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[54] INCINERATOR FOR REFUSE 15 Claims, 3 Drawing Figs.

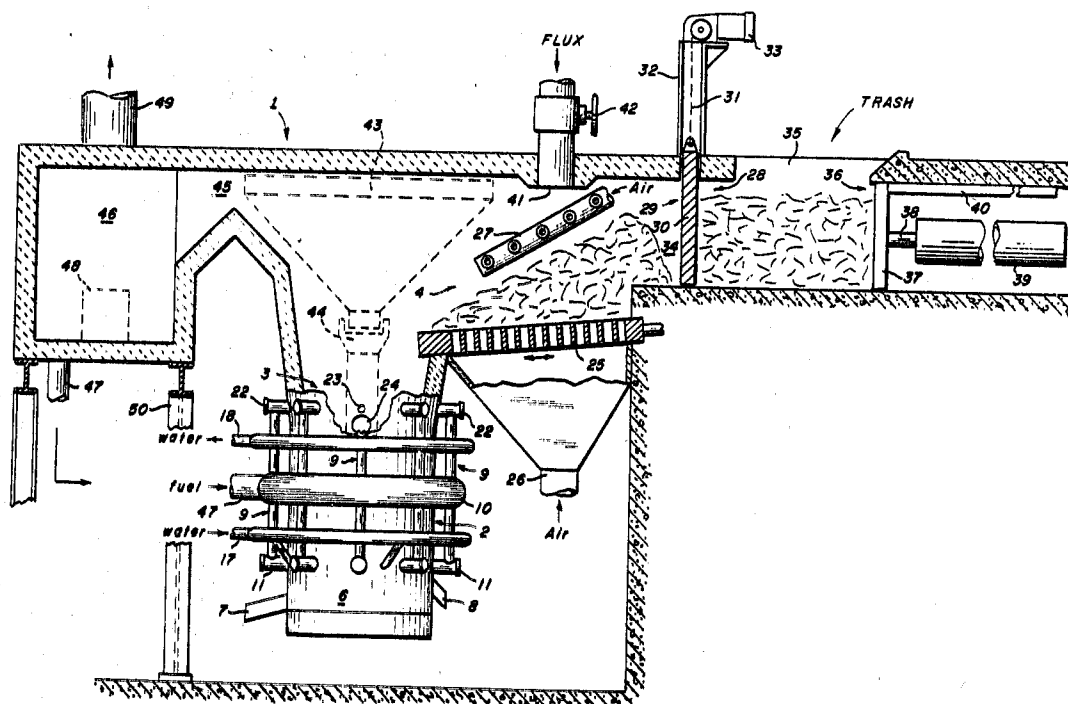
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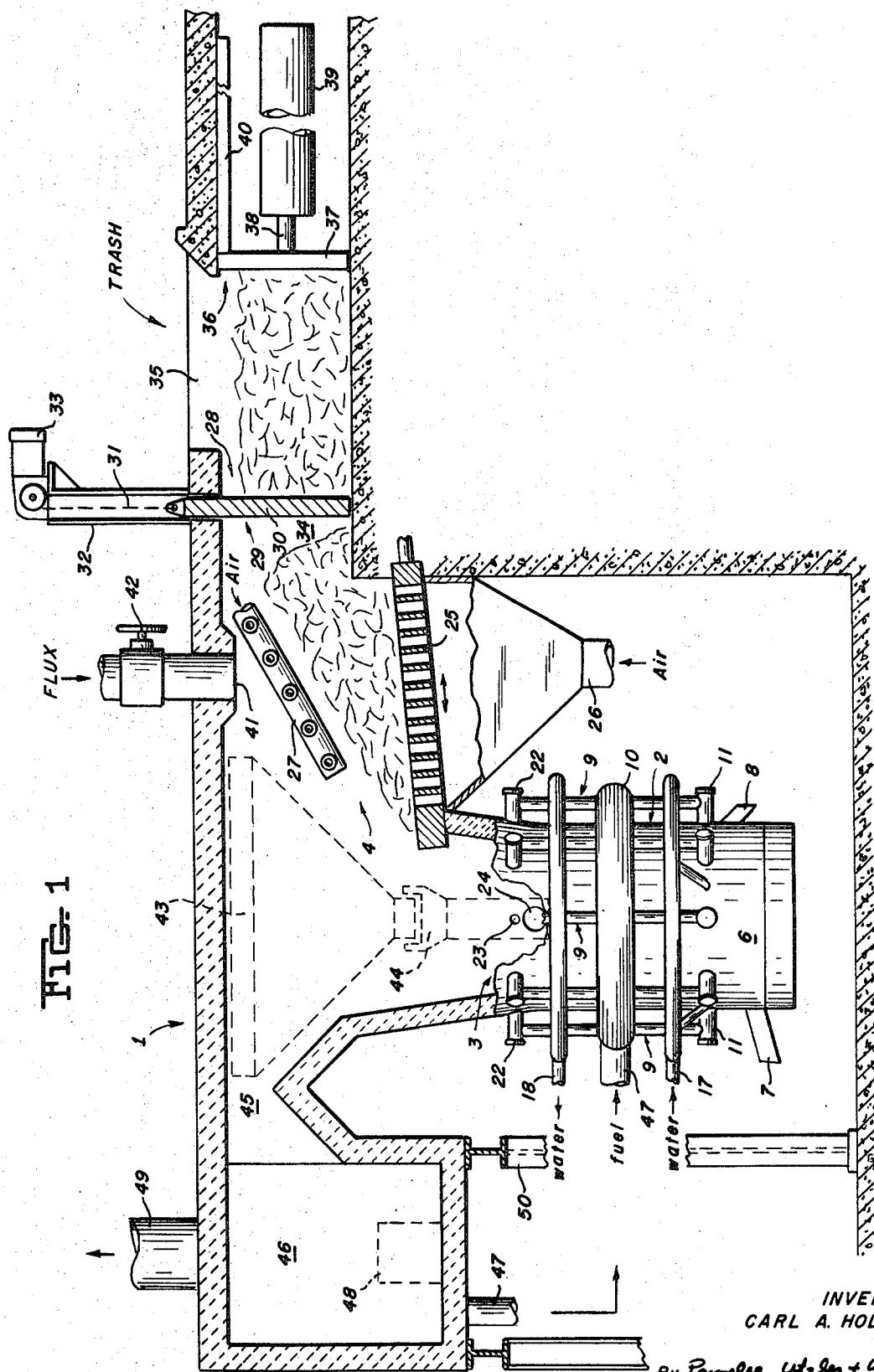
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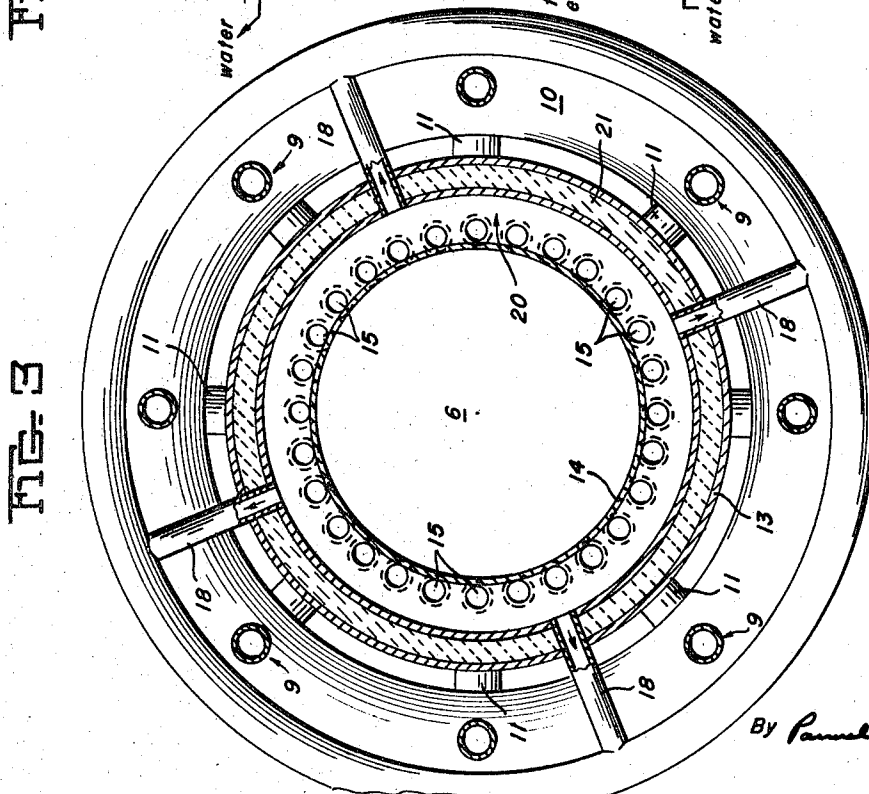
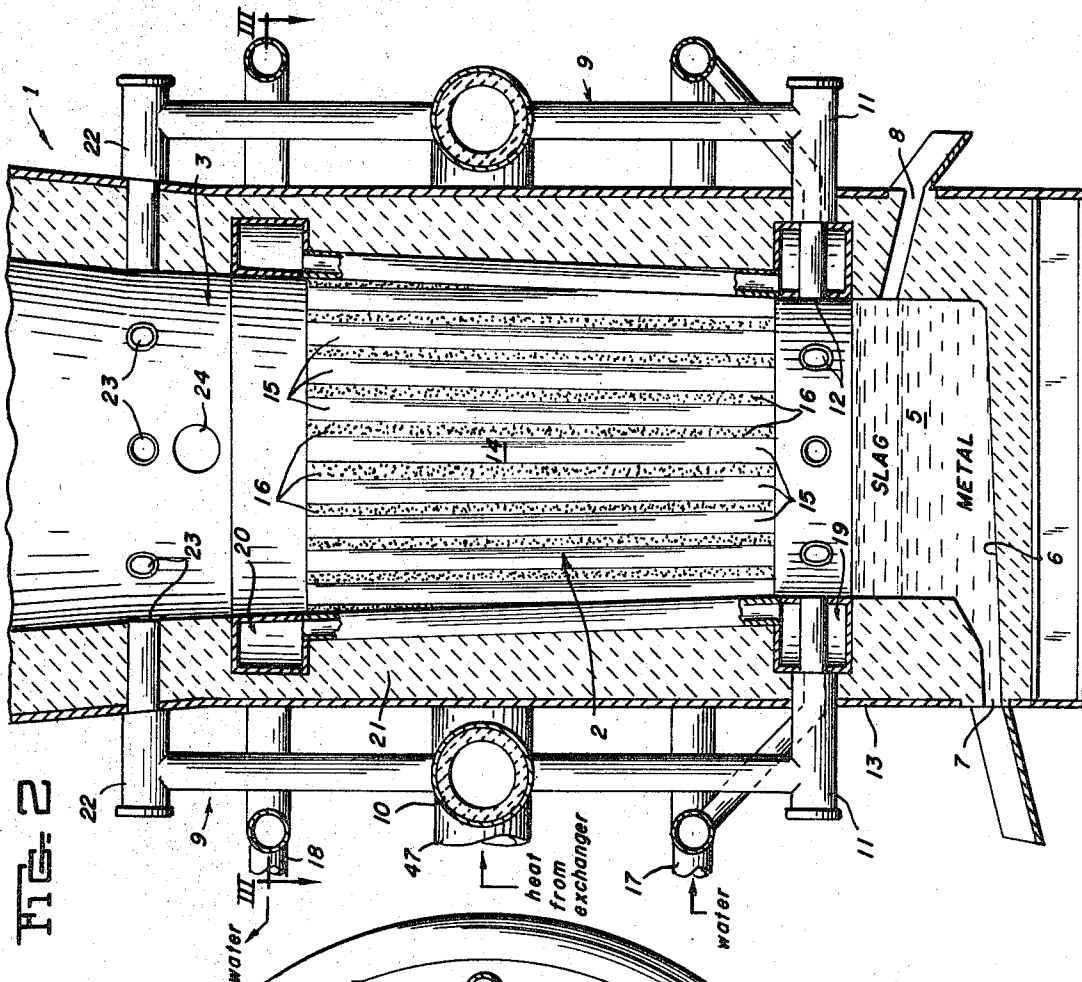
ABSTRACT: A vertical shaft incinerator and a continuous method of refuse disposal for refuse-containing garbage, glass and metallics. The vertical shaft incinerator contains three portions into which air is fed: a hearth portion, which supports a coke bed, having water-jacketed walls and a discharge port for molten metal and slag; an overlying intermediate portion for combustion of combustible but difficult-to-burn materials; and an initial combustion portion of larger cross section than the intermediate portion having a movable grate offset from the intermediate portion for burning readily combustible material. Refuse and preferably a flux material are charged to the grate and carried to the intermediate portion where coke is added and the mixture descends to the hearth portion where molten metal and slag are formed and removed, with off-gases passed upwardly through the mixture used to preheat air fed to the various portions of the incinerator.





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INCINERATOR FOR REFUSE

BACKGROUND OF THE INVENTION

Incinerators generally provide for the combustion of materials such as paper, garbage, wood and other combustible material while glass and metallics must be either separated prior to feeding the materials to the incinerator or removed from the incinerator as solid matter along with ashes from the combustibles. The separation or subsequent removal requires additional time and expense in incinerator operation and requires that some means be provided for the disposal of the separated or subsequently removed glass or metallic materials.

I have provided an apparatus and a process for the incineration of refuse, the refuse including readily and difficultly combustible materials, while at the same time providing for the disposal of glass or metallic materials in the refuse, where the glass and metallics are converted to slag and molten metal and readily separated from each other and may be separately used.

SUMMARY OF THE INVENTION

An incinerator has a vertical shaft with a lower hearth portion having water-jacketed inner walls and ports for removal of slag and molten metal, while overlying the hearth portion there is an intermediate combustion zone portion. Situate above the intermediate portion and of a larger cross section is an initial combustion portion which contains a movable grate offset from the intermediate portion, the grate terminating adjacent to the intermediate portion of the incinerator. Means are provided for introducing combustion air into each of the three portions. Other means are provided for charging flux material to the initial combustion portion and for charging coke to the intermediate combustion portion. In addition, means is provided for charging refuse to the grate in the initial combustion portion and means is provided to move the grate whereby the refuse, following initial burning in the first portion, is deposited in the intermediate combustion zone. The vertical shaft furnace terminates as a gas outlet means, with heated off-gases being used to preheat combustion air fed to the incinerator, and preferably cleaned before discharge to the atmosphere.

In operation, a hot coke bed is formed in the hearth portion of the incinerator. Refuse, containing combustibles, glass, and metallics, is fed to the grate in the initial combustion portion where readily combustible materials are burned. Preferably, flux materials are added to the refuse on the grate and the mixture is carried by movement of the grate to the intermediate combustion portion where, after deposition therein, the slower burning and more difficultly combustible materials are burned. The residual refuse, with glass, crockery, metallics and other unburnable substances has coke added thereto in the intermediate portion and descends to the hearth portion of the incinerator. In the hearth portion, glass and metallics, ash, and other unburned substances are fused to a molten liquid by the burning coke and either alone or with the flux produces a slag that is tapped from the incinerator. The slag may be used in this form as aggregate or land fill or processed to separately separate the metal from the nonmetal. The bulk volume of the unburned material is, in any case, condensed to a small mass. The hot off-gases from the three incinerator portions are used to preheat the combustion air and reduce the total solid fuel requirements and may also be used in a waste heat boiler or the like to produce a heated medium for supplemental use.

By using three more or less distinct zones, the disposal of the refuse may continuously progress without temperature variation in the first zone materially affecting conditions in the last one.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like parts are marked alike:

FIG. 1 is a side elevational partial cross-sectional view of the vertical shaft incinerator of the present invention;

FIG. 2 is a view of the water-cooled hearth portion of the incinerator with a cutaway view of the interior;

FIG. 3 is a view taken along the plane of lines III-III of FIG. 2.

DETAILED DESCRIPTION

Referring now to FIG. 1, there is illustrated a vertical shaft incinerator 1. The incinerator 1 comprises three zones or combustion portions, a lower hearth portion 2, an intermediate combustion portion 3, and an initial combustion portion 4.

The hearth portion 2, where melting of metallics and formation of slag and molten metal 5 in a hot coke bed (not shown) are achieved, has a hearth 6 which may be packed with sand, refractory material or the like for protection, and has discharge ports or taps 7 for the molten metal and 8 for the slag. If desired, the slag and molten metal may be removed through a single tap and subsequently separated or disposed of as a mixture for use as aggregate, fill or other purposes. The hearth 6 is provided to support a hot coke bed. To effect melting of the metallic content of refuse, the hearth portion 2 is provided with a feed means for air, such as a tuyere system 9, illustrated as a bustle pipe 10 with a series of tuyeres 11 having their inner ends 12 opening into the interior of the lower hearth portion 2. The hearth portion contains a water cooling system to protect the interior walls and reduce the deteriorating effect of certain metals such as zinc which would be present in the refuse and which causes disintegration of unprotected refractory material. The walls of the lower hearth portion (FIG. 2) comprise a metallic shell or outer structure 13 and water-cooled inner walls 14 having spaced cooling pipes 15 with intermediate areas of refractory material 16 disposed between the cooling pipes. Cooling medium such as water is passed through inlet line 17, then through the pipes 15 and is exited through water outlet line 18, these lines connecting to headers 19 and 20 respectively in which opposite ends of the tubes or pipes 15 terminate. As above indicated, the cooling provided by the pipes protects the refractory areas 16 from the deleterious effect of the high temperatures necessary in the lower hearth portion 2 and reduce the attack on the refractory material by zinc or other metals present in the metallic debris found in refuse.

Above the lower hearth portion 2, the intermediate combustion portion 3 above referred to is provided wherein difficultly combustible material is burned. The intermediate combustion portion 3 has refractory lined inner walls 21 and an upper set of tuyeres 22 with air ports 23, with air fed thereto preferably from bustle pipe 10. The coke bed, (not shown), resting on hearth 6, terminates below the intermediate portion 3 and no significant smelting or melting of metals will occur at this region. Preferably, the coke feed to the incinerator 1 is positioned adjacent the intermediate portion 3 and coke inlet ports 24 are provided. Thus coke is fed at this region and will travel downwardly with the descending refuse, while air is provided through ports 23 to maintain a desired rate of combustion.

Overlying the intermediate portion and of a larger cross section that it is, is an initial combustion portion 4. This upper region of the incinerator 1 provides for combustion of readily combustible material such as paper, wood, plastics and the like. Situate in the initial combustion portion 4 and offset from the intermediate combustion portion 3 is a movable grate 25. The movable grate can be a conventional travelling grate or preferably a reciprocating type grate as here indicated whereby, through movement thereof, material placed thereon is advanced towards the intermediate portion 3. The reciprocating mechanism is not shown since grates of this type and the manner of supporting them for reciprocal motion are well known. A wind box or other air feed means 26 is positioned below the grate 25 to provide air from a source (not shown) to maintain combustion. While other air inlets 27 are also provided above the grate to direct air for combustion adjacent the refuse on the grate 25. A refuse inlet 28 is located adjacent the grate 25 and there is closure means 29 such as a

movable gate 30 having a supporting means 31, with the gate movable into and out of closed position in a guide 32, a motor 33 or other means being provided to operate the gate. The gate 30 blocks the inlet 28 and is disposed in a conduit 34 having an opening 35 for feeding of refuse. To feed the refuse to the grate 25, a pusher ram 36 with plunger 37 carried by a shaft 38 operated by a cylinder 39 is provided. Preferably an extension 40 depends rearwardly from the plunger 37 to close the orifice 35 when the pusher ram is in extended position for charging of refuse to the initial combustion portion 4. If desired, a vertical conduit may be provided with a closure means whereby refuse is charged to the grate. Also provided adjacent the initial combustion portion 4 is a charging means 41 having a valve 42 for feeding of flux material to the incinerator, or such a charging means may be used to charge liquid or semiliquid wastes to the initial combustion zone.

The incinerator also has coke hopper 43 adjacent thereto with coke feed means such as a screw conveyor or other means 44 provided to feed coke when desired to the intermediate portion 3 through coke charge ports 24.

The incinerator 1 opens into a gas exhaust means 45 which contains a heat exchanger 46 whereby combustion air being fed to the various portions of the incinerator can be preheated and led by feed line 47 to the bustle pipe 10 and also, if desired, to the air inlets 26 and 27 of the initial combustion portion 4 of the incinerator. Preferably, gas scrubbers 48 of a conventional nature are also provided in the exhaust portion 45 of the incinerator so that the exhaust gases are cleaned prior to exit to the atmosphere through a stack 49. Supports or framework 50 are provided on which the incinerator is mounted and is arranged to permit access thereto for maintenance and operation.

The present process for incinerating refuse comprises initially forming a highly heated coke bed in a water-jacketed lower hearth portion of a vertical stack incinerator. Coke is charged to the incinerator and a hot bed formed through ignition and feeding of air through tuyeres located adjacent the lower hearth portion.

The process is suitable for incineration of the total contents of everyday refuse and garbage. The refuse material need not be segregated as to volatile content, organic content, metallics, glass bottles and such, but the entire refuse mass may be fed to the incinerator, resulting in a labor saving and inexpensive method of disposal. In fact, because of the recovery of molten metals in the process, the deposition of appliances or other metallic components along with conventional refuse material is economically beneficial. If desired, some drying of the refuse may be carried out prior to charging to the incinerator, possibly using hot exhaust gases from the incinerator for such drying although this is not necessary.

The refuse may be charged to the incinerator by use of conventional conveying means or directly from carriers such as trucks, or dozers and dumped through charge opening 35 into the charging conduit 34. When the trash is to be charged to the initial combustion zone 4, movable gate 30 is raised and the pusher ram 36 activated to move the trash onto grate 25. On the grate 25 in the initial combustion zone 4, the readily combustible material such as paper, cardboard, wood pieces, volatiles and organics are ignited by the hot gases from the highly heated coke bed and combustion thereof supported by feeding air through inlets 26 and 27 and evaporation of much of the water takes place on this grate. If desired, the air fed thereto may be preheated. Preferably, any flux material to be added to the mixture is fed through charging means 41. Such flux material may comprise limestone, fluorspar and the like and, when fed to the burning refuse on grate 25, the heat will calcine the limestone so that, being preheated and calcined it will have less cooling effect in the other incinerator portions. The grate 25, through its reciprocating movement, causes the ash, burning refuse and any unburned or unburnable material to be discharged in the intermediate combustion portion 3. In the intermediate portion 3, temperatures on the order of 2,000° F. are reached, with excess air being fed to the inter-

mediate combustion zone through air ports 23 from tuyeres 22, the air preferably being preheated to about 1,000° F. — 1,400° F. Coke is added to the descending mixture at the intermediate combustion portion 3 through coke inlet 24. At the temperatures reached in the intermediate combustion portion, difficultly combustible materials which are not completely burned in the initial combustion portion 4 of the incinerator are consumed. Residual refuse, such as metallics and glass, mix with the previously added flux material and coke in the descending charge, gravitate to the hot coke bed in the water-jacketed lower hearth portion 2.

In the lower hearth portion 2, the metallics are melted and slag formed from the glass or other silaceous or inert materials, this portion of the incinerator having a very reducing atmosphere because of the hot coke bed present. The amount of carbon monoxide in the lower hearth portion is controlled by the introduction of preheated air through the air inlets 12 from tuyeres 11 while the upper tuyeres 22 provide a supply of air to complete combustion at the intermediate combustion zone.

In the lower hearth portion, the metallics are melted and slag formed. The lower hearth portion 2 with water-cooled walls has the cooling water forced therethrough under such pressure that a water temperature in the order of 250°—260° F. will be maintained. If desired, the intermediate portion 3 of the incinerator may also have water-cooled walls, although the necessity therefor is especially evident in the lower hearth portion where the melting of the metallics and slag formation are achieved. The molten metal and slag are removed from the incinerator through tap holes, either a single tap hole being used, or as illustrated, separate tap holes being used for the slag and molten metal. If a single tap hole is used, the slag and molten metal can, if desired, be subsequently separated in a slag separator. The slag can then be granulated or spun into slag wool, while the iron may be used for example as pig iron in a gray iron foundry.

The off-gases from the lower hearth portion 2 pass upwardly through the descending mixture, and along with off-gases from the other portions of the incinerator are fed to an exhaust means where they may be used to preheat air being fed to various portions of the incinerator in a conventional heat recuperator prior to cleansing and discharge into the atmosphere as previously described.

I claim:

1. A vertical shaft incinerator for refuse having a lower hearth portion with water-cooled inner walls and means for discharging molten metal and slag therefrom, an intermediate combustion portion above the hearth portion, and an initial combustion portion above the intermediate portion of larger cross section than said intermediate portion having a refuse-supporting and conveying grate positioned to discharge material into the intermediate portion, means for introducing air into each of said portions, means for charging coke and fluxing material into the incinerator, and means adjacent said grate for charging refuse onto the grate.

2. A vertical shaft incinerator as described in claim 1 wherein said means for charging coke to said shaft incinerator is arranged to discharge the coke in the intermediate portion.

3. A vertical shaft incinerator as described in claim 2 wherein the incinerator has a combustion gas outlet, and heat exchange means in the combustion gas outlet for heating air which is supplied to at least one of said portions.

4. A vertical shaft incinerator as described in claim 3 wherein means are provided in the initial combustion portion for supplying air to the incinerator both below and above said supporting and conveying grate.

5. A vertical shaft incinerator as described in claim 4 wherein said supporting and conveying grate comprises a reciprocable grate structure.

6. A vertical shaft incinerator as described in claim 5 wherein said means for charging refuse to said grate comprises a horizontally-disposed conduit having refuse-receiving and discharge ends, a gate for opening or closing the conduit to the

passage of refuse therethrough, and a reciprocable pusher arranged to move material through the conduit from the receiving end to the discharge end when the gate is open.

7. A vertical shaft incinerator as described in claim 4 wherein said charging means for flux material is positioned above said grate whereby flux material may be charged onto the refuse carried by the grate.

8. A process for the incineration of refuse containing both readily and difficultly combustible material glass, and metallics, to produce molten metal and slag comprising: continuously charging said refuse and flux material to a movable grate situate in a heated initial combustion portion of a vertical shaft incinerator to form a mixture wherein readily combustible materials in the refuse are burned, depositing the mixture from the grate into a heated intermediate combustion portion of the incinerator and continuously passing the mixture containing residual refuse and flux material downwardly therethrough wherein difficultly combustible materials are burned and wherein coke is added to the mixture, continuously passing the coke containing mixture downwardly through a highly heated coke bed at a water-jacketed bottom portion of the incinerator wherein metallics and glass are melted and slag and molten metal produced with hot off-gases passing upwardly through the incinerator and removing said produced slag and molten metal from the incinerator.

9. The process described in claim 8 wherein air is fed to the mixture at each of the initial combustion portion, intermediate portion and heated coke bed.

10. The process described in claim 9 wherein air fed to at least one of said portions is preheated by said off-gases.

11. The process described in claim 9 wherein air is fed to

said initial combustion portion both below and above said mixture on said grate.

12. A process for disposing of municipal refuse wherein combustible materials are burned and noncombustible materials are melted to a liquid state comprising: initially depositing the refuse on a grate on which combustion of readily-burnable material in the refuse is initially effected, discharging refuse after partial burning of at least some components thereof into a shaft furnace above the bottom thereof along with coke and substantially completing the burning of the slower-burning combustibles along with some of the coke while unburned coke and noncombustible components of the refuse gravitate to the lower portion of the shaft furnace, and maintaining by combustion of coke in said lower portion a temperature sufficiently high to melt the metal, glass and the like noncombustibles encountered in municipal refuse, discharging the melted refuse as liquid from the shaft furnace, and replacing the refuse on the grate with fresh refuse as the partially consumed refuse is discharged from the grate to constantly maintain a mass of burning refuse on the grate.

13. A process for disposing of municipal refuse as described in claim 12 wherein flux material is supplied to the refuse prior to its discharge from the grate into the shaft for facilitating the melting of the noncombustible components.

14. A process for disposing of municipal refuse as described in claim 13 wherein air is supplied to the material on the grate to effect drying and the initial combustion.

15. A process for disposing of municipal refuse as described in claim 13 including separating the metal and nonmetallic liquids formed in said lower portion of the shaft.

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