The food is of the most nutritious quality that can be had, consisting chiefly of pea soup (including some animal food); suet puddings, with treacle, jam, or raisins; Irish stew; and, where desirable, a lighter kind of soup for young children. Cooking for the sick might be added.

The operation of the plan is carried out by establishing cooking centres in several densely-populated parts of the town, where the food is sold at mid-day *to all comers*. Children's dinners are also provided and consumed on the cooking premises at ½d. and 1d. each.

The only charitable portion of the plan is carried out by the sale of tickets, 1d. each, to the clergy and others, to be distributed amongst the very destitute in severe weather.

The MAYOR OF WORCESTER said that it was necessary to supply the human body with food of the right character. Dr. Strange's paper had very ably illustrated the best class of food to be used for this kind of cookery. They knew Dr. Strange's zeal in this matter, his self-denying labours, and the very beneficial results which had ensued. The cheap dinners and the cheap breakfasts given in Board Schools had produced most sanitary results, inasmuch as the physique and tone of the school children had benefited considerably. He desired to add his testimony to the services Dr. Strange had rendered in this way in the city, and thanked him for bringing the subject forward.

Captain LOCKE (Worcester) said that from his long thirty-six years' experience as a sailor he believed the pea soup mentioned by Dr. Strange was the most nutritious and best fitted for use in that way. He might add that both passengers and crew always enjoyed the above three days in the week as part of their dinner. They always carried split peas, and used rain water if they were fortunate enough to catch any.

CONFERENCE OF MEDICAL OFFICERS OF HEALTH.

This Conference was jointly arranged by the Institute and the Society of Medical Officers of Health. A full report of the subjects discussed is given in "Public Health," October, 1889, pages 162—173.

SECTION II.

ENGINEERING AND ARCHITECTURE.

ADDRESS

BY HENRY JOHN MARTEN, M.Inst.C.E.

PRESIDENT OF THE SECTION.

INTRODUCTORY.

THE subjects for consideration in this section—namely, Engineering and Architecture—although necessarily limited to their sanitary aspects only, cover a wide area, and present numerous and important features, each of which would be more than sufficient for the text of an address.

For instance, the works in connection with fen drainage, town and village sewerage, house drainage and domestic sanitation, water supplies and fittings, luminants in their sanitary aspects, building materials and methods of house construction, warming and ventilation, smoke abatement, and many other matters too numerous to mention, are all included within the limits assigned to this section, and you will probably have the opportunity of discussing some of them.

Although considering the extent of our information, and the light we now have with respect to sanitary matters, and the extent also of our opportunities, we have not much reason to boast of the progress we have made as a nation in practical sanitation, compared with what we might have made during the past 40 years; yet it may be permissible—in fact, it may be advantageous—to take a retrospect of some of the advances made during that period, and I invite you to do so with me for a short space of time.

Fen Drainage.

Amongst the subjects which I have named in my introductory remarks as within the range of those referred to us is that of fen drainage.

The sanitary influences of the works carried out in this department of engineering have, I think, been much overlooked, as those sanitary influences have been *incidental only* to the main objects of fen drainage works, which have been principally directed to the improvement of fen and marsh lands for pasture and other agricultural purposes.

From a sanitary point of view, this subject of fen drainage may not at first sight appear to be a large one, but considering that in the fen counties of Lincoln, Huntingdon, Bedford, and Cambridge there is a population of 850,000 persons, it is certainly worthy of attention.

During the past 40 years great improvements have taken place in this department of sanitary work.

The old windmill, with its irregular, inadequate, and imperfectly applied power, has given way to greatly improved pumping machinery actuated by steam, by which means the line of saturation has been kept at a much lower level than formerly was possible over large tracts of fen country.

The total quantity of land which has to be kept dry by pumping in the valleys of the Ouse, the Nene, the Welland, and the Witham rivers is about 455,000 acres. That acreage is equal to about 700 square miles, or equal nearly to the whole area of Worcestershire; and to show the improvements which have been effected in some parts of these fens, I find it stated in a paper by Mr. Lawrence Gibbs, which appears in Vol. XCIV., Part IV., of the Minutes of Proceedings of the Institution of Civil Engineers, that two fens, viz., Deeping Fen in the Welland Valley, and Littlepool and Downham Fen in the Ouse Valley, having together an area of nearly 60,000 acres, which were formerly kept "in a half-cultivated state" by means of 119 windmills, are now effectually drained by means of four steam engines.

The lowering of the line of saturation, or, in other words, the lowering of the underground water level effected by these improvements, has a most important bearing on the sanitary condition of those fen districts.

When the level or line of saturation is higher than the point below the surface of the ground which is affected by the heat of the sun, or when the level is within capillary range of the surface, large volumes of miasmatic vapours are occasionally given off, which spread their depressing influences far and wide over the fen country.

When, on the other hand, the line of saturation is drawn down below the points named, the evolution of miasmatic vapours is greatly reduced; and with their disappearance, numerous forms of febrile and rheumatic complaints cease to exist.

Great sanitary advantages have resulted also from "The Land Drainage Act of 1861," in accordance with the provisions of which numerous Drainage Boards have been constituted under the authority of "The Land Commissioners for England," whose duties have now been transferred to the recently constituted "Board of Agriculture."

By their favour, I have been furnished with the information, tabulated below, which shows the wide areas over which the beneficial influence of the Land Drainage Act has been extended since it came into operation twenty-eight years ago.

Description.	Number.	Counties.	Area, Acres.	Amounts authorised to be borrowed for Works.
				£
(1.) Commissions of Sewers Recommended	12	6	28,811	40,250
(2.) Separate Drainage Districts Constituted	27	16	65,306	104,535
(3.) Thames Valley	..	..	55,472	71,450
(4.) Somersetshire Drainage Acts	..	..	109,529	66,550
			259,118	282,785

It will be seen, therefore, that "the Land Commissioners for England" have incidentally contributed to the amelioration of the sanitary condition of the inhabitants residing on no less than a quarter of a million of acres, or 400 square miles of country, by the constitution of numerous drainage districts, and by authorising an expenditure for carrying out carefully considered schemes for main drainage and other such works of more than a quarter of a million sterling. I say carefully considered schemes, because as one of their engineering advisers, I know how minutely every point is considered before any drainage district is constituted and before any works are authorised by the Land Commissioners.

The main drains of many old districts have also been greatly improved, by the lowering of the outfalls.

In one case, that of the Grand Sluice at Boston, the sill of the new and enlarged sluice has been lowered 3 feet and the seaward channel 8 feet, thereby practically raising the level of 500,000 acres, or 800 square miles of fen-land considerably above the previous line of saturation.

There is no doubt that these great improvements have materially raised the sanitary status of all such districts, and have done much to minimise the physical disadvantages of fen-life.

In proof of this, Dr. Farr, in his "Vital Statistics" (pages 136 and 137) states, "The great land drainage works have had great influence in improving the health of the inhabitants of the Isle of Ely, as by their means the atmosphere has been purified and dried."

Again the same authority states that at Orsett, near Tilbury, in Essex, a remarkable reduction in the death-rate has occurred during the thirty years, 1841 to 1870, "partly due to sanitary improvements, but mainly to the drainage of the land and consequent dryness of the soil."

He also states that, in three fen districts in Cambridgeshire, namely, North Witchford, Whittlesea, and Wisbeach, containing an aggregate population of between 50 and 60 thousand persons, the death-rate, in the thirty years between 1841 and 1870, has been reduced from $25\frac{3}{5}$ to $20\frac{1}{3}$ per thousand, or nearly 20 per cent.

He also states that in Wisbeach, the deaths from phthisis were reduced from 2 per thousand in the ten years, 1851-60, to 1·6 per thousand in the ten years, from 1861 to 1870—or 20 per cent.; whilst at Orsett deaths from the same cause were reduced in the same periods, from 2·8 to 1·9 per thousand, or 32 per cent.

Town, Village, and House Drainage.

Passing from the subject of fen drainage, I now propose to make a few remarks on the improvements which have been effected, during the past forty years, in town, village, and house drainage.

I remember the early reports of the Sanitary Inspectors of what was then termed the Board of Health, as to the state of things forty years since, with regard to these subjects.

The reports disclosed, as then almost universally existing, a most horrible state of affairs, which is now, happily, only exceptional.

Open and almost stagnant sewers in close proximity either to the front or back doors of rows of houses, and, whilst festering there, giving off large volumes of poisonous gases.

Leaky dumb-wells, sunk in porous ground, receiving the sewage from large numbers of houses, with the pumps for the supply of the said houses drawing their water from shallow wells sunk in close proximity to those dumb-wells.

Drains, where they did exist, untrapped, and through which at night, when all the doors and windows in the houses were closed, the only supply of air for the inmates could be obtained.

Sewers, properly described as only "elongated cesspools," much too large for the work to be performed, constructed in many cases of porous materials, of very unscientific section, and with but little regard to gradient.

No one whose memory does not carry him back to that period, can now conceive of the amount of ignorant and selfish opposition, which Mr. (now Sir Edwin Chadwick, K.C.B.) encountered, when, acting as Secretary to the Board of Health of that period, it became his duty to call public attention to this state of things, and to suggest the remedies for them.

Obloquy was thrown upon everything he said or did in connection with sanitary matters. The facts as to the existing sanitary abominations which he had carefully collected and marshalled, were either boldly denied, or defended as at least necessary evils. Every vested interest, from the night-soil man to high municipal functionaries, was against him, and had he not been as patient as Job, and as callous to adverse criticism as the pachydermatous monster, described in the poem of which that patriarch is the hero, was to spears and arrows, he could not have accomplished the great sanitary revolution which has been his life work, and to which this generation is so much indebted.

I had the pleasure of making his acquaintance during the period when he was battling for sanitary reform against all these adverse influences, and I feel it one of the greatest honours of my life that the friendship then commenced has been continued up to the present time without break or interruption.

One of the great difficulties with which Sir Edwin Chadwick had to contend was the then existing idea that every sewer must be a "Cloaca Maxima."

Classical gentlemen when visiting Rome were shown that sewer amongst the other antiquities of the place, and being in the humour to fall down and worship any work of the imperial and practical Romans, they, of course, fell down and worshipped that particular work, which was all very well in its place, but which was not adapted for the universal and indiscriminate application which they made of it.

If this worship had been in the nature of a "silent culte" it would probably have done very little harm, but, unfortunately, the worshippers were zealous to make proselytes, and everywhere preached the doctrine of large sewers—"nothing smaller than such as a full-grown man could walk upright in,"—and, in fact, everywhere and for all sewage purposes, "Cloaca Maxima, Cloaca Maxima," was the cry.

Proselytes were, of course, soon made amongst the classical architects who had copied the buildings and smelt all the unsavoury odours of Rome, which ought not to have existed had "Cloaca Maxima" been all that highly poetic fancy had painted it; and when they returned to England and received commissions to build or re-build some of the stately mansions of our country gentlemen, they commenced operations by making large cavernous "Cloacæ Maximæ" under and about the foundations—easily satisfying their clients that all was perfection by reminding them of their early studies, and of the great name and glory of the "Cloaca Maxima;" with the unhappy consequence, that, for some *then* inexplicable cause, notwithstanding situation and every advantage of pure air and good water supply, the dwellers in the finished mansion were always victims to some form of the numerous complaints which we *now* know to be due to the presence of "sewer gas."

To show that I am not exaggerating, I may state that not long since I had to inspect a nobleman's house in one of the midland counties, which only 30 years since had been sewered by a leading London architect on the "Cloaca Maxima" principle. Within the last two or three years the house in question had become almost uninhabitable on account of the presence of sewer gas, traceable to these large sewers; and besides the health of the in-dwellers, a rental of several hundred pounds per annum, was placed in jeopardy.

This led to the doing away with the old-fashioned "Cloaca Maxima" under the building, and the introduction of the modern small pipe sewer and fittings, and the house is now free from that insidious guest—sewer gas.

I have mentioned the part taken by architects in the spread of "Cloaca Maxima" worship, and lest they should deem me unfair in singling them out, I am about to confess that engineers, after admiring the bridges, roads, and aqueducts of the old Romans in all parts of their empire, and especially the splendid remains of those works in Italy, were, like the architects, also smitten with the same unhappy disease of "Cloaca Maxima" worship.

It is needless to say that builders and contractors saw no reason to quarrel with "Cloaca Maxima" specifications which made domestic sewerage works "jobs worth doing."

Shortly after the advent of Sir Edwin Chadwick, however,

"Cloaca Maxima" worship received more of that gentleman's attention than its worshippers altogether appreciated; and after being severely wounded in several vulnerable points by that veteran sanitarian, this form of worship was, after a severe struggle, finally and ignominiously done to death in, I believe, a backyard in Westminster.

The way of it was this. Some practical but scientific sceptics one day took a peep into one of the old-fashioned metropolitan "Cloacæ Maximæ."

To their astonishment they found more than four-fifths of the sectional area of our "Cloaca Maxima" filled with putrid mud, over the top of which a little stream of gas-bubbling sewage was dribbling along; that is, they found the boasted "Cloaca Maxima" to be nothing more than a putrid mud trough with a trickle of sewage passing through it.

Having digested this fact, they bethought themselves of trying what would happen if this trickle of sewage were passed through a small glazed earthenware pipe.

Pursuing this inquiry in a methodical and practical manner, a length of such small earthenware pipe was laid down, and the "Cloaca Maxima" quantity of the sewage was poured down its throat, and to everybody's astonishment the little "earthenware pipe" accomplished not only all that "Cloaca Maxima" did, but even more—for it not only freely discharged the whole of the sewage passed into it, but left no festering sediment behind in the pipe.

Here was a great fact established, namely, that a small glazed earthenware pipe, laid at the same gradient as "Cloaca Maxima," could not only discharge all the sewage usually passed by its big brother, but was, in addition, "self-cleansing"—that is to say, it not only left no sedimentitious matter in it, but removed any extraneous matter purposely placed therein.

Now began the battle between the "Cloaca Maxima" principle and what in derision was termed the "pot-drain," and a right royal battle it was.

Architects, engineers, and builders were at first almost universally on the side of "Cloaca Maxima," whilst "pot drain" was supported by Sir Edwin Chadwick, backed only by stubborn facts.

However, after a hard struggle little "pot drain" gained so complete a victory over "Cloaca Maxima" that even its greatest devotees were eventually obliged to discard it as both a costly and dangerous specimen of antiquity.

This is the early history of our present system of sewage removal by water carriage, and so complete has been the revolt from the "Cloaca Maxima" principle, that I may mention as an instance of its discomfiture, I have for several years past, without stoppage or inconvenience, been passing by gravitation, up hill and down dale, the whole of the sewage of Dudley, a town in this county, containing nearly 30,000 inhabitants, through a pipe five miles in length and only 13 inches internal diameter.

Sewage Disposal.

It was soon found that the more perfect system of "pot pipe" drainage brought down to the outfalls not only a larger quantity of sewage than came down under the old system, but that the sewage was of a much more concentrated description.

The reasons for this were that under the "pot" system there was much less leakage into the subsoil, there were no sedimentary retentions, and there was a much more detailed collection than under the old "Cloaca Maxima" system, and these circumstances combined to give great urgency to the question as to what was to be done with the sewage on its discharge from the outfalls; and I remember the great battles which have raged, and which in fact are now raging, about the vexed question of sewage disposal.

The chemists were good enough to make the first attack upon the solution of this question, and dazzled our imaginations with "el dorado" calculations as to the manurial value of sewage deposit, when dried and manipulated according to their respective nostrums, so that the impression began to gain ground that all municipal rates and taxes would eventually be paid, and something over, out of the sewage-discharge of the urban localities.

Great, therefore, was the chagrin and disappointment when sewage manure company after sewage manure company had to be wound up, with assets consisting only of old bricks and mortar hardly sufficient in value to cover the auctioneer's expenses of their sale.

Then came the age of sewage farms and broad irrigation, and a large number of the leading municipal bodies purchased extensive tracts of farming land upon which to dispose of the sewage, and they thus acquired a sympathy with the great agricultural interests of the country, of which they had had no previous experience.

I am sorry to say that the experience these bodies thus acquired introduced them to those aspects of the agricultural question which are charged with originating the habit of "grumbling."

After the first few years everything appeared to be against sewage farms.

In manufacturing towns the farming operations had to be conducted with sewage largely mixed with corrosive acids, upon which acids it was found that neither cabbages nor rye grass would thrive. Actions were being prosecuted on all sides for damages for the pollution of the streams into which the effluent was discharged—as at certain times and seasons neither the land nor the vegetation could take up the whole of the effluent—some part of which had to be discharged raw into the streams.

In other cases actions were commenced to put a stop to the nuisance occasioned by noisome smells emanating from the farms and poisoning the atmosphere for long distances round. The farms were all found to be on too small a scale, and became "sewage sick," and additional land had then to be purchased at much more than ordinary agricultural value; and to cap all, the annual balances were almost universally on the wrong side.

After a few years' experience it was also found that raw sewage, containing all the sediment that was previously deposited in the old elongated cess-pools, was of a very clogging nature, and that in a short time it completely stopped all aëration to the roots of the plants; and that it was, therefore, difficult for them to thrive so well as in natural soils.

Various devices were adopted to overcome this last named evil, such as "intermittent downward filtration," by which system during one day the roots of the plants received a dose of sewage, and the next a dose of air.

These devices were adopted with varying degrees of success, but on the whole they failed to fully cure the evil; and at last it occurred to someone to try to precipitate the matters held in suspension out of the sewage, and only to run the clear effluent over the land.

In the first instance mere sludge tanks were adopted, with rough strainers, through which the sewage flowed at a slow rate so as to allow of the heavier matters being deposited in them, but these arrangements were found to be insufficient.

Lime and chemicals were afterwards added, which greatly aided the precipitation in the tanks, and another great stride was made by the adoption of "quiescent," instead of what were termed "flowing tanks," with a marked improvement in the effluent.

Under the quiescent system originated by the late Mr. James Lomax, of Bolton, the sewage when mixed with the chemicals was allowed a period of perfect rest in the tanks, and thereby the action of the chemicals became more rapid and effective. A further improvement was also effected by drawing off the effluent periodically from the upper portion of the water in the tanks.

The effluent when passed direct into streams from these precipitating tanks was however found, if alkaline, to set up a secondary fermentation, to prevent which the effluent water was passed over a small area of land, and the sludge was utilised as a sort of top dressing to surrounding land, or taken away by farmers as back loading.

The plan last described is that now generally being adopted, and all those interested in the question of effluents are turning their attention to the discovery of some cheap precipitant that shall render the effluent from the precipitating tanks clear and bright, perfectly innocuous to fish life, good as an irrigator when so required, and incapable of secondary fermentation. I think it not improbable that some such material, or combination of materials, may be found before long; in fact, some people are under the impression that it is already discovered, and, if so, then, with sufficient land for precipitating tanks and sludge deposit, we may congratulate ourselves that the sewage difficulty has become a thing of the past,—except in regard to a little item which, I fear, must always be present, and that is "annual cost."

The above is a sketch in outline only of the sewage disposal struggles of the last 40 years, so far as they relate to water carried sewage.

The sketch is necessarily devoid of detail, and it has only been possible to give the more salient features of the retrospect.

Much has still to be done before we can say we have approached perfection; but as every successful effort means thousands of lives either saved or prolonged, we all can only wish God speed to all patient and faithful workers in this department of sanitation, whether their efforts are directed to perfecting the "water carried" or any other system of "sewage treatment and removal."

Very great progress has been made during the past forty years in the details of the fittings for house drainage; and, as our successive exhibitions show, every year is adding to the perfection of domestic sanitary appliances.

They are, in fact, now so perfect, that there is no reason why every house in the kingdom should not be fitted with apparatus which would place it beyond suspicion of any want of proper sanitation; and I am glad to learn that, under voluntary examining associations, even the much-abused plumber is becoming an intelligent and skilled graduate in sanitation.

With some bright exceptions, the improvements in the sanitary conditions of our villages have, unfortunately, not kept pace with those connected with domestic drainage appliances, nor with those in urban districts; but the medical officers of the rural authorities are fully alive to the sanitary defects of their districts, and are doing good work in continually pointing them out; and I am hopeful that the large sanitary powers now at the command of County Councils will be put in force with advantage in those districts, and that in the course of a few years good results will follow.

In the report of the Sanitary Committee to the County Council of the County of Worcester, dated May 18th, 1889, and signed by Sir Douglas Galton as chairman, the following are set out as provisions of the Local Government Act, 1888, having reference to the powers, duties, and liabilities of the Council with respect to matters bearing on *Sanitation*, namely:

(*a*) The appointment, removal, and determination of the Salary of the Public Analyst [L.G. Act, § 3 (x)].

(*b*) Rivers Pollution Prevention Act, 1876 [L.G. Act, § 14].

(*c*) The making of Bye Laws for prevention and suppression of Nuisances [L.G. Act, § 16].

(*d*) The appointment of a Medical Officer of Health [L.G. Act, §§ 17, 18 and 19].

(*e*) Payments in substitution for annual local grants [L.G. Act, § 24], namely:

(i.) To the Guardians of Unions for payments to Public Vaccinators [L.G. Act, § 24 (2) (a)].

(ii.) To the Local Authorities, one-half of the Salary of the Medical Officers of Health and Inspectors of Nuisances [L.G. Act, § 24 (2) (c)].

(iii.) To the Guardians of Unions towards the remuneration of the Registrars of Births and Deaths [L.G. Act, § 24 (2) (d)].

(iv.) In respect of the maintenance of Pauper Lunatics [L.G. Act, § 24 (2) (e) (f) (g.)].

In accordance with these powers the Sanitary Committee, presided over by Sir Douglas Galton, recommended that a legally qualified Medical Officer of Health should be appointed for the county, who, under the control of the Sanitary Committee, should have a general supervision of all sanitary matters arising in the county, and who should not hold any other appointment nor engage in private practice.

The report also recommended as important that immediate steps should be taken to enforce "The Rivers Pollution Prevention Act, 1876," in relation to the streams within the jurisdiction of the Council, and that the several County Councils in the water-shed of the Severn should be requested to concur in a representation to the Local Government Board to constitute a joint committee for that purpose.

By clause 19 of "The Local Government Act, 1888," every District Medical Officer is bound to send to the County Council a copy of any periodical report which he is now required to send to the Local Government Board; and in the event of its being found, from any such report, that "The Public Health Act, 1875," is not being properly enforced in the district, or that any other matter affecting the public health of the district requires to be remedied, the County Council may cause a representation to be made to the Local Government Board on the matter.

Under this clause the eyes of the County Council, as regards sanitary matters, will be everywhere, with a statutory authority, by means of a representation, to call to its aid all the resources of the Local Government Board to remedy any sanitary defect.

By these clauses the County Council is now made an important unit of centralization with regard to all sanitary matters arising within the county, and consequently a much closer and more detailed investigation into sanitary evils is likely to be attained than was possible under the old system, in which the Local Government Board was practically the only centralized authority.

Water Supply.

With your kind permission we will now turn for a few minutes from the somewhat odorous subject of sewage to the sweeter one of water supply, though on looking back I can remember the time when some towns in England were supplied with a mixture very little better than raw sewage, and certainly inferior to some of the clarified and purified effluents of modern times.

At one time, within my memory, a large portion of the metropolis was supplied direct from the lower reaches of the Thames, between Battersea and Vauxhall bridges, with a liquid which at times could only be described as "unadulterated cholera mixture;" and I remember, as a young engineer, going to see a large Cornish pumping engine, just then erected by one of the London water companies for supplying its district with water pumped direct from the Thames, at a spot not more than half a mile below where, what was then termed the Ranelagh sewer, which drained Chelsea and other densely-populated parts of London, emptied itself into the river on the opposite side from the engine.

Public opinion, aided by the outbreaks of cholera, and the

fear of renewed attacks of that scourge,—with respect to which a glimmering notion was dawning upon the public mind that these attacks of cholera had some connection with the want of proper sanitation,—together with the continual bombardments by the Board of Health, ably directed by Sir Edwin Chadwick and his medical staff on all such abominations as unfiltered—between bridge Thames water supply—gradually brought about a better state of things, which in some cases had already been effected in the provinces, and the example set by which, London was urged to follow, namely:—

(1) To avoid originally contaminated sources of water supply.

(2) To filter all supplies derived from surface sources.

(3) To give a constant supply.

In accordance with the first named requisition, the intakes of the Metropolitan Companies were removed higher up the river, beyond the reach of contamination from the London sewage.

The filtration of river water was gradually introduced, but so little was then known of the now common art and mystery of filtration on a large scale, that we had to go to some small works supplying a town in Scotland for our first practical experience on this subject, and the little sand filter there, only a few square yards in extent, is the parent of all the filter beds, upwards of 100 acres in extent, through which the 150,000,000 gallons of river water daily required for the supply of London are filtered, in addition to innumerable filter beds connected with provincial water works.

There was not much controversy about the question of filtration, as its merits were soon appreciated; but a very great fight raged for a considerable period about the question of constant supply.

From time immemorial the supplies given by water companies, with very few exceptions, were, in what was termed "the intermittent system," that is, the water was turned on for an hour or two a day only for each particular street.

The supply of water for the 24 hours had consequently to be caught and stored in tanks, butts, or tubs, or other such receptacles, in which, if originally pure, it frequently became foul and contaminated with surrounding abominations.

This intermittent system involved not only great inconvenience to the consumers, but, from the circumstances above named, was the cause of a large amount of illness; and again the Board of Health, directed by Sir Edwin Chadwick, came to the front and dealt some heavy blows at this antiquated and inconvenient system.

At the time when this controversy first broke out, I happened to be a pupil of one of the leading Metropolitan Water Engineers, who unfortunately held very strong opinions adverse to the system of constant supply, and he upheld the system of "intermittent" supply as perfection. In fact, he went so far as to say that the constant supply system on a large scale was "impossible," and he wrote a pamphlet to prove it, and for any one in his office to hold the shadow of an opinion in favour of the "constant supply" system was, as you may easily suppose, "flat treason."

In reply to this pamphlet, Sir Edwin Chadwick showed that so far from the constant supply system being the impossible theory it was represented to be by the engineer who was so strong a supporter of the intermittent system, it had actually been long in operation on a large scale in Nottingham, the water works in which town were under the able management of a rising young engineer named Hawksley—whose name, as that of a sound and practical engineer has since become of world wide reputation, and of whose works the Faithful City in which we are now assembled has some good examples, and will probably have more.

Amongst the water works originally constructed by the engineer who so strongly advocated the intermittent system, whilst I was a pupil of his, were those at Wolverhampton, in the adjoining county.

These works were constructed on the very strictest principles as a "model intermittent supply" water works, and it became my lot not only to superintend their construction, but to have the management of them placed in my hands after their completion.

For two years I struggled on with the intermittent system, but could make very little progress, as the fittings connected with that system were expensive, and consequently deterred people from having a supply from the water works, and altogether the inconveniences were such as not to encourage domestic consumption.

Under these circumstances, with the sanction of the directors, I made the necessary alterations in the works—which were not of an expensive character—and we commenced giving the supply on the "constant system" in the year 1849, or just forty years ago, since which time the works, which have passed into the hands of the municipal authority, have grown and extended until now they are supplying 120,000 persons on the constant system, and have a revenue of £23,000 a-year—that is to say, an annual revenue nearly equal to the capital originally embarked in the undertaking.

The conversion of the Wolverhampton works from "intermittent" to "constant" supply happened to come to the knowledge of Sir Edwin Chadwick through Sir Robert Rawlinson, then one of the engineering inspectors under the Board of Health, and I was requested to make some experiments as to the hourly consumption in Wolverhampton under the constant system.

These experiments showed that instead of having to provide pipes of a magnitude sufficient to afford a supply of water to every customer at the same time (as had been argued by the upholders of the intermittent system) they need not be larger than sufficient to supply the whole consumption of the twenty-four hours in about nine hours, and in fact that the distribution pipes might be made with safety somewhat smaller than had been the practice under the "intermittent" system.

These facts were brought out in evidence which I gave before the Board of Health in 1850, and also shortly afterwards before a Parliamentary Committee on Metropolitan Water Supply which was presided over by the late Sir James Graham.

The evidence given before this latter Committee settled the question as to the feasibility and advantage of the "constant supply" system, and there has since been no controversy worthy of the name in favour of the "intermittent system."

I should also remark that whilst forty years since it was stated to be an impossibility to give a constant supply on a large scale, now nearly 3¼ out of the 5½ million of inhabitants within the limits of supply of the Metropolitan Water Companies are enjoying the advantage of a supply on that system, whilst in the provincial water works it is almost universally adopted.

The Severn.

Before leaving the subject of water supply, I should like to be allowed to touch upon a question a little nearer home.

You will all be aware that the city of Worcester is situate on the banks of a magnificent river named the Severn, which has its origin far up in the Welsh mountains, and which after flowing thence through Shrewsbury, Bridgnorth, this city, Tewkesbury, and Gloucester, empties itself into the Bristol Channel. And if before coming to the sanitary points which I wish to bring out, you will allow me to digress for a moment, I may remark that this river can boast of having had the first iron boat float upon its fair bosom, and of having been spanned by the first iron bridge ever constructed, a bridge which is still in existence, and which has given its name to an extensive district in Shropshire.

Within the last forty years a considerable length of the river has been redeemed from a state of nature, and has been canalised, under Parliamentary powers granted to the Severn Commissioners, by the construction of locks and weirs between Gloucester and Stourport, a distance of about forty-two miles, and by means of which improvements, goods and merchandise to the extent of about a thousand tons a day are now carried upon it by vessels of from 30 to 150 tons burden.

The spirit of enterprise is, however, not yet satisfied with this achievement, and further improvements are in contemplation, having for their object the provision of a sufficient navigable depth to enable sea-going steamers of from 300 to 400 tons burden to navigate the river up to the Quays in this city, that is to say, to within 30 miles of the very heart and centre of England.

From an investigation which I have recently been called upon to make as Engineer to the Severn Commissioners, I find that the cost of this great inland navigation improvement will be comparatively small, and I trust that most of us may live to see the day when vessels of this description may be found daily plying between Worcester and foreign ports, and so that, practically, Worcester may become the sea port for the great manufacturing interests which have their seats in this and the adjoining county of Stafford.

Let this suffice for the little digression for which I craved your indulgence.

I mentioned just now that the Severn has its origin in the far-off Welsh mountains, upon which the annual rainfall is very heavy; and some eight or ten years since the Corporation of Liverpool, casting about for an increased supply of water for their city and its numerous dependencies, bethought themselves of these Welsh hills, the rainfall on which supplies a large proportion of the water passing down the Severn, and they applied to Parliament for power to construct a large collecting reservoir on an upland tributary of the river named the "Vyrnwy."

The reservoir was intended to be on a large scale, that is to say, it was intended to have an area of over 1,100 acres, a depth of more than 70 feet in some parts, and to hold 13,000 million gallons of water.

The drainage areas or collecting grounds proposed to be appropriated extended over 23,000 acres, and represented about one-ninth of the whole upland range of Welsh hills, whence, as before stated, the larger proportion of the water supplying the Severn is derived, and whence comes by far the largest proportion of pure water passing down it.

In the event of such contemplated works being carried out it became important therefore, not only *per se*, but as a matter of precedent also, that the Severn interests, especially in their sanitary aspects, should be protected by its being made compulsory on the Corporation of Liverpool to deliver an adequate supply of compensation water into the river from the intended reservoir.

I am happy to say that Parliament took this view, and the compensation to be given from the one-ninth of the Welsh Hill water-shed appropriated to Liverpool, is on such a scale that in the event of the other eight-ninths being hereafter appropriated for the sanitary requirements of the metropolis (which has given indications of looking in this direction,) or any other places, there will at all times be at least 100 million gallons of pure Welsh Hill water passing each day under Worcester Bridge, and at times a much larger quantity.

The basis upon which the delivery of this compensation water was settled is somewhat peculiar, and it may therefore be mentioned here possibly with advantage.

There is in the first place a uniform and constant discharge of ten million gallons a day from the reservoir into the river, and in the second place an additional discharge of forty million gallons a day for four days in each of the eight months between the last day of February and the first day of November in each year.

The reservoir is now practically completed, and the water was commenced to be impounded in it on the 28th November, 1888, since which date the statutory quantities of daily and monthly compensation water have been regularly discharged from it.

The reservoir is now filled to within between eight and nine feet from top water line or overflow level, and after having duly provided for the compensation water discharged into the river, amounting to over 4,000,000,000 gallons from the date named, there remains for the use of Liverpool about 11,000,000,000 gallons within the reservoir.

I look upon these flushes of pure Welsh Hill water during the summer months as a valuable sanitary advantage to the river, and it is for this reason that I have mentioned them.

These flushes also being in the nature of small freshets, are of great advantage to the fish life in the river, and especially to the salmon, in connection with which fish the Severn now takes first rank in quantity as it has long done in quality, and the interests in connection with which are worth over £20,000 a year.

Whilst still on the subject, I should state that daily records of the height of the water in the river, of the direction of the wind, and of the temperature of the air and of the water in the river, are being and have been taken during the past three years; and as time passes on, they will form a valuable record for comparative purposes.

These particulars are recorded at various stations extending from Portishead, on the Bristol Avon, to the Reservoir on the River Vyrnwy, a distance of 200 miles measured along the river, and they are collated annually, and printed for public information, by the Severn Fishery Board.

Some interesting facts are being brought to light by these records, one particularly for which I was not prepared, namely, that, except under some special circumstances, the temperature of the water in the river is higher than that of the air, a fact which opens up several questions of scientific interest.

Building Materials, &c.

Having already detained you too long on the matters to which I have ventured to refer, I will leave it to others, more competent to do so, to deal with the architectural portion of the subjects referred to in this section. The question of the architectural progress of the past forty years forms too wide a field for me to do so in this address. I will only remark that it has undoubtedly been very great, especially in regard to the dwellings of the poorer classes.

This improvement has been greatly encouraged by the removal of the duties on building materials which has taken place during that period.

Good drainage and pure water supply were then quite the exception for this class of house, and who can picture to himself the discomfort, disease, and premature deaths which the absence of these requisites caused in the houses of the working classes —a large proportion of which were constructed without back doors or windows, and without any means of through ventilation?

Now in many cases we not only see the comfort and health due to good drainage and good water supply, with better ventilation and larger spaces, consequent on better and cheaper building materials, but, in addition, some not unsuccessful attempts at ornamentation.

With respect to this latter point, I should remark that it has taken nearly a whole generation to get rid of the art-depressing influence of the exciseman in the brickfield, and we are now only beginning to realise the ornamental capacities of our brick-earths when properly blended, moulded, and burnt.

The advent of the exciseman reduced the tasteful artist in brick-earth of Queen Anne's time to the status of the unartistic manufacturer of common "stocks," 9 inches by 3 inches by 4½ inches, and who gradually descended into a low class of "artful dodger," the highest ambition of whose life appeared to be to outwit the representative of the Excise Law.

We should be thankful that we live in times which have enabled us to dispense with taxes on building materials and on the windows which let light and air into our dwellings, and in which we are freed from the hateful presence of the exciseman in the brickfield. Art cannot exist where he is Lord paramount, nor under such peremptory codes as the stringent regulations of my Lords of the Board of Customs.

I have now dwelt upon some of the improvements in sanitary matters of the last forty years—but how much has yet to be accomplished!

How is it that in almost every newspaper we open we find accounts of outbreaks in some place or other of typhoid or scarlet fever, or some other ailment preventable by proper sanitary arrangement?

How is it that our death-rate still shows so high a range of mortality, especially amongst the young children of the poorer classes?

One could go on with a string of such inquiries *ad nauseum*, but I will not weary you, except to say that the work of sanitation still remaining to be done is of colossal proportions.

All honour, therefore, to those who without hope of reward devote their skilled intelligence to the improvement of the sanitary state of their surroundings, for in more senses than one such people are "the salt of the earth!"

Smoke Abatement.

Before concluding this address I wish, with your permission, to call attention to one subject in which during the past forty years we appear not only to have made no improvement, but in respect of which we appear, to some extent by force of circumstances, to have lamentably receded.

I refer to the non-consumption of the smoke made by our domestic fires.

The awful example in this respect is, of course, London, the grimy smoke of which, issuing from 600,000 to 700,000 kitchen chimneys, turns day, in certain states of the atmosphere, into midnight darkness—in fact, into more than midnight darkness, for in ordinary midnight darkness we can generally manage to see a few stars overhead, whilst in the darkness created by the smoke from the domestic chimney we can only painfully grope our way from one faintly glimmering gas light to another, whilst overhead everything is cimmerian.

There have been great heart searchings with respect to this evil, and many suggestions have been made as to its cure, but, hitherto, without success, as we are still the slaves of the "blacks," which blind our eyes, which fill our nostrils and lungs, which dirty our clothes, which duplicate our death-rate during their distressing presence, and which, like the plague of frogs in Egypt, enter our chambers and profusely decorate our beds and furniture with their loathesome digits, and which finally, with their sulphureous impregnations, reduce all our books and papers to a mummy-like condition.

I find from the return of coal, culm, and cinders published by the authority of the Corporation of London, that the quantity of these materials brought into the London district by railway, canal, and sea during the year 1888 was 12,533,088 tons; and deducting the quantity shipped coastwise and exported from the Port of London during that time, which, according to a return obligingly furnished to me by the Board of Customs, amounted to 273,134 tons—and making a large allowance for bunker coal and coal consumed in the outlying districts of the metropolis—I consider the consumption proper to London is certainly not less than 11,000,000 tons a year, that is about 30,000 tons a day on the average. This is rather more than the whole annual produce and consumption of the South Staffordshire and East Worcestershire Mining Districts, known, emphatically, as the "black country."

In the year 1884 the quantity delivered into the London district was 11,140,576 tons, as against 12,533,088 tons delivered last year. This shows an increase in the quinquennial period, 1884—1888, of 1,393,512 tons, or an increase at the rate of 278,702 tons per annum during that period.

Probably one-third of the total estimated annual consumption of 11,000,000 tons takes place in manufactories, which, by law, are bound to consume their own smoke, and in which that operation is to some extent accomplished; but fully 20,000 tons a day on the average will be piled on the domestic fire, the smoke from which is still a legalised nuisance.

During the four winter months in the year, the domestic consumption will probably reach 30,000 tons a day, and with the ever-increasing number of domestic chimneys within the metropolitan area—estimated at about 15,000 a-year—this consumption of fuel must also ever be an increasing quantity.

To give some idea of the size of the coal-scuttle necessary to provide for one day's consumption of coal in the domestic grates of London, it would, in winter time, have to be large enough to hold a lump of coal one acre in area, that is about 300 feet long, 150 feet broad, and 30 feet thick; and it is a lump of coal of that magnitude which, in winter time, is daily reduced in the metropolitan domestic grate to ashes and—*smoke*, and adding the consumption in manufactories, the block would have to be of the same length and breadth but 40 feet thick.

I have not seen any calculation of the numbers of cube miles of smoky atmosphere which would be produced by the combustion of such a lump of coal, but you can easily understand that it would be very great, and that in a still and foggy atmosphere the volume would be concentrated in the disagreeable manner which ends in dense darkness.

Possibly as electricity gradually takes the place of gas as our domestic luminant, the Gas Companies may more than heretofore turn their attention, as suggested by the late Sir William Siemens, to the production of heating gas; and this description of gas, which is of great calorific, but little illuminating power, may take the place of the domestic coal-scuttle, and so bring the production of smoke more under control.

There are, however, dangers to be guarded against, even should the time come when, by such a gas, the domestic coal-scuttle and all its disagreeable contingencies have been banished.

The principle one arises from the fact that the products of combustion evolved by the burning of such gas are only capable of floating in the atmosphere when heated to a temperature of 300° Fahrenheit, and, consequently, the moment they leave the chimney tops they begin to cool, and so, falling below the temperature of equilibrium, they would sink to the ground in still air; and thus, whilst we might escape the Scylla of being suffocated by smuts, we might not be able to escape the Charybdis of being poisoned by carbonic acid gas descending into the narrow streets, courts, and alleys of the metropolis.

The question is full of difficulties and still awaits solution.

The Smoke Abatement Institution has done good service in collecting information on the subject, and in testing various appliances; and the interest of inventive genius in the question is so great, that during the past 10 years three patents relating to it have, on the average, been taken out for every two working days during that time.

I have no suggestion to make for dealing in detail with this question, which is daily becoming more and more urgent, not only with respect to London, but with respect also to many of our larger towns, where great numbers of domestic chimneys are congregated around and amongst coal burning works and factories.

I anticipate, however, that before long the evil will become so intolerable, that it will be dealt with in a very summary manner, by bringing the smoke issuing from the domestic chimney under the same regulations as those for smoke issuing from factory stacks, and until this is done, I doubt whether the individual householder can be brought to attack the question in the only way likely to bring about results on a scale beneficial to the community at large.

Concluding Remarks.

I have now only to apologise for having detained you so long, and to thank you for the attention with which you have favoured me.

We have travelled together along the border lands of the many subjects touched upon in this address—principally engaged in taking retrospective views—though occasionally looking around upon the subjects which are exciting the interest of sanitarians to-day, and now and then taking a not unhopeful peep into the future, which, judging from the diligent and intelligent workers who are now entering the arena, will, I anticipate, be of a much more rapid and brilliant character as regards sanitary progress, than it has been for those who must soon leave it, although the struggles of those who have laid deep and solidly the foundations of sanitary science and practice will always be worthy to be held in honourable remembrance, however brilliant the careers of their successors may be.

The President (Mr. G. W. Hastings) moved a vote of thanks to Mr. Marten for his most instructive and interesting address. Mr. Marten had alluded, from his own experience and knowledge, to the effect produced on the health of a population by fen drainage; and he was sure they would allow him (the speaker) to refer to a statement that was made by his father, Sir Charles Hastings, now twenty-five years ago, on the effect which had been produced on disease in the county of Worcester by the enclosure and, consequently, the drainage of land. Sir Charles Hastings showed from the records of the Worcester Infirmary that down to the beginning of the present century ague was the predominant disease, and that the books of the Infirmary were full of records of such cases; but from the time when the great enclosures in Worcestershire took place, such as the enclosure, for instance, of a great part of Malvern Chase, when the land, though it

was not deep drained, was thrown into furrows for cultivation and ditches were dug, and the surface water carried away, the records of the Infirmary ceased to show cases of ague. Now, if Mr. Marten would allow him, he would give one example from his own experience of the prevalence of "Cloaca Maxima" in houses no very long time ago. Some few years since, he resolved, as Chairman of the House Committee of the Quarter Sessions, to have a thorough investigation of the Shire-hall, which was within the bounds, though not within the jurisdiction, of the city of Worcester. He found that the sanitary condition of the building, as he had strongly suspected, was this: the only drain out of the house was a very large brick drain under the hall, which discharged into a cesspool under the drive just in front of the house, which cesspool had never been approached after its formation for a period of forty years. There was no other outlet of any kind, and there was not a single convenience in the place which had any pipe into the open air. He had the drain, the bricks of which were saturated with sewage matter, filled up and thoroughly deodorised, and a drain of humble little glazed pipes, such as Mr. Marten had spoken of, was constructed on each side of the house outside, with ventilating shafts, carried to the top of the roof in every instance. Since that time the Shire-hall had been a thoroughly sanitary building. He was glad to hear Mr. Marten's remarks about the importance of plumbers' work in sanitary matters. He was also glad to hear that there were no small number of plumbers who had obtained certificates from the Sanitary Institute attending the meeting in Worcester, thus showing that they were not only willing to go to the Institute to perfect their knowledge and to obtain certificates, but that they felt an abiding interest in its work. There was one expression in Mr. Marten's address from which he must take leave to differ on a matter of fact. Mr. Marten spoke of the large sanitary powers that had been given to County Councils. He (the speaker) would be very glad to be told what they were, for as Chairman of the County Council of Worcestershire, he was naturally most desirous that it should in every respect fulfil its duties; but beyond some small matters, he was not aware of any function which it was possible for the County Council to fulfil under the present Act so far as sanitary matters were concerned, with the exception of course of their River Pollution powers. The County Council could, and he hoped would, appoint a Medical Officer of Health: but unless the other sanitary authorities of the county joined in giving him powers, the officer's functions would be necessarily confined to obtaining information and reporting, and he would be unable to do any really active sanitary work of any description. The County Council had powers of enquiry and slight powers of supervision, but they had no power to do sanitary work themselves; and he could only hope that Mr. Marten spoke in the character of a prophet as to the legislation that would come in future years, as the experience of Parliament grew, and as they discovered (as he hoped they would discover) that wide powers were necessary for efficient administration in these matters, that it was not the small bodies to whom they could as a rule profit-ably entrust the health of the population of this country. With regard to the County Council of Worcestershire, if Parliament would only entrust them with some of those large sanitary powers of which Mr. Marten had spoken, he would undertake to say that they would be at once promptly used by the Council. Some people seemed to regard the Institute and its meetings as a means which individuals used solely for the purpose of ventilating their fads. How far this might be so he was not in a position to discuss. He could only say that all he had heard at the Congress seemed to be of a most practical kind. If indeed it was thought a fad to desire that their fellow creatures should enjoy good health, that they should be free from disease, that they should attain to a good longevity, then he admitted that the Institute was certainly productive of fads. From what he had seen and heard, he believed the Institute was carrying out a noble object in spreading among people of this country in every place that it visited sound practical knowledge on sanitary matters, and in instilling into them a high ambition to emulate all that had been well done in sanitary science, and to apply it to their own administration and to their own homes.

On "*Sewage Disposal*," *by* Prof. Henry Robinson, M.Inst.C.E., F.G.S., F.S.I.

The subject of "Sewage Disposal," which I have been desired by the Council to bring before this Congress, may with advantage be regarded from two points of view, namely, one which immediately concerns the individual householder and his family, and, secondly, that which affects the community.

As one of the objects of these Congresses is to impress upon the public mind the necessity for attending to well known sanitary rules as regards house sanitation, I would at the outset say a few words in this direction, knowing as I do how requisite it is to repeat the simplest truths to ensure their being acted upon.

I have no hesitation in stating my opinion that only a very small proportion of the dwellings of the upper and middle classes throughout the country are free from dangers to health, owing to the indifference or neglect of the occupiers to ascertain whether the essentials to making a house healthy have been complied with. This opinion I hold both with reference to houses in the Metropolis and other large towns, and also with reference to mansions and detached residences in the country.

Places of health resort are visited by those who seek a brief rest to recruit their worn out energies, and who occupy houses about whose previous sanitary history no information is available and none is sought by the temporary occupants? It is within the experience probably of every one of my audience that defective sanitation has been discovered in either the temporary or permanent homes of themselves or of their friends, and that the resultant evils were traceable to causes that could have been easily ascertained and remedied had there been a proper previous examination of the house. To most people who are not experts the word "drains" is one which inspires a feeling of annoyance and disgust, simply because it is associated with an unknown and uncertain amount of trouble and expense. It requires an attack or threatened outbreak of illness to bring home to some people the wisdom of putting their house in order in regard to matters affecting health. Anyone can ascertain whether his house is liable to be invaded by sewer gas through untrapped sinks, bath wastes, closets, or other places (which too often are badly arranged), by pouring some pungent smelling liquid (like peppermint) down a gulley outside the house, having previously closed all windows. The presence of this pungent smell at the points I have indicated will be a sure sign of the existence of grave defects, which will pollute the air and water as well as the food, especially milk, and produce either illness or enfeeblement of body and mind.

These few preliminary observations are thrown out with a view to warn any who may be living in a fool's paradise of ignorance or indifference as to the sanitary condition of their dwellings, not to continue to adopt the "out of sight, out of mind" policy on so grave a matter, but to make a point of ascertaining that they are free from the dangers to health through defective house sanitation, which in my experience so widely prevail.

I have thought that the limited time that this paper can fairly occupy would be best devoted to the consideration of some of the most important matters which are attracting the attention both of the public and of experts. I think there will be few, if any, who will regard the means adopted, or in course of adoption, with regard to the disposal of the sewage of the Metropolis as final, or even temporarily satisfactory. It is matter of history that the scheme of discharging the sewage of London at the Barking and Crossness Outfalls, which the Metropolitan Board of Works carried out, was not in accordance with the advice of a Committee of Referees appointed by the Government in 1858 (of which the Chairman of the Sanitary Institute, Sir Douglas Galton, is the surviving member), who considered that sufficient provision was not made for the prevention of the flooding of low-lying portions of the area to be dealt with, and that an unnecessary volume of sewage had to be pumped. They further advised that these Outfalls were in such close proximity to the Metropolitan boundary that the sewage would be liable to return with flood tides, and that deposits of mud, dangerous to health, would take place in those parts of the river where shoals and slack water occurred. The Referees advised carrying the Outfalls to Sea Reach, and largely increasing the gravitation area. These recommendations were disregarded, but experience has shown that the Board of Works might with advantage have listened to them. All who have watched the results will concur with me when I say that the evils that were anticipated have been in the main realised, although it required a Royal Commission and a large outlay of ratepayers' money to establish the necessity for remedial works to prevent the continued pollution and injury to the Thames. The Chemical Precipitation Works which have been added at the Outfalls have for their object the deposition of the solid matter in the sewage, and the removal of it to sea in steamers. The results that have as yet been obtained are far from satisfactory, and in the various experiments that have been made as to the chemicals to be used and their proportions, very grave doubts exist whether anything approaching the requisite standard of purity of effluent has been attained, and my own experience of the river near the outfalls convinces me that serious pollution continues. The late Board appears to have carried to the end of its existence a disregard of the advice given by those it called in to its assistance, inasmuch as Sir Henry Roscoe, who was consulted in 1887, and who carried out observations and experiments with a view to produce a better state of things, seems to have found the task a hopeless one, for he published a report in May last which condemns both the remedial works, which have been executed at enormous cost, and also the system of chemical treatment and of sludge disposal. I have referred to this important subject because the newly created County Council should regard in a critical, and even a suspicious, spirit the traditions of the late Board, and should give careful and independent consideration to the whole question of the outfalls, so that no long period will be allowed to elapse before the Thames is relieved from its present pollution, and the Metropolis ceases to defile the river with impunity. The Council is fortunate in having appointed as Chief Engineer, Mr. Joseph Gordon, whose well-known experience and ability justify a confident hope that he will grasp this important question, and will effect a solution of a problem which admits of settlement if approached free from partisanship or prejudice.

The disposal of the sewage of the various towns situated in

the Thames Valley is making good progress, and every year shows a steady diversion of untreated sewage from the river, which for so long has been regarded by local authorities as the natural carrier of their filth, causing annoyance and injury to adjoining people. This custom has been very well compared to a man throwing a dead cat out of his own garden over the wall into his neighbour's.

In speaking of sewage disposal in the Thames Valley I would give prominence to the recent completion of the sewerage works of Kingston, for two reasons. Firstly, it was mainly owing to the resolute action of the Corporation of this town that the Lower Thames Valley Main Sewerage Board was dissolved, and the various towns composing it were left to group themselves according to their natural circumstances and interests, as I had throughout advised. Secondly, because at Kingston the A. B. C. Company have undertaken the disposal of the sewage under conditions which justify special reference in this paper. It is well known that this Company has fought an exceedingly difficult fight for many years in its endeavour to be adopted as the chemical precipitation system *par excellence*. My own view has always been that the A. B. C. system, as worked at Aylesbury with success, produced the best effluent of any chemical system which did not employ filtration in aid of chemicals; but that the cost of the system could only be justified on the assumption that the dried sludge obtained from the process would realize the price of £3 10s. per ton, which it was alleged to be worth. Chemists applied certain conventional rules as to the value of manurial units to this native guano—as it is termed,—and gave a decided opinion that, according to all chemical tests, the material was worth nothing of the kind. The Company, however, have throughout defied chemists and their experience, and have relied on agriculturists' results, which, they contended, proved their case. At last it appears that the chemical system of analysis is no longer to be solely relied on, and two chemists of eminence, namely, Drs. Dewar and Tidy, in a special and elaborate report made for this Company, state as follows:—

"As to the manurial value of the native guano, we are strongly of opinion that this must be judged rather by the practical results of the agriculturists than by presumed theoretical values based on analytical data, and on the price of ingredients not necessarily in the same physical or chemical condition. Recent research tends to show that very small changes brought about in soils may have very important indirect effects."

This statement entirely varies the conditions which have hitherto been regarded as governing the question of the value of agricultural manures, and the A. B. C. Company now are relieved from the difficulty which has previously pressed heavily upon them, namely, that of employing a chemical process which admittedly entailed a larger expense than other systems without any recognition that a higher value could be claimed for their sludge.

Mr. William Webster has devised a system of purification for sewage by means of Electrolysis, which I have seen in successful operation at the Crossness outfall. The principle consists in breaking up the organic compounds of sewage into their constituent parts, by passing an electric current through iron electrodes, which results in the formation of iron oxides and chlorine. The first produces oxygen and the second produces chloric acid, which destroys organic matter. A non-oxydisable carbon plate is employed for the positive pole, and iron is used at the negative pole, so that by means of a porous diaphragm between, the component parts of the mineral salts are collected. At the non-oxydisable plate a solution of chlorine and oxide of chlorine is produced, and at the negative plate ammonia, soda, and potass are formed, which precipitate the magnesium salts and lime in the liquid. A large portion of the solid and dissolved impurities in sewage are thus deposited in the form of sludge. The process, which is one of much scientific and practical interest, is now under investigation by the officials of the County Council.

Mr. Webster has also arranged an electrical filter for the purpose of treating the effluent where a higher degree of purity is required. He applies the electric current to a carbon filter, the carbon being the positive pole; the nascent oxygen produced in the pores of the carbon by the current destroys organic matter in the fluid, and at the same time preserves the filter in a clean state. This system is obviously applicable to the filtration of domestic water.

M. Hermite (of electric bleaching notoriety) is employing, at Rouen, a battery of electrolysers (with anodes of platinum and kathodes of zinc) to produce a deodorising and disinfecting action upon sewage. He passes the sewage through a battery of this kind containing common sea salt, in the proportion of from 70 to 350 grains per gallon.

I have had under investigation for some time the precipitating and filtering materials which are employed at Acton and Hendon by the International Sewage and Water Purification Company. The process consists in first precipitating the bulk of the suspended and some of the dissolved matters by means of what is termed "Ferozone" (it was formerly called Magnetic Ferrous Carbon), and then in passing the effluent through a filter

containing a material named Polarite. The essential difference between these two materials is that the precipitating substance (Ferozone) which is mixed with the sewage contains mainly sulphate and magnetic oxide of iron rendered soluble, whereas the filtering substance (Polarite) is composed of more than 50 per cent. of magnetic oxide of iron, with silica, lime, alumina, magnesia, and carbonaceous matters which are absolutely *insoluble*. These materials are manufactured from natural deposits which are found in the anthracite coal formation. The main features in this process are as follows: So far as the first part is concerned, the precipitating action is produced without the aid of lime. At Acton about 8 grains per gallon of sewage are employed, and from one to three hours rest are allowed. Clarification and deodorization are thus effected, and the deposited sludge (when pressed into cakes in the usual way) is found to have a manurial value which leads to its being purchased and used on land. The next part of the process consists in passing the effluent from the precipitation tanks through a layer of the other substance—Polarite—and it is necessary to place above it a stratum of sand or other material (the surface of which requires occasional raking over) to intercept any suspended matter which would clog the pores of the filter and interfere with its action. The effect of Polarite is singular, and appears to be unchangeable, at least no alteration in its efficiency has been found after fourteen months use at Acton, according to a report by Sir Henry Roscoe; a longer experience elsewhere is stated to give the same results. This filtering material thus discharges an important function in sewage treatment, as it serves in lieu of a much larger area of land, or of an artificial filter such as is often made by alternate strata of burnt clay and alluvial soil. The explanation of the action of Polarite is that it liberates from its microscopic pores large volumes of oxygen which attacks and destroys organic impurities. The magnetic spongy iron which came into use some years ago for purifying water was found to rust and cake; Polarite, however, is remarkable for its entire freedom from rusting or caking. The results which I have witnessed lead me to form a favourable opinion of it both for precipitating sewage and for the further purpose of filtering effluent sewage either from tanks or from sewage farms when the purification has not reached the required standard.

Another precipitation system, called the "Amines" process, has recently attracted attention. The materials employed are certain organic bases, which are found in the chemical group of Amines (ammonia compounds) in combination with lime. The effect which is claimed for this is that the sewage effluent from the process is sterile as regards the presence of living organisms, as the re-agent which is formed by the chemicals is completely destructive to organic life. I have witnessed a trial of the process at the Wimbledon Sewage Works, where herring brine is used, which is mixed with milk of lime and evolves a soluble gaseous re-agent having a briny odour. This, when applied to the sewage, produces rapid deodorization and deposition of flocculent matter. Dr. E. Klein, F.R.S., has examined the process and confirms the sterilizing of the effluent which is claimed.

The observations and experiments of Mr. Robert Warrington at Rothamsted, on the distribution of the nitrifying organism in the soil (which are at intervals brought before the Chemical Society), have greatly assisted those who are interested in the purification of sewage on land. Dr. Munro at Salisbury has made (and is understood still to be making) very useful trials with reference to sewage sludge. All experience now tends to the conclusion that the old bugbear of chemical precipitation, namely, sludge, no longer need exist where proper precipitants are used.

The regulations which are enforced in this country to diminish death-rate by proper sewerage and sewage disposal works, should be applied abroad wherever our influence can be exerted to mitigate sanitary evils which abound in many great centres of population in the British Empire. At the recent International Congress of Hygiene in Paris, the insanitary condition of Alexandria was referred to, and its state was denounced as a danger to all Europe. The necessity for properly dealing with the sewage of Calcutta has long been recognised, and it is understood that steps are being taken to remedy the existing unsatisfactory state of things that prevail there, Mr. James Kimber, C.E., being now engaged in advising the Commissioners of that place what ought to be done. Numerous similar large centres of population under our influence could be quoted where much needed sanitary reforms are demanded.

There is a great waste of public money throughout the country in regard to sewage disposal. Many towns are continuing the employment of systems which have long since been superseded, and I consider that a time has arrived when an investigation by an impartial and qualified Commission into the question of sewage disposal would lead to most valuable and useful results to the community, both from a sanitary and economic point of view.

Mr. W. C. Sillar (London) thanked Mr. Robinson for his paper on sewage disposal. With regard to that part of it in which he alluded to the process now in operation at Kingston, he would remark that this was no longer merely experimental. It had long passed through the theoretic stage, and its success was now an acknowledged fact. The great requirements in sewage treatment are four in number; we have not only to be satisfied with the purity of the effluent water, and with the preservation of the manurial value of the deposit, but it must be done in such a way that the water is admissible into rivers without injury to the fish, and without causing any nuisance to the neighbourhood. He contended that no solution of the sewage problem should be considered complete which did not preserve the manurial products for the benefit of the agriculture of the country. It was national waste and wrong doing to continue to pollute our streams with what had been proved to contain such great manurial excellence.

Mr. F. Corbett (Worcester) said Dr. Strange had suggested to him that, as Chairman of the Sewerage Committee of the Worcester Town Council, he ought to take some little part in the discussion of the morning. He did so with some diffidence, because they in the local sanitary bodies had not to discuss the various processes which were recommended by inventors. They had to deal with experience which had been gained over a protracted period by other authorities, and to act under the advice of gentlemen of great experience such as their engineer, Mr. Hawksley. In listening to the papers this morning he was not surprised to find that Mr. Marten sat somewhat heavily upon a dictum which was somewhat hastily and crudely announced the other day by the President of the Institute when he laid it down that broad irrigation was the solution of sewage difficulties. Mr. Hastings referred to the case of Malvern. That was an exceptional case. Malvern was a small town, scarcely more than a village, situated on the slope of a considerable hill, and there was a large area of land sparsely populated immediately below, and under the control of people who were deeply interested in the prosperity of Malvern itself. Under those circumstances there had been no difficulty in disposing of the sewage by gravitation, but even at Malvern great difficulties had been found in the way of applying a system of broad irrigation. He (Mr. Corbett) was professionally concerned in a case in which the Malvern local authority had to pay a considerable sum as damages for the gross pollution of the stream into which the effluent water from their sewage works poured. He remembered a case of serious outbreak of disease in the low parts of the town of Malvern caused by the miasmatic vapours which arose from the sewage farm. Within the last two months he had inspected the stream into which the effluent flowed. It was neither adapted for the use of the people nor for their recreation. They would not dream of taking drinking water from it. They would find it far worse than the much abused Severn. They would not dream of recommending a maiden to dip her tresses in it. She would not take their advice if they did so. He was not surprised that the readers of papers that morning were of opinion that the true solution of the drainage difficulty was precipitation, followed perhaps by some system of filtration of the effluent water. The idea that they were going to use either the crude sewage or the effluent water in a profitable manner in farming operations was an entire delusion, which had been exploded over and over again, and ought not to be repeated. It had been said that the only difficulty now left in dealing with sewage by precipitation was the question of cash. There was another difficulty—the question of local sentiment. They had prepared a scheme in Worcester of dealing with sewage by precipitation, but they were met at once by objections to any possible site. They were told on the one hand that they must have a site within their own boundary because no neighbouring authority would tolerate the nuisance of their works. They were told on the other hand that within their own boundary it was unfitting to place such works. One gentleman had objected to the site because his house was within two miles of it. He believed the discussion which had taken place this morning would somewhat appease the public sentiment of Worcester, and relieve the minds of those people who thought they were going to be seriously injured by having sewage precipitation works a quarter or half a mile off their dwellings. The members of the Sewerage Committee of the Worcester Town Council had inspected several precipitation works, and when properly conducted they found no evil resulting from them, and no nuisance to the neighbourhood. Notably was this the case at Sheffield, which had works on a modern principle. It was very difficult to get people to believe that they would not be seriously injured by having sewage works in their immediate locality. If they could get rid of the difficulty by any discussion which might take place at the Congress they would render a considerable service to the citizens of Worcester.

Professor H. ROBINSON, M.Inst.C.E. (London), said that as regarded the question of irrigation that had been referred to, he did not go so far as some of the speakers, and say that the disposal of sewage upon land was to be looked upon as a thing of the past. The question of sewage disposal required to be dealt with skilfully according to the conditions and necessities of each town. A great danger had arisen of late years owing to Committees composed of amateurs being deputed by the sanitary authority to which they belonged to visit various sewage works with the view of getting information as to what was the best thing to be done. There was great danger that, acting under such conditions, men would sometimes form opinions based upon very limited knowledge. So many engineering and chemical questions were involved in the general question of sewage disposal that he would warn those who were endeavouring to get information not to act on the opinions they might form without the fullest consultation with experts, independent of any interest in the various systems. As to the proposal that they should convey sewage uphill by pumping instead of letting it go downhill by gravitation, that was very well for those who would obtain the necessary land for irrigation at any cost. He was a thorough advocate for dealing with sewage on land suitably situated and not impervious in its naturė, but those conditions did not always obtain; and an engineer was bound to deal with each town according to the requirements of the case. He endorsed all that had been said as to the importance of having small sewers and good gradients. Sewers, if properly designed and carried out, could be made self-cleansing, free from nuisance and from the production of sewage gas.

On "*The 'Amines Process' of Sewage Treatment*," *by* R. GODFREY, F.S.I., Assoc.M.Inst.C.E.

FROM the City of London, with its population of teeming millions, through all the gradations of cities, towns, local board areas, down to the humblest hamlet, the question of the disposal of sewage is the one great problem which is agitating the mind of those whose pleasure and duty it is to take cognisance of the public weal, and although the subject has formed, and will continue to form the staple of discussion wherever sanitarians congregate, we seem to be only on the threshold of the solution of the problem. And it is with the object of adding one more item to the lengthy catalogue of papers on the subject that I venture to lay before the Congress the results of enquiries undertaken in the interests of the district with which I am officially concerned.

The history of the sewage question is familiar to all present, and the necessity of a satisfactory solution is sufficiently patent to every one to justify me in omitting all generalisations.

Having to contend with the sewage of a couple of villages, in one of which there is a large paper mill, making about sixty tons of paper per week from the coarsest material, I have been for some time looking for a satisfactory solution of the problem: how to avoid an action for polluting a stream, and, at the same time, to assist the manufacturer, and by so doing benefit the district in which I am engaged. The difficulty is to decide which is the best process, as I find that the first patent taken out for treating sewage was by Higgs, in 1846, just over 43 years ago, and from that time to the present the rate at which patents have been taken out has been about one per month, and yet *the* secret has not yet been discovered, nor has the fortune of the inventor yet been safely invested in "Goschen's."

Almost every chemical of the laboratory has been tried for precipitating the solid matters, and almost every substance known has been tried as a filtrant. One quasi scientist actually using chloroform in his process.

The substances which have maintained their position are lime and sulphate of alumina—scarcely one inventor who does not use one or other of these substances, milk of lime taking the lead. To this is added, by various experts, various chemicals, which are supposed to have the power of neutralising the deleterious matters held in solution. Still, Lord Bramwell's Royal Commission, 1884, on Metropolitan Sewage Discharge, sums up the whole case with the pregnant words, "*no known process of precipitation purifies sufficiently*," and sanitarians are still in the dark as to the great problem of the day. The number of new schemes for purifying sewage still increases, and it is to be hoped that scientists will evolve a method which shall remove the reproach contained in the report alluded to, and which ought not to be allowed to become a *standing* reproach.

Every scheme has now to run the gauntlet of acute critics, who have been educated to criticise during the last forty years, and the authority which has the temerity to adopt a new process, does so at considerable risk of honour and reputation.

The rate at which new schemes are brought out seems to increase, but few are other than devices for ringing the changes on the old formulæ.

In my enquiries I came across the Sewage Works at Wimbledon, where a good system of purification by the lime process was in action under a careful and observant engineer.

The machinery and plant is of a very good type, and a farm is well laid out for irrigation by the effluent.

At the time of my first visit, I found that the works were, by permission of the Local Board, for a time in the hands of a Syndicate, which professes to have found out the grand secret. The normal treatment, as adopted by the Wimbledon Local Board, was suspended, and the "Amines" Syndicate were carrying out a practical demonstration of their system. A new re-agent has been discovered, which so far seems to have more than answered the expectations formed of it.

The requirements of a satisfactory process of dealing with sewage are—

1. A harmless effluent.
2. A harmless liquor from the sludge presses where pressing is adopted.
3. A minimum amount of sludge.

An effluent to be harmless must not only be sufficiently pure that it may be applied to land for irrigation without causing offence, but it ought to be so pure that it may be at once turned into a river, containing at least ten volumes of water to one of effluent without the need of irrigation, and to render it so pure it must be deprived of all living organised matter, as well as the matters held in solution. This, to the eye of the ordinary observer, may appear easy, but to the searching powers of the microscope, in the hands of a careful observer, our purest waters display some of the lowest forms of organic life; how much more, therefore, may it be found that effluents from sewage works, alleged to be harmless, are teeming with life in its most dreaded form, viz., the various bacteria, the typhoid and pneumonia bacillus, and others. Until we arrive at this degree of purity we must not cease in our endeavours to solve the problem.

The sludge question is the most serious of any in the management of a sewage farm, and any process which materially increases its weight must be shunned, unless it has some overwhelming advantages per contra. Sanitarians must not dwell too largely on the profit side of sludge manipulation. Sludge is matter in the wrong place, and must be got rid of at any cost. If it can be utilised, so much the better; but when we find cities making 500 cube yards a day, it is enough to appal the senses. How and where is all this sludge to be disposed of? Land on which to utilize it is not always available, and in my opinion cremation will have to be resorted to, unless its quantity can be materially reduced.

In dealing with the sludge by pressing in one of the various types of press now before the engineer, a difficulty is sometimes felt in disposing of what is technically termed "Press Liquor." To satisfy the requirements of the case this must be of equal purity with effluent, and unless it is so our assent to any scheme as perfect must be withheld.

With my mind in a thoroughly sceptical condition, my visit to Wimbledon, on August 17th last, enabled me to examine minutely, how far the three requirements before named were met. And I am bound to say that, as far as the first requirement is concerned, I was most agreeably surprised. I saw at one stage of my examination of the works, the ordinary effluent flowing on to the land. It presented the usual cloudy appearance as it boiled out of the chamber; the bottom of the chamber was not visible, and it differed in no respect from the many effluents which are distributed over grass land, and was totally unfit to be sent direct into a river.

A large subsiding tank of about 90,000 gallons was being filled with the sewage from Wimbledon, and as it passed into the carriers a supply of milk of lime was being mixed with it; and, here comes the difference—a small quantity of herring brine. All the additional plant required was a small tub against the lime-mixer, from which the lime flowed in a fixed proportion. A complete mixing took place at the tank inlet by aid of a dash-wheel driven by the inflowing current. As the tank filled, the disturbance of the volume of sewage was gradually confined to the centre, where the course of the incoming stream could be distinctly traced, while near the sides the process of precipitation could be seen in operation even before the tank was full.

The solids in the sewage were gradually aggregated into flocculent particles, and on the supply of sewage being cut off the whole tank's contents assuming a state of quiescence, the work of precipitation proceeded with a rapidity which was noteworthy.

The tank was six feet deep, and provided with a floating mouthpiece to draw off the super natant liquid, and this was sent, after half an hour's precipitation, at once to the irrigation area through the same chamber as that from which I had seen the normal effluent some little time previously. The contrast was striking. The effluent was clear enough to allow the bottom of the chamber to be seen, and all trace of smell was gone. The briny smell caused by the introduction of the re-agent was particularly noticeable. I took a sample, which is now before you.

The press liquor obtained from the same sludge is equally brilliant and briny. There was a complete absence of that sickly fœtid smell which too frequently pervades sewage works, under the most careful management.

In the Report of Lord Bramwell's Commission on Metropolitan Sewage Discharge (1884), the description of the rationale of precipitating processes is remarkably lucid, and I may be pardoned for transcribing par. 229 of that Report.

"Precipitating processes, though the same in principle as those of thirty years ago, have been greatly improved in detail, and when well worked are effectual where the quantity of sewage is not great, where the sewage can be properly treated, and where there is a running stream into which the effluent can be discharged in a proportion not exceeding five per cent. of the supply of fresh water.

"There are two chief methods by which effete organic materials, such as excreta, are got rid of, namely, by fermentation and by oxidation. Nature, in this climate at all events, utilises both these processes, and in the above order. The organic molecules of effete matters are first split up by fermentation (and putrefaction is one kind of fermentation) into less complex substances, often of an offensive character, and these are subsequently oxidised into inodorous inorganic substances. The agents by which these fermentations are brought about are those microscopic organisms known as bacteria, which either themselves set up fermentation, or excrete substances which act as ferments.

"Bacteria or their spores are present every where, and, gaining access to sewage, set up fermentation. But they require time for their propagation, and the setting up their resultant fermentation.

"Now, the whole art of treating sewage chemically, as it is termed, is to precipitate and clarify it while fresh, *i.e.*, before bacterial invasion has so far advanced as to set up active fermentation. When this is once set up the results are very disappointing. Precipitation consists in producing an artificial precipitate or coagulum in the fluid, and this coagulum mechanically entangles and carries down the organisms into the sludge. The effluent, now freed in great part from these, must then be brought as speedily as possible under an oxidising influence, either by turning it into a stream containing sufficient oxygen to oxidise the organic materials, or by applying it to land where it is also brought under powerful oxidising influences.

"Should, however, the effluent be kept undiluted, or should it be turned into a stream in too large quantities for the free oxygen to deal with, the organisms or their spores which have escaped in the effluent multiply and set up a renewed putrefaction. Such effluents, though apparently clear, become clouded, and a second deposit takes place in them. Bacterial fermentation of the cleanest fluids is always attended by clouding and turbidity."

This quotation points out very clearly what is required, and it is claimed by the inventor of the Amines process—and I am bound to confess with very great reason—that he does effectually destroy the bacteria, and so remove the possibility of any fermentation arising.

The new re-agent is produced by the action of lime on certain organic bases belonging to the group of "Amines," or ammonia compounds. When these organic bases are acted upon by lime a very soluble gas is evolved, which spreads rapidly through every part of the liquid and is held in solution therein with great tenacity. This gaseous re-agent has been found to be antagonistic to the existence and propagation of every species of bacteria occurring in sewage and other similar waters, for it utterly extirpates them in a remarkably short space of time.

The effluent from such water after treatment by this process is actually sterilised; it shows no living micro-organisms whatever, even under the most powerful microscope, and its sterility is further confirmed by the latest and most severe test known to modern science, viz., inoculation on nutrient gelatine and plate cultivation.

In support of this statement, which cannot but arouse the greatest interest in the sanitary world, I cannot do better than quote from a Report by Dr. Klein (who has just been honoured by the British Medical Association with the Stewart Award).

He examined some sewage—press liquor sludge and subsidence effluent, taken from the sewage works at Canning Town, where an application had been made in January this year. In the sewage he found 2,400,000 organisms; in the press liquor he found 650; in the sludge 400; and in the effluent none. The quantity examined being in each case 1 cubic centimetre.

"This number of bacteria found in the press liquor and sludge is far below that found in ordinary drinking water, such as the water supplied by the various London Water Companies, after this has been stored for a few days, and in some cases even the day after collection."

Dr. Frankland (Proc. R. S., No. 245, Vol. 40, p. 51,) has found that the filtered river water supplied by the London Water Companies contained per cubic centimetre on an average (on January 26th, 1886) 1,525 organisms.

In July of this year Dr. Klein again reported, but this time on a sample from Wimbledon, when the sewage was being similarly treated. In the crude sewage he found 768,000 microbes per cubic centimetre; in the mixture effluent and sludge well shaken up 100 microbes; and in the effluent which was subjected to the gelatine plate test for three periods, viz., 24 hours, 72 hours, and 144 hours, there was a total absence of microbes. And he further says, "the effluent must be pronounced sterile;" thus pointing to the fact that a process had been discovered which satisfies two of the requirements set out at the beginning of the paper, viz., a harmless effluent and a harmless press liquor, both devoid of microbes, and both fit to turn into a river, as on its discharge into a river it could cause no increase in the microbes already present in such river.

As a natural consequence of the sterilising action of this re-agent, decomposition of organic matter, whether incipient or far progressed, and the objectionable phenomena of putrefaction attendant on such decomposition are completely arrested, and even new infection cannot beget fresh putrefaction as long as there is a sufficiency of the gas remaining in solution. In elaborate and repeated tests made by the Government Analysts at Somerset House, upon samples of effluents from various experiments carried out with this process on Metropolitan outfall sewage (the quantities treated aggregating half-a-million gallons), the sterility of the effluent, and also its immunity from new infection, has been conclusively proved, the samples having been kept for four weeks in contact with air, at a temperature of between 70° and 80° F., with occasional exposure to the direct action of the sun's rays.

"The Amines," from which the process is named, exist in many substances in nature. And herring brine is one only of

the many sources from which they can be obtained. They are used either pure or in the form of Amine salts, or in one of the numerous substances containing them. But at present the brine is the cheapest and most readily procurable form in which it can be obtained. And the re-agent formed by its admixture with "milk of lime," and which the inventor has named "Aminol," is a powerful disinfectant, and imparts a sea-breezy odour to the works in contrast to the usual fœtid effluvia.

The proportions of the chemicals, added to the sewage, will vary with the character of the sewage, and with the attending conditions. The cost is stated by the Syndicate, in round numbers, to be from ½d. to ¾d. per 1,000 gallons treated.

Having satisfied two of the requirements set forth, there remains the question of the sludge and its disposal. This is devoid of offensive smell, and permeated with Aminol to such a degree that the inventors claim that, by fortifying the sludge left after a precipitation with one-fifth of the original quantity of the re-agent, this sludge, plus the re-agent, can be economically applied to a second tank full of sewage, and will produce as good effects on the second tank as on the first; and again, by the addition of another fifth of the re-agent to the second sludge so obtained, a third tank can be dealt with, with as good results. This feature in the process is important, and must naturally influence the ultimate cost very materially.

The sludge from this process is of a brownish yellow colour, and lacks the shiny appearance of ordinary sludge; and from its being permeated with the re-agent (Aminol), it may be left exposed to the sun and wind without any fear of offensive vapours being given of. A quantity of about ten tons lying in the open ground at the time of my visit was perfectly inodorous. Treated in the ordinary way by presses, it becomes a *moveable* commodity, half of its moisture having been removed; and it is fully believed that it will be a *marketable* commodity in those places where cost of carriage is not too heavy. Its bulk can be still further reduced, especially in places where a destructor is in use for the purpose of destroying dry rubbish by heat; and laid upon a floor exposed to some of the waste heat of a destructor, it may be made into a powdrette bagged and transported in a handy form. Its manurial qualities are still a matter of investigation, and the Syndicate are acting wisely in not tempting local authorities with visions of large profits from the sale of the cake. The purity of our rivers, and the purity of the air, are matters of far greater importance than a visionary profit from the sale of cake.

On the effect of the effluent on fish life, the inventors claim that, where it goes into a river, and is diluted by not less than ten times its quantity, it is perfectly harmless, and, being rendered sterile, there will be little fear of the presence of the sewage fungus—*Beggiatoa Alba.*

On the occasion of a second visit to the Wimbledon Works on the 26th August, I found the normal process in operation, the Syndicate having ceased its experiments *pro tem.* There was the usual sickly smell of fœtid matter arising from a tank recently emptied, in spite of a quantity of carbolic acid having been put in to deodorise it, black, repulsive, and mal-odorous in the extreme, a cloudy effluent leaving the tanks totally unfit for the river. The sludge pressing house gives forth a sickly smell, and were it not that the effluent was most thoroughly distributed over the irrigation area, a very offensive state of things would have existed. At the same time, it is but due to the engineer of the Wimbledon Local Board to say that the effluent, as it flows into the Wandle, after a second and often third run on the land, is one of the finest, if not the finest, effluent which is to be seen at any works.

Near to the tanks a broad open trench about 12 in. deep had been made by the Amines people, and into this to the depth of 7 in. or 8 in. a quantity of Amines sludge had been thrown seventy-two hours previously. This sludge, I was told (not by an Amines employé) had been fifteen days in the tank, and may be said to have been the deposit from 1,500,000 gallons of sewage from a purely closet town. Pegs had been placed along the centre of the trench to show the extent to which the sludge would dry up, and although there had been a thunderstorm twenty-four hours after the sludge was put in the trench, bringing with it ·21 of rain, and although there had been an absence of sun, the sludge had sunk to a depth of 3 in.; large open fissures broke up the surface, and there was a general natural shrinking of bulk. After seventy-two hours the sludge was the consistence of plasterer's putty, of a greyish colour, and on taking up a piece on a stick, it proved totally devoid of smell, this proving most conclusively that this new re-agent is a thorough deodorant.

Another advantage may be claimed for this sludge—that it may be spread on land in a liquid state, left to dry by the operation of the sun and wind, and then ploughed in when its manurial values will make themselves felt, without the costly, tedious, and, in the case of all other sludges, offensive process of pressing. Or, when thoroughly dried, it may be used as a means of reclaiming waste lands when they are within reach.

At the rear of the press-house were two heaps of cake—as it is termed,—one from the Amines process and the other the ordinary cake. To press this latter thoroughly it is frequently necessary to fortify it with an additional quantity of lime; but the Amines cake, if pressed, does not require such fortification—in fact I believe that when the process has been further developed kiln-drying will accomplish all that will be necessary to reduce it in bulk, sufficiently to make it easily portable and ready to be utilised in various ways.

The difference between the two samples of cake could not but strike the most superficial observer, and it may fairly be conceded that at length we are within measurable distance of the time when it will be possible to treat our sewage and its resultant sludge without fear of injunctions and all their attendant evils, without prejudice to the purity of our rivers, and without polluting the air we breathe.

Mr. C. H. Cooper, Assoc.M.Inst.C.E. (Wimbledon), said the local authority of that district were now treating their sewage by the Amines process; until about a week ago the process was merely being experimented with. He did not consider it fair to the Amines process to say that only a small amount of sludge was produced. If that was so what became of the matters not thrown down? The results obtained by the Amines process showed that it did throw down the greater part of the matters contained in sewage. The effect produced by the process in clarifying sewage was very remarkable. In a tank six feet deep the bottom could be seen in about twenty minutes after the sewage had been admitted. Then, as to the sludge. Ordinary sludge cake, as every one knew, was very liable to give off nasty smells after it had been spread on land, especially if exposed to rain and warm weather. During the last eight weeks some sludge cake produced by the Amines process had lain on a portion of the Wimbledon Farm near some cottages, but although there had been plenty of rain, followed by periods of warm weather, no smell had been given off. He did not think Mr. Godfrey fair in what he said respecting his visits to the Wimbledon works. In the first place, the works never had been in the hands of the Amines syndicate; and secondly, exactly the same treatment was in operation at the time of both of Mr. Godfrey's visits on August 17th and 26th, with the exception that on the 17th the Amines process was being applied to part of the sewage. As to the addition of lime to the sludge as it came from the tanks, it is well known that in almost all processes such lime has to be added to the sludge before it is pressed. The liquor pressed from sludge so treated is a concentrated solution of lime, and forms a re-agent to precipitate the fresh sewage to which it is added at Wimbledon. In the Amines process somewhat less than 50 grains of lime per gallon is applied to the sewage in the following manner: the first time clean tanks are charged 75 grains of lime per gallon is added, the second time 50, and the third time 25; the sludge is then removed from the tanks and the operations repeated with the amounts of lime stated. The cost of the ordinary process and that of the Amines at Wimbledon may be compared as follows:—

Ordinary Wimbledon Process.	Grains of Lime per Gallon.	Amines Process.	Grains of Lime per Gallon.
Lime	10	Lime	50
6 grains of alum equivalent to	20	4 grains of lime equivalent to	6
1 p. c. lime to sludge before being pressed	10		
	—		—
Total equivalent in lime......	40	Total equivalent in lime......	56

As the works are surrounded with houses, deodorants are used in the summer which, when used, make the former process slightly dearer than the Amines. One great advantage in the Amines process was that a double effect was got from part of the lime. Thus, instead of adding lime to the sludge after it had been precipitated, so as to remove the glutinous nature of the latter, a large amount of lime was at once added to the fresh sewage, which not only precipitated the sludge, but also removed its glutinous nature. As to the amount of water in the river into which the effluent may flow, it is unfortunately not always possible to find a river having ten times the volume of effluent. At Leicester, for instance, the volume of the effluent exceeded that of the river into which it was turned during part of July and August. At Wimbledon the effluent flows over land before being discharged into the river. With the Amines or any other process he did not think it likely that at Wimbledon the effluent would ever be discharged direct into the river without being first passed over the land.

Mr. J. Willis-Bund (London) said, when he heard, during Mr. Godfrey's paper, of an effluent perfectly harmless to fish life, as the Chairman of a large Fishery Board he was naturally glad that such a discovery had at last been made; but he was like the lady who said she had been played that trick before, and so seemed a little sceptical. There were one or two questions he would like to ask. Was this effluent all that it was said to be? He did not say it was not: he only wanted information. In what rivers containing fish had the process been tried and the effluent found harmless? It was said to be a sterilized effluent; but it did not follow that because an effluent was completely sterilized it was therefore not harmful; let them take one example. He believed they could sterilize water completely by adding bichloride of mercury, but that would make the water most harmful to life. He had this further question: might not the discharge of a sterilized effluent in large quantities into a river also sterilize something in the river which they wanted to preserve? Those were points which seemed to require some practical investigation and a good deal more information than they had at present, before they could accept the Amines process as a complete answer to the problem that had been set them to solve. One other point: in the Rivers Pollution

Prevention Act of 1876, it was provided that a local authority was bound to admit into their sewers any beastliness that a manufacturer chose to put there, consequently, in different towns, they had a wholly different state of things to deal with. He once, in cross-examination, asked an eminent chemist, who was recommending a particular process to be applied to a particular case, whether he ought not, before he recommended that process, to ascertain what were the ingredients he was going to apply it to? "Oh," he said, "sewage is sewage." When he (the speaker) ventured to differ, the chemist said the quantity of sewage was so much larger than anything else, that they could leave everything else out of consideration. He (the speaker) did not think they could. How far would the Amines process be successful where there was a good deal of refuse of various kinds passed into the sewers? Might not the refuse of a large manufacturing town have the effect of neutralising the agents which produced the good results which were obtained at a place like Wimbledon, where there were no manufacturers?

Dr. J. W. Tripe (London) said the few remarks he had to make were the result of observations derived from one visit only to the works, and therefore they could hardly be taken as having that weight which continuous record would have. That day fortnight he was present at a meeting of a large number of representative engineers and others, for the purpose of seeing the results of the process and the mode in which it was carried out. It was then stated that seventy grains of lime per gallon were used in summer, and a smaller quantity in winter; and a friend of his who was present told him that he heard on good authority that as much as ninety grains of lime per gallon had been used in summer, and seventy in winter. That was a very large quantity: much larger than had been mentioned by Mr. Cooper, the assistant surveyor to the local board at Wimbledon. The effluent was turned on to the land before it went into the river, consequently the effects on fish and the effects on microbes would be materially altered. With regard to the growth on the land he saw at Wimbledon, it was what he should call bad; he did not know whether it was the Wimbledon sewage or the Amines process that was responsible for it. In one part there seemed to be more weeds than anything else. The growth was not by any means so satisfactory as he had seen it on other sewage farms. His nose informed him of an extremely offensive smell; and on looking about to ascertain the cause, he found a large quantity of black sewage amongst a bed of willows. He had always noticed that when sewage got too bad to be carried anywhere else on a sewage farm, it was sent to the willow-beds. There had been two processes going on at one time at Wimbledon, and it was difficult to discriminate as to the results of each. Certainly the sludge thrown out on the ground had no bad smell. He would have said that the piece he took up and broke was nearly all lime, and he thought that if a person bought it to apply to land except as lime he would get very little for his bargain. If the process was to do any good it required more herring brine, and less lime.

He (the speaker) had no interest at all in the matter, except this: that he wanted to see something introduced which, so far as they were concerned at Hackney, where he was Medical Officer of Health, would prevent them from being half poisoned by the sewage which came down there. Another point which seemed to him singular was that most of the examinations which had been reported upon had been made when there had been either a low temperature or much rain. During August they had a remarkable quantity of rain, and that was just the time when these experiments were made. These were points for careful consideration. He was also told that as many as six charges were put into the tank before the sludge was taken out. The engineer would tell them whether that was correct or not; if that were so he was surprised that the effluent came out without smell, as they were told it did. The last speaker pointed out one matter of great importance. If they killed all microbes, injurious and others—for as yet they could not distinguish the injurious from the non-injurious—what about the water? They knew that the oxidation of water went on to a great extent through those microbes; therefore if they destroyed them all, they must have a water which would become bad. It certainly did not seem to him that this process approached anything like perfection.

Dr. A. Carpenter (Croydon) observed that, like Mr. Marten, he had been a disciple of Sir Edwin Chadwick, and had learned from him a large number of lessons which he had been carrying out during the last forty years of his life. He had heard during that time from the promulgation of the process of Higgs downwards until to-day, year by year, statements which corresponded almost entirely word for word with those that had been put forward that day with regard to the Amines process. The only varying point they had in addition was a few grains of herring juice, which certainly gave him an amount of new vision and a little novelty which he had not before as to how to deal with sewage. He was not going to dispute the facts put forward by the promoter, but the point raised by Mr. Willis-Bund and Dr. Tripe to his mind destroyed any value that might have been attached to the process as a means of purifying sewage. They did want microbic life and they could not do without it. If they destroyed it they would do an enormous amount of mischief with regard to their water supply and the life that existed in rivers. He thought Mr. Corbett had given expression to views which were totally wrong, because he had only taken a very narrow area from which to give his experience. Taking his (the speaker's) own case: for thirty years he had had under his eyes, and for a large number of those years under his management, a sewage farm extending over from 400 to 600 acres of land which had been carried on on the same site for thirty years in the midst of a dense population, surrounded by houses of a large value, and occupied by persons who would not hesitate to protest if they perceived any nuisance to their property. What had been the result? At this moment the sewage of from 60,000 to 70,000 people was utilised on the farm, and the effluent as it flowed off was equally as pure as it was twenty years ago, when Dr. Frankland reported on it. With regard to the effect upon the health of the neighbourhood. When the farm was first started, the death-rate in his (the speaker's) district was 26 per 1000, at this moment it was fourteen, and of the last three years it had been under sixteen, while the death-rate of the parishes immediately on the borders of the sewage works was 12 per 1,000. There was no area round London that could vie with the area of Croydon and the area of Beddington and Wallington which lay around the farm, with regard to sanitary arrangements as shown by the birth-rate, death-rate, and the record of zymotic diseases. What had been the effect upon the rates? They had purchased the whole of the land, not at agricultural prices but building prices, paying for it from £200 to £400 per acre, the whole amount was £187,000, capital cost incurred in the purchase and laying out of the land, yet on no occasion had more than a 2d. rate been asked for by the Local Authority for the purpose of dealing with the sewage. His experience led him to the conclusion that it was the best way in which a district could deal with its sewage if they wished to prevent it becoming an expense to the locality. The cost of the purchase of the farm must fall on the locality that wanted it; but the working expenses might be kept down to a very low figure provided that the farm was not managed on agricultural principles. The agricultural mind took it for granted that sewage must be made to stink before it could be of any use; but the great principle with regard to sewage farming was that you must not allow your sewage to stink—no time must be allowed for this object. It must be fresh. It must go directly into the sewer, and the sewer if it was properly laid, would not give it time to ferment. There would be no fermentation, and the microbic life, which existed all over that farm in an enormous proportion would deal with the sewage not by oxidizing it or by a process of fermentation, but by a process of digestion. It would be digested by the microbic life on the farm, which would take out the whole of the ammonia from the sewerage, and the effluent water would go through, only carrying a certain amount of salts, and if the farm was properly managed, that effluent might be received into any stream without the least fear or danger. He had seen over and over again in their carriers trout which would come up from the river Wandle, and which preferred their effluent water to that which they got in the stream itself, the latter was sometimes muddy, the effluent never unless when the carriers were being cleaned out or repaired.

Dr. H. J. Strong (Croydon) said he was able to endorse most thoroughly Dr. Carpenter's statement as to the value the sewage farm had been to Croydon. New sewage ought not to smell at all. The fresh sewage from the furthest part of their boundary, arrived at the outfall about two hours from the time it passed into the sewer. It was there met by an extractor designed by Mr. Baldwin Latham, which consisted of a large revolving sieve-wheel; the sewage flowing against this, the more solid portions of the sewage were retained, whilst to prevent the machine clogging, a fine stream of pure water was thrown against the wire-work. The solid manure is mixed with earth, and used on the farm, and this solid matter forms but a very minute portion of sewage compared with that which is in a state of sludge, and which, flowing through the carriers, is distributed over the land. Both precipitation and irrigation had their defects; either were proper in different localities, but in his opinion irrigation was the best process, because they got rid of the sewage without smell, and with nothing noxious to the inhabitants in the neighbourhood. A corporate body had no right to look upon sewage farms from a commercial point, with a view to profit. The best thing to make it pay was to secure the absence of zymotic diseases, and at Beddington they had enjoyed perfect immunity at a time when zymotic disease had been prevalent in the places around them. If a Sanitary authority disposed of its sewage, and the effluent water was sufficiently clear and pure to pass into a stream without doing harm to the animal life in that river, it accomplished all it wanted, and a moderate cost was not of such importance as the successful carrying out of the object for which it was instituted.

Colonel JONES (Wrexham) thought that the deputations from corporations which went about from place to place to see what had been done in the matter of sewage disposal, would do far better if they sent for advice to those who were thoroughly competent to give it. He had had sewage of 12,000 people to deal with upon 150 acres of his land for eighteen years, and he had found that the growth of crops was promoted, and the sewage was dealt with efficiently and entirely innocuously. From physical reasons every drop of the water from his sewage farm which was not evaporated must flow into the Dee a few miles from the place where the stream was tapped for the water supply of Chester. Therefore his sewage farm was being constantly watched by the water company and the Medical Officer of Health of that city, and when he stated that he never had any trouble of any kind from their visits he thought they would agree with him that he might be satisfied with the effect of land filtration. He did not agree with the view that sewage should be dealt with by sterilisation and postponement of the stage of putrefaction. Nature taught them that putrefaction or fermentation was the only means by which sewage could be broken up and made innocuous. The great point of Mr. Dibdin and Dr. Dupre, who had treated the subject thoroughly scientifically, was the action of organisms in breaking up the sewage and rendering it innocuous. The great point upon which the Amines process was recommended to the public was its sterilizing disease germs, but they could not distinguish between profitable organisations and the rest. That appeared to him to be a misunderstanding of the scientific mode of dealing with sewage. To him it seemed that this was only a variation of the old lime process. They were asked to make an addition of three grains of fish-brine, which had the attraction, to the public mind, of being a homœopathic dose. Three grains per gallon as compared with seventy grains he called a homœopathic dose.

Mr. CORBETT (Worcester) said one or two speakers had referred to the investigation which had been carried on by the Worcester Town Council as if they had acted upon their own responsibility. If they had followed his remarks that morning, they would have noticed that he said they were acting under the advice of an engineer of great experience, and he referred to the name of Mr. Hawksley. He thought a public body, acting under the advice of a gentleman of such vast experience, could hardly be said to be acting on their own responsibility. He, however, thought public bodies would do some good by using their own eyes and using their own noses too. The Committee of the Town Council in inspecting various sewage farms and works were able to test, by practical observation, whether the statements made by experts were altogether reliable. He was not surprised that those who were charged with the management of the Croydon Sewage farm were prepared to stand by their "pet." But there were exceptional circumstances in the case of Croydon. There was a large area devoted to the farm at Croydon, but Croydon was a growing town, and if the farm remained at its present area and Croydon continued to increase, no one would say that in thirty years time the farm would be able to grapple with the sewage of Croydon and discharge a satisfactory effluent water. A sewage farm on the irrigation principle could only be satisfactory under very exceptional circumstances of soil and situation and so forth—circumstances which did not exist in the case of Worcester, and which existed in very few cases.

Mr. G. W. HASTINGS, M.P. (Malvern) said he had nothing to do administratively with the City of Worcester, and he would therefore say nothing of its sanitary plans, as he thought the most valuable contribution that could be made to a discussion by them all was to speak of facts known to themselves. He had had, as Chairman of the Police and Sanitary Committee of the House of Commons now for seven years, session after session, a number of applications with regard to the disposal of sewage. He had heard the ablest counsel of the Parliamentary bar argue on the different views of various applicants, and he had listened to a number of expert witnesses of the highest authority in this country. He was bound to say, whether it be from defect of intellect on his part or not, that he had never yet been convinced that any one of those systems for the disposal of sewage which had been brought before him possessed the excellence which was claimed for them. He had never yet been able with a clear conscience to sanction the expenditure of public money for the adoption of any one of them. He had had two instances before him in which he had been convinced of the successful application of sewage to the land: one of those was Croydon, the other was Reading. When the borough of Croydon applied to his committee a few years ago for a bill with regard to their sanitary works, they showed, in his opinion successfully, that their system of the disposal of sewage was satisfactory in more ways than one: that it was satisfactory with regard to getting rid of the sewage, which after all was the great thing, and in the next place that it was got rid of without detriment to the health of the population who were living near the sewage works, always a very important point in the question. With regard to Reading, he never heard any evidence more convincing than the evidence given in that case, and the farm there was worked by natural irrigation, and was perfectly successful. It was not more successful than Croydon, but it was as successful in the application of the sewage and in the results that followed from it. It was only because he had in some way or other been convinced of the real and true results in those two cases, and had not been convinced with regard to other systems, that he was bound to say, as he had said in the chair of his committee and as he had said now, that as far as he knew the only system by which they could in every way dispose satisfactorily of their sewage, was by placing the liquid sewage, where they had the means to do so, perfectly fresh directly upon the land.

Mr. R. Godfrey (Birmingham) said there was no wonder at the sewage farm at Croydon being a success, considering that they had 600 acres of land at their disposal.

Dr. A. Carpenter (Croydon) wished to explain that the whole of the land was not in use at one time. There were only about 400 acres under irrigation, and the rest being used for other purposes connected with the farm, only 200 under absolute irrigation at the same moment.

Mr. R. Godfrey (King's Heath) repeated that the area at Croydon was equal to an acre per 100 persons of the population. Mr. Willis-Bund had asked what river the effluent under the Amines process had been put into. As yet the process was only an experiment, and he had simply given an account of what he saw to challenge criticism. No rivers had been tested with it yet. He claimed a fair trial for the process. With regard to its effect in dealing with chemical sewage, West Ham and Stratford-le-Bow were both towns making a good deal of chemical refuse, and it could be tested there. Most of the speakers had praised other systems of which they were in favour, and had said nothing in criticism of the Amines process. Let them give it a fair trial. If it failed it must fail; but it ought not to be condemned untried.

On "*A Method of Regulating the Maximum Discharge of Sewers*," by Henry Law, M.Inst.C.E., F.R.Met.Soc.

In designing a system of drainage, it is frequently required to limit the quantity which one or more of the sewers shall be capable of discharging at their outfall.

In the case of the formation of joint boards, for dealing with the sewage of several separate districts, it is usual for the Local Government Board to prescribe two hundred and fifty gallons per house per diem, as the quantity which the joint board shall make provision for receiving into the main intercepting sewer from each branch or district sewer.

Also, in the case of the drainage of only one district, it becomes necessary to limit the quantity which the sewers shall discharge at their outfall or junction with the main sewer, as the case may be; not only because in the treatment of the sewage, whether on land or by chemical process, it would be impossible to deal with the whole of the discharge from the several tributory sewers in times of heavy falls of rain, but further because the main intercepting sewer would become of inconvenient dimensions if made capable of receiving the aggregate maximum discharge of all the sewers which it intercepted.

It is proposed to fulfil this requirement in the following manner:

The discharging capacity of a sewer is always proportional to the cube of the transverse sectional area filled by the sewage, divided by the wetted perimeter. This quotient gradually increases as the depth of the stream in the sewer increases, until it reaches a certain height (which, in the case of a circular sewer, is equal to 0·9496, the whole diameter being unity), after which, as the sewer becomes further filled, this quotient diminishes, and the quantity discharged becomes less.

If, however, the form of the sewer above the line of the maximum discharge is modified in such a manner that, as the sewage continues to rise in the sewer, the quotient obtained by dividing the cube of the area filled by the wetted perimeter remains constant, then the quantity discharged by the sewer will also be constant—neither increasing or decreasing—although the height of the sewage may vary between certain limits.

The accompanying drawing, Fig. 1, exhibits the form to be given to a circular sewer above the line of maximum discharge in order to render the discharge equal in quantity, although the sewage may rise above that level; and the following table gives the width of the sewer at each successive hundredth of the diameter above the line of maximum discharge, the diameter of the sewer being unity, namely:—

Width at the line of maximum discharge	0·4376
" " 1 hundredth of dia. above the same ..	0·3984
" " 2 hundredths " " ..	0·3632
" " 3 " " " ..	0·3317
" " 4 " " " ..	0·3037
" " 5 " " " ..	0·2790

Width at 6 hundredth of dia. above the same ..	0·2574
" " 7 " " " ..	0·2386
" " 8 " " " ..	0·2225
" " 9 " " " ..	0·2090
" " 10 " " " ..	0·1979
" " 11 " " " ..	0·1891
" " 12 " " " ..	0·1824
" " 13 " " " ..	0·1777
" " 14 " " " ..	0·1748
" " 15 " " " ..	0·1735
" " 16 " " " ..	0·1724
" " 17 " " " ..	0·1714
" " 18 " " " ..	0·1706
" " 19 " " " ..	0·1699
" " 20 " " " ..	0·1693

Having determined the maximum quantity which it is required for the sewer to discharge at its outfall; such dimensions must be adopted for the sewer, for a certain length from such outfall, as shall enable it to discharge that quantity when the sewer is filled to the line of maximum discharge, and above that level the sides of the sewer must be made of the form shown in the diagram.

At the upper end of this length of sewer, an opening is made in the side of the sewer forming an overflow weir, the level of the lip of which is the same as that of the line of maximum discharge, that is to say, the same as the lower limit of the height of the stream having the constant rate of discharge; and this sewer is made of such a length that, when the stream rises to the upper limit of such constant rate of discharge, the quantity which will flow away over the weir, shall be equal to the maximum quantity which the upper portion of the sewer can bring down, after deducting from the same the constant quantity which can be conveyed away by the lower length of the sewer with the modified form of section. This discharge from the weir is conveyed away by an independent channel provided for that purpose.

Fig. 2 illustrates the practical application of the method. If, for example, the diameter of the lower or regulating length of the sewer is 2 feet, with a fall of 1 in 500, its maximum discharging capacity would be 590 cubic feet per minute; and if the diameter of the upper portion of the sewer above the weir is 3 feet, with the same fall, its maximum discharging capacity would be 1643 cubic feet per minute; consequently, 1053 cubic feet per minute would require to be discharged over the weir; and if the length of the weir is 22 feet, this quantity would be discharged with a depth of 4·42 inches flowing over the lip of the weir. Therefore, with the

maximum quantity which the upper sewer could bring down, the sewage could never rise in the regulating sewer above the upper limit of constant discharge.

If the upper or regulating portion of the sewer were made in stoneware, moulded to the required form, as shown in the diagrams, no special skill or care would be required in the construction of the sewer.

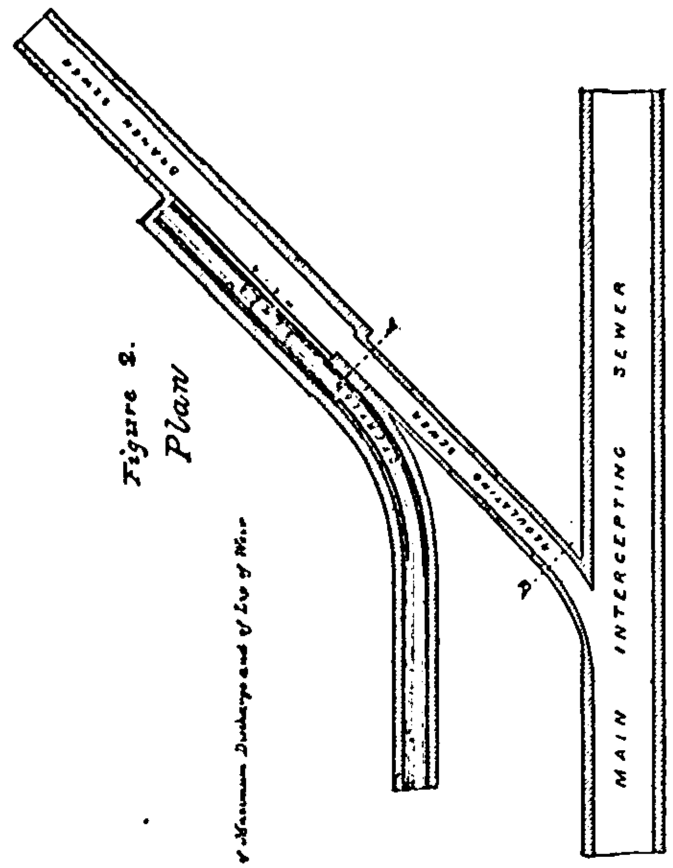


Figure 2.
Plan

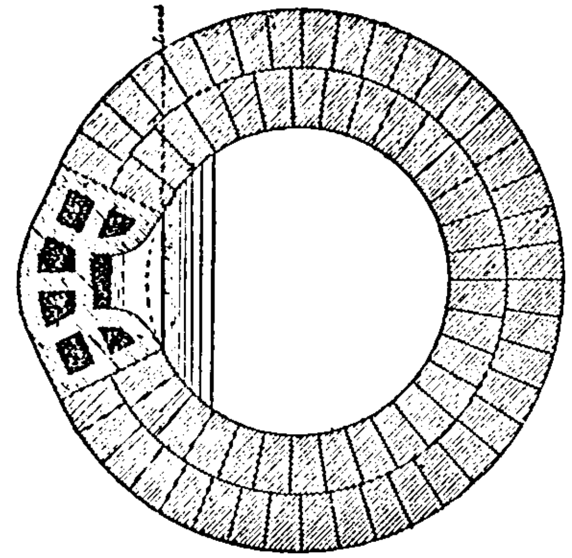


Figure 1.
Section of Regulating Sewer
Between A and B

"*Notes on Water Supply*," *by* Richard F. Grantham, M.Inst.C.E.

The tendency of the population of the country to move towards the towns, and the consequent rapid increase of the already densely-populated quarters of towns, enhances the responsibility of those who are charged with the duty of supplying wholesome water, especially as new sewerage works, particularly in their connection with the houses which the growth of towns makes necessary, may become, without great precautions, means of contamination of the water, to say nothing of the chances of pollution at its source.

It may then be as well to note what has been done, and what is being done, in some of the larger towns towards providing wholesome water, and to refer briefly to the systems and methods which are most efficient in affording a good and sufficient supply.

The Rivers Pollution Commissioners declared that "of the different varieties of potable water the best for dietetic purposes are spring and deep well waters. They contain the smallest proportion of organic matter, and are almost always bright, sparkling, palatable, and wholesome, whilst their uniformity of temperature throughout the year renders them cool and refreshing in summer, and prevents them from freezing readily in winter. Such waters are of inestimable value to communities, and their conservation and utilization are worthy of the greatest efforts of those who have the public health under their charge."

The geological formations which in this country yield the largest supplies of deep well water, are the new red sandstone, the oolites, and the chalk.

Now it is almost unnecessary to point out that the largest towns in the kingdom are dependent to some extent upon water drawn from deep wells. London, Liverpool, and Birmingham, derives each of them a portion of its supply from deep wells, the former from those in the chalk, and the two latter from those in the new red sandstone.

In the case of London, the proportion drawn from deep wells and springs varies from about 13 to 15 per cent. of the whole supply. Liverpool and Birmingham have hitherto depended still more largely upon deep well water. Thus Liverpool, with a population of over 600,000 at one time derived 6,250,000 gallons per day from deep wells, out of a total of nearly 18,000,000 gallons, the remainder being obtained from gravitation works, consisting of seven catchment reservoirs, with a storage capacity of 4,059,000,000 gallons. The supply,

however, has been found insufficient, and the drought of 1887 was severely felt.

Birmingham in 1885, with a population of about 500,000 was supplied from deep wells in the new red sandstone at the rate of 9 million gallons per day, and from streams at the rate of 7½ million gallons. The storage capacity amounted to 617,761,913 gallons, equivalent to 10,000,000 gallons per day for 60 days in addition to the daily supply.

Birkenhead, with a population of about 45,500, derives an ample supply from deep wells also in the new red sandstone.

From the same formation, the South Staffordshire Water Works, which supply an area of about 40 miles in length between Stourbridge and Repton, and about 12 miles in breadth at Lichfield, in 1869 obtained 10,000,000 gallons daily, and this was increased to 24 millions by driving a tunnel into the keuper sandstone and marls and pebble beds.

Croydon, Surrey, with a population of nearly 100,000, is supplied with water of excellent quality from wells and headings in the chalk; and Portsmouth, with a present population of 150,000, has just got supplied at constant high pressure with 5,000,000 gallons per day from springs in the chalk. Other districts are drawing large and unfailing supplies from deep wells in the same formation.

Large volumes of water are also to be found in the oolites, from which, for example, Peterborough, Northampton, Scarborough, and Cirencester draw their supplies.

These instances, which may be taken as typical, show that while for the largest towns these sources alone are inadequate, for towns of more moderate size they yield an unfailing supply independently of dry seasons.

Experience of late years has shown that supplies from such water-bearing strata, as the new red sandstone and the chalk, can be better supplemented and increased by the extension of headings or adits driven horizontally below the water-level, than as was formerly the practice by deepening wells or boreholes. By driving headings into the water-bearing strata, the area of collection of the water is increased in proportion to the length of the headings. Percolation of the water through chalk being along fissures and crevices in the rock, great care should be taken that no pollution is allowed to take place on the surface of the ground below which the water is drawn.

The boring of deep wells has been much facilitated and the cost reduced, by the recent introduction of boring tools of large diameter. Thus, in the new works in the chalk whence Southampton is supplied, tools were employed which bored two wells, each 6 feet in diameter.

But it must be borne in mind that water taken from deep wells, in a permeable district, is so much water abstracted from the sources of neighbouring streams. Schemes have been propounded by which the underground stores of water might be replenished by the admission of the surplus or flood-waters of rivers into "swallow" or "sump" holes, or "dumb" wells sunk into the water level below; but the recovery of the water at the particular locality in which it may be required, can scarcely be depended upon, and this, coupled with the disadvantage of pumping up again water which might have been collected and stored on the surface, make it difficult to see at present what practical benefit could be derived.

Comparing the various sources of supply in respect of quantity, we know that reservoirs fed from gathering grounds must have very ample storage capacity to provide against long droughts. Liverpool, which has hitherto been largely supplied, and Manchester and Sheffield, which have been entirely supplied from this source, felt the drought of 1887 severely. The magnitude of the new works designed for the two former towns shows what large provision is felt to be necessary for the wants of the rapidly-increasing populations. Thus, the storage (available for Liverpool) at Lake Vyrnwy will be about 12,000 million gallons; the present population being 814,873, and the consumption during the year 1887, twenty-three gallons per head. The storage at Thirlmere (for Manchester) when the lake is raised fifty feet, will be 8,130,686,693 gallons; the present population being about 1,000,000, and the present consumption about twenty gallons per head. Deep wells, although alone within a circumscribed district insufficient for the largest towns are certainly sufficient for towns of populations, say of 100,000 or 150,000, and supplies from rivers—taking London and Worcester as examples—do not anyhow fail during dry seasons, whatever their liability to pollution.

Upon this point, with reference to London, it is interesting to turn to the reports of the Water examiner. In November, 1884, the late Colonel Sir Francis Bolton remarked that at that time, after two dry winters and a spring of unusual drought, there were about 410,000,000 gallons passing over Teddington weir. Adding 80,000,000 at present abstracted by the companies, the quantity at Teddington would be 495,000,000, that is, the companies are taking less than one-sixth of the minimum flowing volume. Unfounded statements appear to have been made at that time that the Thames showed signs of exhaustion, but, he adds, "the fact is there is no question of present exhaustion; but in future times, when more than double the present quantity is required, it will probably become necessary

to store in some of the valleys sufficient of the winter or flood waters to give out in compensation during the dry months."

I may remark here that Worcester, with a population of 40,000, is now pumping 1,250,000 gallons per day from the Severn, which, even in the longest drought, yields an unfailing supply.

Later on, in September, 1887, the present Water Examiner of London, General de Courcy Scott, reports as follows:—"The extension of the deep well and adit system of supply within the Thames and Lee basins is much to be desired, as the water derived from the chalk by such water works is of the highest quality, and efforts in this direction on the part of the companies cannot but be viewed with much satisfaction. . . . A marked feature of river supplies is the very large increase of impurities, both suspended and in solution, which results when the rivers are in flood. Water taken from the underground sources, whether from the gravel already referred to, or from deep wells, is free from this defect."

Now let us turn, by way of example, to the statistics of the population of London, the quantity of water used, and the means which in many places have been adopted to prevent waste.

The population of London supplied by the different Water Companies is, according to the June Report of the Water Examiner, about 5,575,507, and the daily quantity of water varied from about 153,617,000 gallons, or 27·76 gallons per head in December, 1888, to 180,878,000 gallons in June, 1889, or 32·44 gallons per head.

In many towns much waste of late years has been prevented by careful supervision, repair of fittings, and the adoption of the waste water meter system.

I have tabulated the results of these improvements in some towns as reported from time to time by the Managers, Secretaries, and Engineers of the various Water Companies or Corporations.

Name of Town.	Quantity of water used before adoption of system per head per day. Gallons.	Quantity used after adoption of system per head per day. Gallons.	Total Reduction per head per day. Gallons.
Carlisle	40	23·50	16·50
Lambeth W. W., London	34	20	14·00
Gloucester	31	17	14·00
Bath	43·7	22	21·70
Clevedon	37	23	14·00
Abergavenny ..	37	21	16·00
Newport	35	19·50	15·50
Birkenhead	35	15·48	19·52

Or more than 33 per cent. on the whole.

There are some towns, however, in which it has been considered that the first cost of adopting a system of preventing waste would be greater than the saving effected by it.

I do not say whether or not the system is practicable throughout London, although it has been adopted with advantage by the Lambeth Water Works, the New River, the East London Water Works, and other London Companies; but the large figures applicable to London are useful as a very striking illustration of the immense importance of the saving to be thereby effected. Thus, if the supply per head per day could be reduced from 30 gallons, taking that as the average, to say 20 gallons, there would, of course, be a saving of about 55,755,100 gallons per day.

The proportions of the daily supply used for various purposes at Liverpool and Manchester respectively are, of the 23 gallons for Liverpool:—

$\frac{1}{3}$ for domestic purposes.
$\frac{1}{3}$ for trade purposes.
$\frac{1}{3}$ waste (this latter is inevitable).

Of the 20 gallons at Manchester:—

13 gallons for domestic purposes.
7 gallons for trade.

The supply of water by meter is frequently advocated as a means of checking waste; but the detriment it is likely to cause to the public health, when applied for domestic purposes, by inducing people—particularly of the poorest classes—to use it as little as possible, outweighs, I think, any advantage it might offer in other respects. But for trade purposes it appears to be the most just and reasonable method; and, according to the recent case of Cooke, Sons & Co., *v.* the New River Company, the right of owners to demand such a measurement of water when used solely for business purposes, has been established.

In some maritime towns, attention has been drawn to the use of sea-water for watering streets and flushing sewers as a means of saving the cost of obtaining the best water for such purposes. In a paper read by Mr. S. H. Terry, of the Local Government Board, before the Civil and Mechanical Engineers' Society, it appears that several surveyors of those towns pronounce salt water to be the best for watering streets. The East London Water Works have for some time used unfiltered water for such purposes, although it involves separate main pipes.

Where towns use river water for all purposes, the efficacy of the system of filtration is of course of the highest importance. An advance has been made of late years in the means of testing

it by the methods of biological examination, which has so largely engaged the attention of Dr. Percy Frankland. General Scott shows by his Report of December last how much he values the bacteriological test, which for sanitary purposes he considers the more sensitive and delicate one.

Chemists appear to be agreed that sand filtration is the most efficacious, as it is the least costly, method of purification on a large scale. The conditions under which the removal and destruction of micro-organisms are facilitated, are an enlarged storage capacity, a sufficient thickness of sand, a slow rate of filtration—one according to the practice of the London Water Companies—not exceeding 540 gallons through each square yard of sand in 24 hours, and a frequent removal of the filtering medium.

Prominence, however, must be given to Mr. William Anderson's experiments on the filtration of the impure water of the River Nethe for the supply of Antwerp. The first attempts were with a certain thickness of sand, and below this a mixture of spongy iron and gravel. The action of the iron was thoroughly effectual, but it was found the filters became so quickly clogged, that only a part of the water would filter through, and so the labour of cleansing the filter was seriously increased. Mr. Anderson subsequently devised revolving cylinders charged with scrap iron, and so arranged that the water passing through them was brought into contact with every particle of iron.

With regard to the general question of obtaining a sufficient supply of wholesome water, there is a tendency of the largest towns to look to lakes as the best and most unfailing sources. Two schemes of such a character, for the supply of London, were brought before the Royal Commission on Water Supply in 1866, but it was objected that though there was no doubt the lake districts were a very fine gathering-ground for soft water, these districts were not unlikely to be claimed as the most natural source of supply for large and increasing manufacturing populations in the north of England, for whom soft water would be particularly valuable; and so far as Manchester is concerned this opinion seems to have been prophetic.

For smaller towns not situate on water-bearing strata, it is unfortunate that in so many cases the rivers, which after all are to a large extent fed by the overflow from under-ground waters, and which, as we have seen, generally yield unfailing quantities, should be rendered unfit by the pollution which is now allowed to exist. If only this pollution could be stopped, or at any rate minimized, and improvements made in filtration, we might, in many cases, look to the rivers as furnishing sufficiently wholesome supplies.

In conclusion, I wish to render my best thanks to Mr. Purchas, of Worcester; Mr. Deacon, of Liverpool; Mr. Hill, of Manchester; and to Mr. John Taylor, of the Lambeth Water Works Company, for much valuable information about the water supplies of their respective towns.

Mr. C. H. Cooper, Assoc.M.Inst.C.E. (Wimbledon), thought Mr. Grantham had under-estimated the amount of water at present derived from borings for the supply of London. The Kent Water Company took all its supply from the chalk; the East London and New River Companies took a large part of their supply from the same strata. Lately the Southwark, Vauxhall, and other companies had also sunk wells. The suburbs round London were largely supplied by private borings in addition to those belonging to small companies. Recently he visited Portsmouth with the municipal engineers, and saw the splendid supply of chalk water furnished to that town; no softening process was used, but the water was remarkable for its transparency. He agreed with Mr. Grantham that headings were a much surer means of getting water than the sinking of narrow borings. Chalk water contained a large amount of organic matter of a very remote origin; and Dr. Percy Frankland had found that such water, although containing a very small number of micro-organisms when first exposed to the air, after the lapse of a few days contained a far larger number of such organisms than were to be found in ordinary water. There was no doubt that where water came from an artesian well it was practically free from contamination; however, in open wells such as draw-wells, there was liability to contamination. At Croydon, where such wells existed, although lined with iron tubing to prevent percolation from the subsoil, Mr. Baldwin Latham showed, by trial holes surrounding the pumping station, that surface water got into the wells. Croydon has since sunk wells at Addington. He was sorry Mr. Grantham had not alluded to the intermittent system which prevailed in some parts of London: cisterns were fixed inside the houses, where they were subject to contamination, and often remained for years without being cleaned out. Many such cisterns were placed underneath floors of bedrooms, where they caught the dust which fell through the crevices when the floors were swept. Legislation is much needed to prevent the contamination of underground water; for while the purity of rivers, lakes, &c., is protected by the Rivers Pollution Prevention Act and the Public Health Act, no enactment has ever been passed to protect the purity of underground water, from which many millions of inhabitants of this country derive their supply.

Mr. H. R. Newton, F.R.I.B.A. (Weybridge), thought it a matter of regret that more attention was not paid to utilising as a means of supply the water which fell from the clouds. They were too largely

indebted to what might be called the manufactured article. Every drop of water which came from the sources of the rivers was derived from the heavens, and no doubt before it was rendered impure was extremely drinkable. He thought that the effect of the water, in the state in which it came from the clouds, on our internal economy might be very beneficial.

Mr. H. S. Ridings (Walthamstow) doubted the desirability for towns of a rain-water supply collected from the roofs of houses. He resided for some time at Carthagena, in South America, where they depended entirely upon the rain, which was stored in large reservoirs built underground, and the results were not at all satisfactory. The water quickly became filled with micro-organisms, which produced most painful diseases. As to the East London Water Works, he could say from observation that they were perfect models. Great advances had been made in many respects since Mr. Bryan had control of them. He had just completed a very remarkable pumping-engine at Waltham Abbey, for pumping the water to High Beech, in Epping Forest; it was a triple expansion engine, similar to those used in great ocean steamers, and he (the speaker) believed this was the only case in which they had been used for such a purpose. The economy in their use had been very great. Mr. Bryan had also lately succeeded, in the parish of Walthamstow itself, in getting through a difficult quicksand that he had been fighting with for the last eighteen months; by means of cast iron cylinders he had now got through it into the chalk. Walthamstow had a population of nearly 50,000, and one part of the town had a constant supply of water from the chalk, the beneficial effects of which were very marked indeed.

Mr. R. F. Grantham, M.Inst.C.E. (London), said Dr. Black's conjecture, that sewage was sometimes annihilated by freshets in a river, was very probable; but the best thing was to keep the sewage out of a river, and not trust to freshets. As to whether micro-organisms would be dangerous to life if retained in filtering beds and sent out again, he would only point to the case of London, where the filtering was very carefully done and where he never heard of anything of that kind occurring. To suppose that typhoid fever was carried down the Severn from Kidderminster to Worcester—which was more than twenty miles—by water was entirely opposed to the theory of Dr. Tidy, who maintained that after water had travelled a certain distance it became so oxydised that there was very little danger of disease being communicated in that way. In reply to Mr. Cooper's suggestion—that he had under-estimated the deep well supply of London—he might say that he based his estimate on the report of the water examiner, whose percentages were no doubt very carefully ascertained, and they might be taken as correct. Water from the chalk was no doubt of excellent quality, but it was hard, and in some cases softening processes were applied; they were not in use, however, at Portsmouth or Croydon, and at Croydon, as he knew, the water was excellent. He was glad to say that in London the intermittent was being superseded by the constant system of supply, and now three-and-a-quarter millions out of five millions of the population had the advantage of the improvement. As to a rain water supply, as far as his experience went, it could not be relied on as a nice water, though it might not be unwholesome. He remembered a house in the Lake district, close to Morecambe Bay, which depended on rain water, and though there were few houses near it and no smoke, when they took the rain water in a glass it showed a black colour; in fact it was contaminated by the deposit on the roof of the house itself, and it was difficult to obtain water in that way without contamination of that kind.

Mr. H. J. Marten, M.Inst.C.E. (Wolverhampton), said, as further local instances of large underground supplies being obtained for water-works' purposes, he might mention that 3,000,000 gallons of water a day were being obtained for the supply of Wolverhampton from a bore-hole sunk into the new red sandstone, and the East Worcestershire Water Company had a well at the foot of the Lickey Hills, the yield of which was over 1,000,000 gallons a day. He was interested in what Mr. Ridings said about the East London Water Works, because it was there he (Mr. Marten) had received his early training with respect to water engineering. Mr. Bryan had informed him that the engine he had recently erected at Waltham Abbey raised no less than 135,000,000 pounds of water one foot high with the consumption of one hundred-weight of coal; that was about 27 per cent. higher duty than the best of the old water-engines at the East London Water Works had hitherto done.

On "*Baths for the People*," *by* Charles Clement Walker, F.R.A.S.

Great and praiseworthy as the progress has been within the last thirty or forty years of the means of cleanliness by baths of various kinds, it is not too much to say that the great mass of the labouring classes are still without these advantages. The term, "The Great Unwashed," though in a somewhat modified degree, may still be the description of the labouring classes, not only of our own country, but that of every country in Europe. In populous towns, public baths (consisting as they do of the Turkish bath, the various descriptions of shower, needle, douche, and other kinds) are for those parts of the community who are not what is termed "the labouring class." The ordinary warm bath and the public swimming bath are

usually within the scope of the artisan, the youth, and the unmarried men of the labouring class; but it will be found on investigation that the married labourers and their families make little use of them; the reason being that the price charged, though so low, is too much for their means. The 2d. or less for the swimming bath is still too much, and this bath has the disadvantage of only being used in summer, whereas, for sanitary purposes, people must be cleansed as perfectly in winter as in summer.

Now, when we consider the circumstances of the labouring class, we find that while they are children the mother can wash them at home, but as they grow up to young men and women this is not possible to be continued by themselves, on account of decency; so that except the young men get a bath in a canal, stream, or other piece of water, they generally go uncleansed from year to year, until cold water over their bodies is a repulsion.

It is quite impossible to lower the prices ordinarily charged for the warm bath and the swimming bath without considerable loss. It may be stated generally that public baths often do not pay their expenses. What, with the interest on cost of construction and the expenses of maintaining them, they seldom "pay." In Birmingham, for example, the interest on cost of construction and expenses in working amount over receipts to about a ½d. in the £ on the rates; and in many other large towns a similar condition of things exists. Valuable as are the results for this addition to the rates, it is not to be expected that the ratepayers will bear a further increase, to make up the loss from a further lowering of prices to meet the wants of the labouring class.

Now, while this is the case with our large and populous towns and cities, it is much worse in smaller towns and semi-populous districts all over the land, which form a much larger population in the aggregate than those towns and cities. The cost in the first instance of building baths is so great that it can rarely be undertaken, and if done by private munificence the cost of maintenance over the receipts is so much, that when it is taken into consideration it prevents the establishment of public baths for any class whatever, so that unless a much cheaper construction of baths and less expense of maintenance be found it seems quite unlikely that such populations will ever have the conveniences of larger towns.

The writer often had these thoughts weigh on his mind while being associated with a somewhat large works in a semi-populous district at Donnington, near Newport, Shropshire, but saw no chance of mending matters until the latter part of last summer, when the idea occurred to him to provide baths for his work-people, upon the plan now before the section. But as people do not take kindly to baths in the winter, the construction was deferred to the spring of this year, and they were ready for the 1st of June. It must be remembered that the ordinary warm, or slipper bath, however good, is not the mode of cleansing that the labouring classes best understand, or will be persuaded to generally use; and if periodical cleansing is to be aimed at, the warm bath is not the most suitable.

Without further preface, the baths before the section will now be described. A special point was made that everything should be done in the most complete and comfortable manner, with a minimum cost, for it is quite impossible that limited populations, without rates to draw on, can have palatial buildings. What was aimed at was completeness and efficiency, with strict economy in construction and working.

Fig. 1 shows the plan. The space of ground most suitable was of irregular form—hence the peculiar shape of the plan of the building. This is only apparent on the drawing, for to the ordinary eye it is neither seen outside or inside. It is 25 feet long, the width being 18 feet 6 inches at one end, 13 feet at the other, 10 feet 3 inches high to the wall-plate, and 17 feet 9 inches to the ridge. The roof is of galvanized corrugated iron, ceiled with deal, painted blueish white, lined with hair felt. The space is amply sufficient for six *ordinary* baths, as they will be styled in this paper, one warm bath, a drying closet of seven horses for towels, a washing machine, and all the apparatus for working the baths, and has a very clean, neat and comfortable appearance. The six ordinary baths, *A*, are arranged on one side in compartments, with doors in front. The warm bath is at *B*, the drying closet is at *C*. The washing machine is kept at *D*, and when in use is drawn out to the area *E*. A seat, *F*, is placed for persons waiting for baths, and has a board on the floor to place their feet on in case they wish to finish their dressing outside after the bath, to save time. There is a porch *G*, with door to prevent draught; and as many workmen and labourers came in dirty from their work, it was found that their dirty hands soiled all they touched, so an addition has since been made to the porch, with a washing vessel and towels to wash their hands before entering the bathhouse; and as their boots are often loaded with dirt, an iron grating is placed outside, level with the ground, to rub their boots on as they walk, and this, with mats inside, keeps all clean.

Each bath chamber is 8 feet long, 4 feet wide, and 7 feet 6 inches high, which gives ample room. The partitions are galvanised, corrugated iron, stiffened at bottom with angle iron,

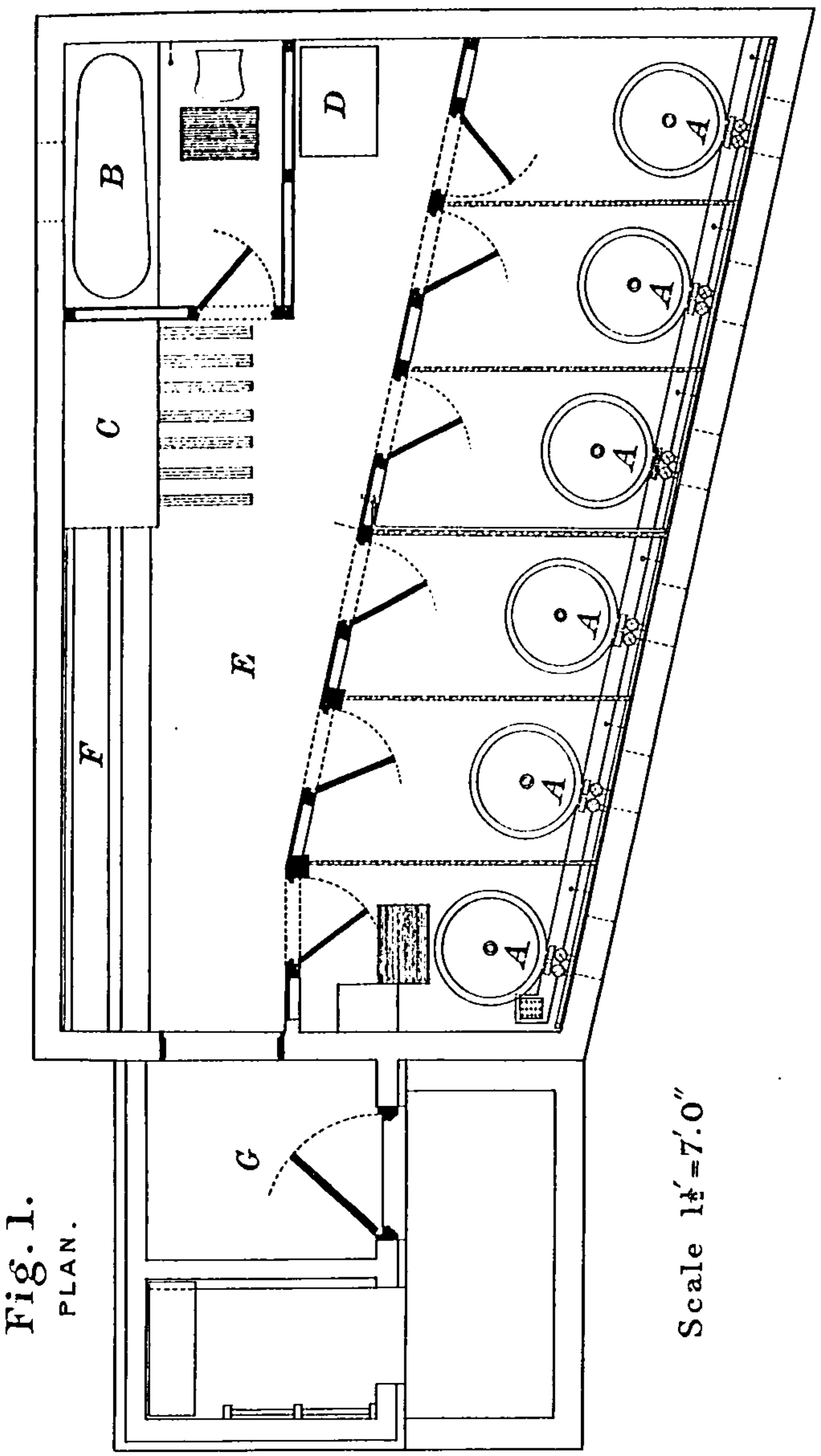


Fig. 1.
PLAN.

Scale 1¼′=7′.0″

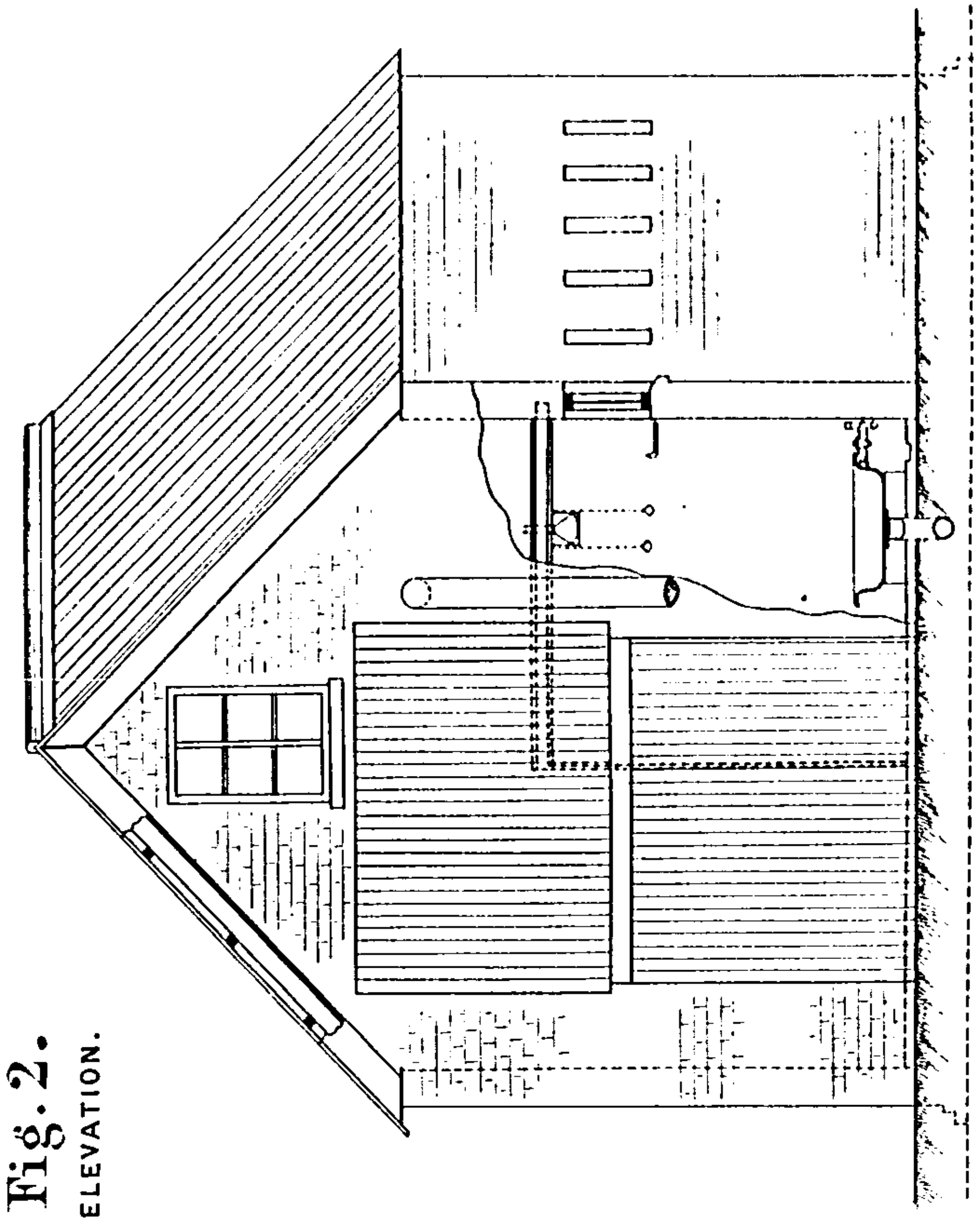


Fig. 2.
ELEVATION.

Scale 1" – 7' 0"

the hollow spaces of corrugations between which are filled with cement to prevent accumulations of soapy dirt. The ceiling is of varnished deal, and forms the floor above, on which the tanks and pipes are placed that work the baths; and as this has a considerable weight to support, substantial wood posts are fixed, each with an iron shoe at bottom, to prevent decay; and as decay is so common in bath-houses, no wood is allowed to come in contact with the quarried floor, which is flushed with a hose daily, the floor having a slight inclination to the channel-drain at side, and soon dries.

Each ordinary bath is of cast-iron, 2 feet 6 inches in diameter by 8½ inches deep; the top rounded off smooth, so that it can be sat upon; and they are set 5 inches above the floor, being found more convenient for either sitting in, or for cleaning the feet while sitting on the stool. There is a wood grating on the floor for the bare feet. These baths have several coats of white paint on the inside. Enamelled iron would have been preferred, but it was found too expensive. Each compartment has hooks for clothes; and to prevent the common custom of throwing the towels on the floor, a hook is placed for them marked "Towels." And that the floor may not be made dirty by the boots being thrown anywhere, a place in a corner is marked "Boots." There is a dish for soap, and a box with two flesh brushes and flannel. Each bath door is numbered. There is a rough glass light at the end, with sliding pane for ventilation, and a gas jet. Over the centre of each bath is a rose above, with two chains, marked "Warm" and "Cold," for the spray. This rose has fine holes, not so large as is used for showers, for as we have to accustom the labouring class to the use of cold water, a shower from a large-holed rose is absolute horror, they cannot bear it. But with the fine spray it is absolute enjoyment, and all speak in the highest terms of how they like it. It is no small matter to teach the labouring class to love cold water. Each bath has two cocks with handles from the hot and cold water mains, being severally marked "Hot" and "Cold." As the bathers supply themselves with water, a black line is painted on the side of the bath 3½ inches from the bottom, to show the height to fill the water. This is found to be quite enough, as the water from the spray falls into the bath. Proper directions are in the bath-room how to use the bath.

As white glazed bricks are so expensive, the walls have three coats of white paint to prevent absorption.

The bottom of the bath has a plug 2 in. diameter. At the bottom of the recess in which it fits, a grating is fixed to prevent pieces of soap getting into the 4 in. iron main drain-pipe to which it is bolted, all joints being "faced." This pipe goes through the building, and is sealed outside; there is no smell whatever from it.

The warm or slipper bath is full sized, of the usual kind, of enamelled tinned iron with Shanks's best fittings. The room has a chair, with wood grating and carpet. It has also a warm and cold spray.

On the floor over the baths is a hot cistern, 4 feet 6 inches by 3 feet 6 inches, by 3 feet deep, with tubes through it heated by steam, and is covered with wood. This cistern supplies hot water to the baths, the cold water supply being from the main. The warm spray is supplied from another cistern 4 feet by 2 feet, by 2 feet deep, and covered with wood. Both these cisterns are encased in wood lined with dry hair felt ½ inch thick, and it is found that they do not lose more than four or five degrees of heat during the day. The cold spray cistern is 3 feet 3 inches by 2 feet 2 inches, by 2 feet deep, and is supplied by a pipe from the main, with a ball cock. All the warm water pipes for the spray are covered with felt. As there is a W.C. in an adjoining building there has been no necessity to provide one. The total cost of the whole complete has been £220.

The steam used to heat the water for the baths is the waste steam from the works adjoining, which, after having heated the boiler and cooking apparatus of the workmen's dining hall for 400 men, and heating the hall, makes the water 180°. This is in use for about eight months of the year, but during the height of summer the waste steam is turned off, as it makes the buildings too warm, and the steam direct from the boilers is then used. For these eight months the cost of heating the water is nothing, and for the remaining four months the cost of the fresh steam is but small. If the baths did not have this steam to draw upon, a separate boiler would be required; but so small a boiler would be sufficient, that an addition of £15 would cover the expense. Two hundred large bath towels are necessary for these baths, and with a stock of flesh brushes, flannels, and sundries, will cost £10. So that a bath establishment, complete in itself, of this size, with washing and drying apparatus, costs £245 to £250.

I have tried to form an estimate of what population such baths would be sufficient for. These six are capable, without difficulty, of furnishing 18 ordinary baths per hour. They have supplied 24 baths per hour, but this was found to give pressure. It will probably be found in a town, that an extra warm bath would be desirable, each bath supplying two per hour in addition to the above 18. I think such a bathing establishment would supply the needs of a town of 12,000 inhabitants with ease.

As all the apparatus is ample size, if more ordinary baths were wanted the addition of a few more baths of this character would be a moderate expense, as their cost is less than half of the warm or slipper bath.

After the baths were used for a month by the persons engaged at the works adjoining, and were found to be so much appreciated and enjoyed, the public were admitted on the following terms:—

Ordinary bath with one large bath towel, use of flannel and two flesh brushes	1d.
Warm bath and two towels	4d.
Extra towel	½d.
Soap tablets	1d.

It was thought better for each person either to bring his own soap, or buy it.

The experience in the working of the baths is that five ordinary baths are paid for one warm bath. The time that the ordinary bath takes is found to be twenty minutes, while half an hour is necessary for the warm bath. The next important fact is that on an average the ordinary bath consumes eight to nine gallons of water, while about forty gallons are necessary for the warm bath. So thoroughly are the bathers cleansed in the ordinary bath, that although they come very dirty from their work, the towels used for drying themselves are returned scarcely soiled.

The directions given for the use of the ordinary bath are that the bather is to fill his bath with hot and cold water, to his own liking, to the line painted on the side of the bath, and if he likes to wash his feet first, he can sit on the stool with his feet in the bath. After which he is to stand upright, pull the warm spray to wet his body all over, and use plenty of soap with the flannel, rubbing himself well, particularly the head and feet. Then use the flesh brushes well, back and front, washing all off with the warm spray, repeating it if he likes. Then when finally cleaned all over, to pull the warm spray and wash all the soap off, and always ending with the *cold* spray, so as to obtain a good reaction, after which he dries himself with the towel, washing the flannel and brushes, and pulls the plug in the bath, rinsing it out clean for the next comer while dressing. Thus the baths work themselves. It is found that everyone uses the cold spray, and speak of the enjoyment of it in the highest praise.

Expenses of Working.

This is a matter which has been carefully considered. If these baths are in a large town, it will be found economical to have a much larger number of them, so as to make it worth while to employ a man constantly, or what is better, a man and wife as bath-keepers, the wife doing the washing and attending to the women's baths. But for a town of say 12,000 inhabitants or less, it should be arranged that the bath keeper have some other occupation, which is his main dependence, and be paid for attending to the baths. The set of baths now described are kept by a labouring man, whose chief occupation is the charge of the workmen's dining-hall referred to; and in the time he has to spare in the morning, he fills the cisterns and heats them, which keep their heat the whole day. This does not take more than a quarter of an hour. He then washes the towels; he gives out the tickets for the money received for baths as required; and prepares a warm bath when asked for. It is found so few come after 6.30 P.M. in the semi-populous district where they are situated, that the baths are then closed, when he flushes out the whole place with a hose, and cleans up for the next day, which occupies him thirty or forty minutes. For this he is paid four shillings per week. This sum, with the soap required for washing towels, the cost of heating the water, wear and tear of towels and brushes, is the cost of working the baths. There is a profit on the soap sold and extra towels. So moderate is the cost of construction and the expense of working that if a person brought his own towel and soap, one halfpenny may be charged for the bath. I see no reason why these baths should not return a moderate interest on their cost, instead of being a loss as public baths generally are. They have now been in operation nearly four months without the least hitch. Everything is so substantial and well made that very little repairs will be required. Once a year the ordinary baths will want two or three coats of enamel paint, and these are all the current expenses.

At present the baths are used only by men and boys. If women are admitted, it must be at set times, when a woman will be in attendance; but for this size establishment it will not pay to have a separate set of baths for women.

Mr. FLETCHER (Bolton) said he was much indebted to the author of the paper for the details of an excellent establishment. They would help him to carry out an idea which he had long entertained, and which, in the good days in store for a better educated country, might come to be by law compulsorily put into practice in all industrial establishments. He should like to establish a bath which several hundred colliers could use in the space of half-an-hour, and where they could leave their working clothes to be dried, damp as they generally are at the end of a shift in a hot and dusty mine from moisture, either internal or external. They would then appear in public undistinguished by the rags and dirt, which could not fail to be humiliating. Such a bath would save the introduction into the men's homes of the odorous working clothes, and would render easy the complete washing of themselves, which, when performed at home, could be accomplished only under difficulties. He thought that could not be done under £1000; and last Christmas day, which he and his men had spent together, he had described this idea to them, and made them a promise that it should take practical shape. His idea was that of a cold and a warm shower for general use, with a locker for each man to hold the clothes, towels, &c., heated to drying point by steam. A tank of soapy water might answer better than soap cakes. That was the idea which had formed itself in his mind; and a swimming tank, heated by the waste steam, would be a great addition. The privacy of Mr. Walker's baths might be worth the cost in his case, but would be unattainable at a colliery, where several hundred men would use the bath daily and nearly all at once, between the hours of three and four o'clock in the afternoon. He was very much indebted to Mr. Walker for having led the way in this matter, and hoped to try and follow him.

Mr. ERNEST TURNER (London) said there was an effective system of bathing in use in the German army, which, however, was subject to the disadvantage that the men had no body of water into which they could plunge their hands, and no convenience for washing their feet.

On "The Technical Education of Plumbers," by H. D. MATHIAS, R.P.C., Liverpool School of Science.

THIS paper pointed out the importance of the technical education of plumbers; and a long discussion followed on the advantages of the examination and registration of plumbers.

On "Antiseptic Ventilation for Hospitals and Sanitoriums," by S. M. BURROUGHS.

THE object of the invention or system shown is to first filter the air, then to regulate its temperature, then to propel it to any room desired, and lastly to render it antiseptic.

After a careful examination of the various systems of ventilation by forced circulation, I have selected that of the Sturtevant Blower Co., of London, as being most suitable for the application of my invention, because it can be made to blow air to any part of a building by means of sheet iron or tin pipes.

The blower consists of a revolving fan having several blades parallel to the axis. It can be run by a steam engine which can also be utilized for lifts, electric lights, centrifugals in laundries, mills for grinding, &c. The waste steam from the engine supplies the heat, excepting perhaps for a large building, when it can be supplemented by live steam.

1. The air can be drawn down a chimney or shaft, and is filtered through a coarse strainer to remove the larger particles, and through finer material to take out fine dust, fog, and smoke.

2. If the air is of the right temperature it is drawn directly into the blower, but if it requires to be heated, a damper directs it into a rectangular box of sheet iron packed with tubes containing waste steam from the engine, or live steam from boiler, or both. In circulating round these tubes the air becomes heated, is drawn through the blower, and propelled through main and branch pipes to any or every part of the building.

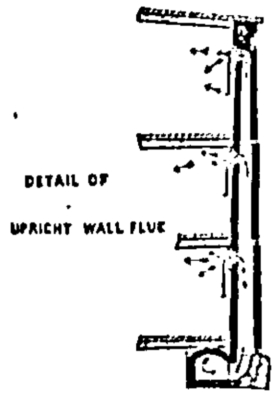
3. If only one antiseptic or air medication be desired at one time it may be distributed from the main pipe, but a different medication can be used for each room if required.

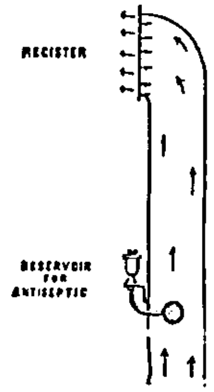
4. A volatile antiseptic may be conveniently introduced by means of suitable mechanism, by means of which the liquid can be made to drop regularly on pure sponge or other absorbent or distributing material, from whence it is readily absorbed by the current of air. Pinol, eucalyptia, pumiline, creolin, carbolic acid, thymol, or other volatile antiseptic, can be readily employed in this manner.

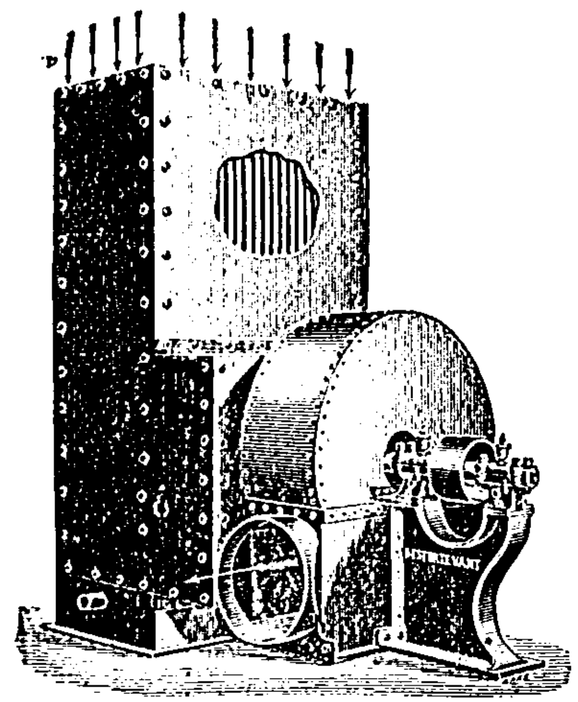
5. If the air is too moist or too warm, it can be both dried and cooled by causing cold water to pass through the pipes referred to instead of steam. The object of the invention is to enable hospital physicians to exactly control the temperature and to medicate the air, having previously deprived it of dust, &c.

The apparatus is not secret or patented, and can be used freely by any one.

This apparatus constitutes the most economical system of heating buildings with which I am familiar. As a system of ventilation, it appears to be the most effectual; while for the antiseptic treatment of consumption and germ diseases, also for making antiseptic the surgical wards of hospitals, it possesses advantages over inhalers and personal appliances, as it does not interfere with the natural breathing.







Mr. S. M. Burroughs (London) said there was a machine working very satisfactorily at Snow Hill Buildings, London. It made the air of all the rooms in the building antiseptic by simply pouring a few drops of the liquid into the receptacle. There was no patent on the machine, and it had been used in factories of all sorts where there was much dust. For instance a powerful blower in the neighbourhood of a planing machine in a wood factory would immediately clear out the dust, and even large substances weighing as much as a pound, if placed in the blower.

Mr. Simmons (Bristol) asked if there were any control over the filter so that there should be no draught.

Mr. S. M. Burroughs (London) said the air was usually directed up against the ceiling or across the ceiling. His experience was that he got no draught at all when the air was blown in as warm as the air of the room. In answer to the further questions he said the same apparatus would be useful for the extraction of vitiated air as well as forcing in fresh or warm air; but it was more practicable to employ the system of forcing air in. The filter consisted of about 25 yards of cloth, so arranged that the air passed through it, and the dust was collected. As there was always such a pressure of air blown in with a good deal of force from this apparatus there could not be any draught coming in from the windows or doors, and that would be a very desirable thing in hospitals. The air as it came into the room was a little warmer than that in the room. That being so it naturally went to the top and created no draught. He had observed in connection with the blower that when they blew in cold air they were likely to feel a slight draught, but with warm air, which rose to the top, there was no draught. The air was taken down about 30 feet, and it could be made to go into pipes for heating, or it could be sent direct into the blower if the outside temperature was desirable. If driven by a small engine the blower could attain great velocity, and it could be used to heat as well as ventilate rooms. For this purpose it was very economical. If the steam engine were used for other purposes, and the waste steam were employed for the blower, the heat would cost nothing at all. The hot air could be blown into any part of the building where desired.

Sir Douglas Galton, K.C.B. (London) said that if warm air were supplied at the upper part of the room he could understand that there would be no draughts; but such a method should be attended by some system of extracting the air also, and not merely trusting to the chance of escape of air through the windows if they were to have a really healthy room. He thought they should have outlets to provide the constant circulation of air, without which there could be no very satisfactory ventilation. He quite saw the advantages in this system, and he should like to have further facts as to the point just raised—that it was a more economical method of heating than that of steam or hot-water pipes. He could quite understand that in a hospital ward or school buildings especially a system of ventilation analogous to this would produce a circulation, and provide infinitely healthier schoolrooms than now existed. To the ventilation of schools their attention ought to be very largely directed, because they were in a most unsatisfactory and unhealthy condition.

SECTION III.

CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS

By John W. Tripe, M.D., M.R.C.P.E., &c.

PRESIDENT OF THE SECTION.

"Winds, with some remarks on their Sanitary Effects."

I have selected this subject for my address, not only as it is one belonging to meteorology, but because winds are necessary to the well-being, if not to the existence of the animal world. Thus, if it were not for winds, the air we breathe would not be changed sufficiently often to support vigorous life. There are also other reasons for introducing the subject at a meeting of the Institute, viz., that winds frequently carry infectious matter to a distance from the source of infection.

The earth is enveloped by an atmosphere, consisting chiefly of oxygen and nitrogen; but it contains in addition varying proportions of aqueous vapour, carbonic acid, various products of imperfect combustion, dust, spores, baccilli, and other microscopic bodies. In its rotation the earth carries the atmosphere with it at the same speed as itself, so that there would be but little wind if the surface of the earth were not unequally heated by the sun's rays. As the sun is always vertical over some part of the earth, on either side of the equator, it heats that portion of the earth, and consequently of the atmosphere above it more than elsewhere. And, as heated air is lighter than cold, it ascends and creates a vacuum when cold air rushes in to fill its place. There is, therefore, always a lower current of air from the poles to the equator, and upper currents from the equator towards the poles or other colder regions. The latter currents becoming colder in their transit, descend at a greater or less distance from the equator, thus creating winds. In addition, as the earth rotates more rapidly at the equator