





by exposure to sewer gases. Several have recorded their opinion that typhoid fever is undoubtedly sometimes caused by inhalation of sewer air. In these very scientific days we are apt to look down with undue contempt on the views held by our forefathers, forgetful of the fact that some of them enjoyed wide experience and had been trained in the habit of close observation, which was all the more necessary before the advent of those aids to diagnosis which are now at the disposal of every doctor.

The conclusions of Laws and Andrewes have not gone uncontradicted. Even before their researches, Professor Frankland, in 1871, showed that although liquids flowing smoothly along gave off no solid particles to the air, yet the bursting of bubbles of gas in a liquid had a marked effect in the dissemination of solid particles. Several later observers, although confirming generally the experiments of Laws and Andrewes, as far as regards the types of bacteria found in the air of sewers, at any rate where the sewage was fresh and not putrescent, do not altogether agree with the conclusions deduced from those experiments.

The most remarkable set of recent experiments on the subject which have come to my knowledge are those of Major W. H. Horrocks, R.A.M.C.\* It is in this paper that the new facts arise which I think should be carefully studied in any fresh consideration of the sewer ventilation question.

The results obtained by Major Horrocks will no doubt be tested by other experimenters, but I think that no one who closely studies the records of his experiments will fail to agree that they deserve serious consideration. I feel satisfied that further experience will only serve to confirm these conclusions. Their bearing on the question under discussion is sufficiently obvious.

The simplest plan of dealing with sewer ventilation is, if I may venture on an Irish bull, to have no ventilation at all. This is the solution of the problem, I suppose, in certain towns such as Bristol and Cheltenham. But in such a case it is obvious that a sudden inrush of sewage, or a sudden expansion of sewer air through the introduction of hot liquids into the sewer, or other cause, will lead to the breaking of the seals of the intercepting traps in the vicinity and the access of sewer air into the house drains. The gases will come out at the low vent, and if the drains are at all defective, there is a great tendency for the gases to penetrate into the house itself. The difference of temperature between the interior of the

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\* Recorded in a paper read before the Royal Society, and printed in the *Journal of The Royal Sanitary Institute* for May, 1907, Vol. XXVIII., page 176, under the title, "Experiments made to determine the conditions under which 'specific' bacteria derived from sewage may be present in the Air of Ventilating Pipes, Drains, Inspection Chambers, and Sewers."

house and outside is sufficient to draw any foul gases in the adjoining sub-soil into the building.

Of actual methods of attempting to ventilate sewers, the easiest and cheapest is to provide surface-level openings in connection, either directly or indirectly, with the manholes. Probably more sewers have been laid on this plan than on any other. But common sense and actual experience tell us that these surface openings are frequently offensive and cause a nuisance. Horrocks's experiments give us good reason for believing that, in addition, they are a danger to health, and that disease germs may be inhaled by persons passing over such openings. I am under the impression that various safeguards which have been proposed in connection with this method, such as filtering the escaping air by means of charcoal or some chemical, are rarely used now. The charcoal method is certainly ineffective as soon as the charcoal becomes wet; also, all these methods must create obstacles to the free passage of air, besides being costly and troublesome to maintain in anything like proper working order.

The next method of sewer ventilation which I shall refer to is dependent upon the abolition of the intercepting trap. This is a method which has found much favour of late, especially among engineers, whereas most medical officers of health I believe have been opposed to it. At first sight it appears an excellent solution of the difficulty, as, by having tall ventilating shafts on each house drainage system, you have the sewers connected to an immense number of ventilating shafts, each of small area, but combined giving an ample area of openings for the extraction of foul and the admission of fresh air. The local authorities have nothing to pay in the shape of way-leaves, no trouble to find suitable positions, no expense of upkeep, no complaints of smells from surface-level ventilators. Some of the soil-pipe ventilators no doubt act as inlets, and others as outlets, and most of them act sometimes in one direction and sometimes in the other. The total result is very satisfactory, however, from the point of view which looks only at the constitution of the sewer air. Probably under such a system the air in the sewers would never smell very foul. But if Horrocks's experiments prove anything, they prove the value of the intercepting trap in preventing the air of sewers from contaminating the house drains, and in cutting off the drains of one house from its neighbour so that the presence of typhoid excreta in the drains of one house will not mean the possible and even the probable passage of the typhoid bacillus into the drain air of the adjoining and other property. In such a case a comparatively minute leak in the drainage system close to the house might be a very great danger. It is

precisely the joints close to the house which, even if sound at first, are apt to become defective owing to a slight settlement of the foundations. I think there is very good reason for the almost universal desire among tenants to know that their drains are effectually cut off from all direct aerial connection with those of their neighbours and from the sewer. I am therefore of opinion that this method, although very tempting on account of its simplicity and cheapness, is dangerous, and cannot be recommended.

In some places where they have not gone so far as to abolish intercepting traps, ventilating pipes of light iron, such as is often employed for soil-pipes, and of 4-inch or 6-inch diameter, are employed, connected directly to the sewers, but running up house walls. These, of course, if carried well above the roof, are safe so long as all the joints are air-tight, both those above as well as those underground. But any settling of the house walls leads to a defective joint at the most important place, namely, the connection of the iron pipe to the earthenware drain. Any leak in this situation allows sewer gas to enter the house. The fear of this creates great difficulty now-a-days in getting permission to fix these pipes to a house side; personally I should have much objection to living in a house to which such a sewer ventilator was attached. There is less objection to affixing such pipes to the walls of buildings such as stables or warehouses. I have seen them attached to telephone or telegraph posts, but I should imagine the effect of strong winds would rapidly cause a defective joint at the foot of the pipe.

Attempts have been made in some places to secure effective ventilation by connecting large diameter pipes to mill chimneys or furnaces to obtain a strong extracting effect. Unfortunately it is found that the suction may be so strong as to unseal the intercepting traps in the immediate neighbourhood of the ventilator, whilst the effect is felt only very slightly at a little distance. Shone's system of mechanical ventilation carries the principle of mechanical extraction very much further, and is undoubtedly very ingenious, with its scientifically arranged size of air inlet proportioned to the distance from the source of extractive power. It seems to me, however, that the cost both of installation and of working must necessarily be very high, whilst any accidental or unauthorised inlets would be liable to upset the working of the whole system.

Some forms of ventilating lamps in the shape of small iron independent columns give a certain extracting effect, and are at the same time supposed to burn up and destroy organic matter and to kill any germs present. I have no doubt that this does occur to some extent, but we

have as yet no satisfactory evidence that this disinfection of sewer air is so complete as to render these lamps safe to be employed so close to the windows of dwelling houses as would sometimes be necessary. Besides, with a sufficient number of these lamps to give efficient ventilation, the cost of the gas consumed would amount in the course of the year to a very considerable item.

To my mind, the only method of sewer ventilation which can be safely recommended at present is by means of independent ventilating columns of iron or steel, tall enough to carry all dangerous gases well above all dwelling houses, placed as near the sewers as possible, and with the smallest possible number of bends. Where lighter but still gastight shafts can be erected against buildings, not used for constant occupation by human beings, these might also be used. It is no use labelling one as inlet and another as outlet, because each column will act sometimes in one way and sometimes in the other. I believe, however, that natural agencies would keep up air currents; such as the wind blowing over the top of the shafts and the effect of the sun's heat, which often, I think, acts very strongly in the case of an iron shaft. Such a system gives us at any rate an outlet for sewer gases, and prevents the forcing of house traps. I do not believe that it would give a pure air in our sewers under all conditions, such as a state of little wind and a close approximation of temperature outside and inside the sewers, but under ordinary circumstances it will keep the air sufficiently safe to allow of the workmen entering the sewers when necessary. This, I think, is all we can expect, and would be very much better than the state of things now existing in many places, in which a policy has grown up of closing all the surface ventilators as complaints occur, until at last the sewers are left unventilated, giving rise to occasional forcing of traps and the consequent dangers.

To refer for a moment to a subject not exactly within the scope of my paper I would say that Horrocks's experiments have confirmed a conclusion which has been forcing itself on my mind for several years past, and that is that the low ventilator, as usually fixed, is a danger and will have to be abandoned. Sometimes these are fixed in the front garden walls of houses: the flushing of a w.c. in a house where there is a case of typhoid may easily convey the germ to a casual passer-by. Similarly with sewer gas escaping through the forcing of a trap. Another form of danger arises from the increasing frequency of fixing an intercepting chamber instead of merely a trap. Builders, unless they are strictly looked after, often neglect to cement the inside of these chambers. The

result is practically to have a leaky drain, as the ordinary brick walls of these manholes are pervious to drain or sewer gas. Similarly the manhole cover is often left unsealed by Russian tallow. What is the use of being so careful to have airtight cement joints to the drain, buried many feet under ground, and yet to leave the manhole defective? Another item requires careful attention. The stopper of the rodding arm of the disconnecting trap in the chamber. All who have had much experience will agree that it is the exception rather than the rule for a builder's workman to fasten in the stopper with Russian tallow. Consequently, when examining such a manhole one finds the stopper loose and practically useless, or out altogether, thus giving free access to sewer air. Or it may be that a mysterious block causes an investigation and the stopper is found to be the delinquent, having been carried through the trap and blocking the drain on the sewer side of the trap. I think some form of stopper arranged to be securely fastened should be compulsory, and I hope that some inventive genius will soon produce an intercepting trap with a patent stopper, easily fixed, perfectly airtight, and immovable under ordinary circumstances, yet easily removed from the manhole top in case of a block, and not substantially more expensive than the ordinary type.

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JOHN S. BRODIE, M.Inst.C.E.

**D**O sewers require ventilating at all? Probably, that infallible authority, the Man-in-the-Street, thinks they don't; that sewer smells are largely, if not entirely, imaginary; that ventilation is only a fad of medical and other sanitary enthusiasts; and that both himself, and his immediate predecessors never suffered any inconvenience from sewer air or sewer gas.

But even usually well-informed people are to be found who are convinced that unpleasantly smelling air or gas issuing from a sewer grating is really not dangerous or injurious to health. This party has, until recently, had much scientific support, from the investigations of such scientists as Dr. Parry Laws, Dr. Andrewes, and others in this country, and of Professors Kirchner and Sokoya, to name only two, on the continent. These learned men have given us their assurance that there is no proof of there being any connection between sewer gas and the spread of epidemic diseases.

Yet another group of people are to be found who don't deny that gases of a dangerous nature are actually to be found in sewers, but who sincerely

believe in the bottling-up theory, presumably on the old principle of out of sight (or smell) out of mind (or danger). These latter advocate the closing up of all openings into or out of the sewers except the connections thereto made by the drains to houses and other premises, and then only by means of air-tight water-sealed traps.

Now, what are the simple facts on this subject?

1st. Every year cases are reported in the public prints of workmen, whose duty it is to see to the efficient working of sewers, being poisoned, sometimes fatally, by the escaping gas from the sewers; and for one case reported it is well known that at least twenty are never publicly made known, when the results are not fatal. Surely, the proof of the quality of the sewer air is in the breathing!

2nd. Why are those who are responsible for the health of the districts committed to their care, namely, the Medical Officers of Health, so anxious that the house (the unit of each district) shall be as effectually cut off from the sewer, by means of the intercepting trap, or some equally efficacious arrangement, as the ordinary householder is to keep out burglars? Because they are well aware of the dangers to health which would follow from a free communication between the sewers and the house drains.

3rd. We now have, as the result of recent bacteriological investigations by Dr. S. Rideal,\* Major Horrocks,† M.D., F.R.S., and others, very good proof that sewer air is "a nuisance and injurious to health."

If, then, we are all of one mind that sewers should be ventilated, the only question (a fairly large one) that remains is, by what method or methods can this object be best accomplished? Very many attempts have been made in the past, by more or less ingenious contrivances, to ventilate sewers. Most of the methods or systems tried have been found wanting, and are now consigned to oblivion.

Generally, it may be said that all efforts to ventilate sewers can be classified into three divisions, Natural Ventilation, Artificial Ventilation, Deodorization.

The Author will content himself with a description of one or more of the most important types only of each of the above methods.

#### NATURAL VENTILATION.

The natural ventilation of sewers may be said to range from the almost total absence of intentional ventilation of any kind, as at Bristol, to a

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\* *Journ. R. San. I.*, Vol. XXV., p. 596.    † *Journ. R. San. I.*, Vol. XXVIII., p. 176.



well thought-out system of high shaft inlet and outlet ventilators, such as has been so thoroughly worked out and is now being adopted at Leicester.

The beginnings of sewer ventilation were doubtless the untrapped house drains and gully connections of the middle of the last century.

Then followed the regularly made shaft connecting the surface of the street with the underlying sewer, generally called a ventilating shaft, but, when of sufficient size to admit the passage down it of a workman, known as a manhole, with open gratings, so as to allow sewer air to escape, or fresh air to enter, it mattered little which.

Then a distinct epoch was marked in the history of sanitary engineering by two important events in 1870 and 1871. One was the invention of the intercepting trap, by Mr. W. P. Buchan, of Glasgow; the other was the succession of the late Sir Robert Rawlinson as Chief Engineering Adviser to the Local Government Board. It may be truly said that the practical sanitary progress made during the last forty years is due to the pioneer work of Sir Robert Rawlinson, who so well and truly laid the foundations, both broad and deep, upon which all the good sanitary work has been built.

Under Rawlinson's sympathetic guidance, Buchan's, or what is now known as the intercepting, trap, was fixed on nearly all house drains, so that no aerial connection between the separate house drains and the common sewer should be possible. He also recommended "that wherever a trap is placed on a sewer or drain, there should also be means for sewer and drain ventilation provided to relieve such trap." Unfortunately the Local Government Board, in their By-laws, did not insist on a ventilator being fixed on the sewer side of the trap, with the result that, while house drains were provided with high shaft ventilation, sewers were not, but relied entirely on the surface gratings. It is easy to see, therefore, that with the general introduction of the intercepting trap, and the consequent shutting off of sewer ventilation by means of the house drains, the conditions of the sewers as regards the emanation of foul smells from them gradually became worse, until about the year 1880 onwards, the question became pressing. In many towns the sewer gratings were gradually closed as they were complained of; in other towns the surface gratings were allowed to remain open, but high shafts against buildings were connected to the sewers; in still other cases a combination of both methods was tried, until by the able experiments and tests made by Mr. Mawbey at Leicester, it is now generally admitted that good sewer ventilation is possible by high ventilating shafts alone, without surface gratings.

From inquiries recently made, the author finds that in regard to

natural sewer ventilation in English towns, the present practice is approximately as follows: 81 per cent. have adopted upright shafts in addition to surface gratings; 14 per cent. are now substituting high ventilating shafts for surface ventilators, which are being closed; 5 per cent. have surface ventilators only.

From the above, we may conclude that sewer ventilation at the surface of carriage ways is now rapidly going out of use, as it should do.

The upright ventilating shafts, whether placed against buildings, or as special columns placed on the footpaths, should be of sufficient height to be from 6 to 10 feet above the ridges of adjacent buildings, of a proportionate sectional area to the sectional area and capacity of the sewer to be ventilated, and from 150 to 200 yards apart.

The first cost of a high shaft system of natural sewer ventilation averages about £120 per mile of sewer ventilated, and the annual cost, including ten per cent. allowance for depreciation, averages about £18 per mile of sewer ventilated.

#### ARTIFICIAL SEWER VENTILATION.

Two systems of artificially-produced air-currents in sewers now hold the field, and both have good promise of ultimate success.

One is the Webb System, a method of extracting foul air from sewers, and at the same time cremating it by heat, invented and patented by Mr. Joseph E. Webb.

In appearance, the Webb Sewer Ventilator closely resembles an ordinary incandescent street lighting gas lamp, with a cluster of three incandescent gas-burners. By a system of heat reflectors, the sewer air or gas is drawn from the sewer through an air-tight copper tube fitted inside the lamp column, into the narrow neck of the lamp, about  $3\frac{1}{4}$  inches in diameter, through which the sewer air is made to pass at a temperature of about  $550^{\circ}\text{F.}$ , generated by the three incandescent coal gas burners in the lamp.

By the Webb method it is claimed that the following are secured:—

- (a) The convection of rays of light and heat by reflectors, thereby producing convex rays.
- (b) The complete destruction of organic matter in the sewer air by focussing heat-rays on it.
- (c) The conservation of heat by air or pneumatic isolation.
- (d) That there is no possibility of organic matter or foul gases passing through the apparatus without being destroyed, from the fact that it does not rely on actual contact with heated surface, but is forced through superheated space.

The cost of installing the Webb system is about £58 per mile of average size of sewer ventilated, and the annual cost, including 10 per cent. depreciation, gas, attendance, &c., is about £33 per mile of sewer ventilated.

The other artificial sewer ventilator is that recently introduced by the well-known sanitary engineers, Messrs. Shone & Ault.

This system is known as the hydro-mechanical system, and is the only method by which the double object of ventilating both the house drains and the common sewers is accomplished by one operation.

The system is based on the principles of coal mine ventilation. The foul air is exhausted from the sewers by means of a fan, driven electrically or otherwise, and the admission of fresh air is rigidly controlled at all openings leading into the sewers. By means of these controllers or regulators, which are adjustable and fixed in the intercepting trap chambers of the house drains, and at other openings where necessary, only sufficient fresh air is drawn into the sewers to keep them wholesome and free from danger, and the amount of vacuum caused by the fan is so graduated as to avoid any possibility of destroying the water-seals in the house drain intercepting traps.

The foul air, when extracted by the fan from the sewers and house drains, is forced through a deodorizing medium, and is then discharged into the open air by means of a high upright pipe or column, of adequate sectional area. The system has been tried, on a limited scale, at Leicester, and has been found to give satisfactory results, at a fairly moderate cost.

It must, of course, be borne in mind that by the hydro-mechanical system, not only is the sewer ventilated, but the house drains also, and allowing for the saving to be effected by doing away with the present inlet and outlet ventilators under the present house drain ventilating system, the cost of Messrs. Shone and Ault's system will probably compare favourably with that of the present system of house drain ventilation *plus* that of any other efficient sewer ventilating system.

In the author's opinion, this system is well worth being tried in new districts, when the first cost would not be great, whereas its adoption on existing sewerage systems, while not impossible, would necessarily involve greater cost.

Exclusive of the ventilation of the house drains, and providing for sewer ventilation only, the cost of installing the hydro-mechanical system is, on the average, about £150 per mile of sewer ventilated; and the cost of working and maintenance, including 10 per cent. depreciation, is on the average about £30 per annum.

**DEODORIZATION OF SEWER GASES.**

Many devices have been tried to render harmless the foul odours emanating from sewer ventilating openings.

As far back as 1862, Sir Robert Rawlinson advocated the use of charcoal filters, and this idea was taken up and thoroughly tried by Mr. Baldwin Latham in 1879 and onwards, but along with many others has now been discarded as being worse than useless.

The apparatus most in use at present as a sewer-air deodorizer, is that of the Reeves Chemical Sanitation Company.

This apparatus consists essentially of two chemical ware vessels, placed in a recess formed in a sewer manhole shaft. One of these vessels contains a patented chemical mixture called Reevezone, and the other contains strong sulphuric acid. These chemicals are caused to mix continuously, the result of their mutual reaction being the formation of sulphurous acid gas, oxygen gas, permanganic acid, and soda sulphate. The gases purify the foul air with which they come in contact, whilst the oxidising solution falls into the sewer and is said to have a beneficial effect on the sewage.

The Reeves apparatus has been extensively tried at Edinburgh, Southport, and other places, and is now understood to be under trial in a modified form on some of the large main sewers of London.

The cost of the installation of the Reeves system is about £100 per mile of sewer ventilated, and the annual cost of maintenance, including 10 per cent. depreciation, about £44 per mile of sewer ventilated.

*Summary of the Approximate Cost of the above methods of  
Sewer Ventilation.*

Name of System.	First cost per mile of sewer ventilated.	Annual cost per mile of sewer ventilated.
	£	£
High Shaft Ventilation ... ..	120	18
Webb's System ... ..	58	33
Shone and Ault's Hydro-mechanical System	150	30
Reeves' Chemical System ... ..	100	44

It is submitted, from the facts and figures given, that the satisfactory ventilation of common sewers is practicable, at a cost which is not unreasonable; and also, that no public sanitary authority is now justified in neglecting its responsibilities in this connection under the Public Health Act, 1875, which plainly states (Sec. 19) that "Every local authority shall cause the sewers belonging to them to be constructed

covered, *ventilated*, and kept so as not to be a nuisance and injurious to health."

#### THE INTERCEPTING TRAP.

It will be gathered, from what has gone before, that the author is not among those Borough Surveyors who have recently taken to agitating for the abolition of the intercepting trap. Not its abolition, but its proper construction as regards size, shape, materials, and proper fixing, is required as regards that useful sanitary appliance.

At bottom, the objections to the trap appear to be as follows:—

1. That it is a hindrance to the proper ventilation of the common sewer. Surely, the exit of foul air from the common sewer, *via the private house drains*, to the open air, only needs to be clearly stated to carry its own condemnation, for reasons which must be obvious to everyone.
2. That it is of itself a small cesspool, liable to produce insanitary conditions. This objection simply begs the question, as, if the trap is laid with reasonable care and intelligence, under normal usage no such insanitary conditions can arise.
3. That it is constantly stopping up and causing trouble, expense, and danger to the household. The author, from the experience of a life-time, can bear testimony to the fact that in every stoppage in an intercepting trap coming under his observation, one of three reasons have been found as the cause of stoppage:—  
(a) An imperfect trap, having practically no gradient, or drop, in itself. (b) A good trap, improperly laid, with the joints badly made. (c) A trap of proper construction and well laid, but such utensils as worn-out blacking brushes, and similar articles, found in it, which should have been put in the house-refuse bin, and not sent down the house drain.
4. That the intercepting trap causes a considerable diminution of the limited fall available in many cases for the house drain. The proper amount of fall, or drop, for any house drain interceptor is certainly not more than *two inches*, and if the gradient of the house drain is cut so fine as not to allow that, it ought *not* to be.

The author is of opinion that, until the present method of water-carried sewage is superseded by some greatly improved method, which at present is certainly not within sight, the intercepting trap is a sanitary necessity, and cannot with safety be dispensed with.

DR. GILBERT J. FOWLER (Manchester) said that he had had occasion not infrequently to go down sewers, and recently he had taken a certain part in experiments on the ventilation of sewers, which had been carried out in Manchester. Opinion on the subject for discussion was evidently still divided. On the one hand they had a large body of experience showing that the health of sewer men was, on the whole, good; and the researches of Parry-Laws and Andrews had been confirmed by Miguel in Paris and by Professor Delépine in Manchester, who had also been unable to find the presence of the specific organisms of sewage in sewer air. One of the sights of Paris was a journey through the sewers. On the other hand, the opinion of those who believed sewage gas to be dangerous to health had received confirmation from the researches of Major Horrocks. It was necessary, therefore, carefully to consider the conditions leading to the production of sewage gas. In the first place, the evolution of sewage gas was due to *accumulations* of foul matter in the sewer. Shortly after joining the Corporation's service in Manchester he had occasion to investigate the composition of gas which had been set alight by a workman's candle, and which had caused a serious accident. He had found that the gas consisted mainly of marsh gas and hydrogen, and was evidently evolved through the decomposition of sewage in the dead end of an old sewer, which had virtually become a septic tank. These deposits, also, were likely to evolve sulphuretted hydrogen, which, in a confined space, was more highly poisonous than many people were aware, as had been shown by more than one fatal accident in Manchester. The danger of evolution of such gas was greatly increased by the presence of certain trade effluents (*e.g.*, strong acids), and fairly drastic powers had been obtained in Manchester to prohibit the discharge of such effluents into the sewers. It was very important, however, to prevent as far as possible the formation of deposit in sewers, by taking care that the sewers were constructed of good material and with adequate fall. This was more easily done in the case of newly-designed systems than where the main system had been laid down many years ago. In Frankfort and in the suburbs of Berlin he had been down sewers where the material used was either glazed brick or very high quality smooth red brick; and also the manner of construction was such as was seldom attempted in this country. The next factor in the evolution of sewage gas was *temperature*. In the course of his work in India he was much struck by the rapidity with which sewage decomposed in tropical temperatures; in consequence of this, special precautions were taken (*e.g.*, in Bombay) before entering sewers. It occurred to him that the high temperature obtaining in Gibraltar (where, he believed, Major Horrocks's experiments were carried out) might partly account for the extraordinary results obtained. A third factor to be considered was the *velocity of flow* of sewage and air. It could be shown by anemometer tests in the sewer that the velocity of air was greatest immediately above the surface of the sewage. In the comparatively small pipes used by

Major Horrocks the velocity of the air currents would be much greater than in ordinary sewers. Bearing in mind the above factors in the problem, the question arose what remedies should be adopted. Experiments had been carried out in Manchester, and had been published in a report to the City Council, to test the efficiency of various methods of artificial ventilation. The Shone system had been found to work well, but necessitated air-tight sewers, a condition which it was not always easy to fulfil. The Webb lamp was successful in preventing nuisance and in destroying any organisms in the escaping gas, but had no great power of ventilation. The general conclusions seemed to be that every care should be taken in the design and construction of sewers to prevent accumulation of sewage matter, and that ventilation should be effected by shafts placed in suitable positions.

MR. C. BROWNRIDGE, (Birkenhead) congratulated Dr. Coutts and Mr. Brodie on the fair way in which they had stated their case. One was rather apt to look upon the subject as a sort of hardy annual, and he was afraid that the man-in-the-street might feel disposed to say "A plague on both your houses": for sanitarians seemed to be divided into two camps, one favouring open ventilation and surface gratings; and the other, upcast shafts. Generally he had found mechanical means of sewer ventilation a failure. He was now in a town where the intercepting trap was general, and where they were swinging over from the surface grating to the high shaft; but he thought they would have to look to the bacteriologist to guide them very much in the matter, and tell them from actual investigation when and under what conditions sewer air was dangerous; the engineer would then have something definite to work upon. The engineer had to see how he could meet the objections of the public, for the latter did not want to be confronted with the smell as they walked along the street. It was, however, not always the smell they experienced that was the real danger, and he thought bacteriologists might give a little assurance on that point. The smell that came from a sewer grating, although nauseous, was not necessarily one that would cause a serious illness, but that was no reason why it should be there. The question was, where were they going to take it; for if a pipe was conveying gases which were a danger to health, then it was equally dangerous, or nearly so, to discharge them above a bedroom window as it was to discharge on the road level. One could not dissociate the subject of sewer ventilation from the design and condition of the sewers and drains. If they did not have good sewers they knew that they were likely to have smells. If they had good sewers, they had very few smells; but how few took precautions to see that they had good sewers and drains. Special precautions were usually taken to insure that the joints of sewers and drains were made sound and watertight, but the equally important question as to whether



the pipe itself was reasonably watertight was often neglected. A bad joint was a danger. An imperfect pipe was likewise a source of danger by reason of the pollution of surrounding soil which resulted. Since November last he had tested under a 20-ft. head for one hour the pipes of thirteen makers, and he had found that only five makers' pipes would stand that test. Consequently, he could not help saying that in many towns there were being put in the ground pipes which were themselves setting up a condition of affairs which could not possibly conduce to the health of the community. In his opinion the intercepting trap was all right in its place if it were properly designed and laid. But the 2-gallon flush from water-closets, which was the limit permitted in many towns, was not sufficient to remove everything from the trap. Consequently, in considering the intercepting trap they ought not to neglect the question of the flush, and they ought to insist on one of not less than 3 gallons. One of the requirements of the model by-laws was that the air inlet should be down somewhere near the floor, and the outlet higher up on the side of the house; but engineers had proved that air currents in a sewer were altogether dependent on the outside wind, and that the outlets and inlets were often thereby reversed in action. If, in providing intercepting traps, they would in all cases put down two pipes of about equal height, it would remove most objections. In Birkenhead they would have no surface manholes in new streets, but upcast shafts at limited distances, these being mainly for the adjustment of the air pressure in the sewers, and not necessarily for ventilation.

DR. E. SERGEANT (Lancashire County Council) said he differed from Mr. Brownridge, who stated that smell need not be dangerous to health. It was a view that many people held, and he thought they were wrong, because he looked upon a smell as an indication of a danger to be avoided. He thought medical officers and engineers had been very much led astray by the researches of bacteriologists, who had done very useful work and on whom they relied very largely; at the same time he should not claim infallibility for bacteriologists. They had, for example, allowed them to assume that if one wanted good air one should go into a sewer. He maintained that was wrong. It did not accord with his own experience, his view being that although sewer gas might not produce a specific disease, it rendered the individual more susceptible to attacks in certain ways. He strongly adhered to the intercepting trap, which he thought should be looked upon as the first line of defence.

MR. COARD S. PAIN (Liverpool) said he would suggest that the man instanced by Mr. Brodie was more likely to have been poisoned by gas which had not escaped from the sewers than by gas that was escaping. As a rule, sewer men were



healthy, and accidents arose chiefly from sudden rainstorms and in unventilated lengths from the absence of oxygen.

No doubt, from a municipal point of view, shafts placed up buildings were an ideal form of ventilation; as the generation of sewer gas was prevented, and the foul air was carried above the level of pedestrians and inmates of houses.

The objections were (a) interference with the rights of property and architectural appearance; (b) the practical impossibility of continually testing to be assured that no defects occurred in the vent pipes, even if they were perfect at first; (c) the serious risk of other defects which were almost certain to arise in course of time.

If sewer gas could be permanently destroyed by cremation, it would seem that the provision of exhaust fans at the lower ends of arterial sewers to take the foul air through incandescent tubes would answer, but the practical difficulty would probably be found in drawing foul air equally from all lateral branches, as there was always a tendency for such currents to follow in one direct course. This being so, it would seem that the converse system would be more likely to be effective, as by it the volume of air forced into the sewers would tend to restrict the generation of sewer gas, and thus render the air at the outlets (which would be carried well above window openings) less vitiated, if not innocuous.

Whether sewer gas was capable of carrying disease or not, it was unpleasant and nauseating; hence, if for no other reason, intercepting traps were desirable. The objection to them as containing cesspools of liquid would not apply in the case of a 6-in. interceptor, where the contents were constantly changed before any ill effects could result; though in 9-in. or 12-in. interceptors (the use of which, in his opinion, was unnecessary) it might be otherwise. They hardly ever stopped up excepting from preventable causes, such as blown sand and the presence of domestic articles, which had no business in the drain.

The diminution in the gradient of the house drain in consequence of interceptors being fixed was really trivial. The use of ventilating shafts attached to house drains for sewer-ventilating purposes was undesirable, owing to the frequent imperfect obstruction of such drains, and from their liability to deteriorate from accident, age, and alterations.

If sewer air was unhealthy in the street, it obviously was more unhealthy if introduced into a house, and the risk of such introduction would be infinitely greater if the house drains were used for sewer ventilation.

It appeared to him that one of the advantages of intercepting traps lay in the exclusion of rats, which were always present in sewers, from the drains of the house.

As regarded the possibility of typhoid being contracted by germs carried in the air, without wishing to trespass upon medical ground he would draw attention to some extremely interesting evidence given in the recent Malvern case, at which he was present, where it was stated that typhoid bacilli were very

delicate and could not flourish under a temperature of 15° C., and that typhoid could not result unless the bacilli were swallowed.

MR. A. J. PRICE (Lytham) said he did not think it was desirable to copy Bristol and have no ventilation, but it was questionable whether so great an amount of ventilation as recommended by many engineers was necessary; at previous meetings of the Institute he had stated that it was not ventilation they needed, but vent. From the experiments of Major Horrocks, quoted by Dr. Coutts, it was proved that bacteria were not ejected from the sewers in the absence of air currents, and that, he thought, showed that we could have too much ventilation. They were all agreed that surface ventilation was not only obsolete, but offensive and dangerous. At Lytham, whenever there was a complaint of a surface ventilator being offensive, he promptly blocked it up; and had for some time past erected tall shafts about 300 yards apart. The size of the shaft would depend upon the size of the sewer. In Lytham he found 6-in. shafts thirty feet high ample; but in Brighton they erected a number of tall shafts two feet in diameter.

He had a strong objection to putting sewer ventilators against houses, and had no sympathy with the views of those engineers who wished to compel householders to ventilate the sewers as well as the house drains up the side of their houses. The sewer ventilators should as far as possible be put in the public streets. With regard to mechanical ventilation he agreed with Dr. Coutts, rather than with Mr. Brodie's views on that point. He agreed there might be places where it would be desirable to use such a system as Shone's, but he did not think that it would work equally well in fine and wet weather. If the system was not automatic it was going to add greatly to the expense, and he could not see how it was going to work efficiently and economically during a heavy rainfall; for at such a time neither the sewers nor the house drains required any ventilation beyond vent. There was no smell in the sewers at that time, but in dry hot weather it was a very different matter.

With regard to the Webb lamp, he had had no experience; but his experience with other gas lamps showed they cost about £10 each per year for gas, and had been abandoned. They had been told that the Webb lamp had an outlet of 3¼ inches in diameter, and as that was only about one-fourth the area of a 6-in. shaft, and the lamps appeared to be spaced about a quarter of a mile apart, how were they going to efficiently ventilate the sewers on that system? There were certain positions where it might be advisable to cremate or disinfect the sewer gas, but he should not be prepared to adopt it as a general system; for he thought they could get better results with tall shafts at a much less cost. With 6-in. shafts placed 300 yards apart, costing £10 to £12 per shaft, they could ventilate a mile of sewers for £70, and the cost of painting the shafts and emptying the rust boxes should not cost £5 per year for each mile of sewer.

He was in agreement with Dr. Coutts and Mr. Brodie with regard to the

intercepting trap, but did not agree with those engineers who contended that it should be done away with. Gullies near to windows in front of houses were very apt to become unsealed in hot weather, and in these cases it would be distinctly objectionable if the intercepting trap were absent. Another point was that the Local Government Board would not sanction any by-laws unless provision was made in them for the fixing of an intercepting trap. Therefore, if they did not see that these traps were put in they ran a great risk if there was any infectious disease in the house. They all knew that when the doctor failed to diagnose the cause of the disease, he generally fell back on the drains; and if two or three medical men agreed that the outbreak was due to the absence of the trap, the local authority would be likely to be mulcted in heavy damages. Even if it were held by other doctors that the trap was the cause of the disease, the local authority had no legal responsibility; for they could only be held to be doing what they were legally bound to do. He was a strong believer in two shafts on a drain, both taken up to such a height that the gases from the drain were discharged safely; but had a strong objection to the mica flap on the air inlet, for he had seen it in practice lead to the unsealing of other traps.

MR. J. S. BRODIE, in reply, regretted that there were not any advocates of the abolition of the intercepting trap present. He thought they would all agree that the old surface ventilator was dead and gone, and that good ventilation could be achieved by means of shafts fixed along the kerbs or at the ends of houses, closing altogether gratings on the surface of streets. Mr. Mawbey, the borough engineer of Leicester, had established that, and they were all obliged to him for what he had done in showing that sewers could be ventilated by shafts only. Bacteriologists had been alluded to with a lack of that respect to which they were entitled, but a crumb of comfort for them was that borough engineers were waiting for a lead from them in regard to the point as to what were the constituents of sewer gas, and what was the proper way to deal with it. He had read with considerable interest the account of the researches of Major Horrocks, but he should like to have these corroborated, because the conditions in Gibraltar did not strike him as being the same as those in this country. For his own part he had very little doubt that they were correct. People said there was very little harm in a smell, but he for one said they must get rid of those smells from sewers. The question of sewer ventilation should no longer be left until complaints arose, and then tried to be remedied by more or less make-shift devices; but should be clearly and definitely provided for in connection with all new or extended systems of sewerage, and the cost included in the capital expenditure for the same.

DR. COURTS, in replying to the discussion, expressed his disappointment that no one taking part in it had voiced the opinions of those who believed in

the abolition of the intercepting trap. He would have been interested in hearing the arguments which they might have brought forward, and particularly how they would have explained the results of Major Horrocks's experiments. Almost the only criticism of Major Horrocks's experiments came from Dr. Fowler, and he agreed with Dr. Fowler that as these experiments had been carried out in the warm climate of Gibraltar, it would be necessary for further experiments to be carried out in England to confirm them or otherwise, and to show how far the conclusions would apply in this colder climate.

He agreed with Dr. Sergeant that the smell of sewer air was not a negligible matter: if it was not always dangerous, it might be regarded as a danger-signal.

He did not agree that there was the same danger in drain air as in sewer air; as in sewer air there was the possibility of danger from the disease germs coming from all the infected drains entering a sewer, whereas the house-drain air could only be dangerous when disease was actually on the premises. It was therefore very desirable to cut off the house-drain from sewer air.

As to the question of the difference between the danger of drain or sewer ventilating openings at or near the ground level as compared with those reaching well above the house-tops, he thought the latter were far less dangerous, as owing to the greater air-movement the sewer or drain air quickly became very much diluted, and the germs blown away from the neighbourhood of the houses. As with other poisons, dose was of great importance in germ poisoning, and the more rapid and extensive the dilution the less the danger.

He was of much the same opinion as Mr. Price in regard to ventilating columns, that they need not be placed at very frequent intervals, and that their chief service was to act as safety valves by preventing the forcing of the intercepting traps on the house drains.

MR. E. M. BATE (Frinton-on-Sea) wrote that, in discussing this subject, it might be of interest to state what had been done at Frinton-on-Sea to overcome the difficulties experienced in sewer ventilation.

Frinton-on-Sea was a purely residential town with wide roads and a good class of property. The air was exceptionally pure, and the least odours were easily detected.

The first portion of the main sewerage was carried out in 1897, with self-cleansing sewers and with ornamental iron ventilating shafts fixed on the Esplanade and several other parts of the town. These shafts were the outlets for sewer gas and the medium for ventilating the sewers. Since 1897 the sewerage had been extended, additional ventilating shafts had been fixed, and the length of the sewers was now upwards of twelve miles.

On account of the numerous complaints received by the Council as to the unpleasant odours from the ventilating shafts, he was instructed to prepare a report, with recommendations, on the ventilation of the sewers.

He submitted a report to the Council in June, 1906, recommending, after investigation, the Reeves new type ventilator for the Esplanade sewer. This ventilator, which had been tested constantly since it was fixed, did the work claimed for it. Caink's ventilator has been used successfully as a sewer safety valve.

In addition, manholes with apparatus for ventilating the tidal sewers and the low-lying portion of the town had been constructed. The outfall sewer was charged with fresh air from the apparatus chamber at every tide, and the tidal action was used as a motive power for ventilating the sewers in the adjoining district. The gases which were previously forced backward and forward twice each day into the town were now, by this scheme, successfully dealt with at every tide.

With the results obtained at Frinton-on-Sea, he did not think the subject of the abolition of the intercepting trap with the view of ventilating sewers on private property needed discussing.