrasses, and—which is a very necessary adjunct to such an establishment—a steam carpet disinfector and beater. The stove used is one of Washington Lyon's, that can now be used with dry air for articles which will not bear steaming. One great advantage that it possesses when being used with steam is that the jacket of the stove is always kept at such a temperature as does not allow the steam to condense upon it. I cannot understand why, when these stoves are fixed in these stations, their doors should be made of such an awkward shape, and their floors be so made as to require a difficult arrangement to draw out and in the receptacle holding the articles to be disinfected—movable rails having often to be adjusted for the purpose. At Glasgow on an average about 2000 articles are disinfected by washing or stoving every day.

Disinfection of articles.

In other disinfecting stations I saw Goddard and Massey's self-regulating stoves at work disinfecting by hot air, and giving very good results wherever ordinary care was taken and ordinary intelligence shown by the man in charge.

In England I saw no locomotive disinfecting stoves at work, but at Paris they use those patented by Geneste and Herscher. This apparatus consists of a disinfecting chamber, in which is a carriage with trellis-work shelves to receive the objects to be disinfected, which must be all of a nature that will not be spoiled by steam. This chamber is closed by an air-tight door. In front of the chamber is a boiler with vertical tubes, in front of which again is a coal-box, under the driver's seat. The whole is mounted on four wheels, and can be drawn by two horses. The disinfection is performed by steam, at a low pressure, being introduced into the chamber of the stove for 15 minutes, the pressure being reduced and re-applied every five minutes during this time. The door is then slightly opened, and the articles left to the operation of dry heat for 20 minutes more, when the door is fully opened, and the operation is at an end. I do not know whether this apparatus has been tested, in the same manner as English ones have been, by sanitary experts, but I should doubt the effectual disinfection of a mattrass by the above process in the time mentioned. I should think it would be effectual with ordinary clothing and all such articles as could be spread out on the latticed trays so as to be quite exposed to the action of the steam. But, apart from such considerations as these, I find that the sanitary authorities have found that these locomotive disinfectors have such inferior action to properly constructed fixed disinfectors in well arranged stations, and that their use is accompanied with other grave inconveniences, that they are recommending that special carriages for conveying infected articles to such stations be always employed instead of sending the disinfecting apparatus to the place where the infected articles are. At the Prefecture of Police they were good enough to give me the proof-sheets of a report on the matter by the Council of Public Hygiene and Health of the Department of the Seine, in which the inconveniences above referred to are thus summarised:—

"In effect, with a movable stove there is evidently, every time it is used, only a provisional installation; it becomes absolutely impossible to secure the complete separation so indispensable between the infected zone and the uninfected; there is necessarily contact with the persons charged with the handling of the things before and after the operation, and then there can be no guarantee that after the disinfection a new contamination will not be produced. And if it be taken into account that these manipulations are done by workmen habituated to these operations, and fatally careless as to its dangers, out of reach of all scientific and reasonable direction, without real control, we must come to the conclusion that these movable stoves do not offer sufficient guarantees. On the other hand, if the stove is placed in a hospital where all the arrangements are intelligently organised, so as to compel the attendants to submit themselves to all hygenic precautions, the service of disinfection is presented to us as affording complete security."

Hospitals.

Isolation of infectious cases.

140. Every year it is getting to be more and more recognised that the only really effectual way of dealing with the more highly infectious diseases, such as scarlet fever, is by isolating the patients; and it is all the more important that this recognition is made, not only by medical men, but by the general public. Dr. Fenton, Officer of Health of Coventry, says in one of his recent reports:—

"The powerful influence which the isolation of infected persons has in restraining outbreaks of epidemic disease has been so frequently demonstrated in Coventry as to require no further proof. The inhabitants appreciate this, and every year a greater proportion of persons who suffer are removed to hospital, and with less reluctance on the part of parents and friends. Last year four-fifths of the cases of scarlet fever that were reported were removed, and in no case known to me did the sufferer remain at home unless isolation were really effective. The result was that the disease never assumed any serious proportions, and, although it displayed a most malignant tendency, only 15 deaths took place from it, and at the end of the year no new case had been reported for a month. Compare this with the epidemic of 1874, when the Iron Hospital was first opened. Owing to the strong objection which parents had at that time to part with their children, removal was effected only in 12 cases. The children remained in their homes, but the disease spread with such rapidity and fatality that in six months 101 deaths took place, and probably more than 2000 persons were infected. Contrasting these two pictures, you will have little hesitation in supporting the Sanitary Committee in their efforts to increase and maintain the efficiency of your Hospital."

In another report he says:—

"Another most satisfactory result was that the rate of mortality was exceptionally low. Comparing the mortality in hospital with that amongst children treated at home, we find only six deaths occurred out of 162 cases of scarlet fever in hospital, while there were twelve deaths out of 106 cases at home. In typhoid fever, too, there was only one death out of nineteen in hospital, against three deaths in seventeen at home. The percentage of deaths in the latter case appears higher than it really was, owing to a certain number of non-fatal cases escaping notice; but, making full allowance for this, there is still a vastly superior chance of recovery in hospital than in the unwholesome, overcrowded homes whence most of the patients are removed, where the nursing, and even the dietary, are often of a very inefficient and improper character."

Isolation Hospitals.

141. Nearly all sanitary authorities have established isolation hospitals independently of any local general hospitals that may exist in their districts, and everywhere their influence, not only in restricting the spread of disease, but also in lessening the mortality from it when it does occur, is clearly established. But in most places the provision made is insufficient, especially as much of it is of a temporary nature—wooden and iron sheds, with or without felt—a kind of construction not

suited for either patients or nurses during an English winter. Some of them have, and all of them require, small *observation* wards for the reception of cases about which there is some doubt, or which may have been incorrectly diagnosed, but which cannot without danger be admitted into the general or special wards.

The fever and smallpox hospitals of the City of Glasgow are at Belvidere, on the Clyde, just at the south-eastern boundary of the city near the old waterworks. They are placed pavilion-wise on an estate of 32 acres, and were designed by the late master of the works, Mr. John Carrick. The pavilions have been built at various times, and the more recently erected ones combine all the ameliorations that were suggested by the experience gained during the occupation of the older buildings. The following is a description of one of these newer hospital pavilions:—On plan it is a long rectangle about 168 feet by 26 feet, standing north-east and south-west, and 60 feet away from the next parallel pavilion. It is divided into two sets of wards, each set comprising an acute ward, 56 feet by 22 feet interior measurement, and a convalescent ward, 24 feet by 22 feet. Access is gained to these two wards separately from an entrance hall in a projecting building; and this projecting building also contains a bath-room (in which, if necessary, patients can be bathed before admission into the wards), lavatory, water-closet, "steeping-room" for soiled linen, and pantry. There is another projection from the middle of the acute ward for a nurses' day-room, which has also a glazed bay projecting into and commanding a view of the whole ward: and in this room are the linen-closet and the "poison cupboard." Each ward is 14 feet 6 inches high to the wall-plate and 23 feet 9 inches to the ridge, the roof being open; has window openings equal to about half the floor area, and has an open fireplace at each end. The acute wards give accommodation to eleven adult patients, with more than 2000 cubic feet of space to each, or to twenty children, with 1200 cubic feet to each. The convalescent wards have beds for four adults, with 2500 cubic feet of air space each, and would give 1250 cubic feet to eight cribs for children. The buildings are of brick, one storey high, but the floor level is 8 feet above the ground. The wards and nurses' room are floored with oak, wax-polished, and the hall and other rooms are laid with tiles. The walls are plastered with Keene's cement, coloured with distemper, frequently renewed. The roofs are boarded under the slates, and all the woodwork varnished. All projections where dust could lodge are avoided. Glasgow Fever Hospital.

The real heating is done by hot water—the cisterns being under the entrance-hall, and heated by steam from a central station supplying the whole of the pavilions. The hot-water pipes are carried at floor level round the rooms, and in winter warm the air admitted by the ventilators; but, as above mentioned, there are also open fires at each end of each ward. To prevent radiation from the large window surface, all the sashes are double glazed, with an interval of three-quarters of an inch between the glass. The temperature of the wards is kept at from 55° to 60° in the coldest weather. The ventilation is effected by direct openings under the windows for the admission of air, and ventilating shafts in the chimneys, together with Boyle's ventilators and glazed dormer windows in the roof, for the outlet. The admission and outlet openings can only be controlled by the nurse in charge.

The bedsteads are all iron, the furniture polished hardwood, and all cupboards, linen chests, and such like furniture are mounted on rollers like American trunks. The mattrasses are stuffed with straw, and the pillows with chaff, the stuffing being burnt whenever soiled, and the whole renewed for every new patient. Other materials, such as wood-wool, have been tried, but the straw and chaff have so far proved to be the best.

Of late years great improvements have been made in regard to appearance in hospital—the moral and physical effect produced by appearances, especially on the sick, having become duly appreciated. I was very much struck with the cheerful appearance of the wards in the workhouse infirmaries I visited, particularly at Birmingham, where admirably arranged infirmaries for 1400 patients have been built, and at Coventry: the broad gangway of crimson drugget and the crimson coverlets, throwing in relief the white linen of the bedding and tablecloths; the flowers on the stands, and the gaily coloured pictures on the walls, quite belying the traditionally painfully clean discomfort of a workhouse. And, speaking of the Fever Hospital at Glasgow I have just described, Dr. Russell says:—

> "The grounds possess great natural beauty, rising gently as you approach the Clyde, where they are broken by three small glens, once the beds and sloping banks of three streams. The whole estate is well wooded, especially along the avenue and western boundary, where the rooks have recently established themselves in the tops of the old beeches. The convalescents are allowed to wander at will over the many beautiful walks, and in summer it is one of the most pleasant of sights to see the children rolling about on the grassy slopes of the glens, and the seats, placed here and there, occupied by groups of people who, for the first time in the lives of many, are tasting the sweets of nature. At the rear of the Fever Hospital several acres are laid out as a flower garden with a greenhouse from which the wards are supplied with potted plants. Flower plots are distributed here and there between the pavilions, and in other open spaces."

Another detail I noticed bearing upon the prevention of the spread of infection was the increased restriction placed upon visits paid by the healthy to the sick in the hospital wards. This visiting is everywhere discouraged as much as possible. At New York friends are allowed to visit patients in the Isolation Hospitals once a week on condition that they change their apparel, remain only half an hour, and fulfil all other precautions that may be deemed advisable to prevent the spread of contagion. In the diphtheria wards mothers are allowed to accompany young children, provided they will stay in hospital till the patient recovers, that they will comply with all the regulations of the hospital, and do what they can to assist the attendants in their duties with other patients.

Reception House.

142. At Glasgow the Sanitary Authorities have made another admirable provision which is used in connexion with typhus fever generally, but also sometimes in connexion with other infectious diseases—a reception house. This establishment has 24 beds, and to it are taken the healthy, or apparently healthy members of a patient's family. They are stripped of their own clothes, which are taken away to be stoved, and other clothing supplied if necessary. They are then kept at the place for from 14 to 17 days, being constantly and carefully inspected. If any disease develops itself the patient is at once transferred to the Hospital. This detention gives time and opportunity for thoroughly overhauling the house from which the patient was brought.

Noxious Trades.

In England.

143. In England the larger manufacturing industries of a nature affecting the public health by their influence on the purity of the atmosphere, are chiefly controlled by the Inspectors appointed by Government under the Alkali Acts, who, as has been mentioned in connexion with the proceedings of the Congress, take cognisance of all noxious gas-producing trades. With reference to other noxious trades, the interpretation given to the words, and the measures taken for their regulation by local sanitary authorities, are very similar at home and in the colonies. The home regulations are chiefly based on the Model Bye-laws. I heard of no noxious trade areas specially set apart, and where such trades could be carried on under privilege of any sort. In London, as in New York and most other large towns, there are districts where these trades have congregated, and where, consequently, workmen employed in them have also congregated with their families. In such localities, as nearly all the population is more or less directly interested in the trades, there is not usually much question raised by the people themselves, but the sanitary authority has, nevertheless, to safeguard the public health by requiring that all needful precautions are taken, and the yearly reports of the Officers of Health shew that this is done.

Noxious Trades in France.

In France the law on the subject, and the administration of it, are very precise. The general law is contained in the Decree of the 15th October, 1810, which is still in force with modifications made in subsequent Decrees. Under the Decree of the 3rd May, 1886, all noxious trades are divided into three classes according to the danger to the public health, or annoyance to neighbours that characterize their operations, and these classes are different to those established under the earlier Decrees. Of trades carried on in this colony, the following are ranked in the first class :—abattoirs, bone-burning, blood-boiling, coke ovens, fat-melting, glue-making, grease works, knackers' yards, manure works and depôts, offal and fresh bone stores, ore-roasting, starch-making by fermentation, stearine-making, and tripe-boiling : in the second class—charcoal-burning, curriers, and greenskin stores, fish-curing, forges and rolling-mills, gasworks, limekilns, machine works, oil and spirit stores, piggeries where more than six pigs are kept, potteries, pyroligneous acid works, and tanneries : and in the third class—asphalte stores, breweries, brickworks, candle-works, distilleries, dye works, fellmongeries, iron and brass foundries, malthouses, marine stores, sheepskin (dry) stores, soap works, and wool-scouring works. Altogether about 500 trades or branch trades are classified.

None of these trades can be established without Prefectoral authorization. The demand for this authorization has to be accompanied with a plan on a fixed scale, shewing all the neighbourhood of the place where the works are to be established for a radius of 500 metres in the case of a trade comprised in the first class, and of 200 and 100 metres respectively for the second and third classes, and also a detailed plan of the works. Due notice is given of the application, and an inquiry *de commodo et incommodo* is made on the spot, and all objectors are heard, and the opinions of the sanitary and other interested authorities are received. In the case of first class trades, the Prefect of the Department decides the question; in the other classes the *Sous-Préfet* of the Arrondissement; but the manufacturer and the objectors can either of them appeal to the Council of State from these decisions. When an establishment is authorized, the authorization is given conditionally, and the works are carried on under inspection, to insure the fulfilment of the conditions.

There are no general rules laid down as to the conditions to be imposed in regard to the several trades, each application being considered on its merits. But the Prefecture of Police in Paris—within the jurisdiction of which the "classed trades" are placed—follows generally the technical conditions laid down with respect to each of them in a work published by its architect-in-chief, M. Bunel, entitled "*Etablissements Insalubres, Incommodes, et Dangereux*," which is a complete cyclopædia of information on the subject of such establishments, the inconveniences and dangers connected with them, and the stipulations to be made in authorizing them. As an example of the practical nature of the work, I may give what he says in the portion devoted to "Technical Conditions" under the heading—

"Fellmongeries.

"*Third Class.*

"*Inconveniences.*—Smell. Getting rid of the washing and steeping water. Smell from these waters, and of the vapour that rises from the pits. Vapours from the hot-water processes. Danger of fire from the stove.—Among the workmen, ulceration of the fingers.

"*Conditions.*—The working places to be thoroughly ventilated ; their floors and the pavement of the yards to be made of impermeable materials.

"The drainage to be underground, the *débris* of skins and wool being kept back by gratings.

"The pits and their borders to be built in masonry in cement and plastered in cement, so as to be thoroughly watertight.

"The fermenting tanks to have airtight covering.

"The stove to be built with incombustible materials, and have iron doors.

"The skins to be treated immediately on arrival at the works.

"All locks, bits of skin, scrapings, and animal refuse matter to be disposed of every two days.

"If wool-beating and washing be carried on in the fellmongery, the special conditions applicable to those trades must be also fulfilled."

Then follow references to scientific and practical reports on fellmongery, to reports of cases on the subject that have been decided in the courts of law, and to reports that have been made by sanitary commissions on the subject. With reference to most of the other "classed trades" the information is equally full.

Noxious Trades in New York.

In New York the "offensive trades" are subjected to daily inspection by the Officers of the Health Department, who also take cognisance of all complaints of the existence of nuisances of whatever character. The citizens look to the authorities for complete and absolute protection from danger and annoyance. The last annual report mentions "heat from steam boilers and pipes, odours from restaurants, perfumery factories, tobacco factories, &c., dust from carpet-beating, fumes from smelting works, photographers' establishments, electroplating establishments, &c., barking of doys, playing of pianos, and hundreds of others. No matter how trivial a complaint may have seemed, nor in what form it has been presented, it has received careful investigation." It is not surprising that 22,200 inspections were made during the year.

Private Improvements.

Private improvement expenses.

144. Under the provisions of the English Public Health Act of 1875, expenses incurred by a Sanitary Authority in effecting sanitary improvements on private private property may, by resolution of that authority, be declared to be "private improvement expenses," and the payment thereof be spread over a number of years. Under these provisions a very large amount of work on property of comparatively poor owners has been done in the way of street-making, drainage of houses, pavement of court-yards, and such like improvements, that it would have been quite impossible for the owners to have done and immediately paid for themselves. And it is precisely the property of such owners that naturally is the most neglected, and that, consequently, most needs sanitary improvement.

Private Improvement rates.

The Act empowers the Sanitary Authority to levy special rates on the property improved for an amount calculated to pay off the principal sum expended on the improvement, with interest thereon, within a period of thirty years. But, as it was found very difficult to collect the rates from the tenants, who, though they could stop the greater part of the amount of the rate out of the rent, did not find it convenient to pay a comparatively large sum of money all at once. Therefore, in most towns the system of private improvement rates is discontinued, and the owner of the property has himself to pay the expenses incurred by instalments, usually spread over a much less period of time than thirty years.

Procedure for recovery of Private Improvement expenses.

The procedure that is followed is usually, up to a certain point, the same. If, for example, a private street requires to be properly made and drained, the Town Surveyor makes a report to that effect. The owners of the property abutting on the street are then served with notices to do the requisite works within a specified time, according to plans and specifications to be seen at the office of the Sanitary Authority. If the work be not done within the specified time, the surveyor reports to that effect, and the Authority orders him to do it. He reports on its completion the total amount of its cost, and he is ordered to apportion it among the owners. He does so proportionately to the frontage of each property in the street. The owners are respectively informed of the amount due from them under this apportionment, and that the apportionment will be binding unless appealed against within a given time. If the appeal be not made, or on its settlement, the Sanitary Authority passes a resolution dealing with the apportioned costs. If the improvement be confined to one property, such as building closets, paving yards, &c., of course no apportionment is needed, otherwise the procedure is the same. So far the procedure is much the same in most towns; but from this point some divergence of practice begins. At Manchester the authorities pass a resolution that the expenses are private improvement expenses, payable in instalments of so much on a certain day every year, together with interest on the amount unpaid, and each owner is informed and held to pay accordingly. At Rochdale each owner is required to sign a bond to pay the amount by instalments. At Liverpool the bond so given is registered in the Register of Lands' Charges under Lands' Charges Registration Act of 1888. At Coventry the bond is entered into by all the owners before the work is begun. At all places much good work is done under these clauses of the Public Health Act.

Sanitary Administration.

Personnel of the administration.

145. The organization of the administrative services connected with the health departments of the municipalities—especially of the larger municipalities—is very complete and effective. The higher offices are filled by medical men and engineers, some of whom have a world-wide reputation; and the whole of the *personnel* is certainly every day improving both in qualification and in position and consideration. This is no doubt mainly due to the growth of the public appreciation

and estimation of the importance of the service, but much of it is also due to the efforts of the officers themselves as a body by the establishment of such associations as those of Medical Officers of Health, of Municipal and Sanitary Engineers, of Sanitary Inspectors—associations recognised and encouraged by both Government and Local Authorities. At the meetings of these associations experiences are interchanged and methods and appliances discussed. The work done by the Sanitary Institute of Great Britain to encourage and direct into practical channels the special professional education of Local Surveyors and Inspectors has also borne good fruit.

Manchester.

The Manchester Urban Authorities were good enough to give me a proof of the new regulations they are about to issue with reference to the duties and work of the officers of the Sanitary Department. The Department is under the control of the Sanitary Committee of the Council of the City, who work with the Medical Officer of Health, and who employ a Chief Superintendent, two Chief Inspectors, and fourteen District Sanitary Inspectors, each of the latter having his special district. Every Inspector of whatever grade is expected to hold the certificate of the Sanitary Institute of having passed its examination for Inspectors. If any have been appointed on the ground of previous practical experience, they are expected to obtain the certificate, and will get no promotion or increase of pay till they have obtained it.

Duties.

The Inspectors are expected to know every house in their respective districts thoroughly. They are reminded of the confidential nature of the information they receive, especially from medical practitioners, and of the necessity of a constant display of courtesy and consideration. The following extract gives a good example of the whole spirit of the regulations :—

"The Sanitary Committee desire it to be distinctly understood that every Inspector will be expected to do his duty towards the public with absolute impartiality. The Committee undertake that no Inspector shall suffer in any way for fearlessly discharging his duty or for reporting sanitary defects in property belonging to persons of position and power. On the other hand, they will view with extreme displeasure any omission by an Inspector to report insanitary property, or to deal impartially with defaulters, whatever their position may be."

The ordinary duties to be fulfilled are generally set forth in the Public Health Acts, and, in a general order of the Local Government Board of England, dated March 25th, 1891; further special duties are inculcated, and their nature and scope and the instructions given for their fulfilment have for their object the making of each Inspector feel a personal interest in, and responsibility for, the health and cleanliness of his district. And this feeling is further encouraged by naming each Inspector in connexion with full details of his year's work in the annual reports of the Sanitary Committee.

The Inspector attends every morning at the Sanitary Office and gives in his report of the previous day's work, and gets orders as to complaints that may have been lodged. Then he goes and receives the instructions of the Medical Officer of Health as to infectious cases reported, precautions to be taken, such as the removal of patients to the hospital, the disinfection of houses, bedding, &c. He next goes to the police office of his district, and notes the complaints that may have been lodged there. He then makes all the inspections and visits necessitated by his various orders and instructions, and does what further is necessary to fully carry them out. When this is all done, the rest of his time is occupied to complete the house-to-house inspection he is bound to make at stated intervals. For the making of this inspection he is furnished with special instructions as to the more important points to observe and note in addition to general condition. These instructions embrace a great deal, and, when properly carried out, must certainly do much to prevent the occurrence of any concealment of infectious disease, any letting of infectious rooms, any waste of water, any smoke nuisance, any sale of improper food, any overcrowding, any erection of buildings without notice, or the existence of any nuisance of any kind or sort whatever. He is "to endeavour to place himself in friendly relationship with the people of the poorer portions of his district; to urge them to keep their houses clean, and to ventilate them as efficiently as may be practicable; to remove as quickly as possible all offensive matters; and to abstain from the consumption of unwholesome food, such as stale fish, unsound vegetables, &c." It will be thus seen that an Inspector at Manchester has not only to be an industrious, active, hard-working man, but one endowed with a great deal of special knowledge, and, above all, with rectitude, intelligence, and discretion. And the Inspectors I met, not only there, but elsewhere, appeared to me to possess these qualifications.

There is also a staff of women employed by the Corporation as District Visitors. And at Manchester, as elsewhere, noble work is being done by women organised in Sanitary Societies, in the work of fighting against the misery and disease that still are the disgraceful concomitants of our people when collected into large cities. I have just received from Dr. Tatham, the Medical Officer of Health, his report for the quarter ending 3rd October last, in which—after reporting on the fact that in a city with over half a million inhabitants only 156 communications or complaints were received by his Department from the general public, and giving a table shewing that, the above included, only 1112 informations were given by the public, the police, and medical practitioners, while 1143 were given by the Female Inspectors—he goes on to say :

"The work of home visitation amongst the dwellers in the poorer parts of the City has, as usual, continued to be ably discharged by the female visiting staff employed by the Corporation. Under the effective personal guidance of the Ladies' Health Society of the Manchester and Salford Sanitary Association, the Female District Visitors have made, during the recent quarter, not fewer than 847 special sanitary visits to poor people, and have conducted 519 enquiries into cases of infectious sickness or of death on behalf of the Medical Officer of Health. In addition to this, the Female District Visitor employed by the Ladies' Society for Visiting the Jewish Poor has made as many as 274 visits during the recent quarter, mostly in the neglected neighbourhood of Red Bank. The Medical Officer of Health has accordingly been favoured, through the medium of this Society, with valuable information as to the conditions of life and of house property obtaining in that neighbourhood.

"It is difficult for those as yet unfamiliar with the prevalent conditions of life in the slums of the City to realise how truly urgent is the need for adequate extension of the work which, on a small scale, is now being carried on under the direction of one or other of these admirable societies by kind-hearted women on behalf of their less favoured sisters and their families in the poorer homes of Manchester."

To facilitate as much as possible the work of the Inspectors and of the Sanitary Department generally in dealing with nuisances, printed forms are prepared dealing with most conceivable kinds of nuisance, no less than 29 of these being given me to exemplify the work of the department at Manchester. These include specifications for all the ordinary forms of sanitary work necessary to be done—drainage, paving, privy and closet-building, &c. And similar provision is made in respect of forms of orders or resolutions of Council necessary to give effect to the reports of the officers.

At Glasgow the sanitary administration is equally well organised, and includes five women as Inspectors, who do exceptionally useful work in visiting the houses in the poorer districts of the city, and inculcating and, as far as possible, enforcing domestic cleanliness. The cost of the whole Department in Glasgow for the year ending 31st May, 1891, was £45,721. Glasgow.

In many of the smaller towns I found equally good organisation on a scale suitable to the requirements of the place.

146. In the country districts of England the guardians of the poor act as "Rural Sanitary Authorities," and administer, or fail to administer, such portions of the Health Acts as are not limited in their application to urban districts. As the time at my disposal was all occupied by visits to towns, I had only few and incidental opportunities of seeing what was done in country places. Bishop's Waltham, in Hampshire, was typical of what I usually found to be the condition of things. It is situated in the Poor Law Union of Droxford, and has a population of about 3000. It is supplied with water by a local waterworks company, and many of the houses have water-closets which are drained into sewers that have been constructed by a Local Highway Board, and have for outlet a small stream. The Guardians of the Droxford Union are the Rural Sanitary Authority, but exercise hardly any of their powers, and fulfil hardly any of their duties as such Authority. They have made no bye-laws nor regulations upon any sanitary matters, and they only interfere to remedy nuisances that can be easily remedied. The nuisance caused by the making an open sewer of the little stream, though brought under their notice, is allowed to continue. The guiding principle seems to be, Do what costs nothing to do; do nothing that would involve a sanitary rate. Such a course of action, or rather inaction, might be unattended with any very grave consequences in a small community living in scattered houses, with the comparatively small water supply that is made to suffice when every one has to pump or draw his own supply, with privies in gardens, and with surroundings that insure a large dilution of all noxious emanations with pure country air; but if the modern conveniences of a plentiful water supply distributed under pressure to every house, and of having water-closets, are accepted, their acceptance involves the obligation of having proper means of removing the water after its use either in the kitchen or the closet. If this obligation be not fulfilled, evil consequences will certainly result.

Rural Sanitary Authorities.

Bishop's Waltham.

Effects of Sanitary Work.

147. To properly estimate the results that have followed the persistent efforts that have been made to improve the health of the people in Great Britain, it would not be fair to look only on the present condition of things. The most strenuous workers in the cause of sanitation would be the first to admit that the present condition of the towns is not satisfactory. The well-organised staffs of inspectors I have described in Section 145 have been appointed, and are maintained, because there is ample work for them to do. But if account be taken of the condition of things, even less than twenty years ago, and compare it with the present condition, and especially if we compare the consequences of the old state with the consequences of the new, we can only come to the conclusion that the results of sanitary work are worth infinitely more than the work has cost, and give every encouragement to continue it. In these new colonies we have many terribly unwholesome spots in our towns to shew us what the dirty habits of ignorant people, overcrowded in badly built houses, with unpaved and undrained yards, with no proper sanitary appliances or refuse-removing service, can do. But these influences have only been at work for seventy or eighty years or less. In Britain they have been at work for centuries; and the special portions of the yearly reports of Officers of Health devoted to descriptions of parts of their districts, reveal conditions that happily are yet impossible here. Many of these have been incidentally mentioned already; and the parliamentary reports and current and newspaper literature are full of descriptions of others. Dr. Leigh, when Officer of Health of Manchester, describing the efforts that had been made to obtain the chief requirements for the health of the people—good water, good unadulterated food, and pure air—and expressing his satisfaction at what had been done by the city waterworks and by the watchfulness of the Inspectors to secure the good water and food, goes on to shew the difficulties that had been encountered to secure pure air, and enumerates what were the chief sources

Former sanitary condition of towns.

of its pollution—such as 80,000 square yards of cesspool four feet deep, being about a square yard for every four inhabitants to breathe at; many miles of unswept streets; courts, passages, and yards partially covered with decomposing animal and vegetable matter; the emanations from the drains and from the rivers and brooks, which were only sluggish sewers; and from all sorts of noxious trades. These causes of pollution naturally were always working the most intensely in the most overcrowded parts of the city, and so in some parts of Manchester there was a frightful death rate. Such conditions and such consequences as these are what should be compared with those of the present.

148. Bearing these points in mind, the results of sanitary work in England—especially the work of recent years, when it has been carried on under better direction and with superior organization and continuity of effort—are most satisfactory, even for the present, and most encouraging for the future. For much of the following account, and especially for the information referring to the two last years, I am indebted to M. Henri Monod, Director of Public Assistance and Hygiene, of Paris, who has published a very valuable work on "*The Sanitary Measures in England since 1875, and their Results*;" the year mentioned being chosen as being the date of the passing of the Public Health Act, which is still the principal of the Health Acts in force.

For many years before 1875 efforts had been made under legislative sanction to improve the sanitary condition of England, but without marked success—the improvement sometimes apparently effected not being of a permanent character, as the rate of mortality fluctuated very greatly. During the ten years ending 1875 it was once as low as 210 in 10,000 living, and once as high as 234; the mean of the ten years being nearly 222. This mean hardly shows any improvement upon that of the preceding 30 years, which was 223·5 in 10,000. The great advantage derived from the sanitary legislation and efforts of these years was experience, and that experience was embodied in the Act of 1875. As soon as this Act got into fair work the results were apparent. Before 1875 the death-rate had for one year only—1856—been so low as 205 in 10,000; since 1880 the death-rate has only once—in 1882—been so high as 196 in 10,000: the mean of the ten years ending 1889 being 190·8. And that the rate of mortality is, as it were, being in some sense controlled, is shewn by the comparative steadiness of the downward curve shown when the rates are graphically projected upon the accompanying graduated diagram of deaths from all diseases. This result of the efforts made to improve the health of the people may be expressed in another way: if the mean death-rate of the decennium 1866-1875 had continued during the decennium 1880-1889, the number of deaths that would have taken place would have exceeded the number that actually did take place by numbers varying from 55,183 in 1880 to 142,466 in 1889, and by a mean number of 87,658 every year. Mr. Noel Humphreys has furthermore shewn in the Journal of the Statistical Society that on account of this diminution of mortality the mean length of a man's life has been prolonged by two years, and that of a woman's life by more than three years. I think the probable explanation of this difference of benefit between the two sexes is due to the fact that women stay more indoors than men, and so, as house sanitation has made more progress than any other branch of the science, they have derived more advantage from it.

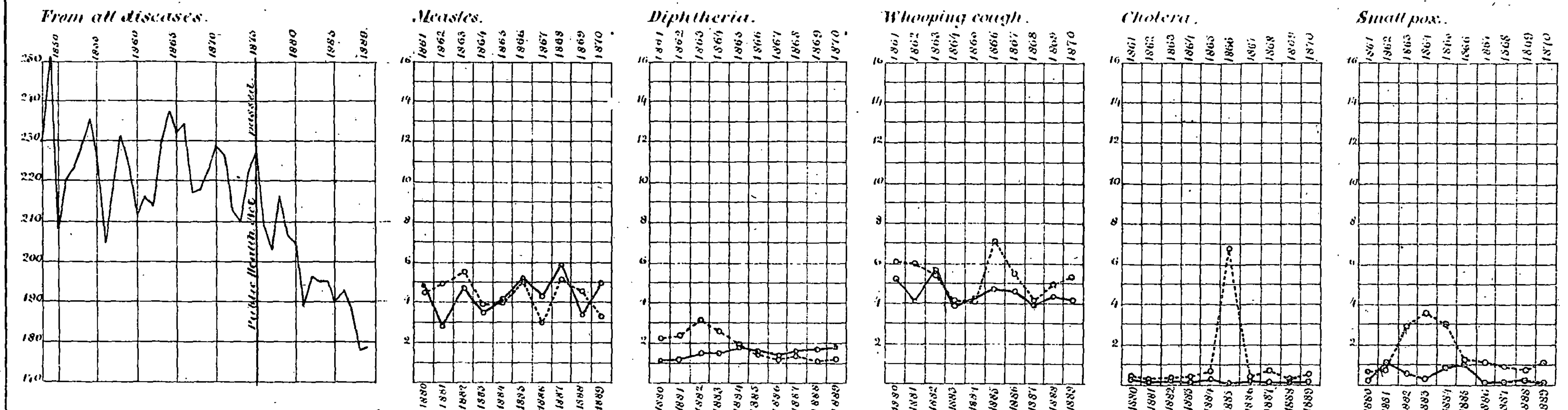
Zymotic diseases. The diminution of mortality has taken place in connexion with most diseases, but more than half of it is attributable to the diminished number of deaths from the zymotic diseases. Taking the periods 1880–1889 in comparison with the period 1861–1870, the following diminutions took place in the proportions of deaths to 10,000 living:—

	1861-70.	1880-89.	Diminution.
Typhoid fever	8·86	2·50	6·36
Scarlet fever	9·71	3·79	5·92
Diarrhœa, dysentery	9·68	7·12	2·56
Smallpox	1·62	0·48	1·14
Cholera	1·08	0·17	0·91
Whooping-cough	5·30	4·52	0·78
Diphtheria	1·87	1·54	0·33
Measles	4·42	4·40	0·02

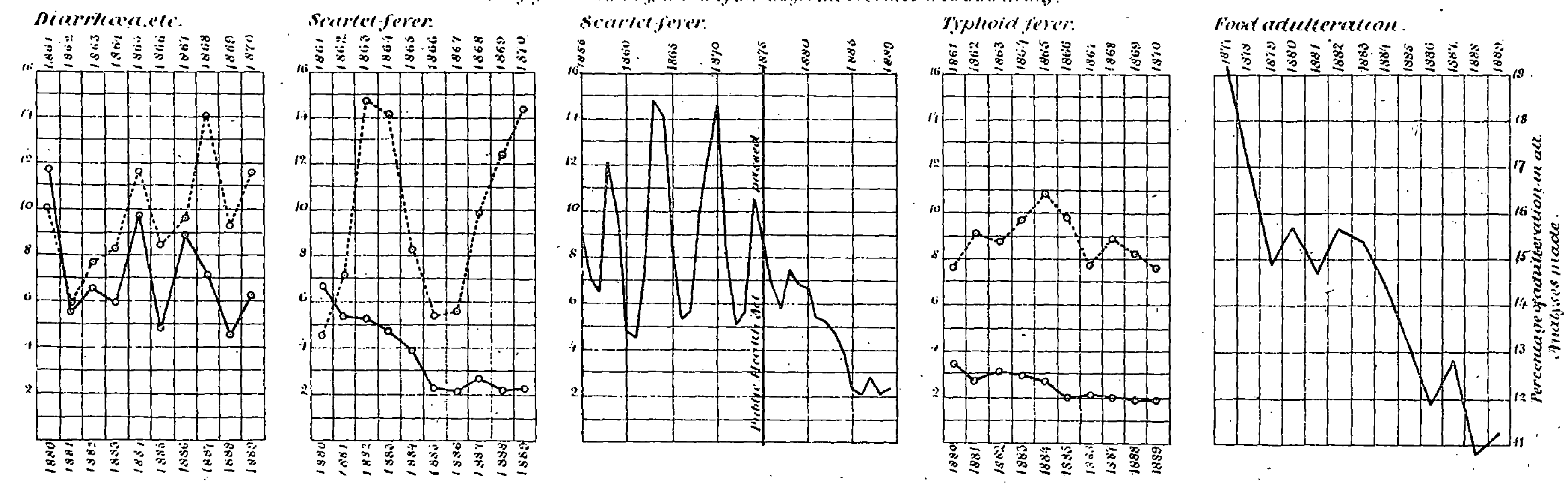
The order of diminution shewn by this table might almost have been calculated on beforehand. Measles. Measles, as I have mentioned before, is not one of the diseases that have to be notified. Its obscure beginnings, and the fact that it is infectious during the incubatory stage, render this children's disease most difficult to combat, especially in a country of compulsory school attendance; consequently, as the accompanying diagram shews, sanitary work has hardly affected the mortality from measles.

Diphtheria. With respect to diphtheria, notwithstanding all the attention that has been paid to it in England, the etiology of the disease remains very obscure. But as it has been observed that the mortality from the disease is not, as in the case of other zymotic diseases like measles, scarlet fever, diarrhœa, &c., in direct proportion to density of population—but, on the contrary, the mortality is the greatest where the population is sparsest, that is, where least sanitary work is done, and consequently, where its effects are least felt,—the similarity of the curves shewn on the accompanying table is not surprising.

Whooping-cough. Whooping-cough is another children's disease usually occurring at an age when isolation of the patients is impracticable, and has, perhaps, more completely escaped from all sanitary control than any other. The diagram of this disease shews a little more difference, especially in the greater steadiness of the later curve.



Diagrams of Death Rates. Where two curves are shown the dotted line refers to the period 1861–1870: the figures on the left hand of the diagrams are rates in 10 000 living.



Cholera was the disease against which preventive measures were first taken—the measures dating from the epidemic of 1832, consequently there was not much scope left to shew the efficacy of further sanitation; yet a diminution of 91 out of 108 shews that it is a disease very susceptible to the influence of sanitary measures, especially as, though Asiatic cholera was two or three times introduced during the ten years 1880-9, it was not enabled to gain a foothold as in 1866. Cholera.

Similar remarks may be made in reference to smallpox, the immunity given by vaccination leaving but little room for improvement. But the diminution of 114 out of 162 would probably have been larger had the same care in regard to vaccination been taken in the country and smaller towns as in the larger. In London, in 1889, out of a population of about $4\frac{1}{2}$ millions, there was only one death from smallpox; and the diagram shews that, two or three local epidemics notwithstanding, no such wave of mortality was caused as during the epidemic of 1863-4-5. Smallpox.

Of the deaths by diarrhœa, 63 per cent. took place in children of under one year of age, and 80 per cent. in children under five. The diminution that the table and diagram shew to have taken place is very remarkable, as infantile diarrhœa is supposed to be so largely due to conditions of temperature beyond control. This accounts for the still great mortality; but the diminution of 2·56 out of 9·68 shews that the observance of the special recommendations made by Dr. Ballard, of the Local Government Board, after his inquiry, (see paragraph 133, page 71), has borne good fruit.

When smallpox had been successfully controlled scarlet fever remained in England the great scourge of the young. The ordinary sanitary measures employed to prevent the origination and spread of disease, such as drainage, water supply, scavenging, &c., did not seem to have much effect upon this very infectious fever. The diagram of the fever from 1855 to 1889 shews that tidal waves of scarlet fever, in an epidemic form, used to sweep over the country with a periodicity so well marked that officers of health, like Dr. Alfred Hill, of Birmingham, used to forewarn the sanitary authorities that in such a year another wave was due, and its coming ought to be provided for. Up to 1854 the mortality from scarlet fever was not separated in the Registrar-General's returns from that from diphtheria. Between that date and 1875 it will be seen there were four of these tidal waves, the years of greatest mortality being 1858, with 12·10 in 10,000 living; 1863, with 14·80; 1870, with 14·50; and 1874, with 10·50: and the years of least, 1857, with 6·5; 1861, with 4·5; 1866, with 5·4; and 1872, with 5·1. Another low tide was due in 1876 or 1877, and it arrived in the latter year with 5·8 deaths in 10,000 living; and another high tide in 1878, when it arrived, but with only 7·5 in 10,000. This seemed to shew that though the periodical influence, whatever it was, was still strong enough to assert itself, though not in so marked a manner as before. When in 1881 the mortality had again got down to 5·5 in 10,000, it was thought that the periodical low-water had again arrived, and that next year would shew a rise; but it did not, and the mortality went down, as shewn year after year continuously till 1886, when it was only 2·1 in 10,000 living. In 1887 it rose slightly to 2·75, but went down again in 1888 to 2·2, and in 1889 to 2·3; apparently showing that the influence causing the periodicity was amenable to control, though, of course, our experience is of too short duration to justify an absolute assertion that it is controlled. The only causes that can be assigned for this diminution of mortality from scarlet fever are the isolation hospitals that had been established, and the disinfecting services that had been organised. The result is shewn on the comparative diagram. In 1881 already 203 sanitary authorities had established isolation hospitals, and their number has since then greatly increased and their character greatly improved. The experience of Coventry, given in § 130, is that of many other places. Scarlet fever.

With respect to typhoid fever, the influence of sanitary work upon its prevalence is unquestionable and unquestioned. As Longstaff says, in his "Studies in Statistics," "The fall of the death-rate from fever is without doubt the great triumph of the sanitary reformers." The chief factor in the amelioration which has taken place, and is shewn on the diagram, seems to have been drainage. For instance, at Berlin, where all the houses are not yet drained into the new sewers, the difference in the occurrence of typhoid fever in drained and undrained houses is very marked. On an average one case of typhoid occurs in every 49 houses that are drained, and one in every nine that are not drained; and one case of death from typhoid occurs in every 137 houses that are drained, and one in every 43 that are not drained. Typhoid fever.

As for diseases not classed as zymotic, a very great diminution has taken place in the mortality from them taken altogether, as shewn by the figures I have already given, and especially among those that might be expected to be amenable to sanitation—for instance, the death-rate from pulmonary consumption. In the ten years 1861-70 the average yearly number of deaths from it was 2488·6 in the million living; in the ten years 1880-89 it was 1736·3, showing a diminution of 752·3 in the million, a difference that signifies the saving of 20,688 lives a year during the latter period, as far as consumption alone is concerned. The cause of this amelioration was clearly shewn when, as a result of Dr. Buchanan's enquiries, it was shewn that there was a direct relation between the mortality from consumption and the drainage of the soil. Wherever the construction of sewers had not had as a consequential result the drying of the soil the mortality remained stationary; wherever this construction of sewers was followed by a thorough or partial drying of the soil the mortality diminished, and diminished in a ratio corresponding to that of the drying of the soil. Consumption.

149. In connection with the amelioration of the public health, some credit is certainly due to the greater attention that is paid to the prevention of food adulteration. I have already remarked Food adulteration.

on the utility of the work of the public analysts, and the effect it has had on the reduction of adulteration in certain districts. The diagram I give of food adulteration all over England will shew that these good effects are not limited to particular places. As before mentioned, fraudulent tradesmen seem to have made a stand from time to time, but the general result is unmistakeable. In 1877, out of 14,706 articles of food analysed over 19 per cent. were found adulterated. In 1889, of 26,954 articles analysed less than 12 per cent. had been tampered with, and in more than half this 12 per cent. the adulteration consisted in the addition of water to milk or to spirituous liquors.

Quarantine.

Medical inspection at Liverpool.

150. If quarantine, even Australasian quarantine, be the best method of excluding an infectious disease—for example, smallpox—from a community that is almost or altogether free from it, the Sanitary Authorities of the Port of Liverpool ought, and certainly would have continued, to practise it. I have received from Dr. Stopford Taylor, the eminent Medical Officer of Health of the city and port, his reports for the years 1887-1890, from which I take the following facts:—"As regards the freedom of Liverpool—with probably a mean population for the four years of about 530,000 inhabitants—from smallpox, it appears that during the four years there were only three deaths from the disease, that is, one in each of the years 1887-8-9, and none in 1890. On an average there are over 5600 vessels engaged in foreign trade, and nearly 17,500 in the coasting trade. As smallpox exists in both English and foreign ports, both classes of vessels might introduce the disease. It further happens that most of the vessels trading with ports and countries where the disease is prevalent do not carry passengers, and consequently, as the officers and crews either remain in Liverpool or return there, it is easy to trace their influence in the propagation of smallpox either in the city or elsewhere; and this has been done. On an average eight or nine vessels infected with smallpox arrive every year. If the patients have recovered the usual entry in the report is, "The vessel and bedding disinfected by the Port Sanitary Authority." If the disease is still in existence the usual entry shews the hospital to which the patient was removed, with the remarks, "The patient was one of the crew; bedding, effects, and vessel disinfected by the Port Sanitary Authority." The full entry in the most marked case of 1889 is—"April 10; s.s. *Bleville*, from Marseilles; Smallpox, two cases; removed to Parkhill Hospital. Remarks:—The patient (the Chief Engineer) was removed to hospital, and the vessel was disinfected, and the bedding destroyed by the Port Sanitary Authority. Four other members of the crew were subsequently removed to hospital, but one only developed smallpox, and the vessel and bedding were again disinfected by the Port Sanitary Authority." Liverpool is furthermore subject to another source of infection. The number of sea-borne passengers is greatly exceeded by the number of land-borne. The average number of emigrants that left Liverpool each year of the four mentioned was over 217,000, of whom more than a third were foreigners, chiefly coming by railway from Hull, at which port they had landed from the continent. All these were examined, and some cases of smallpox were found amongst them and removed to hospital.

All this immense traffic was carried on under circumstances fraught with many elements of danger. There was great and fatal prevalence of smallpox at Sheffield and Preston, and frequent outbreaks in other Lancashire towns. There is a very large trade done with Spanish ports (the extent of it may be judged from the fact that though by far the greater part of it is done in British ships, there are 284 Spanish ships also trading to Liverpool), and in the Spanish ports the disease was very prevalent, and steamers make the passage from them within the period of incubation. Yet medical inspection kept the town free from infection, not for one year, but for the whole series, and did so effectively and with probably not a tithe of the inconvenience to the commerce of the port and to the inhabitants as the quarantining of a single ship by the Sydney authorities inflicts upon a much more restricted traffic.

It must be noted that a good deal of this immunity is secured for persons not otherwise protected, for the seamen's and emigrants' lodging-houses at Liverpool are often crowded with foreigners who have never been vaccinated. But there is no doubt but that the real reason of the sufficiency of medical inspection in keeping out infectious diseases is the guarantee afforded by other preventive measures, such as vaccination in the case of smallpox, cleanliness in the case of cholera, and drainage in the case of typhoid fever. Quarantine is a very insufficient substitute for these: it is usually carried out only by Governments that have not the courage to enforce vaccination or the wisdom to see that expenditure on sanitary work is the most reproductive of all expenditure, as well as the only real safeguard of the health of a people.

It is satisfactory to note that though formerly at the International Quarantine Conferences the French medical authorities opposed the English in their efforts to do away with quarantine, the highest authorities among them now agree with their English colleagues that the only real safety is to be found in sterilizing the soil whereon the seeds of disease are sown. Speaking at the Sorbonne, in 1885, Dr. Brouardel, the Dean of the Faculty of Medicine in Paris, and the foremost Hygienist of France, said:—"When the territory is invaded we have but one question to ask the Authorities—'What measures have you taken to make your town healthy?' A town is not made healthy all at once; years are needed to do it. If the municipality has brought in a supply of pure water; if the houses are kept clean, and the dejections removed without possible communication with the air and the water, we can boldly say to them, 'You are safe. For you the measures that we take in the Red Sea, and at the ports, are useless measures. You are of rock: the seeds of disease will die upon your soil.' For me, and I do not hesitate to affirm it, that is the true solution, it is the solution of the future." * Dr. Brouardel's words have borne fruit. At the time they were spoken Marseilles had just past through a visitation of cholera. The loss of life sustained during it, of course, cannot be appreciated by any monetary value, but Marseilles was then, and still is, carrying on a lively competition for trade with other ports, especially with Antwerp, and this visitation of cholera had a most disastrous effect upon its commerce. The passengers who landed there were 51,000 fewer than in the year before, and the passengers who left were 15,000 fewer, and this difference all occurred in the last six months of the year. In the first six months the tonnage of the port had augmented by 138,000 tons; the cholera came, and for the last six months the tonnage diminished by 1,348,000 tons—both when compared with the preceding year. Marseilles had almost a monopoly of the leather trade, and of the refined sugar trade with all the Mediterranean ports. This was almost entirely lost, and transferred to Antwerp. The Marseilles people determined to have done with cholera, if possible, and what they are doing to secure this is not calling out for stricter quarantine either at their own port or in the Red Sea, but by draining their city and putting their houses in order.

There are two ways of trying to save your house from being burnt: one is to build it with incombustible materials; the other is to watch it constantly lest any sparks fall on it. If you follow the first course you may sleep in peace; if you trust to the second you must always be on the alert. For, as Fauvel well says—" A fire is not proportioned to the spark that lights it, but to the combustibility and accumulation of the matter it meets."

General Conclusions.

151. In writing out these notes of what I saw, heard, and learnt during my visit to Europe, I have endeavoured as far as possible to put the matters before you in such a way as to enable you to draw your own conclusions as to how far the sanitary systems and administration of other countries, and the work and organization by which they are carried out, are adaptable and desirable in Tasmania. If I venture now to place before you a few of the conclusions that I have arrived at, I shall do so with the knowledge that, with the facts I have placed before you, you will be able to control and criticize any suggestions that those conclusions induce me to make. It will probably be more useful and more intelligible if I put my suggestions in a concrete and not in an abstract form, by connecting them with work that we know we have got to do. I will, therefore, begin with the sewerage, drainage, and other matters connected with the sanitation of Hobart.

152. With respect to the collection of sewage, that it should all be collected, including nightsoil, and that the collection should be done as far as possible by glazed stoneware pipes, with impermeable joints, is now so long past the stage of discussion that it may be regarded as axiomatic. The sewers should be capable of taking part of the rainfall on roofs and yards; but, with careful setting out and laying, they need not be very large nor very deep. And danger of their becoming stopped may be avoided; and, if they do become stopped, arrangements may be easily made for unstopping them without much trouble or expense. Some of them will need flushing periodically; but whether the flushing should be done automatically or otherwise is a detail that must be settled for every sewer according to its circumstances. The rest of the rainfall must be sent into existing watercourses. Every sewer must be thoroughly ventilated; and this can be best done without using mechanical appliances. The drainage of such parts of the subsoil as require drying should be effected by drains laid specially for the purpose; and, where it may be necessary to take the land drainage thus collected into the sewers, the same precautions should be taken at the junction as are necessary in the case of house-drains. One general caution I must give: it is not improbable that the opening of trenches all over the city to lay sewers and house-drains may cause such a disengagement of bad air from the sewage-sodden soil as may cause an outbreak of disease. Every precaution must be taken to avert such a calamitous consequence of the unsanitary past of Hobart; but if, notwithstanding such precautions, some disease should occur, the occurrence should not cause any distrust as to the solid benefit to be realised by drainage, and that can be realised by no other means. Sewerage of Hobart: Collection.

153. With regard to the disposal of sewage, the town in England where, all things considered, this disposal is most satisfactorily accomplished, is Southampton; and Southampton is a town which in position and circumstances bears a great analogy to Hobart. I therefore should recommend that the work should be done here on the same general principles as there. The adoption of this recommendation would primarily and consequentially involve the following works; and it will be noticed further on that some of them are also consequentially involved by the adoption of other recommendations I have to make in connexion with the sanitation of Hobart—an interconnexion that I think advantageous, as shewing that what is necessary for one part of hygienic work can be utilized for another. The system adopted at Southampton is the chemical purification of the Sewage disposal.

* " Quand le territoire est envahi, nous n'avons qu'une question à poser aux municipalités—Quelles mesures avez-vous prises pour assainir votre ville? On ne fait pas l'assainissement d'une ville subitement: il y faut des années. Si la municipalité a fourni de l'eau pure; si les maisons sont propres, les déjections enlevées sans communication possible avec l'air et l'eau, nous pouvons leur dire hardiment, Vous êtes à l'abri. Pour vous les mesures que nous prenons sur la mer Rouge, dans les ports, sont des mesures inutiles. Vous êtes de roc: les germes morbides mourront sur votre sol. Pour moi, je n'hésite pas à l'affirmer, c'est là la vraie solution, c'est celle de l'avenir."

sewage by precipitation before discharging it into the tideway as described in § 71 ; and the works and arrangements necessary to carry it out are the providing—

1st. Of the precipitant, ferozone :
2nd. Of means for mixing this precipitant with the sewage :
3rd. Of precipitating-tanks or reservoirs :
4th. Of means of discharging these tanks at all states of the tide :
5th. Of means of lifting the precipitated matter, the sludge, from the tanks and conveying it to the place where it is to be treated :
6th. Of means of ultimately disposing of it as manure, or otherwise.
7th. It may, and most probably will, be necessary to lift part of the sewage from low-lying districts of the town, and if so, provision must be made for so doing.
8th. For providing most economically the steam power necessary to carry out the 4th, 5th, and 7th of the above requirements, destructors will be necessary. And
9th. The provision of fuel for the destructors involves the organization of a regular scavenging service for removing house and street refuse : (this partially exists already).

All this is done at Southampton, and, as I have shewn, is all done without costing the ratepayers anything, except the 9th provision, which belongs not to the sewage disposal but to the scavenging department, and must be done whether the refuse is utilized or not. The reason why it is done without cost at Southampton is that the manure made by mixing the sludge with the street-sweepings is so appreciated by the fruitgrowers of Jersey and Guernsey that they come 150 miles to get it. It may surely be reasonably expected that the fruitgrowers of the Derwent and Huon Valleys will be as wise in regard to their interest.

Until proper detailed plans of the city are prepared it is impossible to give particulars as to how the requirements mentioned should be carried out, or where. As far as the lifting of sewage and sludge is concerned, I have no hesitation in recommending Shone's ejectors for the purpose.

Much of what I have said above is equally applicable to Launceston, where the conditions of the river make it still more imperatively necessary to do something to clarify the sewage before discharge. It is also partly applicable to smaller towns in Tasmania. Where water-closets cannot be had I should recommend that the sanitary service should always be done as part of the public scavenging service.

House Sanitation.

154. With respect to house drainage and sanitation, I have written so fully in §§ 96 *et seq.* that I need not again enlarge upon the subjects. I may repeat my recommendation of trough closets for small tenement houses, schools, and manufactories. I would also strongly urge upon all urban sanitary authorities the necessity of having more control over house-building in their towns, such as the necessity to have their approval of the plans before a house was commenced, and their certificate of completion before it was occupied, would give them.

Scavenging and refuse removal.

155. I have also written very fully on the subject of town and house cleansing and refuse removal; it is the fundamental process of sanitation ; it may be begun at once without waiting for surveys or other preliminaries necessary to begin a system of drainage. The destructor cells I have spoken about may be placed wherever most convenient from the point of view of the collection of the refuse, and practically almost without reference to the place where the ejectors will have to be worked. When the house drains are laid the court-yards of houses should be properly paved, for yards cannot be kept clean unless they are paved ; so good scavenging presupposes good paving ; and the scavenging should extend not only to the streets but to the court-yards, where they serve more than one house, and so are, in a sense, not private yards.

Another matter to be attended to is the smoke nuisance. In towns with a hundred times the manufacturing business of Hobart no one would be allowed to send from a boiler furnace chimney the smoke that is here allowed apparently without any check.

I hope something will be done by town authorities in the way of testing the suitability and durability of our woods for street-paving purposes. I need not repeat what I have said in § 121, but I am glad to find that English surveyors will have a chance also of trying Tasmanian wood.

Special measures for disease prevention.

156. With respect to matters that come immediately under your administrative control, I trust that the information I have given in relation to special measures for preventing the outbreak and spread of disease will prove to be useful. The preventive effect of what has been done in Britain in the way of isolation, especially in isolation hospitals, and of properly organised disinfection services, has been, I hope, too clearly shewn by me to need my calling your especial attention to it. But there are two matters I wish to refer to in connexion with infectious diseases. Our service for the notification of such diseases has never worked satisfactorily—the death returns published by the Registrar-General shewing that a large number of cases occur of which we know nothing. Could we not try to improve upon this condition of things by adopting the English system of making a small payment for certificates? This has proved completely successful after nearly two years' trial. Another point connected with this question is whether consumption should not be included in the category of infectious diseases, as it is in America. The Hon. the Chief Secretary has allowed me to request the Registrar-General for the future in his Monthly Abstracts of Vital Statistics to give separate information as to the mortality from phthisis and other tuberculous

Notification.

Consumption.

diseases both for the chief towns and the country districts—a request the Registrar has kindly promised to comply with. If the tuberculous diseases are included in the diseases to be notified, I can place at the disposition of the Medical Officers of Health of the Colony the information I have as to the preventive measures adopted in the City of New York, and referred to in § 131 of this Report.

157. The other matter is in connexion with vaccination. At present the population of Tasmania is every day becoming less and less prepared to meet any epidemic of smallpox that may any day break out amongst us should the disease be introduced by either passengers or goods. If such an epidemic broke out it would naturally be most severe among our larger town populations—precisely where it is most likely to be introduced. What I would propose is to make an effort to protect them a little more by taking the greater part of the annual appropriation for the vaccination service and spending it in a special effort to induce the people of Hobart and Launceston to protect themselves and their children from smallpox by vaccination with calf lymph such as we are now procuring from New Zealand. This effort should be made on lines somewhat similar to those described in §§ 134 and 135 of this Report so far as they are suitable to our circumstances, and might include such features as the payment of mothers for loss of time in bringing their children for inspection on the eighth day for the purpose of attesting the success of the vaccination. If there be a house-to-house visitation it should not be limited to the houses of the poor. The effort might in the first place be limited to one of our chief towns. Vaccination.

Acknowledgments.

158. I have again to record my hearty thanks to Sir E. N. C. Braddon, the Agent-General of the Colony, for all his kindness and attention to me both during the Congress and afterwards.

I am also very much indebted to Mr. Middleton, the Secretary of the Engineering Section of the Congress, for much attention, and the facilities he put in my way to obtain information. Mr. Cutler, the Secretary of the Architectural Section, was also very kind in sending me copies of papers read in his Section.

I think it must be evident from the whole tenour of my report of my visits to various towns, that I was everywhere received with great kindness and consideration. Where I was not personally known, it was quite enough to say that I came from Tasmania as delegate to the Congress for me to obtain all the information I wanted, though it sometimes involved such an expenditure of time, and, I am sure, often of personal convenience, as to make me ashamed of the trouble I was giving. To the Municipal Officers, and especially to the Engineering and Sanitary Officers of Acton, Birmingham, Coventry, Croydon, Ealing, Eastbourne, Glasgow, Liverpool, Manchester, Marseilles, Paris, Rochdale, Sheffield, Southampton, and Warrington I am very grateful. I have mentioned some of their names, and to mention all would be impossible. But for the kindness of Colonel Grattan, Commanding the Army Service Corps at Aldershot; Mr. Bennett, of Southampton; Mr. C. J. Hill, the Mayor, and Mr. T. Browett, the Town Clerk, of Coventry; Dr. Tatham, of Manchester; Dr. Stopford Taylor and Mr. Percy Boulnois, of Liverpool; Dr. Russell, of Glasgow; and Dr. Ménard, of Paris, this Report would indeed have been meagre. One other honoured name I cannot add: I had the happiness to know him, and some of his best work, that at Gennevilliers, is described herein. But, with full memory of past kindness, I can now only condole with France and Sanitary Science that they have lost Alfred Durand-Claye.

159. In conclusion, I have to very heartily thank you, Mr. President and Gentlemen, and the Government of Tasmania, for the honour done me in appointing me your delegate to the Congress. While duly sensible of the honour and of the responsibility involved in the honour, I should be very ungrateful if I did not also acknowledge the very great pleasure you bestowed on me at the same time by giving me the chance of again seeing friendly old faces and well known old places. But I never lost sight of the object of my visit; and I hope to be able to fully justify your wisdom in determining upon taking advantage of so unique an opportunity for studying Sanitary Science as was afforded by the Seventh International Congress of Hygiene and Demography, and to vindicate your choice of a delegate.

I have the honour to be,

Mr. President and Gentlemen,

Your faithful Servant,

A. MAULT,

Engineering Inspector of the Central Board of Health, one of the Delegates of the Government of Tasmania to the Congress, one of the Vice-Presidents of the Engineering Section of the Congress.

Hobart, December, 1891.

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA.

APPENDIX.

THE following is a list of the Papers read and discussed at the Congress. As I have mentioned in my Report, I shall be happy to lend any one of them for perusal to any person taking an interest in the special matter to which it refers. I have done my best to group them according to their subjects, but have often found it difficult, as the boundaries between the different Sections were themselves not definite. In addition to the following Papers I have also a large number of Reports of the Medical Officers of Health and Engineers of some of the principal cities, towns, and ports of Great Britain, and Statistical and Hygienic information from New York, Denmark, Paris, and Marseilles, that I shall be also glad to lend.

Presidential Addresses.—Sir Joseph Fayrer, on Preventive Medicine ; Sir J. Lister, on Bacteriology ; Sir N. Kingscote, on the Relations of the Diseases of Animals to those of Man ; Mr. J. R. Diggle, on Infancy, Childhood, and School-life ; Sir H. Roscoe, on Chemistry and Physics in relation to Hygiene ; Sir A. Blomfield, on Architecture in relation to Hygiene ; Sir J. Coode, on Engineering in relation to Hygiene ; Lord Wantage, on Naval and Military Hygiene ; Lord Basing, on State Hygiene ; and Mr. F. Galton, on Demography.

Actinomycosis.—By Prof. Crookshank.

Air of Towns, Smoke, Weather, &c.—The Means at our disposal for Preventing the Emission of Smoke from Factories and from Dwelling-houses, by Mr. A. Fletcher — The Air of Large Towns : Methods of its Analysis, by the Manchester Field Naturalists' Society — Town Fogs and their Effects, by Dr. W. J. Russell—Fog in Relation to Health, by Dr. C. T. Williams — On the Effects of the Respiration of Carbonic Acid on Man, by Dr. W. Marcet — Meteorology in relation to Hygiene, by Dr. Buchan.

Alcoholism.—The Effects of on Public Health, by Mr. J. G. Phillips — The Relation of to Public Health, and the Methods to be adopted for its Prevention, by Prof. Westergaard.

Animals, Diseases of.—The Infectious Diseases of Animals communicable from them to Man, or *vice versâ*, by Prof. Perroncito — Veterinary Hygiene, by Prof. Smith. (See also *Anthrax, Consumption, Meat and Milk Infection, Rabies.*)

Anthrax, and its Relations to Workers in various Trades, by Prof. Chauveau — The same subject, by Mr. Duguid.

Anthropometry and Personal Identification.—The Results of Anthropometry at Cambridge, by Dr. J. Venn—Personal Identity as determined by Scars and other Body Marks, by Col. C. R. Greenleaf and Major C. Smart — Anthropometrical Method of Identification, by Dr. Bertillon — Exhibition of Finger Prints and of Registers of them as a means of Personal Identification, by Mr. F. Galton.

Army Sanitation.—The Duties of the Medical Staff with an Army engaged in Active Operations, by Brigade-Surgeon Godwin — The Food of our Soldiers, by Lieut.-Col. A. Wintle. (See also *Hospitals, Typhoid Fever.*)

Bacteriology.—The Mouth as a Source of Infection, by Prof. Miller — The Parasites of the Red Blood Corpuscles, by Prof. Celli — The Behaviour of Bacteria in the Small Intestine, by Dr. A. Macfadyen — Some Fermentations excited by Specific Micro-Organisms, by Prof. P. Frankland — On a New Pyogenic Micro-Organism, by Prof. Max Gruber — On Streptococcus Pyogenes, by Prof. Crookshank — On Bacterial Necrosis of the Liver, by Prof. Hamilton. (See also *Cancer, Consumption, Cholera, Immunity, Infection, Typhoid Fever, Vaccine, Water.*)

Blindness, Diseases of the Eye, &c.—The Prevention of Blindness due to Special Occupations, by Dr. Dvoremaal — The Education of the Blind, by Dr. Campbell — On the Acuteness of Vision of School Children, by Dr. Kotelmann — On the Importance of detecting and treating Defects of Vision, &c. in the Children of Board Schools, by Dr. Brunner.

Burial and Cremation.—On Recent Proposals relating to, and on the Importance of disinfecting all Bodies dying from Infectious Disease, with Remarks on the present system of certifying the cause of Death, by Sir H. Thompson — Burial in Earth, by Mr. F. Seymour Haden.

Cancer and Malignant Tumours, &c.—Psorospermosis as a possible Cause of Epithelial Tumours, by Dr. S. Delépine — Paget's Disease and Psorospermosis, by Dr. S. Delépine — An Exposition of Reasons for considering Cancer to be an Infective Disease, by Mr. C. Ballance and Mr. S. G. Shattock — An Investigation into the Parasitic Nature of Cancer, by Prof. Duplay and Dr. Cazin — The Geographical Distribution of Cancer, by Mr. A. Haviland.

Census.—Method of conducting the Census in Switzerland in 1888, by Dr. Milliet — Results of the Recent French Census, by M. Bouffet — Demonstration of Electric Counting Machine used in the United States Census, by A. Hollerith.

Children, Development of.—Some of the Laws which regulate the Growth of the Child, by Dr. Arbuthnot Lane — On the Hygiene of the New-born Child, by Dr. Deshayes — The Physical Condition of Children seen in Schools, and the Local Distribution of Conditions of Defective Development, by Dr. F. Warner — The Physical Condition of Pauper Children Boarded-out under the Local Government Orders of 1870 and 1889, by Miss F. Fowke.

Children, Diseases of.—Ringworm in Elementary Schools, by Mr. M. Morris — Epidemics in Schools, by Dr. C. E. Shelly — Headache in School Children, by Dr. Guye. (See also *School Life.*)

Children, Employment of.—The Laws Regulating the Employment of Children in the United States of America, by Dr. Jacobi.

Children, Insurance of.—An Objectionable Feature of some Burial Societies in their relation to Infant Life Insurance, by Mr. C. E. Paget.

Children, Neglected, and Reformatory Work among.—Neglected Children of our Towns and Cities, by Mr. W. Mitchell — The Development of the Reformatory and Industrial School System in England, by Col. L. Prendergast — The Effect of the spread of Elementary Education on Criminality in Belgium, by Prof. Kuborn — The Physical and Moral Training of Orphans, by Dr. V. Desguin — Free Dinners for School Children, by the Rev. J. Llewellyn Davies — Can Hungry and Half-clothed Children be efficiently educated? by Mrs. Besant — The need for Children's Convalescent Homes, by Fraulein Nigg. (See also *Imbeciles.*)

Cholera, in Egypt, by Dr. Sandwith — The Bacteriology of Asiatic Cholera, by Prof. Hueppe and Prof. Klein — On Cholera Asiatica, by Prof. Klein.

Climatic and Topical Influences, &c.—The Influence of the Fluctuations of Ground Water upon Health, by Mr. B. Latham — Drainage and Irrigation of Land, by Mr. R. F. Grantham — The Suitability of Tropical Highlands for European Settlement, by Surgeon-General Sir W. Moore — The same subject, by Mr. Clement Markham — The same subject, by Dr. Felkin — The Influence of Clays and Limestones on Medical Geography, illustrated by the Geographical Distribution of Cancer among Females in England and Wales, by Mr. A. Haviland — The Influence of Geology upon Health and Distribution of Disease, by Mr. W. Topley.

Consumption, Phthisis, Tuberculosis.—On the Need of Special Measures for the Prevention of Consumption, by Dr. Ransome — On the Influence of Soil on the spread of Tuberculous Disease, by Prof. Finkelnburg — The Topical Distribution of Phthisis in Havre, and the connexion of the Disease with Crowding, Alcoholism, and Poverty, by Dr. Gibert — Can Legislation assist in preventing the prevalence of Consumption? by Dr. Squire — Dr. Koch's New Methods of treating Tubercolosis, by Prof. Ehrlich — The Etiology of Tubercolosis, by Prof. B. Saunderson — The same, by Dr. Metchnikoff and Dr. Roux — On Tuberculosis, by Dr. Klein — On the alleged danger of eating apparently healthy Meat and Milk of Tuberculous Animals, by Prof. Bang — The same subject, by Prof. MacFadyen and Dr. S. Woodhead — On the Chemistry of Tuberculous Matter, by Mr. R. Wright and Herr Th. Weyl.

Deaf and Dumb, Speech, &c.—Instruction of Deaf Mutes by the London School Board, by General Moberly — The Hygiene of Speech in Children, by Dr. Gutzmann — The Detecting and Treating of Defects of Hearing in Board School Children, by Dr. Brunner.

Demography—Miscellaneous Papers.—Benefits offered to Workers by Employers, by Mr. F. Whymper — Home Work in Russia, by Madame Tkatcheff — Temporary Migration of Labour, by Mr. E. Ravenstein — Migration within France, by M. Levasseur — The Causes of Periodic Demographical Phenomena, by Prof. Földes — Statistics of Barcelona, by Sen. P. G. Faria.

Dental Disease.—Dental Caries, by Mr. H. Sewill — The Care of Teeth in Childhood, by Dr. Cunningham — Dental Reform in the Army and in the Navy, by Dr. Cunningham — Popular Instruction in Dentistry, by Dr. Cunningham — Condition of Teeth in School Children, by the British Dental Association.

Diphtheria.—Causes favouring the spread of Diphtheria, by Dr. Schrevens — Diphtheria in Minnesota, by Dr. Hewitt — Diphtheria in Massachusetts, by Dr. Abbott — Subsoil Water and Diphtheria, by Mr. M. Adams — Diphtheria in Bucharest, by Dr. Félix — Diphtheria in Havre, by Dr. Gibert — Susceptibility to Diphtheria between Old and New Residents, by Dr. Paget — The spread of Diphtheria in Europe, by Dr. Bergeron — Diphtheria and its Distribution—need of Inquiry, by Dr. E. C. Seaton — Dr. Klein on Diphtheria.

Disinfection.—(See *Infection* and *Disinfection.*)

Drainage.—(See *House Drainage.*)

Engineering Hygiene.—(See also *Sewerage, Sewage Disposal, Refuse Disposal, Water Supply.*)—Sanitation of a Mining Settlement, by A. Mault — The Heating of Towns by Steam, by Mr. S. Burroughs — Self-purification of Rivers, by Prof. P. Frankland — Municipal Engineering, by Mr. Percy Boulnois — Railway Hygiene, by Dr. L. de Csatàry.

Entozoal and Parasitic Disease.—(See also *Bacteriology*, and Diseases under their names, *Anthrax, &c.*) — Two Species of *Filaria sanguinis hominis*, by Dr. P. Manson — Entozoal Diseases in Man, by Dr. P. Sonsino — Parasites transmissible from Animal to Man, by Prof. Ralliet.

Food.—(See also *Meat* and *Milk.*)—The Antiseptic Treatment of Food, by Mr. O. Hehner — Improvements in Bread-making, by Mr. J. Goodfellow.

Hospital, Asylum, Ambulance.—The Hospital and Ambulance Arrangements for Infectious Diseases in London, by Deputy Surgeon-General Bostock and Sir V. Barrington — Maternity Hospitals, by Dr. Priestly — Dr. Koch's New Institute at Berlin, by Herr Böttger — English Isolation Hospitals, by Dr. Thorne Thorne — Isolation Hospial, Leamington, by Mr. K. Young — Hospital Tents and Huts, by Prof. Duchaussoy — Temporary Isolation Hospitals, by the Rev. C. Few — Asylum Arrangement and Construction, by Mr. G. T. Hine — The same subject, by Mr. R. Green — Cases admitted into Seamen's Hospital, Greenwich — Ambulance Organization, &c. of an English Army Corps — Advantage of Isolation Hospital in Typhus, by Dr. S. Cameron.

G. Bruce, Q.C. — Sanitary Legislation in Ontario, by Dr. Cassidy — Sanitary Work in Dublin, by Sir C. Cameron — Sanitary Registration of Buildings, by Mr. H. Rutherford — Education of Architects, by Mr. W. Seth-Smith — The Training of Sanitary Inspectors, by Dr. Reid — The Education of Plumbers, by the Plumbers' Company — The Association of Sanitary Inspectors, by the Chairman of the Association.

School Hygiene, &c.—Scientific Observation of Children in Schools, by Dr. Warner — Physical Indications of Injurious Schooling, by Dr. Sturges — Handwriting in relation to Hygiene, by Dr. Kotelmann — The same, by Mr. J. Jackson — The Working Curve of an Hour in Schools, by Prof. Burgerstein — School Hygiene in Belgium, by Prof. Kuborn — Teaching Hygiene in Schools, by Dr. Newsholme.

Sewage and its Disposal.—The Chemical Treatment of Sewage, by Dr. Dupré — The same subject, by Dr. Thresh — Utilising Sewage, by Dr. Carpenter — Hygiene and Sewage Farming, by Dr. Carpenter — Sewage Disposal in relation to Water Supply, by Prof. Robinson — Town Drainage in Italy, by Prof. Pacchiotti — French and English Systems of Sewerage, by Mr. J. Lemon — Removal of Sewage, by Mr. R. Middleton — Sewer Ventilation, by Mr. Santo Crimp — The same, by Mr. R. Read — Sewerage, by Col. Waring — The Subsoil Drainage of Towns, by Senor G. Faria — Town Drainage and Sewage Farms, by M. Bonna — The same subject, by Dr. Henriot — Treatment of Sewage with Peat, by Prof. Pagliani — Wolverhampton Sewage Works, by Mr. R. Berrington — Irrigation Farms, by Herr Markgraff.

State Action in connexion with Hygiene.—International Convention of Hygiene, by Dr. Below — State Control in administering Health Acts, by Mr. Johnson — State Investigations into Causes of Disease, by Dr. Tomkins — State Laboratories for Investigation of Disease, by Dr. Wright — State Control of Sale of Poison, by Dr. D. Thomas — Food Adulteration and International Measures for its Prevention, by Dr. van Hamel Roos — The Law relating to Noxious Gases, by Chief Inspector Fletcher — Government Intervention to prevent spread of Phthisis, by Prof. Corradi — The Contagious Disease Acts (two Papers), by Dr. Nevins — The same subject, by Dr. Holroyde.

Typhoid and Malarial Fevers.—Malaria and Enteric Fever, by Dr. Felkin — The Hæmatozoon of Malaria, by Prof. Laveran — Malaria in the Mauritius, by Dr. Anderson — Typhoid Fever in connexion with Drinking Water, by Prof. Fodor — Typhoid Bacilli in Water and Soil, by Dr. Schottelius — The Etiology of Typhoid Fever, by Prof. Arloing — Enteric Fever in the Indian Army, by Dr. Lane Notter — Enteric Fever in Campaigns, by Dr. Davies — Camp Fevers, by Dr. Squire — Typhoid Fever in the French Army, by Dr. Schneider.

Vaccine.—Bacteriology of Vaccine Lymph, by Dr. Copeland.

Water.—Bacteriological Examination of, by Prof. P. Frankland — The same, by Dr. M'Weeney — Berkefeld Water Filter, by Dr. Prochnik — Toxogenic Organisms in Water, by Dr. Vaughan — Magnesia in Water, by Prof. P. Frankland — Water Supply, by Mr. Binnie — Double System of Water Distribution, by M. Bechmann — The same, by Mr. Matthews — Distribution of Water, by M. Gaget — Revolving Purifier, by Dr. Anderson — Rapid Filtration, by Dr. Wales — Water Supply of India, by Surgeon-Major Pringle — Typhus and Filtered Water at Altona, by Herr Kummel — Water Supply of Maritime Towns, by Dr. Willoughby — Supply for France from Lake Leman, by M. Ritter — Impurities in High Pressure Mains, by Herr Oesten — Cooling Water, by Prof. Oelwein.

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