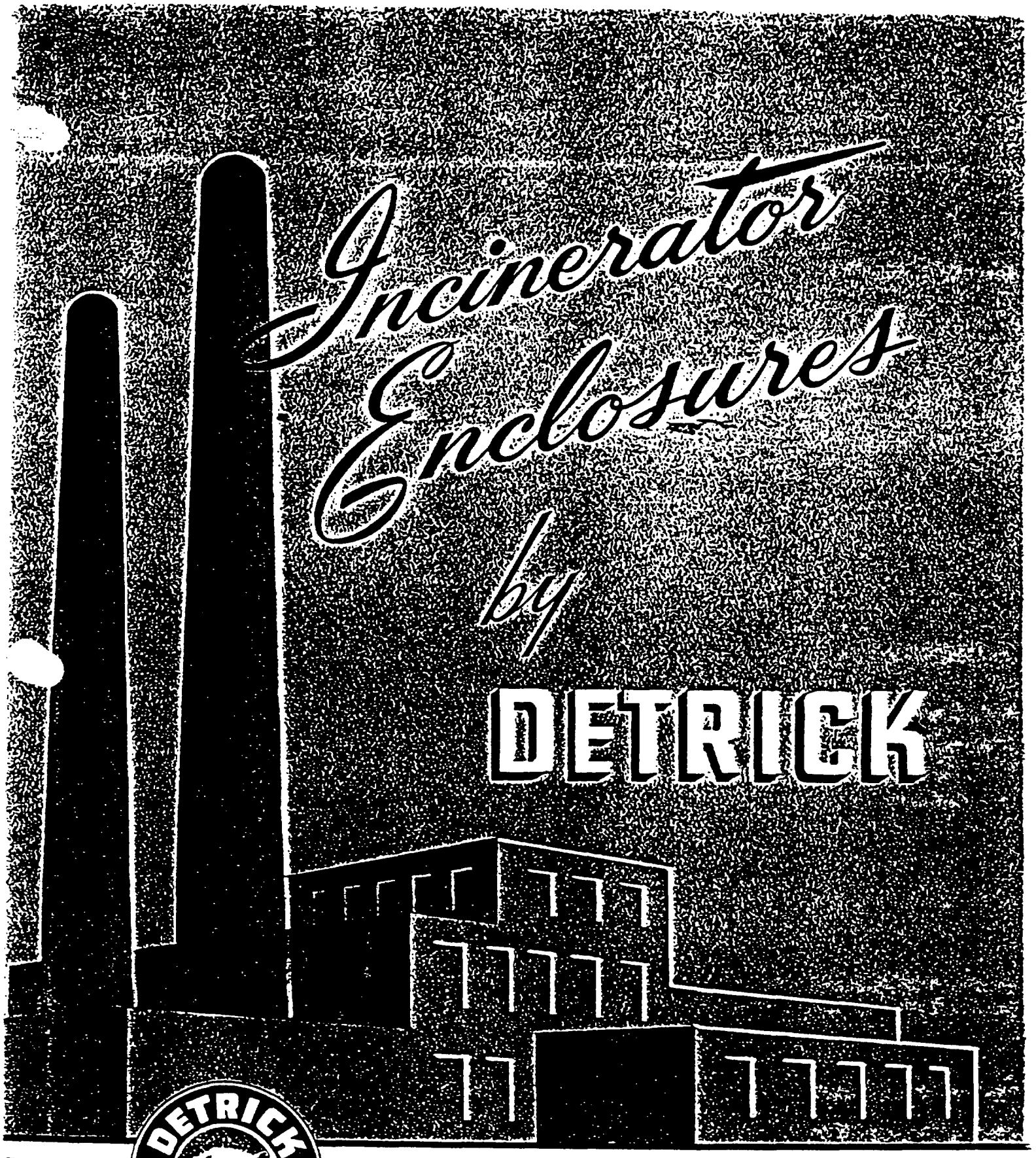
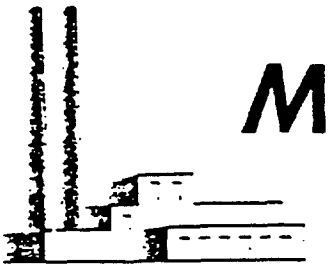


DETRICK Heat ENCLOSURES

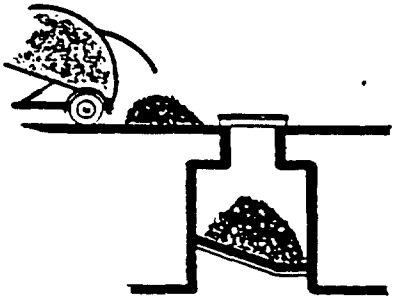
PLAINTIFF'S EXHIBIT
MHD-175



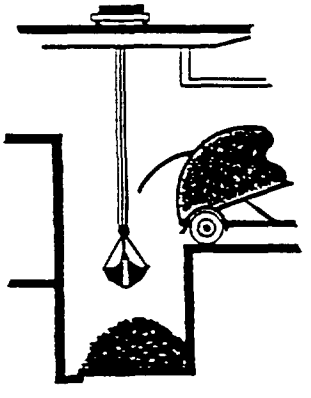
Municipal INCINERATORS

Because of the fact that suitable locations for burying refuse are becoming scarce and objectionable, many Municipalities are finding it necessary to turn to incinerators as a means of disposing of their refuse. When designed correctly these incinerators are clean and attractive and can conform to the architectural and landscape standards of any neighborhood.

The function of an incinerator is to destroy by fire the refuse of a community with the least amount of disturbance to the area. Material handled by the incinerator consists of garbage and trash or rubbish. Some time ago refuse consisted of 65% organic garbage and 35% rubbish. Today, the garbage has decreased to a small percentage, a maximum of 30% but generally less than 10%. This is because of packaged foods, kitchen garbage grinders and other means of disposing of garbage such as cooked hog food.



FLOOR CHARGE



PIT CHARGE

Incinerator plant capacity is based on tons of material burned per twenty four hours. There are two principal types of incinerator plant layouts. The storage pit and crane operation and the floor dump operation. Plant capacity and general economics of operation generally decide the type best suited for the community.

For large plants of 200 tons per day, or more, the storage pit offers greater flexibility of operation, smaller incinerator units and opeation of two shifts per day, or more.

For the smaller plants of 90 tons, or less, floor dump operations are generally used because they are simpler to operate, do not require a crane operator and need a smaller, less expensive building.

INCINERATOR ENCLOSURES

DETRICK Yeary ENCLOSURES

Organized for Service







Detrick is an engineering organization composed of a group of specialists. They have been concentrating for more than 40 years on the subject of enclosing heat, from the early boiler units through all types of industrial furnaces to the modern municipal incinerators. From the beginning they have pioneered in the development of design and materials to meet the ever increasing demand for efficiency in heat enclosures.

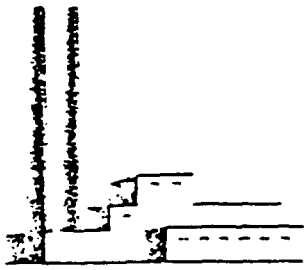
Today, faced with the responsibility of leadership, Detrick is organized to serve through research, engineering, design, manufacturing and erecting supervision. Every installation is an oportunity to serve the customer. This is done through contact of our service engineers, who will assist in maintenance problems and keep the customer informed in regard to engineering and design improvements.

With all this vast experience behind them, Detrick engineers can be counted on to come up with the most effective combination of design and materials to meet any particular problem where the enclosure of heat is involved. This is especially true of municipal incinerators where the function of the unit is to enclose the burning of refuse.

M. H. DETRICK COMPANY

DETRICK Heat ENCLOSURES

Copyright 1956 M. H. DETRICK Co., Chicago 2, Illinois Printed in U.S.A.



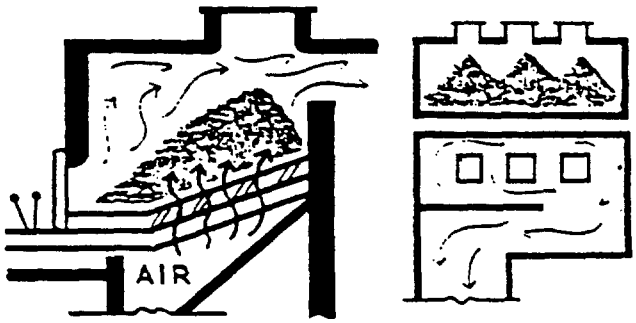
Incinerator TYPES

Incinerators naturally divide themselves into types largely by the kind of grates or automatic sfokers used. Hand stoked units, because of higher labor costs, are used only in plants of 40 to 50 tons capacity. On hand stoked units the burning rate is approximately 40 lbs. per square foot per hour. Automatic stokers have a higher burning rate of 50 to 80 lbs. per square foot per hour.

Automatic stokers are of four general types as illustrated below.

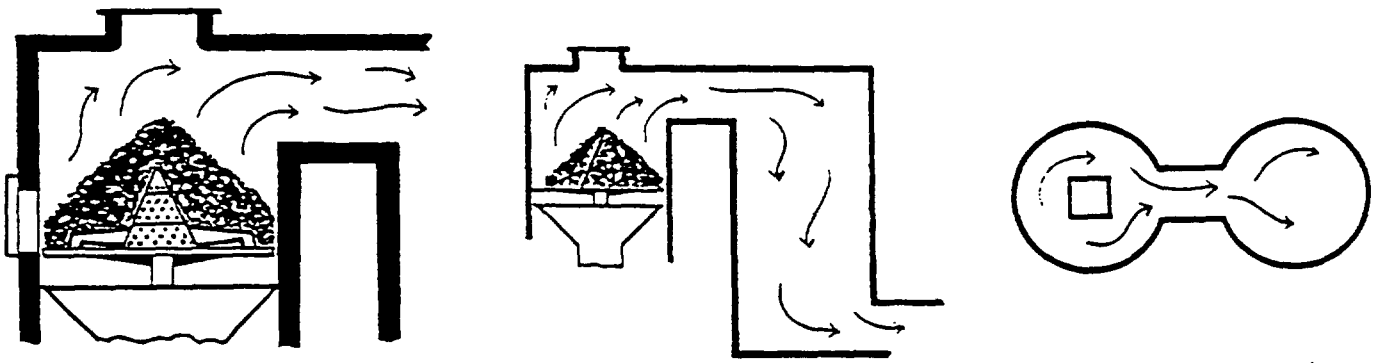
RECTANGULAR TYPE

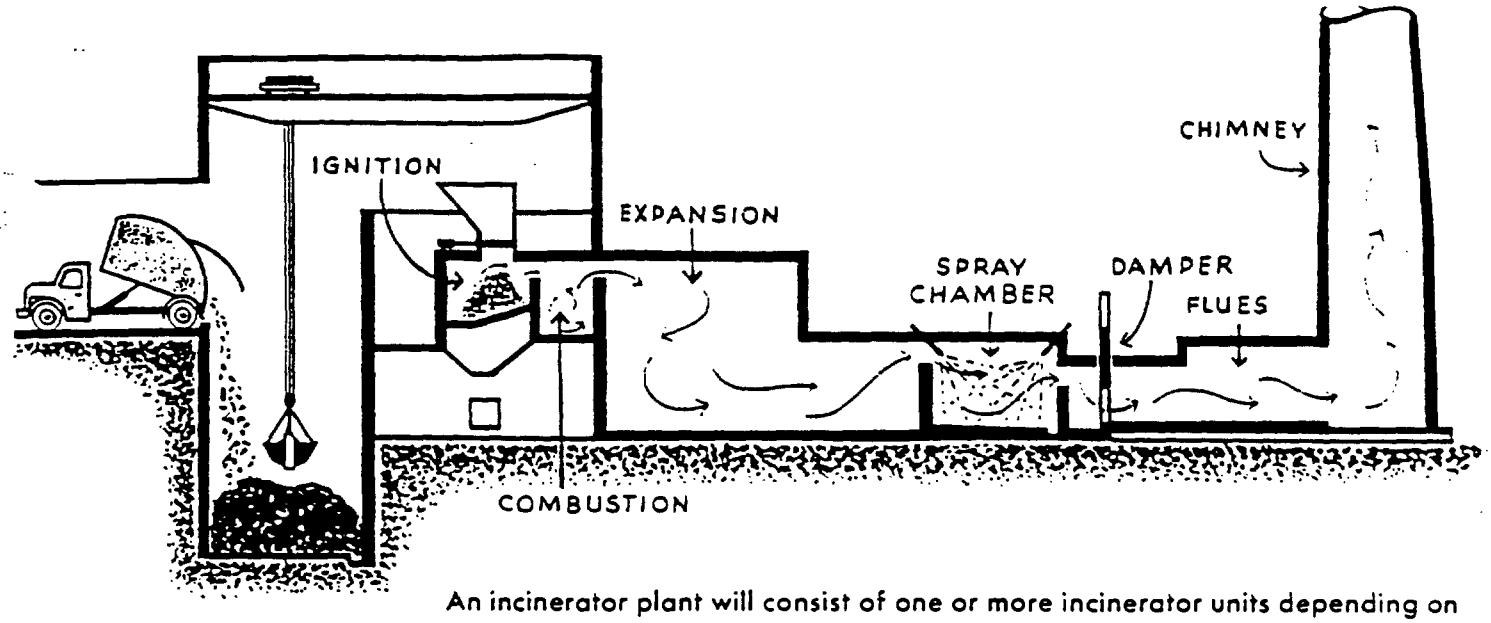
Incinerator stokers, of the inclined grate type, are used on rectangular furnaces. Alternate moving stoker bars agitate the fuel bed and keep non-combustible material moving toward the stoker front where the residue dumping grate is located. Incinerators of rectangular type are usually designed with two to four charging holes.



CYLINDRICAL TYPE

In this type the hopper drops the refuse in the center of a circular grate over a cone which provides for the admission of combustion air to the interior of the fuel pile. This cone rotates and ravel arms, attached to it, agitates the fuel bed and shoves the residue to the outer periphery where the dump grates are located. The automatic agitation results in a minimum of hand stoking.





An incinerator plant will consist of one or more incinerator units depending on the over-all capacity. Each unit is equipped with a charging hopper that will contain enough refuse to charge the grate for one burning cycle. The refuse is dropped onto the grates through a charging opening in the roof. This opening is closed off by a manually or mechanically operated charging gate.

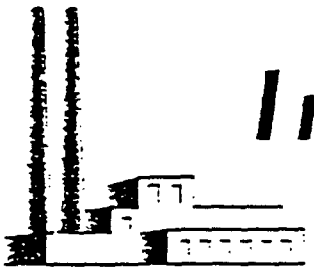
The refuse on the grates or stoker is ignited by the radiant heat from the hot refractory furnace enclosure. Air for combustion is supplied through the grates and, since the refuse burns mainly on the surface, over fired air is supplied through the walls for combustion purposes and to control temperatures in the furnace. Temperatures, at this point, are usually maintained around 1400 to 1800 degrees F. to ignite the refuse even though it may contain considerable moisture. Automatic stoking or hand stoking is necessary to promote burning of the refuse and prevent clinker formation from the non-combustibles.

After the refuse is burned the ash or residue (tin cans, bottles, etc.) is raked out the stoking door or, in a stoker operation, dumped into the ash pit and a new charge is dumped on to the grates through the charging holes and the burning cycle continues. Air and combustion gases flow around and over the piles of burning refuse promoting combustion and then pass into a combustion chamber where combustion is completed. High temperatures must be maintained to burn all gases and any particles carried over in the gas stream thus eliminating any odor problem.

From the combustion chamber the gases pass to an expansion chamber where they are slowed down and given turbulence by changing the direction of gas travel. The lower velocity and turbulence separate the fly ash from the gas stream. The gases then pass through a system of flues to the chimney.

A damper is provided, either between the combustion chamber and the expansion chamber or between the expansion chamber and the flues, to control furnace draft and cut off one of the incinerator units when not in use.

If fly ash needs to be removed to a greater extent than an expansion chamber will provide, a spray chamber with a water spray is used. The water absorbs some of the fly ash in the gases and also slows velocity of the gases through the flues allowing more fly ash to drop out.



Incinerator ENCLOSURES

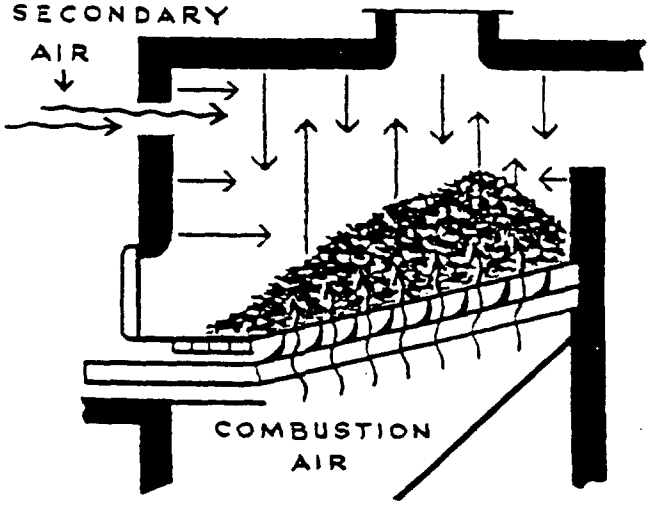
The incinerator enclosure is the furnace structure and refractory brickwork that contains and directs the gases from the burning refuse through the various parts of the incinerator unit to the chimney.

Fundamentally, the enclosure is divided into several chambers, each having a separate and distinct function as illustrated below.

IGNITION CHAMBER

In this chamber the refuse is received, ignited and burned. Temperatures must be kept sufficiently high to ignite and maintain combustion even though refuse is received with considerable moisture (as high as 55% when garbage is included). Heat stored in the refractory walls and arches are important for this purpose.

New charges of refuse are ignited by the radiant heat from the hot walls and arch. Therefore proper design and placement in relation to the fuel pile is important. Refractory selection to withstand temperatures and abrasive action from the refuse are important because this chamber with its charging openings and stoking doors are subject to drafts of cold air when they are open. Each charge can cause sudden change of temperature depending on character of refuse, whether wet or highly combustible.

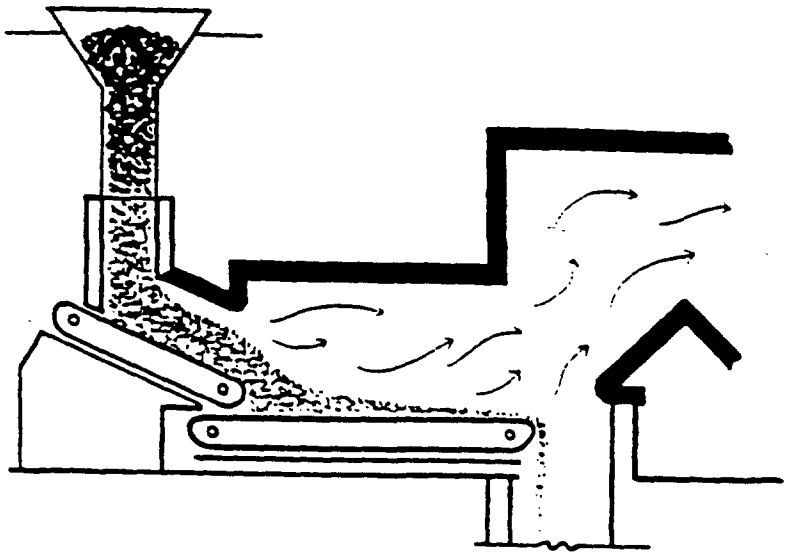


Various parts of this unit, especially the charging openings, are subjected to abrasive action from the refuse charge.

Ignition chamber volumes are usually designed for 10 to 15 cubic feet per ton capacity.

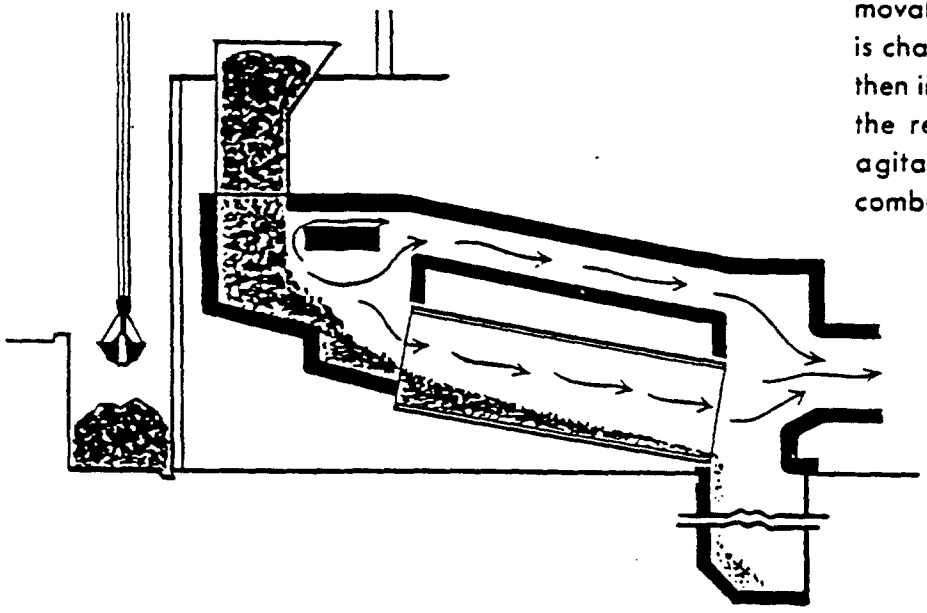
TRAVELING GRATE TYPE

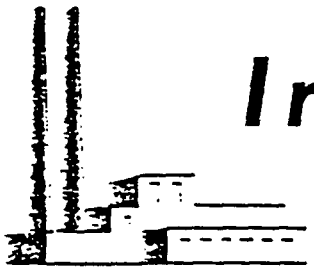
Traveling grate stokers have the advantage of continuous charging and residue removal. An incinerator unit consists of an ignition or feeder stoker and a burning stoker. The ignition stoker is set above the burning stoker so that there is a drop of partially ignited material as it is dumped onto the burning stoker. The most vigorous burning takes place on the ignition stoker where easy to burn rubbish is largely consumed. The burning stoker runs 25% faster than the ignition stoker, allowing hard to burn refuse to be spread thinner over the grate surface.



ROTARY TYPE

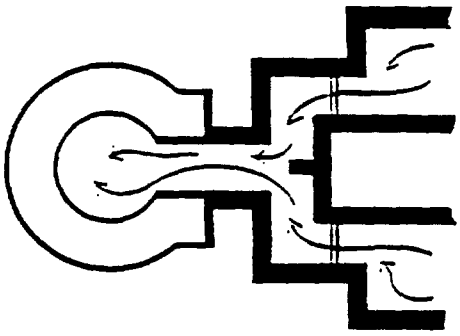
The rotary type also provides continuous charging and residue removal. In the rotary incinerator refuse is charged onto an inclined grate and then into a rotary kiln. The tumbling of the refuse in the kiln provides great agitation and intimate mixing with combustion air.





Incinerator ENCLOSURES

FLUES

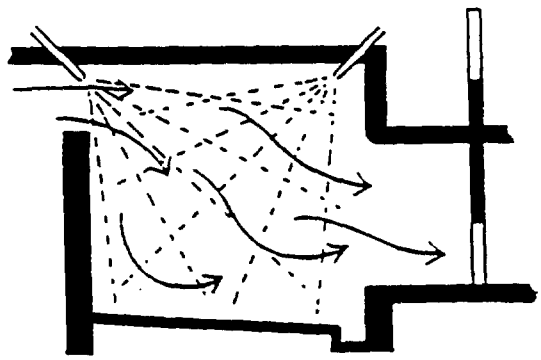


Flues are required to connect the expansion chamber to the chimney. In multiple incinerator units flues are inter-connected so one chimney can service two, or more, incinerators. Fly ash is also deposited here and some designers use curb walls that function like a snow fence to hold the fly ash back. Flue cross section area usually runs from ¼ to 2 square feet per ton capacity and velocities are based on 8 to 25 feet per second. Here again it is important to have walls so constructed that they are well insulated and heat and gas tight.

SPRAY CHAMBERS

Today the properly designed and operated incinerator should not cause any air pollution of consequence. If the ignition and combustion chambers are liberally designed and the expansion chamber and flues are designed for low velocity, very little fly ash will get out of the chimney and combustion will be practically complete giving very little, if any, smoke.

However, if solids need to be removed to a greater extent than the expansion chamber will provide, then a spray chamber at the end of the expansion chamber will help. The fact that the water in the spray chamber has to exist in an atmosphere of 600 to 800 degrees F. indicates that water quantities will be heavy. The water can serve two purposes however. The droplets will trap most of the fine particles and remove them from the gases; also the spray will reduce the gas velocity in the flue.

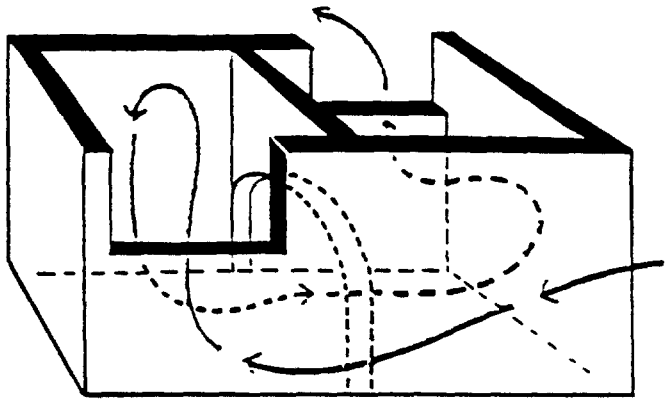


COMBUSTION CHAMBER

Temperatures in this chamber must be kept sufficiently high to complete combustion. Some turbulence must be imparted to the gases from the ignition chamber to intimately mix them with the excess air in the gas stream. For this purpose the combustion chamber is usually designed with bridge walls and/or baffle walls to change the direction of the gas travel. Temperatures are usually in the 1600 to 1800 degree F. range but provision must be made for abrasion and possible higher temperatures.

It is important to have sufficient volume and temperature for complete combustion of the gases and burning of any carry-over from the ignition chamber. Combustion chamber volumes are usually designed for 15 to 30 cubic feet per ton of rated capacity.

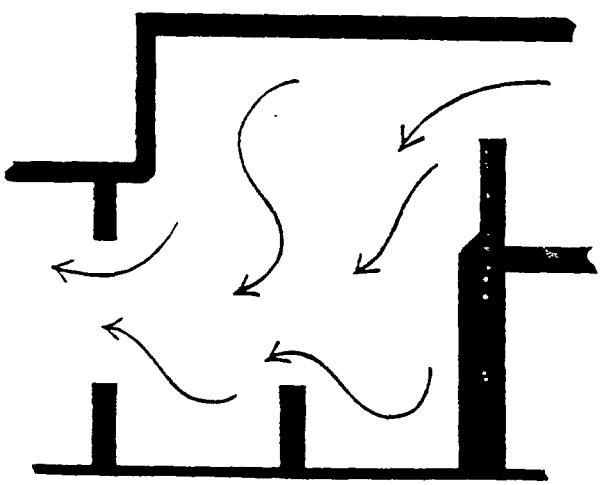
This chamber is also vulnerable to varying temperatures and thermal shock and therefore should have refractory selected for resistance to this condition.



To eliminate any chance of obnoxious odors and air pollution, temperatuures in the combustion chamber should always be maintained above 1200 degrees F. At this temperature any unburnt gases, when mixed with sufficient quantities of air, will complete their combustion. The following are temperatures required for complete combustion of gases usually present in the gas stream :

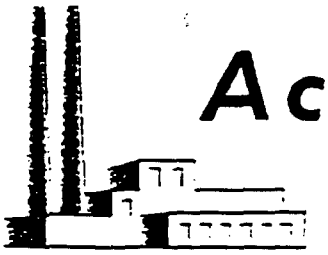
Fatty Acids	800 Deg. F.
Hydrogen	1100 " "
Carbon Monoxide-Methane	1200 " "

EXPANSION CHAMBER



Here the gases are slowed down to settle out the fly ash from the gas stream. Bridge walls and baffles are used to change the direction of the gases and add turbulence, which is important in the removal of fly ash.

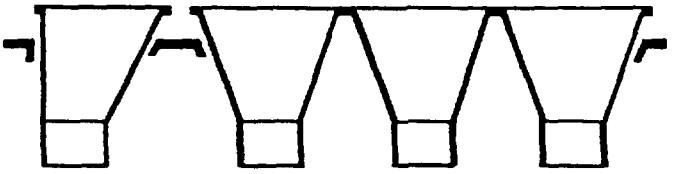
The expansion chamber is designed for low velocity. Walls should be properly insulated and heat and gas tight. Suspended walls in the expansion chamber and flues have less heat storage and therefore dissipate the heat faster. This will allow access to these areas much sooner. A volume of 10 to 40 cubic feet per ton of rated capacity is somewhat standard. Temperatures should be maintained around 1200 degrees F. to assist in complete combustion providing any unburned gases are present in the gas stream.

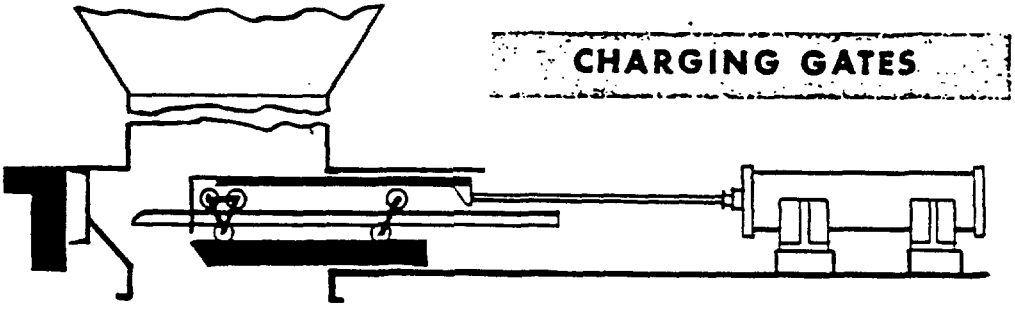


Accessory EQUIPMENT

CHARGING HOPPERS

Charging hoppers are usually constructed of steel plate and should be large enough to hold a complete charge. The design of the hopper and chute should be such that the refuse will not hang up in the hopper and require extra men on the charging floor to push it through.

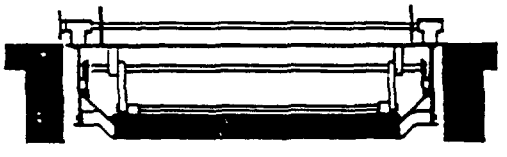




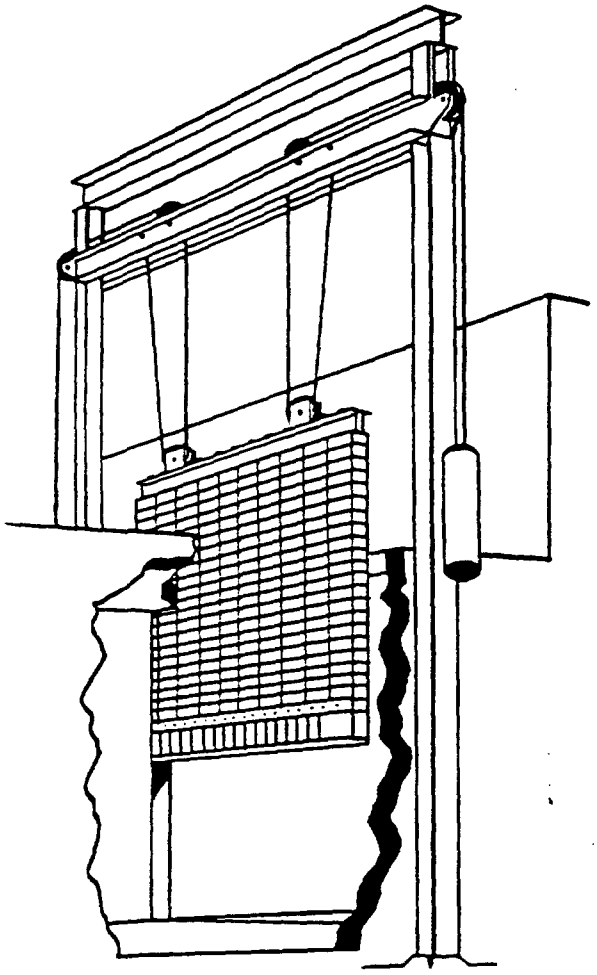
CHARGING GATES

Charging gates, in their closed position, act as a door to cover the charging opening in the ignition chamber arch. They provide a seal with the arch and some clearance must be maintained to be sure no load is placed on the charging opening tile. Charging gates ride on rollers carried by structural steel that is always designed as an independent structure and should never be tied in to the arch structure. When refuse is dropped in the hopper the charging gates take the shock of the falling material and would transfer it to the arch structure if they were tied together. Gates can be pneumatically, electrically or hand operated. Type of operation selected depends on incinerator design and plant layout.

ASH HOPPERS



The ash hoppers are designed to receive the residue from the dump grates. They are of steel plate construction and are usually lined with a vitrified paving brick. The lower section is equipped with a discharge gate that can be either automatically or manually operated. In most cases the residue is water quenched in the hopper and then discharged directly to a truck or hand car for disposal.



DAMPERS

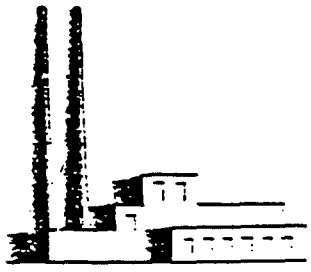
Dampers are required on all incinerator units to control furnace draft and cut off incinerator units when it is required to take them out of service. Location of dampers depends on incinerator design, but they are usually placed between the combustion chamber and the expansion chamber or between the expansion chamber and flues.

Because of their location in a relatively hot part of the unit, dampers must be of a supported refractory or water cooled design. Refractory type dampers supported on an air cooled steel structure have the advantage of low cost operation.

Dampers are designed with counter-balancing weights and are usually hand operated with a chain hoist or winch.

PREHEATERS

Preheaters are not used in many incinerators today because preheated air for combustion is not needed for today's light burnable refuse. If an incinerator handles a large percentage of high moisture content refuse a recuperative type of preheater is placed before the flues to furnish preheated air to the forced draft fan supplying air to the stoker. Preheaters are usually arranged so that they can be dampered off and by-passed if preheated air is not required. Normally, auxiliary oil burners in the furnace are provided in lieu of preheaters in order to maintain combustion temperatures for short periods when refuse contains a high percentage of moisture.



ENGINEERING DATA FOR INCINERATOR ENCLOSURES

REFUSE QUANTITIES

Average—2 to 2½ lbs. of refuse per capita per day
Can be as high as 4 lbs. of refuse per capita per day

INCINERATOR CAPACITY

Rated at–tons of refuse burned per 24 hours

WEIGHT OF REFUSE

Trash or Rubbish ..... 200 to 300 lbs. per cubic yard
Trash and Garbage ..... 400 to 600 lbs. per cubic yard

GRATE LOADING

Hand Stoked ..... Approximately 40 lbs. per square foot
Automatic Stokers ..... Approximately 50 to 80 lbs. per square foot

TEMPERATURES IN VARIOUS CHAMBERS

Ignition ..... 1800 to 2000 degrees F.
Combustion ..... 1600 to 1800 degrees F.
Expansion ..... 1200 to 1600 degrees F.
Flues ..... 800 to 1200 degrees F.

VOLUME IN VARIOUS CHAMBERS

Ignition ..... 10 to 15 cu. ft. per ton of rated capacity
Combustion ..... 15 to 30 cu. ft. per ton of rated capacity
Expansion ..... 10 to 40 cu. ft per ton of rated capacity

VELOCITY OF FLUE GAS

Eight to twenty five feet per second at 1200 degrees F.
Cross Section Area ..... 0.25 to 2.0 sq. ft. per ton of rated capacity

CHIMNEY SIZE (Estimating Only)

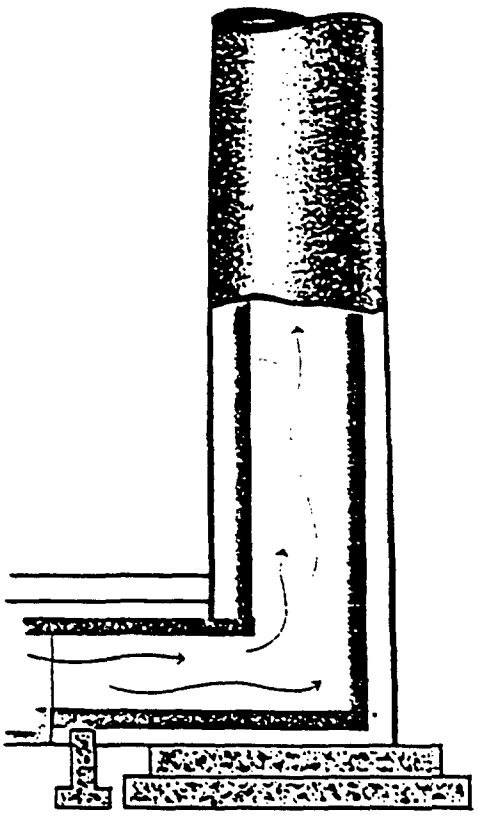
0.25 sq. ft. per ton of rated capacity
Height ..... Approximately 75'0" for 30 tons
Approximately 175'0" for 300 tons

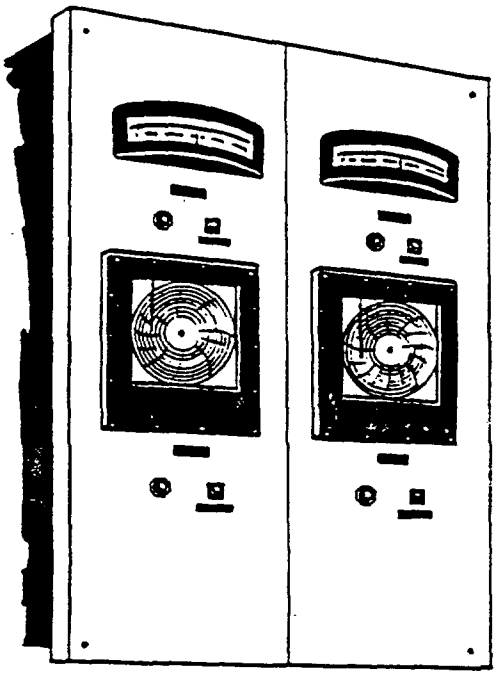
INCINERATOR ENCLOSURES

DETRICK Heat ENCLOSURES

CHIMNEYS

Chimneys of proper size and height must be provided to obtain proper draft requirements for the incinerator units and disperse the gases over a wide area. They vary in height from 75 feet for a 30 ton unit to 175 feet for a 300 ton unit. Chimneys are a special engineering problem. The density of the air in the vicinity of the incinerator, the density, velocity and volume of the flue gases, and any frictional draft losses in travel through the incinerator unit must be calculated in determing the chimney size.





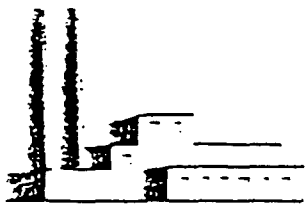
INSTRUMENTS

Most plants require an instrument panel board mounted on the stoking floor for easy observation by the operator. Instruments consist of the following to obtain proper check of operations.

(A) Recording pyrometer with thermocouple placements in combustion chamber and chimney.

(B) Draft gauge for base of chimney and forced draft pressure beneath the grates.

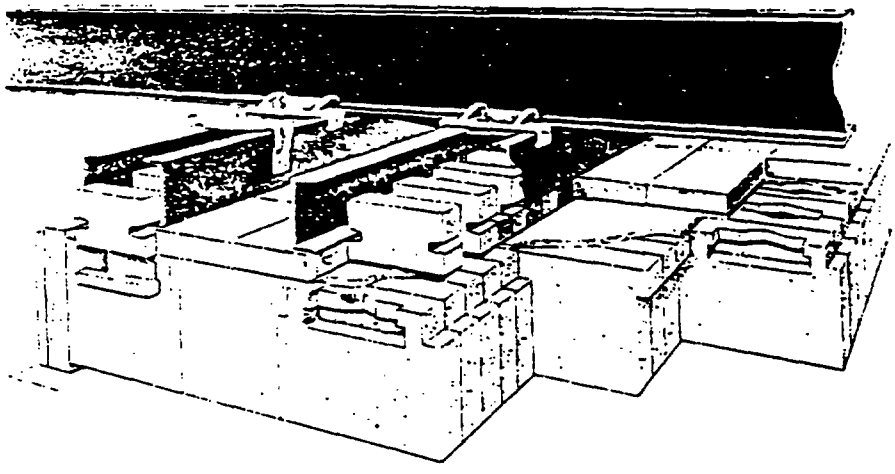
(C) Recording meter for wind direction.



ARCHES and WALLS

for INCINERATOR ENCLOSURES

Because it is necessary to provide large furnace capacities involving wide spans, high walls, and complicated contours, suspended construction is necessary in modern incinerators. Detrick engineers have developed a variety of arch and wall constructions which meet every requirement presented by the incinerator designers.

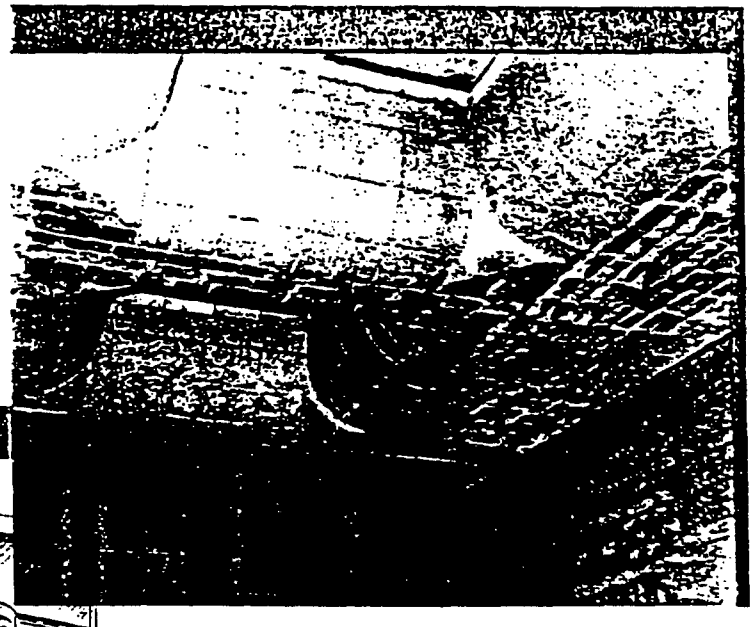


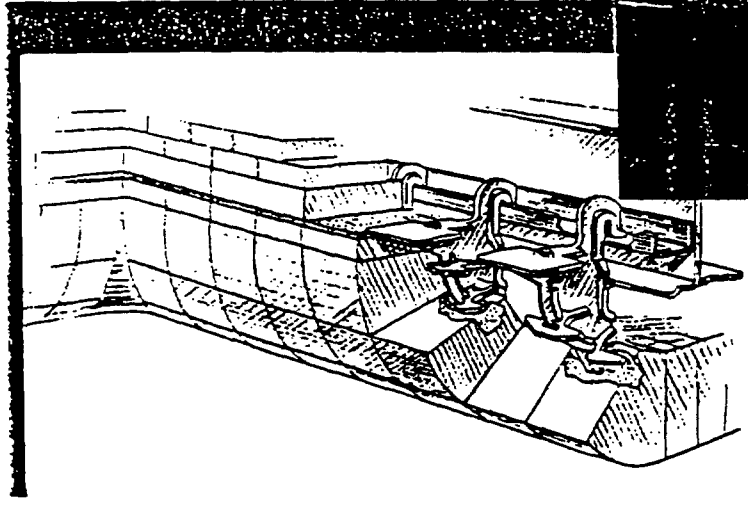
This flat suspended arch is ideally suited for incinerators because:

1. Can be applied to any span and contour.
2. The refractory depth can be varied to suit service conditions.
3. It can be insulated up to the limits of the refractory.
4. It is rendered gas and air tight by a sealing layer over the refractory.
5. It is easy to replace any part without disturbing the surrounding area.

CHARGING HOLES

This is the area that receives the hardest service. The opening has to resist the abrasive action of the charge and the thermal shock of opening and closing the charging gates. The Detrick Nose Construction provides a rugged unit for this area which permits easy entrance of the refuse without interference.





NOSE CONSTRUCTION

The sketch shows how each radial tile is tied back and supported to a rigid steel framework. To overcome thermal shock only one face of the tile is exposed to the heat.

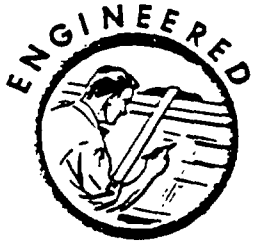
INCINERATOR ENCLOSURES

DETRICK Heat ENCLOSURES

Longer Life–Lower Maintenance

with SUSPENDED WALLS & ARCHES

An incinerator is primarily a refractory lined enclosure, the function of which is to enclose the burning of refuse and direct the flow of gases to the chimney . . . and it must permit the high temperatures neccessary for continuous combustion. Because of this the enclosure is one of the important parts of the unit . . . requiring a proper co-ordination of engineering . . . structure . . . and materials to provide a long life at a lower cost to the community.



Suspended construction is an engineered system of supporting refractories and insulation in integrated units that can be applied in different ways to the various zones according to heat requirements.



Suspended construction permits the selection of materials for their principal function . . . refractories to resist heat . . . insulation to stop heat . . . structural units to carry the load.



Suspended construction permits the designer to control the size and shape of furnace areas and to select the depth of refractories required for needed temperature conditions. Unit suspension allows the application of insulation against heat loss . . . sealing layer to stop air and gas leakage . . . air cooling to hold down the temperature where required.



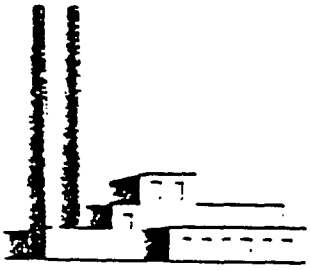
Because of independently suspended sections, local repairs can be made to any part without disturbing the surrounding areas. This reduces maintenance costs and reduces time a unit is out of service.



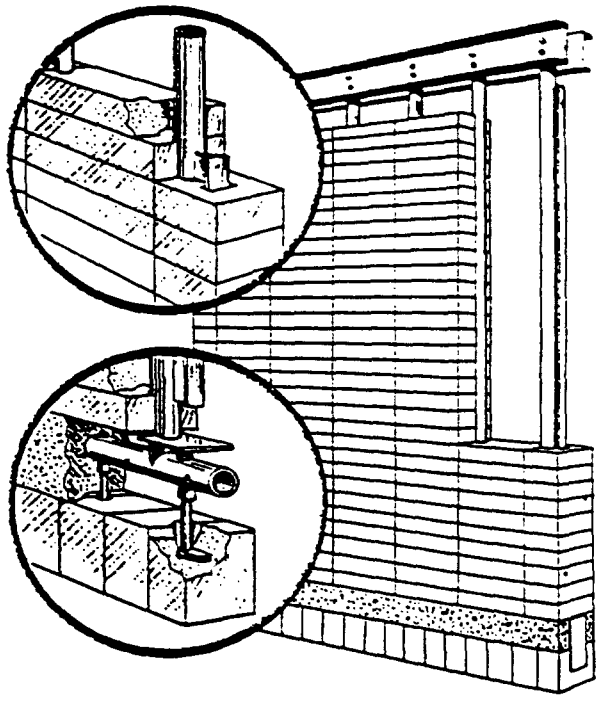
Suspended construction is available at a very small percentage of the total cost of an incinerator. The long life and low maintenance further reduces the annual cost to the taxpayers.

INCINERATOR ENCLOSURES

DETRICK ENCLOSURES



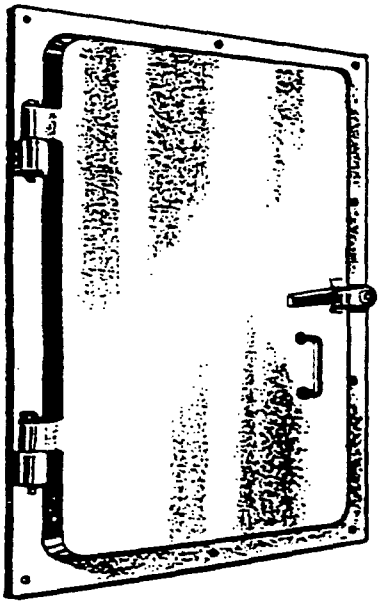
DAMPERS and DOORS



DAMPERS

The refractory type damper is an example of the special problems that are handled by Detrick in engineering an entire heat enclosure.

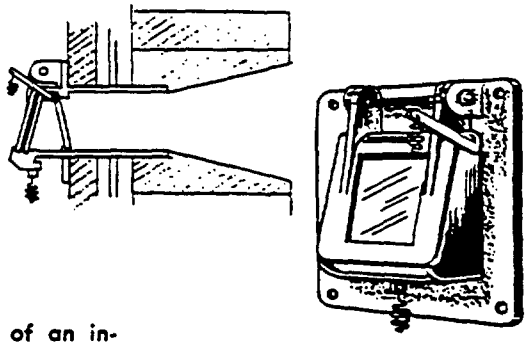
The damper illustrated here has a structural pipe framework. It supports the lower row of dense refractory tile which forms the abrasion edge of the damper. Above this lower edge lightweight insulating refractory tiles are tied back to the pipe structure. Air is circulated through the pipes to cool them when the damper is closed, the draft being provided by openings on the chimney side.



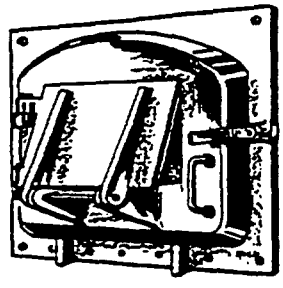
LARGE ACCESS DOORS

DOORS

Obtaining access to various parts of an incinerator unit, as well as observing gas flow, is an integral part of operating an incinerator. These doors must be built as part of the wall structure and so designed as to give easy access for clean-out and other purposes. Because of the large area, some doors must be sufficiently large to permit a man and a wheelbarrow to enter some chambers. They must be of rugged construction and the opening made part of the wall design. Detrick is equipped to design and furnish doors of all types for incinerator units.



OBSERVATION DOORS



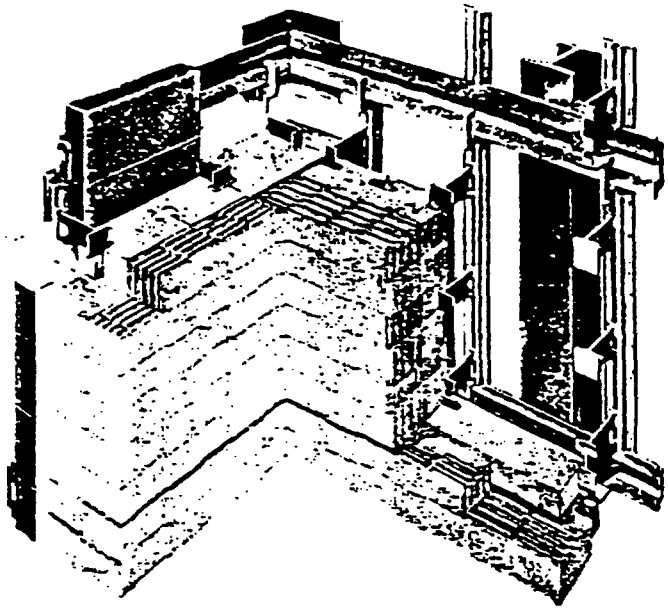
STOKING DOORS

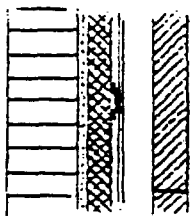
INCINERATOR ENCLOSURES

HIGH TEMPERATURE AREAS

The ignition and combustion zones of a modern incinerator develop high temperatures and are subjected to thermal shock. To meet these conditions this wall design is especially suited because:

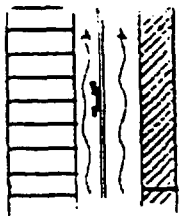
- It can be built to any height because the wall is sectionally supported from the structure.
- The tile units are tied back to the structure and cannot bulge.
- The burning depth of the refractory tile can be varied to suit the furnace conditions.
- It can be made gas and air tight with a sealing layer between insulation and refractory tile.
- It can be insulated or air cooled according to zone requirements.
- Any section can be repaired without disturbing the surrounding areas.





INSULATED OR AIR COOLED

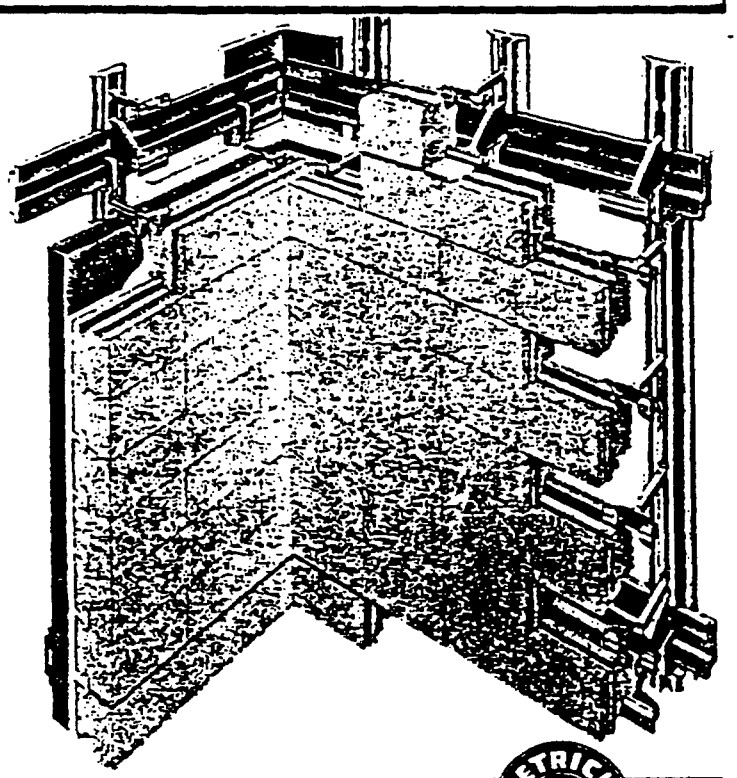
Insulation can be applied as an integral part of this wall construction to any depth consistent with temperature conditions and heat loss requirements. In the extreme temperature zones the insulation can be omitted and the space utilized for air cooling either by forced or natural circulation.



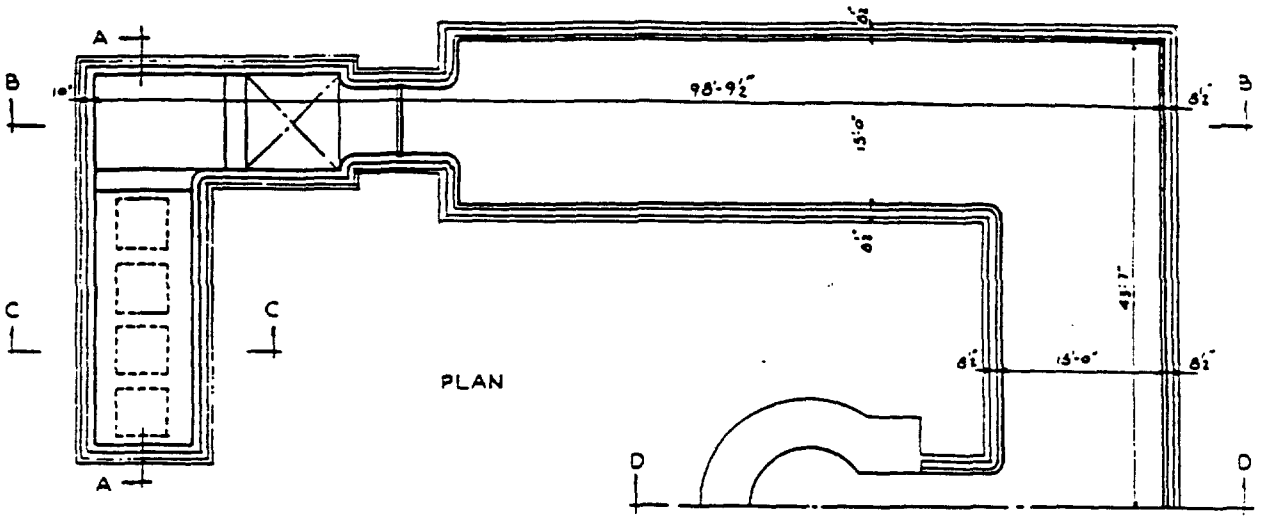
FLUE AREAS

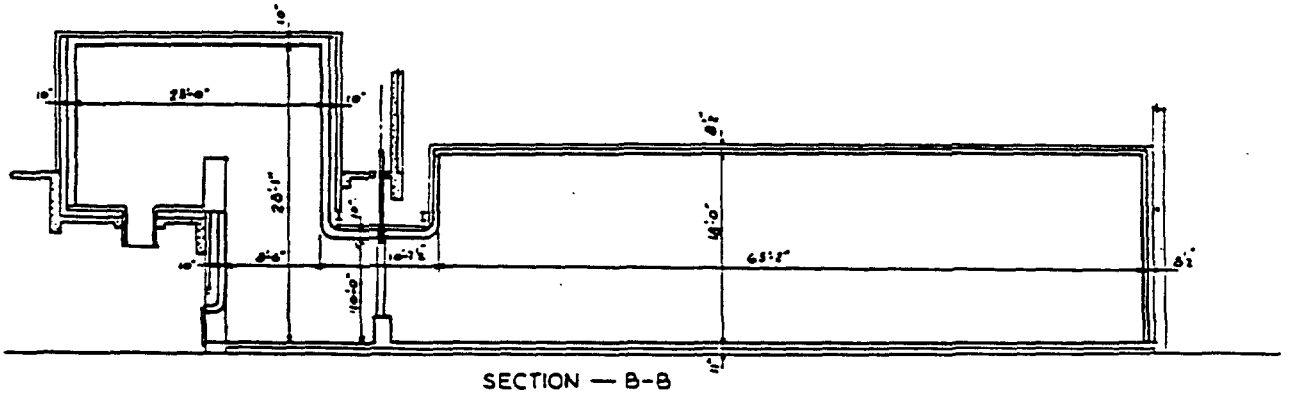
Because of the low temperatures in the back areas of an incinerator, it is not necessary to provide burning depth in the refractory. In fact, the refractory in such areas need only provide a protecting face. Therefore, this construction is ideal because:

- Being a light, thin wall, it provides extra furnace space within given dimensions.
- It can be built to any height and contour.
- Sectionally supported units prevent bulging and relieve physical strain on the refractories.
- Insulation can be applied as an integral part of the wall to control outside temperatures in these areas.

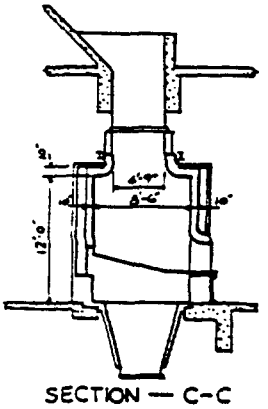


125 TONS PER FURNACE

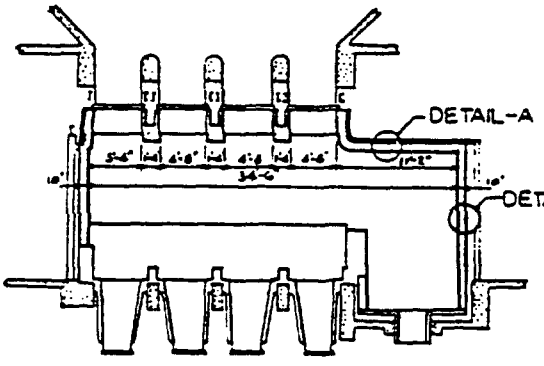




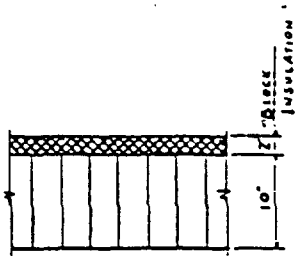
SECTION — B-B



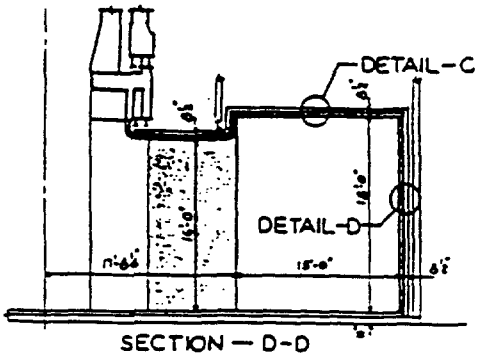
SECTION — C-C



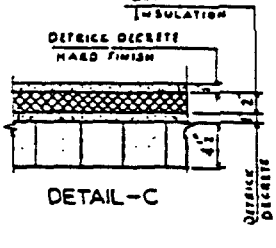
SECTION — A-A



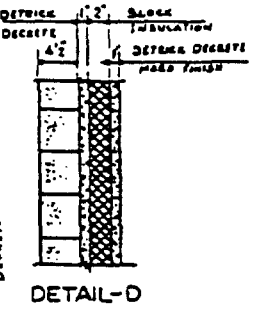
DETAIL-A



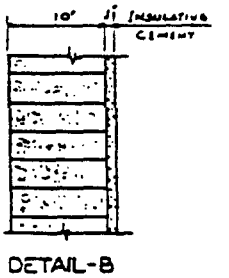
SECTION — D-D



DETAIL-C



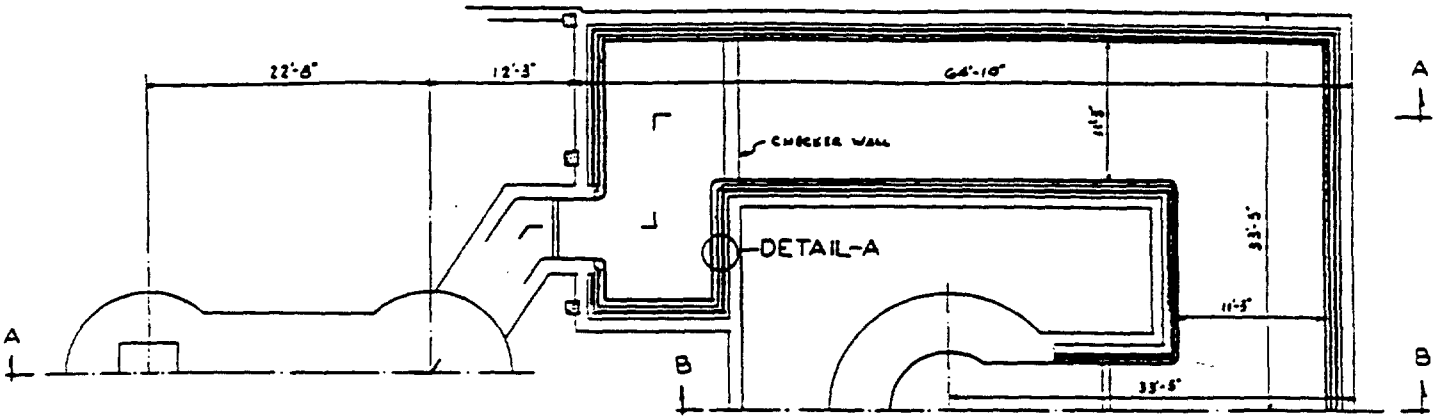
DETAIL-D



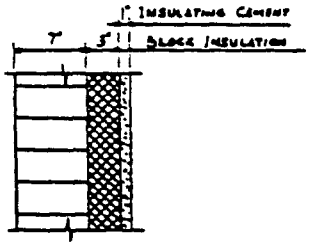
DETAIL-B

INCINERATOR ENCLOSURES

CYLINDRICAL TYPE
125 TONS PER FURNACE

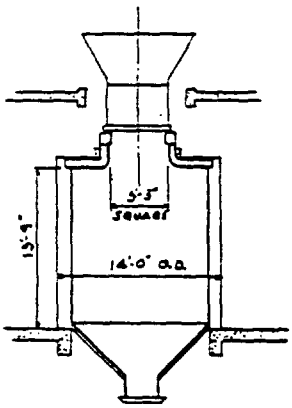


PLAN

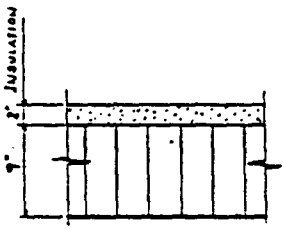


DETAIL-A

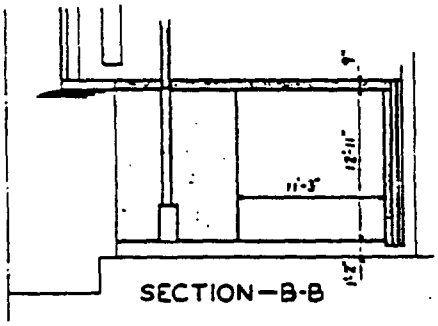
SECTION—A-A



SECTION—C-C



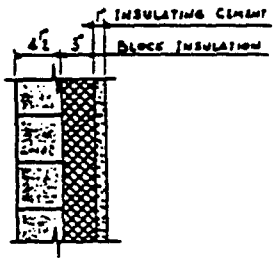
DETAIL-B



SECTION—B-B



DETAIL-C



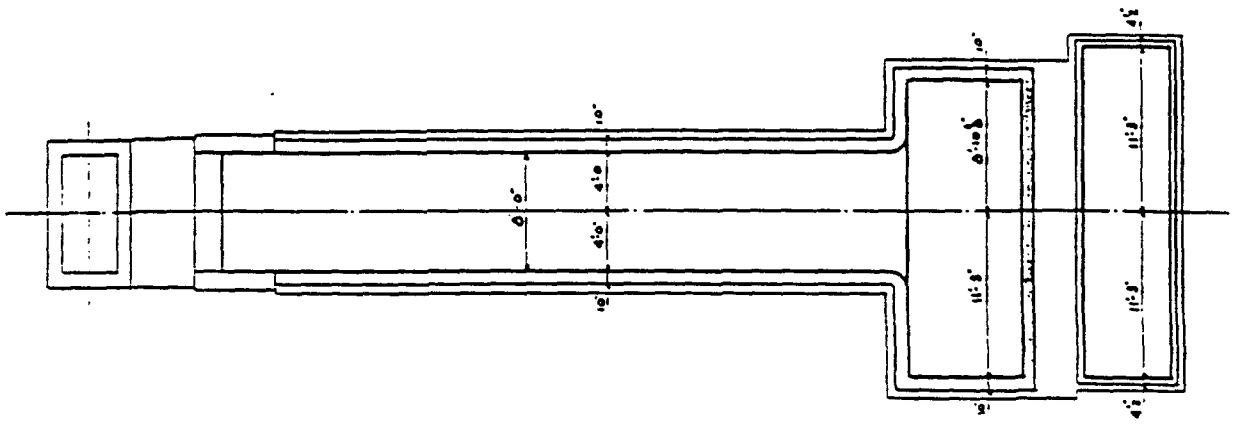
DETAIL-D

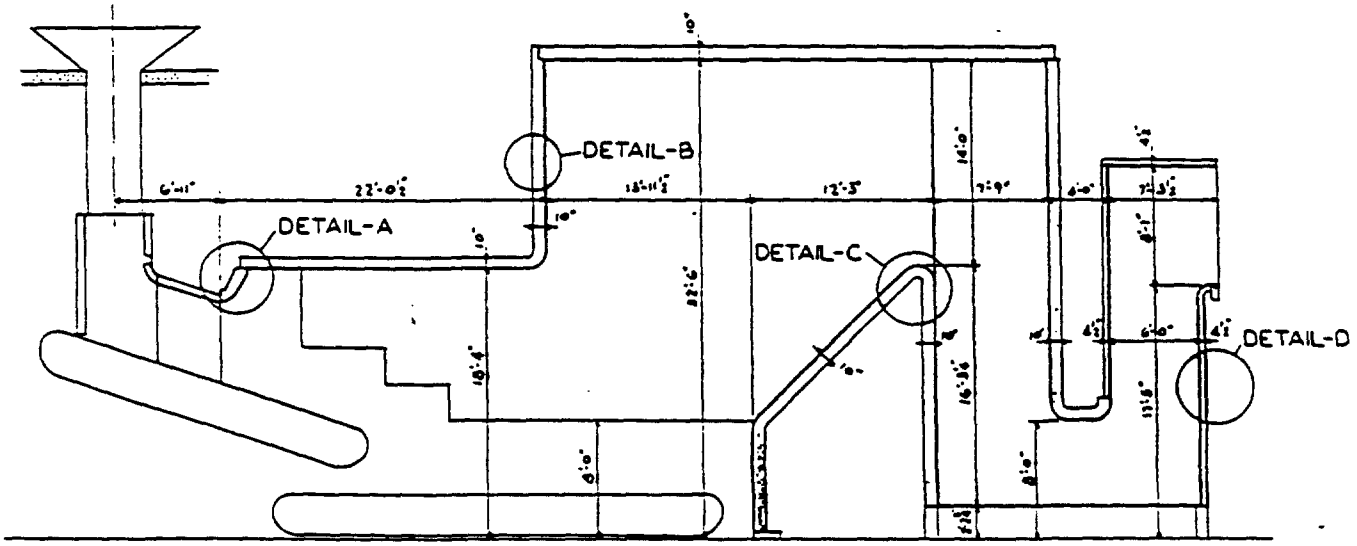
INCINERATOR ENCLOSURES

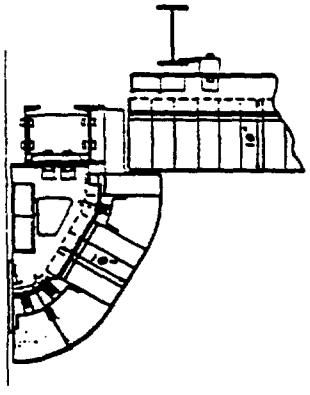
DETRICK Heat ENCLOSURES

TRAVELING GRATE TYPE

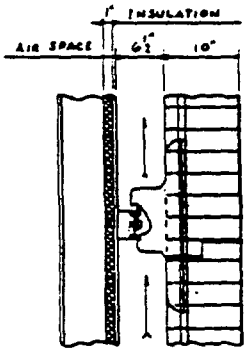
200 TONS PER FURNACE



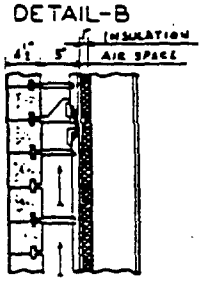




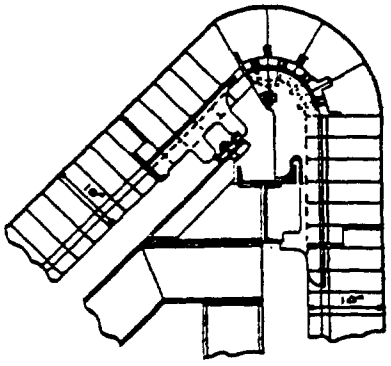
DETAIL-A



DETAIL-B



DETAIL-D

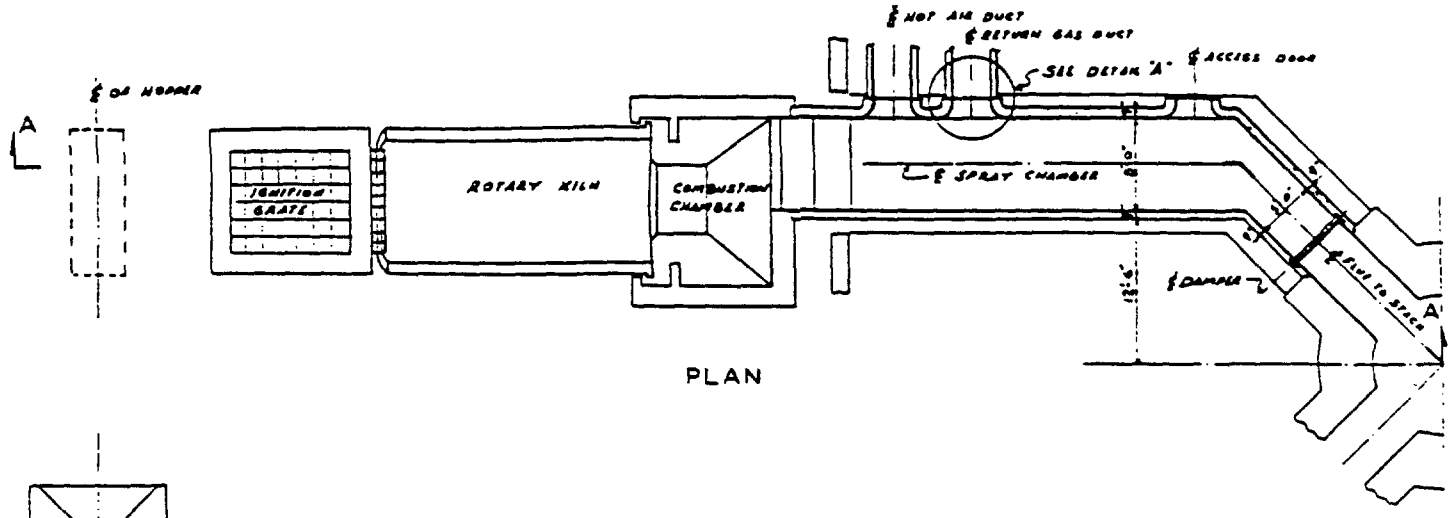


DETAIL-C

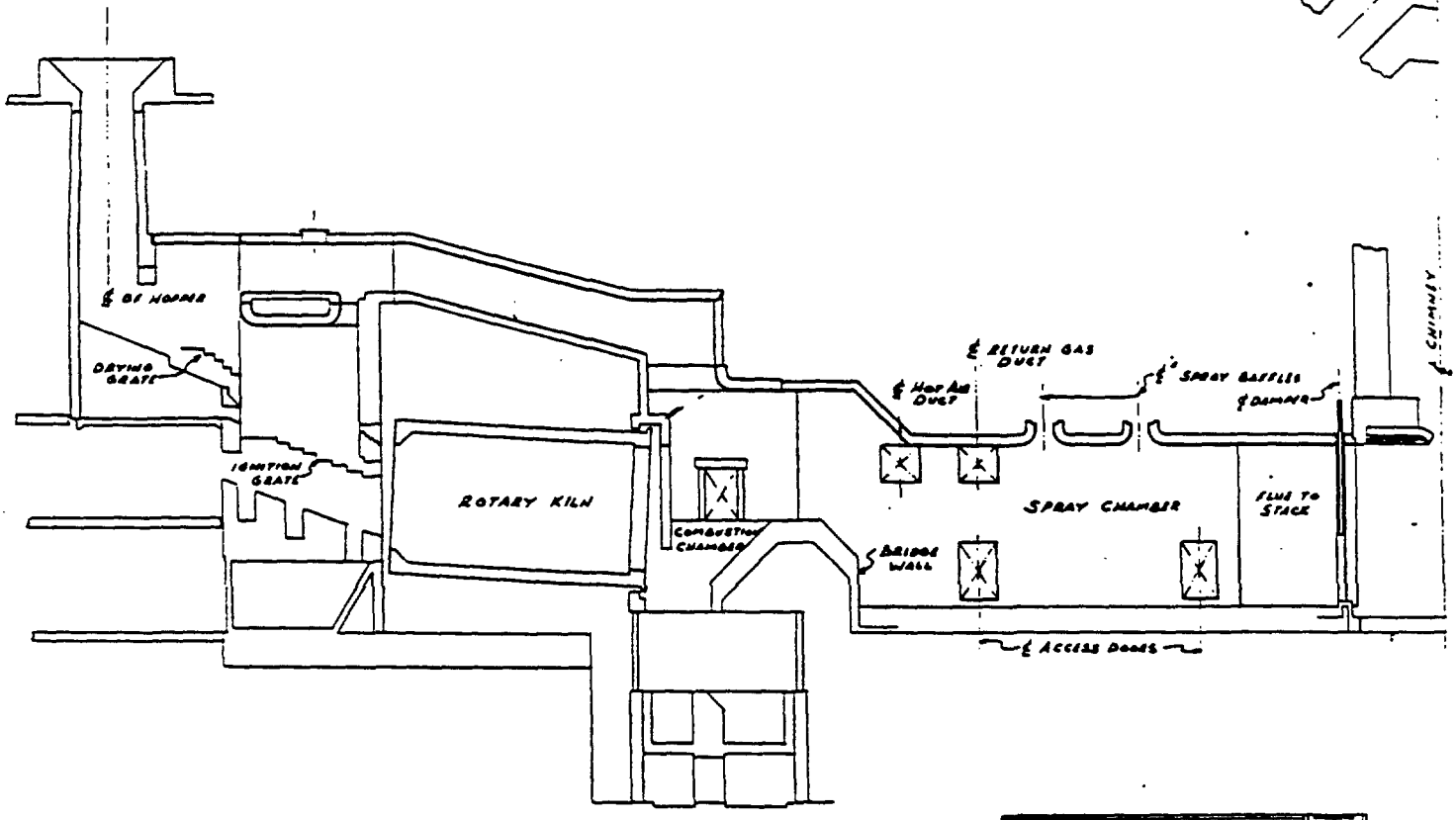
INCINERATOR ENCLOSURES

DETRICK Heat ENCLOSURES

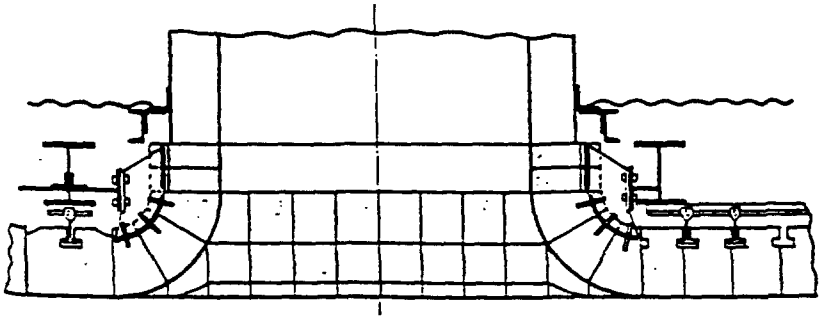
ROTARY TYPE
250 TONS PER FURNACE



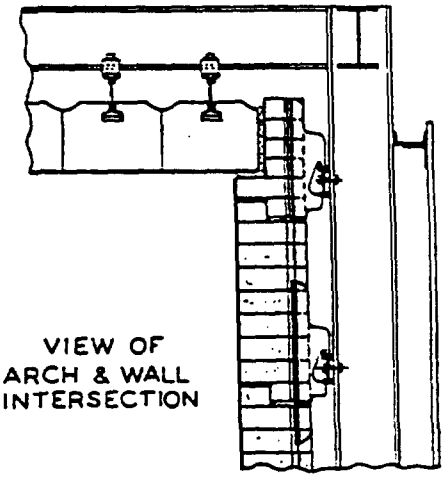
PLAN



SECTION—A-A



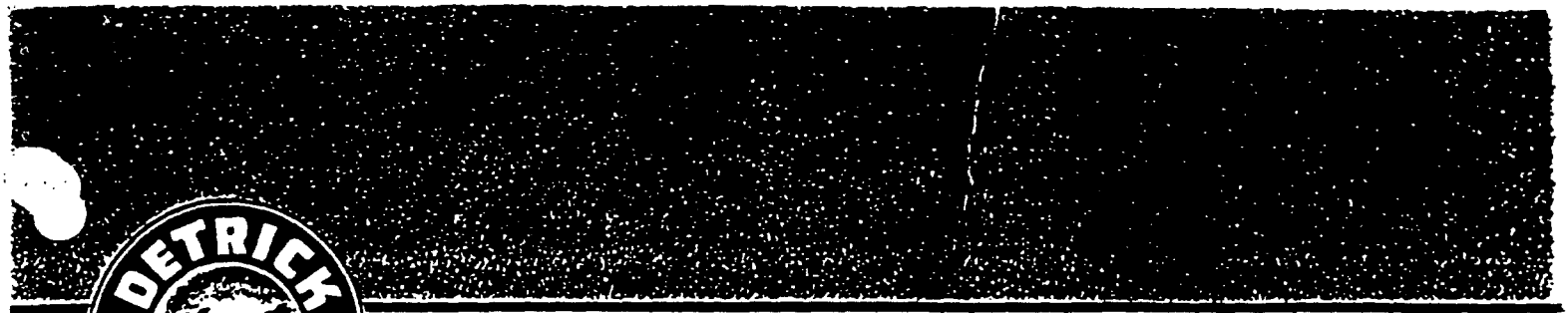
DETAIL-A



VIEW OF ARCH & WALL INTERSECTION

INCINERATOR ENCLOSURES

DETRICK Heat ENCLOSURES



ENGINEERING HEAT ENCLOSURES FOR INDUSTRY

DETRICK SALES OFFICES

Schuler Equipment Company
429-433 Brown Marx Building
Birmingham, Alabama

M. H. Detrick Company
10 High Street
Boston 10, Massachusetts

M. H. Detrick Company
111 W. Washington Street
Chicago 2, Illinois

Ellman Equipment Company
1029 Federal Reserve Bank Building
Cincinnati 2, Ohio

M. H. Detrick Company
937 Schofield Building
Cleveland 14, Ohio

Hendrie & Bolthoff Company
1635 Seventeenth Street
Denver 17, Colorado

M. H. Detrick Company
10600 Puritan Avenue
Detroit 38, Michigan

J. T. Thorpe & Son, Inc.
1351 Ocean Avenue
Emeryville 8, California

M. H. Detrick Company
2284 West Holcombe Boulevard
Houston 25, Texas

Harry McPherson
4049 Pennsylvania Avenue
Kansas City 11, Kansas

J. T. Thorpe, Inc.
948 East Second Street
Los Angeles 12, California

C. J. Gaskell Co., Inc.
216 North Lauderdale Avenue
Memphis 5, Tennessee

The W. Clasmann Company
239 West Center Street
Milwaukee 12, Wisconsin

Edward G. Meninger Company
504 Plymouth Building
Minneapolis 3, Minnesota

A. C. Hays
1221-23 Carondelet Building
New Orleans 12, Louisiana

M. H. Detrick Company
50 Church Street
New York 7, New York

M. H. Detrick Company
1616 Walnut Street Building
Philadelphia 3, Pennsylvania

M. H. Detrick Company
1620 Oliver Building
Pittsburgh 22, Pennsylvania

Utility Engineers, Inc.
630 Dooly Building
Salt Lake City, Utah

M. H. Detrick Company
233 Eastlake Avenue
Seattle 9, Washington

E. R. Jefferson
712 State Tower Building
Syracuse 2, New York

Detrick Company of Canada, Ltd.
1117 St. Catherine St. W.
Montreal 2, Quebec, Canada

Detrick Company of Canada, Ltd.
21 King St., East
Toronto, Ontario, Canada

Fleck Bros., Ltd.
110 Alexander Street
Vancouver 4, B.C.

The Winnipeg Supply & Fuel Co., Ltd.
1651 Portage Ave.
Winnipeg 12, Manitoba, Canada

M. H. DETRICK COMPANY

NEW YORK 50 CHURCH STREET • **CHICAGO** 111 W. WASHINGTON STREET • **PITTSBURGH** 1620 OLIVER BUILDING

