Refuse destructors : with results up to present time / [Charles Jones].

REFUSE DESTRUCTORS,

WITH

RESULTS UP TO PRESENT TIME.

BY

CHARLES JONES, M. Inst. C.E.,

PAST PRESIDENT AND HON. SEC. OF THE ASSOCIATION.

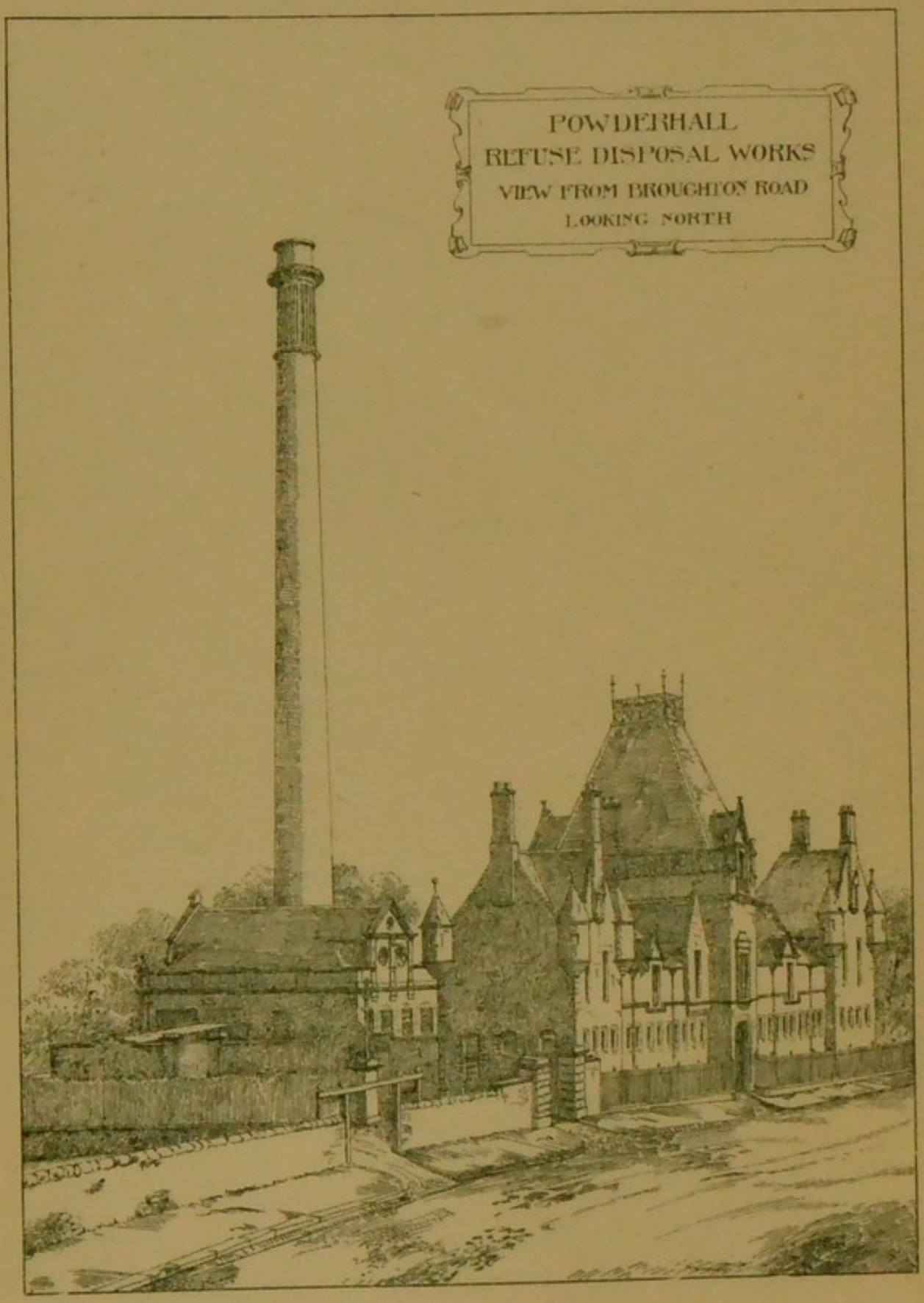
1894.

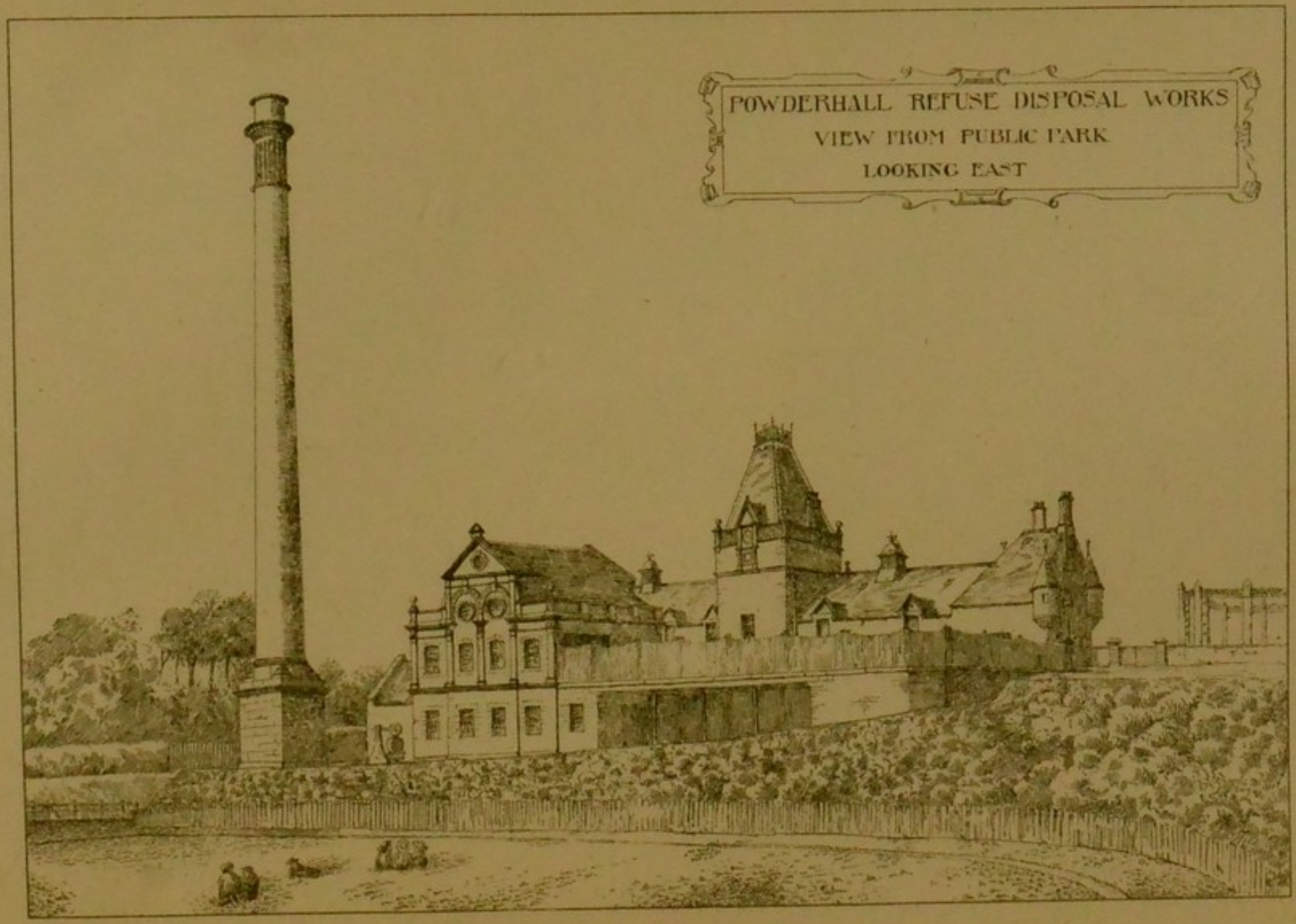
Presented by

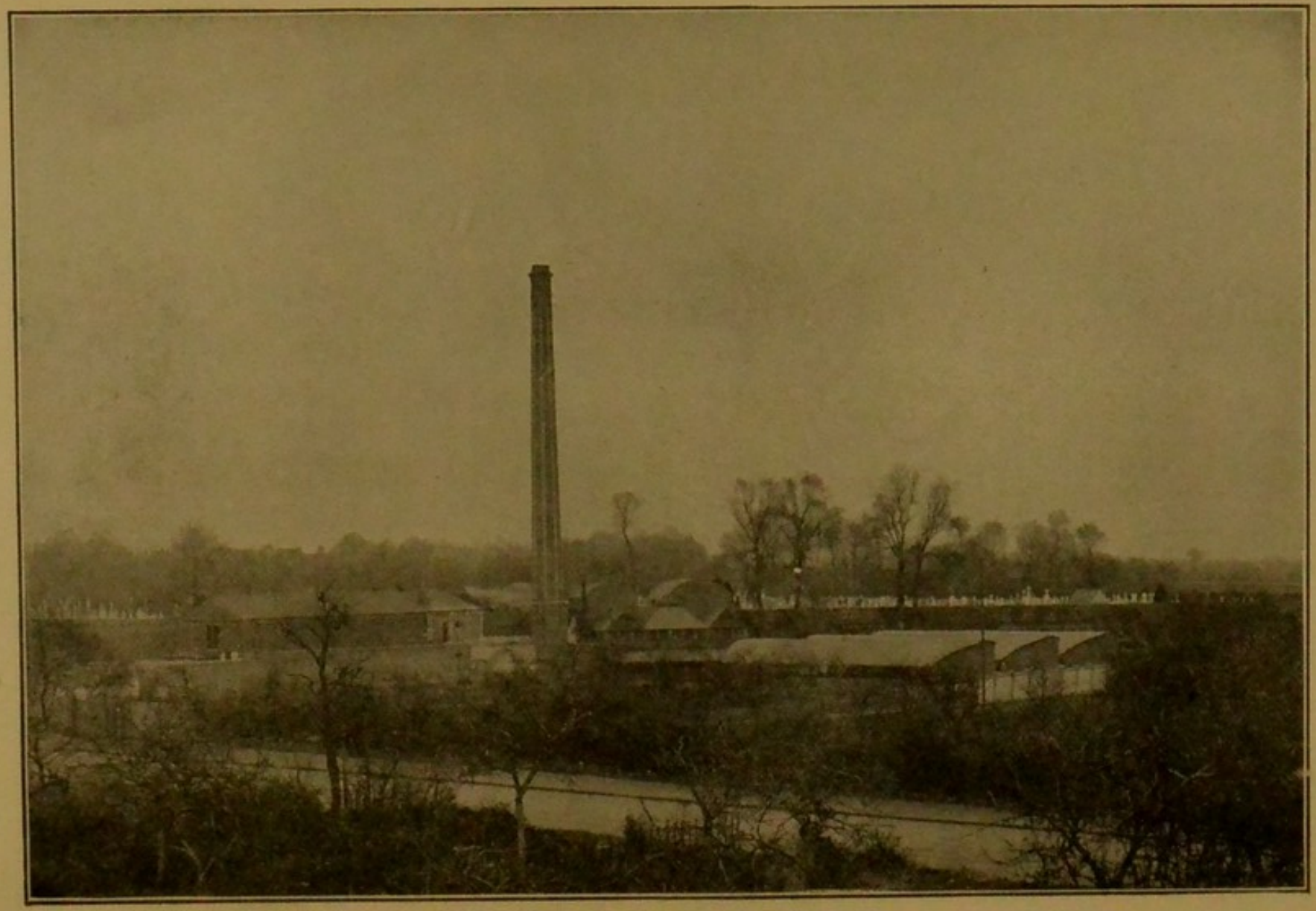
The author

18 94

POWDERHALL
REFUSE DISPOSAL WORKS
VIEW FROM BROUGHTON ROAD
LOOKING NORTH




POWDERHALL REFUSE DISPOSAL WORKS
VIEW FROM PUBLIC PARK
LOOKING EAST



THE EALING REFUSE DESTRUCTOR WORKS.

REFUSE DESTRUCTORS,

WITH

RESULTS UP TO PRESENT TIME.

SECOND AND REVISED EDITION.

A Hand-Book for Municipal Officers, Town Councillors, and others interested in Town Sanitation,

BY

CHARLES JONES, M. INST. C. E.,

HON. SEC. AND PAST PRESIDENT OF THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS, SURVEYOR TO THE EALING LOCAL BOARD.

WITH A PAPER ON

The Utilization of Town Refuse for Power Production,

BY

THOMAS TOMLINSON, B.E., A.M.I.C.E.

With Numerous Diagrams.

LONDON:

BIGGS & CO., 139 & 140, SALISBURY COURT, LONDON.

1894.

PREFACE.

THE paper which preceded the present volume, was prepared by the Author at the request of the late Joseph Gordon, Esq., M.I.C.E.,—the first Engineer of the London County Council—when President of the Association of Municipal and Sanitary Engineers, and was read at a Meeting of the Association at Leicester, July, 1887. The interest created in the subject was such that an edition of five hundred was published, the paper appearing again in the volume of Proceedings for 1887-8. The fact that the Author had given some years of close attention to the subject, had erected the first Destructor used in the vicinity of the Metropolis in 1883, and had been successful in 1885, in designing the "Fume Cremator," a simple mode of dealing with the "Fine powder," "Smoke," and "Unconsumed" gases," and utilising the same as heat producers, secured the kindly interest of his brother officers in England, and many in America, and the Colonies, who were concerned in the important question—"How best to deal with the growing difficulty of House Refuse?"

The valuable Report upon the subject, prepared in 1881, by W. Sedgwick Saunders, Esq., M.D., the Medical Officer of the City of London, had been, to some extent, lost sight of, at any rate no perceptible results had arisen from the preparation of the same, up to the time when the above-mentioned paper was read, and probably had

not been seen by a dozen Municipal Officers in England. Sir Robert Rawlinson, the principal Engineer of the Local Government Board, was present at the Meeting in Leicester, and was so convinced of the importance of the subject, that he arranged for a further investigation by J. Codrington, Esq., M.I.C.E., one of the Engineering Inspectors of the Local Government Board, who issued a well digested report in the year 1888. It has, however, been felt by many that a second Edition of "Refuse Destructors, and their results up to the present time," would be helpful to the Sanitary Authorities of Great Britain, and the Colonies, and in compliance with many requests, the Author has ventured to put forth the present edition.

The immense trouble taken by many of the Officers of Municipal Authorities, and Local Boards, in supplying details, correcting the same in "proof," lending plans to illustrate the work, and in every way assisting the Author in carrying out the object in view, has been such as to call for an expression of his most sincere thanks, and a hope that the publication now put forth may be most useful to them in their several official positions, when seeking information upon the special subject upon which at the present time there is such an awakening in the public mind. The object has been to produce a compilation of established facts and absolute work, which, free from technicalities, may be useful not only to Municipal Engineers and Surveyors, but (in connection with the several tables) to those who are advising upon the general subject, or may be placed in the hands of the Members of the Sanitary Committee as a text book from which it is hoped, they too, may gather some useful information.

The detail Balance Sheets supplied by J. H. Cox, Esq., M.I.C.E., Borough Engineer of Bradford, are put forth as models of how such Accounts should be kept.

It may probably be felt that the Author would be to some extent biased in his judgment by preference for some particular class of Destructor, and particularly for his own hobby, the "Fume Cremator." There may be some truth in the latter, but certainly not in the former,

as will be seen from the Tables published. He has only supplied those which are in absolute work, and whose "working period" has been sufficient to justify their insertion.

During the past few months much has been written relative to the value of the Destructor as an agent for the production of electric energy. Now, although the Author does not dispute the fact that there is a certain value which should of course be utilised, it would be worse than folly to go in opposition to the ascertained facts which have a practical bearing upon the subject. By all means utilise to the fullest extent all that can be got out of the House Refuse ; but if some of the theories propounded are taken as the basis upon which hopes are to be raised and thousands of pounds expended in the attempt to light large towns with the product of the dustbin, then without a doubt, failure will follow the experiment, and when too late, Corporations will learn that an electric installation, whilst utilising to the utmost all that can be obtained from the Destructor, must be absolutely independent of the same, and rely entirely upon its own completeness, even to the smallest detail.

During the preparation of this paper, the Author was brought into contact with Thomas Tomlinson, Esq., B.E.,A.M.I.C.E., who was writing some articles upon the subject from an "Electrical Engineer's" point of view for "The Electrical Review."

The investigations made and the views expressed so accorded with the Author's experience, that with the consent kindly given by the Editor of the "The Electrical Review," an arrangement was entered into for an abstract of the paper by Mr. Tomlinson, and it is appended to this volume. No apology need be made for this addition. To those who claim a more general knowledge of the question, as electricians, than the Author possibly can do, the paper speaks for itself. Clear and unbiased, it deals with the special subject, and will, it is hoped, add somewhat to the general interest displayed in connection with the Destructor question.

The Author lays no claim to what is generally termed authorship, but he has endeavoured, in a plain and simple manner, to bring before his readers facts and details, which, whilst interesting and useful to himself as a Sanitary Engineer, he trusts may also in a similar manner be useful to those who, like himself, are engaged in official duties connected with a Sanitary Authority, and add to the general information upon a difficult yet most important subject.

Local Board Offices,
Public Buildings, Ealing, Middlesex.
November, 1893.

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Ealing, W.:

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Refuse Destructors.

THE subject of the present paper is one which from time immemorial has occupied the attention of every thinking man, at any rate, so far as the sanitary well being of man is concerned. I might carry you back to ancient history, and amongst the Jews, Romans, Greeks, and the natives of India, to show that their one grand primary mode of dealing with their insanitary difficulties was treatment by "Fire." In fact cremation was looked upon as the one great remedial agent for all sanitary nuisances, various nations adopting various modes of procedure in order to deal with the difficulty which gathered round them, under the varying phases of their national life. It is interesting to trace these matters, step by step, and still more so as we are brought to realise the truth of the old adage that "there is nothing new under the sun."

The question, however, which concerns us, as a nation, is one which may be traced back to probably not more than about a quarter of a century, and we cannot but think, with a feeling of respect, of those men who, thus early and amidst many difficulties, endeavoured to deal with this important question. The necessities, however, were not so pressing as at the present time, inasmuch as the opportunities for getting rid of the nuisance arising from house and other refuse were met by the ready mode of removal from town to country, or to brickfields, or to neighbouring gravel pits, or in some other way at the least possible cost, thus ridding the community of that which was even then felt to be a great nuisance. Other influences were brought to bear very strongly upon the question, notwithstanding the admitted fact that house refuse was a conglomeration of all that is filthy and deleterious, and so fully described by Mr. Codrington, in his valuable report upon the subject, in which he says:—"Town refuse consists of the contents of ashpits and dustbins, market and trade refuse, and the sweepings of paved streets, and includes materials which, when sorted out and separated, may yield a small return, or can be utilised in some way."

The influences referred to were to a great extent of a monetary character, for in reviewing the statistics supplied by many districts, it is seen that large sums of money were paid to the various parochial or other bodies for the privilege of collecting the dust; and it is not, therefore, much to be wondered at that these authorities looked with a certain amount of suspicion upon anything which tended to remove from them this source of revenue, and so increase the burden of their rates. There is no doubt that fortunes were made by the collection and proper assorting of this mass of débris. The brickfields, then in the vicinity of London, took that which was most valuable in the way of cinders and ashes, and every other portion that could be in any way transposed into a monetary value was utilised. The soft core, which was valuable for no other purpose, was barged into the country and was there used as manure for the land. These were the days, no doubt, of the "Golden Dustman," and, probably, the neighbourhood of Paddington, was one peculiarly associated with this class of work. The author remembers, many years ago, making arrangements for fitting up the Electric Light at the yard of one of the largest of these dust contractors so that the work might be continued by night as well as by day.

The growth of population, the exodus of the people to the suburban districts, and the removing of the larger brickfields from the neighbourhood of London, exercised an important influence in altering this phase of the house refuse question; and the local authorities found that instead of being paid (in some cases hundreds of pounds, and it may have been thousands) for the privilege of collecting the house refuse, a reversal in the order of things came about, viz., a collection without payment; and ultimately, payment had to be made by the authorities themselves for the removal of the material; and to this must be traced the efforts finally made to introduce a crematory process in order to deal, at any rate, with some portion of the rubbish, and the introduction of the now well-known contrivance—the Destructor—which sprang into existence at this period.

One important factor in connection with the question before us is the enormous quantity of refuse which has to be dealt with, and referring to that portion which comes under the control of the London County Council we find an amount approximating three million tons per annum.

The collection of this material is spread over a large area, but in order to give some general idea, I will take three of the large London districts, viz., Kensington in the West; Hampstead in the North-West; and Camberwell in the South-East.

For the year ending March 31st, 1892, Kensington dealt with 46,270 loads (23 cwt. to a load), and the whole of this refuse had to be barged away on the River Thames and the Grand Junction Canal, the Vestry having to pay 1s. 11d. per load (23 cwt.) on the Thames, and 2s. 8d. per ton on the Canal; this charge being entirely exclusive of the cost of collection. The Surveyor to the Kensington Vestry reports that the total quantity gives an average per annum of 35 baskets for each inhabited house in the parish, the entire cost per load amounting to about 8s., a large item in the accounts of the parish of Kensington. It will be remembered that some few years since Kensington was defeated in its attempt to secure land for the purpose of erecting a Destructor, and has, conseqently, been compelled to employ the above measures of barging and carting in order to get out of the difficulty.

During the past ten years house refuse has increased in Kensington over 50 per cent. the number of loads collected for the year ending March, 1892, being 16,278 loads more than in 1882; and the Surveyor in his last report makes the following pertinent remarks:—"Not only does the quantity of house refuse increase, but the difficulty and cost of its disposal is also daily increasing. In 1882, shoots for house and street refuse cost £116 18s. 0d., and in 1892 they cost £7,858 14s. 9d."—and we can fully sympathise with him in his remarks that the Vestry could save a large sum by burning instead of barging such combustible material—"The burning would cost about 6d. per ton, as compared with about 2s. per ton for barging, and it is to be hoped that the Vestry and parishioners will shortly see their way clear to adopt my reiterated advice in this direction, and so save many thousands of pounds annually, which, to my mind, is now a great waste of money—£5 per freight being the cost for barging away refuse, which only needs igniting to reduce the whole to a small quantity of ashes." Hampstead, during the twelve months ending March 24th, 1892, collected 19,668 tons of refuse, and by the use of the Destructor, which they erected some four years since, were enabled to deal with the house refuse difficulty in a far more satisfactory manner, and at a cost of 25 per cent. less than that of

Kensington. Camberwell, for the year ending March 25th, 1892, disposed of 30,940 loads of refuse (24 to 25 cwt. to a load), being a decrease upon the previous year of 381 loads, arising, it is believed, from the large increase of gas stoves; of this quantity 12,111 loads were removed by barge, 10,397 were deposited by rail, 2,223 were shot at "Cold Blow," Hatcham, and the remaining loads were delivered to private shoots for various purposes near to the locality of collection at agreed prices—359 loads only being deposited at "free shoots." The dust-barging contract was at the rate of 2s. 8d. per dust cart load, the removal by rail is at 2s. 6d. per load—with 3d. extra for delivery and trimming the railway trucks. The Surveyor remarks that "free shoots" are all but extinct, the cost must, therefore, naturally tend to increase. The foregoing figures are in addition to the cost of collection.

Mr. Mead, of Paddington, the large contractor I have before referred to, made the first endeavour to deal with this question. The difficulty, however, was great, and so little attention was given by the constructors of the furnaces to the necessary detail for the working out of a scheme satisfactorily, that very soon the process came to an end, and resource was again had to barging into the suburban districts, along the banks of the various canals, and to depositing the material in some suitable spot—at any rate, suitable in the eyes of the dust-contractor — where, being well fired, it was allowed to smoulder away and pollute the neighbourhood for miles. This actually happened in my own particular neighbourhood, and I am within the mark when I say that an immense heap, probably some ten to fifteen thousand loads, was for a very long time, against all remonstrance, allowed to pollute the valley of the Brent, till at last the strong hand of the law was put in force to suppress the nuisance.

The difficulties and failures of these crude attempts incited men, who took an interest in the matter, to devise other and more perfect forms of Destructor than the one referred to, and, although it is probably some 25 years since the first attempts were made, it is not more than 20 years since anything approaching a successful Destructor was brought into actual work.

Amongst corporations, Manchester was one of the earliest to adopt the new principle, and, I believe about the year 1873, erected the first scientifically-arranged furnace. Some three or four years

later Mr. Fryer (of the firm of Manlove, Alliott and Fryer) came upon the scene of action, and arranged with the Corporation of Manchester for a trial of his furnace—this would be about the year 1878—and which he called the "Destructor." This trial was sufficiently successful to induce the authorities to have another erected, and in a very short period they had no less than three large Destructors at work upon Fryer's patent. Birmingham, Leeds, and Bradford followed suit; and the next firm which appears upon the list is that of Pearce and Lupton, of Bradford, who invented a furnace for which many advantages were claimed (some of these very advantages having recently been re-introduced); but although certain improvements were made, and a fair amount of refuse burnt, the trial was abandoned. The most ingenious invention at this time was from a foreman in the employ of the Leeds Corporation, whose name was Pickard; many of the points noticeable about this contrivance were very admirable. He seems to have realised the difficulties which beset an apparatus of this class; but from some cause or other—probably want of means—was unable to carry them to perfection, and, so far as he was concerned, the matter died out.

To some who will read this pamphlet a description of the principles of the Destructor may be unnecessary and appear almost like a repetition: at the same time I feel that as there are many, both in England and abroad, to whom a detailed description may be acceptable, I will endeavour to describe them fully, bringing the said description up to date as far as possible.

Fryer's Destructor.

(*Plate No. 2.*)

The cells, as shown on diagrams, are constructed to represent any number of cells built back to back, and give the internal arrangements of the flues, feeding hoppers, furnace-doors and fire-bars, or the cells may be built side by side, as at Ealing. The disposition of the cells, either one way or the other, is simply a matter dependent upon the site, the number, and the convenience of the situation. It will be seen that each cell constitutes a separate furnace, consisting of a cavity enclosed by a reverberatory arch lined with fire-bricks. The cell is supplied with a hearth for the reception of the material to be consumed, from which it passes into the furnace proper. The fire-bars are placed in a slanting position in order to favour the passage

of the material to the front, and so facilitate the removal of the clinkers. The top of the Destructor forms a perfect platform, having an opening over each cell into which the refuse to be burnt is shot from the collecting carts. The opening for the entry of refuse is divided from the opening for the exit of gases by a wall, and a bridge is built to prevent refuse, which is heaped on at each charge, from getting into the flue immediately below. Cells are provided with special openings for the introduction of infectious mattresses, diseased meat, dead cats, dogs, &c.; these fall direct upon the burning mass, and are there consumed without nuisance. The clinkering is done about every two hours, and the quantities of clinker and fine ash will vary in proportion to the class of material burnt; in some cases it has been as low as ten per cent., and in other cases as high as 33 per cent. of the material collected. At Ealing the average is 25 per cent., the residuum being a good hard clinker. This is utilised for various purposes, such as concrete, tar paving, artificial stone (when ground up as sand), for building, path-making, hard core for roads, and when used for the construction of walls, it makes a splendid and indestructible material.

At Ealing, in order to avoid the inconvenience to the stokers caused by the fine dust being blown about, a pit of concave form is constructed under the fire-bars to hold water into which the dust falls, and whence it can be removed in a damp state when the fires are drawn.

(*Plate, No. 12.*)

It being essential that the high temperature in the dust chamber should be maintained, it is very desirable that the fires should be kept going both night and day, and an automatic arrangement is also made so that during the feeding and clinkering, when the mouth of the furnace is open, the admission of cold air into the dust chamber, which tends to lower the temperature, should be reduced as much as possible.

(*Plate, No. 12.*)

This is done by means of a cast-iron hinged door, over the opening entering the dust chamber, attached by a chain to the furnace door, and is so arranged that when the furnace door is open the entrance to the dust-chamber has about four-fifths of its area closed;

and when the furnace door is shut the flue door is open. This arrangement, being entirely automatic, is quite independent of the attention of the stokers.

(*Plate, No. 3.*)

Fryer and other makers came into the field, either independently, or by combination. About the time indicated, Healey, for instance, combined with Fryer, and erected a Destructor at Bradford; and afterwards Thwaites introduced a Refuse Destructor and boiler combined, in which the heat of the boiling water and hot gases were said to prepare the refuse for combustion. Next came Young, of Glasgow, who arranged a Destructor with closed ashpit, and by a powerful fan facilited the combustion. The next to enter the field was Mr. Wilkinson, of Birmingham, whose Destructor was somewhat similar to that invented by Messrs. Pearce & Lupton. Another by Burton, who constructed a long simple furnace with two fires, and the refuse was dragged through by a long endless chain, which was moved at intervals by a windlass as the refuse became consumed. Messrs. Stafford and Pearson, of Burnley, invented the "Beehive," followed by the "Nelson," in which the gases of combustion are conducted over a reservoir of water, on the surface of which a small quantity of petroleum is allowed to run automatically, and afterwards are turned into a furnace heated with coke. Hardie, also of Burnley, introduced an apparatus consisting of saddle-boiler, with an inclined furnace underneath, and having air forced through the fire artificially. Then Odger, also of Burnley, constructed a furnace in which the offensive gases were passed through a coke fire; and Horsfall, of Leeds, designed one in which steam and air were thrown under the fire-bars. Coming to more recent inventions, we have that of the "Perfectus," Patent No. 18719, 1888, by Mr. Warner (Goddard, Massey, and Warner), which has been adopted at Hornsey, Bournemouth, Newcastle-on-Tyne, and other places. It may be described as consisting, generally speaking, of a block of brickwork 34ft. wide by 30ft. long, by 10ft. 6in. high, strengthened on the front of each furnace with heavy segmental cast iron facia plates to protect the brickwork, having sliding rails to support the furnace doors, with baffle plates of special construction, so that the fires may be examined quickly without allowing the admission of cold air. The ashpits are the same width as the furnace arches, and their front parts are also covered with iron-

work, having sliding doors, so that they may be closed, if necessary, and the air regulated, or the fires blown up by means of a large blower, which forms part of the plant erected over the top of each furnace. There are two dampers worked from long wrought iron spindles, and balanced on the outside of the furnaces. These dampers are closed each time the men clinker, and each time they draw down fresh refuse to be burnt, so that the furnaces are kept very hot. Internally the block of brickwork contains six reverberatory fire-brick arches 5ft. by about 10ft. One half of the arch is made to cover a special drying hearth upon which the refuse is prepared for actual combustion. The other half of the arches covers the fire-grate, which is made wholly of wrought iron, supported upon strong bearers. The structure is tied together by wrought iron tie-rods at the back and front, supported by channel irons, and at the ends by massive cast iron back stays. Over each damper a vertical flue is constructed, terminating in the main flue leading to the "Fume Cremator," and is covered by a cast iron frame and cover to allow a passage for workmen when cleaning. The top of the furnace forms a level platform, upon which the refuse is tipped from the carts as delivered. Each furnace has an opening or hopper capable of holding about the third of a cartload of refuse, and the contents of this hopper are discharged by means of a wrought iron lever projecting through the furnace roof; there are two doors at the end of the main flue for taking out fine dust, and there are special pockets at various distances, provided with frames and covers for cleaning purposes while the Destructor is in operation.

Healey's Destructor.

Patents No. 2369 (1880); 7703 (1885); 1005 (1892).

This has for its principal feature an arrangement of flues whereby the gases from one furnace have to pass over the fire of another in a more forward state of combustion before escaping. The furnaces are worked in pairs, and the gases alternately made to pass from one to the other by means of dampers. The provision of a movable drying floor over the furnace is also described, upon which the charge rests until it is thoroughly dried. The floor is then allowed to fall and drop it on to the grate.

Whiley's Destructor.

(*Plate, No. 4.*)

Patent No. 8271 (1891),

Is the patent of the superintendent of the Manchester cleansing department, and is designed primarily with a view to labour saving. A trough or hopper is provided at the back into which the carts tip direct. A spout or tube is arranged through which the refuse falls on to movable eccentric grate-bars, similar to Vicars' patent grate-bars. These bars automatically traverse the refuse forward in the furnace, and finally push it against a flap-door which opens and allows it to fall out. A means of changing the speed of the bars from time to time is provided by friction gearing, in which the driving wheel, running on the face of the driving disc, can be moved nearer to, or farther from, the centre of the disc, which revolves at a regular speed. Some trouble has been experienced from the refuse sticking in the hopper, but do doubt that will be overcome. A more serious drawback to the system is that the grate-bars have so much motion that they let fine refuse drop through unburnt, and are, therefore, only suitable for places where, as at Manchester, *they screen all the refuse*, or at least select it. Exception has been taken to the method of pushing out the clinker, as it causes the door to be continually flapping so that it fans cold air into the furnace. At the same time it is only fair to say that with *screened* Manchester refuse, a very fair temperature, said to be about 1000deg. Fahr. is maintained, and the amount burnt is claimed to be 10 tons per cell per day. The necessity for *screening* must, we think, militate against its usefulness.

The Horsfall Destructor.

(*Plate, No. 5.*)

Patent No. 8,999 (1887); and Patent No. 14,709 (1888).

The furnaces of this Destructor are similar in shape and dimensions to the Fryer furnace. One of its most important features is a steam-jet forcing draught to obtain the necessary high temperature. There is also a special feature in the arrangement of the flues and flue openings which are placed in front of the reverberatory arch instead of at the back as in Fryer's furnace; the fumes or gases given off thus passing over the hottest portion of the fire at a temperature, it is stated, of 2,000 degrees before

escaping into the flues, thus destroying all objectionable vapours. It is, however, an open question whether it is advisable to have such a high temperature, as damage may be caused to the furnace lining although it may consist of the best firebrick. The patentees, however, claim that the great amount of heat which can be secured can be made applicable for generating steam for various purposes.

Bouluois & Brodie's Charging Apparatus.

(*Plate, No. 6.*)

Other contrivances have been, and are now, before the public; time will prove their efficiency, or otherwise. One improvement in connection with the feeding I may refer to, viz., that to which the name of H. P. Bouluois, Esq., M.I.C.E., Engineer to the Liverpool Corporation, is attached. The arrangement consists of a tank or waggon, 5ft. wide by 3ft. deep, and of any convenient length, carried on a pair of rails laid across the top of the Destructor and moved by one man working a pinion and wheel gearing. The tank thus commands two cells. The bottom portion of it is divided into compartments 2ft. wide, which, when full, represent a charge of 30 cubic feet of material. Each division is provided with a pair of doors opening downwards, which, when closed, are supported on small wheels running on a secondary rail. A special charging opening is made in the cell for its full width, viz., 5ft., placed directly over the drying hearth, covered with a firebrick arch fitted into an open frame which is easily travelled backwards and forwards on rails by means of a lever arrangement, so as to open and close the charging opening. This sliding arch is made use of to raise and lower, and to support, when closed, the hinged dropping portion of the rail on which the small wheels attached to the doors of the divisions in the tank runs. The tank when empty is brought under the platform and filled by tipping the refuse from the scavenging carts directly into it. When one of the furnaces is ready for charging, the tank is run along by the hand gearing to position, bringing a full division immediately over the charging opening; the arch is then rolled back, thus removing the support on which the hinged portions of the rails rest. These in turn support the doors, which fall open, allowing the charge to fall direct on to the drying hearth inside the cell. The arch is now closed, and in doing so, raises the hinged rails and the doors to their original position, leaving the cell charged with sufficient

material to last from 45 to 60 minutes, according to the class of material to be destroyed, and the tank is ready to be moved on to the next opening, or back to the platform for a fresh supply from the carts as they arrive. This arrangement provides portable storage for a large quantity of material, and entirely does away with the necessity for the shovelling and handling, which is not only very objectionable from a sanitary point of view, but also adds to the cost of destruction.

The Fume Crematator.

(*Plate, No. 11.*)

Having thus given what I hope may be considered a fair descriptive account of the most important furnaces now in use, I may perhaps be allowed to refer to the contrivance to which my own name is particularly attached, viz., the Fume Crematator. There can be no doubt that one of the principal drawbacks, and the cause of particular opposition to the working of Destructors in various towns, was the fact that they were, in their first construction, a nuisance so far as the immediate surrounding neighbourhoods were concerned. The vapours given off in the drying of the material in the first stage of burning were perceptible and the cause of complaint, also the very fine dust which escaped from the shafts. Not long after the Destructor was erected at Ealing, in 1883, this difficulty arose. It was useless ignoring the fact, and inquiries of the various towns only led the author to feel that Ealing was not alone in the matter. Legal difficulties stared us in the face, and after much inquiry, and the most careful investigation, a conclusion was arrived at that the difficulty was only to be overcome by an absolutely *independent* furnace. The Fume Crematator was the outcome of this. It may be felt that the author of this pamphlet must be to some extent biased in favour of this particular contrivance, but he, at the same time, cannot but feel the truth of the old adage "Speak well of the bridge that carries you safely over."

The Fume Crematator consists of a reverberatory arch, with rings of fire-bricks placed in the direction of the gases. Ribs of fire-bricks projecting from the arch serve to deflect the gases, and direct them on to the top of a red hot mass of fire. An intense heat, from 1,000 to 1,500 degrees, is maintained at little expense of fuel, fine coke breeze alone, or with the ashes screened from the refuse, being

all that is required, together with a supply of air beneath the fire-bars, and a further supply to feed the vapours as they pass into the Cremator. Dr. Tidy, in a lecture at the Society of Arts, in 1886, on the treatment of sewage, says:—"To my mind the Destructor has reached its highest state of perfection at Ealing, from the great thought that Mr. Jones, the Surveyor of Ealing, has given to it. The sewage sludge there is mixed with house refuse and burnt. Mr. Jones' view is that every town produces sufficient house refuse to burn the sludge. One has to notice the differences of Destructors. I have seen a good many myself, and I should say the differences are mainly two: first, a certain escape of offensive vapours from the shaft—and I think those offensive vapours are mainly due to partial burning—the destructive distillation, as a matter of fact, of the materials, instead of their complete destruction.; secondly, the escape of fine dust, and such like, from the shaft at certain stages of the operation. I have seen those two nuisances very well marked, and I had occasion to advise on them on more than one occasion. I cannot help thinking myself that in Jones' plan, where he places a muffle furnace, or Fume Destroyer, as he calls it, between the furnace and the main shaft, he has in a great measure met those two difficulties.'

Mr. G. Watson, in a paper read before the British Association says—"Mr. Jones' Fume Cremator has been invaluable in checking the nuisance that threatened to prohibit Destructors altogether," and W. G. Laws, Esq., M.I.C.E., Engineer to the Corporation of Newcastle-on-Tyne, in a paper read at the International Congress of Hygiene, 1891, says—"To meet this difficulty—fumes, empyreumatic vapours, etc.—the Fume Cremator has been devised by which the vapour, etc., from the Destructor cells is drawn over a bed of incandescent coke, and in so passing is raised to a heat of 1200° to 1500°, practically completing the partial distillation commenced in the cells and resolving the empyreumatic vapours into their primitive gases odourless at last The Fume Cremator has effectually met a real want and gone far to render possible the introduction of the Refuse Destructor into situations where predjudice would otherwise have been too strong for it."

The most striking evidence, particularly in connection with the Fume Cremator is obtained from Bradford. Difficulties, such as those I have referred to at Ealing, had occurred at Bradford, and the

eminent scientist, Dr. Wm. Odling, was called in by the Bradford Corporation. He made the following report, which I looked upon as so important in connection with the whole subject of Refuse Destructors, that I do not hesitate to give it *in extenso*.

The Bradford Refuse Destructors.

Dr. William Odling, of Oxford University, having been asked by the Sanitary Committee of the Bradford Corporation to make a personal examination of the Refuse Destructors in various parts of Bradford, with a view to advising them how to deal with the noxious vapours which arise from the burning refuse, made the following report, addressed to Alderman Hardaker, Chairman of the Sanitary Committee :—

"1. Speaking generally, the process consists in setting fire to the refuse, as collected, and allowing it to burn itself out. This burning is conducted in long, nearly horizontal furnaces, called Destructors; the refuse, just as it is delivered by the carts, being introduced at the slightly higher end or back of the furnace, and the ash or clinkers being raked out at the front and slightly lower end, where the fire-bars are situated. It is noticeable that the burning of refuse is carried on without resort to any fuel other than the combustible matter present in the refuse itself; and that despite the frequently wet state of the refuse, its burning in the Destructors takes place steadily and completely. The burning of the refuse constitutes further an available source of heat, actually made use of at one of the stations to raise steam for the supply of an engine used for crushing and grinding the clinkers of the refuse into a valuable mortar. It is impossible for any one not to be struck with the very efficient way in which the Destructors do their work, having regard to the quality and character of the refuse they so completely dispose of in the course of but a few hours. This continuous and rapid destruction of the town refuse as fast as collected, with avoidance of all decomposing and offence accumulations, cannot but be of great sanitary advantage to the town. It must be admitted, however, that the burning process, as at present conducted, is not wholly unattended with a discharge from the chimney-shaft of a little unconsumed vapour, which, under some conditions, may be recognised at a distance as offensive; but this offence, at the worst, is as nothing compared with the offence and injury to health which are so success-

fully obviated by the rapid destruction, daily effected, of tons upon tons of objectionable matter which must, in some way or other, be dealt with in the Borough, as its deposit elsewhere would not now be permitted.

" 2. The gases, vapours, etc., discharged from the chimney shaft are constituted, in the main, of the completely burnt-out products of the combustion of the refuse, and would, if they were entirely so constituted, be entirely devoid of any possible offence. But, together with the great bulk of completely burned and absolutely inoffensive products, there is a small amount of unburnt and partly burnt vapours, which, by their varying proportion and character, suffice at times to impart to the chimney products generally an objectionable smell, recognisable at some distance away. Having regard, however, to the nature of the refuse burnt, it is remarkable how complete the burning habitually is, and how small is the proportion of incompletely burnt products emitted. The more or less objectionable products emitted in such small proportion are mainly of two kinds, and are furnished in two principal ways. Thus, the fresh refuse, being introduced at the back and comparatively cool part of the furnace, is gradually raked down to the front and hottest part, over the fire-bars, where the burning is most active. In its course downwards to the front of the furnace, it gets gradually dried by the heated products from the fire below it ; and the vapours which it gives off in being thus dried escape for the most part unconsumed into the flues. The vapours so given off in the drying of the fresh refuse constitute one possible source of offence, though I do not consider them the principal source. They are composed chiefly of watery vapour or steam, and what little of them is not steam would be all but entirely lost in the large volume of completely burnt products passing up the chimney shaft. But, in addition to the vapours given off in the mere drying, to which I attach only a minor importance, there are the vapours given off by the refuse as it just begins to burn, and before it gets into the condition of active burning, which is raked towards the front of the furnace. Everyone knows the bad smell given by a piece of bone, for instance, burning by chance in an open fire. Strictly speaking the discharge of the vapours given off in the mere drying would be provided for. Lastly, the passage of watery vapour or steam given off in the drying, through the actively burning portion of the refuse, would tend to

make this portion burn with flame, a very desirable result as an aid to the destruction of the empyreumatic vapours given off in the stage of incipient burning. At present the foreman in charge occasionally delivers, with some such view, a jet of water on to the actively burning refuse, but the continuous passage through this burning refuse of the watery vapour given off in the drying of the fresh refuse would be far more efficacious.

"3. The opening into the flues leading from the furnace to the main flue should be so situated and arranged that the smoke and vapour given off by the incipient burning, together with a sufficient supply of air, should be caused, on its way into the flues, to pass over the most actively burning portion of the refuse, and thereby get almost, if not quite, completely consumed.

"4. The flues into which the products alike of the drying, the incipient burning, and the active burning first pass from the furnace on their way to the main flue should be of some length, but of no greater size than necessary, and be constructed with a view to their being maintained at as high a degree of heat as practicable. It is to these strongly heated flues that the complete destruction of any residue of unconsumed empyreumatic vapour must be entrusted. No amount of mere heating, however, will of itself cause their destruction. They must be sufficiently strongly heated in admixture with a sufficiency of air in order to effect their burning or destruction. The flues serving for this purpose might also be made available to aid in some measure the drying up of the fresh refuse passing in the furnace."

Six months previous to the report of Dr. Olding, I had arrived very much to the same conclusion as he had with respect to the furnaces, and had, in fact, erected a Fume Cremator with the results absolutely proved, which he so clearly set forth in his Report to the Bradford Corporation. From what I can gather it appears, however, that the Report was not acted upon at the time.

Attention having been called to this in one of the public papers, a deputation from Bradford visited Ealing and inspected the works, and were evidently much impressed with the simplicity and effectual working of the contrivance. Some time after a second visit was paid, on this occasion unknown to myself, and this inspection proved not

only as satisfactory as on the previous occasion, thus corroborating the opinion previously formed, but also the very important fact that —a deputation, *expected* or *unexpected*, made no difference to the character of the process they came to see—instructions were given at Bradford to fit up there a Destructor of 12 cells in Hammerton Street, with a Jones' Fume Cremator. Since that time Bradford has erected in the town four additional blocks of Destructors, and to all of them a Cremator has been added.

The author looks upon the experience of Bradford to be one of the most valuable in connection with Destructor work, and having a very special bearing upon it, he has thought it well to include in this pamphlet a Report made no longer ago that October, 1889, by F. M. Rimmington, Esq., Borough Analyst, Bradford.

BOROUGH OF BRADFORD.

Extract from the Report of F. M. Rimmington, Esq., F.C.S., October, 1889.

"To the Chairman of the Sanitary Committee.

"*In accordance with your instructions, I have made four visits to the Destructors in Hammerton Street—two visits before the Fume Cremators were in operation, and two since.*

"Friday, October 11th, 1889.—The Cremators having now been in use more than a fortnight, and therefore considered in perfect working condition, I again visited the works and made similar tests to those made on similar visits, the result in every instance indicating a decided improvement in every particular. The smell of the escaping vapours is of course of the first importance as far as the public is concerned, and this objection is now nearly annihilated, only an almost imperceptible taint being present. Several experiments were continued for more than half-an-hour, passing through solutions intended to arrest any compound of sulphur, ammonia, or organic matter, with almost negative results; even the watery vapour from the steam jets appeared to be decomposed, for only 5½ grains of water were obtained from 1 cubic foot (6¼ gallons) of the vapour. This almost goes to prove that every compound is decomposed and reduced to its ultimate elements.

WEDNESDAY, October 16th, 1889.—The experiments on this occasion were the same as on the 11th inst., only carried on for a longer time. The smell of the vapour was exceedingly slight and difficult to describe; the amount of organic vapour even less than before, almost nil, in fact. Ammonia or any salts of ammonia were quite absent, only 0.19 grain of sulphuric acid in one cubic foot. A kitchen fire would yield much more than this. The effect of the gases from the furnaces passing through the Fume Cremators appears to be that all compounds are decomposed, and scarcely a vestige of any that can be construed to be offensive or obnoxious escapes, and in my opinion the result is as nearly perfect as it can be.

(Signed) F. M. RIMMINGTON, F.C.S.,

Borough Analyst.

In connection with this will be found appended amongst the Diagrams, a plan (Plate No. 8) of the Hammerton Street Twelve-cell Destructor with its two "Double Fire" Cremators, and which will give a clearer idea than any verbal description of the difficult work which the Cremator had to do and the success which attended it; and as a matter of practical interest to all those who have to deal with the subject I have appended at the end *(see Tables B, C, D, E,)* the Working Expenses Account of this same Destructor and Fume Cremator to March, 1891, which give, inclusive of *all* expenses, a cost of 1s. 4¾d. per load, which certainly will bear comparison most favourably with the details given with reference to such places — large towns you might almost call them — as Kensington and Camberwell. I think it well to note that the Hammerton Street Destructor has been built some years, and the addition of the Cremators was a work of considerable difficulty; the peculiar lines upon which they had to be laid down adding considerably to the expense of combustion, viz., 5d. per ton instead of the general average cost of 2½ to 3d. per ton. *(See appendix).*

One of the latest reports in connection both with the Destructor and Fume Cremator has been issued by the Borough Engineer of Leicester, and may not be out of place as showing the initial cost of work performed by the Destructor. It was only opened in the early part of 1891.

BOROUGH OF LEICESTER.

Destructor at Nedham Street, June 22nd, 1891.

"Our Nedham Street Destructor is a six-celled one, on Messrs. Manlove, Alliot and Co.'s system, with a Jones' Fume Cremator, and a multitubular boiler which provides steam for a 14 h.p. horizontal engine. The power is at present only used for driving a mortar and clinker crushing mill, but it is intended to erect jigger-screens which will be driven off this engine for extracting ashes from the house refuse for the Cremator furnaces. *This material, viz., ashes screened from the house refuse, is quite satisfactory without any other fuel.* The stack is a little over 160ft. in height, and cost about £1,000. It abuts upon the Destructor buildings, which are only five yards or so from a large Board School, and there are a considerable number of houses of the artisan class immediately adjoining. There has been no complaint. The buildings are not of the mere shed type, but are of a thoroughly substantial character, consisting of office, tipping shed, Cremator and boiler house, engine house and lime and mortar shed. They cost, including roads, drains, and a rather extensive area of granite paving and long lengths of retaining wall, about £3,300. Total cost of the works, without land, £7,000. Six stokers are employed, three on day and three on night duty, and they work off about 220 tons of ashes per week of 138 hours (last week, ending 20th June, 1891, they did 6½ tons per cell per day of 24 hours). For the Cremator we use about one ton of screened ashes per day, this being an addition to the above-named total quantily. The residue in the shape of clinker is about one-fourth (154 tons of ashes yielded 38 tons of clinker and flue dust). The temperature of cells varies according to period of charge from 850 to about 1,470 degrees, and the temperature of Cremator from 1,420 to 1,500 degrees. The whole Borough yields about 38,000 tons of house refuse per annum, and it is calculated that the Destructor will dispose of 10,000 tons at least. It is intended to at once erect two other Destructors—one of six cells and one of ten cells. These works will be more complete in their arrangement than the Nedham Street works, inasmuch as it purposed using the engine power for driving mortar mills, screens for Cremator ashes, pumps for water supply to street watering posts, dynamo for lighting purposes, etc. The buildings to the new Destructors are also to be of substantial and good class."

The one important factor which is at the present time occupying the attention of municipal economists in connection with the Destructor is the power of utilising its steam-producing properties in such a way as shall make it something more than a Destructor, or if the word is still to be retained, "a destructor of that which is evil and offensive, and a conserver of that which is beneficial and good." This has been done to some extent already, and those who have given attention to the subject are probably aware that Ealing, Southampton, Hastings, Leicester, Longton and many other towns have utilised to some degree the power thus obtained in pumping and working machinery of various classes, such as mortar mills, clinker breakers, etc., etc., and in one or two places for the purpose of electric lighting. All these, however, have been upon a comparatively small scale, and, in the majority of cases, the large amount of steam produced has been literally thrown away, and probably nothing may so help forward the work of construction—or the establishment of the Destructor—than the possibility of its being made the means to a very important end, viz., the saving of money to the municipal purse.

I know that this question has been dealt with in a highly scientific manner by more than one better qualified to deal with it in a theoretical form; but there are points in the practical working which to me appear to some extent to have been lost sight of, and an effort has been made, I fear, to prove too much.

Mr. H. B. Thwaites states "That the amount of house refuse required to produce the same result as coal is as 20 : 2, or 2lbs. of coal being required for producing the motive power equivalent to one brake horse-power per hour, it would require 20lb. of house refuse to do the same work."

On the other hand, Mr. Bennett, of Southampton, advises me that in practical working he finds that 60lbs. of house refuse is absolutely necessary to produce the same result, and further he says, "I think it is impossible without auxiliary appliances to obtain a less consumption; and then the auxiliaries consume steam. . . . I have tried, time after time, to maintain our steam with a minimum amount of refuse, and the result arrived at is 60lb. per i.h.p. per hour."

Here we have a great difference of opinion from gentlemen of undoubted experience, but in the latter case the results are obtained

from daily and hourly working of the Destructors. Suppose you take the amount, say, at 40lbs., and multiply that by 24 (hours), and bear in mind that the average destruction of house refuse per cell is not less five tons in 24 hours, the result produced is immense, and the fearful waste now going on in the towns and cities of England is one well demanding the close attention of all who are interested in the economy of municipal work.

It must be remembered that the material with which we have to deal varies in *quality* as in *quantity*. The urban district supply is a different matter from the more rural district, and the refuse when dealt with in comparatively small Destructors — using the words with reference to the number of cells—very uncertain in its operations, and although (as above stated) very large value has been put upon this material when comparing it with coal, we gather from those who have made a careful study of the question that at the very utmost five h.p. to six h.p. may be taken as representing the maximum value of each individual cell. More than one writer upon the subject has made his platform—utilization of the heat for electric lighting purposes ; and no doubt where very large Destructors are in use, so much so as to be looked upon as being in duplicate, and where one set of Destructors may be utilized at a time, I consider, taking a block of twelve cells, that the value may be given as represented by six cells only, if it is to be applied to continuous and permanent work, such as is required in electric lighting. It must be remembered that the Destructor not only varies so far as the material is concerned by which its power is produced, but also its very construction is such as to render it unfit for permanent working ; and probably there are few Destructors in use that can be kept going for more than 48 weeks out of 52 in each year. What, then, is to replace the motive power during the period which elapses while the necessary repairs are being carried out, and which are annually required in order to keep it in a proper working condition? I desire to emphasise this, for in no one paper which I have had the opportunity of studying have I seen any reference to what I may term its intermittent character ; and I do not think it wise that statements should go out which lead authorities to misconceive the value of the contrivance, and so create a false impression quite unnecessarily. That the Destructor is valuable, and an important factor in the economy of Electric Lighting I will not dispute, but it is only so with respect to

the amount of steam which may be used in the reduction of the coal bill, and not one penny in the *initial* cost of an Electric Lighting scheme.

Take Ealing, for instance. On the 9th of November last the fires were put out. It takes three or four days to cool before the work of repair can be properly done. It takes a week or ten days in order to do the necessary work, and it takes another three or four days before the fires are got into what I consider a perfect working condition, viz., on November 24th. What then is to become of your Electric Lighting if you are dependent upon the Destructor as a motive power? This may be a feeble illustration, at the same time it will explain my view better perhaps than a more elaborate statement.

At this point I may, however, mention that at the present time —1893—we are about to establish an Electric Installation at the Ealing Destructor Works at a probable cost of some £40,000, where the generating works, whilst complete in themselves, will utilise the heat derived from the Destructor and the Fume Cremator to the fullest possible extent.

There is another view also to be taken, to which but little attention appears to have been given; in fact I have seen no statistical statements in reference to its general suitability to the towns of England.

I look upon the Destructor as suitable for every place, large or small, with a population of over 2,000 people. But as an Electric Lighting power to such a population as this it would be perfectly useless. In the table *(See table A)* it will be found that there are no fewer than 863 towns in England with a population of less than 25,000, but there are no less then 944 towns with a population of under 50,000, and that out of the 1,005 towns, or thereabouts, which come under the direct supervision of the Local Government Board as Municipalities, Local Boards, or other Urban Sanitary Authorities—omitting London and districts appertaining to it—there are only some twelve towns with a population of over 200,000 people; and I cannot but help thinking that so far as the value for Electric Lighting purposes is concerned, you can only reckon upon the towns over 25,000 population, or a total about 142 towns.

I do not produce these figures in any way as undervaluing any statistics that may be put forth, but when it is remembered that these statements go into the hands of a large class of persons who have no knowledge whatever of the subject other than that which they glean from such papers, I think it far better to put such a question upon what I cannot but consider a fair and indisputable basis. At the same time I would, and do, estimate at the fullest possible value the Destructor as a grand *sanitary* adjunct to every town, as it may be utilized for the smaller towns included in the 863 to which I have already referred, and where five to ten h.p. may be made use of for purposes other than Electric Lighting.

And here I cannot but say that looking over the various forms of Destructor now before the public, that the more *simple*, the less hampered with machinery, and the more generally utilizable, the better, and certainly so far as the application of the Fume Cremator to the Destructor is concerned, I consider it not only as a valuable factor in its original purpose as a fume-destroyer, but further, if utilized, especially in smaller towns, as an adjunct to the Destructor for the creation of steam, it assumes a far more important character, inasmuch as it may be used, and that continuously, even when the Destructor is not working; and bearing upon this, the Engineer to the Borough of Hastings informs me that the Cremator just doubles the i.h.p. he obtains from Destructor-cells alone.

COST OF CONSTRUCTION.

Upon the initial cost of the Destructor, and one which forms a very important feature in all inquiries respecting the same, I am inclined to think a considerable amount of misapprehension exists. Reference to returns or statistics which have been given in papers—some of which are not only interesting but instructive—prove that many inaccuracies occur which have a tendency to mislead and probably deter, in consequence of the uncertainty attending the cost. Upon this point the class of Destructor, the work required to be done, and the size of the town, must of necessity have an important bearing. The question of enclosure, sloping approach, erection of shaft, and engine power, are all matters which have to be taken into consideration relatively, as I before stated, with the town. But the real cost of the Destructor, and of all that is necessary to be done in order to carry out the burning process, may be brought into a very small

compass. To give you an example. In one exceedingly interesting paper I find the following:—"Leicester, six cells, £7,000; cost per cell, £1,160." Looking at this, without a knowledge of the facts, would alarm many Town Councils and create a doubt as to the advisability of committing themselves to so large an outlay of rate-payers' money. But what of the facts? This amount includes "Roads, drains, rather extensive area of granite paving, and long lengths of retaining walls, in all an expenditure of about £3,300" out of £7,000. This I extract from the report of the Engineer to the Borough of Leicester.

In the return for Bristol it will be noted that the total cost of 16-cell Destructor is £11,418, but of that amount no less a sum than £2,909 is expended in foundations and £1,689 for shaft, leaving the cost of Destructor, Cremator, buildings appertaining to same, together with approach road, at £6,820, or alone, £427 per cell.

Again, at Whitechapel the cost of the chimney shaft alone was £2,500, bringing the cells up to a cost of £1,084 per cell, whereas in Salford the cost is taken at only £400 per cell; and at Ealing the total cost of destructor plant is taken at £2,465, or a total of £616 per cell for four cells; but we really have seven cells, and the cost was but little over £350 per cell. I am prepared to admit that in the last three cells a minimum amount of cost was incurred, inasmuch as the foundations, some 12 feet deep, and up to the ash-hearth, were composed entirely of clinker concrete—the product of the four cells adjoining. My own experience in this matter leads me to say that in the majority of cases, excluding excessive cost for foundations, and what may be considered as an ordinary cost for chimney shaft, the cells, including Cremator and shaft, ought not to exceed £400 per cell; and in some cases I have details showing the cost from £200 to £250 per cell. This has been the case at Winchester.

The machinery appertaining to the Destructor must be in accordance with the requirements of the neighbourhood; and if the power obtained be utilized for work which in any way produces a profit, such as Electric Lighting, mortar making, &c., &c., it would form an important asset, and I think may be fairly deducted or allowed for as a set-off against the initial cost of the machinery.

THE DESTRUCTOR.—OBJECTIONS TO ITS USE.

In a return lately issued by a Midland town, one of 28 questions asked is the following :—

"Judging from the experience gained in Destructors of modern construction, and having regard to the fact that the nearer the Destructor the less the cartage, do you consider it justifiable to place a Destructor centrally in a growing town, or do the possible objections, sentimental or otherwise, render it desirable to place a Destructor some distance out of town?"

This question, although somewhat full, is one that probably occupies the attention of Town Councils as much, if not more, than the question of economy. The sentimental view is the one with which we have the greatest difficulty, and it is very noticeable, in going through the evidence which comes to hand from time to time upon the various Government inquiries that are held, and the discussions that take place at Town Councils, that the question most frequently brought forward is—"Is the Destructor a nuisance?" Like all mechanical contrivances, as previously stated, the more simple the better, and there can be no question that if properly constructed and properly attended to, a Destructor may be placed in any position.

In going through the tabulated return appended hereto, this difficulty is fully recognised, and the replies given in connection with the question very fairly and fully answered. I feel it well to elaborate somewhat this point in order to deal with the many difficulties raised; and it is remarkable to find that even medical men, whom you would suppose the very first to hail with satisfaction any contrivance which deals effectually with a fever-breeding nuisance affecting the health of every town, should raise so many difficulties and questions with respect to it; and to hear, as I did not long since at an inquiry held in the North, that a memorial signed by thirty or more medical men had been put in against the erection of a Destructor upon a certain site which, I must confess, I look upon as most unobjectionable. It is no wonder that others, who are less acquainted with the subject, should have some amount of feeling mixed with prejudice respecting the same. A detailed reference to the Destructor at Leicester, from the Engineer to the Leicester Corporation, has been made in this paper, and I append amongst the diagrams (No. 7)

a sketch showing the proximity of the Destructor to important erections—public schools, &c.--in the said town.

In Whitechapel, where I was consulted upon the question of site, the Destructor is placed in the midst of a teeming population, and within a few yards of dwelling-houses. At Hornsey the same remark may apply, and at Ealing this question is answered in a most noticeable manner. The Destructor there has been working, as I have before stated, since 1883—close upon 10 years. It stands on the Southern boundary—the lower portion of the district O.D. 30—consequently every S., S.E. and S.W. wind (those we should avoid if there was a possibility of a difficulty) would blow the vapours, if any, over the most important portions of Ealing, which rises from the Destructor level very considerably, viz., from O.D. 30 northward, to the 200 feet O.D. contour line, 1½ miles distant. Between these two intermediate points nearly the whole of Ealing is situated; moreover, it is adjacent to high-class residential properties—that is to say, within 380 yards are houses of a rateable value ranging from £120 to £330; within 183 yards are two isolation hospitals, erected not only under the approval of the Medical Officer of Health to the local authorities, but with the approval of the medical advisers to the Local Government Board; and within a distance of 600 yards there is a convent and a large military college, not to speak of the 100 to 150 houses of smaller rateable value which have sprung up all around it, justifying the statement of Dr. Thomas Stevenson, one of the Royal Commission of which Lord Bramwell was the head, and lecturer on chemistry at Guy's Hospital, who states "That if a Fryer's Destructor with Fume Cremator was erected, it would not be possible to affect the health of the surrounding population, and so cause the slightest nuisance of any kind or description."

The diagram (No. 13), which I have had prepared, shows the level from the top of the shaft relatively with the tower of our Public Buildings, and will explain the position which we occupy in that respect.

No doubt there have been causes in years gone by which led to the strong feeling that has been created (and especially having to do with the sentimental view of the question), but these have not been the only difficulties with which the Destructor and Cremator have had to contend; many of them are of a character which on the very face of

them have either a personal feeling or some matter of business tactics, so-called. It is difficult, however, to give the reason, especially when we find erroneous and misleading statements put forth by gentlemen whose very position should ensure an unbiassed and trustworthy opinion.

For instance, a well-known Professor, in one of his lectures, makes the following statement:—"If anything in the shape of a Cremator were to be used at all, I would suggest that the gases ought to be passed a second time through the furnace from under the fire-bars." The absolute want of knowledge displayed in these few lines, as well as the extraordinary position in which the gentleman has placed himself, really surprises one. To begin with the last remark. If he knew anything about the actual working of Cremators or Destructors he would know perfectly well it would be almost an impossibility—considering the character of the fumes and the gases which have to be dealt with—that they should be purified by passing *through* the fire-bars of the furnace. Either the fire bars must present an enormous area, with a corresponding enormous cost for fuel, or they must pass through a fire so light in its character that the ordinary draft from the chimney shaft would pull it all to pieces, whereas in passing *over* the fire, which is regulated in its intensity by the inlet drafts (a degree of heat having been obtained averaging from 1,000 to 1,500 deg. F.), the work is accomplished in a most perfect manner, without in any way disorganising the bed of incandescent coke breeze over which it passes. The Destructor having to do a certain amount of work—say from five to ten tons of house refuse per cell per day—anything representing the impediments which the firebars would give to the necessary draught would at once reduce the work to an insufficient and an altogether unworkable minimum.

Upon the question of cost equally erroneous statements were made. The Cremator at Ealing, for seven cells, costs 7s. per day, or £2 9s. per week. There *coke breeze* is used; in others, as at Leicester, Hampstead, Longton, &c., &c., cinders; in some cases a large coke has been used, and I need not say that it is almost impossible to do the work in a proper manner with the large coke, to say nothing of the extra cost. One case I could refer to where a Cremator was being worked with a six-cell Destructor, with coke at 13s. per ton to keep it going, and burning three tons per day. No

wonder the question of cost was raised. At Ealing we have a fire-bar area of 7ft. 9in. by 4ft. I find this amply sufficient for seven cells. The reason cinders are not used is simply that, having to burn all our sewage sludge with the house refuse, we find it necessary to retain the whole of the ashes for the purpose of combustion in the Destructor Cells.

With reference to the utilisation of the Cremator up to the present, and in answer to certain queries raised with respect to its continuous use and the material employed, I may state that out of 397 Destructor cells now at work there are no fewer than 252 cells in which the fumes from the same are being treated by Jones' Fume Cremator. Forty separate Destructors have been erected since the year 1887 ; thirty-eight of these are fitted with the same apparatus.

With respect to the Cremator at Ealing, it has been at work night and day from the year 1885, Sundays and week-days, and has never been out except for more than 14 to 21 days in each year, and then only for the necessary repairs to Cremator and Destructor.

I have communicated with some engineers in reference to the queries raised and statements made, and in reply a well-known engineer, Mr. Cox, C.E., Engineer to the Bradford Corporation (who has, perhaps, the largest experience upon this matter), says :—"Our Cremators were erected to deal with the difficulties which we had to contend against, and not for deputations to visit. They have been burning continuously from the time they were built."

Mr. Lowe, of Hampstead, says :—"Our Cremators are kept going night and day. We consume a certain quantity of rough dust or cinders for supplying the Cremators, at the cost of screening."

Mr. Mawbey, of Leicester, says :—"We use about one ton of screened ash per day for the Cremator."

Mr. Wardle, of Longton, writes :—"We use screened ashes, with a little coke breeze, from the Gas Works."

House Refuse and Sewage Sludge.

Knowing the view that I have always taken in connection with Destructors and sewage sludge, it would hardly be expected that I should conclude a paper upon this particular question without some

reference to the burning of house refuse and sewage sludge at Ealing. I will explain in a few words how this came about.

For some two or three years previous to the year 1883, considerable difficulty had been experienced in disposing of the sewage sludge, the Ealing sewage being treated by precipitation upon the milk of lime process. Whilst the surrounding lands were purely farm lands no difficulty arose, but gradually these assumed the character of market gardens, when considerable objection was raised to the material. We were next obliged to mix it with ashes, and instead of receiving 1s. and 2s. a load for it we had to give it away. At last the question came to be one of paying for its removal, and as we got more and more into the difficulty appertaining to its disposal, so did the market gardeners raise their prices, and in the end it cost some two to three hundred pounds to be rid of one year's supply. In the year 1882 I was at Leeds, attending a meeting of the Association of Municipal and Sanitary Engineers, and amongst other objects of interest, saw for the first time the working of a Destructor, and fully realised the fact that I had met with a contrivance which would enable me to set market gardeners at defiance. I laid the matter before my Board, and at once obtained their consent to the erection of a Destructor, and in 1883 we commenced our burning. In 1885 the difficulty which arose in connection with the fumes, &c., was overcome by the Cremator, and from that time to the present we have burned quite nine-tenths of our sewage and house refuse, the remaining tenth being transferred to our own farm lands.

This, then, is a short history of how we began the principle of sludge and house refuse burning.

In continuation of this subject, I extract a few words from my paper read at the International Congress of 1891, simply correcting the figures up to date. They are as follows:—"I must ask your permission to digress for a few moments, and to make a few remarks appertaining to one of the 'burning' questions of the day, viz., the London sewage or sludge question. It will be remembered that one of the recommendations of the Royal Commission—I think the third —was resolved into the word 'fire,' and I am still sanguine enough to believe that at no distant date the advisers of the London County Council will see their way clear to give a fair trial to the treatment by

fire. Why should not the Metropolitan Board of Works have had the refuse of the dustbin? The various authorities along the banks of the Thames would have been only too glad to have had a depôt, and barge it down to the northern or southern outfall. We all know the trouble that for years and years has gathered round this question, when a remedy might have been found so readily. I have been told that the quantities are so large, and the amount of sewage is so great; but it seems strange in these days of the Forth Bridge and other engineering marvels to hear words of this class. The whole treatment of the London sewage at two outfalls would be a mere bagatelle, if those with whom the matter rests would face the difficulty. I have stated that in England at the present time there are some 384 Destructor cells at work employing less than 200 men, and dealing with something like 700,000 tons of refuse. How much room do you think these 384 cells would take, supposing they had been built at Barking, where I believe there are some 70 acres of land available. You will be surprised to hear that they can be put upon three acres of land, with plenty of room to work between them, and that the cost of erecting them would not amount to more than £300 or £350 per cell. Supposing 384 cells had been built, and the question tried, there would have been, according to the data which we have, and which there is no disputing, as it is in daily work, 1,920 horse-power at hand—or, in other words, the coal bill would have been saved. No nuisance would have been created by the adoption of the process, which, after all that has been said with respect to other systems, has held its ground, and will continue to do so.

"Some of my readers will remember the paper which was read at the Institute of Civil Engineers (Session 1886-87), by Mr. Dibden, upon the question of 'Sewage Sludge,' and the discussion which ensued upon the same; the opinion expressed by Mr. Dibden was—'That the cost of pressing the sludge before burning would render the operation too expensive even to be thought of.'

"I combated that idea at the time. and I can only say that seven years having now passed away since that paper was read, my views are stronger even than they were then. I have burned all (or nearly all) the sludge from my district, and I have never pressed one ounce. There is no difficulty in dealing with this matter at Ealing. One third of the house refuse is devoted to sludge drainage purposes, and the

other two thirds is tipped into the Destructor in the ordinary way. The difficulty in connection with the fumes which it was supposed would arise from the combustion of this material has been absolutely dealt with by the simple contrivance of the 'Fume Cremator,' and no shadow of a complaint has been made since the year 1885, when it was first erected. I know this question is a large one; I know that the sewage sludge of London is enormous; and I know, also, that the millions of tons of house refuse is also enormous; but I think I should hardly be justified in saying that this question is one too big for the engineers of the London County Council to deal with. I give no opinion upon the barging out to sea which has been carried out for a number of years. You remember, probably, the remark made by Mr. Dibdin that 'it was a question of advisability,and not so much of practicability, burning the whole of this; the value of the sludge, whatever it might be, *was absolutely lost*, but when it was taken out to sea it served to manure our *fishfields* instead of our *cornfields*.' It would be very interesting to know if any statistical account has been received as to the effects of the manure upon our fish. One thing is very certain—we have not yet obtained the opinion of the fishes upon the matter; but I can quite understand that if they, as we, had been holding a Congress of Hygiene, the finny tribes would have passed a resolution, and would have carried it unanimously—'That, even fishes may have too much of a good thing.'"

In bringing this work to a close, I have briefly to state that my object has been to take a broad and, if I may use the word, a popular view of an important and interesting subject. I have purposely avoided technicalities as much as possible, and have confined myself to simple facts, although I do not undervalue in the slightest degree the theories which have been advanced, the analyses, quantitative and qualitative, which have been made. I have now for some ten years had the practical working of the Destructor, and know something of the difficulties which crop up in the minds of men who are anxiously inquiring about the merits of the same, and believe that a mode of treating the subject, as carried out at Liverpool, Bradford, Leicester, Hastings, Ealing, and other towns, is likely to commend itself to a large number of my readers, engineers or otherwise, who are seeking for information as to the practical results which have follo wed the use of this invention in the different parts of the country.

It is now some six years since, at the request of my late esteemed friend, Joseph Gordon, Esq., M.I.C.E., late Chief Engineer to the London County Council, I was induced to give the result of my experience in a paper which was read at the Association of Municipal and Sanitary Engineers, at their annual meeting at Leicester. The ball then set rolling has certainly resulted in a large amount of work being done and interest taken in the question, which at the present time is forming a subject of discussion, not only in England and in Scotland, but in the Colonies, the South African Transvaal, and even in Russia, where only lately I have sent out designs for dealing with the house refuse and street drift, Cremators being constructed in which dead cattle and abattoir offal were to be treated ; and I can only add that if any efforts of mine in the past, or in connection with this work, lead to a more practical realisation of the importance of the subject, and not only the necessity of the Destructor as a sanitary adjunct to every town, but the possibility of its being erected and utilised at comparatively small cost, I shall have done an important duty, and be amply rewarded in this result of my labours.

Diagrams.

Note.—I need hardly enter into any further description of either the Diagrams or the Tables; most of the diagrams have been referred to in the paper. No. 1 shows the lines upon which a Destructor should, I think, be built. Of course the sloping roads must be in accord with the physical character of the ground upon which it stands. At Ealing I have a road above the level of the platform, and a slope down, but in other respects I think the general lines of this plan are such as may be fairly adopted. It shows a Twelve-cell Destructor, with double Cremator and one sloping road, with room at the top for waggons to turn and return by the same road.

No. 16, designed for and now being erected in Russia, requires, perhaps, a special word or two. It has been arranged particularly to meet the requirements of a town of some twenty-five thousand inhabitants, and where the "Pail System" is the only mode of dealing with the sewage difficulty, and where the cholera, during the epidemic of two years since, was fearfully fatal. The mode adopted is to collect the contents of the pails, which are charged with small coke breeze, at frequent intervals, a small iron cart being used for this purpose.

It is then conveyed to the Destructor and tipped into the large iron central tank whence it gravitates to the exit door, and it is there met and mixed with additional breeze, which is worked down by an endless screw from tank on either side, and thence into the Destructor cells. The small iron waggons are disinfected each day by means of a powerful gas. The above is the process carried on in the summer. In the winter, the mode of collection differs somewhat. The platform upon which the pails stand is removed, and the small cesspool underneath forms the receiver. The deposit, with the breeze which is thrown in every time a removal takes place, is frozen into a dense mass. A different form of cart is used for the removal. When at the Destructor it is placed in the centre tank, into which a certain amount of heat is introduced from the cells, reducing the deposit into a semi-liquid mass; it then passes to the Destructor cells as before described, the fumes finding their way thence into the Cremator. It will be noted that an intermediate receiver is arranged in which the offal from the abattoir is deposited and calcined, the fumes passing through an additional Cremator. In this district coke breeze is a waste material to be obtained in any abundance.

The tabulated statements which are appended explain themselves. They are abstracted from various returns made, most of them up to date, and have been gathered from Portsmouth, Hammersmith, Liverpool, Aston Manor, and various other towns; and that there may be no doubt about their correctness, they have been verified for the purposes of this work by the engineer of nearly every town referred to. The questions thus asked are general questions likely to arise in an engineer's mind, and I hope that in detailing them in this form they will be a source of useful information and a saving of time to my brother officers who are interested in the question of "House Refuse and Refuse Destructors."

The Utilisation of Town Refuse for Power Production.

By Thomas Tomlinson, B.E., Assoc. M. Inst., C.E.

THE idea of utilising the waste heat of Destructors, and so reducing, if not entirely repaying, the large cost of collection and disposal, is greatly exercising the minds of the authorities, and in accordance with the old saying that "he who pays the piper chooses the tune," municipal engineers and electrical engineers called in as specialists will have to form very definite ideas as to what the value of this waste heat is. This paper is the attempt of an Electrical Engineer to arrive at safe conclusions in the matter, and a presentation of the evidence on which the conclusions are based.

Before considering figures, I propose to consider the limiting conditions of utilisation; these are the conditions of burning, the quantity of material available, and its calorific value.

In a very valuable report to the London County Council on "Dust Destructors," by Mr. Alexander R. Binney, M.Inst.C.E., and Dr. Shirley F. Murphy, I find this general criticism: "We have already intimated that, as regards the best available means of preventing nuisance from destructors, the following points demand special attention:—

1. The temperature obtained should be sufficiently high.

2. The duration of exposure to a high temperature should be sufficiently long.

3. *All* the vapours escaping from the refuse should be heated to a sufficient extent, and there should be no possibility of the escape of any undecomposed vapours into the chimney shaft.

It is of extreme importance that these points should be well considered by anyone proposing to use Refuse Destructors as steam makers, and for these reasons:—Clause 1 implies the use of forced draught, and, so far as I can find, practical experience, as evidenced

by universal practice, says it must be by steam jets. Now Mr. Watson, in a paper read before the British Association (*Engineering*, September 30th, 1892), records, as the result of a valuable experiment made on a "Horsfall" Destructor at Oldham, that "about 7-16ths of the total steam available is used in the steam blast." I shall allude to this again when dealing with the figures of the experiment; but the fact as here set down is suggestive.

Clause 2 is of extreme importance; practically, I should say, if adhered to, it makes impossible the placing of the boilers in a position to enable them to best utilise the heat, *i.e.*, over the hottest part of the fire; especially if taken in connection with Clause 3, which practically implies that you shall bring the gases given off by the drying refuse, at the back of the fire, forward over the hottest part, and shall there subject them to the highest temperature you can get, and for the longest time possible, and you will materially reduce that temperature by placing a large mass of comparatively cold water above.*

In this connection I may say that I was much puzzled to account for the evaporation rate per pound of ashbin refuse obtained at Birmingham, which I could not reconcile with other figures. Prof. Forbes furnished the solution:—"It was necessary there to keep up steam for the treatment of the excretæ, and steam was got up from these furnaces by putting the boilers directly over the furnace. In consequence of this, the combustion is extremely imperfect. The large cooling surface of the boilers impedes the combustion in an effectual degree. In most cases where boilers have been used to generate some steam, the boilers have been put away, and after the gases have passed through the flue they then pass by the boiler, and the error has been in the opposite direction." This seems the proper place to point out that the only figure of evaporation given in this L.C.C. Report (1·79lbs. of water per pound of ashbin refuse), and the deduction of the calorific value of ashbin refuse burned in a Destructor as "about one-fifth the value of an equal weight of coal" is obtained at Birmingham, and evidently under conditions which do not satisfy the sound requirements laid down in that report for perfect (*i.e.*, inoffensive) refuse destruction, and quoted above.

* The two last paragraphs stand as they stood in the articles on their appearance in the *Electrical Review*, and seemed to me then to be the only conclusions to be arrived at. It is, however, perfectly obvious, in the light of the wide success of Mr. Jones' Cremator in practice (of which I was at the time ignorant), that the sanitary conditions here insisted on can be quite adequately fulfilled by low temperature burning in the Destructor, and the insertion of a Fume Cremator in the main flue. As regards the return in net external power, I can find no decisive evidence of superiority, in daily practical work, either way.

The utilisation of the waste heat of Destructors for the generation of steam is rigidly limited by this consideration, that the efficient performance of its primary functions *as a Destructor* shall not be impaired.

If the makers of Destructors, in trying to fulfil the requirements of maximum steam production, impair (as Birmingham shows they will) the valuable qualities of the Destructor—the results of 17 years' continuous improvement—it will be bad for them and bad for municipal electric lighting ; they will, in all probability, convert an extremely valuable Destructor into a combination of an inefficient Destructor and a bad boiler.

The safe line of progress lies in making the Destructor as perfect as possible *as a Destructor* (on the lines of the recommendations in the London County Council Report), passing the gases, after they have performed their destructor functions, through a suitable boiler, and taking the result for what it is worth.

To put this in another way : The conditions for a perfect Destructor are directly opposed to the conditions required for obtaining the maximum available calorific value of the burning refuse, and the Medical Officer of Health, the public, and, as a last resort, the law will compel you to fulfil the conditions for perfect (*i.e.*, inoffensive) destruction of the refuse *first*.

Practical consideration of construction and maintenance, not necessary to specify here, will also tend to prevent any attempt to utilise the maximum heat by placing the boilers in the best position.

Other factors in determining the value of the ashbin refuse of a town are obviously the quantities available per head of population per annum, and the calorific value.

These figures obviously must vary between very wide limits, depending upon the habits of the people, the climate, the season, the fuel used, the attention paid to the sanitary laws, the wealth of the population served, and even—and that very materially—upon so small a matter as the proportion of ashbins which are left open to the weather.

In a paper like this, not special but general average figures must be adopted, and that round number which seems to me to most fairly represent the average yield of ashbin refuse per head per annum under good sanitary conditions, and in a water-closeted district, is 4 cwt. per

head per annum—less, if anything—it being understood that this is ashbin refuse such as is burnable in a Destructor.

Prof. Forbes gives the composition of Paddington refuse at 3·6 cwt. per inhabitant per annum.

OUT OF EVERY 10,000 TONS.

	Tons.
Ashes	5,260
Breeze or cinders	2,880
Animal and vegetable refuse	1,420
Pottery, &c.	290
Coal	15
Bones	25
Rags	42
Iron	35
Bran and pewter	3
White glass	7
Black glass	23

Mr. Jos. Russell, in a paper read before the Sanitary Institute on February 10th, 1892, gave the following analysis of the composition of average London ashbin refuse. (I have put it in the same form as that of Prof. Forbes, for convenience of comparison.)

OUT OF EVERY 10,000 TONS.

	Tons.
Breeze (cinders and ashes)	6,369
Fine dust	1,951
Vegetable, animal, and various mineral matters	461
Waste paper	428
Straw and fibrous material	322
Bottles	96
Coal and coke	84
Tins	79
Crockery	55
Bones	48
Broken glass	47
Rags	39
Iron	21

I have given these two analyses as showing fairly well the composition of the ashbin refuse to which the figure 4 cwt. per annum per head of population applies.

One can easily see from them how, in a very poor neighbourhood, the quantity would probably diminish by the decrease of coal burned per

head, and by increased economy in its use, and how seriously a decrease in this item of coal consumption would affect the calorific value of the residue, especially if the quantity were made up to or above the 4 cwt. per head per annum by the admixture of less burnable materials; and one sees how a figure two or three times as great as our average figure, or even as at West Derby (L.C.C. Report), nearly five times as great (19 cwt. per head per annum), cannot possibly be of this character, or be all made up of ashbin refuse.

I adopt, then, provisionally, this figure of 4 cwt. per head per annum as the average yield of *ashbin* refuse in a town or district with a complete water carriage system of sewage, and with house-to-house collection of refuse at short intervals, and from a population of average wealth.

If the quantity falls much below this, or rises much above it, I should question if its calorific value were not less than I shall afterwards assume that of this quantity per head per annum to be.

Now, what is the value of this in power burned in a Destructor and raising steam?

The first place must be given to the theoretical determination, which in a valuable paper read by Mr. G. Watson (Leeds), before the British Association (see *Engineering*, September 30th, 1892), is given so :—" A calculation, based upon analyses of the products of combustion of Mr. Horsfall's experimental furnace at Leeds, in 1888, and upon the specific heats and weights of the component gases, shows that with a boiler efficiency of 0·8, 1,192 lbs. of water at 32° F. can be converted into steam at 70 lbs. pressure per square inch by the combustion of ¼ ton of ordinary ashbin refuse in one cell in one hour. Supposing an engine to consume 20 lbs. of steam per indicated horse-power per hour, we have, theoretically, from one cell on this system 59·6 indicated horse-power all the time it is working."

I propose, for convenience of comparison and reference, to give the results—theoretical, practical, and promises—in all cases in these forms :

1. I.H.P. hours per ton of ashbin refuse, taking 20 lbs. of water or 2 lbs. of coal per I.H.P. hour.

2. I.H.P. continuously per cell, consuming 6 tons per day of 24 hours.

3. Pounds of water evaporated per lb. of ashbin refuse.

4. Evaporative value compared to coal at 10 lbs. of water per lb. of coal.

It will be readily seen that these figures are for the theoretical estimation given above :—

238·4 I.H.P. hours per ton burnt.
59·6 I.H.P. continuously per cell.
2·13 lbs. of water evaporated per lb. of refuse.
0·213 evaporative value compared to coal.
(If utilised under similar conditions).

Mr. Watson, however, goes on to say : "But at Oldham about 7-16ths of the total steam available is used in the steam blast," and he proceeds to reduce his results by 7-16ths in order to get at the net external power available. This reduces the results given above to :—

134·0 I.H.P. hours per ton burnt.
33·5 I.H.P. continuously per cell.
1·2lbs. of water evaporated per lb. of refuse.
0·12 evaporative value compared to coal.
(If utilised under similar conditions).

Since the furnaces at Oldham attained a temperature of over 2,000° F., it would, I think, be more correct to assume that this temperature is sufficiently high and the consumption of steam for the steam jets sufficient, and that increased efficiency in steam production lies simply in the more perfect utilisation of the heat generated. Indeed, it is pretty certain that the use of so much steam in the steam jets would have the opposite effect to that intended.

To obtain the net external power available on this supposition, we take the evaporation per cell per hour as before (1,192 lbs.), and deduct from this the amount actually used in the steam jet to attain the temperature of 2,000° F., 250 lbs. per cell ; this gives 942 lbs. per quarter ton burnt per hour, and leads to the following figures :—

188·4 I.H.P. hours per ton burnt.
47·1 I.H.P. continuously per cell.
1·7 lbs. of water evaporated per lb.
0·17 evaporative value compared to coal.
(If utilised under similar conditions.)

The correction is unimportant from the point of view taken in this paper, which is that of neither the expert in nor designer of Destructors, looking towards possibilities of improvement, but simply the electrical or municipal engineer looking towards present attainable results ; but it appears necessary, in view of the figure of evaporation said to be attained at Birmingham. To gravely quote an attained figure of evaporation,

higher by 50 per cent. than your own maximum theoretical, would be absurd ; a small excess can be explained by errors of observation or differences in quality of the refuse.

I have given for uniformity the evaporative value compared to coal, but have added, "if utilised under similar conditions," because I consider, as stated before, that utilisation under similar conditions to those under which coal is used in a boiler is impossible, without impairing the value of the Destructor as a Destructor.

Evidently based upon this (or a similar theoretical determination) is that opinion of Prof. Forbes, enunciated in his Cantor Lectures before the Society of Arts, 1892. He says : "Now it will strike you, as it has struck me, as a very wise provision of Nature, when I tell you that if that refuse (at Paddington) were properly burned, and if it were used in the most economical way, it would be found that (assuming the proportion of lighting required for such a population to be, as has been very generally assumed, one lamp per head) the amount of refuse provided by any population is almost exactly as much as is required to supply the illumination by means of the electric light to that same population."

Take population	10,000.
Ashbin refuse	4 cwt. per head per annum.
I.H.P. hours per ton of refuse ..	134.

(I have taken the figure deduced by Mr. Watson rather than that one which I deduced, because this leads to Prof. Forbes's "almost exactly," and as it preceded his Cantor Lectures, was probably that from which he worked.)

Then : total I.H.P. hours per annum.

$$= \frac{10{,}000 \times 4}{20} \times 134 = 268{,}000 \text{ I.H.P. hours.}$$

Now, with low tension direct current dynamos (which would alone be generally applicable, on account of necessity for storage), Mr. Crompton, M.Inst.C.E. (*Min.* Inst. C.E., Vol. cvi.), finds "a collective efficiency exceeding 85 per cent. of the power shown by the indicator

dynamo when fully loaded, and 76 per cent. when half loaded." We will therefore take 80 per cent. as a fair round number.

$$\therefore \text{ E.H.P. hours per annum} = \frac{268{,}000 \times 80}{100}$$
$$= 214{,}400.$$

$$\therefore \text{ Watt hours per annum (at central station)} = 214{,}400 \times 746$$
$$= 159{,}942{,}400.$$

Now, according to Mr. Crompton (same paper), "There is therefore every reason to believe that the efficiency of the low pressure system of distribution, now being carried out in London, will reach an average of at least 90 per cent., and possibly will exceed that figure."

$$\therefore \text{ Watt hours (available in lamps)} = \frac{159{,}942{,}400 \times 90}{100}$$
$$= 143{,}948{,}160.$$

$$\therefore \text{ 8 candle-power lamp hours per annum} = \frac{143{,}948{,}260}{30}$$
$$= 4{,}798{,}275.$$

$\therefore$ 8 candle-power lamp hours per annum per head of population = 480, say.

From this, however, we must deduct the loss due to the storage which would be necessary. Taking this at 20 per cent. on three-quarters of the total, or 15 per cent., all round, we find

8 candle-power lamp hours per annum per head of population = 400, say,

which is about the average number of hours which every 8 candle-power lamp installed is found to be used, giving an earning power of 8s. per annum on current sold at 8d. per unit.

Prof. Forbes's statement, then, turns out, as was to be expected, to be the statement of a scientific fact, and would have been simply stated as such here; but, unfortunately, it appears in Mr. Watson's paper in this form: "Prof. Forbes, however, early in the present year, dealt with the subject in one of his Cantor Lectures, and also in a letter to the Press, in which he stated that burning at 2,000° F., the ashbin refuse of any population was sufficient to give steam to furnish electric light at the rate of one lamp of 8 candle-power per head for two hours for every night of the year," which at once tranforms it into a statement of a practically attainable result, since ashbin refuse can be burnt at 2,000° F. under

present conditions. (Mr. Watson obtained an average of 2,019° F. with a minimum of 1,654° F. and a maximum of 2,346° F.)

I have worked the matter out step by step to show beyond doubt that the practical bars to realisation which lay behind Prof. Forbes's "ifs" (both are strongly dwelt on in the same lecture) have not been allowed for. The first is the practical difficulty of combining an efficient Destructor with a boiler so placed as to be economical: the reduction of our theoretical result due to this factor will, as we shall see later, be one-third to one-fourth. The second is the fact that in actual central station practice, electrical energy, as measured on the consumers' meters, will cost in coal 10 lbs. per unit, where the actual plant could at full load give a unit for 3·3 lbs. (corresponding to an I.H.P. for 2 lbs., and an efficiency of 80 per cent. from I.H.P. to E.H.P.): the reduction of our theoretical result is again one-third. There is a third bar: the excessive cost of such storage as would be necessary to utilise completely the power developed.

The final result, then, is that Prof. Forbes's statement is true as the expression of a scientific possibility extremely remote (as it was clearly meant to be), but untrue—more than nine times untrue—as the expression of fact on which an engineer can calculate now.

Coming now to practically attained results: Mr. W. B. G. Bennett, Assoc. M.I.C.E., in a paper on "The Utilisation of Town Refuse, Sewage Disposal, and Electric Lighting at Southampton" (*Journal of the Association of Municipal and Sanitary Engineers*, Vol. xv.), gives, for a 6-cell Fryer Destructor, the maximum burnt in 24 hours as 50 tons, and the minimum as 25 tons, and adds "this quantity (25 tons) has run an engine 31·5 I.H.P. for 24 hours." This gives:

30·0 I.H.P. hours per ton burnt.
7·5 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·27lbs. of water evaporated per lb. of refuse.
0·027 evaporative value compared to coal.

In giving these figures I assume that the I.H.P. hour was obtained for 20lbs. of steam (so as to keep to that figure); but the real figure certainly exceeded this, and all the figures will be improved by so much in comparison with other figures based on measurements or estimates of evaporation, and taking the I.H.P. hour as the equivalent of 20lbs. of water; but in dealing with small engines it must be remembered that this latter figure is too low. To avoid misunderstanding, I shall, when I come to tabulate the results, distinguish between actual measured

I.H.P. and calculated I.H.P. at 20lbs. per I.H.P. The continuous I.H.P. per cell burning 6 tons in 24 hours is got by proportion from the actual I.H.P., $5\frac{1}{4}$ per cell burning $4\frac{1}{6}$th tons.

It should be noted that Southampton, where these figures were obtained, is specially instanced by Prof. Forbes as having a typically bad arrangement for the utilisation of the heat. In his Cantor Lectures already alluded to he says, "In many places, take Southampton for example as a notable case, the boilers are put in a place where they cannot benefit from the maximum heat." Whether they are worse placed than practical consideration necessitates, *i.e.*, further from the source of heat than is necessary, I cannot say.

On looking to the L.C.C. Report, I find that Southampton collects and disposes of rubbish amounting to 6·1cwts. per head per annum (population 65,325, rubbish 20,000 tons), of which it is noted that "part is burnt, part sold." Six cells at normal rate would dispose of about 12,000 tons, which would be under 4 cwts. per head per annum ; but evidently the cells are at times worked at a higher rate than the normal 6 tons per 24 hours, and at times lower.

The statement that the amount burnt varies from 25 to 50 tons per 24 hours should be noted ; if this indicates a corresponding flux of supply, the utilisation of ashbin refuse as a power producer becomes complicated, unless the demand for power coincides exactly with the supply of refuse. Mr. C. Jones, M.I.C.E. (Ealing), is of opinion that a considerable variation in the amount of the supply must be allowed for.

The indisputable fact established by Mr. Bennett's work is that the refuse of a population of 65,325 will certainly run a 31·5 I.H.P. engine all the year round. If this did not stand as an absolutely achieved result one could go lower. Since in the discussion on a paper by Mr. C. Jones (*Minutes Proc. of Municipal and Sanitary Engineers*, Vol. xiii.), Mr. Lemon (on the authority of Mr. Cartwright) states that 16 tons of refuse runs an 8 I.H.P. engine for 24 hours ; this gives 12 I.H.P. hours per ton of refuse burnt : with so small an engine, this would mean about 24 I.H.P. hours, on a basis of 20lbs. of water per I.H.P. Mr. Hewson, M.I.C.E. (Leeds), goes still lower : "Although we consumed 50 tons of refuse per day, we had no more than 16 or 17 actual H.P." ; this gives 8 to 10 I.H.P. hours per ton of refuse burnt, with the same remark as to the meaning of this result reduced to the basis of 20lbs. of water per I.H P. hour. It would much facilitate

comparison if all results were given in lbs. of water evaporated, since the steam consumption of an engine per indicated horse-power hour varies within such wide limits, according to size and build.

Mr. Hewson's figures were before the introduction of the steam jet.

We next come to Mr. Watson's experiment, an account of which is given in his paper already referred to ; as this experiment is the first (and, so far as I know, the last) attempt to scientifically measure the actual evaporative value of ashbin refuse burned under practical conditions, I shall give Mr. Watson's own account of it :—

" The average temperature of the mattress chamber through which the hot gases pass on their way to the boiler was found to be 2,019° F., the minimum being 1,654° F., and the maximum 2,346° F. The above results are confirmed by the melting of three pieces of cast iron, of which the melting point was not less than 2,010° F., in one of the fires.

" The temperature of the gases as they escaped from the boiler flues was also measured and found to be 855° F., but since the iron could only be hung in front of the opening to the large dust chamber where the gases must already have expanded and cooled considerably, it will be quite safe to assume that the temperature on leaving the boiler was not less than 900° F. The boiler is multitubular, 7 feet in diameter by 12 feet long, and is fed through a new Kennedy's patent water meter, which was used for measuring the water in the evaporative trials. The first trial extended over four hours on June 23rd, the boiler water gauge being marked, and the water brought back to the same level at the end of the test. The second trial was held the following day for six hours, and the average evaporation for the two trials was found to be 278 gallons per hour.

" The steam used by the steam jets was ascertained by means of a two hours' test, and was found to be equivalent to 150 gallons of water per hour.

" The boiler room being quite inadequate, it is fair to assume that with another boiler the gases could be reduced in temperature 200°, or down to 700° F., while, at the same time, relieving the first boiler of its excess of output (which no doubt caused priming), and, therefore, the actual evaporative power may be put at 328 gallons per hour. Deducting the 150 gallons for the steam jets, we have 178 gallons, or 1,780 lbs. of steam at 70 lbs. pressure per square inch per hour available for use, which would be equivalent to 89 indicated horse power from the six cells

burning 1½ tons of refuse. That is about 15 indicated horse-power per cell, as against 32 indicated horse-power, which was found to be the theoretical amount.

"The Oldham plant was not laid out in such a manner as to insure the maximum steam raising capacity, and the author has no doubt at all that with certain improvements a much better result may be obtained, and one much nearer to the theoretical amount, which was based upon a fair efficiency of the plant."

If we take the actual result obtained, we have :—

42·5 I.H.P. hours per ton burnt.
10·6 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·38 lbs. of water evaporated per lb. of refuse.
0·038 evaporative value compared to coal.

If we take the figures deduced by Mr. Watson, allowing for an extra evaporation of 50 gallons per hour with increased boiler capacity, the figures are :—

60·0 I.H.P. hours per ton burnt.
15·0 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·54 lbs. of water evaporated per lb. refuse.
0·054 evaporative value compared to coal.

A comparison of the two sets of figures shows what a very large effect the assumption of the extra 500 lbs. of evaporation has upon the net available power : it would be a fair assumption to say that if a reduction in temperature from 2,000° F. to 900° F. evaporates 2,780 lbs. of water per hour, then a reduction from 2,000° F. to 700° F. would, in a suitable boiler, evaporate 3,280 lbs. of water per hour, provided the 2,780 lbs. was *true* evaporation. Mr. Watson, however, it will be noticed, states "that the over-running of the boiler no doubt caused priming" ; to this extent, whatever it may be, the second set of figures are overstated.

Referring to the L.C.C. Report, I find that Oldham, with a population of 136,469, collects 40,000 tons of rubbish, of which one-quarter is burnt and three-quarters tipped ; this makes the average 6 cwt. per inhabitant per annum, of which 1·5 cwt. only is burned ; it is reasonable to suppose that with tips available the most burnable only is burnt, so that a result obtained here is probably vitiated for purposes of generalisation as to the *complete* utilisation of ashbin refuse (at 4 cwt. per head per annum) by a process of selection. It may be added also that trials of four and six hours' duration are far too short to be an absolutely safe basis for wide generalisation as to evaporative value, especially with a material of such varying quality as ashbin refuse.

There is, then, the figure obtained at Birmingham, which is thus given in the L.C.C. Report:—"At Birmingham, for instance, multitubular boilers are set in such a manner as to form the top of the furnace, and it is found in practice that 1 lb. of refuse will evaporate 1·79 lbs. of water—that is to say, that as a steam producer the refuse is about one-fifth the value of an equal weight of coal."

Here are the resulting figures :—

200 I.H.P. hours per ton burnt.
50 I.H.P. continuously per cell.
1·79 lbs. of water per lb. of refuse.
0·179 evaporative value compared to coal.

Assuming, as I have done throughout, that the Destructor must be first as nearly perfect as possible as a Destructor, then these figures are, on the authority of Prof. Forbes, useless for our purpose.

The fact that these figures exceed by 50 per cent. the theoretically possible figures first given, and also slightly exceed the second set, needs explaining. Unless the Birmingham Destructors have a steam jet, the steam used by which is not deducted—unless, in fact, we are dealing with *gross* evaporation, and not *net*—the figures show what a practical handicap to steam production (outside the furnace) the steam jet is, coupled with a position of the boiler not the best for utilising the heat generated. Both may be, probably are, practically necessary to an efficient Destructor, but both are serious obstacles to the use of the Destructors for power.

Referring now to the answer to Mr. Jones' questions (found at the beginning of the book), which he was good enough to allow me to use before publication, certain questions bear upon the subject of this article ; these are as follows, the numbering of the original being preserved :—

1. Name of town ?
3. Population ?
5. How do you dispose of town refuse ?
6. How many tons or loads of refuse do you collect per day on an average ?
11. How many cells ?
12. Quantity of refuse destroyed per day per cell ?
25. If the heat is utilised, what in your experience is each cell worth in I.H.P. ?

Obviously only those towns or districts, the engineers of which reply to Question 25, need, for the purposes of this article, be considered ; these with the answers are in tabular form as follows :—

1.	3.	5.	6.	11.	12.	25.
Batley	28,700	By Destructor	45 loads ..	6 cells ..	3½ tons, about	5 H.P., about.
Birmingham ..	478,116	Part of ashes are screened and finer portion mixed with pan contents, and sold as manure. Remainder by Destructor ..	699 loads, about. (This includes ashes from pan closets, &c.) ..	37 ,, ..	6 ,, ,,	Several tests show that 1lb. of refuse will evaporate 1·79 lb. of water.
Blackburn ..	120,064	By Destructor	130 tons ..	8 ,, ..	6 ,, ..	Eight cells + the Cremator develop 45 I.H.P.
Bury	58,000	Part by Destructor, part tipped	21,050 loads collected last year	4 ,, ..	6½ ,, ..	We work a 12 H.P. engine.
Ealing	25,000	Mixed with sewage sludge and destroyed in Destructor ..	21½ tons ..	7 ,, and a Cremator	4½ ,, ..	We work two 10 H.P. engines.
Hastings ..	58,000	By Destructor	50 loads ..	4 cells ..	10 ,, ..	Without Cremator, 8½ H.P.; with Cremator, at a temperature of 1,500° F., 17 H.P.
Heckmondwike	10,000	By Destructor	10 loads ..	3 ,, ..	3½ loads, about	12 H.P. engine for grinding clinkers.
Liverpool ..	517,951	By special steamer to sea, by canal barges to contractor, by Destructor and waste lands	In 1891, 96,953 loads	12 cells and 12 more in course of construction ..	8 tons ..	No reliable test has been made, but should say about 5 H.P.
Southampton ..	65,325	By Destructor	71 tons ..	6 cells ..	10 ,, ..	According to condition of house refuse, from 6 to 7 H.P.
Warrington ..	53,000	By Destructor	250 tons weekly	6 ,, ..	7 ,, ..	I should think about 10 H.P.

NOTE.—Ealing: With the addition of one cell, this plant is just about to be further utilised as auxiliary to the electric lighting; this development will be considered later.

It is possible to deduce from the answers to Questions 11, 12, and 25, results in one of the forms already used, *i.e.*, I.H.P. continuously per cell consuming 6 tons per day of 24 hours. These results are :—

Batley—8½ I.H.P. continuously per cell burning 6 tons per day of 24 hours.
Birmingham—50 I.H.P. continuously per cell burning 6 tons per day of 24 hours.
Blackburn—5½ I.H.P. continuously per cell burning 6 tons per day of 24 hours.
Bury—3 I.H.P. continuously per cell burning 6 tons per day of 24 hours.
Ealing—4 I.H.P. continuously per cell burning 6 tons per day of 24 hours.
Hastings—5 I.H.P. continuously per cell burning 6 tons per day of 24 hours (without Cremator).
Hastings—10 I.H.P. continuously per cell burning 6 tons per day of 24 hours (with Cremator).
Heckmondwike—The weight of the loads is not stated.
Liverpool—4 I.H.P. per cell burning 6 tons per day of 24 hours.
Southampton—4 " " " "
Warrington—8½ " " " "

The high results obtained at Batley and Warrington are probably due to there being a very large proportion of coal and cinder in the refuse, since Batley (in Yorkshire) and Warrington (in Lancashire) are both situated in cheap coal districts, which naturally leads to large consumption and wasteful use.*

The result obtained at Birmingham has been already commented on and its cause indicated.

At Ealing, Mr. Jones burns not merely ashbin refuse, but dried (not pressed) sludge in the proportion of two of the former to one of the latter by weight.†

The result, 4 I.H.P. per cell burning 6 tons per 24 hours, is what is now attained, but not what is believed to be attainable when, after the erection of the electric lighting station, the whole waste is utilised. In fact, it merely represents the present utilisation (which is ample for all present purposes). The form of reply to Question 25 shows this: "We work two 10 H.P. engines"; and at Bury and Heckmondwike, where similar replies are given, the same comment is applicable.

* This deduction, apparently reasonable enough, appears to me now to be doubtful. I have been experimenting on refuse in a colliery district, and find the proportion of cinders and breeze less than it is in the analyses of London ashbin refuse as given by Prof. Forbes and Mr. Jos. Russell, as already given.

† I am now investigating the conditions governing the destruction of mixed ashbin refuse and sewage sludge, which seems not unlikely to be widely adopted.

The low output per cell per 24 hours at Ealing is noticeable, and the cause instructive: To the municipal engineer, a hard clinker is of value for bottoming footpaths, &c.; a loose, friable clinker is of no value, and Mr. Jones reduces his output in order to obtain the hard clinker he requires. A small practical point worth notice.

The noticeable point about Hastings is the reply to Question 25, from which it appears that there is a substantial return in power from the use of the "Jones" Cremator.*

I cannot reconcile the figure (4 I.H.P. per cell) obtained above for Southampton, with the figure (7·5 I.H.P. per cell) previously deduced from Mr. Bennett's paper on "The Utilisation of Town Refuse, Sewage Disposal, and Electric Lighting at Southampton," already referred to. The latter figure was deduced from the statement in the paper, that 25 tons burnt in six cells ran an engine indicating 31·5 H.P. for 24 hours; but it was also stated that this 25 tons was the minimum daily supply, which at times rose to a maximum of 50 tons, and it may be that the figure 7·5 I.H.P. is a trial figure obtained under favourable conditions, and the figure 4 I.H.P. the actual average value in practical continuous work.

Coming now to anticipations:—At Widnes the Town Council have before them a proposal (see *Electrical Review*, April 17th, 1893), based on the report of their borough surveyor.

The proposal is for a 6-cell Destructor to deal with 10,000 tons per annum, and in connection with it is to be "a boiler capable of producing 40 H.P., an engine to drive a mortar mill, stone-breaking machine, &c., and an electric light installation." The account adds further, "The cost of gas lighting for the street lamps and the above-named buildings would be about £150."

This proposal is clearly on the lines of the Southampton result, taking the 40 I.H.P. as available for all the hours of the year for a consumption of 10,000 tons. We have

35 I.H.P. hours per ton of refuse burnt.

8¾ I.H.P. continuously per cell burning 6 tons in 24 hours.

* This raises the question as to the power to be obtained from the fuel burnt in the Cremator. In ordinary cases it cannot exceed the power due to the burning of a certain quantity of inferior fuel in a bad position for steam raising; but should there be a large quantity of burnable gases escaping unignited into the flues, then it will add the fuel value of these gases upon ignition. For instance, in Mr. Jones' case at Ealing, it is certain that a large amount of burnable but unignited gas will pass into the flues from the drying sludge, and this will be ignited in passing through the Cremator, which will then add to the power available, in excess of the quantity of fuel consumed in it.

The saving to be obtained by utilising for electric lighting the surplus power available (after the necessary municipal work of stone breaking, clinker crushing, &c., is provided for), is noticeable, £150 per annum on a consumption of 10,000 tons per annum.

In an interview (*Lightning*, March 9th, 1893), Mr. Manville, M.I.E.E., in answer to this question, "Would the refuse of an ordinary parish be sufficient, as a rule, to provide all the light and power likely to be required?" replied, "Quite! I don't think the amount of power which might be realised by the burning of ashbin refuse in various places is appreciated."

This is Prof. Forbes's statement without the saving "ifs," and with power added as well as light, one is therefore prepared for high figures. We learn that "as much as 400 H.P. for 24 hours a day is available from this source (Shoreditch refuse)," as we find the refuse stated as 20,000 tons per annum, the resulting figures are :—

175 I.H.P. hours per ton of refuse burnt.
43⅔ I.H.P. continuously per cell burning 6 tons in 24 hours.
1·5 lbs. of water evaporated per ton of refuse burnt.
0·15 evaporative value compared to coal.

So far as published results known to me go, this result can be obtained as at Birmingham, and not otherwise.

Professor Henry Robinson, M. Inst. C.E., and Mr. W. N. Blair, Assoc. M. Inst. C.E., reported to St. Pancras Vestry (*Electrical Engineer*, June 9th, 1893) on a proposed new electric light station in connection with a Destructor plant.

In one part of the report we find, "If the capacity of the 18 cells thus provided be taken as 10 tons per day (and there is every reason to believe that the consumption of refuse will not be below this amount), the depôt will be capable of disposing of 1,080 tons of refuse during the week, and 60 tons of refuse would be burnt in the cells under the boilers on Sunday, to keep the electric light going." Elsewhere we find : "The power available from the Destructors will be not less than 300 H.P. with the first instalment of three boilers, and 500 H.P. with the complete set of five boilers."

From the two extracts it may be inferred that 500 by 6 by 24 I.H.P. hours are expected for a consumption of 1,080 tons of refuse. The resulting figures are :—

66 I.H.P. hours per ton burnt.
16½ I.H.P. continuously per cell burning 6 tons in 24 hours.
0·6 lbs. of water evaporated per lb. of refuse.
0·06 evaporative value compared to coal.

These results, it will be seen, are 10 per cent. in excess of Mr. Watson's claimed results already given (*Electrical Review*, August 18th, 1893).

Referring to the L.C.C report, we find St. Pancras, with a population of 234,437, collects 78,000 tons of rubbish (6·6 cwt. per head), of which 60,000 tons (5·0 cwt. per head) is to be destroyed.

Mr. Watson's figures were obtained where 1·5 cwt. per head only was destroyed, and remembering the obvious deduction already made, of the decrease in calorific value as the amount dealt with is increased in quantity per head, it seems likely that Mr. Watson's figures should be reduced rather than increased, especially as from the plan I find the mean distance of 12 of the 18 cells is 120 feet from the boilers measured along the flues ; this arrangement being rendered necessary by the large space occupied by the cells compared with the boilers, and by practical considerations dictated by the size and shape of the site—points worth considering in connection with the utilisation of the waste heat of Destructors.

For another reason, also, Mr. Watson's figures must be reduced the moment you come to apply them to the ordinary working conditions of a central station ; they are based upon evaporation, and the I.H.P. hour only represents an evaporation of 20 lbs. of water per I.H.P. hour. Now you cannot, in the ordinary average working of a central station, obtain an I.H.P. hour for anything like this. If you could, the unit of electricity would not cost 8 to 10 lbs. of coal.

Prof. Robinson and Mr. Blair are not, of course, relying solely on the waste heat of the Destructors ; arrangements are provided for hand or automatic stoking of the boilers as required.

Having learned that tenders were actually accepted for an electric lighting station in connection with the Destructor at Ealing, I communicated with Messrs. Bramwell and Harris, the consulting engineers, and asked for an interview, which, in the absence of Sir Frederick Bramwell, Past President M.Inst.C.E., Mr. H. Graham Harris,

M.Inst.C.E., courteously granted. In reply to my question as to the value of the waste heat from Destructors, he replied, " We expect to get continuously from the eight Destructors (including the new one to be added) and the Cremator, 50 I.H.P., specified to cost no more than 22 lbs. per I.H.P. hour, but which we expect to get for 20 lbs., and," he added, " I wish to say this, that from the position of the sewage works, on the extreme edge of the district, it is doubtful if we should have gone there at all for the sake of the waste heat, had it not been for the extra saving due to the utilisation of the sewage effluent for condensation, the added economy of having the two municipal plants under one head, and the fact that the land required is already in the possession of the Board."

Taking Mr. Jones's figures for consumption, 4½ tons per cell per 24 hours, and taking this consumption for 8 cells, we have—33 I.H.P. hours per ton of refuse.

The only other projected combination of Destructor battery and electric light station of which I know is at Leyton.

Here a battery of Destructors for the burning of ashbin refuse and pressed sewage sludge is shortly to be erected. I have no particulars of the proposed Destructors, and the engineer, Mr.W. Dawson, M.Inst.C.E., with commendable caution (especially as the type of the Destructor will probably be new, since the combination of ashbin refuse and *pressed* sludge is new) declines to prophesy till he knows, and will see what it is worth, and take it for that.

Collecting, now, into tabular form the various figures already given, we have :—

Authority (where known).	Town or District.	1.	2.	3.	4.	Remarks.
?	Leeds	238·4	59·6	2·13	0·213	A theoretical deduction based on analyses of waste gases from a Horsfall Destructor.
?	Birmingham	200·0	50·0	1·79	0·179	Boilers set directly over furnaces.
The author	Leeds	188·4	47·1	1·7	0·17	Corrected net external value from theoretical deduction given above.
Mr. Manville	Shoreditch	175·0	43·75	1·5	0·15	An anticipated result.
Mr. Watson	Leeds	134·0	33·5	1·2	0·12	Net external value from theoretical deduction given above.
Prof. Robinson and Mr. Blair	St. Pancras	66·0	16·5	0·6	0·06	An anticipated result.
Mr. Watson	Oldham	60·0	15·0	0·54	0·054	Claimed on result next given as allowance for excess temperature in escaping gases.
,, ,,	,,	42·5	10·6	0·38	0·038	Actually obtained result in two trials of four and six hours duration.
?	Hastings	40·0*	10·0	..	..	This result is with Jones's Cremator. A second result is given below without the Cremator.
?	Widnes	35	..	..	..	
Messrs. Bramwell & Harris	Ealing	34·0	8·25	..	..	An anticipated result—ashbin refuse and sludge mixed.
?	Batley	34·0*	8·25	..	..	Both in coal districts.
?	Warrington	34·0	8·25	..	..	
Mr. Bennett	Southampton	30·0*	7·5	0·27	0.027	As given in Mr. Bennett's paper. A second result is given below.
?	Blackburn	22·0*	5·5	..	..	
?	Hastings	20·0*	5·0	..	..	Without Jones's Cremator. See result given above.
Mr. Jones	Ealing	16·0*	4·0	..	..	The plant is actually doing this now. See above for estimated value.
Mr. Boulnois	Liverpool	16·0*	4·0	..	..	
Mr. Bennett	Southampton	16·0*	4·0	..	..	As given in reply to Mr. Jones's circular. See result given above.
Mr. Cartwright	?	12·0*	..	..	..	
?	Bury	12·0*	3·0	..	..	
Mr. Hewson	Leeds	8·0 to 10.0*	..	..	..	

NOTE.—The columns headed 1, 2, 3, 4, give respectively :—(1) I.H.P. hours per ton of ashbin refuse, taking 20lbs. of water or 2lbs. of coal per I.H P. hour (except where the figures are marked with an asterisk, when the figure is actual I.H.P. as given by the authority quoted). (2) I.H.P. continuously per cell, consuming 6 tons per 24 hours. (3) Pounds of water evaporated per lb. of ashbin refuse burnt. (4) Evaporative value compared to coal at 10lbs. of water per lb. of coal.

Trying now to extract some definite ideas from the mass of conflicting results, opinions and anticipations given above, one is at once struck by the wide difference between the maximum and minimum figures, and by the apparent impossibility of arriving at any fairly definite conclusions. One cause of this is undoubtedly the varying nature of the material from which the various figures were deduced, and it is much to be desired that some simple, practical, and easily applied standard should be arrived at. Certain experiments I am now engaged on lead me to believe that such a standard may be possible by the comparatively easy measurement of contained water (estimated by difference after thorough drying) and fuel (cinders, breeze, &c.), which will not pass through a sieve of a certain specified mesh.* Calorimeter tests are perfectly useless; carbon dust would give first rate results measured that way, but would be not merely valueless, but detrimental under practical conditions.

From the results analysed, any engineer can form his own conclusions. It seems to me that the evaporative value of ashbin refuse, under practical conditions of utilisation, varies from 500 to 800 lbs. of water per ton of refuse burnt; and while I am willing to admit that Mr. Watson's experiment indicates a possibly higher maximum value (1,300 lbs. of water per ton), it would, in my opinion, be unsafe to calculate upon it until the experiment had been repeated and carried out for a much longer time and under the crucial condition of burning everything—except bottles, tinware, and the like—the material to be collected in equal quantities from different localities, rich and poor, of a large town.

* This is gone into at a subsequent stage of the original articles, and the formula for Destructors dealing with ashbin refuse alone, or with ashbin refuse and sludge, are given; but this lies beyond the scope of this paper.

The Powderhall Refuse Disposal Works.

A SUB-COMMITTEE of the Convention of Royal and Parliamentary Burghs, charged with the consideration of the question of the disposal of town's refuse, have issued a report on the subject. The report says that the Corporation of Edinburgh had exhausted all reasonable modes of inquiry as to the disposal of city refuse, and the Committee entirely concurred in the result arrived at in the report of the Committee of the Corporation that the best possible means of dealing with such refuse was by means of Destructors. After careful consideration and investigation of the various systems, the Town Council of the City of Edinburgh had adopted the Destructor of Messrs. Manlove, Alliott and Co. (Limited), of Nottingham, and instructed them to erect a ten-cell Destructor, Fume Cremator, boilers, engines, &c., with all the latest improvements.

THE POWDERHALL DESTRUCTOR.

From the "Scotsman."

THE proposal to erect Refuse Destructors in Edinburgh raised so much opposition and created such alarm, that had it not been for the urgent necessity pressing upon the Corporation the matter might have been dropped long ago. But the Cleaning Department of the City found themselves in a serious difficulty. Huge piles of refuse, representing the accumulation of years, were becoming more and more of a public nuisance, and even threatening to entail upon the ratepayers serious expense in the matter of law suits. To get rid of the City's refuse at all, in fact, had grown to be such a costly businesss that the problem had to be faced, and no more advantageous solution being arrived at, an experiment with the Destructor was at last resolved upon. The intention is in course of time to divide the City into four districts, with a

Destructor to consume the refuse in each, but meanwhile Powderhall has been selected as the first and in some sense experimental site. It is a significant fact that for nearly a fortnight the Destructor has been in active operation, and no complaint has been made by anyone in the neighbourhood. This circumstance would seem to remove the one serious objection to the Destructor, and if the same immunity from smoke and smell continues when the fires are working to their full capacity, the extension of the system is not likely long to be delayed. Councillor Sloan, who has been the moving spirit in the Council for the adoption of the Destructor process, is to conduct the members of the Corporation over the building on Monday week, by which time it is anticipated the finishing touches will have been given to the premises. In some places where Destructors have been erected, either by carelessness or ignorance, very great damage has been occasioned by setting the furnaces, or "cells" as they are called, to do their maximum amount of work before being properly tempered, and to avoid this a commencement has been made in a small way, a limited amount of refuse only being meanwhile consumed each day. Already, however, forty tons are being disposed of, one-half of the daily total supplied by the district, and in course of a short time the full complement of eighty tons will be consumed.

Constructed from plans prepared by the Burgh Engineer, Mr. Cooper, the buildings, designed in the baronial style of architecture, unless closely examined, are more suggestive of a public school than a Refuse Destructor. They cover about an acre of ground, most of which is taken up with the yard and stabling, the Destructor proper only occupying a limited portion of the space. The premises have been constructed as part of the complete scheme which is to serve the City, and under which the necessary horses and vehicles for each will have accommodation on the site of the Destructor. At Powderhall excellent stabling has been provided for twenty horses, and a spacious causewayed yard is available for a corresponding number of carts. A small office and the overseer's house are contained in the same range of buildings, which form the frontage to the street. At the back of the yard is situated the Destructor, which, to the unfamiliar eye, presents the appearance of a series of enclosed furnaces. It is, in fact, nothing more or less, the only difference being that in place of coke or coal the furnaces are fed with refuse. The method of feeding the furnaces is peculiar to the Destructor, the "tip" for the refuse being situated

immediately above the "cells," and communication between the two established by means of sliding doors. The only place where any unpleasant smell is observable is in the "tip," where each day's refuse is heaped before being transferred to the furnaces, and even this, it is contended, will be removed when the fanners are in operation. All the smoke and foul gases are disposed of by passing into four Fume Cremator fires, in which a temperature of between 1,500 and 1,800 degrees is constantly kept up. So far not a morsel of coal has been used, and it is confidently anticipated that none will be required. In the Cremators, of course, coke has been employed, but even this, it is said, will be dispensed with, and its place taken by the cinders which will be separated from the other refuse. The heat generated by the Destructor is to be utilised for driving a mortar mill during the day and a dynamo at night. The mill is to be used for grinding the clinker to powder, in which form it is useful for many purposes, and can easily be disposed of; while the dynamo will supply an installation of electric light to illuminate the premises in the night time. The Destructor, which is in operation day and night, when fully working will employ in all twelve men—four on each shift of eight hours. The total cost of the buildings, &c., was £16,000.

Particulars as to Disposal of Town Refuse.

By the Borough Engineer (J. H. Cox, Esq., M. Inst. C.E.)

COUNTY BOROUGH OF BRADFORD.

THE present area of Bradford is 10,776 acres, and contains a population of 216,361 persons (as per census of 1891), its rateable value being £1,052,465, and the number of houses 48,000, the majority of which have connected to them in their yards or courts spaces—ashpits—into which ashes and other materials are deposited by the occupiers.

There are four Destructor depôts, built on sites in area varying from half-an-acre to four acres; one at Hammerton Street containing twelve cells, one at Sunbridge Road with nine cells, one at Cliffe Lane with eight cells, and one at Southfield Lane with six cells, ranging in distances (from the Town Hall in the centre of the town) from three-quarters of a mile to one-and-a-half miles.

They were built by Manlove, Alliott and Co., of Nottingham—the one with twelve cells at a cost (all exclusive of land) of £10,253; one with nine cells at a cost of £7,980; one with eight cells at a cost of £6,392; and one with six cells at a cost of £2,121, each working satisfactorily. The one at Hammerton Street has been working thirteen years, Southfield Lane eight years, Sunbridge Road and Cliffe Lane two years each, and with one exception are in fairly populous districts.

The Destructors are approached by inclined roads which have gradients of about one in twenty, and are worked continually from twelve o'clock Sunday night to twelve o'clock at noon the Saturday following (being closed Saturday afternoon and all day Sunday) by two relays of twelve men—one relay working twelve hours by day and the

other twelve hours per night alternate weeks, or sixty-six hours per week with periods for rest between each process of clinkering. Wages, 28s. per week each man.

Each cell contains twenty-five superficial feet of grate area (having movable grate bars provided, which, however, are seldom used), and will destroy six-and-a-half tons of refuse per cell per day of twenty-four hours. Two steam jets are fixed under each cell, which play through a short tube to force the draught, the front of the ashpit being made up with iron doors.

The residue from the Destructors, after the refuse is burned, amounts to one-third in weight and one-fourth in bulk ; a portion of the clinker is ground up with lime into mortar, the remainder being disposed of by the nightsoil contractor.

Any fumes which may arise from burning the refuse in the Destructors are destroyed by "Fume Cremator," one of which is attached to each Destructor, the fuel used being coke breeze.

It has been ascertained that each cell is capable of producing from five to six indicated horse-power.

Between the Cremator and chimney is fixed a multitubular boiler eleven feet long and eight feet in diameter, containing 160 tubes four inches in diameter, through which the heat from the Destructor and Cremator passes to raise steam power for the jets to cause the forced draught, and for driving an engine and mortar pans.

TABLE C.

(See Page 19).

HAMMERTON STREET DESTRUCTOR (12 CELLS).

Working Expenses for Twelve Months, ending 31st March, 1893.

RECEIPTS.

	£	s.	d.
Mortar	996	3	0
Destruction of Market Refuse	200	0	0
Ditto of Old Papers	9	14	0
	£1,205	17	0

EXPENDITURE.

	£	s.	d.
Wages for Workmen, including Team Labour	1,142	8	1
Lime	242	4	2
Coal	12	18	3
Coke, Breeze, and Leading	241	6	0
Gas	38	16	0
Water	62	8	8
Rates and Taxes	81	7	7
Insurance on Buildings	1	9	4
Ditto on Boilers	3	10	0
General Repairs, including Tools, Implements, etc.	155	6	10
Oil, Tallow, Waste, etc.	36	2	2
Brushes, etc.	4	10	7
Printing, Stationery, and Advertising	3	0	9
Chemicals for Disinfecting Market Refuse	3	2	10
Acknowledgement paid to G. N. Ry. Co.	1	0	0
Sundries	4	10	0
	£2,034	1	3

	£	s.	d.
Expenditure	2,034	1	3
Receipts	1,205	17	0
	828	4	3
Add for Repayment of Capital in 50 years—£13,500 at Four per Cent.	540	0	0
	£1,368	4	3

21,671 Loads of Refuse burned = 1s. 3d. per load, or 9d. per load exclusive of Interest and Sinking Fund on Cost of Works.

TABLE B.

CLIFFE LANE DESTRUCTOR (8 CELLS).

Working Expenses for Twelve Months, ending 31st March, 1893.

RECEIPTS.

	£	s.	d.
Nil	0	0	0

EXPENDITURE.

	£	s.	d.
Wages of Workmen, including Team Labour	398	18	4
Coke, Breeze, and Leading	119	0	0
Gas	31	3	6
Water	25	5	6
Rates and Taxes	33	7	7
General Repairs, including Tools and Implements	50	4	4
Repairs to Roads	6	18	7
Insurance of Boilers	1	15	0
Brushes, Soap, etc.	1	18	0
Sundries	0	6	6
	£668	17	4

	£	s.	d.
Expenditure	668	17	4
Receipts	0	0	0
	668	17	4
Add for Repayment of Loan in 50 years—£7,621 at Four per Cent.	304	16	9½
	£973	14	1½

9,896 Loads of Refuse burned = 1s. 11½d., or 1s. 4¼d. exclusive of Interest and Sinking Fund on Cost of Works.

TABLE D.

SOUTHFIELD LANE DESTRUCTOR (6 CELLS).

Working Expenses for Twelve Months, ending 31st March, 1893.

RECEIPTS.

	£	s.	d.
Nil	0	0	0

EXPENDITURE.

	£	s.	d.
Wages of Workmen, including Team Labour	411	3	1
Coke, Breeze, and Leading	185	19	8
Rent of Cottage...	9	18	9
Gas	17	17	5
Water	29	17	0
Rates and Taxes	8	10	6
General Repairs, including Tools and Implements	91	8	10
Disinfectants	1	0	0
Insurance of Boiler	2	1	0
Brooms, etc.	0	18	0
Sundries	3	2	10
	£761	17	1

	£	s.	d.
Expenditure	761	17	1
Receipts	0	0	0
	761	17	1
Add for Repayment of Capital in 50 years — £4,472 at Four per Cent.	178	17	7
	£940	14	8

9,267 Loads of Refuse burned = 2s. per load, or 1s. 7¾d. exclusive of Interest and Sinking Fund on Costs of Works.

TABLE E.

SUNBRIDGE ROAD DESTRUCTOR (9 CELLS).

Working Expenses for Twelve Months, ending 31st March, 1893.

RECEIPTS.

	£	s.	d.
Mortar	175	13	10
	£175	13	10

EXPENDITURE.

	£	s.	d.
Wages of Workmen, including Team Labour	588	19	9
Coke, Breeze, and Leading	181	0	0
Lime	54	14	8
Gas	42	16	9
Water	55	10	2
Rates and Taxes...	30	14	10
General Repairs, including Tools and Implements	101	1	6
Insurance on Boiler	1	15	0
Oil, etc.	9	3	11
Disinfectants	1	0	0
Printing, Stationery, etc.	3	0	0
	£1,069	16	7

	£	s.	d.
Expenditure	1,069	16	7
Receipts	175	13	10
	894	2	9
Add for Repayment of Capital in 50 years—£10,622 at Four per Cent.	424	17	7
	£1,319	0	4

12,288 Loads of Refuse burned = 2s. 1¾d., or 1s. 5½ (nearly) per load exclusive of Interest and Sinking Fund on Cost of Works.

TABLE F.

STATISTICS RELATING TO HOUSE REFUSE FOR THE YEAR 1892.

METROPOLITAN VESTRIES AND DISTRICTS.

Authority.	Area in Acres.	Population.	Rateable Value.	Quantity of Dust per Annum.	Inhabited Houses.
			£	Tons.	
Battersea	2,170	157,000	778,722	25,000	20,930
Bethnal Green	755	129,124	426,499	26,091	17,109
Bermondsey	652	84,688	430,528	11,383 l'ds of 2 yds. ea.	11,450
Camberwell	4,342	235,312	1,042,179	30,940	33,849
Chelsea	794	96.272	705,870	23,180	12,195
City	—	—	—	27,682	—
Clerkenwell	380	66,000	360,000	16,916	8,500
Fulham	1,700	91,640	452,086	22,984	12,869
St. George, Hanover Square	1,122	90,000	1,836,401	Contr'd for	12,300
St. George-in-the-East ...	244	45,546	187,079	11,751	5,500
St. Giles, Holborn	245	39,000	418,902	11,263	4,068
Greenwich Parish ...	—	57,244	293,539	21,824	—
Deptford, St. Paul ...	3,426	108,088	492,953	31,831	25,000(abt.)
,, St. Nicholas	—	6,828	55,464	2.300	—
Hackney	3,935	229,531	983,129	46,250	36,000
Hammersmith	2,286	97,239	545,818	22,104	14,200
Holborn	167	37,082	372,471	8.578	3,867
Islington	3,107	320,000	1,700,551	56,691	—
Kensington (1891)	2,245	166,322	2,012,843	51.755	—
Lambeth	—	275,202	—	—	—
Lewisham (including Penge)	—	92,647	—	24,557	—
Limehouse	576	57,599	295,458	Contr'd for	7,559
St. Luke	230	42,411	314,346	,,	5,918
St. Marylebone	1,506	142,381	1,517,476	,,	17,000
Mile End Old Town ...	681	108,000	377,255	21,577	14,674
Paddington	1,280	117,838	1,328,560	36,860	15,16
St Pancras	3,672	234,437	1,592,227	78,000	24,611
Poplar	2,335	166,697	732,387	32,517	22,000
Rotherhithe	886	39,075	223,548	10,081	5,226
Shoreditch	648	124,000	682,328	22,000	15,350
St. Saviour	—	28,622	—	7,384	—
St. Olave	—	12,694	—	5,273	—
Strand	167	25,107 1891.	545,198	11,200	2,154
St. Martin-in-the-Fields ...	286	14,574	527,334	5,881	1,467
Wandsworth, Clapham Parish	—	45,000	—	7,740	—
,, Streatham ,,	—	45,000	—	7,283	—
,, Tooting ,,	—	6,000	—	1,548	—
,, Putney ,,	—	18,500	—	5,466	—
Wandsworth	1,233	43,698	—	7,312	—
Westminster, St. James ...	164	24,993	745,090	6,448	2,641
,, St. Margaret & St. John ...	815	55,525	778,000	15,414	8,800
Whitechapel	—	74,462	—	21,900	—
Woolwich	—	40,848	—	7,514	—

TABLE A.

(See Page 23).

The Population of 1,005 Towns (Urban Sanitary Authorities), as abstracted from the record of the Local Government Board, is as follows :—

							No. of Towns.
Population	under	2,000	... ...	... ...	... ...	104	
Population	over	2,000	and under	5,000	... ...	291	
,,	,,	5,000	,, ,,	10,000	... ...	254	
,,	,,	10,000	,, ,,	15,000	... ...	123	
,,	,,	15,000	,, ,,	20,000	... ...	50	
,,	,,	20,000	,, ,,	25,000	... ...	41	
						—	863
,,	,,	25,000	,, ,,	30,000	... .	29	
,,	,,	30,000	,, ,,	35,000	... ...	18	
	,,	35,000	,, ,,	40,000	... ...	16	
	,,	40,000	,, ,,	50,000	... .	18	
,	,,	50,000	,, ,,	60,000	... ...	15	
,,	,,	60,000	,, ,,	70,000	... .	7	
,,	,,	70,000	,, ,,	80,000	... ...	6	
,,	,,	80,000	,, ,,	90,000	... ...	6	
,,	,,	90,000	,, ,,	100,000	... ...	4	
,,	,,	100,000	,, ,,	120,000	... ...	5	
,,	,,	120,000	,, ,,	130,000	... ...	3	
,,	,,	130,000	,, ,,	140,000	... ...	1	
,,	,,	140,000	,, ,,	150,000	... ...	1	
,,	,,	150,000	,, ,,	200,000	and over	13	
						—	142
TOTAL	... ...						1,005

PARTICULARS AS TO RATES OF PAY AT REFUSE DESTRUCTORS.

By T. H. YABBICON, Esq., A.M.Inst.,C.E., Deputy Borough Engineer, Bristol.

Name of Town.	Bristol.	Battersea.	Birmingham.	Blackburn.	Blackpool.	Bolton.	Bournemouth.	Bradford.	Burton-upon-Trent.	Derby.	Ealing	Hampstead	Hornsey	Hull.	Leeds.	Leicester.	Liverpool.	Newcastle-upon-Tyne.	Nottingham.	Preston.	Salford.	Southampton.
Number of Cells in Destructor at work	16	12	43	8	8	8	6	35	4	6	7	8	6	6	36	12	12	12	5	18	12	6
Number of Men employed by day	9	3 Foremen Stokers, 9 Stokers, 6 Feeders working day and night for 6 days in 3 shifts of 8 hours each.	13 Stokers 7 Chargers	4	5	4	3	12	6 working day and night for 6 days in 3 shifts of 8 hours each, 1 sorter working by day.	8	3	4	4	3	22	5	10	9 men work in shifts of 8 hours each.	9	8	4	2
Number of Hours at Work exclusive of meal time ...	63		59½	67½	54	56	84 including meal times.	12 hours. Intervals for rest and meals every 2 hours after clinkering.		60½	60	60	48	56	48	63	58½ & 63 alternately.		53	60	56½	60
Number of Men employed by night	6		13 Stokers 7 Chargers	4	4	3	2	12		4	2	4	—	3	19	5	6		—	8	4	2
Number of Hours at Work exclusive of meal time ...	63		59½	67½	54	61	84 including meal times	12 hours. see above.		60	66	60	—	59	48	63	58½ & 63 alternately.		—	60	56½	60
Wages, Foreman, per week	—	30/-	32/-	—	29/-	27/-	26/8	35/-	30/-	32/-	32/6 and House.	32/- House, Gas and Coals	—	6¼d. per hour.	38/-	40/-	£2 12s. has also charge of Disinfector	—	27/6	29/-	—	—
Wages per Shift of Daymen, Firemen	4/-	4/8	4/4—4/8	5d. per hour.	4/8	4/4	4/3	4/8	3/4	3/10—4/2	4/-	7d.–8d. per hour	1/- per load of 25 cwt. for burning.	6d. per hour.	5/-	4/8	5/-	4/3	5d. per hour.	4/6	4/2—4/4	3/10½
Trimmers and Sorters ...	3/4	4/8	3/8 Chargers.	—	4/8	4/4	4/3	—	2/10	3/10—4/2	3/8	6d. per hour.	—	6d. per hour.	4/2	—	4/2	3/9	—	3/9	3/4	3/10½
Nightmen, Firemen	4/-	—	4/4—4/8	5d. per hour	4/8	4/4	4/3	4/8	3/4	3/10—4/2	4/-	7d.—8d. per hour	—	6d. per hour.	5/-	4/8	5/-	4/3	—	4/6	4/2	4/2
Trimmers and Sorters ...	3/4	—	3/8 Chargers.	—	4/8	4/4	4/3	—	—	3/10—4/2	3/8	6d. per hour.	—	6d. per hour.	4/4	—	4/2	3/9	—	3/9	3/8	4/2

Disposal of House Refuse.

(EALING).

By C. Jones, M.Inst., C.E.

THE area of Ealing is 3,225 acres, the population 26,500, the Ratable Value £172,000, and the number of houses 4,606 the majority of these of a somewhat superior class, the district being strictly residential, and only five miles West of London. Up to the year 1863, Ealing was simply a country village ; no gas ; no roads worth mentioning ; water supply, chiefly wells ; its sanitary arrangements of a meagre description, and its house refuse arrangements consisted of one old man, donkey, and cart—the allotment gardens and farm lands forming the available tips—the rateable value being £17,000. In the year 1863, a Local Board was formed ; the place was drained ; gas was introduced for public lighting, &c. ; and a systematic dealing with the house refuse was commenced. No difficulty was experienced for some 20 years—the brick-fields at no great distance, and the farm lands sufficed for all the necessities of the case. About the year 1882, a difficulty arose (as referred to in a previous part of this work), in connection with the sludge from the Sewage Works, and this brought about the erection of the Destructor, preceding by some years any other built in the South of England. In the year 1883, two cells were erected by Messrs. Manlove, Alliott & Fryer, with small multitubular boiler, engine, &c. ; and so well did this arrangement answer that in the year 1885, the growth of the district necessitated the addition of three more cells, together with the now well-known " Fume Cremator ; " and in the year 1890, two more cells were added, making seven in all, the foundation of an eighth cell having been laid in, the destruction of refuse at the present time being some 24 tons per day, in addition to the sewage sludge, arising from a population of some 23,000, out of a gross population of

26,500. The difference between these two figures represents the population on the northern incline dealt with at the Sewage Farm. The latest development in connection with the " House Refuse " question is the fact, that at the present moment (1893), has commenced the work of electric lighting, in connection with the Destructor—the first town in England where this practical application—upon so large a scale—is being made; and whether the value is more, or less, the fact that whatever is of value will be utilized is an important one in its bearing upon the question of the ultization of house refuse.

The first outlay in connection with Electric Lighting is £25,000.

TABLE.

EALING LOCAL BOARD DESTRUCTOR (7 CELLS)

Working Expenses for Twelve months, ending 31st March, 1893.

RECEIPTS.

	£	s.	d.
Allowance for saving of Coke for Fuel for Boilers to work Sewage Machinery, &c.	144	0	0
Allowance for Clinker used by Local Board in making New Roads at 1/3 per load	238	16	3
Received for Clinker	14	8	0
Sale of Rags, &c.	32	6	7
Burning Trade Refuse	1	19	0
	£431	9	10

EXPENDITURE.

	£	s.	d.
Wages for Workmen	365	18	5
Coke, Breeze	147	19	0
Gas	15	1	9
Water	17	6	6
Rates and Taxes	5	15	7
General Repairs, including Tools, &c.	19	1	6
	£571	2	3

	£	s.	d.
Expenditure	571	2	3
Receipts	431	9	10
	139	12	5
Add for Repayment of Principal and Interest of £2,400—30 years at Four per Cent.	138	16	4
	£278	8	9

9,120 Tons of House Refuse and Sewage Sludge (mixed) burned = 1s. 3d. per ton, gross cost, or, allowing for assets, 3¾d. (nearly) exclusive of repayment of Interest and Principal on costs of Works.

The Clinker has been most valuable in road making during the period specified, and is being used to some extent during current year.

Particulars of Disposal of Town Refuse.

By the City Engineer of Liverpool (H. Percy Boulnois, Esq., M.Inst., C.E.)

THE area of the City of Liverpool is 5,210½ acres (exclusive of the River), and contains a population of 517,951 persons (Census Return, 1891). Its present Rateable Value is £2,956,167, and the number of dwelling-houses is about 107,000, and nearly the whole of these houses have attached to them ash-pits in which the ashes, and other household refuse, are deposited by the occupiers.

Up to the year 1880, the refuse was disposed of by being barged away along the Leeds and Liverpool Canal, and also by tipping in the vicinity of the City itself ; but in the year 1879, the difficulties in connection with the disposal of the unsaleable refuse in this manner became so great that a Steam Stopper Barge was built capable of carrying 350 tons of refuse, and this vessel went on her first trip in the year 1880. In the year 1884, a second Steam Stopper Barge capable of carrying 380 tons was constructed, and from that year up to the year 1891, about 70 per cent. of the total refuse of the City was conveyed to the sea by these barges to a deposit ground about 24 miles from the landing stage, which consists of about 117,000 acres of sea bottom at a depth of from 20 to 30 fathoms below the level of low water at spring tides.

In the year 1891, it was considered desirable for many obvious reasons that some, if not all, of the refuse should be burnt in Destructors, and a 12 Cell Destructor of the Manlove & Alliott description, with Fume

Cremator, was erected during that year. Since that time 12 more cells have been erected, thus making a total of 24 cells. These Destructors are approached by a double inclined roadway, having a gradient of 1 in 16, and are worked continuously from twelve o'clock mid-night on Sunday, till six o'clock p.m. on the following Saturday. Each cell consumes between seven and eight tons of refuse per day of twenty-fours hours ; and the heat which is generated in the combustion and from the fume cremator, generates steam in the boiler, the steam thus generated being used for a mortar mill and for a disinfector installation on the " Washington-Lyon " system.

An improved method of charging the cells has been introduced in the last 12 cells erected, which has effected a saving of nearly 3d. a ton upon the labour involved on all the refuse consumed in these cells, which is now being effected at about 7¼d. per ton.

The Corporation of Liverpool are at present considering the advisability of extending the Destructor system to other parts of the City, as they are well satisfied with the results achieved by those they have already erected.

Particulars of Disposal of House Dust.

BY THE

SURVEYOR OF ST. JOHN, HAMPSTEAD, N.W.,

CHARLES H. LOWE, ESQ.

THE Area of this Parish is 2,248 acres ; the Population, 74,000 (at the Census in 1891 the number was 68,425) ; and the Rateable Value, £710,379.

In 1868, and for some years previously, the Vestry received payment for the House Refuse, the Contractor finding the plant, and bearing all expenses of collection.

In 1869 this condition of things was changed, as the Vestry was called upon to pay for the removal of the dust. The cost, however did not exceed twopence per head per annum of the population. From the time when the plan was adopted of dividing the Parish into six Districts and each District being visited once a week by the carts, the cost gradually rose until in 1881 it was rather more than ninepence per head per annum of the population.

In 1882 arrangements were made, which have been continuously and successfully carried out ever since, for every house to be called at regularly once a week. Complaints of non-removal are almost unknown. In 1889 a Destructor with "Fume Cremator" was built by Messrs. Manlove, Alliott and Co, and a wharf formed, with stabling, foreman's cottage, etc. on the banks of the Grand Junction Canal near Willesden

Junction, in the Parish of Hammersmith. At first there were but four cells, now there are eight, each of which burns nearly six tons of refuse daily. Seventy-six per cent. of that which is placed in the Destructor is destroyed. The residue consists of sixteen per cent. clinker, and eight per cent. fine ash. A large portion of the clinker is used in the manufacture of artificial paving, of which the Vestry use in footways of secondary importance about 20,000 superficial feet per annum. The saving effected by the utilization of the Clinker being £500 per annum.

This system of dealing with house refuse is effective and, on the whole, satisfactory, but the cost is greater than under the old style, in the case of Hampstead, the Destructor being a considerable distance from the Parish, and only *two* journeys per day can be made to it by each cart.

QUESTIONS.

1. Name of town ?
2. Area in acres ?
3. Population ?
4. Rateable value ?
5. How do you dispose of house refuse ?

6. How many tons or loads of refuse do you collect per day on an average ?
7. Cost per ton or load for collection (exclusive of interest on capital outlay for vans, buildings, &c.) ?
8. Price paid per ton or load, if barged away ?

9. Is the Destructor in a populous district ?
10. Area of site occupied by Destructor ?
11. How many cells ?
12. Quantity of refuse destroyed per cell per day in tons ?
13. Quantity of clinker produced per ton of refuse destroyed ?
14. Maker of Destructor ?

15. Do you consider the work done by it satisfactory ?
16. O.D. Level of site.
17. O.D. Level of highest inhabited part of district within one mile ?

18. Distance of nearest dwellings ?
19. Height of shaft (in feet) ?
20. Are fumes and smoke from cells passed through "Fume Cremator?" (Jones' Patent.)
21. Is result satisfactory ?
22. What do you use as fuel in the "Fume Cremator ?"
23. Is your "Fume Cremator" kept continually burning ?
24. Is waste heat utilised, and, if so, for what purpose ?

25. If the heat is utilised, what, in your experience, is each cell worth in I.H.P.
26. Costs of works, exclusive of site ?

27. Cost of destroying refuse per ton (exclusive of interest and sinking fund on cost of works) ?

28. Cost of cremating fumes, &c., per ton of refuse destroyed ?

29. No. of men employed per day ?
30. No. of men employed by night ?

31. Have complaints ever been made as to smell from chimney or otherwise ?

QUESTIONS.

1. Name of town ?
2. Area in acres ?
3. Population ?
4. Rateable value ?
5. How do you dispose of house refuse ?

6. How many tons or loads of refuse do you collect per day on an average ?
7. Cost per ton or load for collection (exclusive of interest on capital outlay for vans, buildings, &c.) ?
8. Price paid per ton or load, if barged away ?

9. Is the Destructor in a populous district ?
10. Area of site occupied by Destructor ?
11. How many cells ?
12. Quantity of refuse destroyed per cell per day in tons ?
13. Quantity of clinker produced per ton of refuse destroyed ?
14. Maker of Destructor ?

15. Do you consider the work done by it satisfactory ?
16. O.D. Level of site.
17. O.D. Level of highest inhabited part of district within one mile ?

18. Distance of nearest dwellings ?
19. Height of shaft (in feet) ?
20. Are fumes and smoke from cells passed through "Fume Cremator?" (Jones' Patent.)
21. Is result satisfactory ?
22. What do you use as fuel in the "Fume Cremator ?"
23. Is your "Fume Cremator" kept continually burning ?
24. Is waste heat utilised, and, if so, for what purpose ?

25. If the heat is utilised, what, in your experience, is each cell worth in I.H.P.
26. Costs of works, exclusive of site ?

27. Cost of destroying refuse per ton (exclusive of interest and sinking fund on cost of works) ?

28. Cost of cremating fumes, &c., per ton of refuse destroyed ?

29. No. of men employed per day ?
30. No. of men employed by night ?

31. Have complaints ever been made as to smell from chimney or otherwise ?

ANSWERS.

1. ASTON MANOR.
2. 943.
3. 73,000.
4. £200,000.
5. Burn in Refuse Destructor. Sell part to farmers.

6. 70 tons.

7. 2s. per ton.

8. Do our own boating to farmers. Cost varies with distance.

9. Yes.
10. Destructor, &c., 445 yards. Roadway, 372 yards.
11. Eight.
12. About six tons.
13. About 30 cwt.
14. Manlove, Alliott & Co.

15. Yes.
16. 325·00.
17. 412·00.

18. Superintendent's house, 10 yards. Many others, 30 yards.
19. 180 feet.
20. Yes.

21. Yes.
22. Breeze from ashes.
23. No.
24. Yes for mortar making. Propose also for electric light.

25. .....

26. £6,140.

27. 7d. per ton.

28. Practically only cost of screening. See No. 22.

29. Three.
30. Three.

31. No.

ANSWERS.

1. BATLEY.
2. 2,032.
3. 28,720.
4. £94,000.
5. By Destructor.

6. 45 loads.

7. 1s. 9d. per load.

8. .....

9. .....
10. Four acres, including Sewage Works.
11. Six.
12. About $3\frac{1}{2}$.
13. Five cwt.
14. Manlove & Co.

15. Yes.
16. 150·00.
17. 400·00.

18. 150 yards.
19. 150.
20. Yes.

21. Yes.
22. Coke.
23. Yes.
24. Pumping Sewage and Lime Grinding.

25. About 5 H.P.

26. £1,800.

27. $7\frac{1}{2}$d.

28. 7d. per ton, Coke being 10s. 2d. per ton.

29. Two.
30. None.

31. Yes, when "Fume Cremator" is not working.

ANSWERS.

1. BATTERSEA.
2. 2,343.
3. 147,203.
4. £1,330,477.
5. By Destructor.

6. 85 tons.

7. About 4s. 6d.

8. 2s. 6d.

9. Yes.
10. 1¾ acres.
11. Twelve.
12. About six.
13. About ⅓rd.
14. Manlove, Alliott & Co.

15. Yes.
16. 8·00.
17. 96·00.

18. .....
19. 180.
20. Cremators provided but not used as there is no nuisance from shaft, or cause of complaint.
21. .....
22. .....
23. .....
24. Multitubular boiler provided but not used.

25. .....

26. £14,000.

27. About 3s. 6d.

28. .....

29. 18 in three shifts of eight hours each.
30. .....

31. No.

ANSWERS.

1. BIRMINGHAM.
2. 12,365.
3. 478,116.
4. £2,005,881.
5. Part of ashes are screened, and finer proportion mixed with pan contents and sold as manure. Remainder by Destructor.
6. About 699 loads per day. This includes ashes from pan closets, &c.
7. .....
8. 1s. 3d. to 1s. 6d. per ton.
9. Yes.
10. .....
11. 37.
12. About six.
13. Six cwt.
14. Various designs, chiefly our own.
15. Yes.
16. .....
17. .....
18. 50 yards.
19. Two—150, one—260.
20. No.
21. Yes.
22. .....
23. .....
24. Grinding mortar, making concentrated manure, &c.
25. Several tests show that 1 lb. of refuse will evaporate 1·79 lbs. of water.
26. .....
27. .....
28. .....
29. 17.
30. 17.
31. No.

ANSWERS.

1. BLACKBURN.
2. 6,973.
3. 120,064.
4. £421,144.
5. By Destructor.

6. 130.

7. .....

8. .....

9. On the fringe.
10. 15,086 yards.
11. Eight.
12. Six.
13. Six cwt.
14. Manlove, Alliott & Co.

15. Yes.
16. 435·00.
17. 825·00.

18. 100 yards.
19. 300.
20. Yes.

21. Yes.
22. Coke.
23. Yes.
24. Yes, for mortar making.

25. Eight cells + the Cremator develop 45 I.H.P.

26. £8,500.

27. 10d.

28. 2⅔d.

29. Four.
30. Four.

31. No.

ANSWERS.

1. BLACKPOOL.
2. 3,496.
3. 25,310.
4. £179,000.
5. By Destructor.

6. 11,260 per year.

7. 2s. 11¾d.

8. 6d.

9. No.
10. 800 square yards.
11. Eight.
12. 11,260 per year.
13. 2,000 loads.
14. Manlove, Alliott & Co.

15. Yes.
16. 25·65.
17. 74·45.

18. 150 yards.
19. 120.
20. Yes.

21. Yes.
22. Coke.
23. Yes.
24. .....

25. .....

26. £5,129.

27. .....

28. ....

29. Three.
30. Three.

31. At times, but not well founded.

ANSWERS.

1. BOLTON.
2. 2,361.
3. 115,002.
4. £422,327.
5. Part sold, part burnt, and part tipped.

6. About 67,000 tons a year.

7. 3s. 1d.

8. .....

9. Yes.
10. 64 yards.
11. Eight.
12. About 17,000 tons in all per year.
13. ⅓.
14. Manlove, Alliott & Co.

15. Yes.
16. 309·00.
17. 500·00.

18. 30 yards.
19. 180.
20. No. But it would be better to have a "Fume Cremator."

21. .....
22. .....
23. .....
24. Yes, for mortar making.

25. Not ascertained.

26. £4,300.

27. 9d. per ton, which is met by profits on mortar making.

28. .....

29. Four.
30. Three.

31. No.

ANSWERS.

1. BOURNEMOUTH.
2. 2,660.
3. 37,781.
4. £279,895.
5. By Destructor.

6. About 40 loads per day. In outlying districts refuse is tipped.

7. .....

8. .....

9. Fairly so.
10. Three acres.
11. Six.
12. Four loads.
13. 25 per cent.
14. Manlove, Alliott & Co., and Goddard, Massey & Warner.

15. Yes.
16. 135·00.
17. 135·00.

18. 100 yards.
19. 140.
20. On account of additional cells being added the Cremator is insufficient in size.
21. .....
22. Coke.
23. No.
24. No.

25. .....

26. £3,171.

27. 9d.

28. .....

29. Three.
30. Two.

31. No.

ANSWERS.

1. BRADFORD.—Hammerton Street Destructor.
2. 10,776 acres.
3. 216,361—last Census.
4. £1,065,954.
5. Burnt in Refuse Destructor.

6. 70,000 loads per annum, at an annual cost of £8,500.

7. .....

8. .....

9. Fairly so.
10. 6,500 yards.
11. 12 cells.
12. 6½ tons.
13. Reduced to ⅓rd in weight and ¼th in bulk.
14. Manlove, Alliott & Fryer.

15. Yes.
16. 450 feet.
17. 676 feet.

18. 200 yards.
19. 180 feet.
20. Yes.

21. Yes.
22. Gas coke and coke breeze.
23. Fume Cremator always kept burning when the Destructor is working.
24. Yes, for driving mortar mills and supplying steam jets to each cell.

25. About 6 to 7 H.P. per cell—calculating by amount of water evaporated, shows from 8 to 10 H.P.
26. £8,650.

27. 1s. 2¼d.

28. 2¼d. N.B.—Before the steam jets were altered this item was over 5d. per load.

29. Five men, exclusive of manager; 2 additional men for mortar grinding.
30. Five men for mortar grinding; 2 additional men for mortar grinding.

31. Not since Cremators and steam jets were used.

ANSWERS.

1. BRADFORD.—Sunbridge Road Destructor.
2. .....
3. .....
4. .....
5. .....

6. .....

7. .....

8. .....

9. Yes.
10. 2,263 square yards.
11. Nine cells.
12. $6\frac{1}{2}$ tons per cell per day.
13. .....
14. Manlove, Alliott & Co.

15. Yes.
16. 382 above Ordnance datum.
17. 550 feet.

18. 150 feet.
19. 180 feet.
20. Yes.

21. Yes.
22. Gas coke and coke breeze.
23. Yes, when Destructor is in operation.
24. Yes, for supplying steam to steam jets under each cell for the purpose of forcing the draught.
25. .....

26. £7,800.

27. Same as Hammerton Street Destructor.

28. Ditto.

29. Four men.
30. Four men.

31. No.

ANSWERS.

1. BRADFORD.—Cliffe Lane Destructor.
2. .....
3. .....
4. .....
5. .....

6. .....

7. .....

8. .....

9. No.
10. 6,145 square yards.
11. Eight cells.
12. $6\frac{1}{2}$ tons per cell per day.
13. .....
14. Manlove, Alliott & Co.

15. Yes.
16. 506 above O.D.
17. 675 feet above O.D.

18. 650 feet.
19. 180 feet.
20. Yes.

21. Yes.
22. Coke and coke breeze.
23. Yes.
24. For steam jets.

25. .....

26. £6,390.

27. Same as at Hammerton Street Destructor.

28. Ditto.

29. Three men.
30. Three men.

31. No.

ANSWERS.

1. BRADFORD.—Southfield Lane Destructor.
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. No.
10. Two acres.
11. Six cells.
12. 6½ tons per cell per day.
13. .....
14. Manlove, Alliott & Co.
15. Yes.
16. 631 above O.D.
17. 820 above O.D.
18. 105 feet.
19. 130 feet.
20. Yes.
21. Yes.
22. Coke and coke breeze.
23. Yes.
24. For steam jets.
25. .....
26. £2,121.
27. Same as at Hammerton Street.
28. Ditto.
29. Three men.
30. Three men.
31. No.

ANSWERS.

1. BRISTOL.
2. 4,538.
3. 225,146.
4. £1,015,054.
5. Partly sent to tips and partly to Destructor.
6. 197.
7. 3s. 6d. Carts, horses, and men.
8. None barged away.
9. On two sides.
10. 1a., 0r., 10p.
11. Sixteen.
12. 5·1.
13. Forty to fifty per cent.
14. Manlove, Alliott and Co.
15. Yes ; but the quantity of clinker is excessive.
16. 30·50.
17. 212.
18. 154 yards.
19. 180 feet.
20. Yes.
21. Yes.
22. Coke breeze mixed with cinder screenings.
23. No.
24. } Not at present.
25. }
26. Foundations below floor level, £2,909; Destructor, Cremator, buildings, and approach, £6,820; chimney, £1,689.—£11,418.
27. 9½d., not including Cremator. This the gross cost, not taking credit for sales of residual products.
28. 2¼d.
29. Nine. Now going to be increased to twelve.
30. Six.
31. No; but there has been one complaint of dust from works.

N.B.—The result of the inquiry into the subject of wages and hours employed by the Destructor men is that we are going to substitute three shifts of six men each in the 24 hours, instead of two shifts as at present, and I think the extra amount of work we shall get through will compensate for the extra wages.

ANSWERS.

1. BURSLEM.
2. 2,419.
3. 32,000.
4. £100,082.
5. By Destructor.

6. 30.

7. 1s. 1d.

8. .....

9. No.
10. Two acres.
11. Four.
12. Six.
13. 30 per cent.
14. Manlove, Alliott & Co.

15. Yes.
16. 388·00.
17. 531·00.

18. 270 yards.
19. 80.
20. Yes.

21. Yes.
22. Screened ashes.
23. Yes.
24. Yes, for boiler.

25. .....

26. £2,150.

27. Annual working expenses, £260.

28. Nothing.

29. Two.
30. Two.

31. No.

ANSWERS.

1. BURTON-ON-TRENT.
2. 4,025.
3. 46,051.
4. £229,057.
5. Half by Destructor and half by tips.

6. 48.

7. .....

8. .....

9. Yes.
10. Three roods.
11. Four.
12. Six with fixed bars and about nine with movable bars.
13. 33 per cent.
14. Manlove, Alliott & Co.

15. Yes.
16. 151·00.
17. 275·00

18. 160 yards.
19. 140.
20. Yes.

21. Yes.
22. Breeze and waste coke.
23. Yes.
24. Yes, for driving two mortar mills and to supply steam for Disinfector.

25. .....

26. £4,800, including Disinfector and two mortar mills.

27. .....

28. .....

29. Three men and one boy.
30. Two.

31. Yes, recently.

ANSWERS.

1. BURY.
2. 5,835.
3. 58,000.
4. £235,000.
5. Part by Destructor and part tipped.

6. 21,050 loads collected last year.

7. 2s. 6d. per load of 25 cwt.

8. .....

9. Fairly.
10. 460 yards.
11. Four.
12. $6\frac{1}{2}$.
13. 33 per cent.
14. Manlove, Alliott & Co.

15. Fairly satisfactory.
16. 340·00.
17. 400·00.

18. 100 yards.
19. 180.
20. We have no Cremator.

21. .....
22. .....
23. .....
24. Yes, for a mortar mill.

25. We work a 12 H.P. engine.

26. £3,600.

27. 1s. $6\frac{1}{2}$d. (about).

28. .....

29. Two.
30. Two.

31. Yes, occasionally.

ANSWERS.

1. BUXTON.
2. I,174.
3. 8,000 resident ; 20,000 season.
4. £60,000.
5. By Destructor.

6. 18 to 20 tons in season.

7. 1s. 6d. per ton.

8. .....

9. Fairly.
10. 1,750 yards.
11. Two.
12. Nine to ten.
13. 25 per cent.
14. Manlove, Alliott & Co.

15. Gives the greatest satisfaction.
16. 936.
17. 1,139.

18. 40 yards.
19. 150.
20. No.

21. .....
22. .....
23. .....
24. No.

25. .....

26. £1,836.

27. Annual working, £100.

28. .....

29. One.
30. One.

31. Not a single complaint, and works have been in operation 7 years last September, and none need arise if stokers will do their duty.

ANSWERS.

1. CHELTENHAM.
2. 4,300.
3. 44,000.
4. £228,757.
5. Part burnt in Destructor ; part sold for manure.

6. Thirty tons.

7. 4s. per ton.

8. .....

9. No.
10. Situate in a field of about six acres ; only a small part occupied.
11. Eight ; but only six in use at present.
12. About four tons.
13. No record.
14. Manlove, Alliott & Co.

15. Yes.
16. 152.
17. 238.

18. Quarter mile.
19. 160 feet.
20. Yes ; Jones' Fume Cremator.

21. Yes.
22. Coke.
23. No ; only when required.
24. It is intended to use the heat for lighting the works with the Electric Light.
25. Experience insufficient, but am testing.

26. About £6,000; eight cells, chimney, approach road, Cremators, engine, boiler, and dynamo.
27. 10d. per ton.

28. Too irregular use to be estimated.

29. Three.
30. Three.

31. No, except as to flying paper from chimney.

ANSWERS.

1. DERBY.
2. 3,445.
3. 95,000.
4. £386,000.
5. By Destructor.

6. 40 tons.

7. 4s. per load.

8. Fine ashes are mixed with night soil and sold at 1s. per ton.

9. No.
10. Two acres.
11. Six.
12. Seven.
13. 33 per cent.
14. Manlove, Alliott & Co.

15. Yes.
16. 153·00.
17. 274·00.

18. 700 feet.
19. 160.
20. We have no Cremator.

21. .....
22. .....
23. .....
24. Yes ; for Elevator.

25. Have not tested.

26. Carbonizer, Destructor and Royalty, £2,900 ; Shaft, £300.

27. .....

28. .....

29. Twelve.
30. .....

31. Occasionally.

ANSWERS.

1. EALING.
2. 3,225.
3. 26,000.
4. £168,238.
5. Mixed with sewage sludge and destroyed in Destructor.

6. 21½ tons.

7. 2s. 6d. per ton.

8. .....

9. Yes.
10. The Destructor is at Sewage Works—an area of 3 acres.
11. Seven and a Cremator.
12. 4½ tons per cell in 24 hours, sludge and house refuse mixed.
13. 25 per cent.
14. Manlove, Alliott & Co.

15. Yes.
16. 25·00.
17. 200·00.

18. 75 yards.
19. 143.
20. Yes.

21. Yes.
22. Coke Breeze.
23. Yes.
24. Yes; for raising steam to work machinery for treating sewage, pumping, &c., and is to be further utilized for Electric Lighting of Ealing.
25. We work two 10 H.P. Engines.

26. £2,400 for 7 cells and chimney shaft.

27. 1s.6¼d., including cremating fumes. This is the gross cost, including repayment of Loan, &c.; from this should be deducted value of steam, clinkers, &c., which reduces cost to 3d. per ton net.
28. 3¾d.

29. Three.
30. Two.

31. Not since Cremator has been at work.

N.B.—The character of material burnt (Question 12) accounts for the apparently small quantity destroyed as compared with other places where only House Refuse is dealt with.

ANSWERS.

1. EASTBOURNE.
2. 5,506.
3. 35,000.
4. £214,089.
5. By Destructor.

6. 36 loads.

7. 3s. 8d. per load.

8. .....

9. No.
10. One acre. The Sewage Pumping Station is on the same land.
11. Four now ; adding two more.
12. 8¼ loads.
13. Six cwt.
14. Manlove, Alliott & Co.

15. Yes.
16. 22·00.
17. 63·00.

18. 50 yards.
19. 140.
20. Yes.

21. Yes, decidedly.
22. Coke.
23. No.
24. Yes ; for pumping sewage.

25. .....

26. £3,470.

27. 9¼d.

28. 1½d.

29. .....
30. Two men and one boy.

31. Once, from dust from clinkering.

ANSWERS.

1. EDINBURGH.
2. 6,166.
3. 267,672.
4. £1,939,387.
5. To farmers and in old quarries and hollows.

6. 315.

7. We put material free on board ; farmer pays carriage.

8. .....

9. .....
10. .....
11. .....
12. .....
13. .....
14. Manlove, Alliott and Co.

15. .....
16. .....
17. .....

18. .....
19. .....
20. Yes ; Jones' Fume Cremator.

21. .....
22. .....
23. .....
24. .....

25. .....

26. .....

27. .....

28. .....

29. .....
30. .....

31. .....

N.B.—The Destructor only commenced working at Michaelmas, 1893, consequently questions could not be answered.

ANSWERS.

1. GLASGOW.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15. Our Cremating Furnaces are worked in conjunction with screening
16. and mixing machines, the manurial portion of the refuse being
17. prepared and sold to farmers, and only the rougher or unsale-
18. refuse cremated. That being so, it would be needless to make
19. a comparison with Destructors constructed for the cremation
20. of all the refuse collected.
21.
22.
23.
24.
25.
26.
27.
28.
29.
30.
31.

ANSWERS.

1. GOVAN.
2. 1,069 Imperial acres. (Dry land.)
3. 63,000.
4. £236,555.
5. Almost entirely by Destructor.
6. 45 tons.
7. 1s. 3d. per load, about 1s. per ton. This is done by contract.
8. .....
9. No. In an outlying district.
10. 6,292 sq. yds., with 4 acres additional of low ground where clinker is tipped.
11. Six; other two in course of being added.
12. Five tons (all refuse passed over weighing machine).
13. Not ascertained.
14. Goddard, Massey & Warner, Nottingham.
15. Yes.
16. 48·77.
17. 165·00.
18. 950 feet.
19. 120 feet.
20. No.
21. .....
22. .....
23. .....
24. Not as yet, but space left and flues arranged for boiler.
25. .....
26. About £5,000.
27. About 10½d. per ton.
28. .....
29. Six at furnaces, with a seventh attending weighing machine. Work carried on continuously night and day in three shifts of eight hours each.
30. .....
31. No.

ANSWERS.

1. HAMPSTEAD.
2. 2,248.
3. 70,000.
4. £691,962.
5. Mainly by Destructor.

6. 64 loads.

7. 5s. 0½d. The distance being such that only an average of two loads per day can be carted.
8. .....

9. No.
10. Wharf, nearly an acre.
11. Eight.
12. 5½ tons.
13. 24 per cent. 16 per cent. clinker, 8 per cent. fine ash.
14. Manlove, Alliott & Co.

15 Yes.
16. 100·00.
17. 160.00.

18. 50 yards.
19. 120.
20. Yes.

21. Yes.
22. Breeze sifted from dust.
23. Yes.
24. No.

25. .....

26. £5,600.

27. 1s. 7d. ; but from the Annual Total a sum of £500 per annum profit on artificial stone has to be deducted.

28. A little less than one penny per ton.

29. Four.
30. Four.

31. No.

ANSWERS.

1. HASTINGS.
2. 2,079.
3. 58,000.
4. £356,620.
5. By Destructor.

6. 50 loads.

7. 3s. 5d.

8. .....

9. Fairly so.
10. $\frac{1}{3}$rd acre.
11. Four.
12. Ten.
13. 10 to 15 per cent.
14. Manlove, Alliott & Co.

15. Perfectly so.
16. 24·30.
17. 304·00.

18. 300 yards.
19. 130.
20. Yes.

21. Quite.
22. Small coke.
23. No.
24. Yes, for salt water pumping, working an engine developing 34 H.P., and Steam Disinfector.
25. Without Cremator, $8\frac{1}{2}$ H.P.; with Cremator, at a temperature of 1,500° F., 17 H.P.
26. £4,000.

27. 1s. 10d.

28. .....

29. Two.
30. Two.

31. No, never when Cremator has been at work, and only occasionally when not at work.

ANSWERS.

1. HECKMONDWIKE.
2. 697.
3. 10,000.
4. £33,000.
5. By Destructor.

6. 10 loads.

7. 1s. 3d.

8. .....

9. Yes.
10. 630 yards.
11. Three.
12. $3\frac{1}{2}$ loads (about).
13. 25 per cent.
14. Manlove, Alliott & Co.

15. Yes.
16. 200·00
17. 450·00.

18. 120 feet.
19. 120.
20. No Cremator.

21. .....
22. .....
23. .....
24. Yes; for driving a 12 H.P. engine for grinding clinkers, &c.

25. Have not tested.

26. £2,000.

27. 1s. per load.

28. .....

29. One.
30. One.

31. No.

ANSWERS.

1. HORNSEY.
2. 2,745.
3. 44,184.
4. £328,561.
5. By Destructor.

6. Between 30 and 40.

7. We pay the men 10d. per load for collection, any load of less weight than 25 cwt. not being paid for.
8. .....

9. Yes.
10. ¾ acre.
11. Six at present ; provision made for six more.
12. Eight.
13. About 24 per cent.
14. Goddard, Massey & Warner.

15. Very satisfactory.
16. .....
17. .....

18. .....
19. .....
20. We have a "Fume Cremator," but the combustion in our furnace is so complete that we do not find it necessary to use it.
21. .....
22. .....
23. .....
24. Yes; for driving mortar mill, clinker crushing, &c.

25. .....

26. £8,006 for buildings and machinery for treating refuse.

27. 1s. per load (25 cwt.)

28. .....

29. Four in two shifts of about 8 or 9 hours each. Furnaces banked up remainder of night.
30. .....

31. No.

ANSWERS.

1. HUDDERSFIELD.
2. 11,788.
3. 97,552.
4. £429,144.
5. By burning in Destructor and tipping.
6. About 100 loads per day.
7. .....
8. 1s. 10d. per ton.
9. No.
10. About one acre.
11. Ten cells.
12. About 6 tons per cell per 24 hours.
13. 33 to 40 per cent.
14. Manlove, Alliott & Co., Nottingham
15. Yes.
16. 225.
17. 500.
18. 50 yards off.
19. 180 feet.
20. Yes.
21. We have no complaints.
22. Coke from Gasworks.
23. Yes.
24. Producing steam.
25. .....
26. £7,500.
27. About 10½d. per ton.
28. About 2d. per ton. Varying with price of coke.
29. Five stokers.
30. Five ditto.
31. Slight complaints of dust and unburnt paper from chimney, but this has been obviated.

ANSWERS.

1. HULL.
2. 7,901.
3. 204,150.
4. £730,724.
5. Dry ashpit refuse is burnt at the Destructor.

6. 50 tons refuse, 400 tons night soil.

7. The contracts are let at a rate per house, varying 2s. to 2s. 3d. per year.
8. .....

9. Yes.
10. One acre, including Works Department.
11. Six.
12. Five tons.
13. ⅓.
14. Manlove, Alliott & Co.

15. Yes.
16. 6·00.
17. 17·00.

18. 50 yards.
19. 180.
20. We have no Cremator.

21. .....
22. .....
23. .....
24. No.

25. .....

26. Destructor and Buildings, £1,968; Chimney, £932; Approach, £300; total, £3,200.
27. .....

28. .....

29. Three.
30. Three.

31. Occasionally, as to charred paper.

ANSWERS.

1. HYDE.
2. 3,042 acres.
3. 32,000.
4. £108,290.
5. By burning in Destructor.

6. Only just commenced.

7. Ditto.

8. Ditto.

9. Yes.
10. Two roods, 12 perches, 17 yards.
11. Four at present ; space for four more.
12. .....
13. .....
14. Goddard, Massey & Warner.

15. Yes.
16. 261·00.
17. 428·00.

18. 150 lin. yards.
19. 180.
20. Yes.

21. Yes.
22. Coke.
23. Nearly.
24. Yes; for engine power.

25. .....

26. £4,000.

27. .....

28. .....

29. Three.
30. Two.

31. No.

ANSWERS.

1. LEEDS.
2. 21,572.
3. 375,540.
4. £1,257,500.
5. By Destructor chiefly.

6. 400.

7. 2s. 9d.

8. 2s. 3d. freight up (recouped).

9. We have three, two are in the town.
10. 23,000 yards, 5,167, 5,000.
11. 14, 12, 10.
12. $5\frac{1}{2}$ tons.
13. 40 per cent.
14. Manlove & Co. the first, Leeds Corporation the last.

15. Yes; we have improved the original designs.
16. .....
17. .....

18. .....
19. .....
20. No.

21. Yes; especially at Beckett Street and Kidacre Street.
22. .....
23. .....
24. Grinding mortar.

25. .....

26. £7,310. £6,223. Not yet ascertained.

27. 1s. $3\frac{3}{4}$d.

28. .....

29. 19.
30. 16.

31. Not recently.

ANSWERS.

1. LEICESTER.
2. 8,587.
3. 180,000.
4. £641,269.
5. ⅔ to Tips ; ⅓ to Destructor.

6. 160.

7. 2s. 1d. per ton.

8. .....

9. Yes.
10. 2,000 square yards.
11. Six.
12. Nine tons.
13. 15 per cent. clinker ; 7 per cent. ashes.
14. Manlove & Co.

15. Perfectly so.
16. 214·25.
17. 291·00.

18. Adjoining.
19. 160.
20. Passed through Jones' "Fume Cremator."

21. Yes.
22. Screened ashes when in use.
23. No.
24. Grinding mortar, &c.

25. Have not tested.

26. £6,669.

27. 1s. 3½d.

28. No separate record.

29. Three.
30. Three.

31. None whatever.

ANSWERS.

1. LIVERPOOL.
2. 5,210.
3. 517,951.
4. £3,203,767.
5. By special steamer to sea; by canal barges to contractor; by Destructor and waste lands.
6. In 1892—141,413 tons.

7. Depends on distance.

8. By Canal; about 2s. for disposal and freight.

9. Yes.
10. 1,508 yards.
11. Twelve; and twelve more in course of construction.
12. Eight tons.
13. 30 per cent.
14. Manlove & Co.

15. Yes.
16. 55·00.
17. 224·00.

18. 59 feet.
19. 175.
20. Yes.

21. Yes.
22. Coke Breeze.
23. Yes.
24. Grinding mortar, &c.

25. No reliable test has been made, but should say about 5 H.P. per cell.

26. £7,500.

27. 1s. 4½d.

28. 2½d.

29. Eight.
30. Seven.

31. No.

ANSWERS.

1. LONGTON.
2. 1,934,
3. 34,237.
4. £92,786.
5. By Destructor.

6. 10,300 loads, 7,569 burnt.

7. 1s. 6d.

8. .....

9. Populous district adjoining.
10. 11,000 square yards.
11. Four.
12. Six tons.
13. 25 per cent.
14. Manlove & Co.

15. Yes.
16. 471·00.
17. 650·00.

18. 50 yards.
19. 150.
20. Yes.

21. Yes.
22. Coke breeze and best of refuse.
23. Yes.
24. Grinding mortar, &c.

25. Have not tested.

26. .....

27. $9\frac{3}{4}$d.

28. Practically nil.

29. Two.
30. Two.

31. No.

ANSWERS.

1. MANCHESTER.
2. 12,790.
3. 505,000.
4. £2,798,005.
5. By Destructor.

6. 500 tons.

7. Cannot tell; pail contents are brought in as well.

8. 1d. per ton per mile by boat and rail.

9. Some of them.
10. Each cell occupies about 50 feet.
11. 44; and 24 in addition in course of erection.
12. 10 tons.
13. 25 per cent.
14. Corporation, 42; Mason, 2—44.

15. Very.
16. .....
17. One Destructor at highest, one at middle, one at lowest.

18. Adjoining.
19. .....
20. In some cases.

21. Yes.
22. Chiefly house refuse.
23. Some. With some of our Destructors Cremators are not necessary.
24. Yes; for making mortar and cutting and crushing provender for 450 horses.
25. Cannot tell.

26. About £500 per cell.

27. About 1d. by our latest Destructors.

28. .....

29. For our new Destructors one man only is required to watch 20 cells.
30. .....

31. Not lately.

ANSWERS.

1. NELSON (LANCS.)
2. 3,185.
3. 25,000.
4. £78,370.
5. By tipping.

6. 25 loads.

7. 1s. 9d.

8. .....

9. Yes.
10. 284 square yards.
11. Three.
12. $1\frac{1}{4}$ tons.
13. 12 per cent.
14. Richmond & Co., Burnley. The construction of a larger Destructor is under consideration, which will certainly be on different lines to the present one.
15. Fairly so.
16. 438·00.
17. 660·00.

18. 13 yards.
19. 90.
20. Yes.

21. Moderately.
22. Coke.
23. No.
24. No.

25. .....

26. About £700.

27. 5s. (the refuse, which is very foul, is mixed with coke).

28. 3s.

29. One.
30. None.

31. Yes.

N.B.—The present Destructor is one of the "Beehive" type.

ANSWERS.

1. NEWCASTLE.
2. 5,371.
3. 192,000.
4. £915,841.
5. The greater part is burnt by Destructor, the remainder to deposits, both within and without the city.
6. About 230 loads. This includes ashpit stuff, privy, pail and dry house refuse.
7. .....
8. .....
9. No.
10. About one acre.
11. Twelve.
12. Seven.
13. About 25 per cent. ashes and clinker.
14. 1st six by Manlove & Co., 2nd six by Goddard, Massey & Warner.
15. Yes.
16. .....
17. .....
18. .....
19. .....
20. No.
21. Yes.
22. .....
23. .....
24. No.
25. .....
26. About £6,900.
27. About 8d. net cost, after allowing for sale of ashes, &c
28. .....
29. Nine. Three men each shift of eight hours.
30. .....
31. Yes; a few.

ANSWERS.

1. NOTTINGHAM.
2. 10,960.
3. 213,000.
4. £739,200.
5. By Destructor and by sale.

6. About 200 tons.

7. .....

8. Sold at 1s. 6d. per ton in trucks at depot and 1s. in carts.

9. .....
10. 800 yards.
11. Four and one under boiler.
12. Seven tons.
13. One-fifth.
14. Manlove & Co.

15. Yes.
16. 82·63.
17. 180·00.

18. 200 yards.
19. 160.
20. We have no Cremator.

21. .....
22. .....
23. .....
24. Yes; for working Elevator to Destructor, Steam Pumps and Electric Light Installation.
25. Have not tested.

26. £6,000, including Electric Light Installation.

27. .....

28. .....

29. Nine and one engine driver.
30. None.

31. No.

ANSWERS.

1. PRESTON.
2. 4,030.
3. 109,038.
4. £344,595.
5. By Destructor.

6. 80 tons. Part taken to Destructor, part to tips.

7. .....

8. .....

9. Yes.
10. 1,430 yards.
11. Twenty-eight.
12. 950 per month.
13. 25 per cent.
14. Manlove & Co.

15. Yes.
16. 130·00.
17. 135·00.

18. 50 yards.
19. 180.
20. No.

21. .....
22. .....
23. .....
24. Generating steam, &c.

25. .....

26. £4,121.

27. .....

28. .....

29. Three.
30. Three.

31. No.

N.B.—A new Destructor, 20 cells, with "Fume Cremator," has lately been constructed, but has not been in work sufficient time to detail results.

ANSWERS.

1. ROTHERHAM.
2. 5,995.
3. 44,000.
4. £18,849.
5. To farmers ; tips ; Destructor.

6. Fifty-two loads.

7. 1s. 7d. per load.

8. .....

9. Not exactly.
10. About three acres, building, approach, &c., only occupying about one acre.
11. Six.
12. 5½ loads.
13. Thirty per cent.
14. Manlove, Alliott and Co.

15. Yes.
16. Eighty.
17. 220 and 300.

18. About 80 yards ; next about 150.
19. 130.
20. Yes ; Jones' Fume Cremator.

21. Yes.
22. Coke and siftings from Gas Works ; also coke from rubbish.
23. From 7 a.m. to 12 p.m.
24. No.

25. .....

26. £3,250 ; Destructor, Cremator, shaft, sheds, foundations, &c.

27. About 9d. per ton.

28. About 1½d. per ton.

29. Three.
30. Three.

31. A few complaints of smell from chimney now and again.

ANSWERS.

1. ROYTON.
2. 2,112.
3. 13,395—(Census, 1891).
4. £49,653.
5. Destructor.
6. .....
7. .....
8. .....
9. .....
10. No.
11. Four cells.
12. .....
13. .....
14. Goddard, Massey & Warner, Nottingham.
15. .....
16. .....
17. .....
18. .....
19. 180 feet.
20. No.
21. .....
22. .....
23. .....
24. For sludge presses.
25. .....
26. .....
27. .....
28. .....
29. .....
30. .....
31. .....

ANSWERS.

1. SALFORD (N. DISTRICT).
2. 1,426.
3. 37,864.
4. £163,524.
5. By Destructor.

6. 63 tons.

7. 1s. 2d.

8. .....

9. Yes.
10. 1,650 yards.
11. Six.
12. Seven.
13. 33 per cent.
14. Manlove & Co.

15. Yes.
16. 92·00.
17. 145·00.

18. 60 to 70 yards.
19. 180.
20. Yes.

21. Yes.
22. Selected cinders.
23. Yes.
24. No.

25. .....

26. £5,000, including a brick river wall.

27. 7d.

28. Less than $\frac{1}{4}$d per ton, as selected cinders are used, which are brought from various works, and we pay the carters 4s. per week for bringing them.
29. Three.

30. Three.
31. No.

ANSWERS.

1. SALFORD (S. DISTRICT).
2. 1,329.
3. 109,732.
4. £417,672.
5. Part to Farmers, remainder to Destructor.

6. 44,154 tons per annum.

7. 1s. 6d.

8. Cartage to Farmers cost 1s. 9d. per ton, from which deduct 1s. 3d. received for manure.
9. Yes.
10. 8,400 square feet.
11. Twelve.
12. 5½.
13. 50 per cent.
14. Six by Manlove & Co.; six my own designs.

15. .....
16. 17·40.
17. 184·00.

18. 20 feet.
19. 180.
20. No.

21. .....
22. Selected cinders.
23. Yes.
24. No.

25. .....

26. First six, including chimney, £2,287; second six, £976.

27. 10½d.

28. Less than ¼d. per ton, as selected cinders are used, which are brought from various works, and we pay the carters 4s. per week for bringing them.
29. Three.
30. Four.

31. No.

ANSWERS.

1. SOUTHAMPTON.
2. 2,004.
3. 65,325.
4. £260,000.
5. By Destructor.

6. 71.

7. 11d. per load.

8. We receive 1s. per ton.

9. Yes.
10. 400 square yards.
11. Six.
12. Ten.
13. 20 per cent.
14. Manlove & Co.

15. Very.
16. 11·00.
17. 50·00.

18. 30 feet.
19. 160.
20. No.

21. Great.
22. .....
23. .....
24. Used for compressing air for lifting sewage, driving machinery and Electric Light Installation, &c.
25. According to condition of house refuse, from 6 to 7 horse power.

26. £3,723.

27. 3½d.

28. .....

29. Two.
30. Two.

31. None whatever.

ANSWERS.

1. WARRINGTON.
2. 2,004.
3. 53,000.
4. £166,565.
5. By Destructor.

6. 250 tons weekly.

7. .....

8. .....

9. No.
10. With other works about four acres.
11. Six.
12. Seven.
13. .....
14. Manlove & Co.

15. Yes.
16. 27·00.
17. 95·00.

18. 600 yards.
19. 150.
20. We have no Cremator.

21. .....
22. .....
23. .....
24. Drying Excreta.

25. I should think about 10 H.P.

26. .....

27. 10d.

28. .....

29. .....
30. .....

31. .....

ANSWERS.

1. WEST DERBY.
2. 5,566 acres.
3. 40,000 (estimated).
4. £192,635.
5. Up to October, 1893, by tipping in pits, &c.; since October, by burning.
6. 32.
7. 2s. 3d. per load.
8. .....
9. Yes.
10. 8,250 square yards.
11. Six.
12. Destructor has not been working sufficiently long for me to answer this question.
13. See No. 12.
14. Fryer's Patent, manufactured by Messrs. Manlove, Alliott & Co., of Nottingham.
15. So far as it is at present possible to form an opinion—Yes.
16. 200 feet.
17. The Destructor is situated at the highest point of the district.
18. 80 feet.
19. 160 feet.
20. Yes.
21. See No. 15.
22. Coke, and any loads of ashes (from bakehouses, &c.) which do not contain vegetable or other refuse.
23. Yes.
24. No.
25. .....
26. £5,500.
27. Cannot answer this question yet.
28. Ditto.
29. Two.
30. Two.
31. No.

N.B.—The Destructor having only been at work one month, the particulars are necessarily somewhat abbreviated.

ANSWERS.

1. WHITECHAPEL.
2. 406.
3. 75,162.
4. £405,000.
5. By Destructor and to brickmakers.

6. 60 loads.

7. .....

8. .....

9. Yes.
10. 8,000 square feet.
11. Eight.
12. 50 loads of all description of refuse.
13. 25 to 30 per cent.
14. Manlove & Co.

15 Yes.
16. .....
17. .....

18. Six feet.
19. 180.
20. No.

21. Yes.
22. .....
23. .....
24. No.

25. .....

26. £9,000.

27. .....

28. .....

29. Two firemen, one barrow man and two changes.
30. .....

31. .....

ANSWERS.

1. WINCHESTER.
2. 1,043.
3. 20,000.
4. £91,000.
5. By Destructor and to agricultural land.

6. Twelve.

7. 1s.

8. .....

9. No.
10. .....
11. Two.
12. Six loads.
13. .....
14. One, Manlove & Co. One, Goddard, Massey & Warner.

15. Yes ; very satisfactory.
16. 105·00.
17. 319·00.

18. 200 yards.
19. Utilize shaft of Pumping Station.
20. No.

21. .....
22. .....
23. .....
24. No.

25. .....

26. £660.

27. Sale of clinker about pays for men's wages.

28. .....

29. One.
30. .....

31. No.

ANSWERS.

1. WOOLWICH.
2. 1,125.
3. 40,848—(Census, 1891).
4. £184,157.
5. Burnt in Destructor.

6. 33 loads=66 cubic yards.

7. About 2s. 5d. per load.

8. .....

9. No. Situate at the Parish Wharf next the River Thames.
10. 8,250 square feet.
11. Six cells.
12. 33 loads, or 66 cubic yards in the six cells.
13. About 25 per cent.
14. Messrs. Manlove, Alliott & Co., Nottingham.

15. Yes.
16. 17·1.
17. 154·2.

18. 210 feet.
19. 160 feet.
20. Yes. (Jones' Patent).

21. Yes.
22. Coke Breeze.
23. Yes.
24. No.

25. .....

26. £5,618 1s. 7d.

27. Wages and breeze, £11 5s. 8d. per week.

28. About 1d. per load.

29. One leading hand (who also works Disinfector) and eight stokers employed in three shifts of eight hours each.
30. .....

31. No complaints from smells, but on first starting from parched paper, which has been remedied by means of baffler in flue.

QUESTIONS.

1. Name of town?
2. Area in acres?
3. Population?
4. Rateable value?
5. How do you dispose of house refuse?

6. How many tons or loads of refuse do you collect per day on an average?
7. Cost per ton or load for collection (exclusive of interest on capital outlay for vans, buildings, &c.)?
8. Price paid per ton or load, if barged away?

9. Is the Destructor in a populous district?
10. Area of site occupied by Destructor?
11. How many cells?
12. Quantity of refuse destroyed per cell per day in tons?
13. Quantity of clinker produced per ton of refuse destroyed?
14. Maker of Destructor?

15. Do you consider the work done by it satisfactory?
16. O.D. Level of site.
17. O.D. Level of highest inhabited part of district within one mile?

18. Distance of nearest dwellings?
19. Height of shaft (in feet)?
20. Are fumes and smoke from cells passed through "Fume Cremator?" (Jones' Patent.)
21. Is result satisfactory?
22. What do you use as fuel in the "Fume Cremator?"
23. Is your "Fume Cremator" kept continually burning?
24. Is waste heat utilised, and, if so, for what purpose?

25. If the heat is utilised, what, in your experience, is each cell worth in I.H.P.
26. Costs of works, exclusive of site?

27. Cost of destroying refuse per ton (exclusive of interest and sinking fund on cost of works)?

28. Cost of cremating fumes, &c., per ton of refuse destroyed?

29. No. of men employed per day?
30. No. of men employed by night?

31. Have complaints ever been made as to smell from chimney or otherwise?

Abstract of Questions and Answers.

1.—No. of Towns, 46 ; No. of Destructors, 51.

2.—Varying from 406 acres at Whitechapel to 21,572 acres at Leeds.

3.—Varying from 10,000 at Heckmondwike to 517,951 at Liverpool.

4.—Varying from £33,000 at Heckmondwike to £3,203,767 at Liverpool.

5.—In the case of 33 Towns, all the House Refuse is burned ; in the remaining Towns, part burnt, part to Tips or, as in the case of Liverpool, to Sea.

6.—Varying from 10 Loads per day at Heckmondwike to 699 Loads per day at Birmingham.

7.—Varying from 11d. per Load at Southampton to about 4/6 per Load at Battersea.

8.—The answers are few, in some cases a profit is made, in others the cost amounts to as much as 2/6 per Load.

9.—Out of 51 Destructors, 30 are in populous Districts or "fairly so."

10.—This varies very much, the site for Destructor Works being also utilized for other purposes ; the area ranges between 64 yards at Bolton, and several acres in other Districts.

11.—Varies from 2 Cells at Buxton to 44 Cells at Manchester.

12.—Varies from 3½ Tons to 10 Tons—it is evident however, that this depends very much upon the Stoker and the Class of Material ; at Ealing, for instance, it is only from 4½ to 5 Tons per 24 hours per cell—but the material is Sewage Sludge as well as House Refuse, and the Clinker is removed only once in 2 hours instead of the usual 1½ hours. A much more valuable clinker being the result.

13.—In some cases as much as 33 per cent., but 25 per cent. is the general result.

14.—Manlove, Alliott and Co.; Goddard, Massey and Warner; Whiley; Horsfall and Healey; the "Beehive" at Nelson is one by itself, manufactured by Richmond and Co.

15.—Generally speaking, satisfactory.

16-17.—These bear specially upon the question of the height of Chimney Shaft, and are important, in showing that in the majority of cases the level of ground one mile from Destructor is *above* the level of top of Shaft

18.—In some cases within 50 feet, in the majority within 100 yards.

19.—Shafts range between 140 feet and 180 feet in height.

20.—Out of 51 Destructors referred to, 30 have "Fume Cremators"—of these, one has never been used—one is said to be too small—and one having been built double its proper size and coke having been used at three times the cost of Coke Breeze, the "Fume Cremator," after being in use for 8 weeks, was pronounced expensive.

21.—In every case where the "Fume Cremator" is at work, the reply is "the result is satisfactory."

22.—In the majority of cases, Coke Breeze, Coke Breeze and Screened Ashes, Screened Ashes alone, Small Coke. About one sixth use Coke.

23.—About one fifth of the number are intermittent. Two of these are by the Seaside, and when the wind is steadily *from* the Land these are not kept going.

24.—In thirty-two cases waste heat is utilized, and in two cases provision is made for so doing.

25.—Where tested—from 5 to 7 H.P. is the result—with the exception of Hastings, where a far higher power is obtained.

26.—No general reply can be abstracted. Reference must be had to "Cost of Construction," page 24.

27.—With the exception of three cases, where the cost is evidently mixed with other incidentals, the expense incurred in "destroying refuse" is represented as varying from 3½d. to 1/7 per ton or load—about 10d. is a fair average; Ealing is high in consequence of destroying the Sludge, but the amount is reduced largely by allowance for Clinker, etc.

28.—The cost in this matter varies from ¼d. per ton, where only cinders are used, to 3¼d. per ton (at Ealing). One isolated case where Coke is used stands as high as 7d. per ton.

29-30.—The answers must be referred to for a satisfactory conclusion, but 3 men to 6 or 7 Cells is a fair average for day work, and 2 men for same number of Cells at night.

31.—In only a very few cases have complaints been made.

Dates of Erection of Destructors

Referred to in the foregoing pages, together with additions made subsequently.

1892	Aston Manor
1879-90 ...	Blackburn
1880	Birmingham
1881	Bolton
1880	Bradford
1885	Bradford
1891	Bradford
1891	Bradford
1880	Bury
1887-91 ...	Batley
1886	Buxton
1887-92 ...	Bournemouth
1888	Battersea
1889	Burslem
1890	Burton-on-Trent
1890	Blackpool
1892	Bristol
1894	Birkenhead
1890	Cheltenham
1882	Derby
1883-5-9 ...	Ealing
1891	Eastbourne
1893	Edinburgh
....	Glasgow
....	Govan
1882	Hull
1883	Heckmondwike
1888-9	Hampstead
1889	Hastings
1889	Hornsey
1891-2	Huddersfield
....	Hythe
....	Hyde
1883	Leeds
1887	Longton
1885	Lett's Wharf
1890	Leicester
1891-3	Liverpool
1878	Manchester
1883	Nottingham
1885	Newcastle
....	Nelson
1886-93 ...	Preston
1892	Rotherham
....	Royton
1883	Salford (North)
1888	Salford (South)
1886	Southampton
1884	Winchester
1886	Whitechapel
1892	West Derby
1893	Woolwich

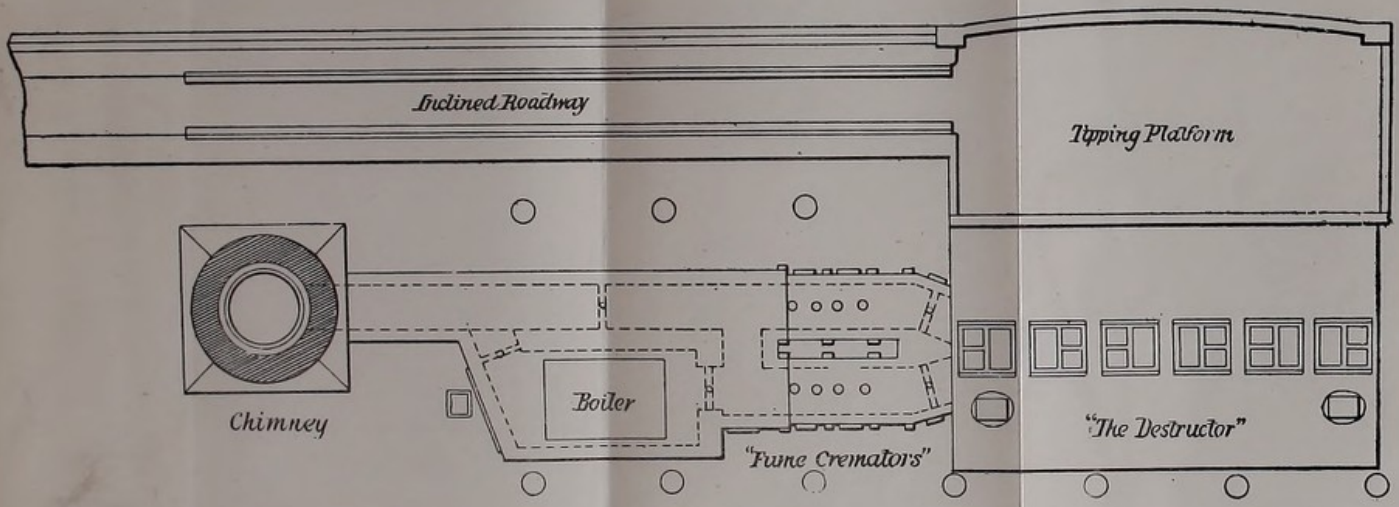
Destructors (majority with Fume Cremators) have been erected in the followiug Towns, England and Abroad, particulars not come to hand.

....	George Town (Demerara)
....	Gibralter
....	Russia
....	London County Council
....	Melbourne (Victoria)
....	Para (Brazil)
....	Wellington (New Zealand)

(Plate, No. 1.)

Design for a

TWELVE CELL "DESTRUCTOR" AND "FUME CREMATOR."



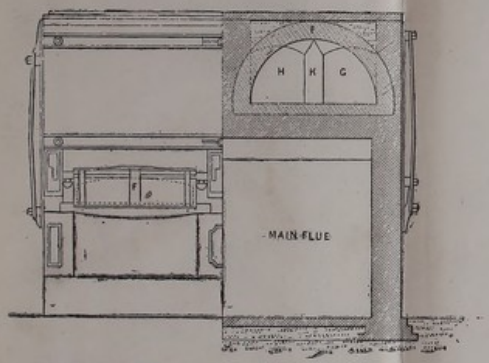
C. JONES, M.I.C.E.

(Plate, No. 2.)

FRYER'S PATENT DESTRUCTOR FURNACE.

BACK TO BACK.

SCALE. 10 feet

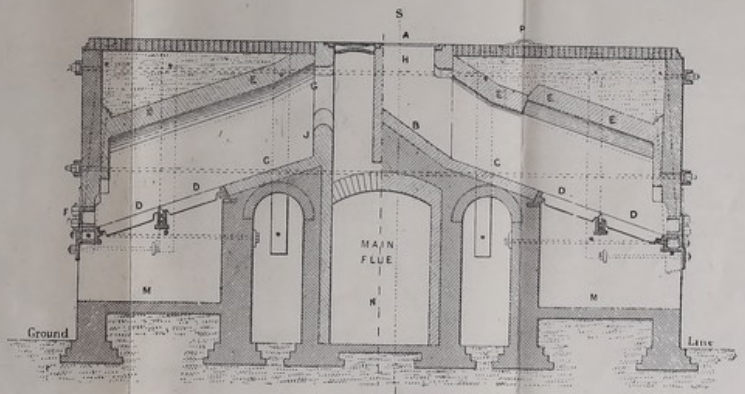


HALF ELEVATION.

HALF SECTION. AT S S

REFERENCE.

A *Refuse feed Opening.*
B *Incline above Hearth.*
C *Drying Hearth.*
D *Fire Bars.*
E *Reverberatory Arch.*
F *Clinkering Doors.*
G *Opening for Gases.*
H *Opening for Refuse.*
J *Bridge to keep Refuse out of the Flue.*
K *Wall to divide Gases from Refuse.*
M *Ash pits.*
N *Flue to Chimney.*
P *Mattrass Opening.*

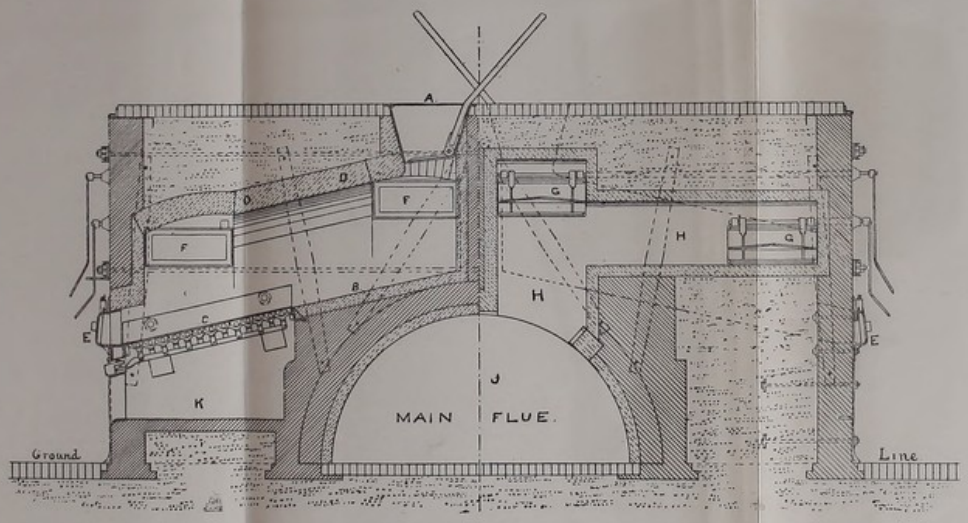


CROSS SECTION. S

(Plate, No. 3.)

WARNER'S PATENT "PERFECTUS" DESTRUCTOR.

BACK TO BACK.



CROSS SECTION.

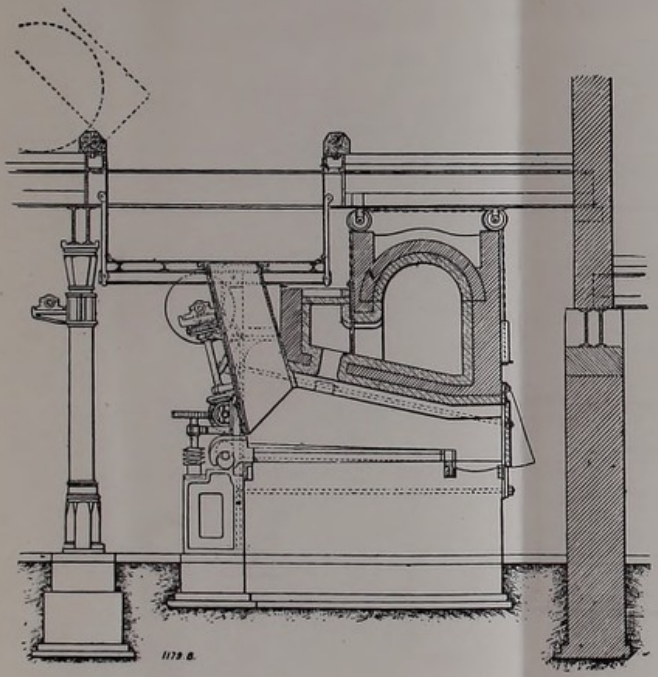
Scale ¼ Inch 1 Foot

REFERENCE.

A *Refuse feed Hopper.*
B *Drying Hearth.*
C *Rocking Fire Bars.*
D *Reverberatory Arch.*
E *Clinkering Doors.*
F *Outlets for Gases.*
G *Dampers.*
H *Side Flues.*
J *Flue to Chimney.*
K *Ash Pit.*

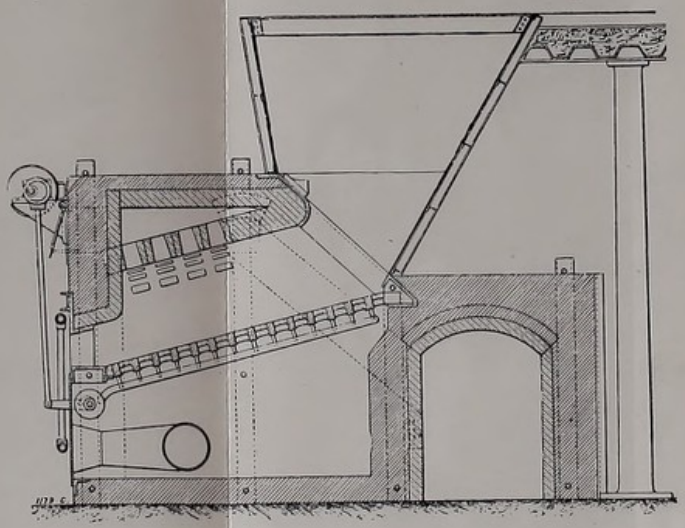
(Plate, No. 4.)

WHILEY'S DESTRUCTOR.



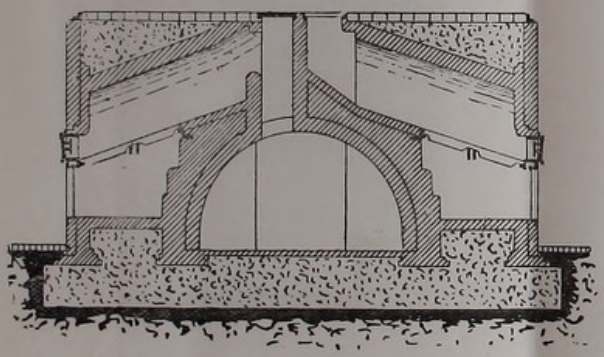
(Plate, No. 5.)

HORSFALL'S DESTRUCTOR.

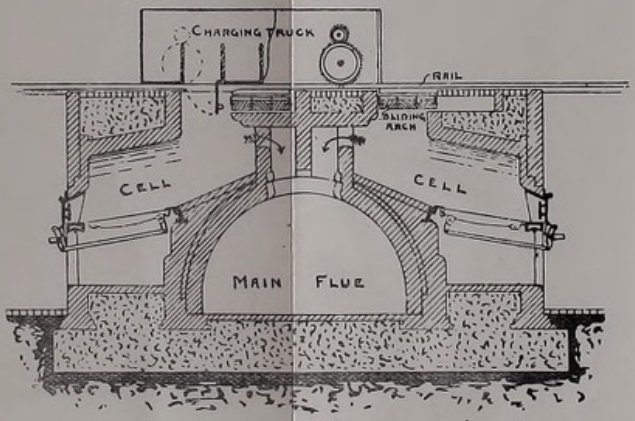


(Plate, No. 6.)

CITY OF LIVERPOOL.

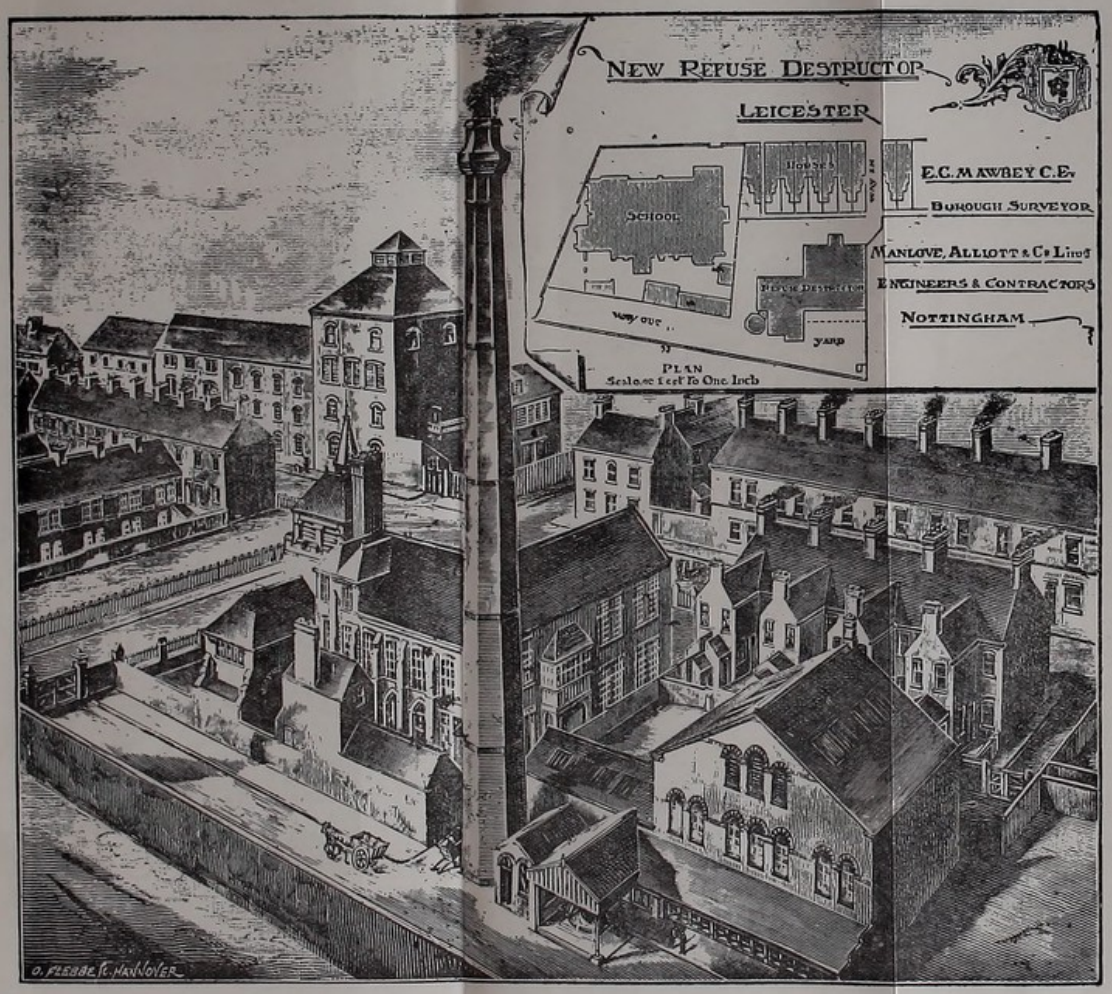


FRYER'S



BOULNOIS & BRODIES
CHARGING APPARATUS

(Plate, No. 7.)



REFUSE DESTRUCTOR AT LEICESTER,

Showing close proximity to middle-class Dwelling Houses and large Public School.

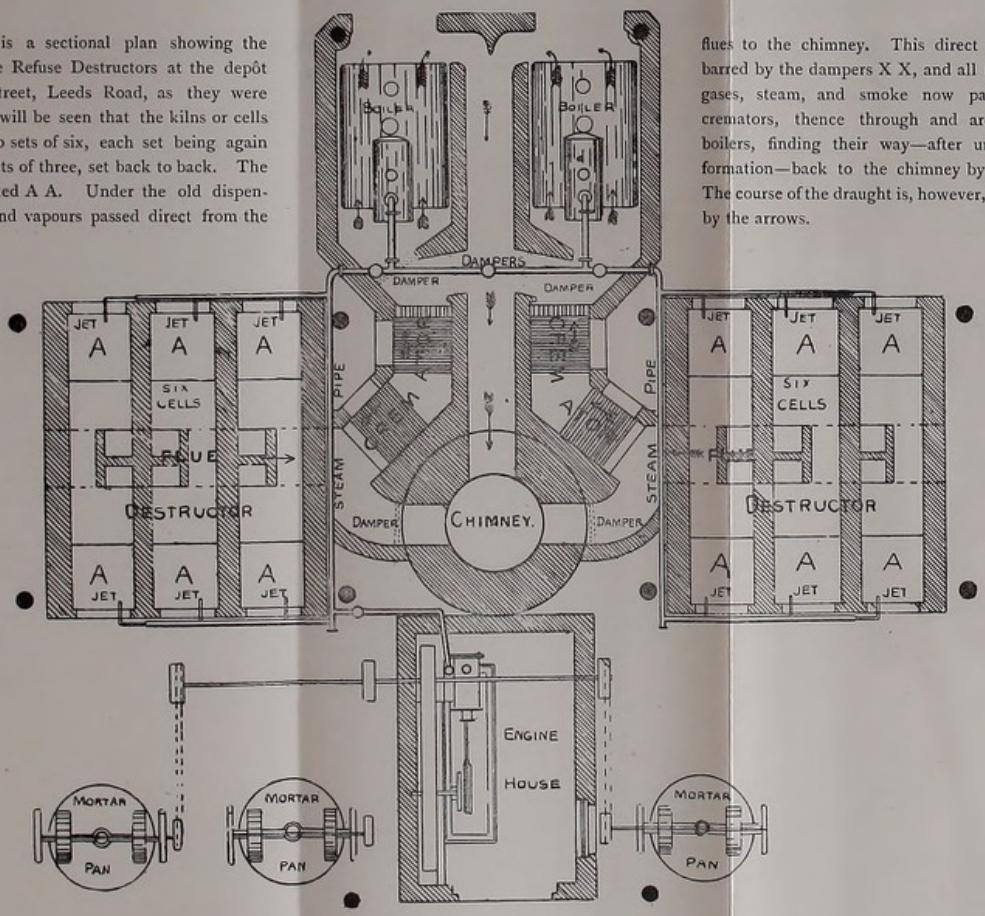
(Plate, No. 8.)

Plan of a

DESTRUCTOR ERECTED AT HAMMERTON STREET, BRADFORD.

CREMATORS ERECTED 1889.

This sketch is a sectional plan showing the arrangement of the Refuse Destructors at the depôt in Hammerton Street, Leeds Road, as they were altered, 1889. It will be seen that the kilns or cells are arranged in two sets of six, each set being again divided into two sets of three, set back to back. The firegrates are marked A A. Under the old dispensation the smoke and vapours passed direct from the flues to the chimney. This direct passage is now barred by the dampers X X, and all the unconsumed gases, steam, and smoke now pass through the cremators, thence through and around the steam boilers, finding their way—after undergoing transformation—back to the chimney by the central flue. The course of the draught is, however, clearly indicated by the arrows.



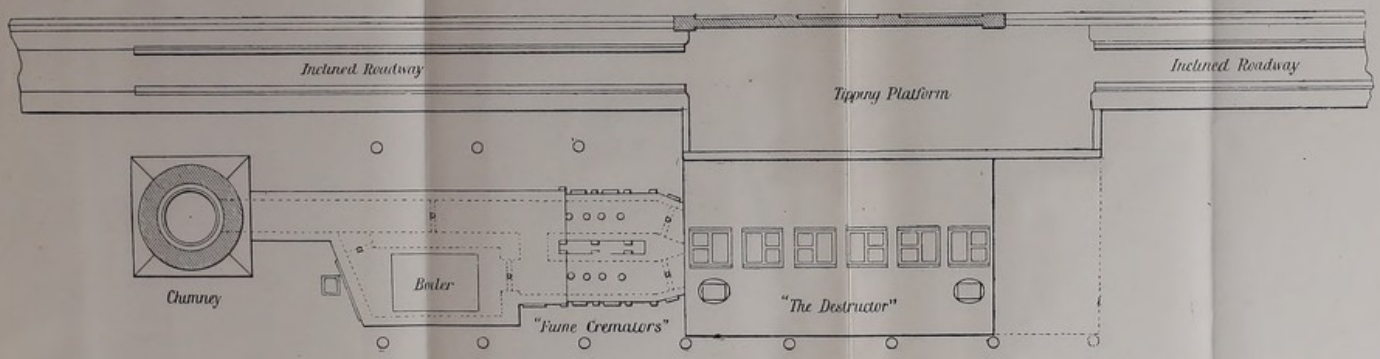
(Plate, No. 9.)

Plan of a

TWELVE CELL "DESTRUCTOR" AND "FUME CREMATOR,"

ERECTED AT BATTERSEA,

1887.



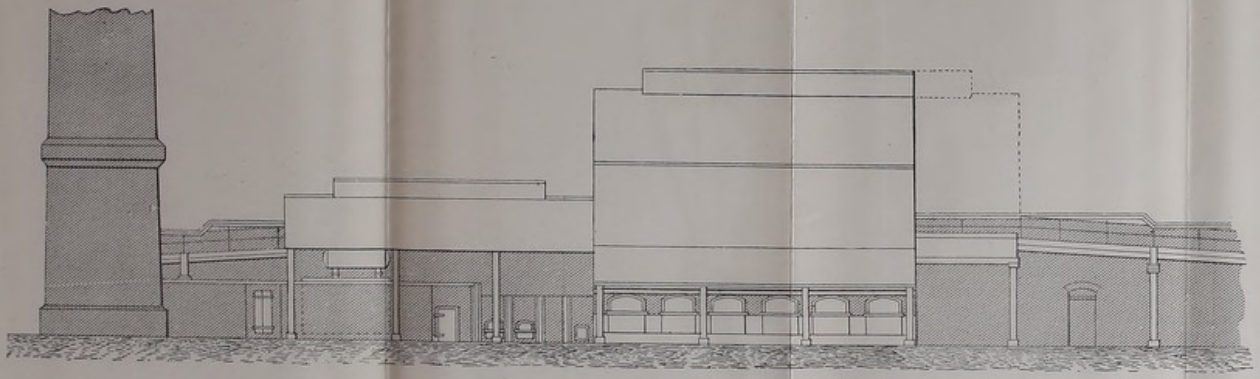
(Plate, No. 10.)

ELEVATION OF

TWELVE CELL "DESTRUCTOR" AND "FUME CREMATOR,"

ERECTED AT BATTERSEA,

1887.



Scale $\frac{1}{16}$ Inch to 1 Foot

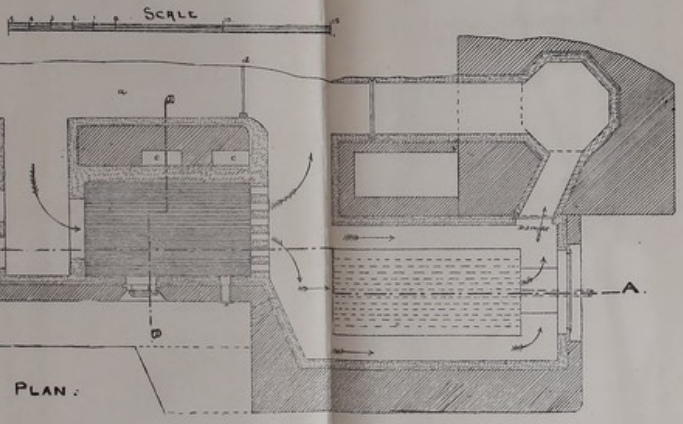
JONES'S PATENT "FUME CREMATOR,"

AS IN USE AT

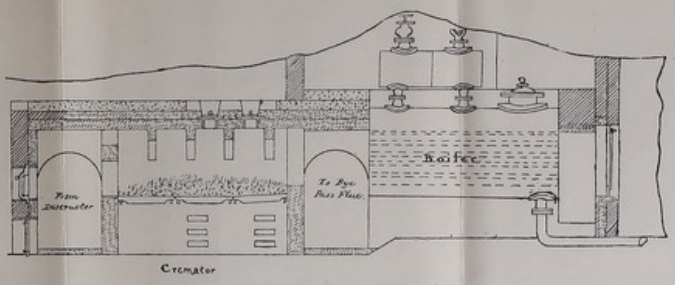
EALING, MIDDLESEX.

REFERENCE.

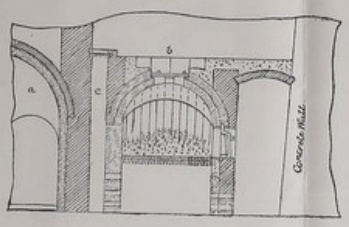
A *Dust Chamber and Main Flue.*
B *Feed Holes.*
C *Air Regulating Flues.*
D *Iron Door.*
E *Damper.*



PLAN.



SECTION A.A.

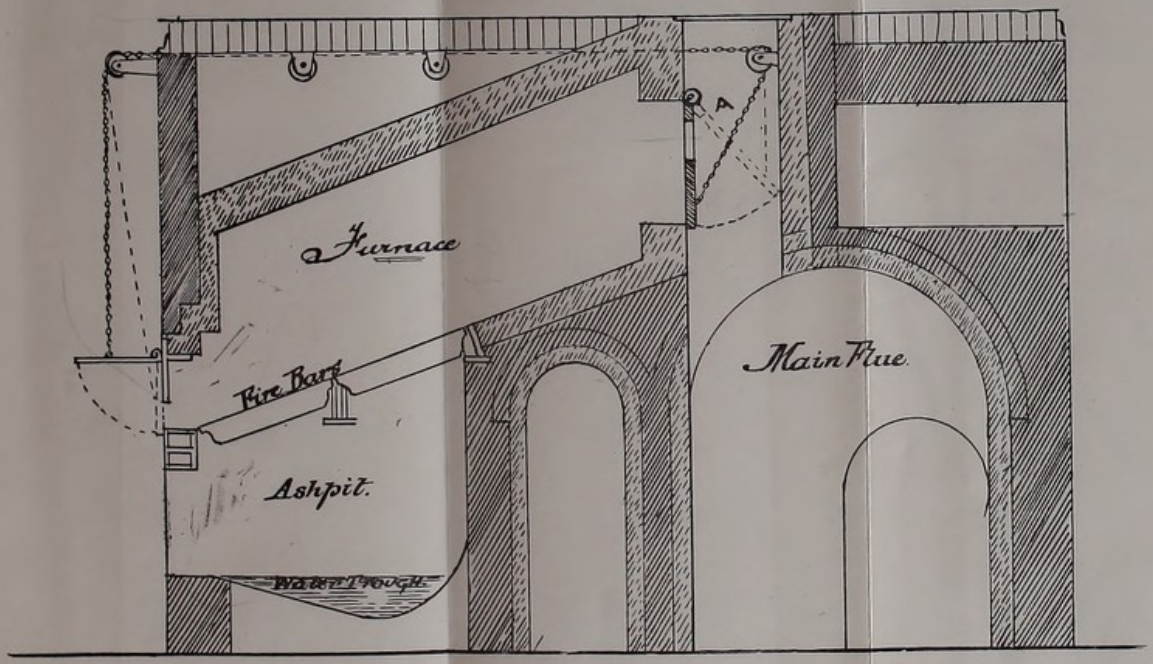


SECTION B.B

(Plate, No. 12.)

EALING

SHOWING AUTOMATIC DOOR, A, AT REAR OF CELL, ALSO WATER ASH PIT.



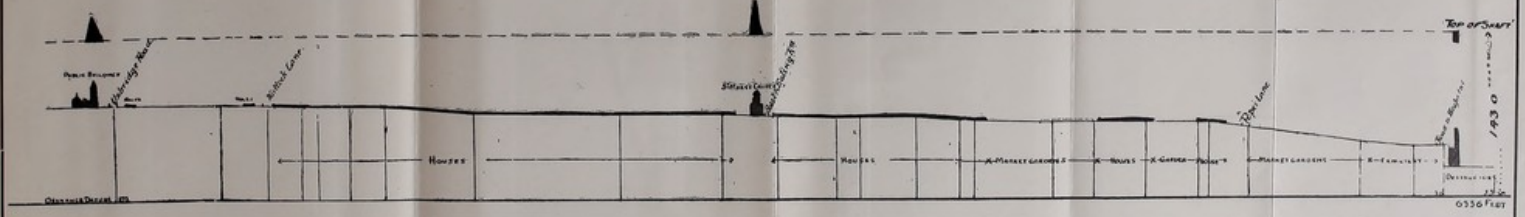
SECTION THROUGH DESTRUCTOR.

C. JONES, M.I.C.E.

(Plate, No. 13.)

EALING LOCAL BOARD.

SECTION SHOWING RELATIVE LEVELS FROM PUBLIC BUILDINGS TO DESTRUCTORS.



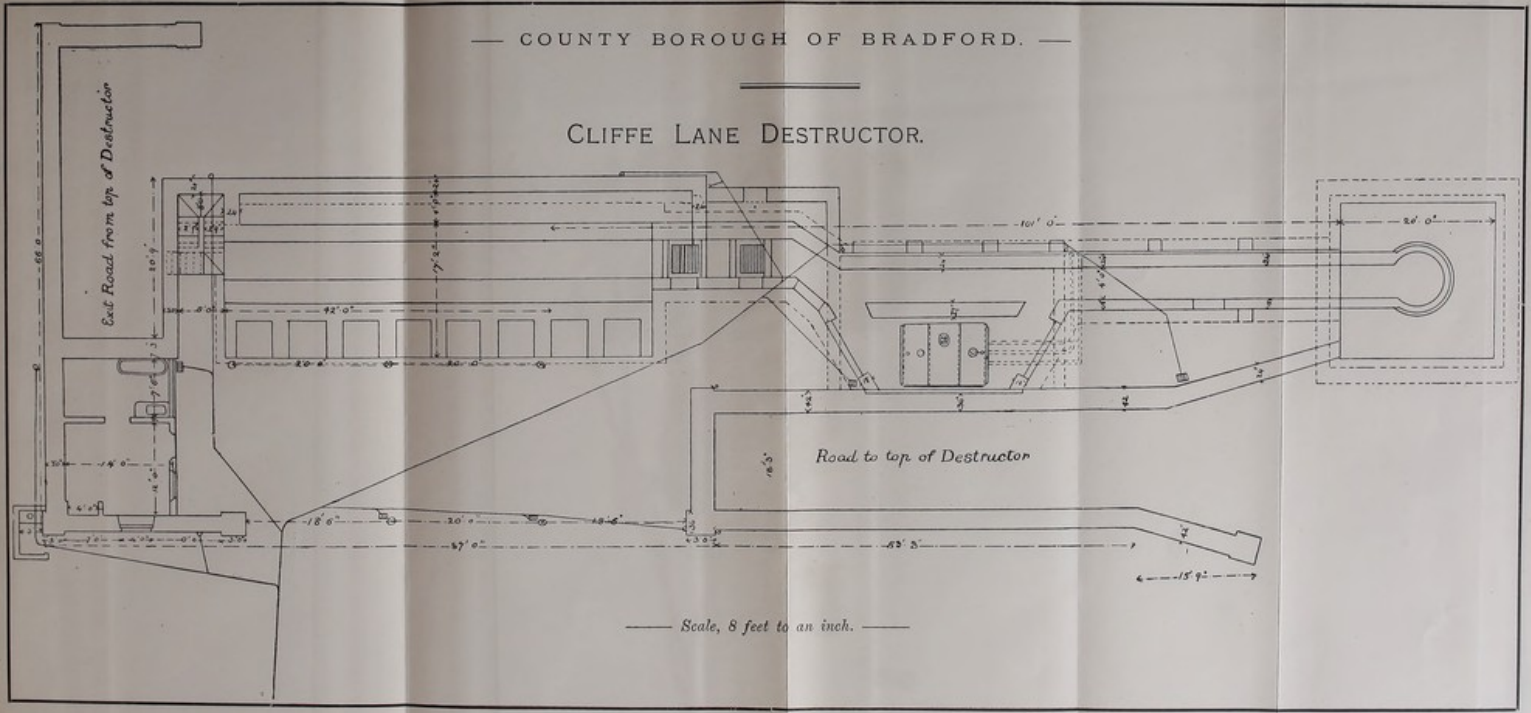
Horizontal Scale, 440ft. to One inch. *Vertical Scale, 50ft. to One inch.*

C. JONES, M.I.C.E.

(Plate, No. 14.)

— COUNTY BOROUGH OF BRADFORD. —

CLIFFE LANE DESTRUCTOR.

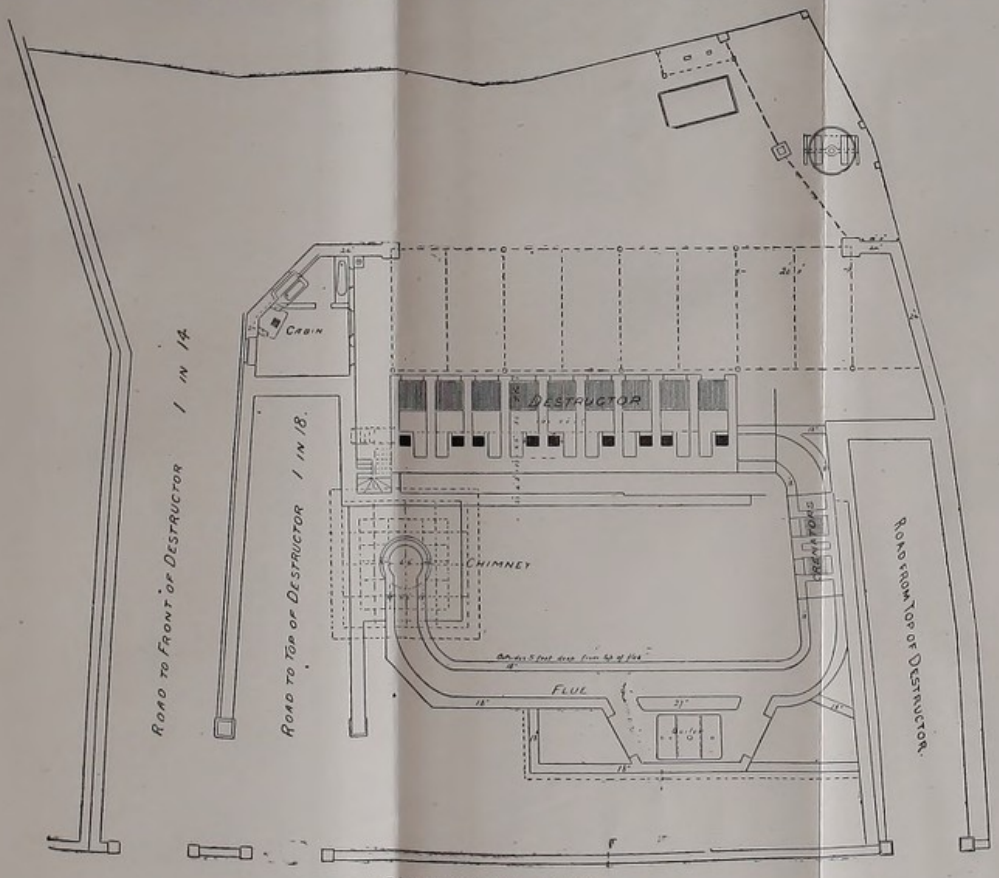


— *Scale, 8 feet to an inch.* —

(Plate, No. 15.)

BOROUGH OF BRADFORD.

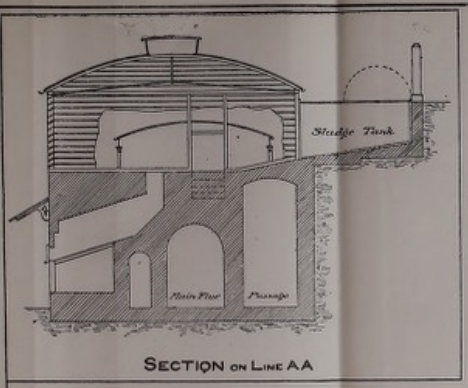
SUNBRIDGE ROAD DESTRUCTOR.



(Plate, No. 16.)

SIX CELL "DESTRUCTOR" & "CREMATOR" ERECTED IN RUSSIA, 1893.

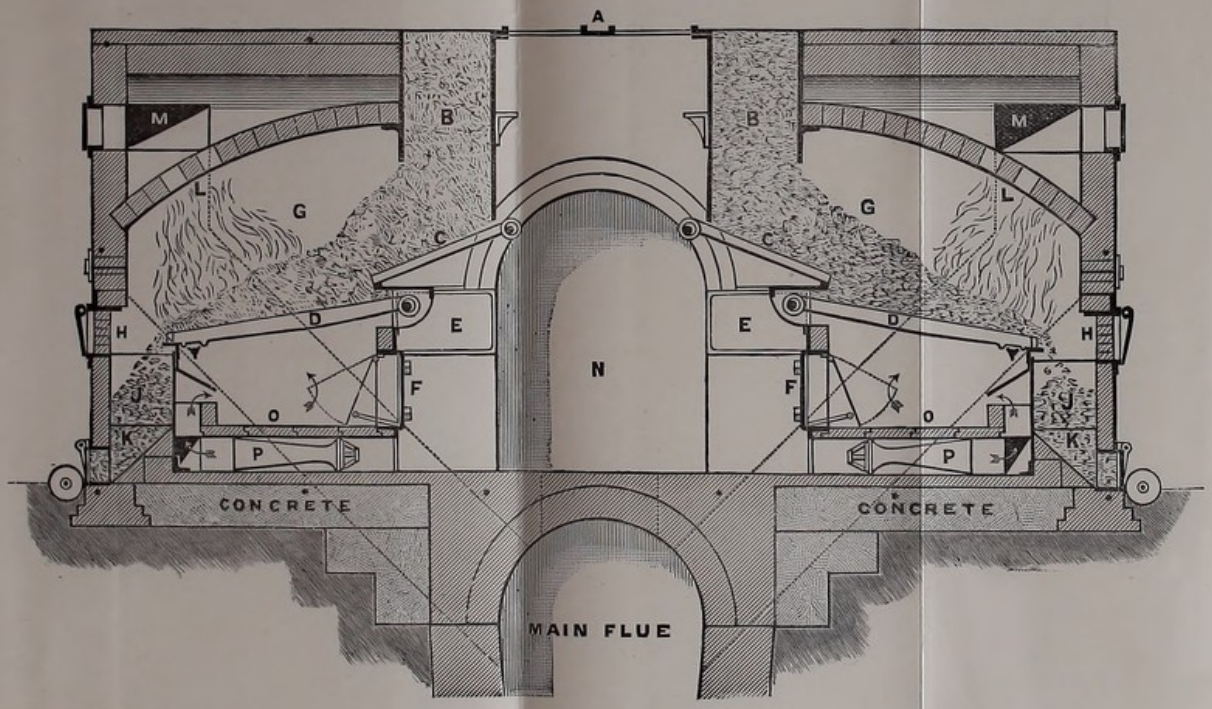
SPECIALLY DESIGNED FOR DEALING WITH HOUSE REFUSE (Pail System) & OFFAL.



SECTION ON LINE AA

CHAS JONES, M.Inst.C.E. ENGINEER

HEALEY'S "DESIDERATUM" REFUSE DESTRUCTOR.

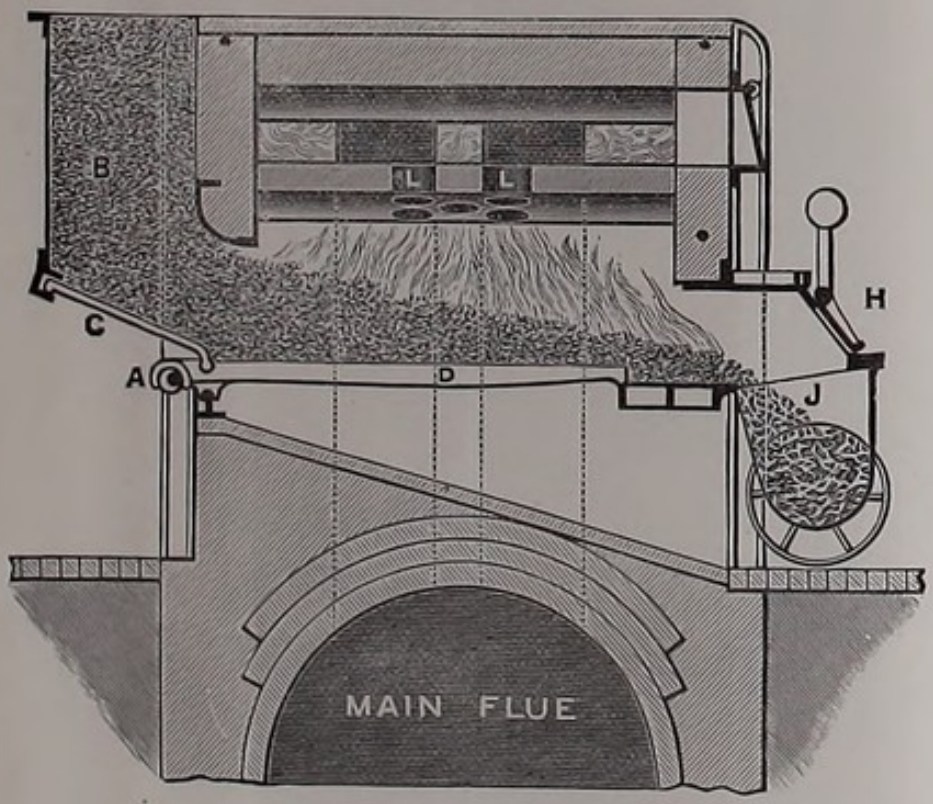


A *Narrow Guage Tramways.*
B *Hoppers.*
C, D *Moving Bars.*
E *Framing.*
F *Closed Doors.*
H *Starting Doors.*
J *Clinker Coolers.*
K *Sliding Plates.*
L *Final Combustion of Gases.*
N *Central Cave.*
O *Ash-Pits.*
P *Steam Blowers.*

(Plate, No. 18.)

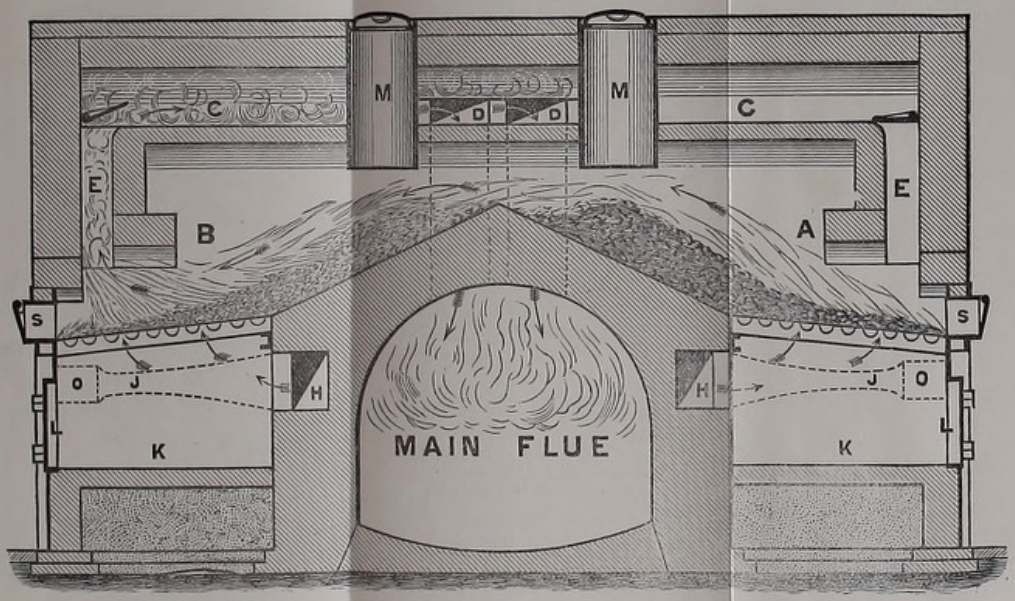
HEALEY'S "DESIDERATUM":

ALTERNATIVE ARRANGEMENT.

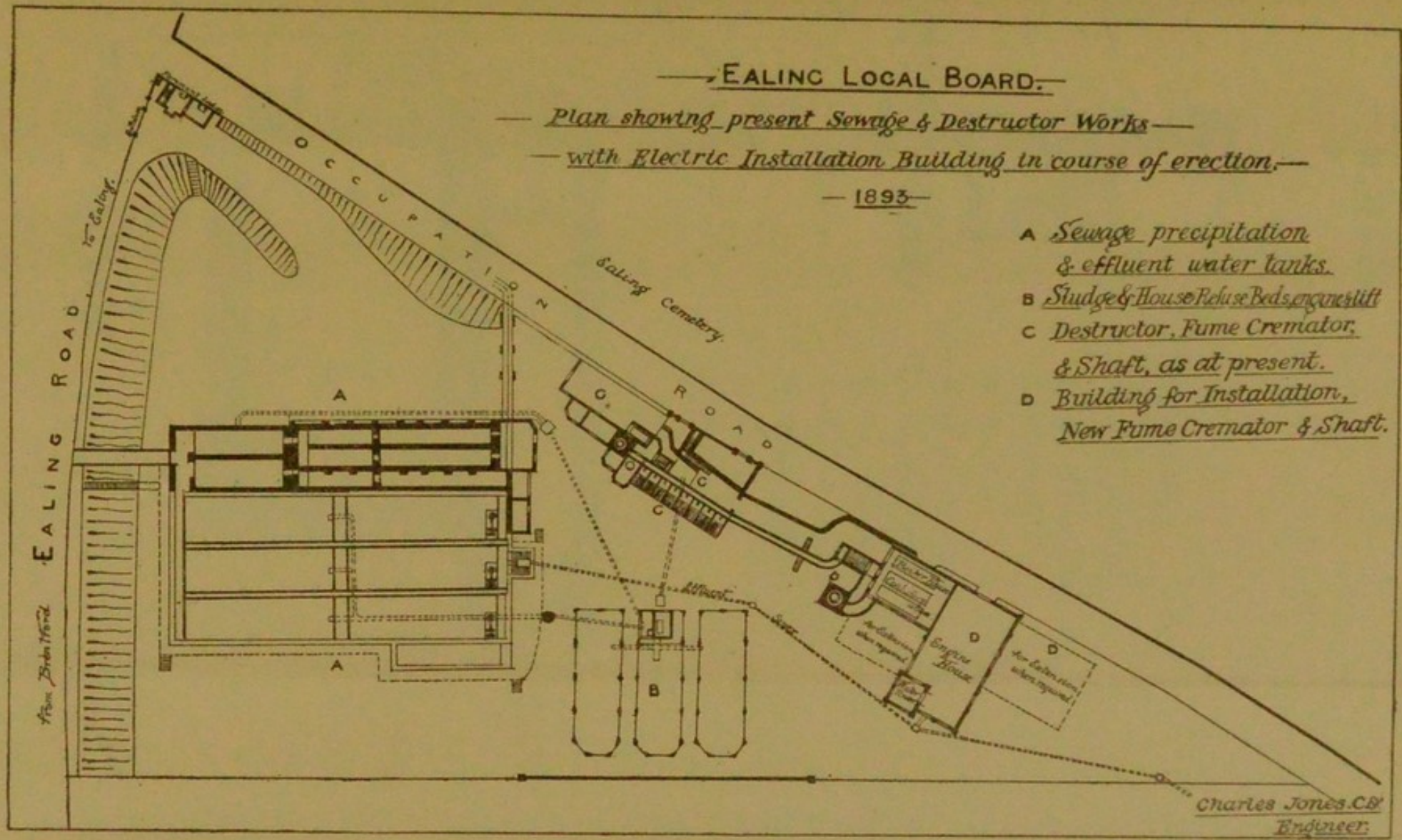


(Plate, No. 19.)

HEALEY'S "ECONOMIC" REFUSE CREMATOR.



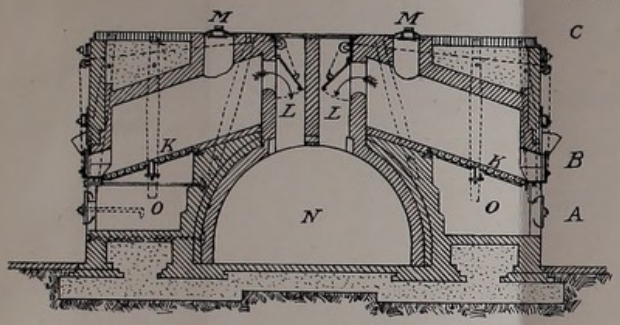
A *Front Fire.*	E, H *Flues.*	M *Feed Holes.*
B *Back Fire.*	J *Steam Blowers.*	O *Air Inlets.*
C *Secondary Arch.*	K *Ash-Pits.*	S *Clinker Doors.*
D *Outlets.*	L *Ash-pit Doors.*	


EALING LOCAL BOARD.
Plan showing present Sewage & Destructor Works
with Electric Installation Building in course of erection.
1893
A Sewage precipitation & effluent water tanks.
B Sludge & House Refuse Beds, engine & lift
C Destructor, Fume Cremator, & Shaft, as at present.
D Building for Installation, New Fume Cremator & Shaft.
EALING ROAD
OCCUPATION ROAD
Ealing Cemetery
From Brentford
To Ealing
A
B
C
D
Effluent
Sewer
Engine House
Charles Jones C.E.
Engineer.

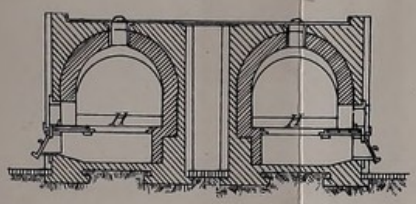
PLAN OF REFUSE DISPOSAL WORKS,

POWDERHALL,

EDINBURGH.



Cross Section. of Destructor

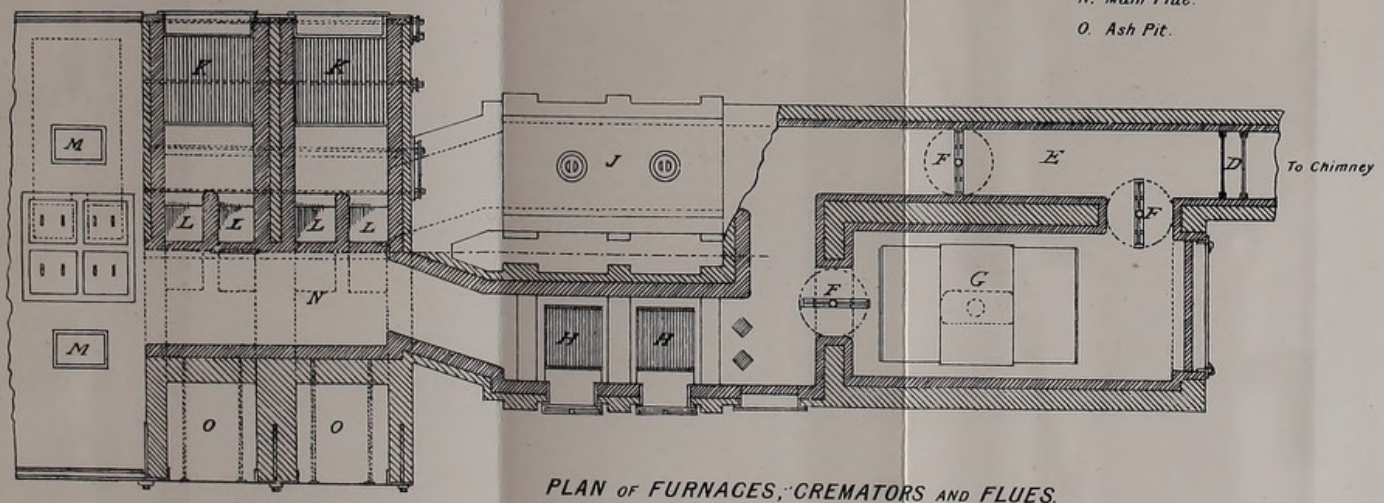


Cross Section of Fume Cremator

REFERENCES.

D. Dust Screens.
E. Bye Pass Flue.
F. Dampers.
G. Boiler.
H. Cremator Grates
J. Cremator Top.
K. Furnace Grates.
L. Flues from Furnaces
M. Charging Doors.
N. Main Flue.
O. Ash Pit.

Plan at C. Plan at B.

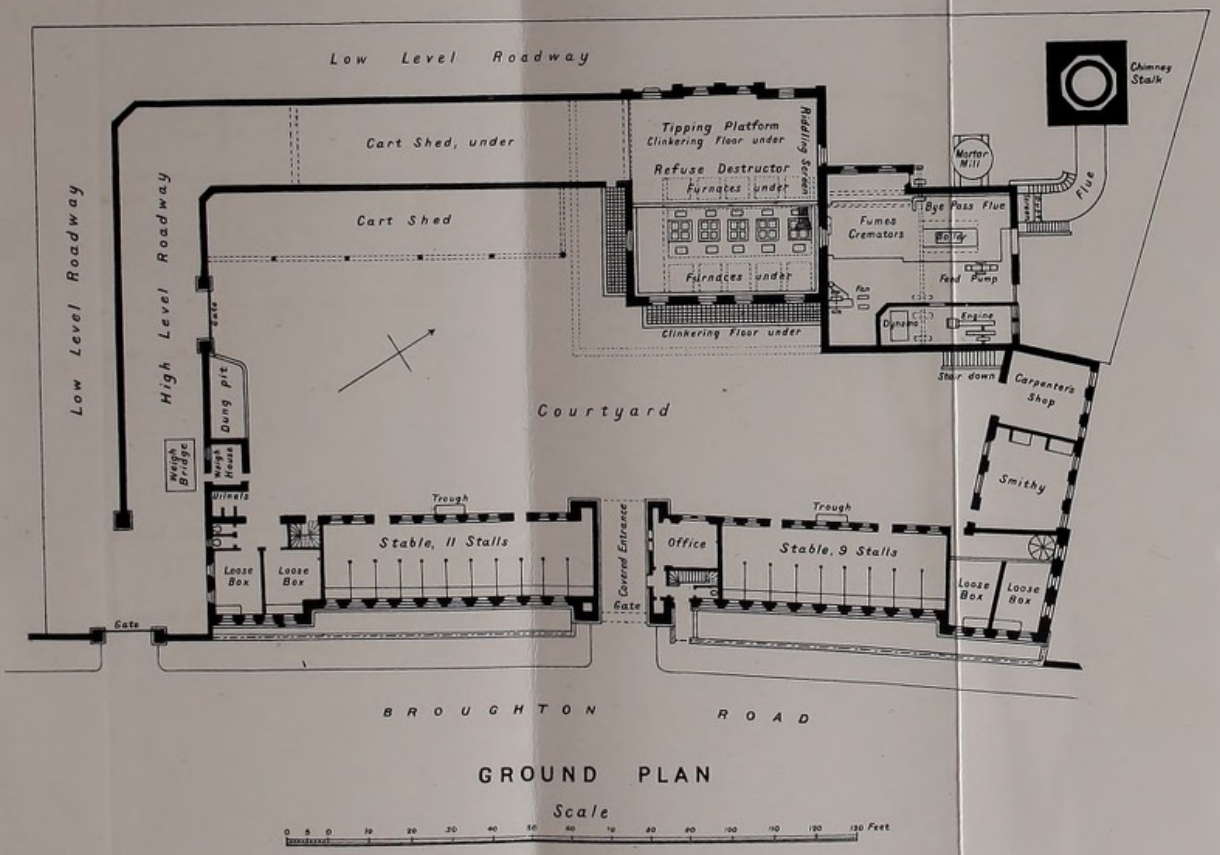


Plan at A.

PLAN OF FURNACES, CREMATORS AND FLUES.

SCALE $\frac{1}{8}$" = 1 FOOT.

PLAN OF REFUSE DISPOSAL WORKS, POWDERHALL, EDINBURGH.



GROUND PLAN

Scale

0 5 0 10 20 30 40 50 60 70 80 90 100 110 120 130 Feet