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SMALL DESTRUCTORS FOR INSTITUTIONAL AND TRADE WASTE

SMALL DESTRUCTORS FOR INSTITUTIONAL AND TRADE WASTE

BY

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WITH TWENTY-EIGHT ILLUSTRATIONS

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Preface

COINCIDENTLY with the widespread adoption of Refuse Destructors for dealing with civic waste, there has been a keener appreciation of the duties devolving upon large Public Institutions and Works in the disposal of their waste; but while the Municipal Refuse Destructor has been exhaustively discussed, its smaller prototype—the Destructor for dealing with Institutional and Trade Refuse—has been practically overlooked.

In the various works on Refuse Disposal the small Destructor has not been discussed. In those works for which the author has been responsible such omission was not an oversight; nor may it be fairly attributed to a desire to inflict another book upon suffering humanity, but mainly because that large body of

PREFACE

Municipal engineers who are directly interested in the disposal of civic waste have but a minor interest in the disposal of Institutional and Trade Waste.

Those responsible for the design, planning and superintendence of Public Institutions and large works are more directly concerned in the disposal of the waste therefrom: and the author undertook the preparation of this small work in the hope that it may be found of service to Architects, Medical Superintendents, large Manufacturers, and all who are immediately concerned in the final and sanitary disposal of the waste produced in Hospitals, Infirmaries, Asylums, Sanatoria, Convalescent Homes, Hydropathic Establishments, Hotels, Collieries and large Works, where the available waste may frequently be turned to profitable account for power production.

If any further explanation be necessary, I would add that the need for a work of the kind was suggested to me after a perusal of the evidence given in the case of Chapman *v.* Gillingham Urban District Council, which glaring example of carelessness in refuse disposal is referred to at some length in these pages.

In the *Daily Express* of April 4, 1903, the following startling sentences may be found under the heading of "Tragedy in Pork":—

"To the Cork Board of Guardians, yesterday, the Workhouse Master reported that seven pigs fed in the House had died during the week.

"A Guardian stated *that they were fed on linseed poultices from the Fever Hospital*, and it was not surprising that they died. A special enquiry into the affair has been ordered."

Such a case as this following immediately upon that already referred to only serves to show that while we are making splendid progress in the final and sanitary disposal of our civic waste, much yet remains to be done on similar lines in the disposal of waste in our Public Institutions.

While it is true that the Hospital Refuse Destructor is not a new invention, it is equally true that many of the small Destructors in use are crude in design, unsatisfactory in working, and productive of nuisance.

If such nuisance should be avoided anywhere it should surely be rendered impossible in close proximity to the afflicted; and those who unfortunately "fall by the way" can surely best recuperate in an atmosphere void of offence.

The whole teaching of this small work, in so far as the Hospital Refuse Destructor is concerned, may be briefly expressed as follows :—

The modern Institutional Refuse Destructor must be a small replica of the larger Municipal Refuse Destructor, and the vital principle of the latter, viz., high temperature working, must be the vital principle of the former.

Precisely the same principle applies in the cremation of small animals; and also every form of objectionable trade waste, where it is produced in quantities. Who will dispute the advantage, for instance, of at once disposing of the objectionable waste of a Soap Works or a Preserve Works on the premises? Does it not enhance the reputation of the maker, and the product, if it can be said that it was made under modern, cleanly and healthy conditions?

* When giving evidence before the Royal Commission

* See Second *Report,* 1904, Royal Commission on Coal Supplies.

on Coal Supplies, some few months ago, I was privileged to explain the latest practice in the utilisation of the lowest grade fuels for steam-raising purposes. Refuse fuels long regarded as worthless are now being treated on similar lines to trade refuse: such fuels, indeed, constitute trade refuse, representing a valuable asset. What has been accomplished in this direction is herein recorded.

In many industries, while the refuse is of a less valuable character than colliery waste, it yet possesses a definite value; and the striking examples furnished by many small Municipalities may with advantage be closely studied by the large manufacturer, who must be convinced that it is a mistake to accumulate or pay for the periodical removal of waste which may be quickly and cheaply disposed of, while frequently yielding a very useful return in the form of power.

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Chapter I

THE DISPOSAL OF INSTITUTIONAL REFUSE

Introductory

THE erection of small Destructors or Incinerators in connection with Hospitals, Infirmaries, Asylums, Convalescent Homes, Hydropathic Establishments, and Sanatoria is not a new departure. Many years ago, it was recognized that a separate furnace located within the walls of the Institution was a necessity in order to dispose of objectionable and dangerous waste therein produced.

The early furnaces erected for the purpose were not altogether satisfactory, and in many respects bear the same relation to their modern prototype as is borne by the early Municipal Refuse Destructor to that of modern design and construction.

While the larger Destructor for dealing with civic waste has been constantly improved, the smaller Destructor for Institutional purposes has been practically neglected, with the inevitable result that the final and sanitary disposal of Institutional waste has not increased in popularity. In many places small Destructors have been regarded as a nuisance, and this for practically the same reasons which many years since brought the larger Destructors into disrepute.

Low temperature, slow combustion, crudeness of design, and antiquated methods of charging the objectionable refuse into the furnaces have all had a marked effect in retarding progress, leading architects and medical men to the conclusion that if possible it would be well to deal with the waste of Institutions in other ways.

One of the alternative methods employed has been to send quantities of poultices, bandages, dressings, etc., to the boiler-house to be fed into the boiler-furnaces. This course is usually and rightly resented by the engineer and fireman. Such material cannot always be thus got rid of immediately, and in the warm atmosphere of the boiler-house quickly becomes highly objectionable.

To engage a fireman to burn Welsh coal, worrying him to keep the steam pressure up, and to provide him with a quantity of filthy waste to get rid of must always lead to trouble, and cannot under any circumstances be recommended.

In order to keep the steam pressure up the fireman naturally hesitates to dispose of the waste until what he regards as the favourable time: the fires are then choked, and the presence of such material, heavily charged with moisture, in the boiler-furnace, retards combustion and wastes fuel; and, what is more serious, a proportion of the noxious gases distilled usually get away up the chimney into the surrounding atmosphere. Nor is this all: some very light material, such as paper and wool, is at times discharged from the chimney top in a more or less charred condition.

This method of disposing of Institutional waste cannot be too severely condemned: it is crude and unsatisfactory in the extreme. The author is acquainted with some few Institutions where it is practised, and is able to say that constant annoyance is given to those in charge of the boilers, while they are frequently admonished for that which they not only cannot prevent, but are forced to do.

Some years ago, in a small Yorkshire town, the carcases of condemned swine were sent to the Gas Works to be burned in the boiler-furnaces. For some time, with an ever growing resentment, the stokers thus disposed of the unwelcome carcases; but at length they determined to take a firm stand, and declined to burn any more of the pigs. That the stokers were justified in their decision will not be questioned: they were not engaged to burn such fuel.

The authorities, at their wits' end to know what to do with the occasional condemned carcases, and unwilling to erect a Destructor, then decided to bury the troublesome carcases. But this was not permitted for long; recently-buried carcases were exhumed, and from subterfuge to subterfuge the authorities were at length compelled to erect a Destructor.

The attitude of the stokers at the Gas Works in question is to be commended. Their case is but parallel with that of many stokers in Public Institutions who are compelled to handle material far more objectionable than the remains of a recently-expired pig, and to produce steam from the same. In declining to work under such conditions, they would not only be rightly protecting themselves, but they would do not a little towards bringing such Institutions up to date, compelling the authorities to provide an effective means for the final and sanitary disposal of their waste.

The widespread adoption of Refuse Destructors by Municipal authorities during the past few years has kept the Destructor maker busy; and to some extent this may account for the lack of attention which has been given to the design of the smaller Destructor for dealing with Institutional waste. While the former has undergone many changes and is now practically perfect, the latter, with the exception of two or three makes, has received but little attention, and is to-day more or less unsatisfactory.

As already observed, the weak points of the early Destructors installed in Public Institutions are briefly as follows: (1) The low temperature system of working and (2) slow combustion, or mere cooking of the waste. (3) Crudeness of design. The furnace being squat and shallow, insufficient combustion space is provided, the furnace being altogether too small for the work demanded under the existing conditions. (4) Antiquated and unsatisfactory methods of feeding the refuse into the cells, this being usually done through an opening in the top of the cell, the opening being covered with a loose-fitting metal plate or lid, permitting noxious gases to escape from the cell. (5) An excessive cost for maintenance and repairs, due to weakness in the design and construction. (6) High working cost owing to the use of coke for heating the furnace, this fuel not being thoroughly or economically burned owing to the sluggish draught. Further, owing to the method of operation and the design of the cell, the weight of coke burned to destroy a given weight of refuse has been altogether disproportionate, and far too expensive.

Lastly, the provision of *two* coke fires instead of *one* has involved the burning of far too much fuel, as well as calling for too much attention upon the part of the man in charge.

All these weak points have now been successfully overcome in some Institutional Refuse Destructors of modern design, and such Destructors will be found described and illustrated herein. It is now possible to obtain small Destructors for dealing with Institutional waste which are in every respect equally as satisfactory as the large Destructors of modern types erected for destroying Municipal refuse.

That drastic improvement in the larger Destructor which has had such far reaching and beneficial results is of equal importance in connection with the small Destructor. High-temperature working and rapid combustion, owing to the provision of Forced Draught, is the vital improvement.

Instead of slow combustion, the combustion is vigorous, and the temperature within the cell has been so increased that any escape of noxious gases is rendered quite impossible.

The author remembers visiting the Western Hospital of the Metropolitan Asylums Board in company with Dr. Ashburton Thompson, of Sydney, N.S.W., Chief Medical Officer of Health for New South Wales, when, in order to show the remarkably high cell temperature, two dead cats were thrown therein, and although the chimney was carefully watched for some few minutes afterwards no visible discharge therefrom was observed. This is, perhaps, but parallel with the introduction of the carcases of two horses into the combustion chamber of a large Destructor, when the chimney was also equally free from any visible discharge.

The advantages of a high cell temperature will at once be evident. To introduce the bodies of small animals into a cell not provided with Forced Draught would result in nuisance, and the discharge from the chimney would at once furnish very striking evidence as to the contents of the cell.

In some respects this high cell temperature is of greater importance in connection with the Hospital Refuse Destructor than with the larger Destructor, because in the case of the former much of the material to be disposed of is of such a character as demands rapid high temperature combustion, and a thorough diffusion of the gases in a combustion chamber maintained at an intense heat.

Further, it is worthy of remark that no Municipal authority would now think of erecting a Destructor unprovided with Forced Draught; indeed, it is open to serious question whether the Local Government Board would approve of such a scheme under any circumstances.

The Forced Draught Destructor possesses other advantages over its earlier prototype, which may be briefly enumerated as follows :—

(A) A very moderate chimney will suffice, such a chimney as may be readily hidden. This is a distinct advantage, as a prominent chimney does not lend itself to æsthetic treatment, and often spoils the appearance of a pile of fine buildings.

(B) Owing to the accelerated combustion, the ground space required for a Destructor to deal with a given weight of refuse is considerably less than that required by Destructors of the old type.

(C) Firebars, a serious and costly item with Destructors of the early type, are now preserved, owing to the cooling effect of the Forced Draught, and will last for many years.

(D) The provision of Forced Draught has the effect of securing a constant efficiency in working, the fire being independent of adverse natural conditions, which often operate seriously against any furnace dependent upon natural or chimney draught alone.

In general design the early Destructor suffers by comparison with those of modern design. The combustion space was limited—a fatal mistake; the construction was altogether too light for the work demanded, the staying, bracing, and tyeing of the structure being weak.

With the modern Destructor great strength and durability is aimed at and secured, the work being in every respect equal to that put into the larger Municipal Refuse Destructors. Hence the cost of upkeep and maintenance is reduced to the minimum, and uninterrupted working is secured—a matter of extreme importance, especially in an Institution where a duplicate Destructor is not provided.

In connection with the modern Destructor, the arrangements for feeding or charging the refuse into the cell have received considerable attention and may now be regarded as satisfactory, reducing handling of the material to the minimum, enabling the original receptacle to be raised, tipped and emptied at an easy distance from the ground, discharging its contents direct through a charging hopper at the side of the cell direct on to the hearth.

With the older types of Destructors an opening was provided on top of the cells, and the material had to be lifted in its receptacle on to the top of the cell, the contents then being tipped through the opening on to the hearth below.

A loose metal lid or cover was usually provided to close the opening, but this not being gas-tight, and frequently warping by the action of the heat, the noxious gases slowly distilling on the hearth immediately under will pass upwards, and in some Institutions the author has noticed a hood and ventilating shaft provided directly above the charging hole to permit of the escaping gases passing into the chimney.

Such provision is very conclusive evidence that a trouble exists, and it would surely be wiser to provide a gas-tight cover than to incur additional expense to unsatisfactorily bolster up a weakness which could very easily be remedied.

Bulky articles, such as mattresses or bedding, must of necessity be introduced into the cell at the front; and in any Institution where such articles have to be destroyed the Destructor should be provided with suitably large doors, so that the article may be introduced whole instead of being cut up, which involves unnecessary handling. The early Destructors were invariably provided with small doors and a small opening at the top, hence any bulky article could not be introduced whole.

There is a disposition upon the part of medical men to be content with the ordinary natural draught Destructor, not because they are satisfied with the same, but rather because they are not aware that the early type of Destructor is now out of date.

It is not to be expected that the busy medical man can be immediately conversant with every improvement in Hospital accessories; and so it is that the early type of Destructor is still used, not by reason of its excellence, but because it is erroneously assumed that any drastic improvement is not practicable.

The Refuse Destructor, although being an important adjunct to a Public Institution, is frequently looked upon as a kind of necessary evil which must be tolerated, but at the same time of such an objectionable character as not to invite too close an acquaintance.

The character of the material dealt with, and the fact that the Destructor is the rendezvous for the filth of the Institution is naturally apt to secure for it a more or less definite isolation, with the inevitable result that very frequently Destructors are not operated as they should be. The author has, for instance, observed that, in order to avoid a little trouble in charging the refuse in at the top of old Destructors, the attendant will, if opportunity offers, feed the refuse in on top of the very accessible coke fire in *front,* thus at once creating a very serious nuisance.

In the first place, this is possible because the coke fire is so much easier to get at than the cremator chamber; and secondly, because the operation of the Destructor is not supervised as it should be.

It will be argued, and rightly too, that it is too costly to so watch the attendant that he is compelled to do his work properly. It is true that the resident engineer cannot find time to watch the man at the Destructor. The best course then, surely, is to provide a Destructor so designed that it is far easier for the man in charge to operate the same properly than otherwise. This it will be observed has been carefully borne in mind in the design of the modern high-temperature Destructor. The cremator chamber or drying-hearth is the most accessible part of the cell; and even if the attendant is inclined to be lax or awkward, he has no alternative, it is only possible to charge the refuse into its proper place.

With this design of Destructor it will be observed that the refuse cremator chamber or drying-hearth is at the *front* of the cell, and it is all but impossible for the man in charge to introduce the refuse on to the secondary fire beyond, at the *back.* In order to do this he is put to a great deal of labour and trouble, and so no scope is offered for a man who is inclined to shirk his work.

In the case of many Institutions it is not possible to work the Destructor constantly or steadily, and in order to dispose of the refuse as produced the operation of the Destructor is necessarily so intermittent as to conduce to nuisance under ordinary conditions. A Destructor provided with natural or chimney draught only is unsuitable for intermittent working: there is insufficient command of the combustion, and the necessary heating up of the cell is too slow and uncertain. With Forced Draught, however, the secondary fire is under complete, easy, and instant control, and may be quickly forced as desired; so that even with irregular operation it is a simple matter to rapidly raise the furnace temperature in readiness for a charge, and to maintain the temperature until the material is disposed of.

Even if the operation of the Destructor is not intermittent the use of Forced Draught renders nuisance impossible. Being always independent of natural atmospheric conditions the air supply for combustion is at all times under immediate control; the heat developed within the cell is more intense, and easily maintained; the cremation of the waste is accomplished very rapidly; and there is an entire absence of that distillation by slow combustion which has been most prolific of nuisance both with large and small Destructors dependent entirely upon natural or chimney draught.

In order to destroy refuse *as produced*, which should be the *desideratum* in every Public Institution, it is of importance that the rate of combustion in the Destructor be controlled, and this controllability is only possible with a Forced Draught Destructor. Those same adverse atmospheric conditions which periodically affect the working of steam boilers entirely dependent upon chimney draught have a precisely similar effect upon the combustion process in connection with the Destructor ; but while in the former case it only involves a shortage of steam, in the latter case it conduces to nuisance resulting from the escape of unburned and noxious gases.

The provision of Forced Draught in enabling the combustion to be controlled is also of value in giving a useful elasticity to the Destructor. If it is *not* possible to bring the material to the Destructor at regular intervals, it *is* possible to accelerate the rate of combustion, thus avoiding the retention of refuse in the buildings, or in the Destructor house. That this is a matter of importance will not be questioned by those who have seen some of the refuse receptacles and their contents placed in the Destructor building, there to stand until the cell is in a condition to receive the succeeding charges.

It has already been remarked that the provision of Forced Draught secures a higher temperature *within the cell,* and as a consequence the gases pass into the chimney at a much higher temperature than is the case with a Destructor of the older type. This escaping heat may be utilised in various ways. If the Destructor is dealing with from three to five tons of refuse daily, it would be remunerative to instal a small steam boiler in connection with the Destructor cell. This would serve not only to provide steam for the Forced Draught, but also to heat a considerable volume of water for the Laundry or other Institutional purposes, thus representing so much useful gain.

In the case of Destructors of smaller capacity than those mentioned above, wherever practicable it is well worth while to so arrange the same that the hot gases can be passed through the Economiser, assisting to heat the feed-water for the steam-boilers. The utilisation of the waste heat from a Destructor calls for careful consideration in connection with every installation of reasonable size, and in the planning of new and large Institutions it is a matter well worth careful consideration.

It is not always possible to so locate the Destructor that the chimney serving the steam-boilers can be used. In such cases it is therefore necessary to provide a separate chimney. If the Destructor be of modern design and provided with Forced Draught, a very

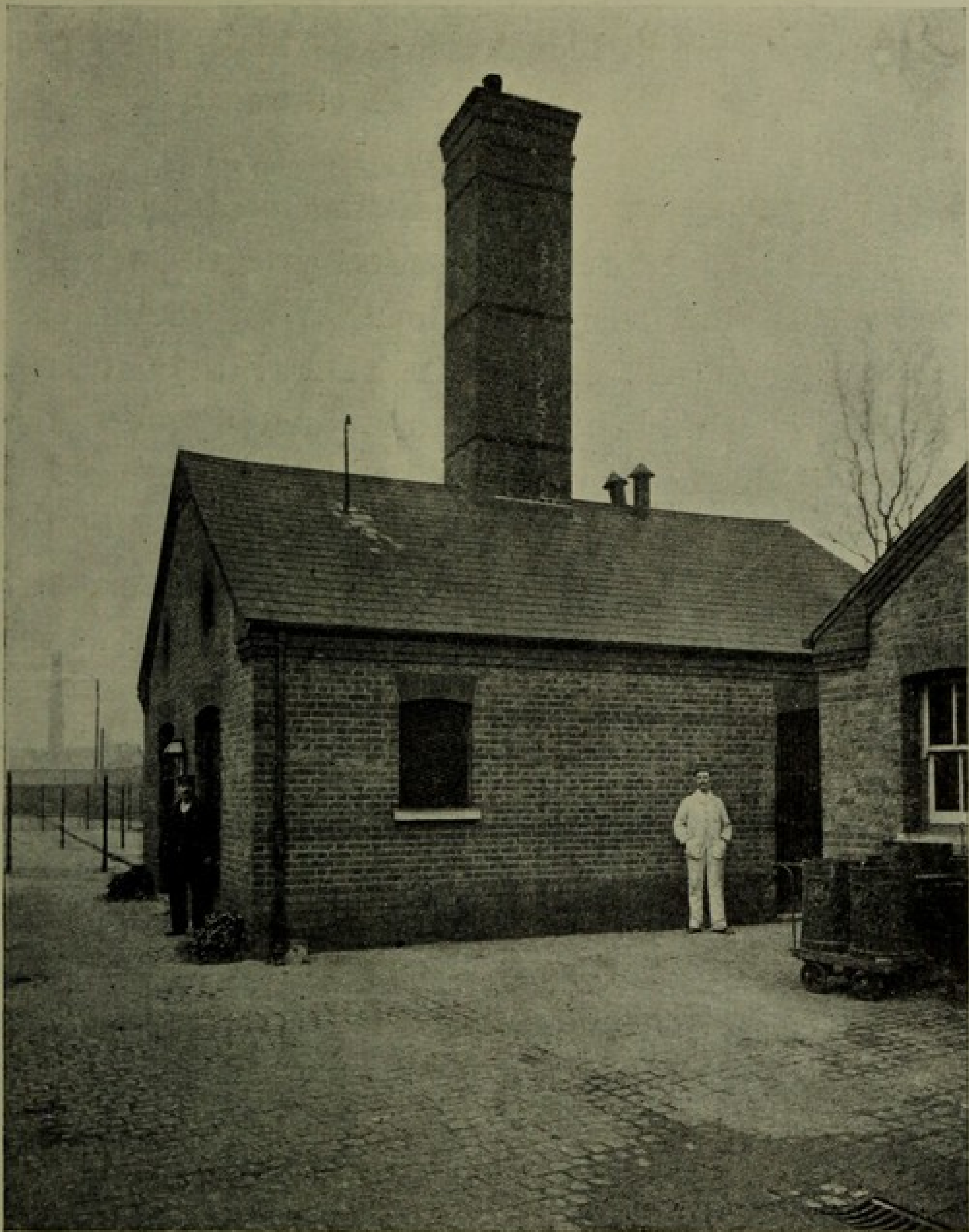


FIG. 1.

small and unobtrusive chimney will suffice. Such a chimney as may be designed in harmony with the general surroundings, being small and low, it is also a simple matter to hide the same. This is a distinct advantage, and one which should appeal to the architect.

Fig. 1 is a view of the building containing two Destructors and a Steam Disinfector at the Western Fever Hospital, Segrave Road, West Brompton, London, one of the several similar Institutions under the control of the Metropolitan Asylums Board. The chimney is rather less than 40 feet in height, and is divided internally into three parts, one half of the chimney divided into two parts serving for the two Destructors, the opening for each Destructor at the chimney top being formed by an ordinary 9-inch chimney pot, one of which may be seen in the photograph.

An outlet of this size is quite sufficient to serve for a modern high-temperature Destructor dealing with 2 tons of refuse per day. Hence it is possible when the Destructor is contained within a building forming part of the main block of buildings to readily screen the chimney, if so desired.

It has been observed that with Destructors of the early type the working expenditure for secondary fuel, i.e. coke, is high, and altogether disproportionate to the weight of refuse destroyed. Coke is a slow-combustion fuel, and to get the best results from the same artificial draught is demanded. It will be obvious that under certain circumstances coke must be employed as the secondary fuel; but as a general rule, with a modern Destructor, coke breeze is in every way suitable for getting up and maintaining the requisite temperature.

Even in an Institution where steam heating is provided, and very little coal apart from that used for the steam-boilers is used, coke breeze, supplemented by the cinder and ashpit refuse from the boilers, will be found quite suitable as a secondary fuel. In other Institutions where a considerable quantity of coal is used for heating and domestic purposes, sufficient cinder and calorific material may be available to provide the necessary secondary fuel.

It will thus be seen that it is possible to operate a modern Destructor at a low working cost. Indeed, it is not too much to say that, taking into account the reduced cost of operation alone, it would pay well to replace every Destructor of the old type with a modern Destructor.

Chapter II

ISOLATION HOSPITAL REFUSE DESTRUCTORS

DURING the past few years a large number of Isolation Hospitals have been erected, many of which are very small. It may be fairly submitted that a Destructor is a very necessary adjunct to every such Hospital, and even if it should not be necessary to put the same into use very often, it is nevertheless important to have available for immediate use an apparatus which will very quickly and effectually dispose of such waste as is produced.

Until quite recently an efficient small Destructor was not available, and it is a common occurrence even now to meet many architects and engineers who have but little idea that it is possible to construct a Destructor on modern lines down to such small sizes as one half hundredweight or one hundredweight per hour.

The mischief which may arise even from one small-pox patient is clearly shown in the appended report of the action heard in the King's Bench Division only a year since—Chapman *v.* Gillingham Urban District Council.

* CHAPMAN *v.* GILLINGHAM URBAN DISTRICT COUNCIL.—This case, heard in the King's Bench Division, was an action by Mr. Stephen Chapman, market gardener, The Gleanings, Hempstead, near Chatham, and his wife, to recover from the Gillingham Urban District Council damages for the death of their child, caused through the alleged negligence of the council. The defence was a denial of negligence, but that what the council did it was empowered to do under the Public Health Act, 1875. They further denied that the plaintiffs suffered any injury or loss through negligence.

Mr. Rufus Isaacs, K.C., and Mr. S. A. Kyffin were counsel for the plaintiffs, and Mr. Dickens, K.C., Mr. Eldon Bankes, K.C., and Mr. Lushington for the defendants.

Mr. Rufus Isaacs said that the plaintiffs had for several years occupied 7¼ acres of land at Hempstead as a market gardener. His relatives lived closed by. Near, also, was a building intended for a stable, measuring some 15 feet by 12 feet. An epidemic of small-pox broke out somewhere in the district, and the authorities sent a patient to the stable in December, 1901, with an attendant to look after him.

His Lordship (Mr. Justice Grantham): Was there any drainage there ?

Mr. Isaacs : I may say that there was no drainage of any description at this stable, neither was there any water supply except from a rain-water butt. There were no appliances which ought to be in existence for a place where there were housed such people as small-pox patients. Great consternation was caused among the inhabitants of the place, because the patients were brought from an infectious district into a healthy one. On December 18, plaintiffs' little daughter sickened, though she had not for six weeks been away from

* See *Public Health Engineer*, April 4, 1903.

that immediate locality. On December 29th she died. Then the plaintiffs caught the disease, and though they were at one time in a very serious condition they recovered. Later, Mr. Chapman's father and mother became ill with small-pox and died. Then Mrs. Chapman's mother took the disease and she also succumbed. It was difficult to imagine a more serious state of affairs, which was created simply through the wrong action of this district council.

Mr. Chapman gave evidence as to the arrival of a patient at the stable. The nurse was an old man. Later, a sort of broken-down caravan arrived, and two patients occupied it. He had often seen the caravan full of smoke, and the patients would then put their heads out of the place where there ought to have been a window to get a breath of fresh air. The only water for those patients was brought by an official in gallon jars from a distance. He had seen refuse on and near his land and numbers of used-up lemons. After the removal of the patients he saw the bedding in the stable ; it was black. Witness gave details as to the illness in his family and in the families of his relatives, and was then taken at length through certain plans showing the locality. He said his daughter went along certain of the roads not very far from the stable, but he denied that she had been close to that building.

Charles Henry Moore, foreman bricklayer, living between plaintiffs' house and the stable, gave evidence as to the nurse throwing refuse about carelessly. The top part of the stable door was often open, and he considered it was to let the smoke out. There was no proper chimney, only a " bit of pipe."

Mrs. Hillier, Mr. James Rawlings (a relieving officer), Mr. Walker (owner of land in the neighbourhood), and Dr. Robert Grant, Chatham, also gave evidence of the nurse's alleged carelessness and negligence. The doctor said the stable was not suitable for a hospital, nor even for a temporary hospital. It ought to have been surrounded by a fence 6½ feet high, but this was quite open, with the exception of a faggot fence some distance away. The fence would do more harm than good, as it would act more as an attraction and a funnel for the small-pox virus. The cubic measurement of the whole building was only 870 feet, while the proper capacity was 1,000 feet to 1,200 feet for each patient.

Mr. Richard Hill, surveyor, Fenchurch Street, said that in October last he visited the place. It was 168 feet 6 inches from the road. There was no appearance of there having been any former drainage. As to the ventilation of the stable, the part occupied by the nurse had a boarded ceiling 6 feet 6 inches from the floor. The part used for the patients had no ceiling, but there was a space in the roof which went over the boarded ceiling of the nurse's compartment. That, however, was worse than useless, because it was incapable of ventilation. The only window which would open was only 2 feet by 2 feet 6 inches, one-half the size required for an ordinary dwelling room, for which one-tenth of the floor space was the minimum.

Mr. Dickens, on behalf of the defendant council, said public bodies had a great difficulty to contend with, that of not being protected by Act of Parliament. If a hospital for infectious diseases was put up in such a manner and at such a place as to make it a "legal nuisance," the local authority was liable to pay any damages which might result. But all things must be taken into consideration in such matters. Take this case, for example. The population of Gillingham and its environs numbered many thousands of people, of whom the greatest number were working-men employed in the dockyard and large factories. Therefore, seeing the great amount of contact that there must be among those people in their daily avocations, it behoved public bodies like the defendant council to act with the greatest promptitude to prevent the decimation of the population. The council discovered that a man employed in dockyard work had been suddenly taken ill, and small-pox was certified to be the disease. The council at once made inquiries for a place in which to isolate the patient, and he was taken to the stable in question. Having regard to all the difficulties of the emergency, the council ought not to be held responsible. The questions now to be considered were: (1) Was there negligence on the part of a public body? (2) Was the hospital a nuisance in itself? And (3) was it a nuisance in the way in which it was conducted?

Mr. E. C. Warren, medical officer of health for the district in question, said that a considerable portion of the neighbourhood was thickly populated. On December 1, 1901, a case of small-pox was discovered near the docks. It was absolutely necessary to remove the man, and he was taken to a " Decker " tent in the grounds at the back of the Infectious Diseases Hospital, which was in a thinly populated neighbourhood. According to the Local Government Board instructions the patient was not far enough away from a " public building." Consequently witness brought the matter before the local authority. He was given a free hand, and as one of the members of the council offered the stable in question—it was fitted up as well as possible for the reception of the patient—that being the most suitable place available at the time. The male nurse was given a digging fork with instructions to put all refuse into the ground and cover it with quicklime and Jeyes' fluid. Witness frequently visited the hospital, asked the nurse whether he had carried out instructions, was informed that he had, and personally saw the holes which the nurse had dug and in which the refuse had been thrown.

Mr. T. D. Savill, M.D., the expert on small-pox, said he considered the stable to be a suitable place for a small-pox hospital, and that the precautions directed by Dr. Warren were sufficient.

Dr. T. F. Ricketts, medical superintendent to the small-pox hospitals of the Metropolitan Asylums Board, said the site in question, which he had seen, was reasonable. He had had experience of from 14,000 to 15,000 cases of small-pox. It was almost certain that the little girl, having become infected, was the means of all the other people of the family catching the disease. Of more than 700 nurses and scrubbers under his jurisdiction in connection with the Asylums Board all were revaccinated with the exception of one, who was overlooked. Of that large number all steered clear of small-pox except the one who was not vaccinated.

Mr. Dickens, on behalf of the council, argued that there was no legal obligation on the council to establish an isolation hospital. They felt, however, that they had a moral obligation. They might have left the first case of small-pox at the place where it was discovered. Had they done that, however, in all probability a fearful epidemic of the disease might have raged. Under the circumstances they removed the case to this stable, which was the earliest and best spot available, and the result of their precautions had resulted in the present action, where heavy damages were claimed.

Mr. Justice Grantham, in summing up, remarked that this was a very important case, affecting not only the plaintiffs but the public at large. He put before the jury two questions : (1) Was the hospital a nuisance, thereby occasioning damage to plaintiffs ? and (2) was there want or proper and reasonable care and skill exercised by the authorities or their servants ? If the jury decided in the affirmative then they would have to assess a certain amount as damages. The first question, however, was the important one to be considered. Everyone must have sympathy with a public body like this council, considering their situation at the outbreak of this epidemic of small-pox ; but he hoped that this case would be a warning to public bodies all over the country to look to the fact that it was necessary to prepare places for patients of this description beforehand. The Local Government Board had done all they could, and the public bodies under them ought to act accordingly.

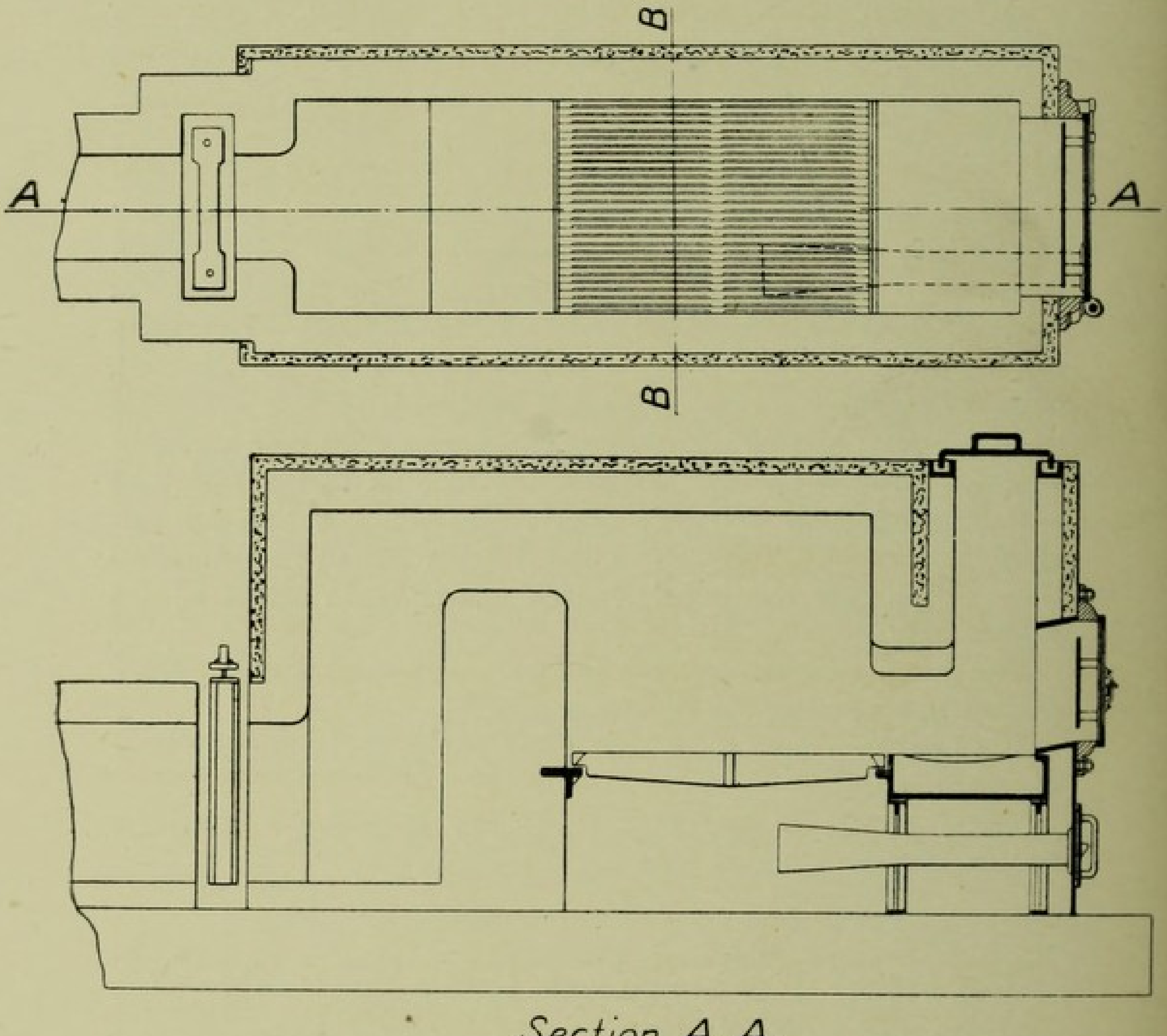
The jury, without leaving the box, returned a verdict for plaintiffs, assessing the damages at £250.

His Lordship gave judgment accordingly, and refused a stay of execution.

The foreman of the jury said they considered that the Urban District Council had acted incautiously.

The author does not suggest that a small Destructor was altogether practicable in the case in question ; but such an example would seem to clearly emphasise the vital importance of providing a Destructor even with the smallest Isolation Hospital, and to ignore the question of final and sanitary refuse disposal even under such circumstances may be productive of the most serious consequences.

Small Destructors for Isolation Hospitals will certainly be extensively adopted in the near future. It



Section A. A.

FIG. 2.

is a healthy sign of the times that the importance of providing a Destructor, even in very small Institutions, is now generally admitted.

With small Destructors in such Institutions it is not always possible to provide Forced Draught, seeing that many such Institutions are not provided with steam-boilers; but this need exercise no deterrent effect upon the adoption of a Destructor, because under such circumstances the Destructor may be specially designed to work with natural draught, and those objections which apply to the larger natural

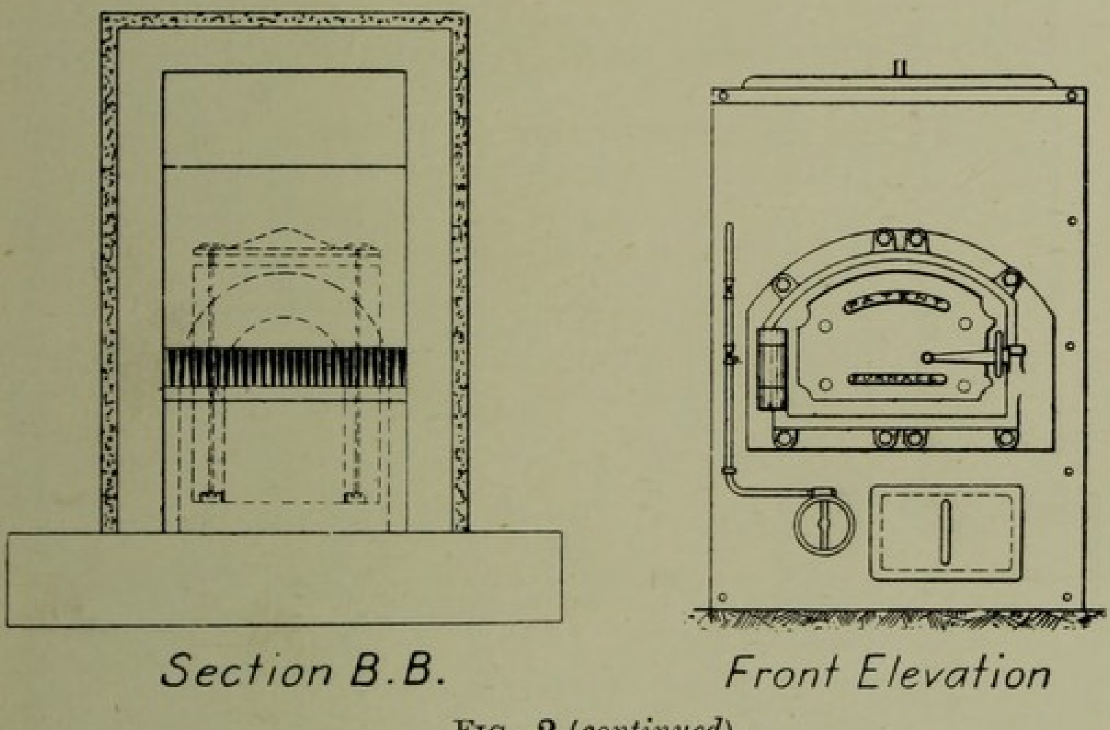
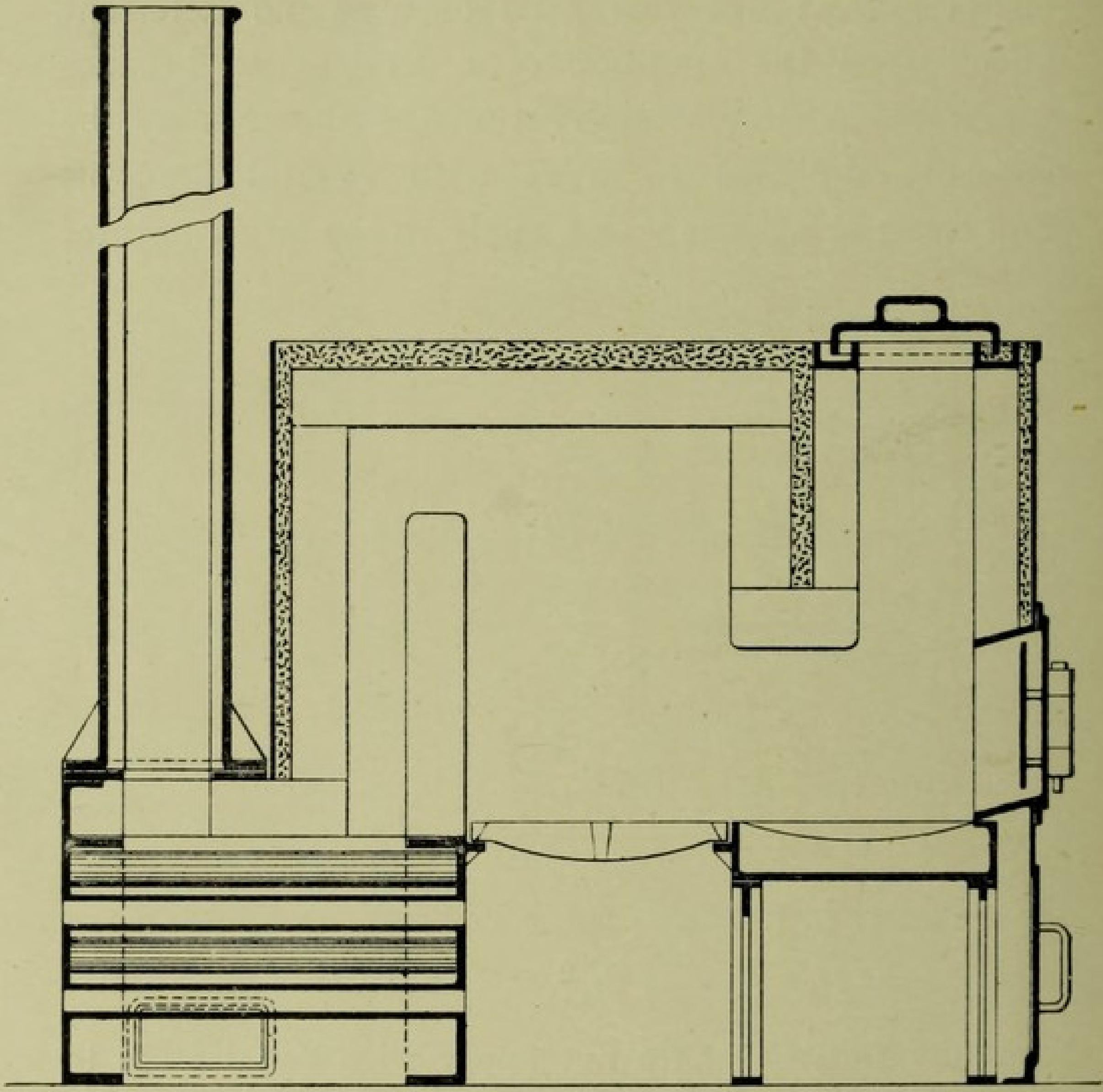


FIG. 2 (*continued*).

draught Destructor do not apply with equal force to the smaller Destructor in an Isolation Hospital, because the latter is not called upon to deal with any serious quantity of refuse. It is in many instances only used occasionally, and there is always ample time to get the cell into good condition by means of a secondary coke fire before the Destructor is required to deal with a charge of refuse.

Fig. 2 illustrates Meldrum's steel-cased type of Des-



Section through A.B.
FIG. 3.

tructor for small Infectious Diseases Hospitals, Isolation Hospitals, Sanatoria, etc. This Destructor has a capacity of from one to two hundredweights per hour and is provided with Forced Draught. In general design it is practically the same as the larger Des-

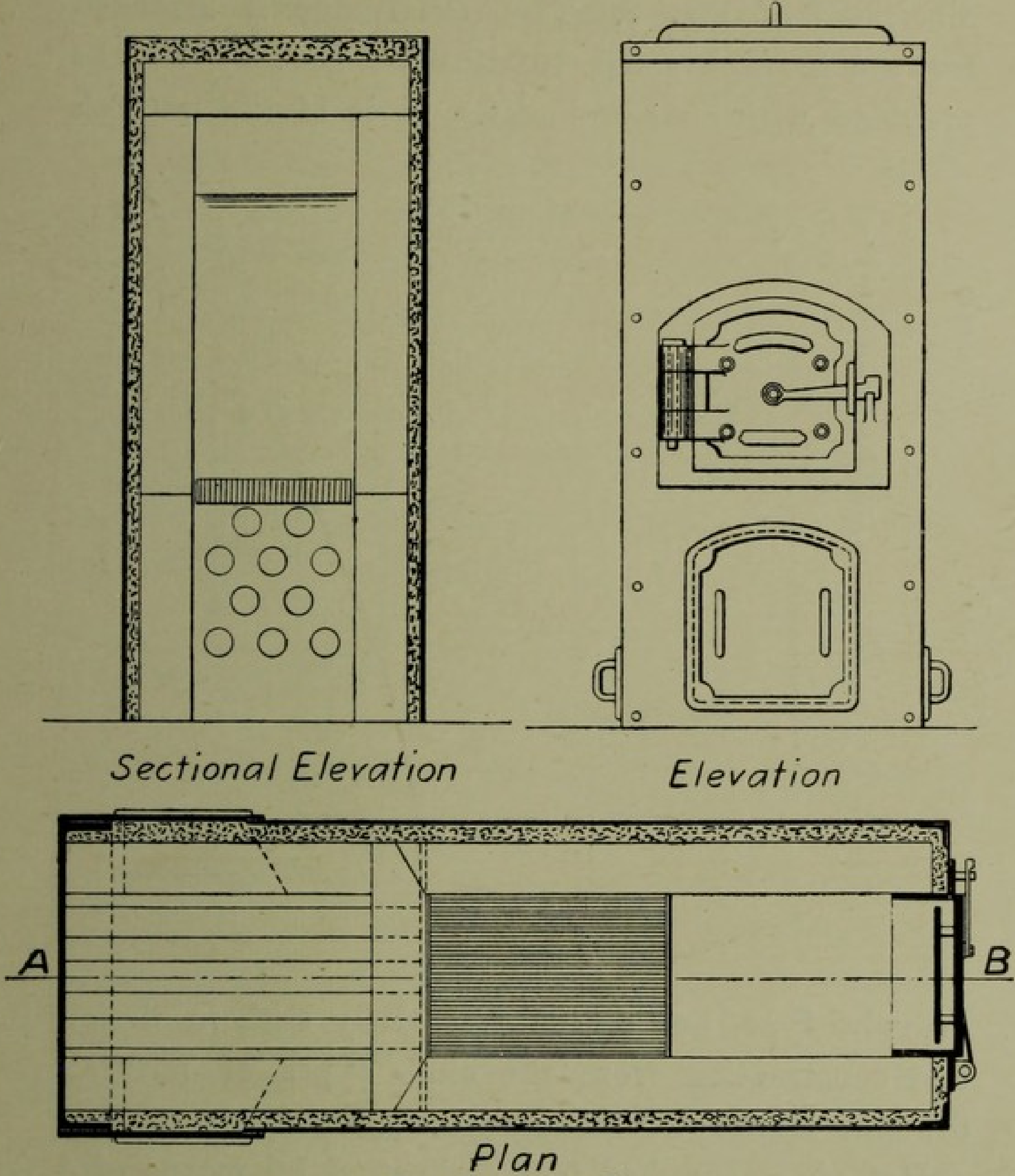


FIG. 3 (*continued*).

tructors of the same make illustrated in Figs. 11 and 12, while Fig. 27 shows a Destructor of the same type and capacity erected complete. A smaller Destructor especially designed for small Isolation Hospitals is illustrated in Fig. 3. This Destructor is arranged for use in such small Institutions as may not be provided with a steam-boiler. It is of the natural-

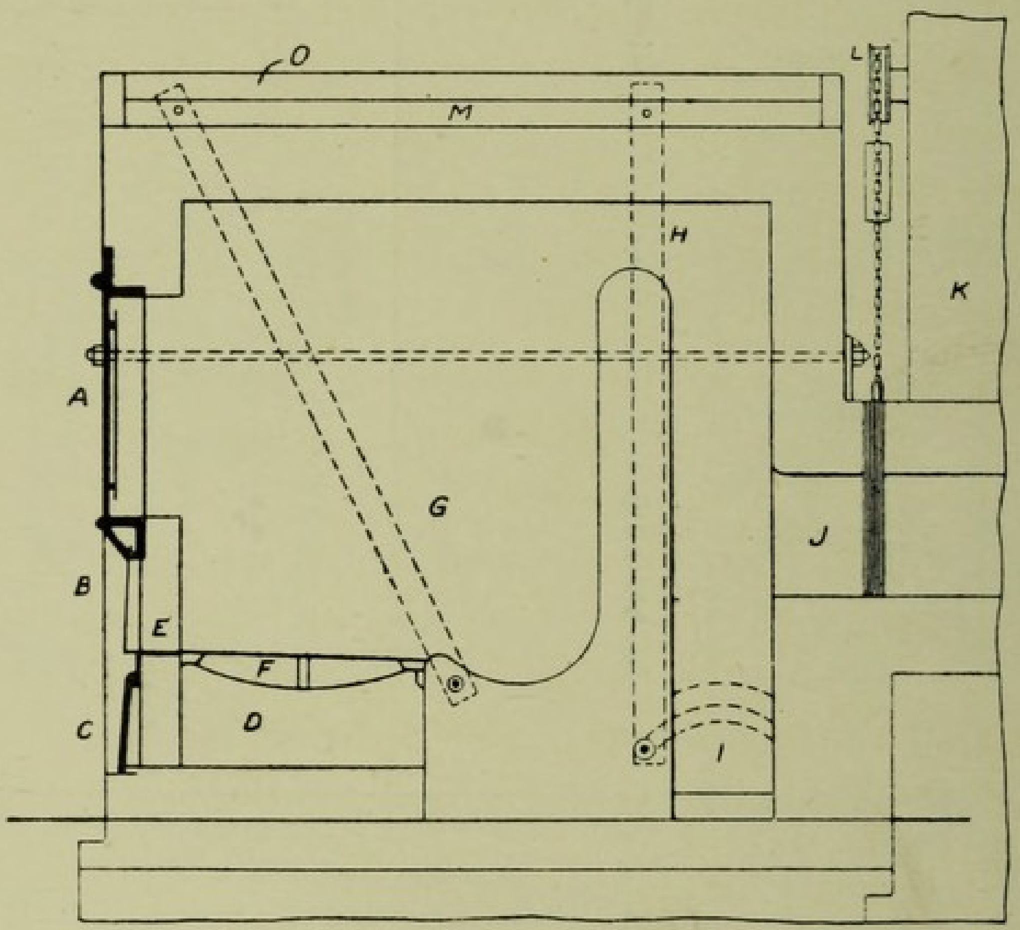


FIG. 4.

draught type, but differs essentially both in design and construction from the older types of natural-draught Destructors.

Hot air is supplied for combustion by means of a small Regenerator or continuous air heater, wherein the incoming air is heated by the outgoing hot gases.

The value of a hot air supply for combustion, which has been so conclusively demonstrated in connection with many large Municipal Refuse Destructors, must be obvious in connection with a small Destructor unprovided with Forced Draught, and yet called upon to dispose of highly objectionable and dangerous waste.

There are many small Isolation Hospitals without a steam-boiler, nor does any motive power exist which would serve to operate a Fan instead of a Steam Jet Blower. In such cases the Regenerative-type of Destructor will be found exceedingly useful, the supply of hot air for combustion ensuring a high temperature within the Destructor cell, and accordingly an immunity from nuisance.

Sanatoria

With the advances made in the erection of Sanatoria for the treatment of Consumption, the danger arising from the *tubercle bacilli* in sputum has become increasingly manifest, and the crusade against expectoration in public vehicles has doubtless been productive of much good.

It would appear to be of great importance that every Sanatorium should be provided with means for the final and immediate disposal of sputum. That such material can be readily disposed of there is no doubt, although to the layman it may seem impossible that waste of such a character can be successfully disposed of even by the agency of fire.

In order to deal with such objectionable material in a satisfactory manner the Destructor must be specially designed for the purpose. The arrangement for charging the waste into the Destructor, while being of a simple and direct character, must obviate handling. The average Hospital waste is often very objectionable, but compared with a sickening gelatinous mass such as has to be disposed of at Sanatoria the average refuse of Hospitals must be welcome to the man in charge of the Destructor.

Chapter III

INSTITUTIONAL REFUSE DESTRUCTORS DESCRIBED AND ILLUSTRATED

THE Warner Crematory, which is usually operated by chimney or natural draught alone, is illustrated in Fig. 4. It will be observed that provision is made for the admission of mattresses through the door (A) above the ordinary fire door (B), the latter and smaller door being used for stoking and firing coal or coke as may be required on to the firegrate (F).

A Destructor or crematory of similar design to this is shown in Fig. 5, this being a view of a Destructor erected some years since at the Northern Hospital, Winchmore Hill, under the Metropolitan Asylums Board.

The Destructor was fed through an opening in the top, and was used for several years, eventually being replaced by the Destructor illustrated in Fig. 11 about two years ago.

Another Destructor of the Warner type is illustrated in Fig. 6. This, it will be observed, is combined with

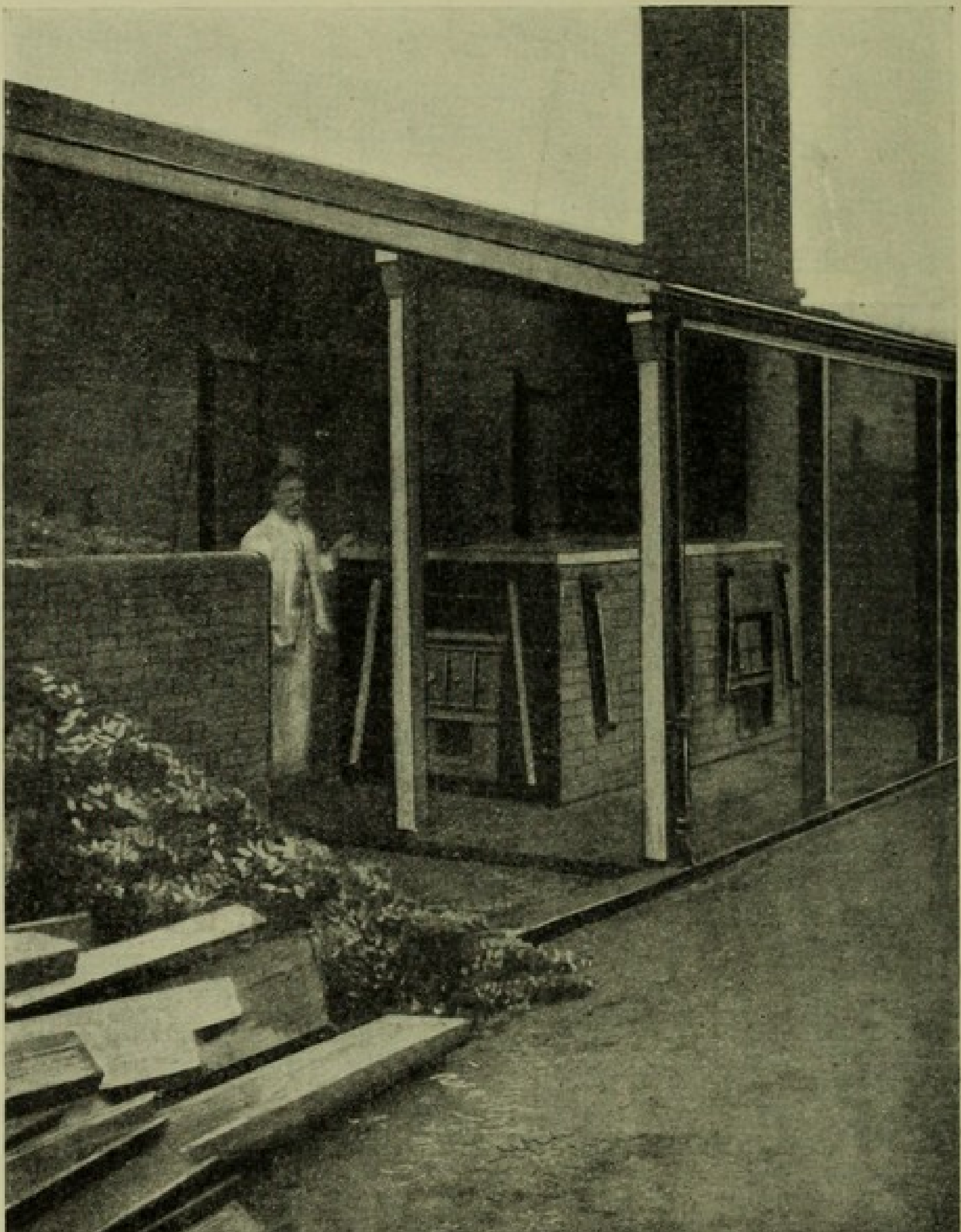


FIG 5.

a Steam Disinfector. Like the Warner Crematory already referred to, this is of the ordinary natural-draught type, and is also arranged for feeding at the top through the opening (D), the material falling into the dished chamber (B) immediately behind the coke-fired grate (C). The hot gases passing to the chimney (O) must pass through the flue (J) circulating round the base of the steam Disinfector (F), and generating steam in the space between the inner and outer shell of the Disinfector, the safety-valve (R) being set to blow off when the desired temperature is reached.

Horsfall's Hospital Refuse Destructor

This Destructor, which is illustrated in Fig. 7, is of the modern high-temperature type, embodying Horsfall's Steam Jet Blowers for supplying Forced Draught.

It is made in two standard sizes, having 9 and 15 square feet of grate area, respectively, and may be arranged for charging at the front, top, or back of the cell; but unless the site permits of sufficient excavation to place the Destructor a few feet below the ground level, the top feeding is likely to prove awkward, the distance between the ground level to the top of the cell being 7 ft. 5 in.

This Destructor possesses several of the well-known features of the larger Horsfall Destructor, such as the front exhaust flue, which may be carried in any

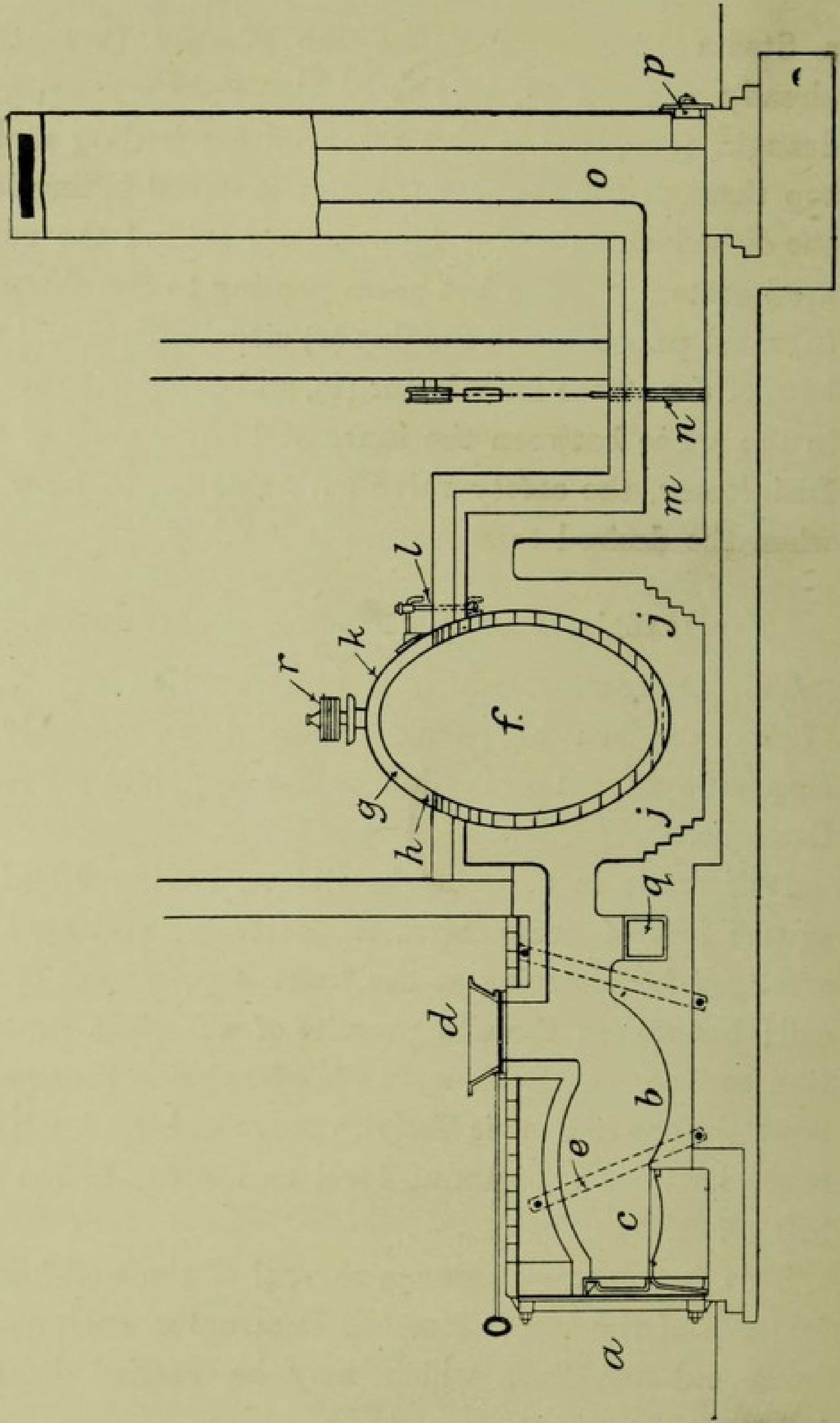


Fig. 6.

direction from the top of the cell, and the Steam Jet Blower for providing Forced Draught, which, it will be noted, is arranged at the back of the cell.

The larger size of Destructor of this type having a grate area of 15 square feet is capable of destroying 5 tons of refuse daily; and when dealing with this

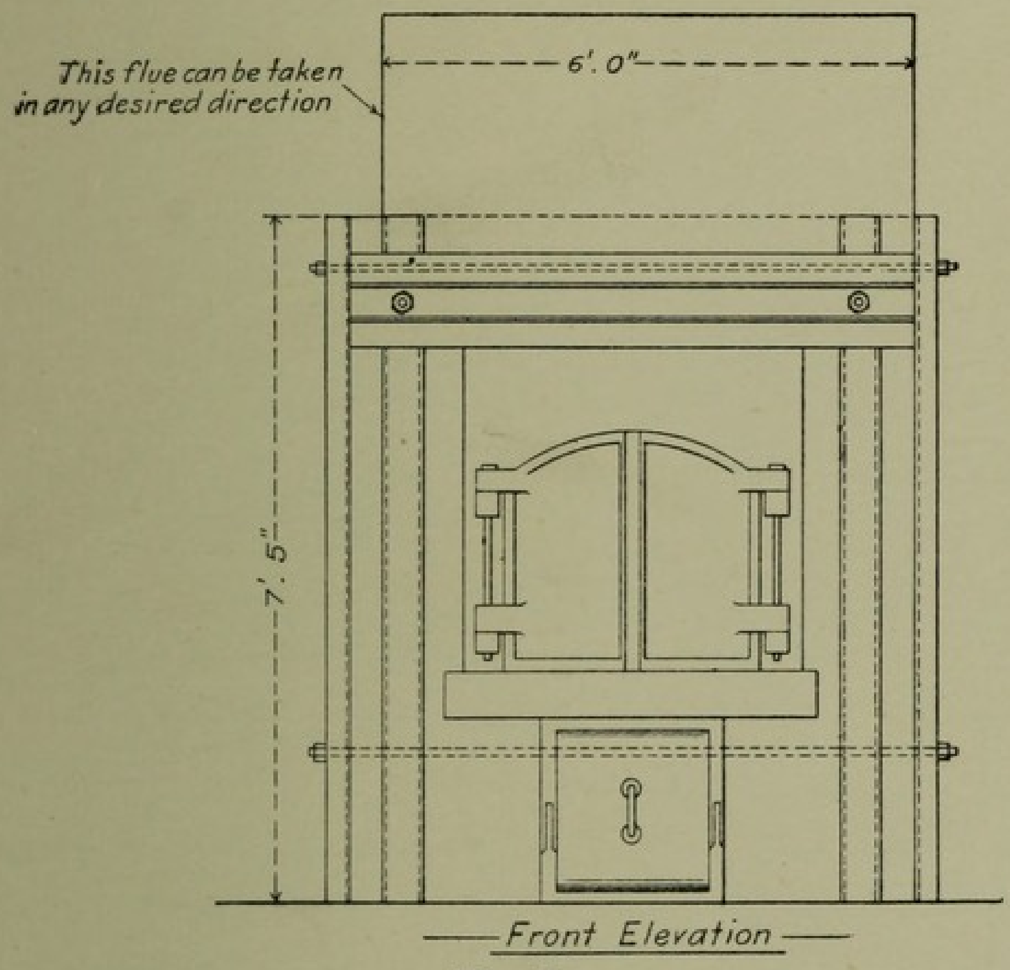
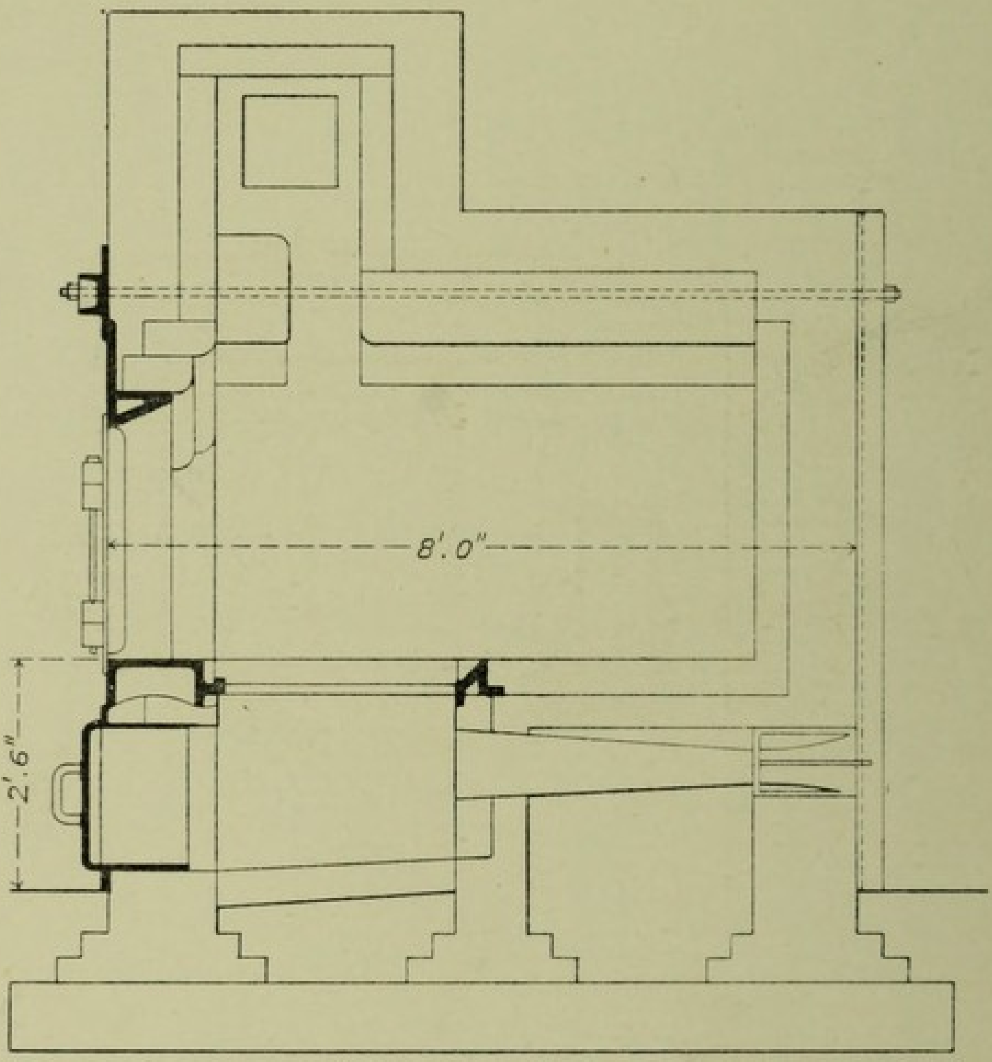


FIG. 7.

quantity of material in a high temperature Destructor, as already remarked, it is advisable to utilise the heat for some useful purpose, such as heating water, or raising steam in a small boiler.

Sargeant's Incinerator

This Incinerator or Destructor, which has been extensively adopted, is illustrated in Figs. 8 and 9. In design it is somewhat similar to the Warner Crematory illustrated in Figs. 4 and 5.



Sectional End Elevation

Fig. 7 (*continued.*)

Fig. 8 is a front view showing the fire-door (A) for access to the main coke fire, which is arranged immediately in front of the drying-hearth or main cremator chamber, this being directly behind. The refuse is charged into the cell on top through the opening (B), which is covered by means of a sliding door. The hot gases from the main coke fire pass through the cremator chamber and over the material lying therein, the whole volume of gases then passing over a second

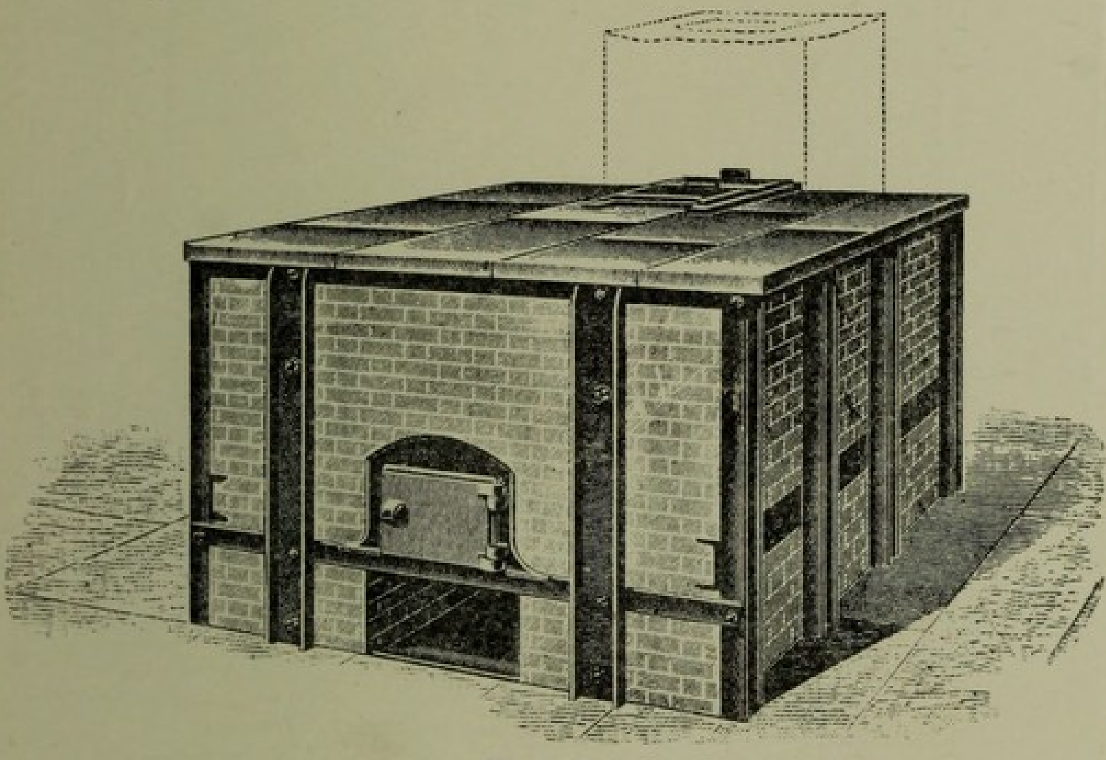


FIG. 8.

coke fire provided at a lower level in the flue, the fire-door (C) being provided for access to the second coke fire or Incinerator.

Unless the whole structure can be sunk from two to three feet below the ground level, some labour is entailed in charging the material in at the top of the cell, owing to the height of the charging opening at the top above the ground level.

This Incinerator or Destructor is usually operated by means of a chimney or natural draught alone. Fig. 9 is a view from the back or chimney end of the cell, clearly showing the charging opening, and the second coke fire in the main flue. The two small doors

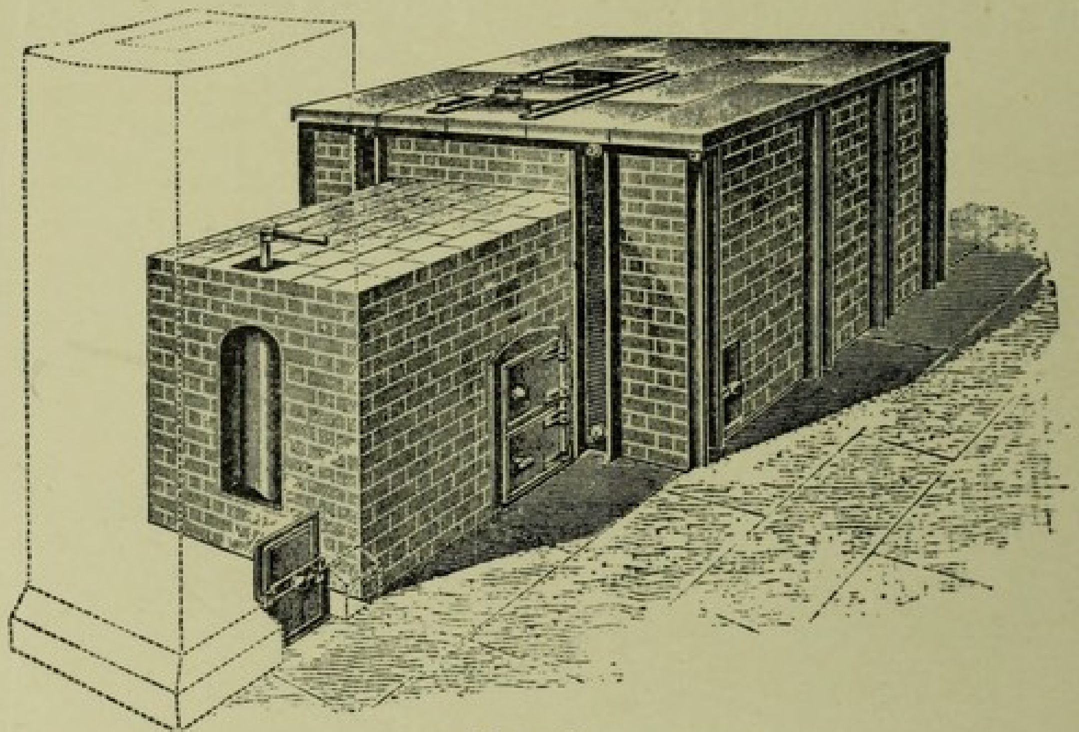


FIG. 9.

D and E are provided for the periodical removal of dust.

A later type of Destructor of the same make is illustrated in Fig. 10, mainly differing from the Destructor already discussed in the provision of a top shoot for the charging of mattresses.

That this is an improvement upon the original design for the introduction of mattresses will be evident, and it entirely gets over the common difficulty due to the provision only of a door or doors at the front of the cell which are frequently altogether too small for the purpose.

At the same time it may be observed that it is always useful to be able to introduce a mattress on edge, if practicable, as this largely obviates the smothering

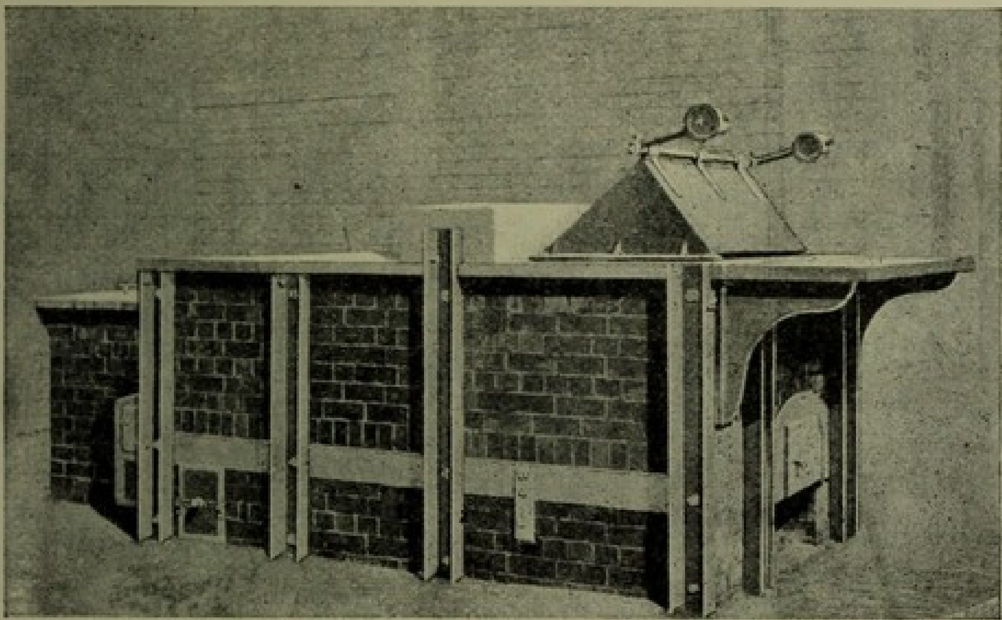


Fig. 10.

effect on the fire which must result from the introduction of such bulky articles flat.

Meldrum's Hospital Refuse Destructor

This Destructor differs essentially from the other Hospital Refuse Destructors already described. The whole of the refuse is fed direct from the Institutional receptacles through a charging-hopper on to the drying-hearth, which is arranged immediately in the *front* of the cell, the drying-hearth being dished so as to readily hold any liquid waste.

Directly behind the drying-hearth the secondary fire is arranged, and this may be provided with cinder and calorific refuse, coke breeze, or coke as desired.

Between the drying-hearth and secondary fire a fire brick arch is provided which is set rather low, this being kept in a state of incandescence by means of the heat from the secondary fire. It is so arranged that the heat is projected forwards on to the material lying upon the drying-hearth, and the gases arising therefrom strike the incandescent arch before passing over the secondary fire. The location of the arch also has the effect of deflecting the gases passing from the drying-hearth downwards on to the secondary fire, ensuring their rapid ignition.

Beyond the secondary fire a combustion chamber is provided, through which the whole volume of gases from the cell must pass before reaching the chimney.

The temperature in the combustion chamber is very high and well maintained, owing to its close proximity to the secondary fire, and in starting a high temperature can be quickly reached before the first charge of refuse is fed on to the drying-hearth.

Forced Draught is provided by means of a Steam Jet Blower, and the action of this blower upon the secondary fire is such as to quickly reach and readily maintain a very high temperature.

As the steam-boilers in a Hospital are frequently some little distance away from the Destructor, a special form of superheater is provided to perfectly dry the steam supplied to the Blower, thus materially adding to its efficiency.

The charging-hopper already referred to may be

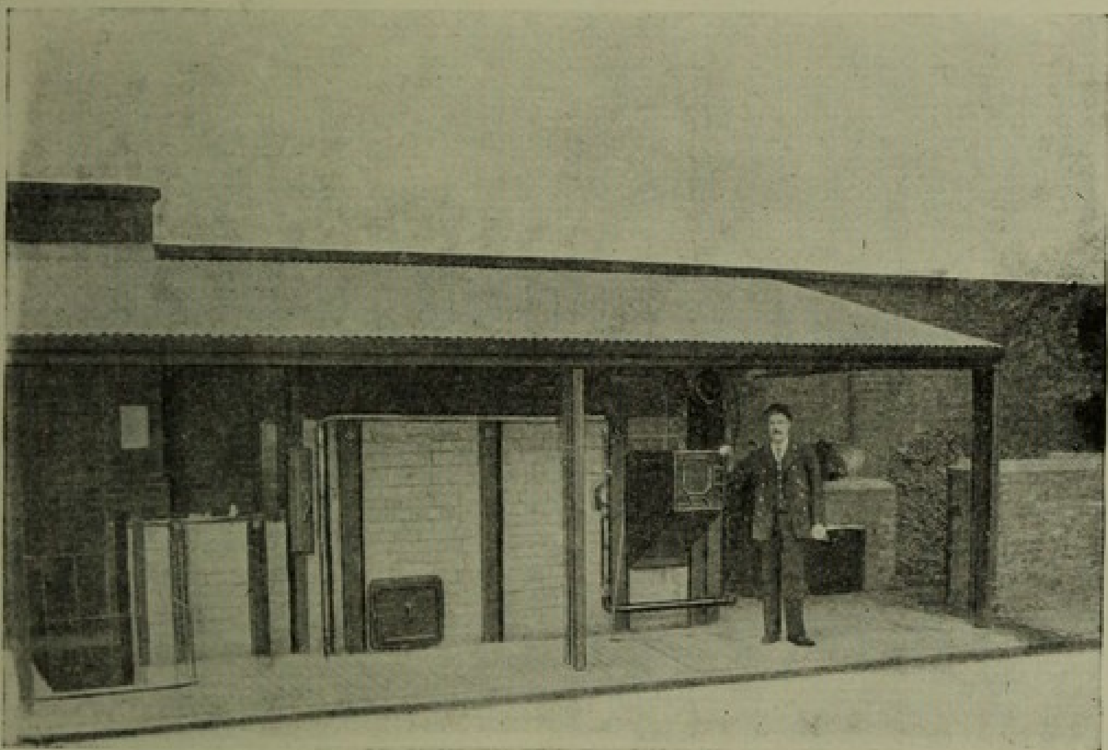


FIG. 11.

arranged either on the right or left hand side of the cell or at the front directly over the fire-doors. Being placed as low as possible it offers a cleanly and very easy method of charging the material. A counter-balanced firebrick damper is provided on the fire side of the charging-hopper to close the opening, and a top cover may also be used if so desired.

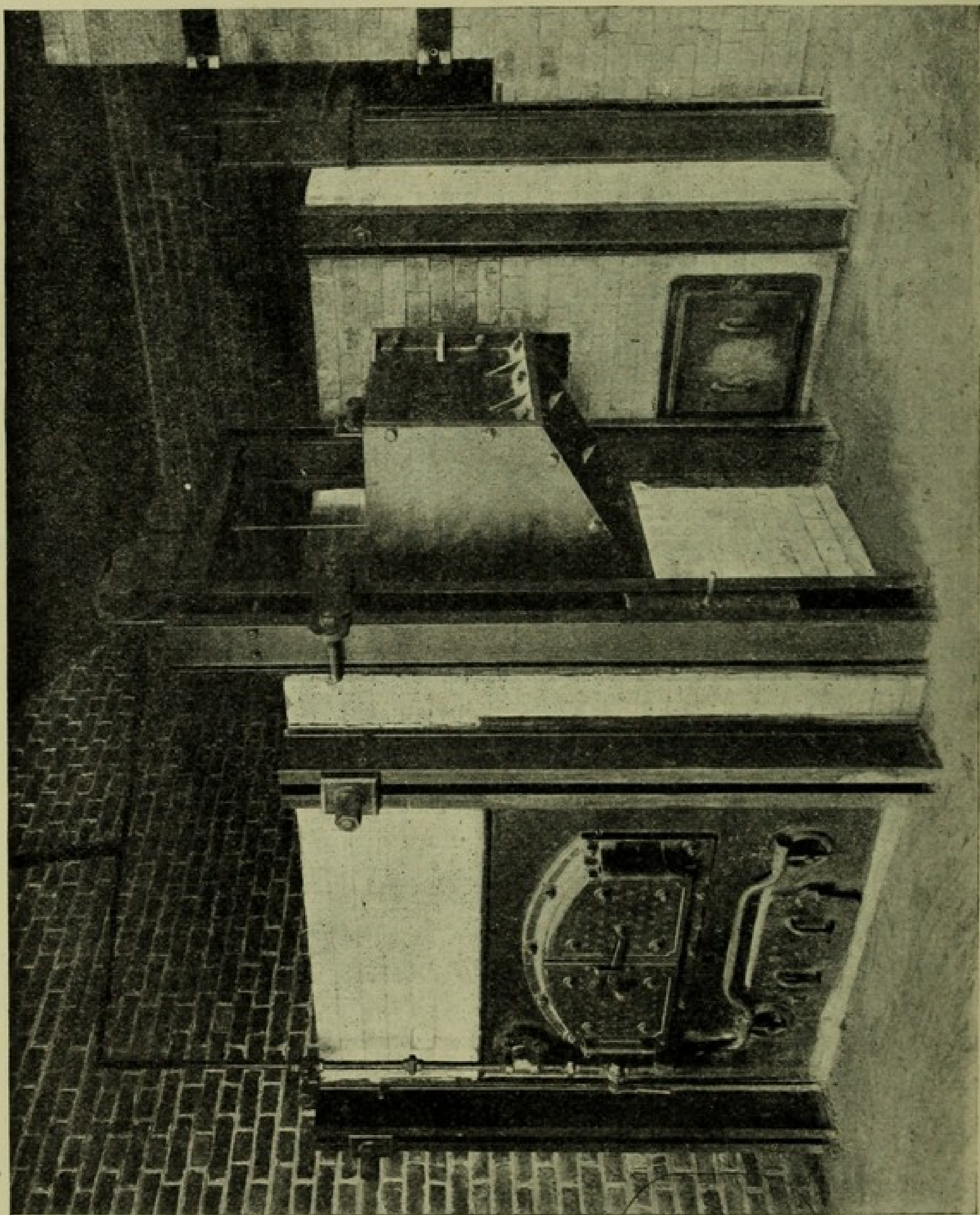


FIG. 12.

The contents of the galvanized pails or receptacles from the wards and kitchens may be readily emptied through the hoppers with but little labour, it being quite unnecessary to handle the refuse in any way.

Fig. 11 furnishes an example of very cleanly operation at the Northern Hospital, Winchmore Hill, this photograph being taken when the Destructor was in operation. At this Institution as much as 2½ tons of miscellaneous waste is frequently disposed of in 12 hours.

Fig. 12 is a view of a similar Destructor erected at the large new Joyce Green Small-pox Hospital, Dartford, having a capacity of 5 tons of refuse daily.

This Institution, as also the Northern Hospital, is one of the many similar Institutions under the control of the Metropolitan Asylums Board.

Chapter IV

PORTABLE DESTRUCTORS

THE Portable Destructor, which has only been introduced within the past two years, has met a long felt want, and is useful for a variety of purposes. For thinly populated districts, small seaside and health resorts, and for camps, it offers at once all the advantages of final and sanitary refuse disposal without nuisance, at a moderate first cost, and a low working cost.

As it may be readily moved about, one such Destructor may be used for some few adjacent small communities. In the case of a town having a population not exceeding 5,000 it affords a satisfactory and cheap method of final and sanitary disposal.

The vexed question of a suitable site so frequently raised in connection with larger and fixed Destructors is at once solved: the horses or other means of locomotion have only to be attached, and the refuse can be destroyed away from houses and out of sight, thus satisfying every objector.

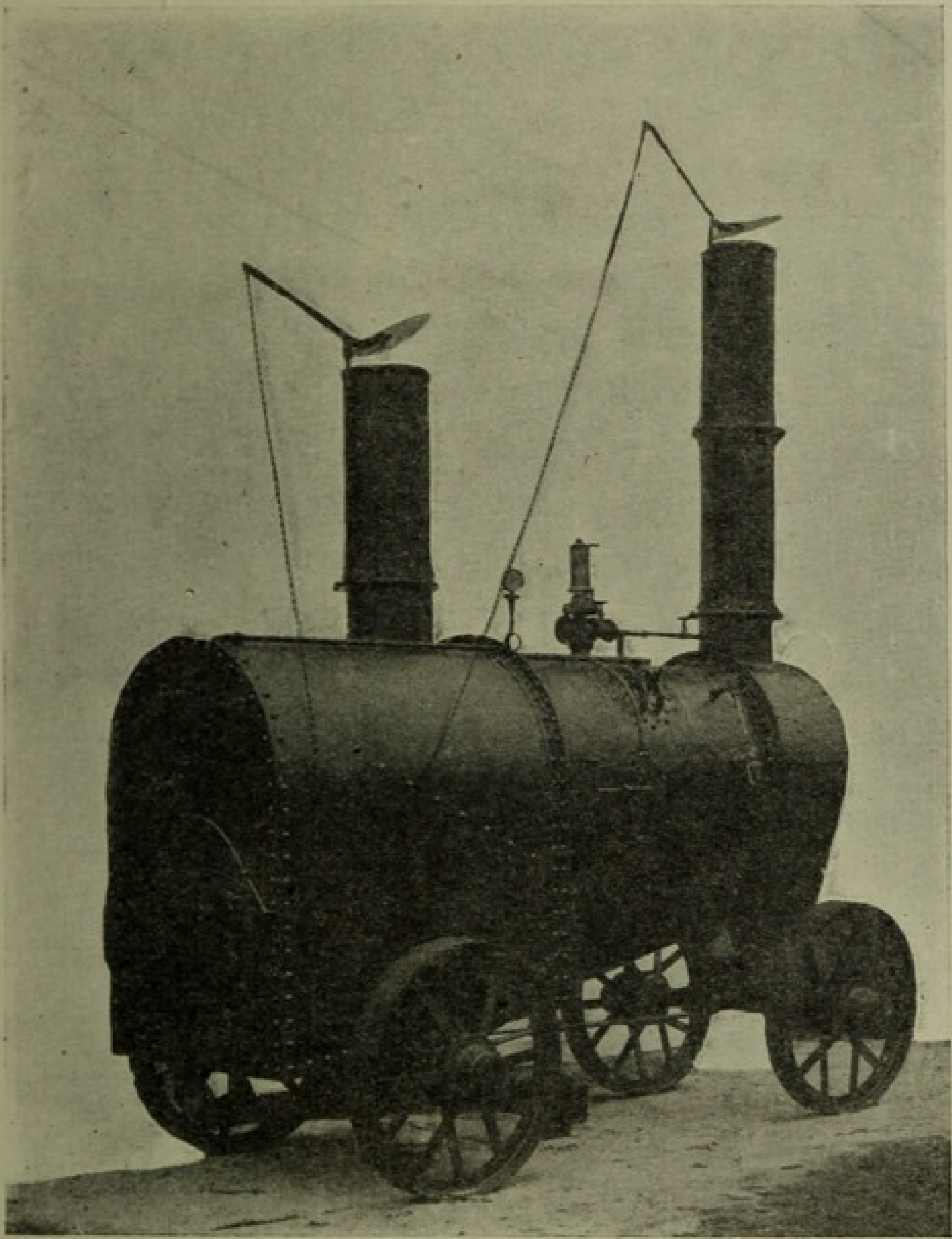


Fig. 13

Fig. 13 is a view of a Horsfall Portable Destructor. The furnace is somewhat similar in design to the larger Horsfall Destructor, being provided with a firebrick arch and a front exhaust for the gases, so arranged that the escaping gases must leave the furnace at the front, rising to the crown arch, and passing through an opening immediately in front of the boiler.

It will be observed that the arrangement of the boiler and furnace is very compact. The boiler is of the Multitubular type, and in addition to supplying steam for the Steam Jet Forced Draught Blower may be arranged to supply steam to a small engine, or for other modest purposes as circumstances may warrant.

This Destructor has a destroying capacity of 4 tons daily, and may readily be moved about as required by three horses, a traction engine, or a steam roller.

Fig. 14 illustrates Meldrum's Portable Destructor, which possesses a number of novel features, and while being compact, it is very strong in construction.

Although only one chimney is provided, either all or part of the gases may be byepassed as may be required. The chimney, it will be observed, is hinged and firebrick lined ; a chimney which can be brought to the horizontal when necessary is obviously very useful.

The boiler is of the Multitubular type, specially

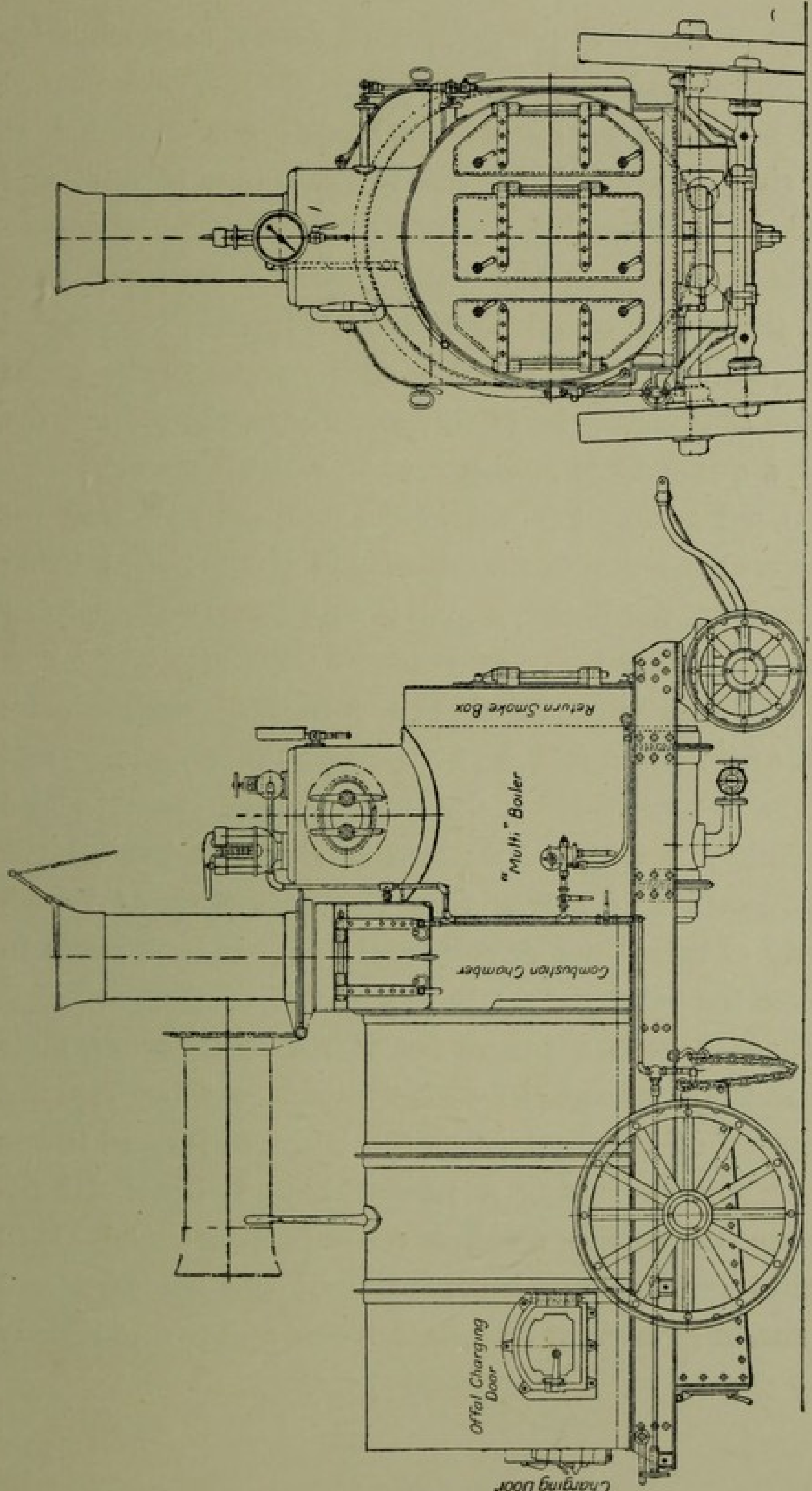

Return Smoke Box
"Multi" Boiler
Combustion Chamber
Offal Charging Door
Charging Door

Fig. 14.

designed for the purpose, and easily accessible for inspection and cleaning.

It will be seen that a separate door is provided at the side of the cell for the introduction of offal and similar objectionable waste.

The capacity of the destructor is 5 tons per day, and the cell is of ample size for readily disposing of this quantity, while the area of the tubes in the boiler is also sufficiently large to readily pass the gases from such a quantity of refuse.

Forced Draught is provided by means of Steam Jet Blowers, the steam for supplying the Blowers being taken from the boiler, which is also equal to supplying steam for other purposes.

The Destructor is of the following dimensions: 7 ft. 4 in. wide, 8 ft. 7 in. high, and 14 ft. 8 in. long, and weighs 7 tons. Needless to add great strength and durability is demanded; and having in mind all the requirements of a Portable Destructor to deal with 5 tons of refuse per day, it would appear impossible to reduce the total weight to less than 7 tons.

That there is a future for Portable Destructors is beyond all question. The rapid and widespread adoption of Destructors in the larger cities and towns is already exercising a powerful and beneficial influence upon the smaller communities. The small capital expenditure involved, and the sanitary and economic gain must at once impress many who rightly consider that the most efficient sanitation is equally as necessary for the well-being of a small as for a large community.

It is difficult to exaggerate the value of the Portable Destructor for Military purposes. For the camp in time of peace, for base camps, and as an adjunct to Military Hospitals it offers a most convenient and rapid means of disposing of every form of objectionable and organic waste.

Dr. George Vivian Poore, one of the highest authorities on camp sanitation, has repeatedly directed attention to the ever-present danger of accumulating organic waste in camps. Referring to Salisbury Plain he writes as follows :—

* " I am of opinion that much that I have witnessed on Salisbury Plain in connection with camp scavenging is bad, and is not calculated to teach the soldier the right principles of dealing with organic refuse, *which is always his most dangerous enemy*. The science of scavenging requires to be taught. If the duty of scavenging be left to the ignorant, and be controlled by persons who think that necessary details are beneath their notice, then annoyance and disease are the only results possible.

" If the scavengings of a camp are to be satisfactorily dealt with, the question of their *ultimate disposal* must

* *Colonial and Camp Sanitation*. By Dr. George Vivian Poore, M.D. Lond., F.R.C.P.

be ever present in the mind of the scavenger. The materials collected have *to be burnt,* to be buried, or to be otherwise dealt with. *The mere dumping of refuse in mixed heaps* ought to be abandoned."

Dr. Poore specifically refers to the large camp at Salisbury Plain, and what actually happens in time of peace. It is, therefore, not surprising to find some striking evidence as to the lack of sanitary precautions during the South African Campaign recorded in the Report of the Royal Commission on the War in South Africa.

The Report of the Royal Commission on the War in South Africa serves to confirm much that has been said from time to time concerning the neglect of sanitation in camps. The disposal of refuse is touched upon in his evidence by Lieutenant-General Sir Charles Warren, who, in reply to Question No. 15,813, made the following observation: "Dirty straw or refuse should not be allowed to lie about or be thrown into corners, *but ought to be burnt.*" Surgeon-General J. Jameson, M.D., in reply to Question No. 11,730, remarked as follows:—

"If sanitation had been understood, not alone by our own officers, but by the rank and file and the commanding officers, it would have saved thousands of lives."

Field Marshal Lord Roberts gave it as his opinion that a special service of sanitary officers should be provided ;* while a well-known civilian surgeon—Dr. A. W. Fripp—in reply to Question No. 11,870, told the members of the Commission "that he took a Disinfector to South Africa with him, and that '*he was roared at*,' but very soon they sent them out to as many of the Hospitals as they could get them to. . . All the excreta from the typhoid patients *ought to be destroyed in some way*."

Apparently, then, not only were Destructors not provided, but even Disinfectors were not considered necessary. Camps were pitched upon ground previously occupied by tents with typhoid patients, according to the evidence of Lieutenant-General Sir Charles Warren, while other witnesses mentioned the location of camps in close proximity to numbers of decomposing carcases of horses.

As clearly showing that the necessity for final and sanitary disposal of all organic waste is now recognised by the medical branch of the army, it may be instanced that one of the most eminent sanitarians in the Army Medical Service recently told the author that the Portable Destructor would most certainly be adopted for use in any future campaign.

There can be no doubt that the Portable Destructor would have been a most valuable adjunct to the medical branch of the Army during the South African War.

* It is interesting to note that a number of sanitary officers have lately been appointed.

The glaring neglect of ordinary sanitary measures helped to swell the death-roll most alarmingly. The great and constant wastage of animal life, the filthy accumulations of animal and vegetable waste, offal, and carcases rapidly decomposing with large bodies of men—often poorly fed—in close proximity thereto, could only result in disease and death.

According to the published statistics there were *twenty-five men* engaged in the war to *one officer*. *Ten* men to *one* officer were killed by wounds, and *thirty eight men to one officer died from other causes.*

Although it is obvious that the officers were drawn from a section of the community whose powers of resisting disease is greater than that from which the non-commissioned officers and men were obtained yet in the above figures we have such evidence as clearly supports the views advanced by many eminent sanitarians in the early stages of the war.

Sir Walter Foster, M.P., drew public attention to the terrible risks being run by the neglect of sanitary measures early in the campaign, but it was all in vain. The sound advice proffered was apparently considered in some quarters to be merely obstructive, and was looked upon by others as a fad. That Sir Walter Foster knew what he was talking about must now be evident to all. The terrible statistics tell their own tale, and appeal alike with force to the humanitarian and the sanitarian.

In the recently issued Report of the Commission on Dysentry and its relation to Enteric Fever, the rapid spread of zymotic diseases is unanimously attributed to flies. It would have been but true if the members of the Commission had gone a step further, accounting for the plague of dipterous insects, aided in their rapid multiplication by the accumulation of organic waste, offering as it does every scope for ovipositing.

If organic refuse be immediately destroyed this ovipositing cannot take place. The author is in agreement with Dr. Poore, and regards the presence of flies as a reproach for not dealing with organic waste as produced in a final and sanitary manner.

At Fratton, about a year since, several deaths occurred from *entero-colitis*, directly due to the contamination of food by flies from the surrounding refuse tips; and this, coupled with the conclusions of the Commission already referred to, present a strong case for the final and sanitary disposal of all waste.

Ordinary garrison refuse is usually of such high calorific value as to be very serviceable for power production; and much might be done in this direction by the provision of fixed Destructors of the modern high-temperature type.

For ordinary camp purposes, either in time of peace or war, the Portable Destructor is capable of meeting all requirements, and is likely to be largely adopted.

Chapter V

AMERICAN PRACTICE

IT is creditable to the medical profession in America that while but little progress has been made in the adoption of the larger Municipal Refuse Destructors in American cities, great progress has been made in the adoption of Institutional Refuse Destructors. Even in connection with comparatively small Bacteriological and Pathological Laboratories, Destructors have been installed, and the advantages accruing from destruction by fire seem to be very clearly recognized and appreciated.

The particular type of Institutional Refuse Destructor which has been most extensively adopted in America is that known as the Morse-Boulger Destructor, which, while differing essentially from all British Institutional Refuse Destructors, appears to give much satisfaction.

The makers of small Destructors in America have not made the same mistake as some British makers in not providing a reasonable range of sizes in small

Destructors. For example, the Morse-Boulger Destructor is constructed in at least seven distinct sizes varying in destroying capacity according to the size.

The smallest size, which is only serviceable for a private Bacteriological Laboratory, is of the following dimensions: 3 ft. 2 in. long, × 2 ft. high × 3 ft. wide, the largest size being 20 ft. long × 8 ft. high × 8 ft. wide, its destroying capacity being sufficiently high for the largest Public Institutions.

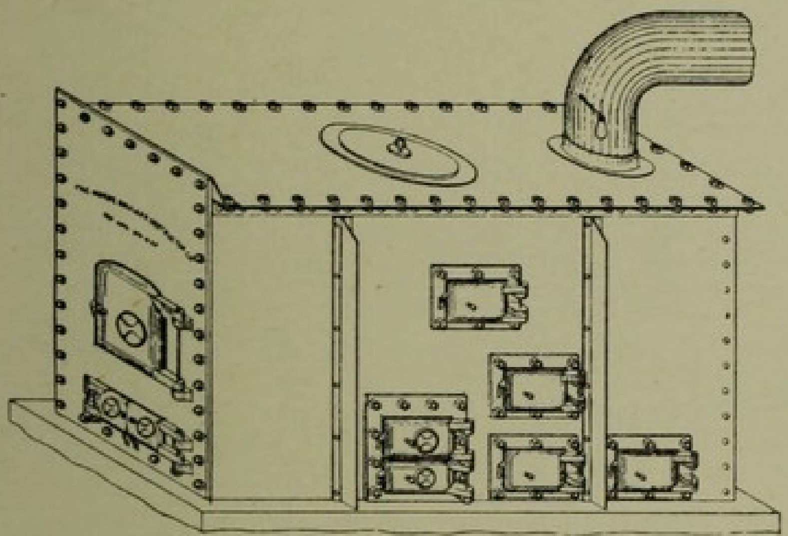


FIG. 15.

Fig. 15 is a view of a Morse-Boulger Destructor as erected at the Burbank Hospital, Fitchburg, Mass., this being of the following dimensions: 7 ft. long × 4 ft. high × 2 ft. 4 in. wide, a very useful size for a small Hospital. This size of Destructor is cased in quarter-inch steel plate, as are also all Destructors of this type, from the smallest to the largest sizes.

Judged by the standard of our small British Destructors, those we are now discussing do not upon the whole compare favourably. For a given destroying capacity our modern Destructors are not only smaller and occupy less ground space, but owing to their design they are capable of being operated at a lower working cost for secondary fuel. Again, in addition to being less complex in design, our Destructors in the larger sizes are more substantial in construction, more expensive in first cost, but exceedingly durable, giving but little trouble, and costing but very little indeed for upkeep and maintenance.

The general design of the Morse-Boulger Destructor will be seen by referring to Fig. 15, and while being subject to modification to meet special circumstances, it may in the main be described as a Destructor cell lined throughout with special fireclay lumps, having two refuse grates one above the other, two auxiliary fires are provided, either of which may be operated with coal, coke, wood or oil fuel as may be most convenient. The main fire is at the front end of the cell, and immediately before the main refuse grate, while the secondary or crematory fire is arranged at the back or chimney end of the cell.

The refuse is charged in at the top, direct on to the firebrick grate, the combustion chamber at the rear end having previously been heated up to a state of incandescence by means of coal or other fuel burned on the rear or secondary firegrate.

Coincidently with the charging of the refuse in at the top of the cell the main fire is started on the grate at the front of the cell. The grate area of the main fire at the front is usually about twice as large as that of the secondary firegrate at the rear end of the cell.

The hot gases passing from the main fire travel over

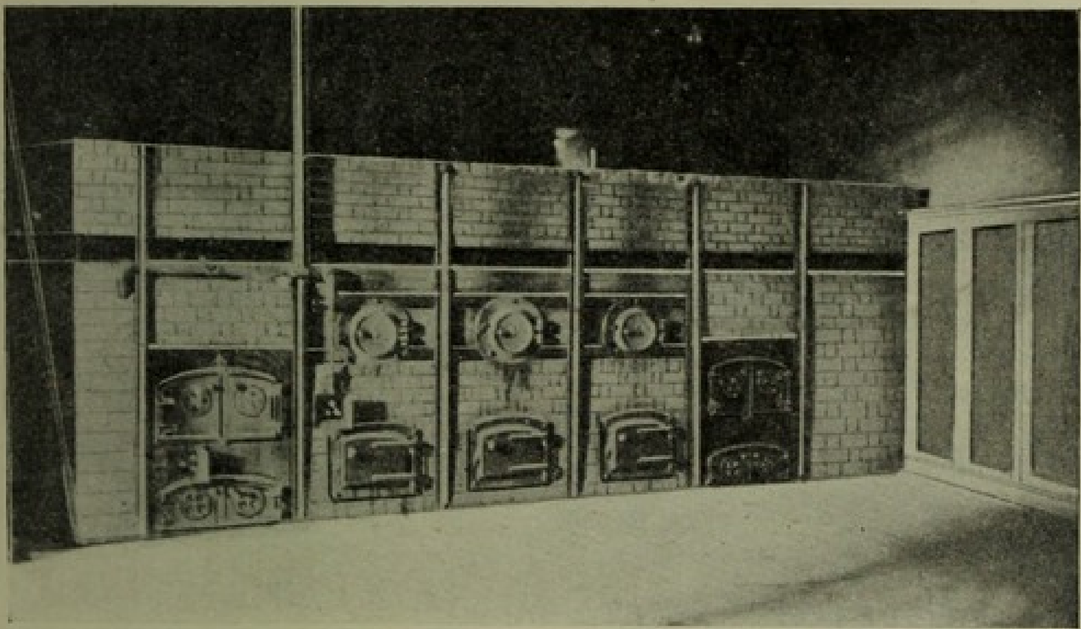


Fig. 16.

the top refuse grates returning underneath the same and over the top of the under or middle refuse grate, the whole volume of gases then passing over the second-fire at the rear and through the combustion chamber to the chimney.

It will be observed that the American Destructor essentially differs in design from Destructors of British make, which are far simpler, more rapid and effective in operation, and less costly in upkeep and maintenance.

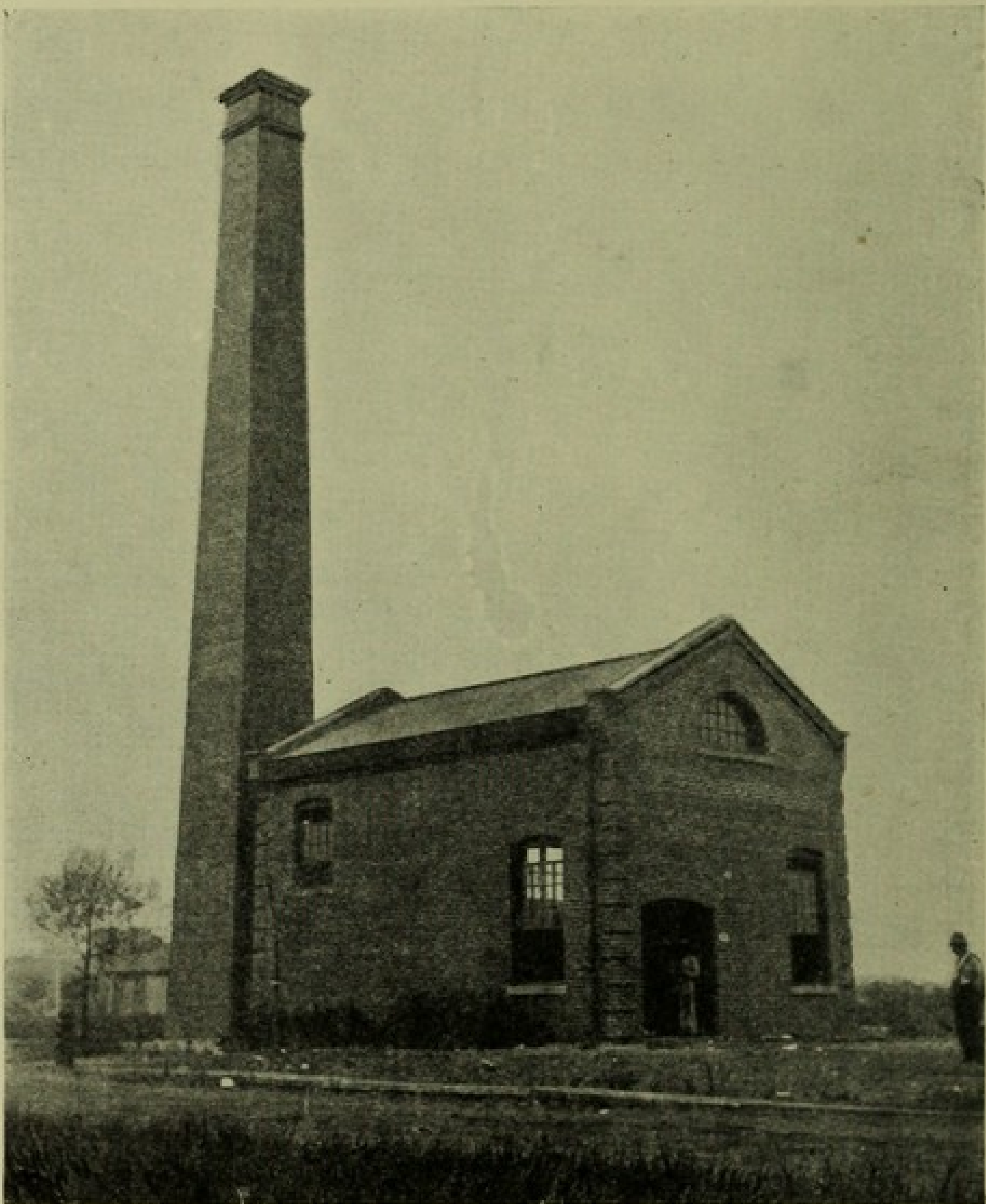


FIG. 17.

The secondary fire at the rear end of the cell is, of course, an adaptation of the Jones' Fume Cremator, and the inclusion of such an additional secondary fire in connection with a Destructor, whether of American or British make, is at once a sign of weakness.

Just as the cremator is a matter of past history with the large Destructors, likewise, in so far as our best modern practice in this country is concerned in connection with small Destructors, a secondary fire between the cell and the chimney is quite superfluous, and is no longer included.

Fig. 16 is a view of a Morse-Boulger Destructor erected ten years since at St. Luke's Hospital, New York City, and is typical of the earlier design and construction. At this Institution about four tons of general Hospital waste is disposed of daily.

An external view of the Destructor building at the Navy Yard, League Island, Philadelphia, is shown in Fig. 17. The Destructor contained within the building shown is one of the Morse-Boulger type, of which quite a number have been adopted by the United States Government at their Military and Naval bases, as also in other departments.

Fig. 18 illustrates a Morse - Boulger Destructor erected at the Broad Street Station of the Pennsylvania Railroad Company in Philadelphia. This furnace was specially designed for destroying about one cubic yard of cancelled tickets daily, in addition to the miscellaneous office waste of a large establishment.

The waste is brought by a chute from the top storey

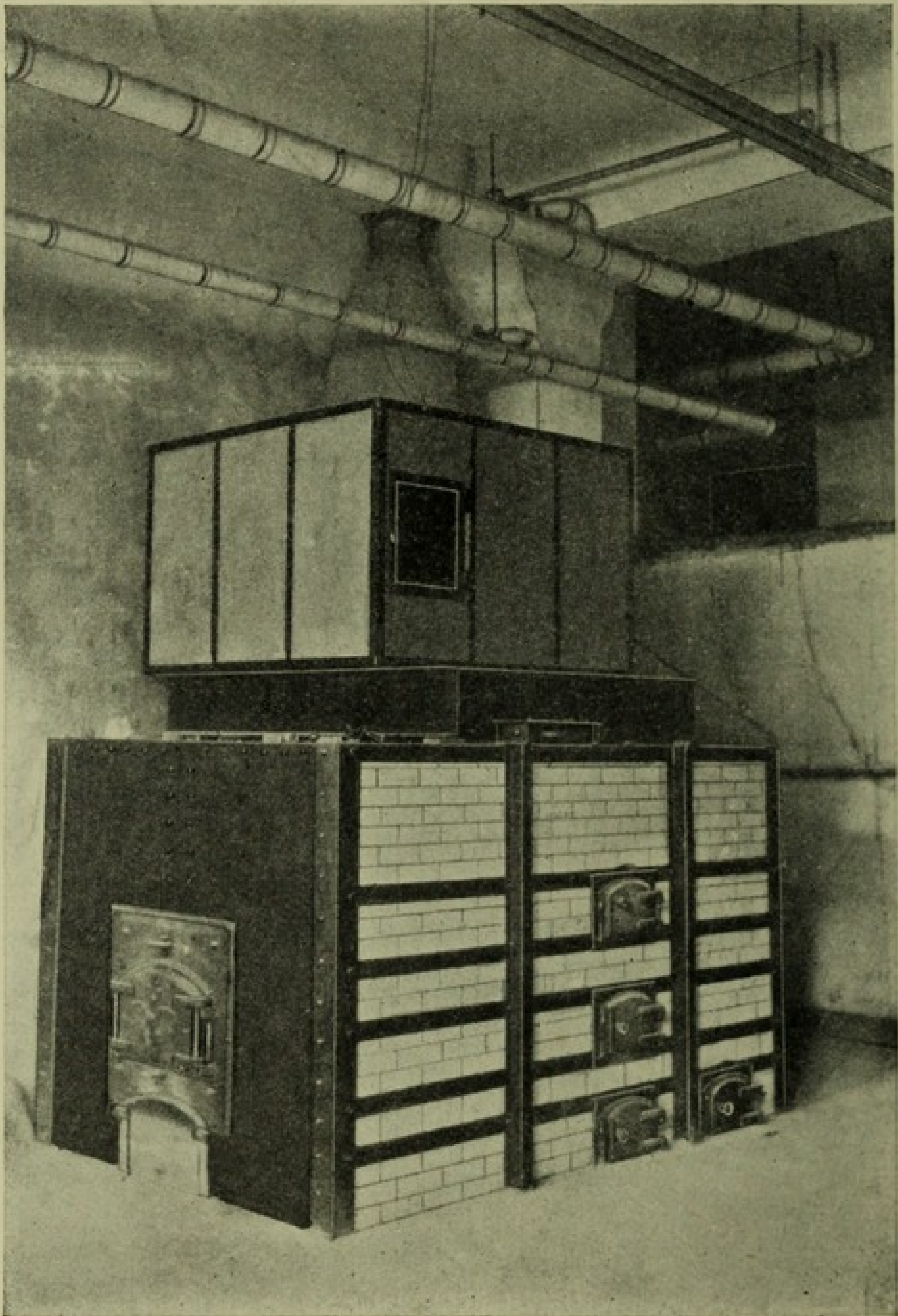


Fig. 18.

of the building and discharged into the Destructor, which is provided with a special locking-device for securing the doors and openings during the combustion process, the cancelled tickets, bonds, and other papers being destroyed as a precaution against duplication or re-issue. The work done by this Destructor is

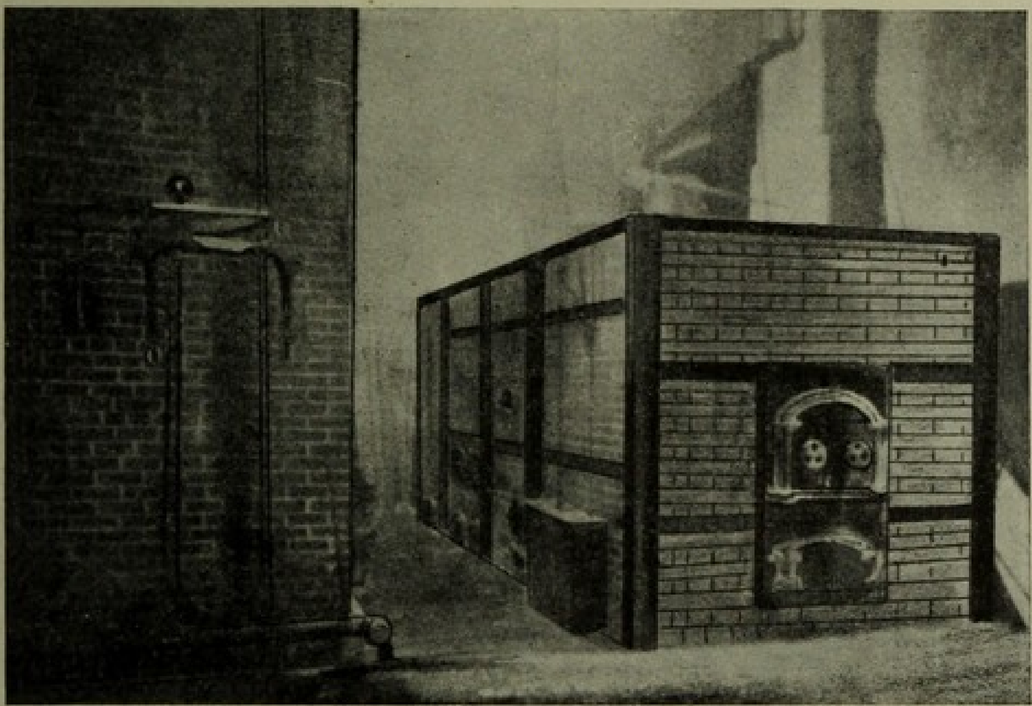


Fig. 19.

quite unique, and would seem to suggest yet another possible use for small Destructors.

The Destructor illustrated in Fig. 19 is in operation at the department store of Messrs Lit Bros., in Philadelphia, and is a typical example of a modern American Destructor for disposing of trade refuse, the hot gases being passed through a Green's Economiser, heating the feed-water for the steam boilers.

The refuse is brought from the various floors of the building through a chute and delivered into a room adjoining the Destructor, being then charged direct into the cell. The hot gases leaving the cell pass through an underground flue to the Green's Economiser.

This is a very useful method of utilising the heat from small Destructors : and in the planning of Public Institutions and Works it is well worth while to arrange for the Destructor to be erected alongside of the Economiser. Even from two or three tons of refuse daily, the resultant heat is a very useful quantity, the value of which is now clearly appreciated.

At the *New Astor Hotel*, on Upper Broadway, New York City, a Destructor has recently been installed, a small steam boiler being provided in connection therewith to utilise the hot gases from a daily consumption of 5 tons of refuse.

The inclusion of a boiler with so small a Destructor is a striking illustration of the possibilities of heat-utilisation, even in connection with the refuse of large hotels. Destructors are now in course of construction at the following large hotels in New York City : The hotels, *Belmont*, *St. Regis*, *Knickerbocker*, and *Imperial*, as also at the *Hotel Belle-Vue*, *Stratford*, in Philadelphia, and the *New Hotel* at Saratoga, N.J., and so far as the adoption of Refuse Destructors for use in hotels is concerned it must be conceded that America run us very close indeed.

It does, however, seem incongruous to find Destructors so widely adopted in Apartment-houses, Hotels, Stores, and Hospitals in American cities, while no real effort has yet been made to effectively tackle the greater problem of disposing of civic refuse in a final and sanitary manner.

On the whole we have little, if anything, to learn from American practice. The wide adoption of small Destructors and their use for such a variety of purposes should, however, foster a spirit of enterprise in this country.

In American cities Destructors have been extensively adopted in Hospitals of various kinds, Medical Schools, Disinfecting Stations, Bacteriological and Pathological Laboratories, Asylums and Sanatoria; and although American Destructors are inferior to our own, yet on the whole the importance of disposal by fire is more clearly recognised than is the case in this country.

Such statistics as are available would seem to show that the weight of refuse produced daily per 100 inmates in American Hospitals is fully twice as much as is produced in Hospitals in this country.

Taking an average Fever Hospital in London, having a total number of 1,000 inmates and staff, the average weight of refuse produced daily is about two tons. Belle-Vue Hospital, a representative Institution of the kind in New York City, having a "population" of from 1,200 to 1,500 persons, has to dispose of from five to eight tons of refuse daily, an extraordinary quantity when compared with the figures already quoted.

It may be urged by some that the greater quantity of refuse produced in American Hospitals furnishes a very strong case for the widespread adoption of Destructors. While there is admittedly reason in this it does not in any way affect the main principle, which must ever be that the refuse of Public Institutions should be disposed of in a final and sanitary manner on the premises; and no Public Institution may be considered as complete in its equipment unless up-to-date means are provided for the expeditious disposal of all waste as produced.

Chapter VI

THE DISPOSAL OF TRADE REFUSE

A REMARKABLE instance of the profitable utilisation of Colliery waste came under the author's notice a few months since. Messrs. Holt and Willetts, of Cradley Heath, purchased a plot of land in close proximity to an old worked-out colliery, of which there are a large number in the Black Country. Situated upon the plot of land in question are several large mounds made up of fine refuse fuel from the colliery, the bulk of which has been stacked for many years.

Colliery Refuse

It occurred to Messrs. Holt and Willetts that this waste might be utilised for steam-raising purposes, and having installed two large Lancashire boilers, they decided to apply Meldrum's Patent Forced Draught Furnaces thereto, with the result that for two years past they have used no other fuel but the refuse from one of the heaps.

Prior to using this waste these enterprising people were burning a slack coal costing only about 6*s*. 6*d*.

per ton delivered, and one might at first sight reasonably assume that little scope existed for any remarkable economy. Events, however, have proved the contrary to be the case; and it is estimated that the waste from *one* alone of the several heaps will provide all the fuel required for over forty years, a consumption of 27 tons per week sufficing to generate all the steam required.

Such a case as this may well appear incredible to some; but when one examines the figures of analysis it must be allowed that such a result is only what might be reasonably expected.

The waste in question may perhaps best be described as a shaly slack, varying in size from $\frac{3}{4}$ in. to $\frac{1}{8}$ in., no less than 60 per cent. being of the smaller size and dust. Its calorific value is as follows: 8,216 B.T.U. = 8·5 pounds; volatile matter = 36·93 per cent.; and the percentage of incombustible, 23·1 per cent.

The sample giving the above result was tested in June, 1903, and was a fair average sample.

Such a case as this very clearly illustrates the waste of byegone years, and affords a remarkable object-lesson as to the value of that which for many years past has been looked upon as worthless.

The following table is of interest as showing the calorific value of a variety of refuse fuels from Collieries. It will be observed that many of these fuels possess such high percentages of incombustible that it is manifestly impossible to burn the same in any steam-boiler furnace, if any serious amount of work is demanded from the boiler. The limited grate area in an internally-fired boiler is all against the successful utilisation of such fuels for steam-raising purposes, and experience has clearly shown that, unless other means be employed for burning the lowest grade fuels, they are likely to accumulate and waste.

From a National point of view, this would be deplorable; and it must be conceded that not a little can be done towards husbanding the coal resources of our country by utilising every ton of low grade fuel which can possibly be turned to good account for purposes of power production, bearing in mind that every ton of such fuel so used has the effect of rendering saleable a definite quantity of coal of a higher calorific value. It will likewise be evident that in so doing the Colliery proprietor is able to actually dispose of the maximum weight of fuel mined, which, apart from any considerations of a National character, must be a source of profit to the individual.

Again, if the Colliery proprietor can be persuaded to use the very lowest grades of fuel on the spot for power production, the steam user must to some extent benefit, owing to the maximum quantity of cheap small fuels put upon the market.

Table Showing the Calorific Value of Various Kinds of Colliery Refuse.

Colliery	Class of Refuse	Calorific Value	Volatile Matter	Incombustible	Moisture
1. Fryston Colliery Co.	Fine Washings	8·19	39·36%	38·9 %	—
2. New Charlston Colliery	Refuse from Washing Machines	10·28	—	11·3%	11·4%
3. New Charlton Colliery	Pond Settlings	12·04	—	0·78%	40·2%
4. Woolley Colliery .	Pond Settlings	11·66	21·125%	17·4%	—
5. Crawshaw and Warburton, Dewsbury	Shale . .	4·45	27·03%	56·63%	—
6. Neepsend Gas Works, Sheffield	Fine Coke Dust	9·4	4·3%	13·5%	—
7. Nunnery Colliery .	Pickings from Screens	8·5	24·075%	36·8%	—
8. Ditto	Coal Washings	5·1	17·125%	54·66%	—
9. Ditto	Pickings .	13·0	35·16%	9·23%	—
10. Morley Main Colliery	Bottom Hub	7·1	41·6%	42 %	—
11. Aldwarke Main .	Pickings .	10·8	35·5%	24·066%	—
12. Nostell Colliery Co.	Shale and Coal Pickings	9·62	—	?4 %	—
13. Low Moor Colliery, Ltd.	Tank Settlings	5·75	20·63%	20·66%	10·5%
14. Nunnery Colliery Co.	Pond Settlings (fron tip)	10·3	27·43%	16·06%	—
15. Park Coal Co., Mirfield	Coke Dust and Coal Dust	10·2	22·96%	22·23%	—

It will be observed that several of the waste fuels included in the foregoing table of analyses are of fair calorific value. For instance, Pond settlings, with a calorific power of 12·04 and a remarkably low percentage of incombustible. The value of such a fuel is, however, seriously affected by the heavy percentage of moisture present. As this fuel is allowed to settle in a "pond" and is then removed from the bottom in the form of mud, it is not surprising to find the percentage of moisture is given as a fraction over 40 per cent.

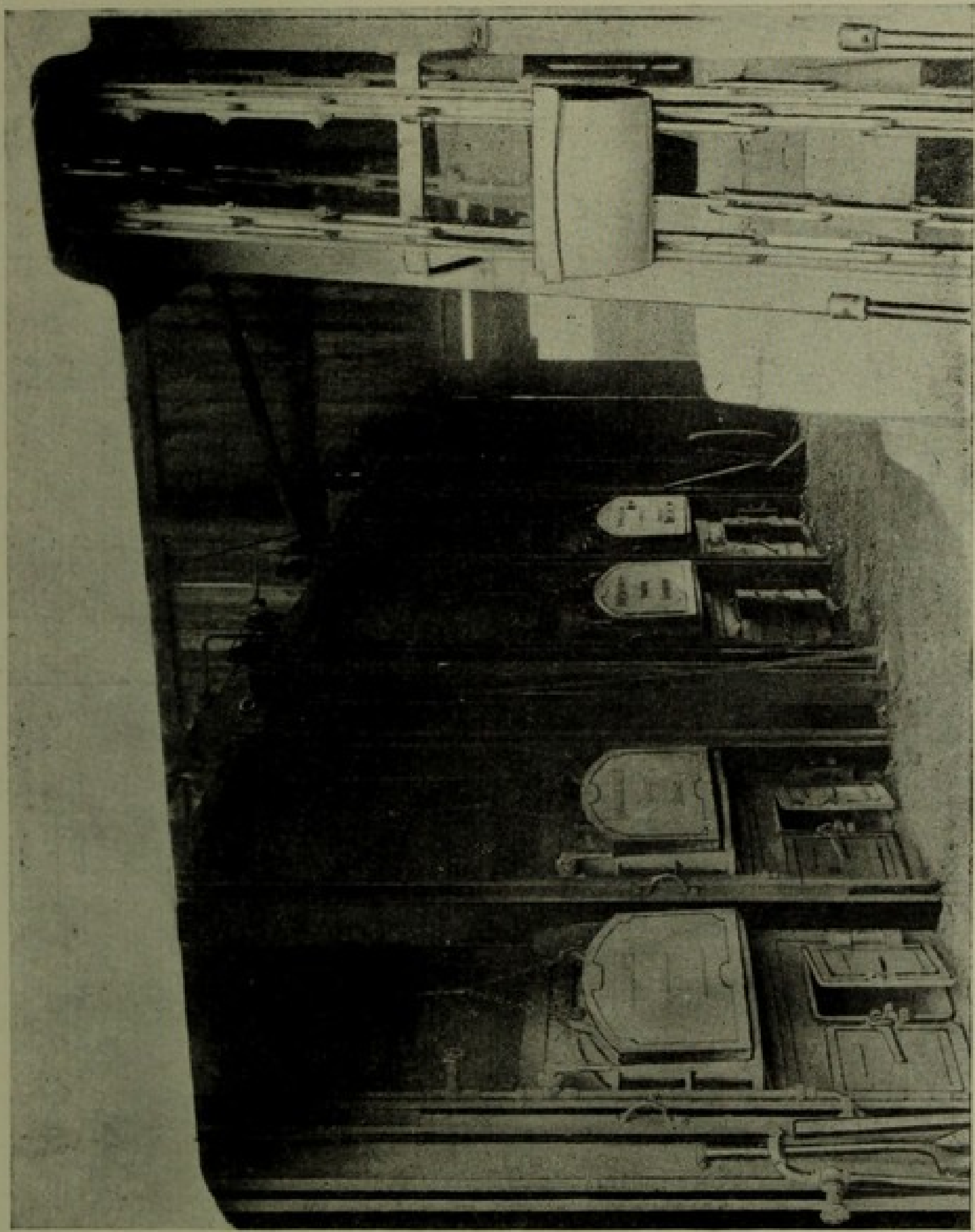


Fig. 20.

Such a fuel as No. 1, "Fine Washings," is exceedingly difficult to burn in any boiler-furnace. Its calorific power is not high, and the percentage of incombustible, 38·9 per cent., must prove troublesome. To burn such a fuel in any boiler-furnace internally fired, and get a heavy duty out of the boiler is quite impossible.

In order to successfully deal with such fuels as Nos. 5, 7, 8 and 10, as well as some of the other low-grade refuse fuels mentioned, an external furnace designed upon the lines of a Refuse Destructor will alone meet the case; and if such fuels are to be dealt with it is only upon such lines that success will be assured.

Most of the experiments made up to the present time have been confined to refuse fuels of a shaly nature, such as No. 5 in the table of analyses, and unpromising as this material is, remarkable results in power production are being obtained therefrom.

The Meldrum Destructor Furnaces erected at Houghton Main Colliery, and which are illustrated in Figs. 20 and 21, are burning a shale refuse, the calorific value of which is approximately given in the following figures of analyses :—

No. 1.	*Size 3-in. squares.*		
	Calorific Power	=	1,933 B.T.U. per pound.
	Volatile Matter	=	16·60 per cent.
	Incombustible	=	71·6 per cent.
No. 2.	*Size 6-in. squares.*		
	Calorific Value	=	2,416 B.T.U. per pound.

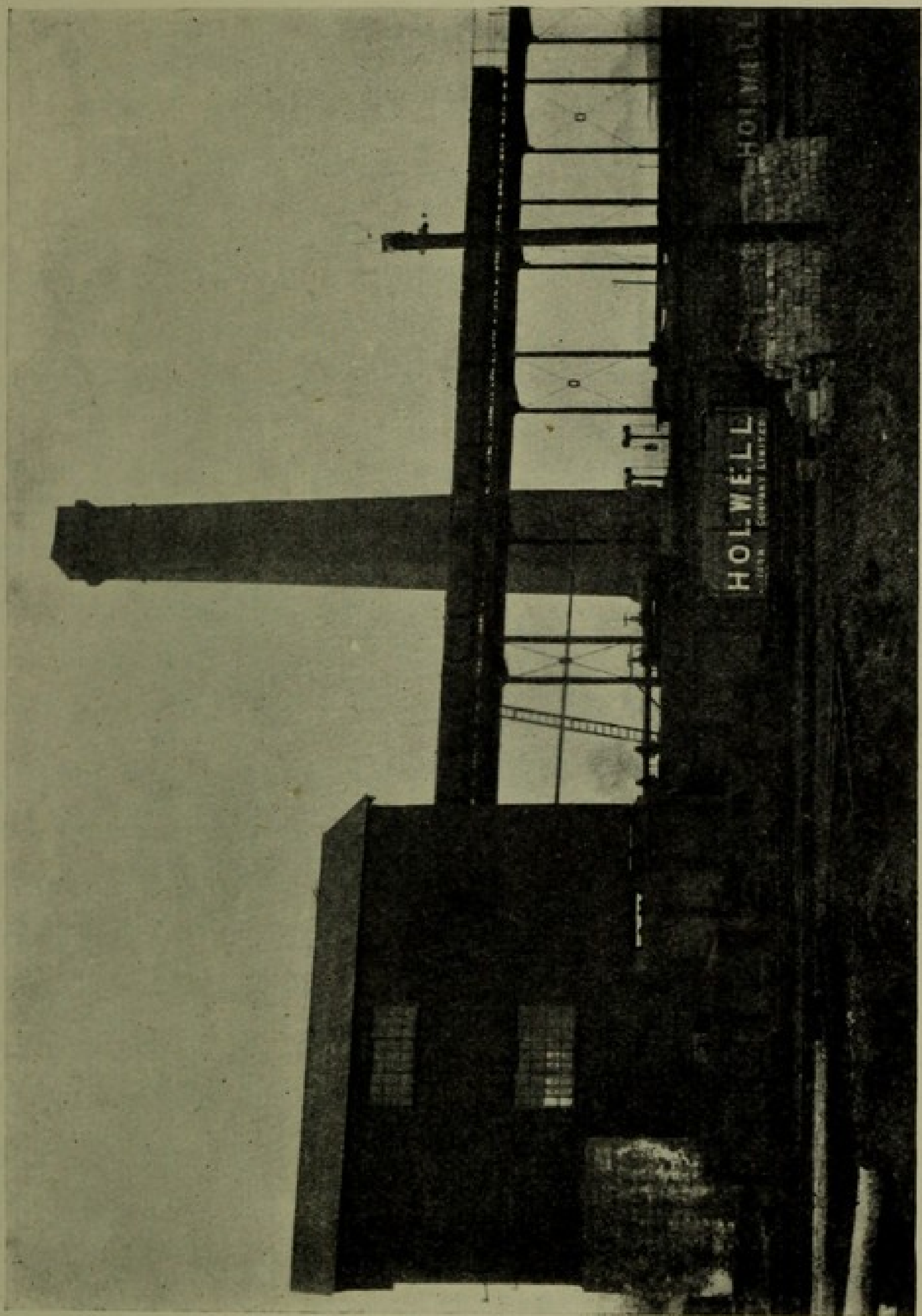


Fig. 21.

	Volatile Matter	=	20·16 per cent.
	Incombustible	=	63·80 per cent.
No. 3.	*Size 3-in. square.*		
	Calorific Value	=	6,573 B.T.U. per pound.
	Volatile Matter	=	23·73 per cent.
	Incombustible	=	19·43 per cent.

Each Destructor Furnace is arranged immediately in front of a Lancashire boiler 30 ft. long × 8 ft. in diameter, and with each boiler no difficulty is experienced in obtaining an evaporation of 1,000 gallons per hour.

Such a rate of evaporation is remarkable with such a low-grade fuel; and it is perfectly safe to say that with any other system of firing the waste in question would not permit of even half of the above rate of evaporation being reached.

Mr. W. H. Booth has advocated the use of an external cell or furnace in connection with Lancashire boilers for burning even good fuels, and he has made out a strong case, the crux of which is that the Lancashire boiler can only be provided with a very limited grate area.

Mr. Booth rightly observes that "The trouble with the Lancashire boiler is that it will only contain firegrates having a joint width less than the diameter of the boiler to the extent of 18 per cent. Such firegrates cannot be made longer than about 7 ft. for hand-firing, and even this length is too much for any but the most skilful fireman to attend to properly. Thus a large boiler is seriously limited by its internal firing arrangements. When externally fired the Lancashire boiler will do very much more work than when internally fired, and its furnace can be more easily arranged to give more perfect combustion; but external firing is condemned by the Boiler Insurance Companies, and is certainly not advisable when bad water is used.

"There is, however, no reason why the Lancashire boiler should not be fired with coal in an external furnace, the products of combustion passing into the tubes, as in the case of a Destructor installation."

Needless to add Mr. Booth was anticipated. Some years ago experiments made in the burning of an ordinary Lancashire slack in the Rochdale Destructor cells had the effect of showing conclusively that excellent results could be obtained, and further, that the loss of heat units absorbed by the firebrick walls of the cell was not by any means so serious as had been freely predicted.

Test at Rochdale Destructor with Slack Coal Burned in Destructor Cells.*

Duration of Test . . .	7½ hours.
Grate area of Destructor .	45 square feet.
Number and type of Boilers	2 Lancashire, each 30 ft. by 8 ft.
Total weight of fuel burned	10,864 lbs.
Weight of fuel burned per hour	1,448 ,,

* See reference over.

Weight of fuel burned per square foot of grate per hour	32·2	lbs.
Total weight of water evaporated actual . .	60,870	,,
Total weight of water evaporated as from and at 212° Fahr.	79,615	,,
Water evaporated per hour actual	8,116	,,
Water evaporated her hour as from and at 212° Fahr.	10,616	,,
Water evaporated per pound of fuel actual . . .	5·60	,,
Water evaporated per pound of fuel as from and at 212° Fahr.	7·33	,,
Temperature of feed-water .	52° Fahr.	
Steam pressure per square in.	113 lbs.	
Thermal value of Slack . .	12,300 B.T.U.	
Price of Slack	7*s.* per ton *d/d.*	

As the only test of the kind ever made, so far as the author is aware, the results are very satisfactory, and while capable of improvement, it is quite clear that small bituminous fuels may be burned in external firebrick cells with such efficiency as is claimed by Mr. W. H. Booth and others.

The author is in cordial agreement with the views expressed by Mr. Booth, and there is no doubt whatever that within the next few years we shall see much

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done in this direction. The external firebrick cell, with its large area of incandescent brickwork, is the direct opposite to the ordinary furnace, whether the boiler be of the Lancashire or water-tube type. In the former case the gases are distilled under such conditions as promote rapid ignition, while in the latter case the cooling surface, either in the shape of boiler plates or tubes, present precisely opposite conditions; the gases as distilled strike a comparatively cold instead of an intensely hot surface.

Mr. Frederick Grover, of Leeds, who was commissioned last year by the Indian Government to inquire into the causes of the smoke trouble in Calcutta, refers in his report to some experiments which he conducted at a mill in that city with a Babcock & Wilcox boiler, the object being to prevent smoke when using a native slack fuel. Curiously enough, Mr. Grover succeeded by providing an extended external furnace outside of the boiler, so arranged that a large area of incandescent firebrick should surround the mass of fuel, serving to promote rapid ignition before the volume of gases passed forward to come into contact with the tubes. Mr. Grover's experiments in this direction appear to have been uniformly successful, and the results obtained certainly tend to confirm the views advanced by Mr. W. H. Booth and others as to the advantages accruing from the burning of bitiumnous fuels in external brick cells.

Wood Refuse

In addition to colliery refuse, there are yet other classes of industrial waste which may be advantageously employed for the production of power. Prominent among these may be mentioned Wood Waste—the refuse of Saw Mills, Case and Box-making, and other Wood Working factories, comprising Bark, Waste Wood, Chips, Shavings, Saw Dust, etc.

Generally speaking, very little has been done in this direction, and in very few factories indeed in this country is wood waste being burned to advantage for power-producing purposes.

In wood working industries a very considerable amount of waste is produced, possibly more than from any other manufacturing process, and being of a fairly dry and combustible character, it is very useful indeed for steam-raising purposes.

Wood has a distinct and remarkable value as a fuel, but in burning the same for power-producing purposes it must be dealt with in a proper manner, or the results obtained will in all probability be disappointing.

It is doubtless due to the indifferent results obtained with wood as a fuel that many steam users to-day have but a very poor opinion of its fuel value ; it is, however, but fair to add that wood has never failed to satisfy when it has been burned under proper conditions, and in suitable furnaces, and that even now it is the staple fuel of not a few countries, being largely used for steam-raising purposes in Westralia, Central and South America, India, Finland, and in some parts of Russia.

Enormous quantities of Jungle Wood are being burned in Madras, even with boilers of the Lancashire type, and highly satisfactory results are being obtained.

In our own country wood was in general use as fuel until the year 1570, and it was only owing to its ever-increasing scarcity that coal eventually became our staple fuel.

Sixteenth century records mention the offences of an iron-master in the neighbourhood of Durham, who during the course of his busines career had cut down and burned no less than 30,000 oak trees; and the historian playfully remarks, " If he live long enough it is doubted that he will leave so much timber in the whole country as will repair one of our churches if it should fall."

Those who doubt the fuel value of wood should bear in mind that even some centuries ago, when wood was burned in the crudest manner possible, it was in great favour as a fuel, and not only for domestic purposes. Nor can it be urged that wood was then favoured because it was the only fuel available. In the year 1306, King Edward I. was petitioned by Parliament to prohibit the use of coal in London for any purpose. The citizens were so offended by the " sulferous smoke and savor of the firing," that the King complied with their request, and the penalty for the use of coal was the destruction of the furnaces or kilns in which it had been used.

Even as late as the year 1714 the use of coal was prohibited in Paris, and still fifty years later, when wood was very expensive, there was a very strongly pronounced feeling against the use of a mineral fuel.

In the chemistry of coal it is very interesting to trace the gradual change of the woody matter through its successive stages. Very gradually, but surely, all the constituent parts of the wood, except the carbon, are eliminated, and as the outcome of vigorous life, followed by a long process of decomposition, we have coal.

Some actual figures of analyses, showing the constituent parts of various wood as compared with the richest coal, may be of interest more particularly in demonstrating the fuel value of wood.

Analyses of the Wood of Various Forest Trees

	Carbon	Hydrogen	Oxygen and Nitrogen	Mineral Matter and Ash
Oak	48·9	5·9	43·1	2·0
Birch	48·9	6·2	43·9	1·0
Beech	48·3	6·0	45·1	0·6
Cherry	48·9	6·5	44·3	0·3
Poplar	49·5	6·1	42·7	1·7
Willow	50·1	5·9	42·0	2·0
Pine	51·0	6·1	41·9	1·0
Fir	51·1	6·1	41·8	1·0
Mean Composition of Wood	49·6	6·1	43·1	1·2
Without Ash	50·2	6·2	43·6	—

	Calorific Power in British Thermal Units.	Carbon Value.	Evaporative Power, in pounds, of water from and at 212° Fahr.
Wood, kiln dried .	8·000	·550	8·28
Wood, air dried, with 20 per cent. of water	5·600	·385	5·80

In order to fully appreciate the values expressed in the foregoing theoretical figures, it is useful to compare the same with those of one of our richest British fuels—an anthracite coal having a calorific power of 15,000 British Thermal Units, i.e., a theoretical evaporative power of 15·53 pounds of water per pound of fuel, from and at 212° Fahr., and a carbon value of 1·031.

It may be safely assumed that wood, when thoroughly dried, contains about 50 per cent. of carbon, 6 per cent. of hydrogen, 42 per cent. of oxygen, and 2 per cent. of ash. Owing to the high percentage of oxygen present, and its neutralising effect, probably no more than 1 per cent. of hydrogen is available for combustion. Thus the heat obtained in the combustion of wood is almost entirely due to the carbon.

Curiously enough, although wood has been, and is still, extensively used for steam-raising purposes, few authentic records of evaporative tests are available. The author obtained the following figures from a reliable source, and they are of great interest as showing the remarkable evaporative value of wood as a fuel, even when burned in an ordinary boiler furnace.

Test No. 1.

Kind of wood =	Red and White Pine (cut one year, and damp).
Pounds of wood burned per hour =	796 pounds.
Water evaporated per pound of wood from and at 212° Fahr. =	3·25 pounds.

Test No. 2.

Kind of wood =	Same as above, but artificially dried.
Pounds of wood burned per hour =	538 pounds.
Water evaporated per pound of wood from and at 212° Fahr. =	5·0 pounds.

The comparative commercial value of fuels must always be largely determined by the percentage of incombustible residuum, and, as will be obvious, wood is low in incombustible. But it must be borne in mind that about three tons of wood refuse have to be burned to give the same result in steam generation as may be obtained from one ton of average soft coal.

It will thus be evident that the labour factor has to be seriously reckoned with; and so in cases where a large quantity of wood is available, such a system of feeding the same into furnaces should be adopted as will tend to minimise labour, so that, if possible, no more actual cost is involved in burning wood than in burning coal.

In a properly constructed brick furnace or cell, on the general lines of a Destructor furnace, and equipped with forced draught, from 80 to 100 pounds of wood-waste per square foot of grate surface per hour can be readily burned; and in large Saw Mills and Wood-working factories, where sufficient refuse is available, it is quite possible to close the coal account altogether, producing the whole of the power required from the wood-waste alone.

It may be remarked: If this is correct, then why is coal still in general use in Saw Mills? and why is the wood refuse still looked upon in many works as a nuisance rather than an asset?

The answer is simple. For the most part, Saw Mill proprietors have endeavoured to burn their wood-waste under such conditions as would not permit of satisfactory results being obtained.

Again. In many cases the Saw Mill is provided with a small boiler and a very moderate chimney. The boiler was designed for meeting given steaming requirements with coal as the fuel; the grate area and air space of the firebars was arranged for burning coal and not wood waste, and under such conditions the latter cannot be burned to advantage.

Even if the chimney draught be sharp and the grate arranged for burning waste other difficulties may arise, more especially in burning the lighter portions of the waste, such as chips, shaving and sawdust. Some of which is not unfrequently discharged from the chimney top in a charred condition.

In a few instances, Saw Mill proprietors have erected crude brick cells in which the refuse is burned, the gases passing through a flue or connecting throat to the boiler. This method, while getting over some of the difficulties already enumerated, has not had the desired effect.

Failures and only partial successes have had the effect of bringing the Saw Mill proprietor to the conclusion that wood-waste is not satisfactory as a fuel; but such a conclusion is entirely erroneous and unwarranted. To look into the matter is to be convinced that the Saw Mill proprietor has not shown that wood-waste is useless as a fuel, but rather that he does not know how best to deal with the waste to turn it to good account.

The Saw Mill proprietor is not necessarily an engineer, and furnace design and construction is essentially the work of the engineer who specialises in that particular branch. The fact that a certain amount of waste is produced in an industry is surely no reason why the producer of the waste should best know how to employ the same for the production of power?

It is because the specialist has not been recognised in the past that so little progress has been made in the profitable utilisation of wood-waste for power production. Crude attempts, and consequent failures, instead of bringing the steam user to recognise that he should consult with those who know, for the most part seem to bring him to the extraordinary conclusion that he has done all that can possibly be done, and that coal must be burned in the future.

As already observed, if sufficient refuse is available, the use of coal for steam-raising purposes may be entirely dispensed with by employing Destructor cells or furnaces, such as are here described and illustrated. Further, when once the firebrick lining of the cell is in an incandescent state, smoke is entirely prevented; and a boiler fired in this way by means of high-temperature gases from an external cell will not suffer to anything like the same extent as a coal-fired boiler.

This is explained by reason of the large grate area, and the heavy charges of fuel fed into the cell; consequently, the fire-doors have not to be opened so frequently. Further, the large area of heated brickwork tends to neutralise any inrush of cold air, and thus the fluctuation in the temperature of the gases passing through the boiler is not serious. A boiler fired in this manner is obviously not subjected to racking strains, due to sudden changes in temperature, to anything like the same extent as is the case with a boiler fired with coal.

Probably in the case of many Saw Mills where Gas Engines are employed, and there is no steam-boiler in use, the refuse disposal difficulty is even more acute; but there appears to the author to be no reason why users of Gas Engines should not also have a small Refuse Furnace and a steam-boiler. The power produced could doubtless be utilised in many instances for lighting, heating, or supplementary driving, and still other outlets for the use of the available power may be suggested according to circumstances.

The Wood Refuse furnaces on the market are but few in number; and as it is not within the province of this work to deal with boiler furnaces, attention will be directed to external furnaces, and furnaces designed upon similar lines to Refuse Destructors only.

Shepherd's Patent Wood Refuse Furnace, illustrated in Fig 22, is an external brick cell or furnace usually occupying a space about 4 ft. by 4 ft. 6in. It is firebrick lined, and has an outer casing of ordinary facing bricks, the whole structure being stayed by means of angle-iron ties. The refuse is fed in at the front through an opening at the base of the hopper, the sliding door covering the opening being operated by means of a counterbalanced weight.

The firebars sharply incline from front to back, so

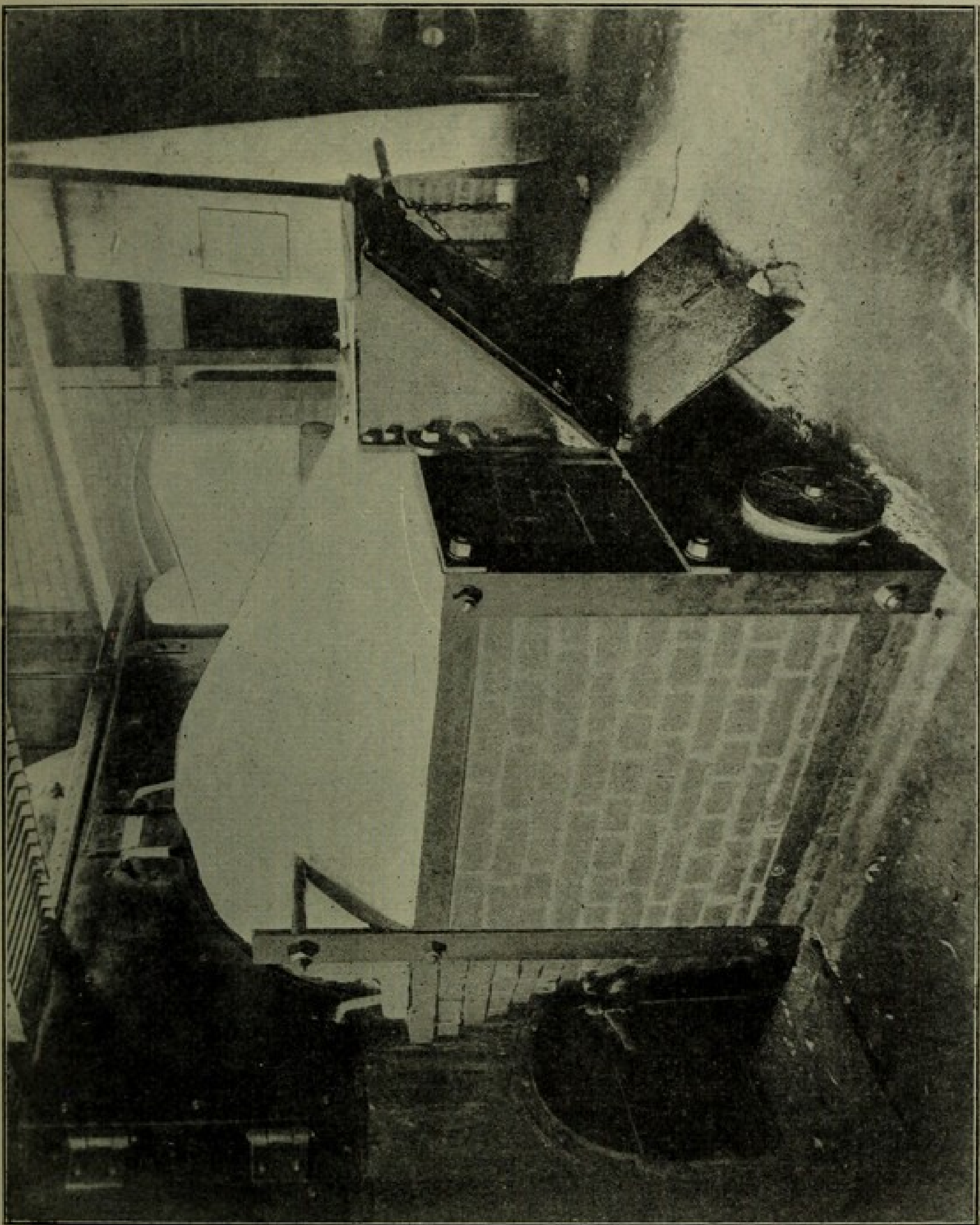
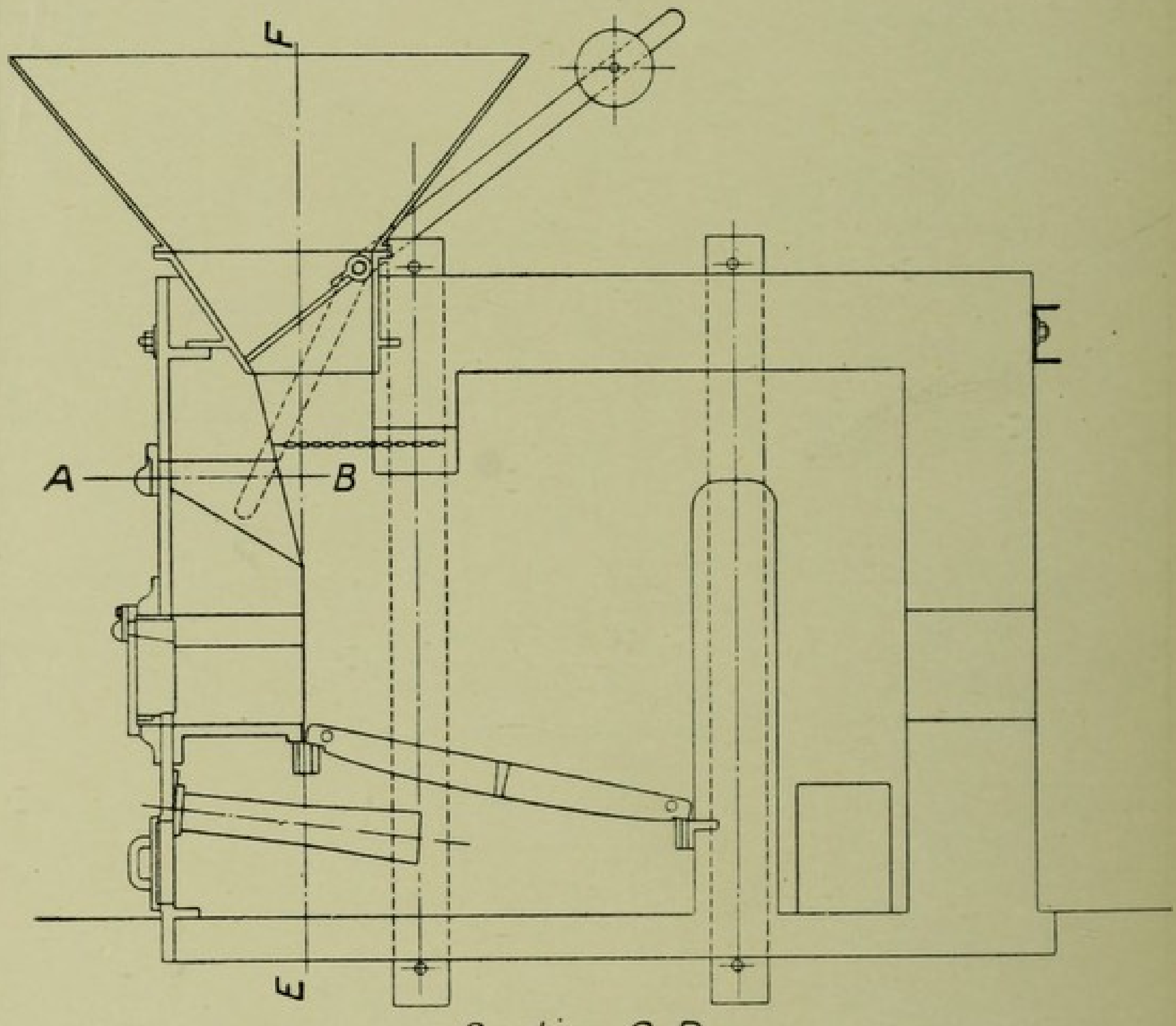


Fig. 22.

that the back of the grate is considerably lower than the front. Beyond the firebridge a baffle wall is arranged to prevent any unconsumed material being carried through the boiler and thence up the chimney.



Section C. D.

Fig. 23.

It is said that this arrangement of cell can be adapted to any type of boiler, and that back draught is impossible; but it is difficult to see why this should be so, because it is not the design of the furnace which can produce or prevent back draught, but rather the conditions existent beyond the furnace, i.e. the area of the flues and the chimney.

Shepherd's Wood Refuse Furnace is of the natural draught type, being dependent upon the chimney for

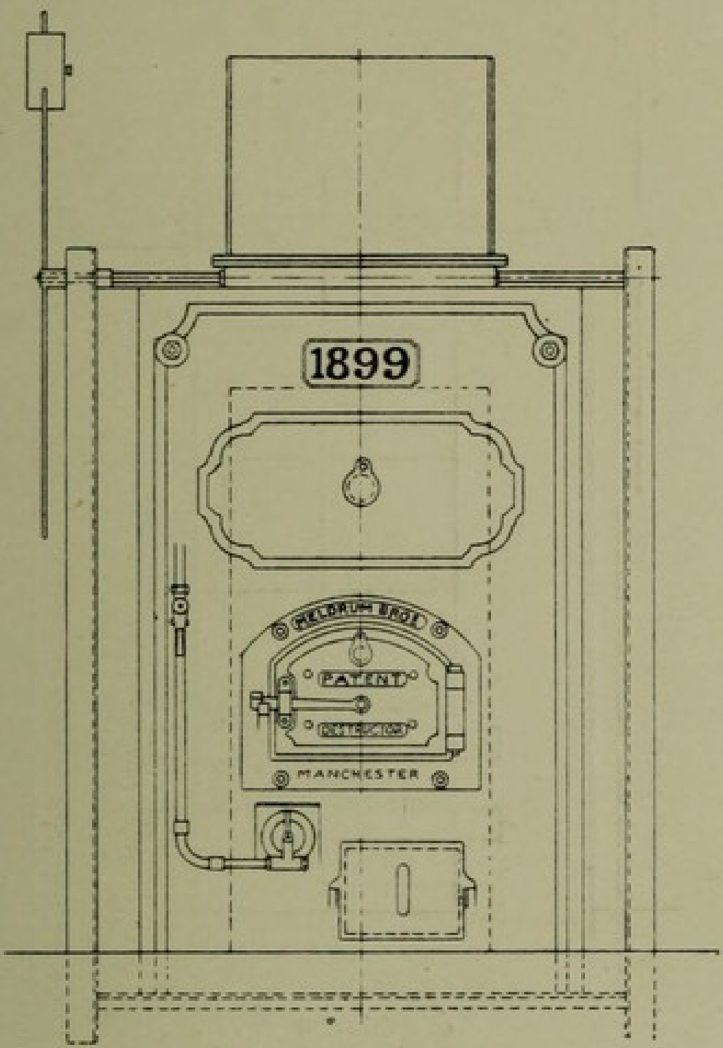


FIG. 23 (*continued*).

the air supply for combustion. The rate of combustion, and accordingly the rate of evaporation from the boiler, must therefore be determined by the existing conditions.

Meldrum's Patent Destructor Furnace, arranged for burning wood-waste, is shown in Fig. 23, which design of furnace was adopted by one of the Railway Companies in the North of England in order to burn

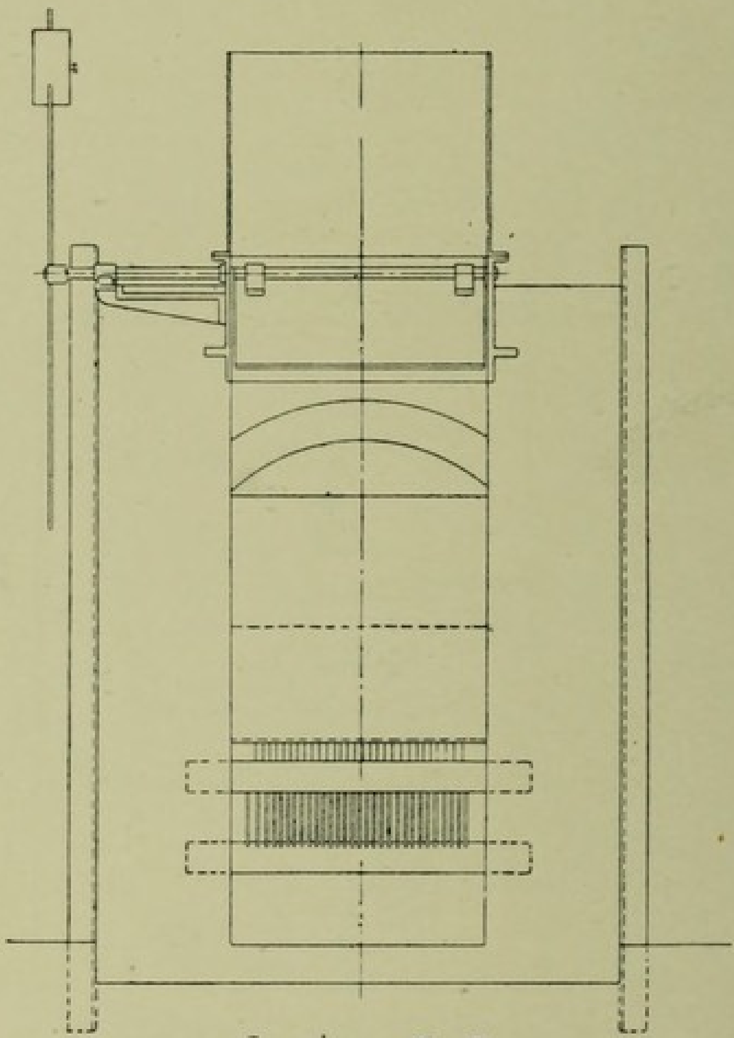


FIG. 32 (*continued.*)

the whole of the wood-waste from large carriage shops.

It will be observed that a charging hopper is provided on top of the cell through which the bulk of the waste may be fed, large pieces of wood being preferably fed in through the fire-door at the front.

The furnace is capacious, there being ample height above the firebars to permit of a heavy fire being carried, and the high bridge and combustion chamber beyond tends to effectually prevent the carrying forward of small refuse into the boiler flues. Forced Draught is provided by means of Steam Jet Blowers.

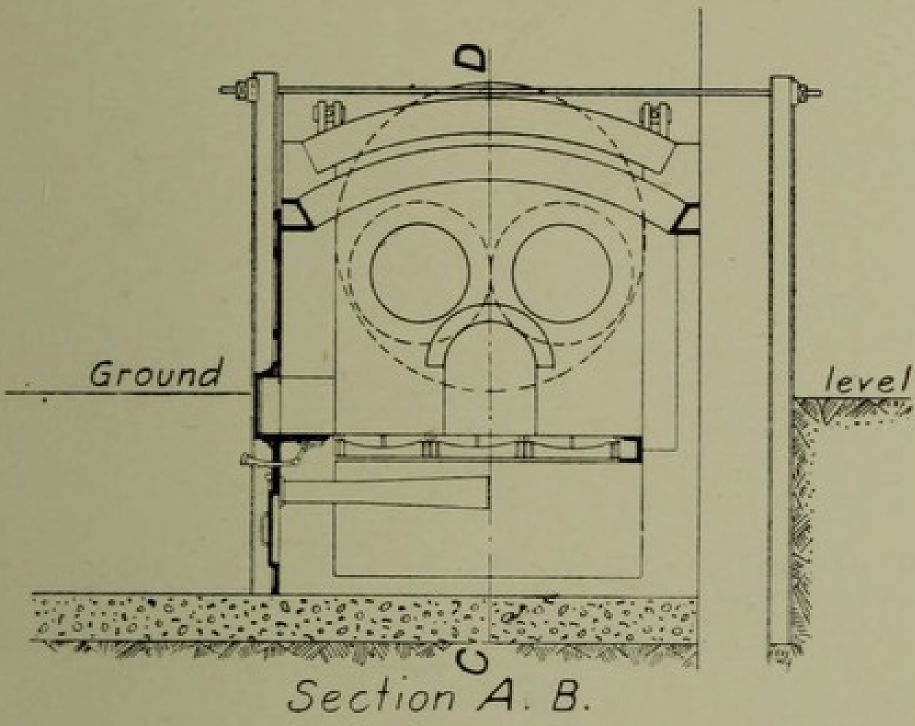


FIG. 24.

Fig. 24 illustrates a Destructor cell of similar design adapted to an existing Lancashire boiler at a large Saw Mill in Glasgow. In this case, it will be observed, the Destructor was sunk below the ground level, the charging hopper of a rather different type being arranged somewhat lower. This Destructor, it will be noted, is also provided with Steam Jet Blowers for Forced Draught.

Previous to the erection of this plant the Lancashire boiler was fired with coal; but the refuse was found to be quite equal to producing the whole of the steam required, and with the starting of the Destructor the use of coal ceased entirely, the saving effected being at the rate of about £1 per day.

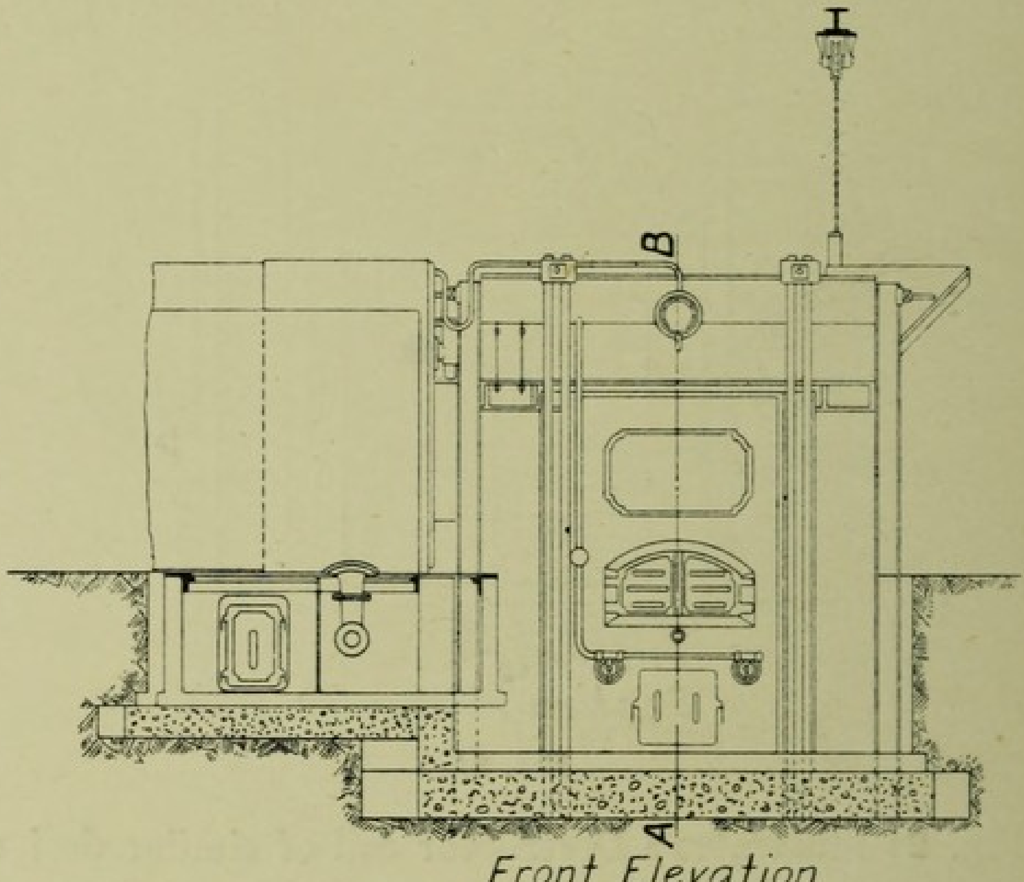
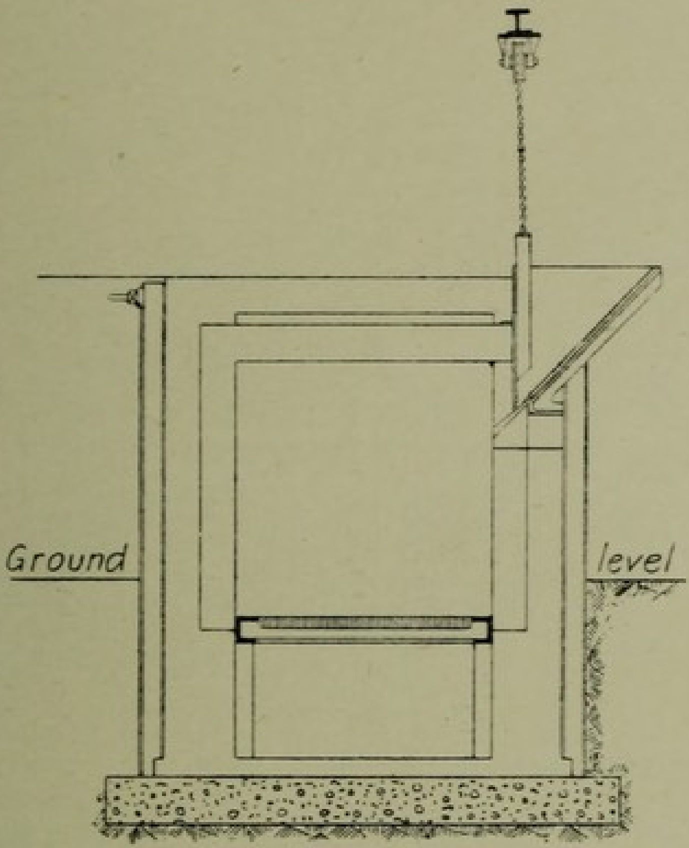


FIG. 24. (*continued*).

It need scarcely be remarked that for this class of work experience in furnace design and construction is essential; and further, such cells must be of the very best possible workmanship and construction, lined throughout with the finest firebricks, and thoroughly braced and stayed.

The method of charging may be modified to suit existing circumstances. For instance, to facilitate the feeding of the refuse, the hopper may be considerably lengthened, and this, with a large firing-door in the front, should effectually meet the most exacting requirements.



Section C. D.

FIG. 24 (*continued*).

The hopper may be readily arranged at the front or at either side of the cell, rather than at the top, if so preferred, and it may be filled from various parts of the factory by the cyclone, if so desired.

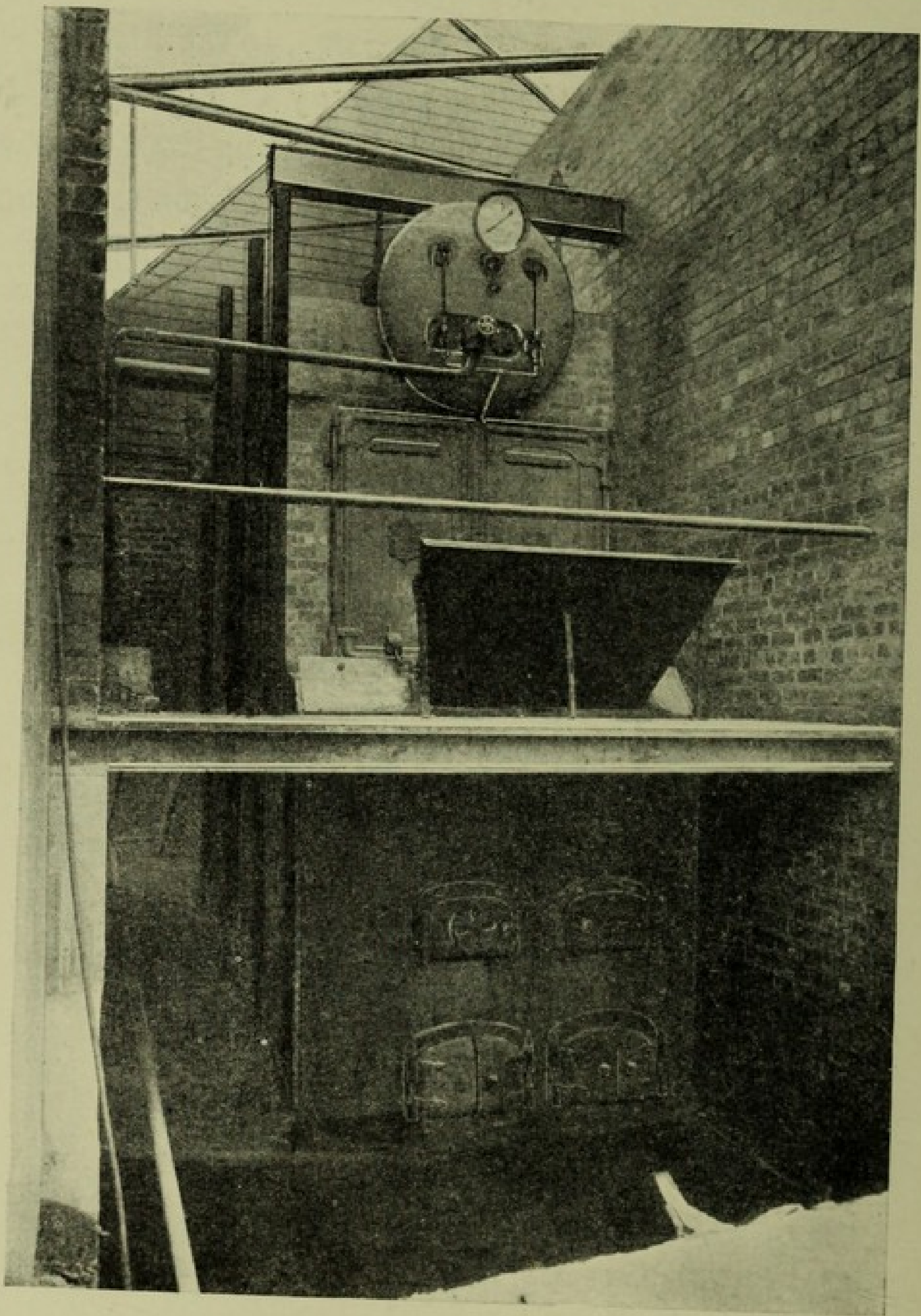


Fig. 25.

A "Babcock & Wilcox" Water-Tube Boiler arranged for firing with Wood refuse is illustrated in Fig. 25. It will be observed that in this particular instance the waste is delivered overhead, being wheeled along the gangway and tipped through the charging hopper, which is arranged as high as possible and immediately underneath the large doors giving access to the tubes.

Owing to the large grate area available and the internal firebrick walls a considerable quantity of wood-waste may be effectually disposed of, while fully utilising the resultant heat for steam raising.

It will be noted that this arrangement also leaves the coal-fired grate and fire-doors free for the use of coal at any time as may be found necessary.

To those interested in the utilisation of wood and wood-waste, and other low-grade fuels for the production of power, the following tables will be found of service:—

Calorific Values of various Low-grade Fuels.

——	Approximate Total Heat of Combustion of 1 lb. of Fuel.	Equivalent Evaporation from and at 212° Fahr. per lb. of Fuel.
Peat (25 per cent. moisture) . .	·7000	7·25
Straw	·8000	8·40
Wood (air dried)	·8000	8·28
Peat (desiccated)	·10000	10·35
Wood Charcoal (desiccated) .	·13000	13·46
Wood (desiccated)	·11000	11·39

Composition of Wood.

(*Rankine.*)

Kind of Wood.	Composition.				
	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Ash.
Beech	49·36	6·01	46·29	0·91	1·06
Oak	49·64	5·92	41·16	1·29	1·97
Birch	50·20	6·20	41·62	1·15	0·81
Poplar	49·37	6·21	41·60	0·96	1·86
Willow	49·96	5·96	39·56	0·96	3·37
Averages	49·70	6·06	41·30	1·05	1·80

Approximate Weights of one Cord of various Kiln-dried Woods, and their Evaporative Power compared with Coal of Average Quality.

(*Hutton.*)

Kind of Wood.	Approximate Weight of one Cord of Wood.	Weight of Coal that one Cord of Wood is approximately equal to in evaporative power.
English Oak	3,850 lbs.	1,560 lbs.
Ash, Beech and Thorn (each)	3,520 ,,	1,420 ,,
Red Oak, hard Maple and Walnut (each)	3,310 ,,	1,340 ,,
Apple tree, Pear tree, Cherry tree and Plum tree (each)	3,140 ,,	1,260 ,,
Birch, Elm, Plane tree and Hazel	2,880 ,,	1,190 ,,
Chestnut, Brushwood and Yellow Pine	2,520 ,,	1,130 ,,
Pitch Pine, Alder, Aspen and Poplar (each)	2,130 ,,	1,050 ,,
Willow, White Pine or Deal (each)	1,920 ,,	970 ,,
Hemlock	1,220 ,,	580 ,,

QUANTITY OF ATMOSPHERIC AIR REQUIRED IN PRACTICE FOR THE COMBUSTION OF ONE POUND OF VARIOUS FUELS.

(*Hutton.*)

DESCRIPTION OF FUEL.	Air required for Combustion with Natural Draught.		Air required for Combustion with Forced Draught.	
	Weight in pounds.	Cubic feet at 62° Fahr.	Weight in pounds.	Cubic feet at 62° Fahr.
Wood, moderately dry .	10	132	7·5	99
Wood, well dried . .	12	158	9·0	119
Straw, dry	11	145	8·25	109
Sawdust, dry . . .	13	170	9·75	128
Peat, moderately dry .	13	170	9·75	128
Peat, well dried . .	16	211	12·0	158

Having discussed the value of some refuse fuels or Trade waste possessing a definite calorific value, we will now briefly deal with other classes of industrial waste, some of which have but little calorific value while much requires the use of a proportion of secondary fuel to ensure its satisfactory cremation.

Linoleum Waste

The refuse or waste of a Linoleum and Floorcloth factory may be turned to good account, being of a highly combustible nature, and very useful indeed for the production of power. It is true that Linoleum Works are but comparatively few in number, but the quantity of waste produced in such works is by no means small, and it may be said that it is waste of a dangerous character to accumulate, being highly inflammable.

So far as the author is aware, at only one Linoleum factory in Great Britain is the trade waste being disposed of in a modern Destructor furnace on the premises ; in this particular case very satisfactory results have been obtained. With such waste one would naturally expect excellent results in power production; and it is to be regretted that the large Linoleum manufacturers in this country have not yet availed themselves of the fuel value of their trade waste, while at the same time ridding themselves of refuse of a dangerous character.

Tanners' Waste

Spent Tan is another class of trade refuse which is extensively produced in all parts of the country. For many years past large quantities have been disposed of in steam-boilers fitted with Meldrum's or other Forced Draught Furnaces, the Tan in some cases fresh from the pits, and in other cases pressed, being then mixed with a proportion of slack coal. In this way the average Tannery has been able to dispose of the trade waste practically as produced.

While such a method of disposal is perhaps upon the whole the most suitable method in the case of a small Tannery, it is by no means the best method of disposal for large Tanneries, where a very considerable amount of tan is produced.

Even in some of the smaller Tanneries, owing to the limited grate area in the steam-boilers, it is found difficult to dispose of the whole of the wet refuse available. The only solution is either a larger boiler, or an external Destructor cell arranged in front of the existing boiler, and the latter course is not only cheaper but far more satisfactory.

In many large Tanneries, if the whole of the spent tan were disposed of in one Destructor cell, instead of in several boiler furnaces, not only would a considerable saving in labour result therefrom, but not a little of the coal bill would also be saved.

The external cell, with its larger grate area and incandescent firebrick interior, is far better adapted for rapidly disposing of such waste, and the burning of the same under the more favourable conditions would demand the use of considerably less additional fuel, and so tend towards economy in the production or power.

Paint and Oil Waste

The inflammable waste of a Paint, Oil and Colour Works might, with great advantage, be disposed of as produced on the premises. It is no exaggeration to state that the refuse of such an industry is dangerous in the extreme, and to accumulate the same is to run a very serious risk.

It may be said that the proportion of waste is but small in this industry ; but in a large works the accumulation soon becomes a serious matter, and we frequently find useful space occupied by a miscellaneous collection of dangerous rubbish.

To dispose of such waste as produced is not only to eliminate risk, but it also tends to keep the works free from the nuisance of accumulated waste, which is always more or less a source of trouble.

Preserve Works Waste

In Preserve Works it is of great importance to provide a Refuse Destructor, even if only viewed from a sanitary standpoint. In the fruit season, when immense quantities of fruit are being converted into preserve, the preliminary sorting of the fruit must involve the rejection of a quantity of unfit fruit.

It is not pleasant to think that a preserve was made in a works where the unfit fruit was merely laid aside to decay and pollute the atmosphere. The purchaser, even devoid of all sentiment, would naturally prefer to know that the preserve was made under the very best modern hygienic conditions, i.e., that the factory is a perfectly clean one, well ventilated, and kept entirely free and clear from all organic waste, than which nothing could be much more objectionable.

Wherever food of any kind is prepared there are the most vital reasons why the condition of the works should be above suspicion ; the accumulation of animal or vegetable waste is a very serious matter, and its importance will not be questioned by any thinking individual.

It is necessary to emphasise in this "cheap age" that a low price article of diet produced amid unsatisfactory surroundings is not to be compared with a higher priced article manufactured in a modern, well-equipped and perfectly sanitary factory.

Not a little of the waste produced in a Preserve Works is of a most objectionable character : bruised, badly damaged and decaying fruit, cores and pulp, and other waste of a sloppy nature, disagreeable alike to the sight, and, if kept, to the olfactory nerves. Much material of this kind is carted away from works in London, and then later barged down the river and tipped on waste land. In other parts of the country similar material is dumped on waste land as near to the works as is practicable. It is doubted by many who have not troubled to investigate, that such unpromising material can be destroyed by fire, but it is nevertheless a fact.

To dispose of waste of such a nature on the premises and practically as produced is obviously the best method, and any other method of riddance cannot be seriously compared with it.

To be dependent upon others to send and remove the waste must involve more or less prolonged storage on the premises. To send such objectionable refuse away to be dumped on waste land is at the best an irresponsible method of riddance. To accumulate it on vacant land outside of the gates of the Factory is a bad advertisement, and indicates an utter disregard for even the elements of sanitation.

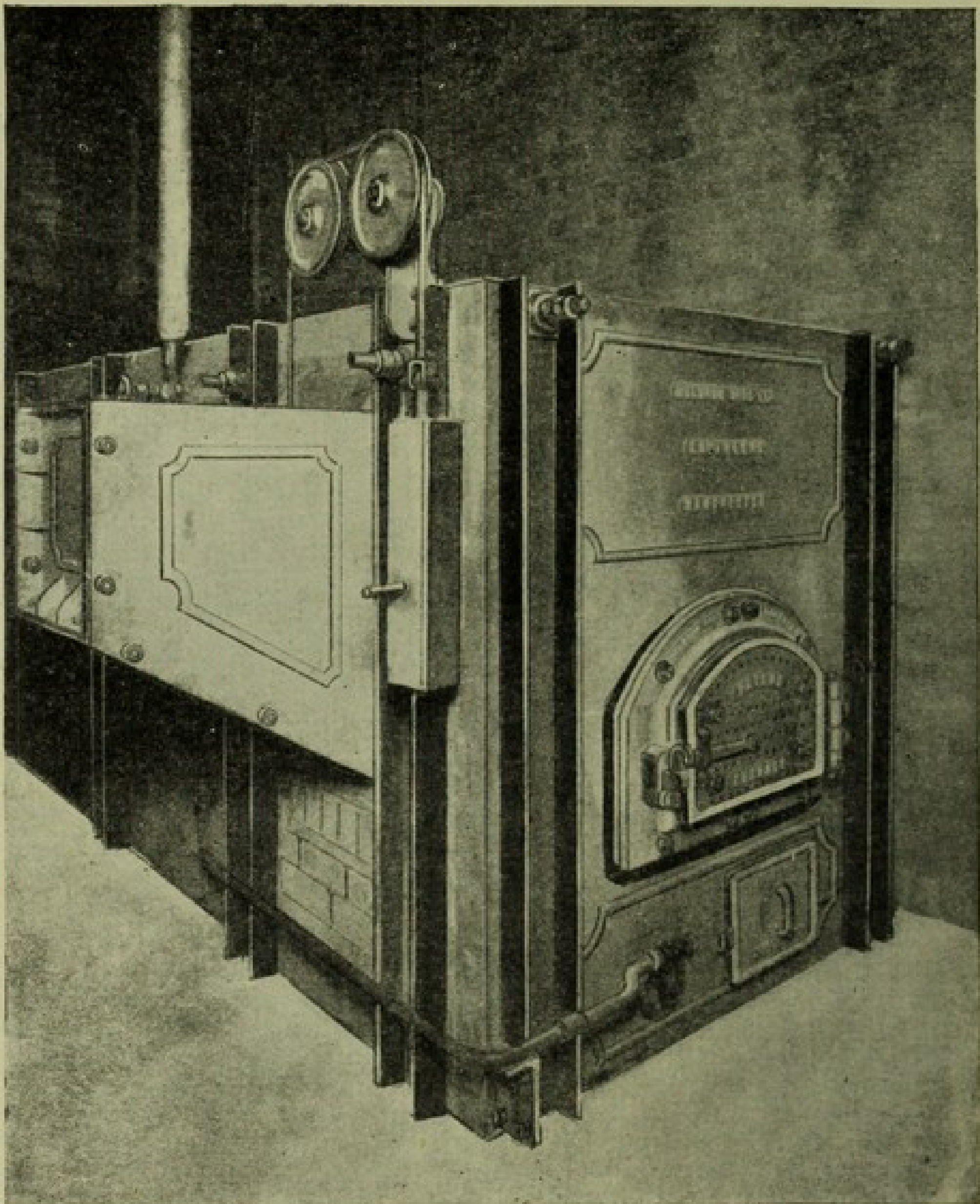


Fig. 26.

Hotel Waste

Objectionable trade waste, where produced in any quantity, should be disposed of as produced on the premises. In most large modern works this is clearly appreciated, and small Destructors erected within the works are recognised as being absolutely necessary. Even in the case of large modern Hotels, a Destructor is now admitted to be a necessary adjunct.

Fig. 26 illustrates such a Destructor erected at the New North British Railway Company's Waverley Hotel, Edinburgh, where about three tons of miscellaneous waste is destroyed daily. In New York, most of the large modern Hotels are provided with Destructors, in some cases as much as five tons of refuse being thus disposed of every day.

To bring the whole of the waste of a large Hotel to the Destructor as produced, is unquestionably far more satisfactory than storing the same for the Municipal authorities or the contractor to collect; and those who may have been at the back door of some large Hotels at the same time as the dust cart will agree that there is a very striking contrast between the back and the front entrances; and even the daily presence of the dust cart for half an hour at the rear of our large Hotels does not add to their many attractions.

In order to successfully dispose of the very moist waste of Preserve Works, for instance in a Destructor, it will be obvious that a secondary fuel is required.

Core and fruit pulp which contain 90 per cent. of moisture may appear to the uninitiated to be even beyond the capacity of the modern Destructor, but this is not so. Such material is first fed on to the drying-hearth within the Destructor cell, and by the agency of heat the whole of the moisture is rapidly expelled, the dry residue then being pushed forward to give up its heat units for the drying of the succeeding charge.

The secondary fuel need not be an expensive item ; in many cases the ashpit waste from the fuel burned in the steam-boilers is quite sufficient to furnish all that is required.

In order to determine how far the ashpit riddlings would serve for this purpose, an analysis was made of this material from the steam-boilers of a large Preserve Works in the neighbourhood of Manchester, with the following results :—

6.090 B.T.U. per pound.
55·06 per cent. incombustible.

In this case it has been found that the above material is quite equal to dealing with a considerable quantity of pulpy waste which is disposed of in a Destructor.

As showing how some large manufacturing concerns are now disposing of their waste on their premises as produced, it may be remarked that the following, among others, have modern Destructors in use :—

Messrs. Cadbury Bros., Bourneville, Birmingham; Messrs. McVitie & Price, Biscuit Works, Willesden Junction; the Wholesale Co-operative Society, Ltd., of Manchester, at their Soap Works, Irlam; Biscuit Works, Crumpsall; and Preserve Works, Middleton Junction, etc.

There cannot be the slightest doubt that the whole tendency is in this direction; and the time is coming when every works of reasonable size will be so equipped that the whole of the trade waste will be disposed of in a final and sanitary manner as produced.

Fig. 27 illustrates a small high-temperature Trade Refuse Destructor of the Meldrum type, erected at the large Biscuit Works of Messrs. McVitie & Price, at Willesden Junction, London, for disposing of the miscellaneous refuse from the works, including such material as egg shells, a considerable quantity of paper labels in a saturated condition as washed off the tins, etc. The quantity of refuse produced at a works of this kind is far more than would generally be supposed, and although not of a very offensive character, is by no means ornamental when allowed to accumulate in a heap just outside the premises.

The small Destructor illustrated in Fig. 27 is capable of destroying one ton of waste per day. In general design it is precisely similar to the larger Destructors of the same type shown in Figs. 11 and 12. Instead, however, of being a complete brick structure, the outer

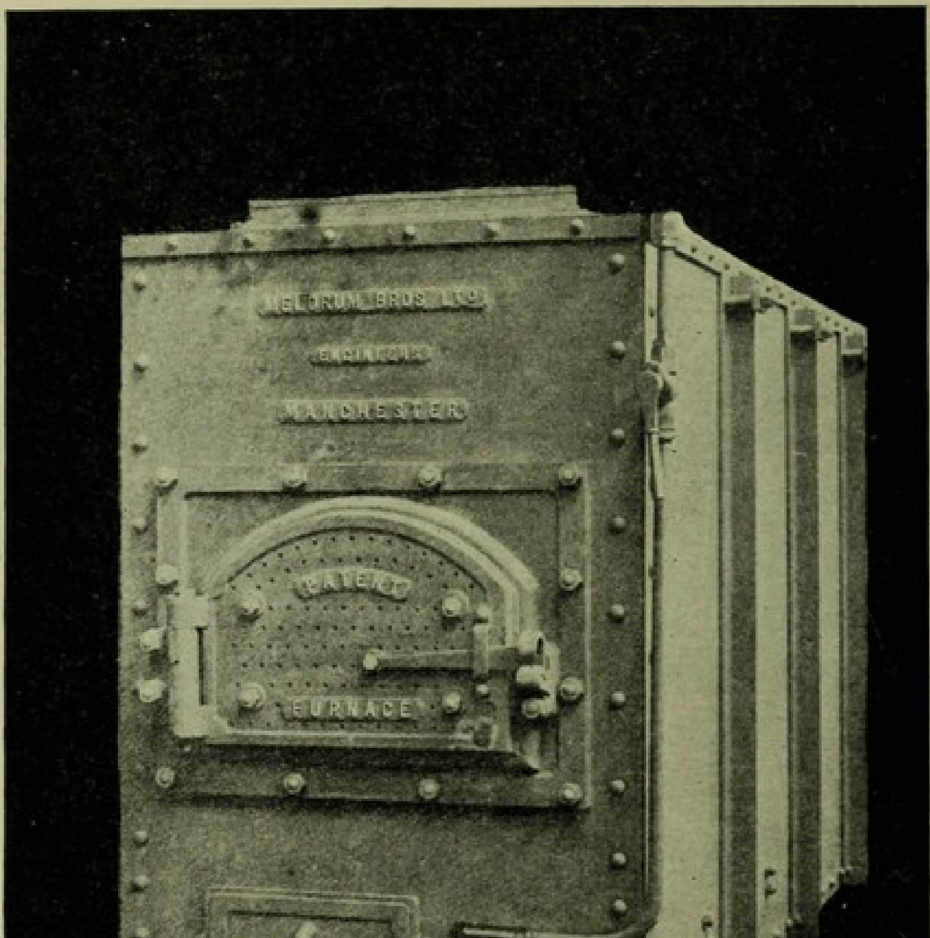


Fig. 27.

shell consists of steel plates, the internal lining being composed of special fireclay lumps. The total height is only 4 feet; the refuse may be readily charged in at the top, on to the drying-hearth immediately at the front of the cell. Forced Draught is provided by means of a Steam Jet Blower, which will be observed in the right-hand bottom corner of the illustration.

Carcases, offal and Animal Waste

Within the past two or three years the Board of Agriculture have directed the attention of many Municipal authorities to the necessity of providing effective means for the disposal of carcases.

In some few instances Municipal authorities have been requested to take steps to so modify their existing Destructors that whole large carcases may be introduced therein for cremation.

Many modern Destructors are well equipped for the easy and rapid cremation of large carcases; and in the design of large Destructors for disposing of Municipal waste provision is now usually made for the easy introduction of carcases.

About a year since the Right Hon. Joseph Chamberlain caused much amusement in the House of Commons, in replying to a question put by that ubiquitous Scotch member, Mr. Galloway Weir, concerning the disposal of diseased pigs at Hong Kong. The then Colonial Secretary was able to satisfy Mr. Weir that a Destructor had been sent to Hong Kong, and that in future the unfortunate pigs would be disposed of in an up-to-date manner.

The carcases of condemned animals have to be disposed of frequently in all parts of this country, and unless a well equipped modern Municipal Refuse Destructor exists, or special means be provided, the disposal of large carcases or parts thereof must prove to be a very troublesome matter.

In some places Digesters are provided, but unless the Digester be large, the carcase must be cut up, and even after all the grease has been extracted in the Digester by the action of low-pressure steam, the swollen pulpy mass remaining has still to be disposed of, and can only be satisfactorily dealt with by the agency of fire. It would therefore appear to be necessary to provide a Destructor as an adjunct to a Digester, and as the Destructor may be arranged to provide a useful quantity of steam for the digestion process, the two appliances may with great advantage be combined.

At Lumley Street Destructor, Sheffield, during the year ending March 25, 1903, no less than 872 dogs, 41 pigs, 12 cats, and nearly 193 tons of fish were destroyed; and at the Dalmarnock Destructor, Glasgow, during the same time, 56 horses and 27 tons of bad eggs were passed through the cells.

Of course it is a simple matter to deal with such waste in a town provided with a large modern high-temperature Destructor ; but in towns without any Destructor, both large and small, it may well be asked —What is done with such dangerous waste ?

At large cattle wharves and markets, where numbers of foreign animals are constantly being landed, it is imperative that effective means be provided for disposing of the carcases of such beasts as may be condemned ; and it is interesting to observe that this matter engages the close attention of the Board of Agriculture.

In small towns lagging behind the times, where, in spite of all that has been urged from the public health standpoint, a Destructor is not provided, few can be found who would dispute the necessity of providing means for the rapid and final disposal of the most objectionable waste, such as offal, carcases, etc., and yet nothing is done. Such waste goes somewhere—and, it may be remarked, anywhere but the proper place.

For small communities having a population of 5,000 to 6,000 the Portable Destructor would meet the case, and would be found quite equal to dealing with even the most objectionable waste. While such small communities may fail to provide a fixed Destructor because of the cost of the same, they now have no excuse for disposing of their waste in a manner which may be fairly compared with the method of the Troglodyte.

Where animal waste and *carcases alone* have to be destroyed, the Destructor must be specially designed for the purpose, and, generally speaking, it is found necessary to use coke as the secondary fuel. Forced Draught is an essential, in order to reach and maintain that high temperature within the cell which is of vital importance in order to ensure the rapid and effective

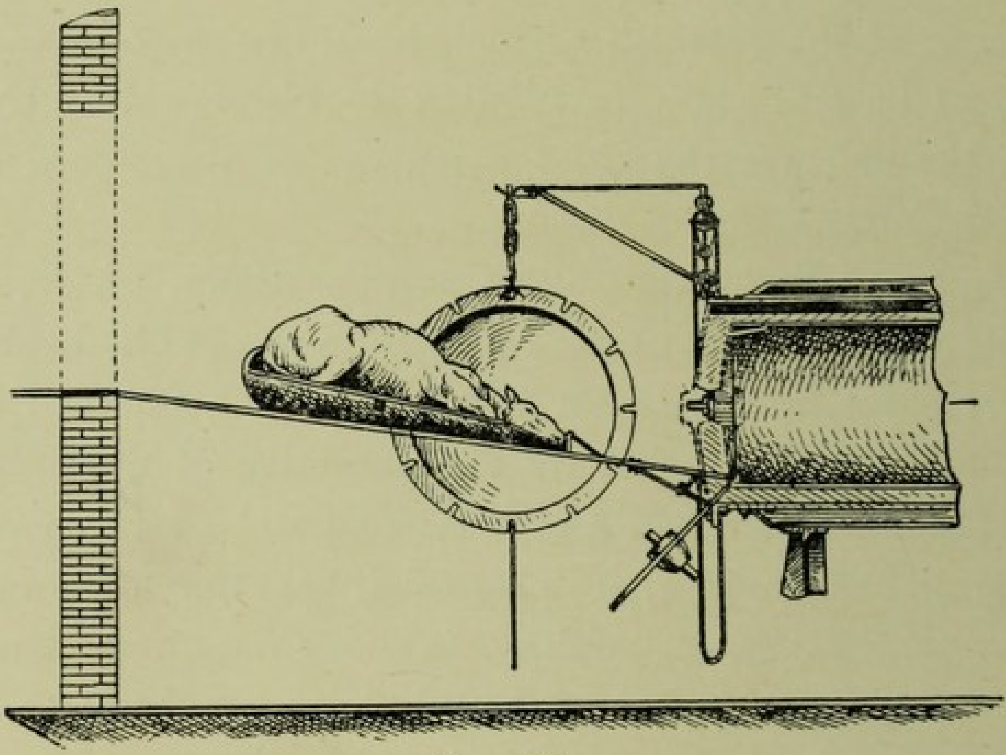


Fig. 28.

cremation of such waste with an immunity from nuisance.

A special hearth for the reception of the waste must be provided, as also a combustion chamber. To attempt to destroy carcases by introducing the same on top of fuel will result in nuisance. To charge carcases into a cell not provided with Forced Draught will, in all probability, result in a slow cooking process, which is not satisfactory, and is certain to be productive of nuisance.

Fig. 28 illustrates the Otto Economic Carcase Destructor, which consists of a double wrought-iron drum, steam jacketed, and carrying a grinding roller in the under cylinder, which acts as a steriliser, extractor, dryer and grinder, a patent fat receiver and separator, a size pump and concentrator and air pump and feed-water heater, and a manure grinding mill, and the necessary shafting, piping and valves.

The apparatus is operated as follows: A charge is fed into the drum through a manhole or by a funnel; the inner drum is then closed by means of a slide, and the whole machine by a steam-tight cover.

Steam at from 4 to 6 atmospheres is then admitted into the jacket of the cylinder to heat it, the drum, having openings in its periphery, is caused to revolve, and the solid roller within it grinds the charge, forcing the produce through the ports into the jacketed cylinder, on the inner surface of which are fixed shovels, which turn over and agitate the flesh and facilitate the drying process. The pump is then started to draw off the gases, which are passed into the furnace to be cremated, and after a suitable lapse of time steam is admitted to the inside of the cylinder. The drum being still rotated, all the glue and fat is extracted and collected into the separator, whence they are transferred to the size receiver and fat purifier.

The steam is then transferred to the jacket to dry the residuum, the steam and gases are drawn off, and the contents, now quite dry, are extracted.

The whole operation is said to occupy about four hours, involving a consumption of 12 cwts. of coal, the products comprising about 6 cwts. of fat and 4 cwts. of guano manure.

The advantages claimed are perfect sterilisation—all bacilli being destroyed at a temperature of 118° centigrade—odourless discharge of foul gases, and the production of fat, glue and manure.

Simple although it is claimed to be, the process impresses one as being rather complicated. It is, however, typical of a well-devised system of Digestion, which has been practised extensively on the Continent for the disposal of both large and small carcases.

The quantity of fat extracted is more than would be credited by the layman; it is claimed that the value of the fat and manure leaves a margin over the cost of operation.

While much may be said for Digestion, it must be borne in mind that on the Continent, where such a system of disposal has been extensively employed, there has been no effective alternative method of disposal. The only satisfactory Refuse Destructors erected have all been built within recent years, and all are of British design.

On the other hand, in this country, while there are many advocates of Digestion, and not a few who view with alarm the loss of the fat when the carcases of beasts are cremated, the consensus of opinion is all in favour of cremation, nor is this to be wondered at.

In a modern Destructor the whole carcase of a beast may be introduced with but very little handling, and if placed in the combustion chamber of a Destructor of fair size, sufficient heat is developed to ensure rapid cremation without any nuisance whatever. As no fuel is required, this may be set against the marketable products which are sacrificed. Instead of 6 cwts. of fat, the residuum is a small quantity of dust, and if an equine beast, four horseshoes.

Further, the capital expenditure in the purchase of a somewhat complex plant is saved; and on the whole it may be fairly submitted that the Municipal Refuse Destructor has the advantage.

In connection with a horse slaughtering business, where carcases are purchased, the circumstances are obviously different. In this case it is a commercial venture, and in order to make the business a paying concern, the proprietor naturally turns to the most profitable account every part and product of the carcase; he is dealing with carcases every day, whereas the Municipal authority is only called upon to deal with such carcases under exceptional circumstances.

The process of Digestion involves nuisance to a greater or lesser degree, according to the location and arrangement of the works, and the means provided for dealing with the fumes. As a system, it must inevitably be more objectionable to the individual than the Destructor Works.

With the average Digestion plant, even in a large town, the carcases have to be cut up; and it is generally admitted that, from an economic point of view, it is only worth while to pass certain portions of a carcase through the Digester, that is, such portions as will yield a reasonable return in the shape of fat or grease.

To introduce the *whole* carcase of a horse or a bullock into the combustion chamber of a Destructor will always be looked upon in certain quarters as wasteful; but be this as it may, it is at any rate a *final* process, and one that is calculated to best serve the interests of the community as a whole.

Once permit the carcases of diseased and condemned beasts to be disposed of by private individuals, and there is but little security for the community; of this we frequently have very conclusive evidence even under the existing stringent conditions. Those who advocate Digestion are invariably influenced by economic considerations alone. Firstly, they would preserve and sell the skin, as also such other parts of the beast as have a commercial value. Secondly, they would recover the fat from such parts of the carcase as will yield fat in sufficient quantities to pay for the treatment.

Such portions of diseased animals as possess no commercial value, nor contain fat in such proportion as will pay for its extraction, are a source of danger ; as is also the case at times with some parts of the beast which are sold.

To avoid the unnecessary handling and cutting up of diseased beasts, to effectually prevent the sale of any portions thereof, and to safeguard the interests of the community, the disposal by fire of whole carcases presents the only solution.

The recent action of the Board of Agriculture in connection with Refuse Destructors, which has been already referred to, would seem to show that disposal by fire is now recognised as the most satisfactory method of disposal, and there are distinct signs that much will be accomplished in this direction in the near future.

Butler & Tanner, The Selwood Printing Works, Frome, and London.