March 28, 1876.

GEORGE ROBERT STEPHENSON, President,
in the Chair.

No. 1,474.—“Sewage Interception Systems, or Dry-Sewage Processes.” By GILBERT RICHARD REDGRAVE, Assoc. Inst. C.E.¹

“It has long been amongst the most fixed of the certainties which have relation to civilised life, that, wherever human population resides, the population cannot possibly be healthy, cannot possibly escape recurrent pestilential diseases, unless the inhabited area be made subject to such skilled arrangements as shall keep it habitually free from the excrements of the population.”²

The Author feels that, in basing his observations upon the above quotation from the writings of an able exponent of sanitary science, he cannot too early express the obligations he is under to the medical officers of the Local Government Board for much of the information which he now brings forward. In the Reports of Dr. Buchanan and Mr. J. Netten Radcliffe in 1869, and in the subsequent Report of Mr. Radcliffe in 1874, together with Mr. Simon's Report on “Fifth Diseases,” dated July 1874, will be found nearly all the facts needed for the thorough investigation of the subject; and it is from the above sources that the following information has mainly been derived.

For the continuous and rapid removal of the excreta from populous districts, there can be no two opinions concerning the advantages to be derived from the use of water as a carrier. A theoretically perfect system of sewage removal would probably be one where a large volume of rapidly-flowing water, passing through the town in impervious open culverts, received from points situated immediately above it, the dejections, liquid and solid, of the entire population, and carried them at once into large rivers, not used for drinking purposes, or direct into the sea.

As a modification of this, which would be a most wasteful plan, and which would almost necessitate that privies should be outside

¹ The discussion upon this Paper was taken in conjunction with the succeeding one, and occupied portions of three evenings.

² *Vide* Twelfth Report of the Medical Officer of the Privy Council, p. 17 (1869).

dwellings, the modern water-closet has been introduced. This contrivance enables the privy to be removed into the interior of houses, and effects a vast saving in the water supply. Even this plan, however, implies the fouling of a large volume of water. Moreover, it brings with it many evils in the shape of concealed drains and sewer gases; and it is a system eminently unsuited for poor and ignorant populations, owing to its complicated machinery, and its liability to derangement and abuse.

Lastly, there is the water-supplied trough or tumbler-closet, which can be so arranged as to be entirely self-flushing, which needs no movable machinery, and which reduces the amount of water to be fouled to a minimum. Mr. Simon says concerning this plan that, managed or constantly superintended by the local authority, it seems the best of all yet discovered privy contrivances for the uncivilised quarters of towns.¹

In whatever manner water may be employed for the removal of the excreta, a vast quantity must be rendered impure; and great expense is entailed upon towns where an endeavour is made to defecate and purify such polluted waters before they are finally discharged into rivers or into the sea.

The Author leaves entirely out of consideration all sewage processes involved in the use of water as a carrier, and invites discussion rather upon the contrivances in common use in so-called cesspool and midden towns, where a system of interception or some variety of dry-sewage process is employed.

Many towns are so situated that a water-carriage system for the removal of the excreta is almost an impossibility; and there are large towns where, even when a system of drainage has been carried out at enormous cost, the difficulties of dealing with the polluted waters at the outfall appear so insuperable, that a return to the pre-existing midden system, or to some form of interception, has become almost a matter of necessity.

In connection with the proposed subject it may be as well, in the first instance, to draw attention to the fact that, even where a water-carriage system prevails in any town, some plan of removing house refuse, ashes, and dust, some 'dry system' of collection, must also be in force; while an 'interception system,' however carefully it may be carried out, still leaves a vast quantity of slop water and surface drainage to be cleansed and defecated at the outfall.

¹ *Vide* Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. II., p. 36.

Indeed, the Rivers' Pollution Commissioners, in their First Report, after a careful comparison of thirty-one towns, in fifteen of which the midden system prevailed, while sixteen were water-closet towns, came to the conclusion, upon somewhat false premises, that it mattered little, as regards the degree of pollution in the sewer water, whether a system of interception was practised or not. They say: "The retention of the solid excrements in middens is not, therefore, attended with any considerable diminution in the strength of the sewage, although the volume even in manufacturing towns is somewhat reduced."¹

This state of things must, to a great extent, be brought about by leaky and pervious cesspools, absence of proper urinals, ill-paved roads, and the filthy habits of the population generally, and might be reduced to a minimum by careful scavengering and strict supervision, both of which duties must be uncompromisingly and carefully performed in all towns and areas where cleanliness is sought after and enforced.

The term 'interception' implies the exclusion from the sewers or drains of all faecal matters, and the possibility of interception involves the existence of a system of sewers, which may, however, have been laid down for the removal only of surface water and slops. Five-sixths of the population of this country are dependent upon some form or other of middens or cesspools for the reception of their excreta; and only in a few large towns, and in these only within the last few years, have efforts been made to remedy the defects and nuisances which appeared to be inseparable from the midden system.

The Author proposes to deal with the subject under four heads:—

I. THE EXISTING PLANS OF SEWAGE INTERCEPTION—

- (a) By various forms of middens, and by middens of improved construction;
- (b) By boxes, tubs, and pail-closets;
- (c) By earth, ash, and charcoal-closets.

II. THE SANITARY ASPECT OF SEWAGE INTERCEPTION.

III. THE COMMERCIAL ASPECT OF SEWAGE INTERCEPTION.

IV. GENERAL CONCLUSIONS RESPECTING DRY-SEWAGE PROCESSES.

It is unnecessary to do more than glance at the old-fashioned pattern of midden-closet, with a fixed receptacle. It can only be spoken of, in the language of Mr. Radcliffe, as "the standard of all

¹ *Vide* Rivers' Pollution Commission (1868). First Report, vol. i. (1870) p. 30.

that is utterly wrong" ¹—constructed as it is of porous materials, and permitting free soakage of filth into the surrounding soil; capable of containing the entire dejections from a house, or from a block of houses, for months and even years; uncovered and open to the rain, the wind, and the sun; difficult of access for cleansing purposes, and wholly unventilated and undrained. Of this foul and disgusting type there are only too many examples in all old towns; and midden-closets of this description prevail almost without exception throughout the manufacturing districts. It will hardly be credited that in the year 1871 there were in Birmingham 13½ acres of space devoted to middens, "practically open to the air." ²

The first step towards improvement in midden construction is to provide a roof or covering to keep out the wet; and when this is done, precautions should at the same time be taken to insure efficient ventilation through safe channels, that is to say, other than through the privy seat. The old tunnel middens of Liverpool were among the worst types of covered middens. Thus, in the First Report of the Rivers' Pollution Commissioners, mention is made of a single midden 160 feet in length by 6 feet 4 inches in height, and 3 feet in width, entirely devoid of egress for foul gases excepting through the privies.

A further stage of improvement consists in rendering the midden impervious, by constructing it of non-porous materials, and in furnishing a drain to carry off the excess of liquids. The next advance in the right direction shows some simple arrangement for deodorising the contents of the midden with ashes, or some other cheap deodorizer; while the form is modified to permit this to be accomplished readily, and to render it capable of being easily cleansed. As instances of such improvements, Plate 3, Fig. 1, shows the midden privy used at Nottingham, and Fig. 2 the modification of this form of privy adopted at Stamford. In these examples the receptacle is concave, in order that the dejections may gravitate to the centre, and the brickwork is carefully cemented on the inside, to render it impervious. There is also a special opening through which ashes may be thrown on the excreta, and a shaft is carried up for ventilation. The riser of the seat is of brickwork, or in the Stamford example of 2-inch stone; the floors also in both cases are of non-porous materials. The Stamford model is the

¹ *Vide* "Report on Certain Means of Preventing Excrement Nuisances in Towns and Villages." Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. II., p. 144.

² *Vide* Report of the Public Works Committee on the Sewage Question, 1871, p. xi.

better of the two, for in this instance the seat is hinged, so as to throw up and permit of the ashes being sprinkled on the freshly deposited excreta, and as the pit is shallower, it necessitates more frequent cleansing. The 'Burnley midden of glazed stoneware, Fig. 3, is provided with an overflow pipe connected with the sewers, and is a good type of a drained, non-porous receptacle. The cost, moreover, is small, only 18s., and the danger of leakage is avoided.

Another important advance is gained when the size of the midden is reduced to a mere space under the privy seat: this space should be formed of non-porous materials, and be furnished with a ready means for the removal of its contents. Here entirely changed conditions are arrived at with respect to the removal, which, in middens of this class, must take place at the shortest possible intervals. This alone is an immense improvement upon systems which involve the storing of considerable quantities of putrefying excrement for long periods of time in the midst of crowded populations. The middens in use at Manchester and at Hull are shown in Figs. 4 and 5, and are selected as good specimens of this class. The Manchester midden, now to a great extent superseded by the pail-closet, has a glazed earthenware sloping bottom, with a door conveniently placed for emptying the contents. The emptying takes place fortnightly. This type is known as the "bevel-midden." The Hull closet is similar in arrangement, but the stone floor falls in the opposite direction, and the midden, being less capacious, has to be emptied weekly. The emptying takes place from the front, in lieu of from the side, as at Manchester, the riser of the seat being made movable for the purpose; and as the excrement must be removed through the privy, the plan is defective. The Hull midden, moreover, has no air shaft, which is certainly a drawback: the flue for ventilation in the case of the Manchester privy has, by the bye-laws, to be carried up 3 feet above the eaves of the houses.

From privies of this kind the transition to those with movable receptacles is a natural one, and, in accordance with the shape and size of this receptacle, such privies are called tub, pan, or pail closets. In the simplest arrangements of this type merely a wooden box is placed under the seat for the reception of the excreta; this box when full is tipped into the scavenger's cart, and replaced under the seat. Such was the system in use at Nottingham several years back, and this plan still prevails in some districts in Leeds. At Bilston a fresh box is placed under the privy seat; the full one being carted away to the depôt to be emptied and cleansed. This is a further step in the right direction, and is now almost universally practised when a pail system is employed.

A suggestive midden contrivance is in use at Stockport and in some parts of Leeds. Here, as shown in Fig. 6, a trough is placed under the front part of the seat for the purpose of conveying away the urine to a separate receptacle, or direct to the drains. By this means not only are the midden contents kept much drier, and an entire immunity is secured from splashing, but a smaller quantity of deodorizer for the solids can be employed, and considerable freedom from offensive smell is secured. Urine rapidly undergoes putrefaction, and this process is attended by the production of myriads of living organisms, chiefly vibrios and bacteria, which at once bring about a similar change in all organic matter with which they come in contact. The advantages arising from the separation of the liquid from the solid dejections are therefore most important, from the sanitary as well as from the economical point of view, and when this plan is extended to the pail system, it greatly facilitates the carriage of the tubs, and increases the manurial value of the contents.

The difficulty of cleaning out the angles and corners of the boxes at first made use of, and their non-adaptability to closets of different shapes, led to the employment by preference of oval or round tub-shaped receptacles, which had long been used on the Continent. This was partly due also to the introduction of the invention of M. Goux, patented in this country about six years ago, and this plan was the forerunner of the Rochdale and Manchester pail systems. The company formed to work the Goux patents made use, in the first instance, of oval tubs of the form and dimensions shown in Plate 4, Fig. 7. Before placing these tubs under the closet seat, they were lined with some absorbent refuse material. The lining was adjusted and kept in position by means of the core or mould, which was allowed to remain in the pails until just as they were about to be placed under the seat; the core was then withdrawn, and the pail was left ready for use. This system has been tried at Salford and at Rochdale, and is now in use at Halifax and at Aldershot Camp. The proportion of absorbents in a lining 3 inches thick to the central space in a tub of the above dimensions would be about 2 to 1; but unless the absorbents are dry, this proportion would be insufficient to produce a dry mass in the tubs when used for a week, and experience has shown that after being in use for several days the absorbing power of the lining is already exceeded, and the whole contents have become liquid.

There would appear to be but little gain by the use of the Goux lining as regards freedom from nuisance, and though it removes the risk of splashing and does away with much of the unsightli-

ness of the contents, the absorbent, inasmuch as it adds extra weight, which has to be carried to and from the houses, is rather a disadvantage than otherwise from the manurial point of view. The great superiority of all the pail or pan systems is due to the fact that the interval of collection is reduced to a minimum, the changing or emptying of the receptacles being sometimes, as at Edinburgh, effected daily, and the period never exceeding a week.

After a trial of the Goux process the Rochdale authorities introduced a pail system similar in every respect, but omitting the absorbent lining to the receptacles, and under the able management of Alderman Taylor, Rochdale has become a model town, as respects the mode of dealing with its excreta. The Author proposes to describe the system somewhat in detail, because the plan adopted has served as a pattern to other towns, and because there are indications, in the success that has been attained, that this mode of dealing with human excreta may lead the way to the profitable utilisation of sewage. The tubs employed consist of a paraffin cask cut in half and supplied with handles. A strong cast-iron rim (Fig. 8) is fixed on the inside of the tub about 3 inches down, to form a stop for the lid. The cost of a tub so prepared is 4s. 9d. Galvanised iron tubs have also been tried; but as their first cost, 9s. 6d., is double the price of the wooden ones, and as they only last about half the time, the advantages they possess in point of being lighter and more easily cleansed than the wooden ones, and the fact of their being of considerably greater capacity, do not sufficiently counterbalance these drawbacks. At Birmingham, however, galvanised tubs (Fig. 9) costing 10s. each are in general use.

The privies in Rochdale are all numbered consecutively in a district register, and a systematic collection from each of the six districts into which the town is divided for this purpose is carried out. By a well-arranged mode of book-keeping, the carters and collectors are checked in their work, and any omission is at once ascertained. The whole of the work is done in the day-time, and every closet is emptied weekly. The privies are provided with a door giving access to the space under the seat, and when the tub is removed it is at once covered with a lid and placed in a van (Fig. 10), while a clean tub having in it a small supply of disinfecting fluid is substituted for the full one taken away. The cost of the collecting van is £47; it is contrived to hold twenty-four tubs: each van makes five journeys a day. In 1874 five such vans in full work collected weekly from three thousand three hundred and fifty-four privies in all parts of the town.

Another feature of the Rochdale system is the separate collection of the ashes and house refuse. A special tub is set apart for this purpose for every house. It stands under a covered shed, and is provided with a hinged flap for a lid. A cart, the cost of which is £25 (Fig. 11), is employed for the collection of the ashes. This cart accompanies the van in its rounds, so that the removal of the ashes and the excreta is conducted simultaneously. Three such carts, in full work, collected weekly in 1874 from three thousand three hundred and fifty-four ash places throughout the town.

Alderman Taylor has carefully investigated the expense of the collection of the ashes and excreta in a separate form, and from his figures the following table has been drawn up. The figures relate to the collection in 1875.

Weight of excreta collected weekly	96 tons.
" ashes " " 	161 "
Total weight	<u>257 "</u>

Number of pails of excreta collected weekly 5,082

$$\frac{96 \times 2240}{5082} = 42 \text{ lbs. average weight per pail.}$$

The expenses of collection, exclusive of wear and tear, interest on capital, and depreciation, are:—

	£.	s.	d.
15 horses at 20s. per week	15	0	0
Pay of 30 carters and collectors	33	15	0
Total	<u>48</u>	<u>15</u>	<u>0</u>
Proportionate cost for the collection of the pails containing } excreta	27	8	0
" " for collection of ashes	21	7	0
	<u>48</u>	<u>15</u>	<u>0</u>

Cost of collecting 5,082 pails, £27 8s. = 1·294d. per pail per week, or 5s. 7d. per pail per annum.

Population using pail system, 50,000.

	d.
Cost per head per annum for excreta therefore	= 6·84
" " " ashes " 	= 5·33
Total annual cost per head for collection of ashes and excreta	<u>= 12·17</u>

This estimate agrees closely with the observed cost in other towns, and it may be assumed, with reasonable accuracy, that the annual cost to a population for the removal of its ashes

and excreta on the dry system will be about £50 per 1,000, or 1s. per head; from this sum the amount realised by the sale of these substances as manures has not been deducted. The Rivers' Pollution Commissioners found that the cost of removing the ashes and excreta, collected on the dry system, from nine important towns in South Lancashire, inhabited by one million one hundred and ten thousand persons using one hundred and thirteen thousand privies, and amounting in the aggregate to 347,000 tons of manure, was little less than 1s. per head per annum, and realised rather less than 5d. per head of the population. There might be perhaps a slightly increased cost, as indicated by Alderman Taylor's figures, in a separate collection of the ashes and excreta, but the advantages accruing from keeping these substances apart would far outweigh this, when the question of manure-making comes to be dealt with.

Those simple closet arrangements have next to be considered where an attempt is made, injudiciously in many instances, to deodorise the excreta by the application of absorbent material, such as earth or ashes. A closet of this kind may or may not be associated with the pail system. At Manchester, where a form of ash-closet is extensively used (Plate 5, Fig. 12), a cinder-sifter attached to the privy is combined with a pail receptacle. The sifter is so arranged that the fine ash is directed by a shoot on to the excrement, while the cinders fall into a bucket whence they may be taken for re-burning. Various materials have been tried for the sifters, and zinc perforated with $\frac{1}{2}$ -inch holes is now used, as it is found least liable to clog. Mr. Radcliffe says, with respect to an inspection of the Manchester ash-closets, that "great differences were in consequence observed in the quantity of exposed excrement, and some differences in the faecal smell. But where least care had been taken, and also where the pail contained simply the uncovered excrement of several days' accumulation, the faecal odour was inconsiderable."¹ It would appear from this that there is little to be gained in point of deodorisation by the use of ashes as at present practised. As will be shown later, the true plan of employing ashes or other deodorizers is to apply them in small quantities to the solid matters in a vessel from which the liquids have been excluded.

Probably the best known contrivances for deodorising and disinfecting the excreta deposited in dry closets are those in which advantage is taken of the deodorising properties of dry earth,

¹ Vide "Report on Certain Means of Preventing Excrement Nuisances in Towns and Villages." Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. II., p. 184.

so prominently associated with the name of the Rev. Henry Moule. In Mr. Moule's closets a supply of earth, contained in a hopper behind the seat, is thrown on to the excreta as deposited, by the action of an ordinary pull-up handle, similar to the pull of a water-closet, or by the weight of the user on a balanced seat or footboard, or by both combined.

Dr. Bond has patented an ingeniously-arranged dry closet, wherein the vessel, fixed beneath to contain the dejections, is so constructed as to receive the liquids and solids into separate compartments. A box for the supply of the deodorising material, consisting of sifted ashes, is attached to the lid (Fig. 13), and the person on entering the closet raises the lid and distributor, and by so doing measures out a charge of the deodorizer; on leaving the seat he closes the lid, and by this means discharges the ashes over the solid excreta.

In Moser's "universal closet" a supply of the deodorant, stored in a chamber at the back of the seat, is spread over the dejections in measured quantities by a pair of bellows actuated by means of a lever handle. In this closet the urine is diverted by a shield or "urine guard" into an independent vessel containing absorbent material.

In Gibson's dry closet a movable shoot attached to a hopper receives a small quantity of the deodorizer, and distributes it on to the excrement by an action similar to that of a shovel. Mr. Gibson has also a stand-pipe with a funnel mouth (Fig. 14), so situated as to receive the urine and convey it direct to the drain, without mingling with the solid excreta. All such contrivances as this aim at economising the quantity of the dry deodorizer, and if the user of the closet can be trusted to avail himself of mechanical means for deodorisation he will, probably, be just as likely to avail himself of a supply of dry material, situated conveniently for the purpose, to be thrown on the dejections with a hand scoop. All mechanical devices for the distribution of deodorizers which the Author has yet seen, even including the simple ash-sifter at Manchester, are more or less liable to get out of order, and are ill adapted, therefore, to "uncivilised populations." With reference to the separation of the liquids and the solids and the use of earth or ashes, it has been conclusively shown that, to absorb the urine and deal with the excrement of an average population, a daily supply of earth amounting to $4\frac{1}{2}$ lbs. per head will be required; and when this quantity comes to be used for a large population the cartage to and from the dépôts will be enormous. When the urine is separately stored, there still remains the difficulty of

dealing with it, unless, as Mr. Gibson proposes, it is allowed to run direct into the sewers.

In ash and charcoal closets similar arrangements to those already examined in the case of dry-earth closets as a rule prevail.

Animal charcoal forms such an excellent deodorizer, that when the urine is kept apart from the *faeces*, from $\frac{1}{2}$ oz. to $\frac{3}{4}$ oz. suffices, if carefully distributed after each use of the closet, to remove all disagreeable smell from the solids. This is an important consideration when the cost of collection and carriage has to be dealt with, and indicates the right way of using deodorizers. The Carbon Fertiliser Company has devised a first-rate separator-pail, for keeping the liquids apart from the solids (Fig. 15). The object is effected by a horizontal perforated diaphragm, which retains the *faeces*, but allows the urine to pass through into the lower part of the receptacle. This plan of separation is the only one that answers, where the chamber slops are also thrown into the pails.

The sanitary bearings of dry collections have next to be considered; and upon this point medical testimony, while it is unanimous in condemning the dangerous and disease-spreading character of the old unimproved midden of the accumulative type, tends conclusively to prove that, under a well-managed tub or pail system, nearly all the former objections to a dry process are removed. Messrs. Radcliffe and Buchanan say in their Report, dated 1869, dealing with this subject: "It is impossible not to be struck with the advantage that a tub or pail system has in relation to diseased excrement. The facility and thoroughness with which any required chemical disinfection may be done, and the way in which the excrement itself can be wholly got rid of, leaving none of its products behind—nothing soaking into the ground, or hanging about middenpits or sewers—obviously suggest most important powers possessed by this system for preventing spread of the excremental diseases."¹ This, it must be remembered, is an advantage common to no other method of dealing with excreta, and is one rendered peculiarly valuable by the increased knowledge respecting the propagation of diseases of the typhoid class.

All authorities are unanimous also in declaring that the pail system, when properly carried out, as at Rochdale, reduces the excrement nuisance to a minimum, and both in those towns that have come under the Author's personal observation, and from the evidence gathered from the inhabitants themselves, little inconvenience is caused either to sight or smell by the use of the tubs

¹ *Vide* Twelfth Report of the Medical Officer of the Privy Council, p. 138 (1869).

or pails, or by the mode adopted for changing or collecting them. From the sanitary point of view Mr. Simon's testimony is of the highest value, and this gentleman pronounces respecting dry processes as follows: "That, failing a water-system, both large and small populations can obtain under other and amended systems of privy-management a complete or comparatively complete freedom from excremental nuisance and injury."¹

But it is from the commercial aspect that the dry system of dealing with human excrement presents its most important advantages, and if ever the manufacture of manures from excreta is to become a source of profit—and it is impossible to doubt that it ere long will do so—it will be effected by a proper treatment of pail-carried excreta. In spite of all that Stock Exchange sewage companies may urge to the contrary, experience has repeatedly demonstrated, that when once the valuable manurial components of the excrements have been diluted with 100 times their weight of water, the only method of utilising the liquid as a manure is to apply it in definite quantities to properly-prepared land; though even when this is effected under the most favourable circumstances, there are no evidences that a profit can thus be obtained from sewage. When, however, the liquid and solid dejections, collected free from admixture with foreign substances, and in an undiluted form, have to be dealt with, the question of their profitable utilisation is placed upon a different footing. When, moreover, by the employment of closets of some such construction as that shown in Fig. 16, the collection of the liquids and solids can be carried out in separate vessels, the possibility of making a profit by the manufacture from the excreta of solid manures may be predicted with certainty.

From careful observations of the quantities of excreta collected in pails, it may be assumed that each individual of an average population will yield 1 lb. of mixed pail sewage per diem, or $3\frac{1}{4}$ cwt. per annum. The cost of carrying this quantity to a dépôt is, in accordance with the Rochdale estimate, 6·84*d.* per head, or say 3*s.* 6*d.* per ton. Allowing for interest on capital and depreciation on works and plant, it will not be far wrong to assume the cost of the pail stuff, delivered at the wharf or dépôt, at 4*s.* per ton. By processes familiar to chemists, this ton of pail sewage, the produce of 6·16 average individuals, is found to possess in the form of a finished manure a value, in round numbers, of 16*s.*

¹ *Vide* Reports of the Medical Officer of the Privy Council and Local Government Board. New Series, No. II., p. 34.

That is, the theoretical annual value of the fæces, and that portion of the urine voided with the fæces, of an average population amounts to a little over 2s. 6d. per head, while the average value of the whole of the excreta has been variously estimated at from 8s. to 10s. per head per annum.

General Scott, C.B., Assoc. Inst. C.E., who has devoted great attention to the production of manures from dry sewage, has recently demonstrated that from the liquid and solid dejections collected on the pail system it is possible to prepare, at a reasonable profit, concentrated manures containing from 5 to 6 per cent. of ammonia and from 8 to 10 per cent. of phosphoric acid, and which would therefore command a market value of from £7 to £8 per ton, and upwards. Manures of this class are sold at prices approximating to their theoretical value, *i.e.*, their value as indicated by chemical analysis; while feeble manures, such as those prepared from sewage sludge and the contents of ordinary ash-pits and middens, rarely fetch more than from one-fourth to one-tenth of their theoretical value. It would take about 10 tons of pail sewage to produce 1 ton of the above-described concentrated manure, or each ton of such manure would be the annual produce of sixty-two average individuals. As will readily be understood, when the excreta are largely mixed with earth, charcoal, or ashes, which give weight and bulk without value, the possibility of producing high-class manures becomes out of the question. Here is at once the reason why all the poor manures, made from mixtures of excrement with what have been termed "profligate associates," are sold with difficulty, and rarely fetch more than a few shillings per ton. Efforts to obtain more concentrated mixtures have from time to time been attended with fair success. The Author has lately inspected the Paris Municipal Works at Bondy, where sulphate of ammonia is being made from the liquid contents of the *fosses mobiles* at a small profit. Urine collected separately was some few years back profitably treated at Glasgow for the extraction of carbonate of ammonia; and only last year a company at West Bromwich succeeded in producing a concentrated manure, by boiling down the mixed pail contents to dryness, which commanded £7 10s. per ton. The works had, however, to be abandoned on the score of creating a nuisance.

The conclusions formed by the Author upon dry-sewage processes are:—

1. That in towns where, for local reasons, a water-carriage system for the removal of the excreta is impracticable, it is

possible, by a modification of the midden-closet, to effect this removal without nuisance and without injury to health.

2. That the removal of the excrements can best be effected by employing pail or tub closets which provide for the separation of the liquid and the solid dejections, and are emptied at intervals not exceeding one week.

3. That the local authority should conduct the removal of the excreta and also of the ashes, and should regulate this removal by stringent supervision.

4. That it is possible, by suitable manipulation, to prepare from human excreta, collected on the dry system, concentrated manures which will repay the cost of collection and cover all the expenses of their production.

The Paper is accompanied by a series of diagrams, from which Plates 3, 4, and 5 have been compiled.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Scale, 1/6 of an Inch = 1 Foot.

Ins 0 5 10 15 20 Feet

Fig: 8.

EXCREMENT PAIL WITH LID ON FULL, TO RETURN TO WORKS.

EXCREMENT PAIL EMPTY, READY FOR USE.

Fig: 9.

PAIL.

LID.

PART SECTION OF TUB.

ROCHDALE PAIL AND COVER.

Full Size.

SECTION SHEWING THE LID IN POSITION.

BIRMINGHAM PAIL AND COVER.

Scale: 1/2 Inch = 1 Foot.

Fig: 7.

ABSORBENT RECEPTACLE.

MOULD.

LINED PAIL USED FOR "GOUX" SYSTEM.

Fig: 10.

SIDE ELEVATION OF NIGHT SOIL VAN.

ROCHDALE NIGHT SOIL VAN.

Scale: 2 Feet = 1 Inch.

END ELEVATION OF NIGHT SOIL VAN.

Fig: 11.

ASH CART.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

ELEVATION IN YARD

SECTIONAL ELEVATION

ENLARGED SECTION THRO' PRIVY SEAT

Scale, 1 Inch to a Foot

ENLARGED SECTION OF PRIVY SEAT & CISTERN

Scale, 1 1/2 Inch to a Foot

PLAN

SECTION

PLAN ABOVE PRIVY SEAT

PLAN OF PRIVY FLOOR

PLAN

PLAN

SECTION THRO' PAIL SHEWING STRAINER

Scale, 4 Feet to an Inch

Scale, 4 Feet to an Inch
MANCHESTER ASH CLOSET.

DR BOND'S DRY CLOSET.

GIBSON'S DRY CLOSET.

SEPARATOR PAIL USED BY CARBON FERTILIZER COMPY

PAIL SYSTEM WITH SEPARATE URINE COLLECTION.