forward her paper, and said that the subject which it embraced was, in his opinion, a very important one. Referring to the bread, he said that with regard to the outer parts, he thought he should feel inclined to advise that they should always be removed, because, besides being tough, they contained a certain amount of silica, which proved extremely irritating to persons of delicate constitutions, especially to children. With regard to the other points, he said he could only cordially agree with what Miss Yates had said.

The motion was then agreed to.

Miss Yates, responding, said that what she meant to convey was that, for the majority of people, if the wheat was thoroughly cleansed from the beard, dirt, foreign seeds, &c., and ground very fine, the outer part would do. It was so much easier to get the whole grain ground fine, that, if persons could digest it, for the sake of their getting the other portions, it was better for them to do so. She thanked the Section for the vote they had passed.

SECTION II.

ENGINEERING AND ARCHITECTURE.

ADDRESS

By Prof. Henry Robinson, M.Inst.C.E.,

VICE-PRESIDENT OF THE SECTION.

An address to the section of this Congress which deals with "Engineering and Architecture," might be devoted to technical details that would only interest experts. It is however thought that the objects which the Sanitary Institute of Great Britain have in view will probably be better served if some of the broad principles that govern the question of house sanitation, water supply, and sewage disposal, be touched upon with the view of recording the points on which there is a general agreement, and of indicating where changes are called for.

There will be no attempt to introduce novel ideas, as existing data afford ample opportunities for the skill and energy of engineers and architects. To those non-professionals who may hear or read these remarks, it is suggested that they, too, should require nothing novel to attract their attention, as it is considered that the reference to a few facts as to what is occurring every day will afford sufficient food for thought.

The Institute aims not merely at the advancement of technical sanitary knowledge by promoting collections of useful appliances such as those which are brought together in this town, but it also desires either to create or to increase an interest in the public mind with reference to matters affecting health, and thus to secure sympathy and co-operation far and wide.

The work of any institution like this naturally commends itself to the public mind, as it is helping to carry on the great work of sanitary improvement which has already accomplished so much in the direction of diminishing the death rate in the kingdom, and of reforming sanitary evils where they existed.

Some of the pioneers of sanitary science who are still in our midst can testify to the glaring abuses which have been battled with and overcome. To realise this it is only necessary to refer to the Local Government Board Report for 1880-81. This shows that there had been a diminution of 4½ per cent. in the death rate of England and Wales during the last decade, and states:—"It may therefore be roughly estimated that about a quarter of a million of persons were saved from death who would have died if the death-rate had been the same as in the previous thirty years." Further, that "more than three-quarters of this reduction of deaths comes under the head of the seven zymotic diseases, that is to say, of the diseases which are most influenced by sanitary improvements. Of the three quarters just half is in fever, the decrease of which more than any other shows itself in connection with such faults of drainage, of water supply, and of filth accumulation which it is within the province of good sanitary administration to remove."

The Lord Provost of Glasgow, in a speech made at the Institution this year, pointed out the great improvement that had been effected in the health of that town since it had received the blessings of a good water supply, better drainage, and the vigorous enforcement of bye-laws against overcrowding, &c. He stated that the death-rate in that town from 1851 to 1860 was on an average 33 in the 1,000, from 1861 to 1870 it was 30 in the 1,000, and from 1871 to 1880 it was still further reduced to 27 in the 1,000. The saving of life indicated by these figures should impel those administering the sanitary affairs of any town having a high death-rate to set seriously about the improvements which are obviously necessary.

Engineers and architects may agree on right principles, and may devise skilful means for carrying them out, but their field of labour will depend entirely on the appreciation by the masses of the requirements of health. There is less difficulty in getting people to see the necessity for new roads or railways, and to find the money for them, than to find money to make their homes healthy.

In referring to subjects which seem suitable to this section it will be difficult to avoid saying that which must be already known to many. There are, however some truths and facts which bear repetition, and require to be reiterated to force them home to the minds of the mass of the outside public, whose opinion has to be formed and brought to bear on the defects which still have to be dealt with if the proper standard of excellence is to be attained in matters affecting the lives and the health of the community.

House Sanitation.—Captain Galton fully describes in his book on "Healthy Dwellings," the rules which require to be observed in selecting a site for a house and in regard to its internal arrangements. Those who have to deal with house construction and sanitation *de novo* have abundant data to guide them in obtaining the essentials of light, warmth, ventilation, and the like, as well as the conditions affecting materials and details of construction. It should not be considered that arrangements of house drains, waste pipes, &c., are undeserving of the closest attention on the part of the designer of a house, however much they may require a train of thought very different to that involved in dealing with questions of architectural design or of decorative effect.

It is no exaggeration to state that not one quarter of the dwellings of all classes, high or low, rich or poor, are free from dangers to health due to defects with respect to drainage, water, or ventilation which were capable of being easily avoided at the outset. The existence of sanitary defects is not always revealed in a startling manner by results which attract such serious attention as to ensure rectification, as is the case where illness breaks out of a character clearly attributable to bad drainage or water supply. Nevertheless, these original defects will inevitably entail a loss of health and energy to the occupants of the houses, and this may go on for years working insidiously but with deadly effect.

The public are now more alive than they were to the necessity for enquiry into these matters, and consequently sanitary authorities (who cannot go much ahead of public opinion) are better able to enforce regulations, and are more willing to bear the expense of doing so.

To ensure healthy homes local authorities should have bye-laws requiring compliance with general rules which are now well known and hardly require to be specified.

A summary of them may, however, be given for the guidance of those who are not experts.

House drains should be trapped from the main sewer, and should, where possible, be laid outside and not under a house. No connection with a drain should under any circumstances be made inside a house without an efficient trap.

Sinks should discharge outside the house on to the surface of a trapped gulley on the ground level, having a grating communicating directly with the air.

Overflow and waste pipes from cisterns, tanks, lavatories, baths, &c., should not be carried directly into a drain, soil pipe, or water closet trap. A separate cistern for water closets should be provided from that supplying drinking water.

Rain-water pipes, where in proximity to windows, should be cut off from direct communication with the drain.

Soil pipes should, where practicable, be carried outside houses, and should be continued above the roof (but clear of windows) for ventilation.

The connection between soil pipes and drains should be by a curved pipe to prevent lodgements taking place.

The excellent model bye-laws prepared by the Local Government Board afford the necessary data to guide sanitary authorities. They have effected already much good, and a similar code should be in universal operation.

The Metropolis Local Management Act of 1855, as regards the London vestries, and the Public Health Act of 1875, as regards other sanitary authorities, impose on those bodies the responsibility of seeing that the houses are in a sanitary condition. Clauses 73 to 81 of the Metropolitan Act state the essential conditions to be observed in house construction; clauses 82, 83, and 84 give the vestries power to ascertain that these are complied with. The bye-laws issued by other sanitary authorities, and sanctioned by the Local Government Board, have the same object in view. In their operation, however, they are practically applied to buildings which are proposed to be erected, or in some cases to alterations in existing ones.

It is obvious, however, that the condition of the drains, soil pipes, ventilation, &c., of the old houses should also be the subject of investigation. But it is not until the attention of the Medical Officer of Health is arrested by the occurrence of fever, or other form of illness, that their condition is enquired into at all, although they might have been in so insanitary a state as to be unfit for habitation.

The conversion of unhealthy old dwellings (which form so large a proportion of the houses in large towns in this country) into healthy ones, is a task which without reference to bye-laws presents no attractions from an architectural point of view, but has nevertheless to be undertaken by those who are best fitted from their position and influence to deal with the subject.

These observations apply with the greatest force to the houses of the poorer classes, who have not the opportunities of exercising any critical supervision of their own. As regards the houses of the better classes, the same remarks apply to an extent greater than should be the case, considering the irretrievable mischief consequent on treating these matters apathetically.

In order to arrest attention to the condition of houses, and to expose their unhealthy state, the following plan is suggested:

It should be compulsory on the part of medical men, or of the occupier after notification by the medical man, to return to the Officer of Health for the district any case of illness of the classes agreed on as arising from sewer gas, infected water, and the like. This notice should be accompanied by particulars of the house in which the illness occurred, and whether it was an imported case, or originated in the house. It should then be the duty of the Sanitary Authority to have affixed to a plan of the district a coloured wafer or dot corresponding with each disease. This plan should be open to public inspection, as well as any reports explanatory of each case. The effect of this would be that a house, or group of houses, in which filth diseases occurred would be revealed at once to the eye of an intending occupier by the array of wafers, warning the unwary against the danger they are running. Such a visible registration of preventible diseases would reveal where the old houses had been allowed to remain in their original insanitary state. It would also serve as a further safeguard against jerry building, so that a dishonest builder, who had evaded the local Bye-Laws, and escaped detection at the hands of those whose duty it was to see the work carried out as it was approved, would be exposed, and penalties enforced against him.

This proposed visible registration of disease was suggested by Mr. J. W. Batten (Barrister-at-Law) at Plymouth some years ago. He pointed out, after the reading of a paper on "Wreck Charts," that the fever dens and houses in Plymouth, which were unfit for habitation, might be regarded as places in a town where human life was wrecked, and as much required to be indicated in a visible manner as a rock or shoal at sea did.

This suggested registration of disease by maps appears to be in operation in Newcastle. In the *Lancet* of the 16th of this month, it is stated that a map "records, by dots of different colours, all the cases of scarlet fever, enteric fever, typhus, small-pox, and whooping cough, according to the locality in which they are reported." It is further stated that all such cases are voluntarily notified to the Officer of Health. Dr. Armstrong deserves well of all sanitarians for having introduced this system.

A means of compelling enquiry into fatal cases of typhoid and enteric fevers, and similar diseases arising from preventible causes, would be to require an inquest to be held, at which evidence would be elicited which would point to the cause of the disease, and the necessary steps to remedy the mischief would follow.

An illustration of this is afforded by a case reported in the *St. James's Gazette* of the 20th, as follows:—An inquest was held yesterday by Dr. Danford Thomas on the body of a

woman—the wife of a gasfitter—who died in the Middlesex Hospital, according to the verdict of the jury, from blood-poisoning. The drainage of the house in which the deceased woman and her husband lodged, in Ann Street, Soho, was, it was stated, defective, and the illness from which she died was, there could be little doubt, caused by the polluted atmosphere she inhaled. "Defective drainage," said a medical witness, "brings on diptheria in some, pyæmia in others." A notice to the sanitary authorities of the parish was agreed to by the jury; and the case will, it is hoped, lead to a thorough examination of the drainage of other houses in the district. It is painful to know that, after all that has been done of late years in the way of sanitary improvements, persons still die almost daily, poisoned by the drains that should save life, and not destroy it.

On the efficient way in which the plumbing and sanitary work in a house is executed depends, to a large extent, whether a house is healthy or not. Experience proves continually that much of this work is done by incompetent or careless people, and requires subsequent rectification, probably after illness has caused an investigation to be made. In America, legislation has aimed at correcting this evil by making it a penal offence for plumbing work to be badly carried out.

The necessity for vigilance on the part of local authorities over buildings of a certain class cannot be better brought home to the public mind than by quoting from one of the reports of Colonel Frank Bolton, the water examiner of the metropolis, who states, "Now, as heretofore, it appears to be the rule in building a certain class of houses to place the cistern over the water-closet, with an untrapped waste-pipe communicating with the drains. These cisterns are often open, and regularly receive the drippings from the roofs and gutters; they are, moreover, in close proximity to the dust-bins and other deposits of filth and garbage, while children amuse themselves by throwing all sorts of dirty rubbish into the water, including dead puppies and kittens, with an occasional cat."

When a house is let by a landlord it would be presumably fit for habitation. There can be no doubt that equitably this condition ought to apply both to furnished and unfurnished houses. It is assumed by anyone either purchasing or hiring a house that it is habitable, and is in a proper sanitary condition. A recent trial, however, led to an exposition of the law by Mr. Justice Watkin Williams. He explained that it is only furnished houses to which, without a special covenant, there is an implied warranty of healthiness; so that, if a house is let unfurnished, the occupier cannot cancel his tenancy if he finds it in a bad state. The remedy is for an intending purchaser or occupier of a house to require a certificate that certain stipulated conditions have been fulfilled. This would render it necessary for the landlord or vendor to ascertain (what is only equitable that he should) that the house is fit for habitation before he derives any benefit from his property in it.

Similar certificates should be required for all new houses, and no one should be allowed to let or sell a new house until the local authority had given a certificate. This would involve more inspection and a larger staff than now exists, but the cost of this might fairly be borne chiefly by the builders, who should pay according to a sliding scale. The cost should not fall wholly on the rates. This plan is now in successful operation in several towns, and heavy penalties are imposed where a house is allowed to be inhabited without a certificate. The cost of the increased staff, no doubt, will be thought an objection, were it to be charged on the rates, especially in a town where, as frequently happens, the members of the governing body for the time being prefer a low rate to such safeguards as those indicated.

Those who have to struggle against either the ignorance or indifference of the public as to the sanitary safety of their dwellings, or who are striving to frustrate the machinations of jerry builders, will concur in the desirability for some further legislation in the direction suggested with reference to the detection, registration, or avoidance of preventible disease.

In dealing with cases of supposed defects in the drainage, or other sanitary arrangements of a house, the first difficulty is to ascertain what has already been done. It too frequently happens that the records only show what was proposed to be done, and sometimes not even that, with respect to matters of real importance. This is avoidable, and it is necessary to impress on all who are either engaged in constructing new houses, or altering old ones, to preserve a careful and intelligent record of the arrangements which have been carried out by them.

At the Annual Conference on the Progress of Public Health, which was held at the Society of Arts in 1880, this point was referred to by Mr. Stansfield, who spoke with the experience derived from his previous position as President of the Local Government Board. He said: "I, as owner or occupier, or any person who purposes to buy, want to know whether a house is healthy; some inconvenience occurs, some evidence of its imperfection and unhealthiness, and I want to find out what it is. I ought to be able to go to the local authority, and say, it is your function and your duty to look after the healthworthiness of this house. You compel me to drain into your sewers, and you are bound to future occupants of the house to show

them, by plans, the nature of the connection between the drains and the sewers."

Pail System.—It should be regarded now as settled with reference to the removal of excreta, that the water-carriage system is the proper one to aim at adopting. The pail or tub system has still its advocates whose opinions prevail occasionally, and lead to its use. It should, however, be confined to the few exceptional cases where small groups of houses cannot be connected with a sewerage system.

Arrangements for dealing with the excreta from a house other than by drains, is considered by sanitarians to be a mistaken principle, inasmuch as it does not dispense with a sewerage system for the removal of other than domestic filth.

The pail system has no doubt been introduced with advantage into places where the previous state of affairs was the old privy, or the fixed midden systems. As either of these involved the certainty of the refuse being kept for a longer time than is consistent with sanitary rules, a moveable receptacle is an improvement.

Arrangements for the retention of fœcal matter in a house, whether for a long or short time, are objectionable on sanitary and sentimental grounds. On sanitary grounds if it is kept for a long time, and on sentimental grounds as regards its visible removal.

It should, however, now be regarded as beyond controversy, that a water-carriage system of sewerage has to be eventually introduced into every town, and that whatever measures have to be resorted to from local or other causes, they should only be regarded as temporary.

Mr. Rawlinson, C.B., C.E., when referring to the pail system in the Blue Book of 1875, properly described it as an "expedient."

The circumstances under which the employment of the pail system would be justified are well stated in the report of Dr. Netten Radcliffe to the Local Government Board in 1875.

Separate System.—It is a matter of great importance where sewage has to be pumped or purified in some way at the outfall, that the bulk of the surface water should be excluded from the sewers. Natural channels or water courses could be utilized to receive surface water in cases where they would not be allowed to take sewage. The volume to be conveyed to the outfall would be reduced to a more constant quantity, enabling the sewers to be smaller than is possible where they have to receive large and sudden volumes of rain-water. The difficulties of pumping and purifying would be also reduced.

The local authority is required, under sec. 15 of the Public Health Act, to provide sewers (sewer being defined to include "sewers and drains of every description,") which will effectually deal with both the sewage and the surface water that arises in or finds its way naturally into their district.

Just as the local authority is bound to provide sewers sufficient to take sewage proper and also surface water, so on the other hand the owner or occupier has a right, under sec. 21, to carry surface water as well as domestic sewage into the sewer.

Under Section 21 of the Act, the householder has the right to drain his premises into the public sewer, subject only to the method of connection being approved. The premises are so defined by the Act as to include, with the building, the land, and easements appertaining to it. The sanitary authority has no power to compel the observance of any bye-law which they might pass at variance with this, as bye-laws and regulations are intended to further the purposes of the Act, and not to restrict or get rid of them.

If, however, the local authority adopted a duplicate system of sewers, one for sewage proper and one for surface water, it appeared that it had no legal right to put in force a bye-law compelling the owner or occupier to separate the surface water from the sewage.

It is thought that such a practical difficulty should be remedied by giving the local authority power to compel the surface water to be carried into channels specially provided for that purpose, and thus enable the separate system to be put in force where it was advised to be carried out. The surface water thus excluded must not be too polluted, as is the case with road water in large towns.

Sewerage.—As the object to be accomplished in a system of house drains is to effect the immediate removal of the fluid refuse from the house, at the same time sewer gas is, by effectual trapping, prevented from coming into it from the main sewer, so that which has to be accomplished in a system of sewerage is to continue the prompt removal of the fluid refuse away to the outfall.

Certain rules require to be rigidly adhered to in sewerage works, and admit of no dispute. Amongst others, straight lines between lamp-holes, or man-holes, or at changes of gradients, are imperative. Without provision for inspection, no sewerage works are properly designed, and sewers cannot be efficiently inspected, and obstructions removed, if the above rule is departed from, unless the sewers are large enough for a man to walk through.

Abundant flushing and ventilation are essentials. In some cases ventilation of the main sewer has been accomplished by carrying pipes up adjoining houses, or up the public lamps, or by furnaces and stacks. The thorough flushing and ventilation of the public sewer, like the perfect flushing and ventilation of the private house drain and soil pipe, are of the first importance. Even where a sewerage system is well devised as regards gradients and natural or artificial flushing, frequent ventilators are necessary for the escape of sewer gas, the increasing and diminishing flow at different times of the day acting with a pulsation which causes natural ventilation. Where, however (and this applies unfortunately to a large number of cases), the sewerage system has not the merit of being self-cleansing, and collections of dangerous matter can arise, artificial flushing is required, and ventilation ought not to be confined to the usual openings from the sewer to the surface, but artificial means must be adopted. It has been suggested, that it should be compulsory, in building new houses, to construct a shaft, not less than six inches in diameter, from the house drains up to the roofs of all houses, and to ventilate the public sewer through the private house drain and soil pipe. There would appear, however, to be an objection to this. To ventilate the main sewer through shafts forming part of the structure of a dwelling would involve the danger of sewer gas passing into and around the house through the brickwork itself, either by percolation or by means of cracks, or in consequence of alterations. It is considered to be desirable to treat the ventilation of the main sewer as having to be accomplished independently of the ventilation of the house drains.

Sewage Disposal.—Having dwelt on the means whereby fluid refuse is best removed by a system of sewerage, it is desirable to refer to the important and difficult question of how it is to be disposed of. No general rule can be said to apply, and each case must be dealt with according to the conditions which govern it. Considerable advance, however, has been made in the last few years in the direction of reducing the difficulties which hitherto existed within a much smaller compass. It is agreed that the fertilizing properties of sewage should not be wasted if they can be utilized at a profit. Suitable land of sufficient area offers the natural means for this purpose. It is, however, often impossible to find it at a reasonable distance for an outfall, in which case an alternative has to be resorted to.

The question should be regarded as a combination of sanitary and agricultural interests, the first being paramount, and if the second be incompatible with the first it must be disregarded.

Time does not permit of the various means whereby sewage can be dealt with and purified, with or without the utilization of its manurial properties, being considered; but reference will be made to some recent experiences and opinions in regard to the application of sewage to land.

In a valuable paper read this year before the Society of Arts by Mr. Warrington, on "Nitrification," the question of the purification of sewage by filtration through the soil was entered into. The production of nitrates in the soil is known by chemists to be due to a process of oxidation, and it is found that nitrification in the soil is caused by the action of a living ferment of the bacteria family, and that sewage itself will supply the substances required for the nourishment of the oxidising organisms. Also, that sewage containing the organisms necessary for the destruction of its organic impurities only requires to be applied to a filtering medium, favourable as to composition and as to intermittency of action, to ensure the fermentation being carried on to completion. The double result follows, namely, of purifying the sewage and of depositing the nitrates thus produced in the soil for the purposes of vegetation, nitrates being the form in which nitrogen is chiefly assimilated by plants.

It was pointed out in this paper that the purifying action of soil on sewage was due to—1. Simple filtration or removal of suspended matter. 2. The precipitation and retention by the soil of ammonia and various organic substances previously in solution. 3. The oxidation of ammonia and of organic matter by the agency of living organisms.

After describing the interesting chemical actions which take place, it was shown that it would be possible to construct a filter bed having a greater oxidising power than would be possessed by ordinary soil and subsoil, and that such a filter bed could be formed by "laying over a system of drain pipes a few feet of soil obtained from the surface (first six inches) of a good field, the soil being selected as one porous and containing a considerable amount both of carbonate of calcium and organic matter." A filter bed of this kind was considered to be far more porous than a natural soil and subsoil, and would possess active oxidising functions throughout its whole depth.

As the presence of antiseptics was found to interfere with this fermentation, it follows that refuse from chemical works would hinder the purification of sewage by the soil.

An artificial filter has been made at the Merton Sewage Works by Mr. Latham. Here a dense clay was met with, which was dug out over an acre and burnt into ballast. A filter bed was formed to a depth of five feet by alternate layers of ballast

with six inches of surface earth, and this filter is stated to be purifying the sewage of about 14,000 people. It was calculated that, allowing for the necessary rest, a similar filter over ten acres would suffice for the population for the whole year.

Dr. Lawes and Dr. Gilbert have long pursued investigations at Rothampstead as to the chemical changes that take place in the soil under varying circumstances, and have published much valuable information. Dr. Angus Smith, one of the inspectors under the Rivers Pollution Prevention Act, 1876, in his report to the Local Government Board this year gives a great mass of valuable information relating to the chemical investigations he has for years been making, and amongst them are data as to the action of air on sewage, and to the mode of treating sewage so as to hasten aeration. Dr. Smith in the same report, as well as in his previous report of 1879, refers in detail also to the treatment of sewage by chemicals. These accumulated experiences are now available for the guidance of engineers in disposing of sewage.

In addition to the valuable practical results deducible from Mr. Warington's experiments another series of observations deserves to be referred to as of use to the engineer engaged in sewage disposal.

Dr. Walker and Mr. McKie conducted a series of experiments in Carlisle in 1881 on the purifying effect of soil when used under the same conditions as exist in nature. Full details of these experiments were published this year in my book on "Sewage Disposal."* The conclusions arrived at were that land of the kind experimented on at Carlisle, which consisted of loamy earth, overlying sandy subsoil, well drained, might purify the sewage of about 500 people per acre without regard to agricultural results. A table in the same book shows that an average of 19 towns where broad irrigation was practised gave 137 people to the acre.

With reference to chemical treatment or precipitation of sewage, the knowledge which has been gained is being applied quietly, and free from the strong influences which prevailed a few years ago when irrigationists and precipitationists were in constant conflict to the confusion of those who had to advise local authorities in disposing of sewage. Experience now proves that where chemicals are required in aid of filtration the simplest are the best, and these can be obtained in the open market without resorting to patented systems of any kind. The rule to observe is to employ chemicals that produce the minimum bulk of sludge. This admits of being the more readily

* Robinson on "Sewage Disposal." Spon, London.

disposed of either by drying by exposure to the air or in filter presses.

Those who have to advise in regard to sewage disposal should avoid being identified with any system, thus preserving an impartial position which will enable them to deal with the circumstances of each case free from prejudices.

The practical aspect of the sewage question is now most favourable for engineers to deal with the sewage of a town. Where land can be obtained of the necesary area and quality the original views of irrigationists can be carried out by the utilization of the manurial properties of sewage on a large area. Where it is not possible to obtain a large area, or where the land is clayey and not suitable for filtration, it need no longer be assumed that chemical treatment must necessarily be resorted to, although in some cases it is desirable. A small area of land can be converted, as already described, into an artificial filter capable of purifying large volumes of sewage without chemical treatment.

As the various difficulties which existed a few years ago in regard to the purification of sewage have now been diminished by the further knowledge that has been gained, it may be reasonably expected that the Rivers Pollution Prevention Act of 1876 will be made more operative than has hitherto been the case. If sewage continues to be discharged into a stream without the "best practical and available means" required by the Act having been employed to render the sewage harmless, it is not for want of clear data to show how it can be purified, as the issues that have to be decided are now very much narrowed.

Water Supply.—With respect to the rules which govern the selection of a source of water supply for a town, it sometimes occurs that chemical analyses of samples of water are relied on solely as furnishing all the data necessary. Chemical analyses, however, without observance of the condition of things surrounding the point from which the sample of water was taken, do not suffice. This is specially the case where the sample is taken from a river which is liable to contamination by animal organic matter, or from a shallow well which is supplied by surface water, without the necessary depth of filtering and oxydizing strata intervening to remove impurities.

Chemical analyses cannot detect pollution due to infected animal matter, neither does an analysis enable a distinction to be made between nitrogen in the water as organic compounds of a dangerous kind, and nitrogen in the form of harmless inorganic salts of ammonia, nitrous or nitric acids.

The way to ensure perfect safety in a source of water supply would of course be to exclude waters which cannot be considered as theoretically free from the possibility of pollution. This is advocated by some, but it would necessitate giving up all river water, except that at the fountain head, and adopting subterranean water. The heavy cost involved in obtaining this perfect supply would lead to a restricted use of water, with the consequent insanitary results that would follow from such restriction.

The water supply for the metropolis is mainly from the Thames, which is a river certainly not free from sewage pollution, even at the points of intake. Yet it is well known that the districts consuming it, in its filtered form, are as healthy as those adjoining which consume deep spring water.

By exercising careful judgment, and with a full knowledge of the conditions requiring observance, an engineer can select a source which will satisfy the reasonable requirements of the case.

A constant supply is essential for sanitary reasons. The evils resulting from an intermittent supply are many. For instance, it involves storing the water and the risk of the receptacles being polluted, even in the houses of the better classes, much more so in those of the poor. This cannot better be illustrated than by quoting from one of the official reports of Colonel Frank Bolton, the water examiner for the metropolis. He states, in speaking of these receptacles, that "many of the cisterns, tanks, and butts for containing water in small basement houses in the metropolis are in a disgusting and filthy state. Cisterns may be seen without lids, and with portions of rotten lids floating in the water, full of rank and decaying vegetation, and other most objectionable substances, such as old rags and paper; and, in closer examination, the contents show more or less organic deposit, and under the microscope would be found to abound in infusorial life."

The different terms in which analyses of water are rendered by chemists is the cause of inconvenience to engineers engaged in cases of water supply, and it is very desirable that a better agreement should exist by which impurities in water were returned under precisely similar headings, so that engineers had not to work out a comparison between an analysis of water which is in terms of "albuminoid ammonia," and one in which the impurities are returned as "nitrogen in the form of nitrates and nitrites."

Further Legislation.—Further legislation on certain matters is necessary to meet altered circumstances, or to enable the experience which has been gained to be put into operation.

The arrangement of sanitary districts, according to the old Poor Law divisions, requires modification.

The distinction between urban and rural districts in regard to the power to make bye-laws regulating buildings and streets or roads is anomalous, inasmuch as many districts that were rural at the time the Public Health Act was passed have so changed by the increase in population, and its congregation in large groups, as to have become urban in parts of it, and to require the same bye-laws as urban authorities have.

According, however, to existing legislation there is no power on the part of rural authorities to make bye-laws regulating buildings, streets, or roads, even where the conditions of population are similar to those which obtain in urban districts.

Manufactories in some cases have been erected outside urban districts in order to avoid the borough and general rates. These works lead to houses being built around them without, however, being under sanitary supervision.

The establishment of a county authority over areas capable of being combined conveniently owing to their physical features, appears to be a subject for future legislation. This authority (which it has been suggested, might consist of the chairman of each local board in the county), should have power to dispose of many matters of detail which now occupy the time and attention of the authorities at Whitehall.

It has already been pointed out in speaking of the separate system, that a modification of the Act is needed to enable the surface water of premises to be excluded from the sewer where the sanitary authority requires it to be done after providing a separate sewer.

It is desirable that a heavy penalty should be imposed by law where a house was let or sold when in an insanitary condition. Parliament has made it an offence to sell food which is unfit for consumption and a danger to health. It should be made an offence to sell or let a house which is equally a danger to health.

What is required is that existing anomalies and ambiguities in legislation be removed. (The Police and Sanitary Committee, presided over by Mr. Sclater-Booth this session, accomplished useful work in the direction of maintaining uniformity of bye-laws.) That compulsory powers should be substituted for permissive in every matter connected with the department of health. That a central local authority should have power to deal with matters concerning the group of local authorities in its county. And (as has been often urged) that a Department of Health, with a permanent chief, might be created.

Conclusion.—The training of those who are appointed to positions such as Surveyors to Local Boards and Inspectors of Nuisances, requires careful attention. Their duties are important ones, and good or bad results follow the efficient or inefficient discharge of them. Men filling positions of this kind ought to be required to comply with some test, or to pass some examination. They should also be more independent than they are of the influence of members of the authority whom they have to serve, and this can only be effected by making their appointment incapable of being cancelled without the consent of the higher authorities. On the conscientious and efficient discharge of their duty by those who have to carry out sanitary work, depends the health and welfare of the community, and a negligent or incompetent person can produce enormous mischief. This responsibility, whilst entailing a corresponding anxiety to those engaged, is accompanied by the knowledge that their work is one which, if well done, results in diminishing the death-rate and improving the health of those in whose midst they are called upon to devote their energies.

Captain Douglas Galton, C.B., said he was sure they would all agree with him that a most hearty vote of thanks should be given to Professor Robinson for the very able and practical address he had given to those assembled. He quite coincided with the view which Professor Robinson had enunciated at the end of his address—that they should, as far as possible, make their sanitary improvements depend upon local and not upon centralized action. He had long felt that they had solved many problems which related to the larger questions of sanitation, but there still remained a very great deal to be done in the way of the sanitation of their houses. No doubt they had the Artizans' and Labourers' Dwellings Act, which enabled the worst tenements to be pulled down, but there remained still an immense number of houses which could not be touched under that Act. Of course, it was very difficult to interfere in the case of every individual house, but he had always thought that if new houses, both in the town and the country, were subject to the approval of some local authority, so that no new house should be built unless it satisfied sanitary requirements, they would make a very rapid increase in the number of their healthy dwellings. As bearing upon this question, and the importance of improving the dwellings of artizans and other labouring classes, he would mention that a letter had just been put into his hands, addressed to the Mayor of Newcastle, and the President and Members of the Sanitary Congress, and which came from a person signing himself as one from the lower ranks, a Yorkshireman living in London. He would read the letter, which was as follows:—

"Honoured Sir and Gentlemen.—Permit me, as one in the lower ranks, and a Yorkshireman by birth (Clifford-cum-Boston), who for over a quarter of a century has been associated with the lower strata of society in the Metropolis of England, and so privy to some of the trials and sufferings that class endure, to state that notwithstanding the great improvements made in their places of abode from a sanitary point of view, having special regard to air and drainage, yet to this day, and even in the most recently erected houses, within four miles radius of Whitehall, London, we have thousands of dwellings to which water is conveyed in a pure state into the iron cistern and therein polluted by the foul air arising from the W.C. through the pipe from the cistern. Two years ago, I occupied the front parlour of one of ten cottages belonging to one landlord, and situated in Ebenezer Place, Camberwell Road, London, S.E., when three children in the cottage were taken ill. Having a desire to know the nature of the complaint, and, if possible, the cause which led to it, I made inquiries, and Mr. Norman Elliott, the medical man of Denmark Hill, certified to the fact that their illness arose from the poisoned water they drank, combined with the bad drainage. Thus certified, I represented the matter to the Sanitary Inspector of St. Giles' parish, Camberwell, who paid an early visit to the premises. The result was that the landlord had early notice given him to remove the causes by good drainage and unpolluted water, and these were thus secured to ten dwellings. My chief object in giving you a case in point is, that you will be pleased to consider and formally recommend a medium of action to be taken, legislative or otherwise, to accomplish the object. I remain, honoured sir and gentlemen, Isaac Clifford Wood, artizan, 31, Hollydale Road, Queen's Road, Peckham, London, S.E."

That, said Captain Galton, only illustrated very clearly what Prof. Robinson had told them about the pollution of water in cisterns, and it was also very strong evidence of the great necessity for enforcing, as far as possible, a constant water supply in dwellings, especially those occupied by the poor.

Mr. E. C. Robins, F.S.A., said he had very great pleasure in seconding the motion for a vote of thanks, for Professor Robinson had gone into his subject in an extremely practical manner, and the speaker thought that the headings of the subjects sufficiently indicated the extreme value of the paper. It would take up a very long time to discuss all the topics of such a comprehensive paper as this, which in the case of a President's address was unusual, but he was sure they would all agree that the whole subject had been reviewed in an eminently instructive manner. One of the most important parts of the paper was that which dealt with suggestions for the improvement of the law. The whole system of sewers, there was no doubt, must eventually be re-organised. He had great pleasure in seconding the motion.

The motion was then put and carried unanimously.

Professor H. Robinson, C.E., said he was very pleased at the attention with which his Address had been listened to, and at the way in which the vote of thanks had been proposed and passed. The trouble it had given him to compile the Address would be abundantly compensated for.

"*On the Desirability or otherwise of providing Town and Country Houses with Grease-intercepting Chambers to Scullery Sinks*," *by* W. Eassie, C.E., F.L.S., F.G.S.

A subject of some considerable controversy among practising sanitary engineers is the treatment of grease and fat in water-borne sewage between the scullery sink and the outfall into the sewer. For grease makes a law unto itself, and this law is interpreted in several ways.

It must be at once conceded that fatty matter will congeal and become solidified, rising to the top of the water, and that it will sometimes reach the sewer, especially when the underground house drain has a great fall. But on the other hand, it must be admitted that it will not *always* reach the outfall, even with a reasonably ample fall, and that it has a tendency when cool to adhere to the inside of the traps, and to the sides of the drain, in some cases eventually stopping them up. I thought that perhaps a few remarks upon the subject might interest some members of the Section.

It is supposed by many that there is no necessity whatever for any special treatment of the grease which is sent into the house drain from the scullery or kitchen sink, and this is made a hard and fast rule. This might be taken as correct were the house to be treated a cottage or small villa, with but a few inmates, say eight or ten in number, because the quantity of produced fats in cookery and washed-off grease from pans and plates would be inconsiderable, and a liberty might be taken in supposing that the bulk of the grease would reach the sewer, and that it would ride safely in globules to the sewer on the surface of the flushing water. But the case is varied, and a new issue joined, when the house to be dealt with might, by courtesy, be termed a *mansion*, and when some ten or a dozen of the family, and a retinue of servants—steward, butler, and under butler, housekeeper, footmen, cook, scullery maids, still-room

maid, house maids, and odd men—are all in residence. The grease introduced into the drain under these conditions is, to say the least of it, enormous; and its passage into the house drain is facilitated by a plethora of hot water, and by careless or thoughtless scullery maids who will not take the trouble to scrape off any superlying grease from the interior of the pans before cleansing them for next usage.

Given a six inch, well laid, drain pipe, with a clear outgo inside, free from obstructions due to unequal collaring, and even smooth as salt glaze or glass glaze will make it, is it to be supposed that because such a drain will work well in a small house that it is certain to do so with a residence of any size—an hotel, or club, and the like? I venture to think not, and the difficulty is in no way obviated by enlarging the size of the drain; indeed it is then very often increased, because there is more surface for the grease to cling to when the wetted perimeter of the pipe is enhanced during a sudden flushing of the drain, intentionally or during a storm.

In any residences where such a number of persons reside that neither the word cottage or even villa will apply to designate them perfectly, the quantity of sand used in the scullery for cleansing and scouring the copper and iron pots and pans is enormous, and sand being so cheap a commodity, I question whether any one has fully taken into account the cubic feet of this material which must descend into the drain during a single month, when the residence is in full swing, with added guests, and the servants of the visitors to swell the number.

I do not think for a moment that any amount of fall in the drain or flushing power from the scullery taps would suffice to scour out all this sand to the drain. At least, I have never fairly yet met with an instance where, in a large establishment, the sand did not cause a stoppage in the drain, when no interceptor had been provided. The sand might be dispatched to the sewer, were it sand pure and simple, but it has now become clogged with fat, sticky, and almost irremoveable in consequence.

If, in all cases, the scullery sink were near to the outfall into the sewer, for instance close to the front area, and a properly built disconnection chamber, one might perhaps venture, even in a large establishment, to rely upon the fat-laden water being driven to the sewer. But unfortunately in the bulk of houses, and in large mansions especially, the scullery sink is situated at the far end of the premises, sometimes a hundred feet or more away from the flap in the sewer. And if it be a risk to take when the house is a small one, the family few, and the drain a short one, with a splendid fall, that every particle of

grease shall reach the sewer, what shall be said when the drain is a very long one, the gradient bad and cannot be improved, and the residents at a palatial figure? Surely here some provision must be made for grease interception, plus the sand factor.

It may appear that this is simply slaying a dead lion. But this cannot be so characterized, because some engineers of note say that they never yet saw any necessity for grease interception, and, therefore, never provide for it. All I will venture to say on this head is, that were they to revisit their clients' mansions after a few years had lapsed they would often see unmistakeable signs about the root of the scullery waste pipe that the stone flags had been up more than once, and intermittent discomfort regularly anticipated, to the benefit, doubtless, of the jobbing builder.

One great objection to the collection of cooled-down grease in a house drain is that no amount of hot water or chemical material will once more solve it. Moreover, there is the constant attraction which grease always offer for rats. I have several times exhibited pieces of sink waste pipes formed of lead over a quarter of an inch in thickness of material, where the pipe has been gnawed away until the rat could enter the house. They were not satisfied, perhaps, with the food conceded them in the sewer, but they wished perhaps, to explore the El Dorado "through the looking glass." There can be no doubt that rats enter house drains chiefly in search of fats, and every one will admit that when once in a house drain they will soon emerge from it, even when the house drain is surrounded by concrete—always provided that the lead pipe continuation is large enough to pass its body. Syphon traps in the line of the drain cannot safely be relied upon, because, for curiosity, I have made rats to dive through the hydraulic seal in order to escape their pursuers. When there is no syphon, only a flap-trap at the eye into the sewer, the case is worse, because sewer rats can creep behind a non-tightly closed flap-trap—and what flap-trap remains closed long?—as easily as a cat will paw open a larder or pantry door.

When it has been decided to collect the grease and sand from a scullery sink, it is a very improper method of doing so by placing an open trap in the floor just under the scullery sink. This, before long, gives off the most offensive smells, and no amount of cleaning-out of the trap will remove its traces. While at the same time, the evil is accumulative.

It is better to place it outside the house, if this primitive plan of a mere trap is resorted to; and a very good trap of this kind is Dean's trap, exhibited at the Exhibition buildings

by Messrs. Rimmington Brothers & Co., of Newcastle-upon-Tyne.

The usual kind of trap used for grease collection is the common mason's, or dip-trap, and the scullery waste-pipe is not furnished with a syphon, but is dipped into the trapping water. A much better contrivance is now in common use. Here an access-tap is fixed under the sink-soffit, and the lead pipe is carried to a tank and delivers its conduitory over the water inside the tank. The out-go pipe is trapped by being bent down, and the fat is collected from the top of the water after a time, pure enough, in some country places, to feed pigs with.

It is really a question, *en passant*, whether the fat could not be made to pay for collection, instead of being buried away. I knew the manager of the establishment near Barking outfall of the metropolitan sewers, and he informed me that the fats collected and refined were extremely valuable, and that only the haphazard collection was to blame.

One of the best grease interceptors which can be used for automatically flushing out the drain as well is Mr. Field's flushing tank. It will serve these purposes whether in stoneware or iron; but if the house be a large one, and there is a site out of doors handy, and the fall suitable, an iron one is preferable, because it congeals much more quickly the fats, and they cling to the cool iron readily, forming, so to speak, an inner girdle of grease, which thickens as time rolls on, and is easily removed in cakes. I am sorry that Mr. Roger Field's punctiliousness as a Judge at the Exhibition forbade him exhibiting; but I dare say all here present know the contrivance in question.

Another grease collector, very nearly approaching to Mr. Field's in pattern, is one just introduced by Messrs. Doulton, of Lambeth, but I have, as yet, no experience of its working or staying powers. Messrs. Doulton are manufacturers of other patterns of grease traps, of more ordinary construction, which act very well.

A grease-intercepting tank, formed of stone-ware, much used by those who approve of grease traps, is that of Mr. Hellyer's. The grease enters at a dipped pipe, some little below the standing water level, so as not to disturb the congealed head. The hot greasy water is cooled in its transit to the outlet, and the fatty particles rise to the top. The outlet is at the further end, and there is a hand hole to the head of the inlet mouth. There is a ventilating pipe, a cast-iron cover properly luted, and a brass plug and washer with iron handle and pipe for emptying the tank and flushing the drain when the superjacent fat has been removed, and when the depth of the drain will allow of a flushing pipe below the outlet at the top of the grease chamber.

Such is my attempt to assail the stronghold of those who do not entertain the necessity for grease interception. It is only begging the question to say that the building of a grease tank is a return to the old cesspool system, which cannot be true, because nothing but fats should enter the grease tank, not even other sink wastes, rain water, or surface deliveries. Certainly the subsided matter is foul and the floating material the same, but provided the trap is cleaned out regularly, all will prove soundly beneficial to master, wife, and servants alike. And the safe rule, when such a contrivance has been once supplied to a house, is to engage with some person to clean it out, for a given sum, so many times per annum, using plenty of ground lime. Surely it is as easy for a servant to bear this necessity in mind, as it is for her or him to remember that their quarter's wages are due on a given day.

The CHAIRMAN said he had great pleasure in proposing a vote of thanks to Mr. Eassie for his paper.

Mr. R. B. GRANTHAM, C.E., seconded the motion, and said it gave him very great pleasure to do so, because the paper and the suggestions contained in it were extremely practical. The speaker said he was not so much engaged in house drainage as in main drainage, but he had of course to consider how every kind of house drain could be discharged into the sewers. Mr. Eassie had had very great experience in this matter, and was so well known that they might rely upon what he had so well described in this paper as being the best way of getting rid of the grease. The speaker had also had some experience in this matter, and he had found a very great amount of inconvenience and annoyance, and, he believed, injury to health, caused by removing the grease. He knew of one case in Hampshire,—a large establishment, where the grease was immediately outside the house, just under the scullery window, and they had the greatest difficulty in getting rid of it, because the effluvia coming from it was so strong. The men were obliged to have handkerchiefs tied round their mouths to prevent their being sick. The speaker said he thought at the time that the cesspool was not large enough to hold all the grease, and that it would not be many months before it would get stopped again. It collected at one side, and almost stopped the outlet into the main sewer. He had listened very attentively for the remedies which were suggested. He used hot water, and had succeeded in removing the grease. He was very glad to hear of the system which Mr. Eassie had alluded to in his paper, and that it was available for the purpose. He had been laying some sewers in one town where a question arose as to the use of flushing tanks, and he had given the matter his consideration. Simple as the matter appeared to be as a branch of the sanitary question, it was really of considerable importance, and he was very glad to have had an opportunity of seconding the motion.

The motion was then put and carried.

Mr. H. SAXON SNELL, F.R.I.B.A., said he did not propose to question the desirability of putting grease traps in any establishment, but it appeared to him that very often these grease traps were placed where the necessity for them did not exist. The question was, in large establishments where hot water was used in large quantities, did the fat congeal before it passed the trap? He thought not, and that in the very best constructed trap that could be devised a very small proportion of the fat which came out of the sink or the scullery was actually caught in the trap. In very cold weather it might be, and then the contrivance, which was shown on one of the diagrams, would prove valuable. It was a very difficult thing to make an experiment in a matter of this kind, but he felt convinced that a very small proportion of the fat from the kitchens of public institutions would ever be caught in grease traps such as were proposed by Mr. Eassie, and the conviction was forced upon him that they would prove to be a delusion. One point which had been suggested was that other water should not be allowed to go into the grease trap; but his opinion was that it should, for it would assist in coagulating the fat.

Mr. E. C. ROBINS, F.S.A., said the last speaker had remarked that it would be a difficult thing to make a practical experiment, but he had been forced to make one, and he would give the Section the result of his experience. In a previous house he lived in, he had no trouble with the matter, and he had no grease trap. In his present house he put in the drains, and he was twice annoyed within twelve months with a stoppage of grease. His wife had previously objected to the use of a grease trap, but now it became necessary for him to invent some such method for preventing the nuisance. He proceeded to describe at length, and gave a diagram of his method for doing this, saying he never had his drain stopped again. The trap he had used did catch the fat, and to his mind it only remained a question of whether a large trap, requiring to be cleaned out once a month, or a small one, to be cleaned out by the servants of the house every day, was the best. In the latter case the accumulation of fat could be removed by the servants of the house with a spoon, without inconvenience from offensive effluvia. The water below the level of the outlet rapidly became very foul, and required frequently baling out.

Mr. D. EMPTAGE stated that he had laid in scullery sink drains, both with and without grease traps, and had paid considerable attention to the subject, and his experience led him to the conclusion that these traps were an evil. One case particularly had come under his notice, and this was a public institution, having upwards of three hundred inmates. At this establishment the scullery sink drain was 9 in. in diameter, 250 feet long, with a fall of 1 in. in 48 in., and an

intercepting trap to catch the grease. This trap was always choking up, great inconvenience and an abominable smell being the result. He had the trap removed, and the drain relayed with very even joints, having a clear run throughout. The drain had been working now for three years, during which time he had frequently inspected it, and had always found it working satisfactorily.

Mr. HUBERT LAWS, C.E., gave his experience of grease traps, and said that upon examination, he always found there was a large amount of grease collected.

Mr. E. W. C. F. SCHMIDT, Dr. RUSSELL, and Mr. AICOCK also spoke upon the subject, and Mr. EASSIE briefly replied.

"The Separate System of Drainage," by MR. J. LEMON, M.I.C.E.

I HAVE selected this subject, because it is one upon which difference of opinion exists between sanitary engineers, in the hope that it may be well ventilated at this congress.

In the early days of sanitary engineering when that veteran sanitary reformer, Mr. Edwin Chadwick, C.B., advocated sewage purification, the principle of "The sewage to the land and the rainfall to the river," met with considerable support, but the opponents of this system discussed it with considerable virulence. Mr. Chadwick, Mr. Rawlinson, and others were nicknamed "The quart into a pint school." They were accused of the enormous crime of wishing to dispense with brick sewers altogether, and drain large towns through small pipes. The controversy as to the respective merits of brick and pipe sewers waged fiercely, and in the mêlée the separate system was more or less ignored.

About this time the main drainage of London and other large cities was under consideration, and it was very easy to prove that small pipes for these works were useless. Happily we have now passed through this stage of professional intolerance, and the drainage engineer designs his sewers in accordance with the work which they have to do, and the advocates of brick sewers or pipe sewers for all purposes exclusively no longer exist. During the consideration of the question of admitting the rainfall into the main sewers of London, careful analyses were made by Professor Way of the surface water as taken from the streets, and the results showed considerable pollution. It was ultimately decided, as most engineers are aware, to admit $\frac{1}{4}$ inch of rainfall in 24 hours into the metropolitan sewers, and to provide for excessive rainfall by storm

overflows into the river Thames. This decision of Sir Joseph Bazalgette and the consulting engineers gave a most decided check to the separate system of drainage.

Sir Joseph Bazalgette, in the paper read by him at the Institution of Civil Engineers, in the year 1865, stated that the "separate system" would involve a double set of drains to every house, and the construction and maintenance of a second series of sewers to every street. Applied to London, it would involve the re-draining of every house and every street in the Metropolis, and, according to a moderate estimate, it would lead to an expenditure of from ten to twelve millions of money, while the interference with private property would alone render such a proposition intolerable. I need not say that this expression of opinion from an eminent drainage authority was another heavy blow to the separate system.

In the year 1867 I submitted a scheme in public competition for the main sewage of the City of Winchester on the separate system, and was awarded the first premium.

During the consideration of the various schemes I was bitterly assailed in the local press for advocating what were called "The obsolete principles of the General Board of Health." I held my ground, and I have since had the satisfaction of carrying out the works, and being able to report that there is not a single gully connected with the sewers in the city, although the roof water and water from back yards is in some cases admitted.

During the last 10 or 15 years the separate system has rapidly regained the lost ground, but in order that it may not have another relapse I wish to put before the Congress the principles upon which I consider it should be carried out:

1st. What is the "separate system," so called? Does it mean the *entire* and *absolute separation* of the rainfall from the sewage? If so, then I say at once there is no town in England where it is carried out. It is a common practice amongst its opponents in order to hold it up to ridicule, to assert that it does mean an entire and absolute separation of the sewage from the rainfall, but Mr. Edwin Chadwick was always in favour of admitting the roof water from houses and the water from paved surfaces such as streets, mews, courts, alleys, and paved squares, so that even he was not in favor of the separate system pure and simple.

There is no town I know of where there are such natural facilities for carrying out the system in its integrity as at Winchester. The city was formerly drained into cesspools in the chalk, and the surface drainage was carried into the brooks and the river at all available points. In the scheme I adopted, I simply left the surface drainage alone, and provided for the

sewage and a small quantity of rainfall from the houses, feeling confident that a margin for rainfall under the most favourable circumstances was necessary. The city passed stringent bye laws, which were ably carried out by the city surveyor and his assistants, but in spite of all these precautions, some portion of the rainfall is connected with the sewers, and the flow in the sewers at times of rain is considerably increased.

2nd. Is it desirable to entirely exclude the rainfall from the sewers in all towns and under all conditions?

To that question I say no. In my judgment it is neither desirable nor practicable for the following reasons, viz:—

No. 1. The rain is a scavenger, and carries away the impurities from the surface of our streets and courts in the thickly populated towns.

No. 2. The rain flushes the drains and sewers in towns destitute of all other modes of removing deposits.

No. 3. The rain can be stored and used for flushing purposes by the use of Mr. Roger's field flush tanks, and the drains and sewers kept clean, noxious gases therein being thereby prevented.

And No. 4. The quantity of rainfall to be excluded from the sewers must entirely depend upon the size and character of the town, the means of sewage disposal, and other local circumstances.

Having given the above reasons for the partial admission of rainfall under certain conditions, I may state I do so in the interest of the separate system, as I am convinced the advocacy of its use absolutely, in all towns under all conditions would defeat its true progress, and be as unwise as the former advocacy of pipe sewers *versus* brick sewers for the Main Trunk lines in the Metropolis.

The class of towns and the conditions under which the rainfall should be kept out of the sewers as far as practicable, are as follow:—

Towns where it is necessary to pump the sewage on to land for purification.

Towns where it is necessary to pump the sewage for treatment by precipitation.

Towns where it is necessary to pump the sewage for treatment by precipitation and intermittent filtration combined.

Towns where the sewers are tide locked, and it is important to decrease the quantity as much as possible.

The other class of towns in which the rainfall may be partially admitted into sewers, are as follow:—

Large and thickly populated towns where the impurities washed from the streets and courts would seriously pollute the river into which the town is drained.

Towns drained into the sea by gravitation where there is a free discharge at high water.

Towns where the dry system is in operation.

It will thus be seen that I have divided the towns into two classes, with the view of separating the rainfall from the sewage, as far as practicable, and at the same time not putting the separate system where I considered it would be out of place.

The advantages which I claim for the adoption of the separate system in the first mentioned class of towns may thus be briefly stated.

By the separate system the quantity of sewage to be provided for is more accurately ascertained, the areas of the sewers are, consequently, better apportioned to the work they have to do, and deposits therein, and consequent noxious gases from sewage decomposition, thereby prevented.

The power of the engines and dimensions of pumps can be calculated on a more reliable basis, as it is not necessary to allow a large margin, or to provide large surplus power to meet storms and sudden gluts of rainfall.

The capacity of the reservoirs, or tanks for precipitation, can be less, and can be designed by the engineer with tolerable accuracy.

The area of land for irrigation can be less, and the disadvantages and difficulty of pouring large quantities of diluted sewage upon lands in times of heavy rain are thereby removed.

In tide-locked sewers, the quantity of sewage is reduced, and the consequent flooding of basements and cellars prevented.

The silting up of the sewers by the detritus from the roads and streets during heavy rains (a very serious matter where pipe sewers are used) is also prevented.

The advantages which I claim for the admission of the rainfall in the other class of towns, under certain conditions, are as follows:—

In large towns with paved surfaces it is less costly to admit the rainfall than to construct special culverts for surface water, the distance from the river being so great in most cases that a system of surface drainage would be necessary. The washings from the paved surfaces are so highly impregnated with organic matter that it is desirable, in order to prevent pollution of the river, to intercept it by the sewers and deal with it in the same way as ordinary sewage.

In such towns I advocate the removal of a given quantity of the surface drainage, that is to say, the first portion of a storm or fall of rain, which is always highly impure, by the sewers, and the removal of the last portion of a storm or heavy rainfall which is comparatively pure, by means of specially constructed

storm water culverts on the principle adopted by Mr. Bateman and recommended by Mr. Baldwin Latham.

By this simple arrangement a given quantity of sewage can be received into the sewer, and when it is exceeded the whole of the discharge would flow into the river by the storm water outlet.

This is a far better arrangement than the storm overflows to the main sewers in London and other large towns.

In cases where towns are drained into the sea by gravitation at high water there is no object in separating the rainfall from the sewage, and storms and heavy rainfall can be provided for by properly constructed overflows much more economically than by separate surface drains.

In the case of the dry system so much in vogue in the midland districts of England, the adoption of the separate system would be out of place. The sewers in such towns are mostly surface culverts, and although they also take the slops, and the discharge from them is very impure, there is not that necessity for keeping the rainfall separate; and as most of these towns are paved towns and come under the before-mentioned category, the sewage can best be dealt with on what is known as the single system.

It is a curious fact that in towns drained on the single system the local authorities have been compelled to supplement the sewerage system by surface drainage, London being no exception to this rule, showing clearly that the provision made for the rainfall is in most cases inadequate; and the flooding could be prevented by the judicious utilization of the existing valley lines.

Next in importance to the disposal of rainfall is

Subsoil Drainage.—In some cases it may be said to be more important. It certainly forms part of the separate system, and the same arguments in favour of the separation of the rainfall can be used in favour of the separation of the subsoil water.

In the Blue Books, on town drainage, medical men bear testimony to the decrease of phthisis in well drained towns by the lowering of subsoil water. How is this effected? In some cases it is due to the subsoil water following the line of sewer, through the newly made ground by the sides of and over the sewers. In other cases it is due to imperfect jointing of the pipes and the pervious character of the brick sewers.

That such a valuable portion of the sewerage of a town bearing, as it does, a large part in the reduction of the death-rate, should be left to chance and imperfect workmanship, every engineer will admit is not creditable to the profession.

I do *not* mean to say that subsoil drainage is wholly neglected, but I say its special treatment is an exception to the rule.

I give herewith the quantity of subsoil water admitted into the sewers in the following towns, from returns made by the Local Government Committee:—

Town.	Sewage per diem, including subsoil water.	Subsoil water only.
Kendal	750,000	350,000
Warwick	700,000	one-third subsoil water.
Coventry	1,220,000	500,000
Rugby	400,000	150,000
Harrogate	168,000	83,000
Chorley	500,000	200,000
Bradford	700,000	300,000
Penrith	1 of sewage to 3 of subsoil water.	

It will thus be seen that the subsoil water forms in some cases nearly half the quantity of sewage, and this diluted sewage is pumped up, and poured on to land in addition to the rainfall.

In a monetary point of view, the question of subsoil water is more important than the rainfall, as the expense of lifting it is continuous, whereas rain falls on the average about 155 days in the year.

To remedy this defective construction, I recommend the adoption of a separate system of subsoil drainage in all water-logged soils, so as to relieve the sewers of the influx of spring water, facilitate the construction of the sewers, and reduce the working expenses.

I have carried out such a system in Winchester with the best results (a cross section of the sewer and subsoil drain is submitted), and I shall always adopt a similar course under the same circumstances and conditions.

By the observations I have had the opportunity of putting before the Congress, it will be seen that I wish to establish the principle of partial separation of the rainfall in certain towns, and the separation of the subsoil water, but that no fixed law can be adopted by engineers which is applicable to all towns under all conditions. The question of the adoption of the separate system, and the extent thereof, must be entirely governed by local circumstances.

I hope that civil engineers will now look upon this question, not as a matter of controversy, but that they will deal with it with the same judgment as they did the question of brick and pipe sewers, that is to say, lay down no fixed law, but adopt the provisions of nature to the use, the convenience, and the health of man.

The CHAIRMAN asked the Section to give a hearty vote of thanks to Mr. Lemon for his paper.

Mr. LYON seconded the motion, which was carried unanimously.

Mr. R. B. GRANTHAM, C.E., said, that at Slough they had succeeded in separating the sewage from the surface water by means of separate pipes. The system of drainage which formerly was carried out could not be used. A new system of sewers was therefore laid down, and care was taken that only the sewage went into them. They had purchased 25 acres of land, and this was so far more than required for their purpose that it had not been necessary to crop all of it up to the present time. The land was let, and the person who leased it did what he liked with it. The soil was a very fine one for the purpose, and took all the sewage they required to pump. There was a population of 5,500 inhabitants on an area of 13 acres. They had to lay three-quarters of a mile of the sewage pipes under the level of the Thames at high water, for which purpose iron was used, which increased the expense. They found it necessary only to pump about four days a week, and the rest of the week they were ready for any circumstances which might arise. At ordinary times, they found that four days a week was quite sufficient for their purposes. The lift of their pump was 25 feet, and the length of the rising main a mile and three quarters.

Mr. E. PRITCHARD, C.E., said, he had listened with very great pleasure to the reading of this most valuable paper upon what might be considered to be a most important part of the sanitary engineer's work—the construction of sewers. Every town or district must, of course, be governed by its own conditions, and he thought that the reader of the paper had very clearly laid down that he did not gainsay this important fact. As to the question of the non-admission of rainfall into sewers, there were some instances where it would be practically impossible to do this, and he gave as an instance the town of Birmingham. The separate system of sewers would not mean merely a separate system, but a triplicate system.

Mr. G. J. SYMONS and Mr. E. SCHMIDT also took part in the discussion, and Mr. LEMON replied.

On "Dr. Renk's Observations on Sewer Gas, and its Exclusion from Dwelling Houses," by EDWARD COOKWORTHY ROBINS, F.S.A.

IN my address at the Royal Institution, on the occasion of the Anniversary of the Sanitary Institute, I referred to the original researches of Dr. Pettenkofer and his chief assistant, Dr. Renk, undertaken at the Hygienic Institute of Munich; and I detailed the result of their experiments on ground air, which proved that pressure of the ground air through the floor of a basement was

greater than the resistance, but that it might be drawn off through subterranean channels by the kitchen chimney flue.

To-day I propose to refer to Dr. Renk's pamphlet on sewer gas, detailing the results of his experiments in house drainage; and I do so in accordance with my own suggestion in the aforementioned address—viz., that this Institute should be the repository of the records and results of original scientific research, of interest to sanitarians, and of importance to the welfare of the people, as their best insurance against preventible disease.

With the proverbial fulness of detail of German writers, Dr. Renk devotes many pages to elementary introductory matter, for it is remarkable that the Germans are behind us in Sanitary appliances in connection with house drainage; and the subject not being so generally well understood in Germany, the necessity for an elementary treatment is greater in his case than it would be in ours, thanks to our sanitary authors, and to this and kindred Institutes.

But in the matter of warming and ventilation of public buildings (not private ones) they are far ahead of us, and treat the matter with a scientific seriousness which is not common in this country.

It is always interesting to observe how different minds arrive at similar conclusions, more especially when those conclusions are attained by independent investigation and scientific experiment. And since no single appliance is for ever applicable to all possible cases, it is valuable to add to our resources.

Dr. Renk opens his paper with an explanation of the term sewer gas, and gives a resumé of the experiments which have been made on the composition of sewer gas, and the amount of gas given off by the decomposition of excrementitious matter, through which we need not follow him, since these things are fully gone into in Dr. Parkes' work. He admits the presence of solid particles, bacteria, &c., but expresses himself a disbeliever in the so-called sewer gas theory; that is to say, while he believes that inhaling sewer gas is prejudicial to the nervous system, and is one of the many causes of the impurification of the air we breathe, he does not consider it provocative of specific forms of disease, and he questions the possibility of solid and liquid particles passing from sewage into the superincumbent air—shewing that he is unacquainted with the researches of Professor Frankland, whose paper on this subject at the Royal Society, has determined that "The breaking of minute gas bubbles on the surface of a liquid, consequent upon the generation of gas within the body of the liquid, is a potent cause of the suspension of transportable liquid particles in the surrounding air."

The diagrams at the end of his pamphlet, some of which I exhibit, illustrate his discussion of the causes which lead to the escape of sewer gas, and of the best form of syphon traps to resist the pressure of sewer gas.

Fig. 10, plate 1 (*see fig.* 1), is important as shewing a case where in consequence of the waste-pipe between the two sets of closets "running full" the water is sucked out of the upper floor traps, and is forced out of the lower floor traps, in each case forming a passage for the sewer air.

Dr. Renk points out that the mere height of water in a trap is no necessary indication of its comparative efficiency; thus, in the figures 2 and 3, where, if both limbs of the syphon are of equal area, and the height of the vertical or longer side is made sufficient, the resistance is equal to a column of water double the height of that contained in one limb. But if the area on the side of the drain be less than on the opposite side, the resistance is equal to that of a column considerably less than double the height. In the opposite case the resistance is considerably greater. Thus, supposing the column on either side to be 5 centimetres high, if the areas are in the proportion of 1 : ·55 the resistance is that of a column 7.75 centims. high;

FIG: 2.

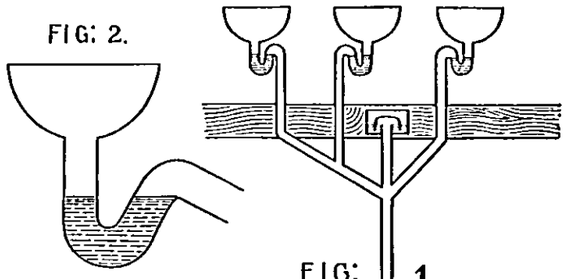
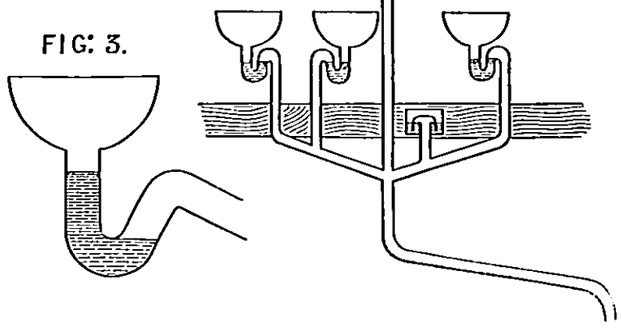


FIG: 1.

FIG: 3.



if they are in the proportion of 1 : 1, the resistance is that of a column 10 centims. high; and if they are in the proportion of 1 : 9·4 the resistance is that of a column 23 centims. high. This is supposing the pressure to be exercised from the side of the drain.

The evil arising from the rapid evaporation of the water in all the ordinary bell-traps has led Dr. Renk to invent a special form of trap, reducing the area of water exposed to the air to its smallest limit.

Under the outer grating is a plate, perforated by tubes equal in area thereto, which descend to near the bottom of the well of the trap, while the central outlet drain-pipe rises between them to two-thirds the depth of the well as shown on his drawing, thus obviously answering the end proposed, but from its liability to be soon choked it is of questionable value.

The application of this trap to basins, baths and cisterns is also shown. Syphon, ball and gully traps have now superseded bell traps, which are as obsolete as pan water-closets in modern practice.

But after all, such expedients do not prevent the necessity of ventilating the soil or waste-pipe, and Dr. Renk has shown Prof. Pettenkofer's plan of doing this. Prof. Pettenkofer continues the soil-pipe above the roof, and above the highest connection therewith he places a gas jet to quicken the draught by raising the temperature of the air at that point, and Dr. Renk would put no cowl on the top, not believing in them. It is pretty well agreed now that, except for the prevention of down draft, cowls are of no practical use.

He also considers that there is nothing gained by having air inlets at the foot of soil-pipes, and he points out that from the position in which these are often placed they are more likely than not to lead to the contamination of the air in rooms near to which they are situated.

He gives a drawing on the same sheet showing that extract ventilators in rooms where there is not this upward suction in the soil-pipe, are apt to draw the air into the room through the sink or w.c. from the cesspit.

Cesspools are common in Munich, and the pneumatic system for emptying same, is adopted, as it is in France, but it is less well done than by Mons. Tallard's process, which was exhibited at Kew, as I experienced to my own annoyance, when, on my way to Pettenkofer's Hygienic Institute, I had to pass on the opposite side of the way to where an operation of the kind was in progress.

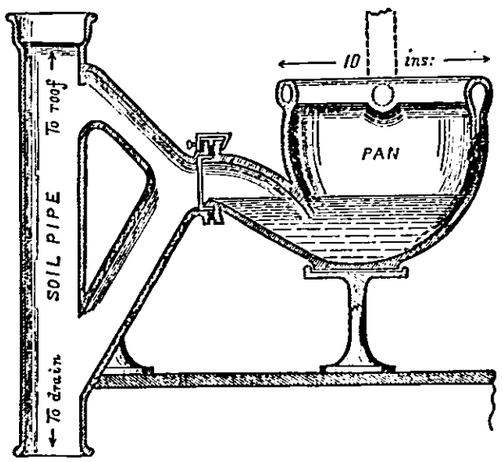
The pressure of the air in pipes would in all probability be much less in such circumstances. It is where the storm waters

suddenly fill the sewers and compress the air, and force it through the house drains into the houses, that so much care has to be taken to have a perfect system of air and water intercepting agency.

The conclusions of Dr. Renk, to which I have adverted, are all based on careful scientific experiments and analyses, of a character quite unsuitable to introduce into a cursory notice of his labours such as this.

I have received from Chicago, in America, from the inventor, a description and illustration of a form of water-closet basin and ventilated waste, called "The *Hygienic*," which, to my mind, overcomes very many of the difficulties besetting other apparatuses. It is in process of being secured by patent, and is known to many present.

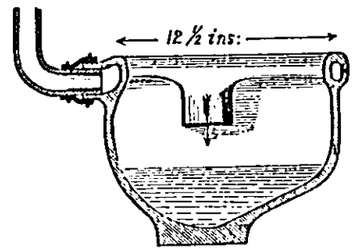
The triangular arrangement of the pipes forming in one piece a portion of the soil-pipe, with its two branches of large area, is connected to the outlet from pan by cramps, screwed up with India rubber washers between the flanges. The downward branch is the outlet for soil and water, the upward branch is the passage for air, and the junction of same with the basin is midway.



SECTIONAL SIDE VIEW.

By this means the exit arm from the closet is perfectly ventilated by the upper arm, no pressure is put on the water seal, and the point at which the pan is fixed to the washer is get-at-able, and capable of perfect junction.

The form of basin is good, the scour of the water is certain, and the whole has more good principles combined in its simple construction than I have seen for some time, and practically solves many of Dr. Renk's problems.



TRANSVERSE SECTION OF PAN.
(Looking from the Back.)

I may add that in America the soil pipes are made of cast iron, with lead caulked joints, often pitched internally, and fixed inside the premises, and are carried up through the roof.

The CHAIRMAN moved a vote of thanks to the reader of the paper.

Mr. J. LEMON, C.E., seconded the motion.

Professor F. DE CHAUMONT, F.R.S., made a few remarks on the subject, with reference to the proposed form of closet, and pointed out some objections to the forms of closet commonly used which had not been entirely met in the one under consideration.

Mr. D. EMPTAGE pointed out that the closet which Mr. Robins had brought before them was fitted with a basin similar to that used for a valve closet. It was an excellent shape for that purpose, but was, in his opinion, quite unfit for a direct-action closet, to flush which effectually three conditions must be observed. The first was that there must be a sufficient quantity of water, and at the least two gallons; the second, that it should be delivered quickly, or in five seconds; the third, that the contour of the basin should be such that the water would fall direct upon the contents of the trap. In this last particular, he said, the basin before them was very defective. The water streaming down its sides would have a tendency to cause the contents to ride up rather than to force them through the trap.

Mr. S. ALCOCK said he had heard of some means of intercepting sewer gas before it entered houses. He described an intercepting man-hole which he had adopted in connection with his own house, and had found valuable. The drain itself was open by a half pipe at the bottom of the man-hole, which was kept continually sweet and well ventilated by means of a pipe or shaft, and it also enabled them to test each house drain, and see whether it was working efficiently.

Mr. R. B. Grantham, C.E., said that at Slough great complaints were made of the gratings in the middle of the streets, and at first great nuisance was caused by the discharge of the accumulations from old cesspools into the sewers. Occasional flushing had improved the air in the sewers. The gratings were then covered over with zinc plates; but since that ventilation had been effected by means of the gas lamps, and iron pipes carried up the sides of houses.

The motion for the vote of thanks was then put and carried unanimously.

Mr. E. C. Robins, F.S.A., stated, in reply, that the conditions required by Mr. Emptage were certainly attained by the example he had quoted in illustration of a practical solution of the theoretical difficulties raised by Dr. Renk. The volume of flush-water is discharged immediately opposite the exit orifice—its force is accumulated by the form of the lower part of the pan—by using a syphon-action water-waste preventor, the whole two gallons would be discharged at once through a one-and-a-half-inch service pipe. There was no second trap to be cleared. The dip was into the basin water itself, and in this was like Pearson's trapless closet; but no plug was required and no second basin. Mr. Alcock was quite right in his observations about man-holes. The plan now generally adopted was to provide a shallow man-hole both in the front and back areas of houses in terraces separately admitted to the public sewer: the drain between these points to have no inlets: all branch drains to meet into one or other of these man-holes by channels perfectly straight: no drains to be laid in a curved form: the portion of the tubular drain pipes within the man-hole should be open, the upper half of the same being omitted: and a syphon-trap to cut off the sewer air to be fixed on the sewer side of the front man-hole. This system aërating the intercepting man-hole met the difficulty arising from the passage of air bubbles containing germs from the sewer side of the water seal of an ordinary syphon-trap to the house side of the same.

Sewer Ventilation, by W. Geo. Laws, M.Inst.C.E.

It is unnecessary, before a meeting of Sanitary Engineers, to enter into any discussion as to the necessity for the ventilation of Sewers, and the writer proposes only to bring forward some objections to the usual mode of doing this, and to suggest a method by which it may be more rationally and effectually carried out.

The usual method of sewer ventilation is by an open grating

on the manhole, which allows any sewer gas to pass away directly into the air. Sometimes a more complicated arrangement includes a wire basket filled with charcoal for the purpose of deodorizing the gas. So long as this charcoal is fresh it does, no doubt, absorb some of the gases, but, in a very short time, it becomes inert, and, unless often renewed, is of very little use.

The main fault of this system is that when effective in carrying off the sewer gases it, at the same time, ensures their being delivered at the point where they are most objectionable, viz.: at the street-level, where, before they are dissipated they must come in contact with, and be breathed by the passers by. The manholes are usually in back streets, close of course to some of the back doors, where the inmates frequently stand to gossip, where in the poorer parts of the town children constantly play, and where the wheeled traffic being least the gas is more slowly mixed with the air. Who that occasionally passes through a back street, cannot recall some sickening, full flavoured whiff that made him quicken his space, while glancing round for the cause, and instinctively "noting" the "honest British grate," which serves at once to mark the progress of sanitary science, and to distribute its blessings? Who that has seen children playing round such a grate, dropping stones through the bars, or watching the foul stream below, can doubt that here may be the cause of many an outbreak of fever, or case of blood poisoning?

The ventilating grate is frequently also the cause of mischief in another way, for the sticks and rubbish that are swept or pushed through it often are the immediate cause of a stoppage in the sewers, which may, or may not, be soon betrayed by the more rapid exit of noxious effluvia at the nearest vent, and which can only be remedied by flushing, or opening the drain. Before this is done one or more houses may have been flooded by the gas and serious mischief done.

The narrow back street, with the yard walls on either side, forms a complete trough, which, on a still airless night, may easily be filled, two or three feet in depth, with very slightly diluted sewer gas.

As a means, indeed, for securing that every passer-by shall breathe the greatest possible amount of poisonous gas, the arrangement is almost perfect—as an outcome of sanitary engineering effort it is depressing—indeed it is only to be surpassed, in effect, by some of the more ingenious contrivances, by which the enterprising builder succeeds in "laying on" sewer gas to the rooms of modern houses, and, like Samson, slays his thousands, but with a more effective weapon; going cheerfully

on his way upheld by a conscious rectitude of intention, and a happy ignorance of the startling success of his efforts.

Sanitary Engineers have long recognized the fact that no water trap is secure against occassional pressure of gas in the sewers and drains, which must, and does, more or less effectually break the water seal and allow the gas to pass into the house.

They have therefore very generally adopted the plan of carrying an open ended ventilating pipe from the soil pipe at least up to the eaves.

This effectually prevents pressure on the closet or sink traps, and is a most commendable arrangement.

Architects, however, are very naturally averse to disfiguring their elevation by an unsightly pipe, and the result frequently is that this safety valve of the drains is rendered worse than useless by being terminated at, or even below the eaves. Few who read these lines but can call to mind some instance of an open soil pipe ventilator, ending with a handsome cap, within a few feet of a bed-room window, into which, if open, the gas must be blown in at least one direction of the wind.

This open ended soil pipe is, however, the true germ of efficient and safe ventilation, not only of the house drains, but of the sewers. All that is necessary is that it should be connected directly with the drain or sewer, *without a trap*, and that it should be carried to the highest point of the building, above all windows and openings.

This would be effected by forming the soil pipe of well-glazed sanitary pipes, such as are now used for the best chimneys, and building it into the chimney-stack—making, in fact, a separate gas chimney—through which all noxious gases from either drains or sewers could freely escape.

This "gas-chimney" should preferably be laid alongside or between the kitchen chimneys, the heat of which being partly communicated to the gas would assist in securing an upward draught in all seasons. The sewer gas would be delivered among the freshly made and finely divided carbon of the smoke from the kitchen fires—a most powerful deodorizer and disinfectant—and it would be delivered far above all occupants of the houses or passengers in the streets, securing, at least, that before it reached them it must be very largely diluted, and so rendered less harmful.

It has frequently been proposed to ventilate the sewers by erecting tall chimneys with a furnace to create a draught, and connecting them with the drains. This seeems feasible at first, but has one fatal objection. The sewerage of a large town may be compared to the "arterial" system of the body—the flow of *gas* is naturally towards the capillaries (the house drains); and

to render the furnaces effective, it would be necessary either to erect the shafts over the main drains in the lower parts of the town near the outfalls, and so reverse the natural course of the gas and make it flow in the same direction as the sewerage; or to add a "venous" system to collect the gas from the house drains into larger "veins" upon which the furnaces could be placed; or otherwise to place a furnace shaft at the end of each house drain.

This latter is practically the system proposed by the writer, as every house drain would terminate in a warmed ventilating shaft, while openings would be provided in the lower parts of the town on the main sewers to allow of the entrance of fresh air.

It is a system that could be readily and economically carried out in all towns which have the power of making building regulations. All builders of new houses might be compelled to provide the additional "gas chimney," and the cost would be so small (about 50s. in an average three story house) as to create no opposition among the builders, while architects would not object to a plan which makes no unsightly blot on their elevations.

Among houses already built, its introduction would be of course slower and more costly, but even there the constant pulling down and rebuilding going on in the heart of large towns would soon secure a sufficient number of ventilators in each street—a dozen gas chimneys, for instance, would amply ventilate a 3 ft. × 2 ft. main sewer.

Naturally to this, as to all systems, objections can be raised, and we may consider some of them.

Firstly. The dangers of leaks in the gas chimneys.

This danger is more apparent than real. In the first place, it is not beyond the skill of the average builder to joint a 6-inch or 9-inch sanitary clay pipe so as to be practically gas tight; and in the second, being open ended, there is absolutely no pressure within it, and therefore no tendency to leak.

Secondly. The danger of a down draught instead of an up draught.

Of course, in carrying out this system, it would be necessary to have on the main sewers in the lower parts of the town openings for the admission of air.

In most cases the outlets of sewers are under water for at least some part of the day, and without openings to admit air we could have no ventilation. Should it happen that the whole body of gas in the sewers was *heavier* than the outer air, then we should have a down draught, and the fresh air would enter at the chimney tops, and the gas be delivered at the air openings on the main sewers. Then we should be *accidentally* in exactly

the position in which the present system *purposely* places us, viz., of having the gas delivered at street level.

But this case would so rarely occur that it need not alarm us. In most cases, the air of the sewers is sensibly warmer than the external air, owing, in no small degree, to the quantity of warm water which passes into them.

A case far more likely to occur, would be that a considerable proportion of the gas chimneys might have a down draught, while the rest had an up draught. But this would have no ill effect as the gas would still be conveyed away, and delivered at the top of some one chimney or another, and it matters little to A if his proportion of sewer gas is delivered at B's chimney or *vice versa*. In either case it is got rid of at a safe level.

Thirdly. The possibility that during summer, when part of the house fires are unlighted, the gas might find its way down the unoccupied chimney, and into some dwelling-room—this is known to occur occasionally with smoke, and might do so with gas. Undoubtedly this would be an evil, though not of very frequent occurrence. It could be met, however, by laying the "gas chimney" invariably alongside the kitchen chimney, which is always lighted while the house is occupied, and by a cowl arranged to deliver at the sides, or at a slightly lower level than the other chimney pots.

Fourthly. The objection of cost.

If the system be effectual, this is a very secondary consideration, while in all probability the substitution of earthenware for lead and metal in the main soil pipe would lead to a saving rather than an increase of cost.

The writer makes no claim to any priority of idea—no doubt the same plan has occurred to many besides himself—but he believes that the method is worth consideration, and that its discussion by Sanitary Engineers may be productive of benefit. This must be his apology for a somewhat crude and bald paper.

The CHAIRMAN in proposing a vote of thanks to Mr. Laws for his paper, said he should like to make a few remarks upon this subject. One suggestion of Mr. Laws was in opposition to what the speaker said he considered the right system of ventilating sewers. Mr. Laws advocated the ventilating of the sewers by means of houses, and suggested that a law should be made that every new house should have a ventilating shaft attached to it. It was well known now that the best practice was to keep the house independent of the main sewer. This was a question of principle, and the author of the paper they had just heard read recommended that that principle should be discarded. He should not refer to that matter further than to ask

those who were interested in this subject to refer to his address of that morning, in which they would find allusion made to that point. He would only say that he did not approve of the suggestion made by Mr. Laws because he did not think it was in accordance with the best experience in sanitary engineering. Then upon another point, he remarked that people should not have a sewerage system arranged so that they had a deposit in that system which would involve anything dangerous. As a matter of principle, every thing should be avoided which was likely, in the slightest degree, to make collections of matter which might produce dangerous effects. Foul gas should not be produced and should not exist in the sewer at all. He gave a case where he said there was a serious outbreak of diphtheria, and he took an active part in endeavouring to discover the cause, and a meeting was held for this purpose. A great number of the residents complained of the foul state of the ventilators, and one of them actually plugged up the ventilators. This showed the amount of ignorance which existed in matters of this sort.

Mr. S. ALCOCK said he should be very sorry to adopt such a system as was recommended in that paper, for builders would be almost certain to make the ventilating shaft the means of letting the sewer gas all over the building. Speculative builders were not capable, in his opinion, of doing anything else. Ventilating shafts, might be the means of clearing sewers of the gas, but they would also be the means, if in the position recommended by the writer, of filling the houses with it. The sewer authority should take care to clear the sewers without attempting to enter upon private grounds. There was no doubt that the sewers should be kept free; but he trusted the house would never be made the means of helping to ventilate the sewer. He had great pleasure in seconding the motion for a vote of thanks.

Mr. J. LEMON, C.E., said he quite endorsed the remarks of the previous speaker, that it was not desirable to ventilate the sewers by the means of pipes in houses. With regard to open gratings in public streets, this was a matter which was very much over-rated, and very much misunderstood. A gentleman once complained to him that the open grating was a nuisance. He answered that it was something better than that, because it was a nuisance detector. Open gratings showed people when their sewers were in an unsanitary state; and he would go further and say that when there were proper discharges and proper gradients, this gas would not arise, and that gases only arose when the sewer was improperly constructed. The objections which were raised with regard to open gratings would not occur with properly constructed sewers.

Mr. HUBERT LAWS said that too great a stride was made when they stepped from an open ditch to a closed sewer. He considered that a perfectly open sewer with a smooth channel was preferable to a hermetically closed sewer; this however was not practicable in populous places, for obvious reasons. That being his opinion, the Section

would not be surprised to hear that he advocated that sewers should be as open as possible; that is to say, they should have perfectly open ventilating grates at short intervals, preferably in the main streets, where the foul air would be sooner dissipated and where children would be less likely to play. It seemed to him that it was a very desirable object, if sewer gas did exist, that it should escape in the open air, and not in the house. He quite agreed with the writer of the paper that the more openings the better, and that there should be openings up chimney stacks in addition to, but not in substitution for, the street ventilators; but the question which presented itself very seriously to him was the liability of the gas to get down the adjoining chimney.

Mr. D. Emptage said he could not agree with the plan proposed by Mr. Laws of carrying the sewer vent-shaft up inside the chimneys, as he considered there would be great risk that the gas would escape into the house, either through defective work, or by the means of an adjoining chimney. At the same time, he was of opinion that if every house had a separate ventilation for the sewers, carried to its top, a current of air would be introduced at the street gratings which would entirely remove the evil now so generally experienced. He gave an instance in which he said they had openings at each end of their drain and soil pipes, in order to induce a current of air through them. He contended that upright shafts to each house to act in communication with the street gratings was the only practical way of inducing a current of air through the sewers.

Mr. T. P. Barkas said that the gas, after rising up the pipes, which Mr. Laws had suggested would not merely be blown down the chimneys, but could enter also the bedroom windows and the attic windows. There was not only this evil to look for as the result of the adoption of the system proposed by the reader of the paper, but he foresaw at the same time that there would be practical difficulty as to ventilating the sewers by means of large shafts. Where there were miles of sewers it would take a great number of shafts to provide sufficient means of ventilation for all of them. The whole question was one of vital importance and well worthy of consideration. He questioned very much whether the owners of shafts would be willing to allow such a use of them as was proposed, and altogether he was in grave doubt as to whether the plan recommended was a desirable one to adopt. He was not quite sure whether it would not have been desirable to have kept up, as some gentleman had already suggested that morning, the system of open drains. That system certainly offered a very large number of means of escape for the effluvia. As regarded their city, he must say that they were very admirably situated as far as their sewers were concerned. He should be very sorry to dogmatise as to the best mode of ventilating sewers, but he was rather disposed to think that the mode recommended in the paper was one of the worst.

Professor F. de Chaumont, F.R.S., said that the only true system

of properly ventilating sewers was by having every thing connected with them as open as possible. With reference to the proposal made in the paper to have shafts and furnaces for ventilating sewers, he thought that that had long ago been dealt with, and the idea exploded. The principle was employed in Sir Joshua Jebb's system of ventilation in the model prisons, such as that at Pentonville. From a careful examination which he had made some years ago, he came to the conclusion that the plan was inoperative, except in the immediate vicinity of the furnace. But it was only at Pentonville that even an attempt was made to carry it out completely,—for in one prison he had visited he found that although the furnace had been built for twenty-one years, the fire had not once been lighted. At Southampton, where the prison was on Jebb's principle, he asked a Town Councillor if he knew anything about the furnace, and he answered that he did not, and that he really did not know there was one in existence.

Mr. E. C. Robins, F.S.A., said that there was very great risk of gases being introduced into the house if this system of ventilation were adopted. He alluded to some very interesting experiments on the porousness of materials which had been made on this subject in Munich, and some growing out of his own practice. The ventilation by pipes carried up to 3 feet above the highest chimney stacks, fixed outside the house, was unobjectionable.

Captain R. T. Hildyard said the great thing was to see how the largest amount of ventilation was to be got in the least hurtful way. He advocated the use of gratings to ventilate sewers.

Mr. H. E. Armstrong, M.R.C.S., took up the discussion and said, that as regarded the subject of ventilating sewers by the means of shafts, he was not prepared to express an opinion on the matter. He did not think, however, that the owners of chimney shafts would like to allow their property to be used for the purpose proposed. As regarded the subject of open sewers, he thought that was a very difficult subject to deal with. He had at first differed from the views of the author of the paper, but he had thought the matter carefully over during the last few months, and he had had some painful experiences of illness caught by children through playing over street grates. He had come to the conclusion that it would be better to deliver sewer gas at a greater height from the ground, so that it might have a fair chance of being diluted. The chance of sewer gas being carried off over the chimneys was not great. He thought that advocating entirely open sewers was a retrograde proposal.

Mr. Balfour, C.E., said, from his experience of works in various places, the confinement of gases in sewers, and the consequent accumulation in quantity as well as concentrated virulence in quality, were the cause of complaints. By simply free and frequent outlets (say every 100 yards), the abundant diffusion by the entrance of fresh and exit of foul air, is found practically to be destruction and pre-

vention of the otherwise dangerous cases, when confined and under pressure by insufficient or complex methods of ventilation. In various towns this has been unquestionably proved by chemical analysis of the sewer air as made before and after free ventilation. On this important point, now agitated in many towns and villages, I would quote the official regulations by Mr. Rawlinson, the Local Government Board Engineer-in-chief, who as truly said of him, "has the authority of an unequalled experience." He states, "There are many towns in which sewers are not ventilated, because the authorities refuse to have any open sewer ventilator at the street surface; this is a sad mistake, as a town having unventilated sewers, and house drains connected with them, must have disease in excess." Pipe shafts to be carried up house walls, from their limited capacity, and the density of the main sewer air are only of value for individual house drains. Smells, when really prevailing at sewer ventilators (and not as in many cases from mere sentiment and imagination) were valuable as notices for practical examination of the cause, such as the sewer silting, back gasses from branch drains, or perhaps neglect of the *débris* intercepting pans placed under the grated ventilators. Better far to receive notice in the milder form in the open thoroughfares than inside the dwellings, by fever and other serious cases of disease occurring.

Captain Douglas Galton, C.B., alluded to the means adopted in Memphis, in the United States of America, to ventilate the sewers, first by openings in the street drains, and, secondly, by having no trap between them and the house drains, but to carry the house sewer pipes up to the level of the roof. This, he said, answered there perfectly, but he pointed out that the distance was not very long to the outfall,—about a mile and a half, and sometimes nearly two miles; and, moreover, these were drains limited to the removal of house sewage, and in no sense sewers of deposit. He said he had always held the strongest possible opinion that it was extremely undesirable to use the house drain as a ventilator for the town sewer, and he had always advocated having a trap between the house drain and the sewer.

Mr. R. B. Grantham also took part in the discussion.

The vote of thanks was then passed unanimously.

Mr. W. G. Laws, C.E., in replying to the discussion, said he did not think that any rights which could be good for the public could be bad for the private individual. The whole question might be said to lie in a nut-shell—were they to ventilate at street level or above street level—which secured the greatest amount of safety to health? He thanked them for the vote they had passed.

Industrial Dwellings from a Sanitary point of View, by John Price, Resident Agent, Newcastle-on-Tyne Industrial Dwellings' Company.

At the outset I must express my great satisfaction that the President of the Institute has relieved me of the task of pointing out the many advantages resulting to the community from the erection of Improved Industrial Dwellings, as he has treated the subject in a far more able and convincing manner than I could attempt to do. It therefore will not be necessary for me to trespass much on your time, but I will merely offer a few remarks suggested by a lengthened experience in the management of such dwellings.

The recently issued report of the Parliamentary Committee on Artizans and Labourers' Dwellings, whilst it contains much valuable information relative to the cost and acquisition of sites for the purpose of erecting various blocks of dwellings for the working classes, throws but little light on the actual working of such undertakings, as but one of the witnesses examined before the Committee had lived in one of these blocks of dwellings, and was therefore able to speak practically of their merits or disadvantages. The opinions of one who has resided for twelve years in a large block of industrial dwellings, and has had daily experience of their working may not prove unacceptable.

I should be glad to be able to dispel the illusion which sometimes exists, that the working classes as a body are afflicted with but one idea regarding sanitary matters; the truth being, that as great a diversity of opinion exists amongst them as in any other section of the community, not only with regards to sanitary matters, but also on social, religious, and political subjects. During a thirty years intimate association with the working classes I have met with many persons who took an honest pride in keeping their homes and surroundings clean and healthy; I have also occasionally come in contact with others who seemed insensible to the virtues of cleanliness and the value of fresh air, and who, if allowed, would speedily have brought disease and the disastrous consequences which follow in its train not only on themselves but on their neighbours. This latter class will be found to be the persons who most loudly complain of the irksomeness of regulations necessarily devised for their own safety, which they endeavour to treat with contempt, and also try to persuade the thoughtless to follow their example.

The question as to whether the block plan of dwellings for the working classes, when under proper management, are as

healthy as ordinary houses, is now satisfactorily set at rest by reliable evidence based on lengthened experience. The death-rate of the blocks of dwellings belonging to the London Improved Industrial Dwellings Company, of which Sir Sydney Waterlow is chairman, only averaged 16·4 per 1,000 during the year 1881, against 21·2 in the metropolis generally. When it is considered that this company has already provided house accommodation for about 20,000 persons, and is extending its operations annually, the information which it is able to afford is entitled to our respect.

The Peabody Trust, which has provided accommodation for about 12,000 persons in their various blocks of dwellings, exhibited an average death-rate of 17·22 for the year 1881, as against 21·2 in London generally.

The Metropolitan Association, which accommodates upwards of 6,000 persons in their various buildings, records a death-rate of 14·3 only for the year 1881.

The average death-rate of the block of buildings belonging to the Newcastle Improved Industrial Dwellings Company, which contains a population of about 500 persons, is still more favourable, as during the twelve months ending 30th June, 1882, only six deaths occurred in these buildings, whilst during the same period the births numbered 34; or an average death-rate of 12 in the 1,000, and a birth-rate of 68 in the 1,000. Since these buildings were opened there has been a total of 62 deaths and 162 births. The death-rate of the rest of the parish of All Saints', Newcastle (in which the above buildings are situate), was 22·2 in the 1,000 during the year 1881. The average death-rate of the Pandon group of houses which were adjacent, but now demolished, exceeded 40 in the 1,000. The results shown in the last-named block of buildings must be considered the more satisfactory when it is remembered that the majority of the tenants are labourers working on the Quayside or neighbourhood, few of whom earn more than 20s. weekly when fully employed. Other striking instances could be adduced of the low rate of mortality exhibited by populous blocks of workmen's dwellings, proving decisively that the healthiness of a given area does not always depend on the density of its population.

The evidence given before the Parliamentary Committee showed that the problem of how to provide healthy dwellings for the poorest class, at rents suitable to their means, had not yet been satisfactorily solved. Numbers of poor people have been turned out of their homes, and excellent dwellings erected on the site for which rents are asked that the poor cannot pay. They are thus driven to find accommodation elsewhere, better

adapted to their pockets, though probably at the sacrifice of their health and comfort. We must, therefore, not forget that necessity, not choice, often compels the poor to herd together and diffuse the germs of disease throughout the community as a penalty or in retaliation for the treatment to which they are sometimes subjected.

The individuals and companies who have provided the various blocks of model dwellings now in existence should not be blamed hastily, because they cannot do impossibilities. Without some prospect of a satisfactory return for their investment, it would be difficult to find capitalists willing to provide half of the money required for the purpose, before the Government would lend the other half, and as the payment of the interest on the Government loan and the redemption of the capital forms a heavy drain on the revenue of most Companies, they naturally endeavour to obtain such rents as will enable them to discharge their liabilities, and afford a satisfactory return to their shareholders. Where the work has to be carried on on a sound commercial basis no other procedure can be expected, and the very poor must depend to some extent on philanthropic aid for better dwellings.

Industrial dwellings, to be a success, must possess certain requirements suited to the wants of the class for whom they are erected, the most important of which are convenient situation, and also convenient domestic arrangements, in which those vital essentials, fresh air, pure water, good drainage, and reasonable rents should meet with due recognition. Abundant evidence was furnished to the Parliamentary Committee that the working man will make many sacrifices for the great advantage of residing near his work, and I venture to state that the strongly expressed opinion of the London working men is thoroughly endorsed by his brethren in the country. Pictures of rural paradises, with their desirable attractions, soon lose their charm, when accompanied with a succession of lost quarters, the result of the cost and inconvenience of access. Model dwellings are, therefore, most appreciated by working men when placed near the scene of their daily labour. The arrangements most preferred are those which bring the fewest families or persons in contact with one another on a flat or landing. As a rule, the buildings should not exceed four stories in height; the stair-cases should be about four feet in width, and broken by short landings, lighted by large windows open to the external air; the window-sills should not be less than three feet from the floors for the safety of young children, and for the same reason well stair-cases should be avoided. The steps of the stairs should only have a 6-inch "rise," for the more easy

accommodation of old people and young children; they should be fire-proof, and well lighted with gas on an evening. There should be a thick layer of deafening between the floors. The water-closets should be placed in an offshoot from the main building, opening on to each landing, and well ventilated by open windows and air bricks. The water-closet apparatus should be as simple and effective as possible. Patents depending upon the proper working of valves and ball-cocks should be avoided as the fruitful cause of trouble and expense; little reliance must be placed on their proper use by tenants where more than one family have access to them. I have seen excellent closets stopped up with cloths and all manner of earthenware and hardware, children of careless parents being the principal offenders; what is everybody's duty is often most neglected. It will be found most economical in large buildings of this class to appoint a person whose duty it should be to attend to the proper flushing of water-closets daily. I would suggest that there should be a large cistern under the roof (distinct from the cistern used for domestic purposes), a ¾-inch feed pipe should lead to each W.C., which should consist of a simple metal or earthenware pan, provided only with a tap, flushing rim, and plug, placed under the seat securely, and under the sole control of the attendant, who, by the necessary daily inspection, would detect any stoppage or injury to the fittings. The expense of such supervision would probably be soon saved in plumbers' bills. Of course the soil-pipes should be well ventilated above the roof of the building, and all drains and sinks should be properly trapped. The attendant on his daily rounds would also be able to see that these are kept in proper order. The dust-shaft, extending to the full height of the building, should have proper hoppers connected with it to prevent the dust coming from the lower or upper landings; a nuisance sometimes complained of in block dwellings. The wash-houses should be placed on the roof or in the yards, fitted with set pots and requisite conveniences. The soft water from the roofs should be stored in tanks for washing and domestic purposes—it will be much appreciated by sensible tenants, and save the water bill greatly.

The great desiderata of these large blocks of buildings is ample play-ground for the children, without which they play upon the stairs, and are often the cause of strife amongst neighbours. I know those who have experience in the matter may say that it is more easy to state what is desirable than what is practical. The enhanced value of land in all our large towns precludes any liberal investment on what appears so financially unremunerative as play-grounds, yet they are essential

adjuncts wherever there is an infantile population. Mr. Powell, on behalf of the London Trades' Unions, enumerated before Sir Richard Cross's Committee certain objections which the working classes of London entertained against the earliest erected blocks of dwellings, amongst which was their barrack-like and uninviting appearance, and also their want of play-grounds for children. Recently these defects have been greatly remedied.

It has been admitted that many of the newly erected blocks of dwellings give no cause for complaint, and the prejudice which once existed against this class of buildings is rapidly dying away, as evinced by the unceasingly numerous applications for accommodation in them. With regard to the Newcastle Improved Industrial Dwellings, with which I am more immediately connected, they are now fully occupied, and as the rents are about 25 per cent. lower than the London Companies charge for similar accommodation, we may perhaps claim the credit of housing a larger proportion of the lowest-wage paid class of labourers, than are to be found in other blocks. The large room attached to the buildings, in which social re-unions of various kinds are frequently held, is another special feature which, I believe, has been productive of much good. Although the Company are not insensible to their imperfections of construction, they arise more from limited capital than from any indisposition to carry out what they know is desirable. The extraordinary low average death-rate of 12 in the 1,000, shewn by their buildings for the year ending 30th June, 1882, should be a significant testimony of the attention paid to sanitary matters, as it should also be of the value of such buildings to the community, a subject which was so well and exhaustively handled by the President of the Institute in his opening address.

I cannot resist this opportunity of expressing my share of the wide spread regret caused by the action of the Corporation of Newcastle in turning out hundreds of poor persons consequent on the New Street Improvement Scheme at the East-End, and making no provision for their proper housing. A few took refuge in our new buildings, but the majority crept into other places better adapted to their habits and means, though probably to the detriment of the public health. I think that sufficient evidence has been adduced as to the value of Industrial Dwellings to the community to commend them to the practical support of not only philanthropic individuals, but also of Corporations and public bodies generally.

The Chairman moved a vote of thanks for the paper.

Mr. Daglish said he had listened with very great pleasure and very great interest to the paper which had been read by Mr. Price. In his opinion a "resident director" should actually be on the spot, for he would take more interest in the welfare of the people who paid the rents, and he would be not merely a shareholder. The concern had not, he must say, been unsuccessful, for they paid a dividend of four per cent. some time ago. They had not paid anything lately for various reasons. This year he thought they had paid one, and he hoped that they always would do so in future. He must mention one point, and that was that as an Industrials Dwelling the Government now called upon them to pay inhabited house duty, which he considered a great abomination. Every tenant they had as a tenant was an inhabited householder, and it was hard upon them, he thought, that they should be made to pay £50 or £60 a-year for inhabited house duty because the Government chose to say that their building, containing very numerous tenants, was a house under one roof, instead of a number of houses occupied by tenants paying less than £20 a-year rent, the sum at which duty became levyable.

Captain Douglas Galton, C.B., said he was sure they had all listened with very great interest to the paper, and also to Mr. Daglish's speech. He remarked that, in his opinion, such papers as these were most valuable, because there was not the slightest doubt that the question before them was becoming one of the most absorbing interest. As regarded the question of the price of land, there was no doubt that it was one of immense difficulty. The Metropolitan Board of Works had, to some extent, assisted some of the Industrial Dwellings Companies in London by not putting the highest price upon the land. He thought that it would be really possible, in course of time, to have all houses converted into really good dwellings, in even the most crowded towns, provided the Corporation made up their minds it should be done. Of course it was possible to erect dwellings outside the towns for a certain number of those persons who were displaced by having their unsanitary dwellings destroyed; but there was a very early limit to that, because a very large number of that class of the population must live close to their work. He could only say that he would commend to the attention of all town authorities the importance of assisting private enterprise when the promoters were willing to devote themselves to the task of making improved industrial dwellings.

Mr. S. Alcock remarked that this was, in his opinion, one of the most important matters that had come before them, and he thought that, after all, they could only look upon industrial dwellings companies as pioneers of the way in which such dwellings ought to be provided. Unless it could be shown that these companies could provide dwellings which would give sufficient remuneration for the capital that persons invested in them, what they would be able to do would be infinitesimal: they would not succeed really in providing for the wants of the working classes generally. So far as Sunderland was concerned they had very advantageous dwellings for the working classes, consisting of cottages of one storey, self-contained, and having three or four rooms, at a rent of 4s. or 5s. per week. There were a good many points of view from which he thought this question might he looked at, but he believed that the sanitary question was not the most important, but that good sanitary dwellings would have a great tendency to exterminate the criminal classes.

Mr. J. Lemon, C.E., said that in the address they had heard from the President of the Section, the question was raised as to whether the erection of these dwellings did not pay in the long run, and whether the saving of life by the prevention of dirt and disease, of a large population, was not a source of wealth to the community generally. He himself had no doubt that this was a fact which could be easily and conclusively proved by statistics. The local authorities, he thought, were only doing their duty to the ratepayers when they consented to a loan for the carrying out of these works. He did not think that public companies could afford to pay any loss which was occasioned over the erection of these healthy dwellings, nor did he think it was right that they should do so. If these buildings were to be erected in the centres of towns, as it seemed necessary that they should be, he thought that the only way out of the difficulty was for the local authority to make some concessions to the private individual who might happen to have the enterprise to erect the buildings. They would be doing their duty to the ratepayers in so doing.

The vote of thanks was then passed.

SECTION III.

CHEMISTRY, METEOROLOGY AND GEOLOGY.

ADDRESS

By Arthur Mitchell, M.A., M.D., LL.D., F.R.S.E.,

PRESIDENT OF THE SECTION.

The special aim of this address is to show that the relations of weather to the distribution of deaths from certain diseases, that is, to the fatality of those diseases, has now been so definitely ascertained, in so far as regards this country, that no account of these diseases can be regarded as complete which fails to treat of those relations. In other words, the ascertained relations of weather to deaths from the diseases in question, must now be accepted as part of their known natural history. As regards certain diseases the facts have been analysed, sifted, and cross-questioned, with the result of showing that the relations between weather and deaths from those diseases are so steady as to be manifestly the outcome of an obedience to law. It also appears that what is now known to be true of the diseases which have been investigated with some fulness, will probably be found to be as true of many other diseases when they have been submitted to an equally pains-taking investigation.

This is the special aim of the address. All I desire is to show the *constancy* of the relations of weather to disease. It is with the *constancy*, not with the *characters*, of these relations that I wish to deal. Had I dealt with their characters and with the speculations which these fairly raise, I should probably have been followed with more ease and greater interest; but dry and difficult as my subject is, I am not without the hope that I may succeed in establishing my position.

Such a question as what are the relations of weather to deaths from particular causes can only be answered by statistics. But

it is difficult, on looking at long columns of figures, to see what they teach; and when vast masses of figures are dealt with, as is the case in the research of which I am about to disclose one important result, it is practically impossible in an address like this to present the figures themselves in a way which would not be confusing.

It happens, however, that the figures can be presented graphically, so as instantly to exhibit what they teach; and such a presentation of them is seen on the numerous diagrams which hang on the wall.

Unless, however, the method of thus presenting numbers graphically is clearly understood, I shall not succeed in demonstrating what I wish to demonstrate.

The horizontal black line in each figure represents the mean weekly death-rate on an average of the fifty-two weeks in the year, or group of years under investigation, and it may of course have reference either to all the causes of death, or to deaths from some one cause. With this—the average weekly death-rate—the death-rate for each week separately is compared; and the difference above or below is calculated in percentages of the mean weekly death-rate for the whole period. When the percentage for any week is *plus*, the amount is marked, according to some adopted scale, on that one of the vertical lines which corresponds to the week in question, and above the mean line, of course. When, on the other hand, the percentage for any week is *minus*, a mark showing the amount, according to the same scale, is placed below the mean line on the vertical line representing that week. When the result for all the weeks is marked on the fifty-two vertical lines, the marks are joined by a line drawn through them, and we have then a curve sometimes above and sometimes below the mean line—showing at a glance the weeks in which the mortality was above or below the mean, and the measure of that excess or defect.

The relations of weather to disease have long occupied the attention of Mr. Alexander Buchan and myself. In our first efforts to ascertain those relations we dealt chiefly with the eight principal towns of Scotland, but it soon became apparent that the smallness of the population of these towns, the division of time into months instead of weeks which the Scottish Registrar General adopted in his returns, and the shortness of the period over which these returns extended, made Scotland unsuitable as an area from which the facts we needed could be gathered. We then turned to London, 1st, because it had an enormous population contained within an area so limited that it might be regarded as having one uniform climate during each of the seasons of the year, and 2nd, because it possessed full