12TH OCTOBER, 1911.

REFUSE DESTRUCTORS.

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The author does not think that any apology is necessary for reading a paper on the above subject before the members of this Association, because while doubtless the subject appeals principally to the Sanitarian, still in the design of the Modern Refuse Destructor there is much of interest to the Mechanical Engineer, and the fact that such plants now play a part in power production is yet another reason why the subject is one worthy of the consideration of our members.

It is not proposed in this paper to deal with the necessity for the Refuse Destructor, except to say that experts of all countries, with the possible exception of America, are practically unanimous that destruction by fire is the only proper and hygienic method of disposing of the garbage of any city; and there are few cities of any size which are now without a Destructor of some kind. Members are probably quite aware that more than one epidemic has been traced to the refuse tip, generally through the agency of the household fly, which one minute is browsing (if such an expression may be used) on the putrescent matter of the tip, and the next is busying himself on breakfast tables. During the recent Medical Congress held in Sydney, a paper was read by Dr. Willis on "The House Fly," and its important agency in the spread of typhoid fever, and the following extract taken from this paper states forcibly the absolute necessity for the Refuse Destructor.

"Most public health workers," said the doctor, "believed that the ordinary house fly plays at least some part in the transmission of typhoid fever. The debatable point appeared to be in its importance in that connection. House flies were most numerous in most houses in the warmer weather, and they had, in the majority of cases, free access to human food. Their anatomy favoured the retention of live bacilli in their insides for days. That this retention did take place has been proved bacteriologically in the case of thyphosus and other organisms. Their habits of feeding placed them in the possible position of being often loaded with typhoid bacilli. House flies produced large numbers of deposits of fluid and faeces every 24 hours. If the flies had fed on material containing typhoid bacilli, the typhoid bacilli might be contained in large numbers in these deposits for a number of days. The manner in which flies fed, especially when ingesting soluble solids favoured infection of human food with any bacteria the flies might have previously imbibed. There were many evidences pointing to the casual connection between flies and transmission of typhoid, and it would appear, therefore, that the house fly was an important agent in transmitting typhoid, at least in unsewered districts.

"The chief breeding places are collections of horse manure, spent hops, decayed fruits and vegetables, in rotten flock beds, straw mattresses, old cotton garments, waste paper, etc. Municipal tips were most important breeding places.

Similar testimony could be quoted from other Medical men as to the evils of the tipping system, but it is sufficient to point out that, if, as is the case, a Destructor forms part of nearly every municipality of any size in Great Britain, climatic conditions in Australia render such apparatus even more necessary.

The writer does not think that any good purpose will be served by dealing at length with the history of the evolution of the Destructor, but it may be mentioned that the

first destructor was, as far as can be gathered, installed in the year 1876 at Manchester, the inventor being Mr. Alfred Fryer, and it is worthy of note that this installation is still at work, though of course with many adaptions and alterations. This Destructor worked under natural draught conditions, and it was not until forced draught was substituted, and consequent high temperatures obtained, that a Refuse Destructor came to be recognised as an indispensable adjunct to any progressive municipality.

The writer proposes in this paper to deal in detail with a Destructor installation at work at the Electric Light and Power Supply Corporation Power House, Balmain, for the design of which he was responsible, and to consider in detail this design, with some other Destructors by English manufacturers at work in some of the other cities of the Commonwealth.

In most Destructor installations the furnaces, or cells, are designed to deal with 15 tons per cell per 24 hours, or say roughly a little more than ½-ton per cell per hour, and in connection with this point, that is to say the number of cells necessary to burn any given amount of refuse, too much emphasis cannot be laid on the great difference between English and Australian refuse. It is known that there have been some failures experienced with Destructors of English design erected in Australia, and, while these Destructors came to this country with excellent reputations, they have not always succeeded in maintaining the same. In more than one instance these Destructors have failed to burn the quantity guaranteed by the maker, and, in the writer's opinion, this is due to the great difference existing between English and Australian refuse, the latter having at least 25 per cent. greater bulk than English for the same dead weight, hence the necessity for providing more capacious furnaces and with greater headroom. Furthermore, Australian refuse has at least 30 per cent. less heat value than English, which means that, to burn the same quantity in

a given time, a grate of considerably greater area must be provided. The Balmain Destructor has a grate area of 42 sq ft. per cell, each grate being 7 ft. wide and 6 ft. long. This area is the largest that one man can satisfactorily control, and in the author's opinion is the minimum necessary for burning 15 tons per day of 24 hours.

It must not be forgotten in dealing with this all-important point of grate area, that climatic conditions in Australia are such that the Destructor fireman's lot at certain seasons of the year is not a particularly happy one, and that a little extra grate area is of great assistance to him as compared with a smaller area which he has to clinker more often to get through the proper amount of work for the day. The writer knows that some excellent figures have been obtained from English Destructors at work in Australia, on test runs of short duration, but he thinks that over an extended period some of these installations would show very much poorer results.

Before proceeding to consider the Balmain Destructor, it is perhaps necessary to state that there are at the present time only three or four firms devoting their energies to the manufacture of such plants, and the principle obtaining in each is the same, that is to say; the refuse is deposited on a suitably proportioned grate upon which it is burned by means of forced draught, the products of combustion being taken to a common combustion chamber, from whence they pass through a steam generator and thence to the chimney.

Whilst all Destructors follow this general idea, there is a considerable difference of design in the details of the method of charging the cells and the cleaning of the same, also in the design of the furnaces, the position of the combustion chamber relative to the furnaces, the type of boiler, the means of providing forced draught, and the heating of the same, when this is done. Plate I., Fig. 1, will help to make these points of difference more clearly understood.

The figure shows a cross section through one of the furnaces (usually termed cells) of which there are two, and the boiler. The garbage to be destroyed comes in on the high level road, the carts backing against the tipping beam, and discharging the contents on to the charging floor, which is also the top of the furnaces. From this floor the refuse is shovelled into the hopper, which, at a signal from the fireman, is opened and the contents precipitated on to the floor below, termed the drying hearth. After remaining on this hearth for a period, during which it is dried by means of the radiant heat from the arch over the grate, the refuse is pulled forward on to the grate by the fireman, combustion takes place, and the gases pass by the outlet flue into the combustion chamber.

At this point it should be mentioned that, in any Destructor installation, there are never less than two cells, each being charged and clinkered in rotation, and at a fixed time. consequently whilst one cell is discharging gases at high temperature into the combustion chamber, the other cell (only recently charged) is sending gases there at a comparatively low temperature. The gases distilled from a newly charged cell, if allowed to pass direct to the chimney, would cause a serious nuisance, and it is highly necessary that these noxious gases should be properly burnt by being raised to a high temperature before they are permitted to escape to the atmosphere. By mixing them in the combustion chamber (which has a fairly constant temperature of 1500 deg. Fahr. or over), with the high temperature gases from the cell which is at its best, this burning of the noxious gases is properly performed before the gases reach the comparatively cold tubes of the boiler.

The position of the combustion chamber is such that its roof forms the floor of the drying hearth, and there can be no doubt that this arrangement materially assists in drying the refuse, and consequently increasing the burning

capacity of the cell, particularly during continuous wet weather when the refuse contains a very large percentage of moisture.

Plate I., Fig. 2, shows a sectional plan of the Destructor block at ground level. The course of the gases can be traced from the combustion chamber F. through the boiler, thence through the air heater (more fully described hereafter) and so on to the chimney.

Plate I., Fig. 3, shows another view of the Destructor block, viz.: a sectional elevation through the Destructor cells. This figure illustrates the construction of the furnaces. It will be noticed that the furnaces are lined with 9in. fire brick, generally of Scotch or English manufacture, and over the main arch is turned a relieving arch to permit the main arch being renewed with a minimum of trouble. The outside walls are of common brick set in lime mortar, and lime concrete is used as filling over the main arches; cement concrete cannot, of course, be used on account of the heat. The charging floor is paved with good hard brick laid on edge, and the complete block is suitably braced by rolled steel joists as buckstaves, and tied with substantial bolts fitted with plate washers.

Plate II., Fig. 1, shows a plan view of the installation taken at grate bar level, and it illustrates the position of the fan and the air heater for forced draught to the furnaces, it also shows the chimney. As may be noticed in the figures 1 to 4 the combustion chamber is situated below the drying hearths, whilst on Fig. 4 may also be seen the large door for access to the chamber, and for cleaning purposes.

Plate II., Fig. 2, shows the front elevation of the Destructor cells and a part section through the rear chamber of the boiler. The air heater is clearly shown in this view as also are the rolled steel joists coupled together as buckstaves, the balanced clinkering doors made in halves, and the ashpit doors below.

Having outlined the general arrangement of the Destructor, the various parts and operations may be considered in more detail and points of difference as compared with other designs noted.

The first point to consider is with regard to the method of charging the cells, and which, as appertaining to the Destructor illustrated by the figures above referred to, has already been described. Plate II., Fig. 3, shows the Balmain Council carts tipping their contents on to the Destructor, and Plate III., Fig. 1, the chargeman raking the refuse into the hoppers. Most destructor manufacturers follow this method, but some adopt as an alternative what is known as front feeding, that is to say, the refuse is delivered into hoppers on the ground level, from which it is fired on to the grates in the same manner as a coal fired furnace.

Whilst there is something in the argument that the front feeding system gives a better fire and more freedom from holes than the top feed, still, it must be apparent that considerably more labour is required in the former as compared with the latter system, and there is the further disadvantage of the clinker and refuse being on the same floor, whereas with the top feed they are quite separate. The difference between the two systems is perhaps of little importance with a small installation dealing with say ten tons per day, but, for larger plants, comprising perhaps 12 cells, and each destroying 15 tons per 24 hours, it appears to the writer that the top feed is altogether preferable.

Whatever system of charging is adopted, the method of removing the residue after burning is finished is identical in all destructors, the clinker being dragged out through the large balanced doors in the front of the cell, from whence it falls into some type of truck, and by which it is removed to the tip or other convenient place.

Plate III., Fig. 2, shows the Patent Clinker Railway. After clinkering is finished, a fresh charge is dragged down by the fire man from the drying hearth on to the bars, the draught is again started, and fresh charges are from time to time placed on the fire until, in about one hour's time, the cell is again ready for clinkering.

As members will have judged from the above brief description, the feeding of refuse into the cells, and the subsequent removal of the clinker are operations requiring a large amount of manual labour, particularly in the case of large plants handling say 250 tons per 24 hours, and it is much to be regretted that no satisfactory system has yet been invented for doing the work mechanically. Many attempts have been made by experts to solve the problem, but the writer believes he is right in stating that so far, not one has been really successful. The principal difficulty is, of course, that refuse, as brought to the Destructor, may consist of almost anything, and the difference in the size and nature of the material to be handled makes it most difficult to perform the operation by machinery.

A further difficulty in the way of mechanical charging is that of preventing smoke issuing from the hopper whilst the charging operation is proceeding, and furthermore there is the fact that the composition and nature of refuse are such that, no matter in what type of hopper it is placed, it packs very closely and forms bridges which require a lot of moving, that is to say, the material is not free running. Whilst considerable thought has so far been given to the subject and without much success, he would be a brave man, who in these days of progression, would say that the problem will not be solved in due time. However, inasmuch as the adoption of refuse destruction depends, in a large measure, on the cost per ton entailed, and bearing in mind that practically the whole of this cost is at present absorbed in feeding and clinkering, some mechanical means of effecting this operation is much to be desired.