As there are two distinct methods adopted by different makers for feeding the refuse into the cells, so are there two separate designs for the cells themselves; first, that in which each cell is separate and complete in itself, as in the Balmain installation, and secondly, that in which all cells are common to each other, and without dividing walls, except so far as the ashpits are concerned. The latter design will be referred to again later.

Both systems have their advocates, the principal objection urged against the common cell being, that when one is being charged, cold air is admitted to all, tending to reduce the temperature of the whole. On the other hand there is the advantage that the heat from each cell helps the others and, assuming that one cell has been charged with green refuse, then the other cell or cells being at their best, assist considerably in reducing the one newly charged. The writer believes that there are probably good features in both systems, but nevertheless he considers that, if anything, the separate cell system is the better, principally because it is comparatively easy to renew, or repair, any one cell whilst the others are at work—an important point in a large installation.

Dealing next with the combustion chamber, which part some makers omit altogether from their designs, the writer considers such to be essential, that is if the gases escaping from the chimney are to be unobjectionable, and it is certainly his opinion that the omission of a combustion chamber is not conducive either to steady steaming or proper combustion of the gases.

In addition to the fact already mentioned, viz.: that the combustion chamber acts practically as a temperature equaliser, or heat reservoir, it also forms a most useful dust catcher. The amount of dust carried over with destructor gases is very considerable, and the combustion chamber is not only a suitable point at which to rid the gases of some of their contents before entering the steam boiler, but owing to the size and design thereof, it is an easy matter to remove the dust therefrom, after it has been deposited, with a minimum of labour.

With regard to the best type of steam boiler for combining with a refuse destructor, here again there is considerable difference of opinion, and Cornish, Lancashire, and Water Tube Boilers respectively have been freely adopted. The two firstmentioned have of course the advantage of larger water capacity as compared with the Water Tube, which feature, bearing in mind the fluctuations in the temperature of the gases due to charging and clinkering which occur in every Destructor, however well designed, conduces to a steady steam pressure. Water Tube Boilers, on the other hand, are quicker steam raisers, occupy less floor space, are more easily adaptable for firing with waste gases, and are certainly more easily cleaned. The last point is an important one in view of the large quantity of dust carried over by the gases. On the whole the writer prefers the Water Tube Boiler and in some designs it is placed so that the gases are admitted at the side, leaving the front free for coal firing, if at any time required. The increasing use of the destructor in connection with electric supply installations has also rendered the provision of boilers constructed for high pressures imperative, and for such requirements the Water Tube has much to recommend it in preference to the Lancashire and Cornish types.

Forced draught is now provided in all Destructor installations, the pressure adopted in the ashpits being equal to 2in. to 3in. water gauge, and in nearly all cases the air is heated so that it reaches the ashpits at a temperature approaching 300deg. Fahr.

One of two systems of providing draught is generally adopted, either Steam Blowers or Fans, and much controversy has taken place as to their relative efficiencies. The writer, after experience with each is satisfied that fan draught is the more efficient, but if the amount of steam used by a blower is of no account, and the first cost of fan power is a great consideration, then a steam Blower should be provided.

The air is generally heated either by the Howden system, so favourably known in sea-going practice, or by passing the gases, after they have left the boiler, through a series of vertical cast iron pipes. The air to be heated is circulated around the outsides of these pipes and then passes to the ashpits to where it is induced by means of the draught set up by the steam Blowers or Fans.

In the Balmain installation a new system of heating the forced draught was adopted, the arrangement being as shown on Plate II., Fig. 1. The whole of the rear chamber of the Water Tube Boiler was filled with 1½in. diameter tubes, one end of these being open to the atmosphere and the other terminating in a box to which the suction to the Fan was connected. Air is drawn through the tubes by the Fan, and the waste gases leaving the boiler circulate round the outside, the air being delivered to the furnace at a temperature approaching 300deg. Fahr. The arrangement is a compact one and the writer believes it had not previously been tried. It should also be noted that the free ends of the tubes are nearest the clinkering floor, so that the dust created during the operation of clinkering is quickly removed by the Fan and the ventilation considerably improved.

The Destructor as a Power Producer.

Whilst it cannot be too strongly emphasised that the primary purpose of the Destructor is to satisfactorily destroy refuse without causing a nuisance, and that this condition must govern all others, it must still be apparent that the amount of heat generated in the modern high temperature Destructor of moderate size is considerable. As is usually the case with new schemes, the advent of high temperatures in Destructors gave birth to a number of extravagant claims, not only on the part of the manufacturers, who claimed that enormous savings and benefits could be brought about by the combination of Destructor plants with electricity works, sewerage and water pumping schemes and the like. In fact it was almost claimed that in ordinary household refuse a new fuel for general purposes had been discovered and extravagant figures were stated and sometimes guaranteed as to the quantity of water that could be evaporated per pound of refuse.

The natural sequel to these unwarranted claims was that a number of combined schemes for utilizing the steam generated by the combustion of refuse for power purposes proved failures, and much harm to the progress of the Refuse Destructor was the result.

To-day, however, the limitations, and also, it may be added, the advantages of the Refuse Destructor for power purposes are clearly defined, and during recent years many well considered installations, wherein full advantage has been taken of the steam generated, without in any way sacrificing their ultility, have been brought to a successful issue.

Amongst such schemes the writer considers the Balmain Destructor may be included, and in Plate III., Fig. 3, are given the results obtained from this installation over a period of nine months. Owing to insufficient refuse being available, the Balmain Destructor works only eight hours out of the twenty-four, but nevertheless the record of 102.5 K.W. Hours delivered at the switchboard is a good one, and compares favourably with the performances of many English Destructors burning "old country" refuse.

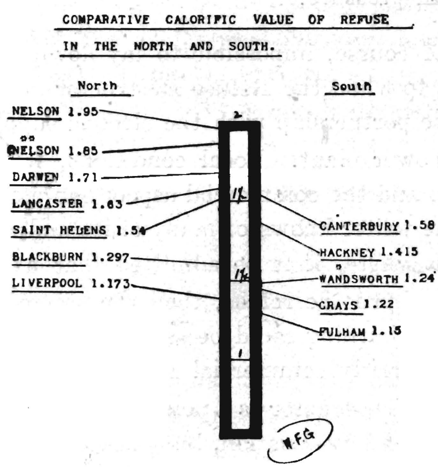
In considering the Refuse Destructor as a power producer, it must not be forgotten that to some extent the proper burning of refuse and power production go hand in hand, for to destroy refuse without creating a nuisance, perfect combustion is absolutely necessary. This entails a high temperature in the combustion chamber, free from any considerable fluctuation, which in turn ensures the maximum utilization of the heat units in the refuse and a reasonably steady steam pressure.

It is, of course, impossible to lay down any hard and fast rule as to when the Refuse Destructor may be brought into effective partnership with the electric supply station or any other power plant. Local conditions, surrounding circumstances, and the commercial aspect can alone determine this, but the writer knows of many cities and municipalities in Australia where, if it be admitted that a Destructor is necessary to burn the refuse, then the steam generated in the process of burning could be satisfactorily used. Looked at from the strictly commercial aspect of pounds, shillings, and pence, the Destructor as a power producer only, will not, of course, stand investigation, but granted the necessity for the Destructor in placing the sanitation of a city on a satisfactory basis, then there are undoubtedly avenues existing for the satisfactory utilisation of the heat developed.

Whilst the purpose of this paper is to deal more particularly with Australian conditions, it should be stated that the refuse obtainable in most English towns contains considerably more heat units than that in the cities of the Commonwealth, consequently in England, the addition of a power plant to a Destructor, can be viewed in a more favourable light.

Rates of evaporation of considerably over 1½ pounds of water per pound of refuse have been recorded with Destructor installations in England, but the writer has never obtained from Australian garbage an evaporation of more than one pound of water per lb. of refuse, the temperature of the feed being about 200deg. Fahr.

The diagram illustrated on this page has been prepared from information procured by an English authority on refuse destruction, Mr. Goodrich, and it is interesting as it shows the calorific value of refuse from various English towns.



oo = Test continuous for one month.

o = Test continuous for one week.

FIG. 6.

It is worth recording that there are now over one hundred Destructor installations in the United Kingdom with which are combined power plants for the generation of electricity and the pumping of water or sewage. Several cities utilize the steam so produced for electric traction, and it is a pity that in the city of Sydney, where in each 24 hours nearly 200 tons of refuse are burned, giving on a conservative basis some 600 K.W. each hour, some satisfactory method of utilizing this power cannot be found.

Clinker Disposal.—The residue after burning, consisting of clinker and fine ash, amounts roughly to about 30 per cent. of the total weight of garbage burnt, and the disposal of this residue is a problem that has to be considered with every Destructor installation.

At Balmain the site for the power house was chosen principally because of the opportunities presented for disposing of the residue cheaply.

In many Destructor installations, however, the site does not lend itself for the easy disposal of the residue after burning, and in such cases the problem of how to dispose of it at a minimum of expense is a serious one.

It has been proved that the Balmain clinker forms an excellent constituent for concrete, and as such it has been specified by several of the leading Sydney architects. The demand for its use, however, is necessarily limited owing to the fact that, beyond a certain radius from the works, cartage charges become too expensive.

In Great Britain, clinker has been put to a great many uses, amongst which may be mentioned concrete blocks for house construction, as a basis for disinfectant powder, for the manufacture of asphalte and for paving slabs. For the last named purpose clinker has been very extensively used, the residue being first ground in a mill and after being screened through a $\frac{1}{4}$-inch mesh it is mixed with Portland cement, in the proportion of two of ground clinker to one of cement. The moulds are then placed under an hydraulic press, and the concrete subjected to a pressure of approximately $1\frac{1}{2}$ tons per sq. inch. After removal from the press the slab is taken from the mould and placed in the open to dry where it remains for about 3 months, when it is in good condition for being used.

There can be no doubt as to the suitability of the slabs for street paving, but the demand for them is limited, and while they form an economical and efficient paving, this does not solve the problem as to what can be done with the major portion of the residue.

The writer considers that after making ample provision for utilizing the clinker in the manner indicated above, the solution of the problem is to choose a site for the installation of the Destructor in immediate proximity to an old clay pit or quarry, into which the residue can be dumped, and there are few municipalities where such a site cannot be found.

Commercial Aspect of Refuse Destruction.—It is only in very exceptional circumstances that the Refuse Destructor can be made a commercial success, and those municipalities desiring to have the most up-to-date methods of sanitation must be prepared to pay handsomely for having their refuse destroyed by fire. In many cases, however, the steam gene rated can be satisfactorily used and a good return received, while, as before mentioned, the sale of the clinker often helps to pay off some of the actual cost of running the plant.

In England, where wages are low, the average cost of labour per ton of refuse destroyed is approximately 1s., but in Australia the same work cannot be done for less than double this amount. In the case of small two cell plants, the cost per ton for wages would, of course, be more, and it is safe to say that, in the case of a plant to deal with the smallest tonnage, the yearly charges, including interest and depreciation, would not be less than £500.

To the cost of wages must be added depreciation and repairs, also interest charges. In any well built Destructor the depreciation charges are considerably lower than would be expected. In the case of the Balmain Destructor, the furnaces, although in actual operation six days per week for the last three years, have never required any repairs, and only one or two minor details have needed attention. In the writer's opinion the life of a well built Destructor can be taken as at least 20 years, and if 6 per cent. be set aside to cover depreciation, this should be ample. Allowing 4 per cent. for interest on capital outlay and taking a two cell Destructor serving a municipality of say 30,000 inhabitants, and capable of burning one hundred and twenty tons per week, the total cost per ton destroyed would be approximately 2s.

Considerable as this amount may seem, it is unlikely that anyone would prefer the cheaper, but odious, method of the tip.

In conclusion the author desires to express his obligations to Mr. J. E. Donoghue, Chief Engineer and Gen. Manager of the Electric Light and Power Supply Corporation, Balmain, for much information relative to the working of their Destructor installation.