STEAM JET ASH CONVEYORS

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STEAM JET ASH CONVEYORS

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The practical application for conveying ashes by means of the steam jet, developed recently to a high stage of perfection, may be considered as the latest development in the field of power plant engineering. Power plant owners are just awakening to its adaptability.

The steam jet ash conveyor is an apparatus for the removal of refuse resulting from the combustion of coal in boiler and special furnaces from its original point of deposit to a final disposal station. The deposit point refers to the ashpit generally, but in the handling of soot and combustion ash refers to either the back passes of a boiler, breechings, economizers, base of the stack, or the back of the mud drum in the Stirling type of boiler. The final point of disposal may be either a bin discharging the refuse into a railroad car, a wagon, an automobile

truck or a target box discharging on an open field.

Primarily the apparatus may be divided into two distinct parts: suction and discharge lines. The suction line is located so that the intakes may be arranged to allow the ashes to be either mechanically or automatically fed into the system. The ashes may be hoed, shoveled or fed, according to conditions at each individual installation.

Ashes are drawn or hoed into the suction intakes when the bottoms of the ashpit doors are located two or three feet above the boiler room basement floor. The intake of the suction line is then located immediately below, usually supported on the floor by footings. The operator merely hoes the ashes through the door into the intake tee. They are removed through the

pipe as fast as the man can conveniently work without tiring. It should be particularly borne in mind that only one intake may be open at a time. When the tee ahead of the one which is being used is opened, there would be a tendency to short-circuit air, thus decreasing the vacuum at the point desired. The operation of this system may be handled easily by one man, inasmuch as but one intake tee is used at a time.

Shoveling ashes into the conveyor pipe is resorted to when the apparatus is located in a trench below the boiler-room floor. This condition exists in plants having either no basement or when the furnace conditions require the withdrawal of the refuse from doors in front of the grates. Hand-fired furnaces or natural draft stokers are general representative types requiring this method of ash withdrawal.

Feeding ashes through a gate in a hopper bottom ashpit into the conveyor pipe is a method not so frequently used, but when adaptable to conditions, offers an ideal method of disposal. The design of this method of feeding does not allow the ashes to avalanche into the conveyor but considers regulating the flow, thus insuring that the system will work without clogging. The ashes should discharge from the hopper and go into the system at an angle of repose of about 45 degrees. The operator can easily prevent clogging by standing beside the trough and withdrawing the larger clinkers. These are broken up during periods of non-operation for future feeding into the system.

To insure sufficient vacuum in the suction line the steam nozzle is located

as close to the first intake as convenient. The discharge part of the apparatus is located beyond the main steam unit and may be considered as carrying the ashes in suspension due to the velocity of the steam ejected from the nozzle. Therefore, discrimination is made between suction and discharge lines by the fact that in the former ashes are carried in suspension by the vacuum in the conveyor pipe, created by the nozzle ahead, while in the discharge line the ashes are held in suspension by the pressure exerted behind.

Maximum theoretical power developed by a jet of steam flowing through a nozzle is dependent only upon the weight of steam per unit of time and the initial velocity. Therefore the higher the initial pressure (or corresponding velocity) for a given rate of flow, the greater will be the power developed and the

higher the efficiency. The maximum velocity at the mouth of the nozzle for a given rate of flow is obtained when the expansion to the external pressure occurs within the nozzle. It is of utmost importance that a nozzle be correctly proportioned to convert the pressure into velocity energy. It may be stated that the velocity of the steam passing through a correctly proportioned expansion nozzle increases from approximately 1400 to 2400 ft. per sec., for mostly all operating pressures.

To obtain maximum velocity the nozzle must converge at the throat by a well rounded curve and diverge to the mouth at an angle of approximately 10 degrees. The weight of steam discharged through a nozzle is a function of the diamater and may be determined by Napier's Formula. The initial pressure at the nozzle and the nozzle's diamater must be known. Table 1. is based on this formula.

Table 1 Part 1

Flow of steam in Pounds per minute
Through nozzles of different diameters
at different pressures

Dia. in Inches	Area Sq. In.	Pressure, Pounds Gauge 80	90	100
1/8	0.012	0.995	1.10	1.21
3/16	0.028	2.24	2.48	2.72
1/4	0.049	3.98	4.39	4.81
5/16	0.077	6.23	6.875	7.54
3/8	0.011	8.96	9.92	10.85
7/16	0.150	12.21	13.49	14.78
1/2	0.196	15.92	17.61	19.30
9/16	0.249	20.17	22.3	24.42
5/8	0.307	24.90	27.55	30.16
11/16	0.371	30.15	33.31	36.45
3/4	0.442	35.85	39.6	43.43
13/16	0.518	42.10	46.5	50.90
7/8	0.601	48.75	53.96	59.10
15/16	0.690	56.10	61.9	67.80
1	0.785	63.75	70.4	77.22

Note: Slide Rule Calculations

Table 1 Part 11

Flow of steam in Pounds per minute
Through nozzles of different diameters
at different pressures

Dia. in Inches	Area Sq. In.	Pressure, Pounds Gauge 110	115	125
1/8	0.012	1.31	1.36	1.47
3/16	0.028	2.96	3.07	3.31
1/4	0.049	5.23	5.44	5.86
5/16	0.077	8.51	9.175	10.75
3/8	0.011	12.28	13.23	15.6
7/16	0.150	16.72	18.0	21.22
1/2	0.196	21.82	23.5	27.7
9/16	0.249	27.60	29.75	35.1
5/8	0.307	34.10	36.7	43.31
11/16	0.371	41.25	44.4	52.4
3/4	0.442	49.20	52.9	62.3
13/16	0.518	57.64	62.0	73.1
7/8	0.601	66.84	72.0	84.8
15/16	0.690	76.74	82.6	97.5
1	0.785	87.31	93.9	110.82

Note: Slide Rule Calculations

Table 1 Part 111.

Flow of steam in Pounds per minute
Through nozzles of different diameters
at different pressures

Dia.in Inches	Area Sq. In.	Pressure, Pounds Gauge 150	175	200
1/8	0.012	1.73	1.99	2.26
3/16	0.028	3.9	4.49	5.09
1/4	0.049	6.9	7.96	9.02
5/16	0.077	10.75	12.47	14.05
3/8	0.011	15.6	17.95	20.35
7/16	0.150	21.22	24.43	27.7
1/2	0.196	27.7	31.9	36.13
9/16	0.249	35.1	40.4	45.75
5/8	0.307	43.31	49.89	56.5
11/16	0.371	52.4	60.36	68.31
3/4	0.442	62.3	71.83	81.3
13/16	0.518	73.1	84.25	95.45
7/8	0.601	84.8	97.77	110.5
15/16	0.690	97.5	112.24	127.1
1	0.785	10.82	127.71	144.5

Note: Slide Rule Calculations

For similar boiler operating conditions the diameter of a nozzle is increased proportionally with the decrease in boiler pressure. A boiler plant operating at 200 lb. boiler pressure will require a smaller nozzle for the removal of the ashes than a plant operating at the lower pressure of 100 lb., although the smaller nozzle of the former may use more steam than the latter.

Determining the most efficient operating nozzle before an installation is completed is difficult. It is based upon the design of the boiler plant, operating conditions, boiler pressure consistency and moisture content of the ashes and the final disposition of the ashes. The design of the boiler plant determines the location of the riser conveyor pipe. All existing piping, apparatus, roof trusses and contemplated work must be taken into consideration. It is desirable to locate the

riser convenient to the first intake inasmuch as the main steam unit is usually located at the base, and the proximity of the nozzle to the first intake tee generally results in a better vacuum.

Steam is transmitted to the nozzle at as near boiler pressure as possible. This is accomplished by using a steam line of sufficient size, with a minimum number turns, and if possible taken off of the main header. Traps are provided if the boiler pressure is low or condensation is likely to occur, thereby providing a thoroughly dry steam.

The property of the ash is an important consideration for this type of apparatus. Wet ashes have a greater weight per unit volume and are not as capable of suspension as the drier ash in the high velocity air. Therefore, wetting and then introducing the ashes into the system usually causes a depositing on the bottom of the pipe

Ashes are generally fed as hot as possible. The steam condensing on the cooler surfaces of the ash "kills" the heat before delivery is effected. Additional labor and extra expense are entailed when it is found necessary to saturate the ashes with water or to keep the ashpits in a wet condition to avoid burning the grates.

Location of the final disposal station for the ashes is determined by the purchaser's conditions. The bin should be located as near to the riser as possible to reduce the operating power. The horizontal discharge is located in a straight line from the riser to the bin avoiding turns, bends and the resulting scrubbing action that occurs when the direction of flow is changed of high-velocity abrasive material.

The clearance limitations for bins located over a track is specified by law.

These bins are therefore located high enough to allow the ashes to be discharged directly into gondolas. This necessitates a high vertical riser before it takes the horizontal course, often projecting through coal bunker and the roof of the plant. The height of the riser is determined by information concerning the ash bin, such as the desired capacity and requirements.

Bins are made of either reinforced concrete or steel. The former construction is generally used, being cheaper and offering more resistance to the corrosive action of the ashes. The bin columns and flat slabs are poured at the same time, provision being made for openings large enough for the installation of gates of sufficient capacity to allow ready removal of the refuse. It may be either cylindrical, rectangular or square with sufficient reinforcing to over-

come the internal pressure of the confined material. In smaller capacities, it is more economical to plaster concrete on a surface of expanded metal if of sufficient strength and properly designed.

Table II represents approximately the actual costs for the material and complete erection of reinforced-concrete and flat-bottom ash storage bins.

Table II. Cost of Reinforced-Concrete Flat-Bottomed Ash Storage Bins.

Capacity of bin TONS	Internal Size In Feet	Cost
10	8x8x12	$1500
20	10x10x16	1800
30	12x12x16	2000
40	13x13x18	2250
50	14x14x19	2450
60	15x15x21	2650

Bins constructed of steel have been used extensively but it has been found advisable to line their inner surfaces with concrete, particularly where the ashes are allowed to accumulate for a considerable length of time. When well constructed with proper riveting, caulking and painting, they satisfactorily resist the corrosive action of the ashes. Their general construction is with hopper bottoms, supported on latticed steel columns.

The flat bottomed concrete bin is now constructed more extensively than those with the hopper bottoms. The ashes when being discharged are allowed to form their angle of repose and flow freely through the gate, thus removing the maximum quantity. The actual slope of the bin bottom is away from the gate. The condensation accumulating within the bin is removed by properly

located nipples buried in the concrete so that the discharging ashes are comparatively dry and have a free flow. The hopper bottom bin concentrated this moisture at the gate with an arching effect, which prevented a free flow until the wet material had been removed by poking with heavy bars. During the winter a collection of moisture at the gate had a tendency to freeze over,requiring considerable waste of live steam against this material before it could be removed.

When it is desired to discharge the ashes directly for filling purposes near the plant, a water jet is installed in the horizontal near the end of the discharge pipe to settle the entrained fine material. The water control valve should be located near the operating steam valve of the ash-handling system. The ashes pass through a sc screen of atomized water vapor which is

surrounded and settles the finer particles to the coarser ones. It is not considered necessary to saturate the ashes, but the use of sufficient water is required to settle the suspended dust.

Coal from different localities is mined with a widely varying ash and sulphur content, difference in B.t.u., and particularly a difference in temperature of the ash fusibility. When the fusing temperature has been exceeded, the refuse turn into a fluid mass clinging tenaciously to the brickwork and the grates upon cooling. The properties may be predetermined by the individual furnace design, of which there are four general classifications, namely: overfeed natural-draft stokers, underfeed forced-draft stokers, continuous traveling grates and hand-fired furnaces.

From the overfeed natural-draft stoker the refuse is generally medium sized and abrasive, carrying easily in suspension in the conveyor. The rough surface of the ash is exposed to the high velocity air currents, which assists in clearing the system of the finer particles. The furnace temperatures in this type of stoker are generally not too high and the larger clinkers being friable are easily broken before being fed into the intake.

The forced-draft underfeed type of stoker has an exceedingly high temperature in the combustion chamber. The refuse is always large and extremely abaasive, being fused by both the high temperatures and the continual agitation of the stoker operating mechanism. Stokers of this type are used in plants of larger capacities. The steam jet ash conveyor is not recommendable for

removal of refuse from stokers of this type, unless clinker grinders are provided, or sufficient space in the ashpit is allowed to give the men access in breaking up the clinkers before their discharge into the system. More time is frequently required in breaking up clinkers, under ordinary operating conditions than is required in the whole operation of discharging them from the boiler plant into the bins.

The traveling grate stoker deposits its refuse as the links pass over the rear shaft. Irrespective of the kind of coal, the ashes are generally fine and are easily handled in a conveyor.

Inasmuch as the ashes deposited by the various types of stokers are abrasive, and weigh from 30 to 50 lb. per cu. ft., it is necessary to make the pipe which is used for their conveyance of heavy and hard white

cast iron. The pipe is made in lengths not exceeding 6 ft. in the 6 and 8-in. systems so that they may be conveniently handled without breakage. The maximum lengths of the 8-in. pipe weigh 630 lb., each - averaging 105 lb. per foot.

As the ashes are conveyed in the pipe, moving at a high velocity and in suspension, it is of utmost importance to provide easily renewable wear liners where they impact at the bends. Specially designed fittings are provided and arranged in such position that the liners may by replaced without disconnecting the system. Covers are advantageously placed for the purpose of holding the liners while other covers are provided for inspection, thus avoiding the possibility of any damage being done due to worn out replaceable parts. The liners are constructed of a specially hard chilled white

cast iron and afford the maximum resistance to wear.

Reinforced extensions are used beyond each bend, providing an economical method of replacing sections worn by the ashes. The amount of wear in the system is proportional to the amount of ashes removed and the distance between the disposal point and the ashpits, because of the difference in the velocity of the air necessary for the conveyance of the ash within the pipe.

The efficiency of the steam jet ash conveyor is based on the quantity of steam used per ton of ashes removed. When a small nozzle is used, or when only a low nozzle-pressure is obtainable, the vacuum within the conveyor pipe is correspondingly low. A slightly larger nozzle, or increased steam pressure, increases the total quantity of ashes removed. The pounds of steam per ton of ashes required

becomes a minimum when a man feeds the ashes to the intake at normal speed.

In long suction lines the nozzle located at the base of the riser creates insufficient vacuum at the intakes located at the farther end of the line. This vacuum loss is due to the frictional resistance offered by the walls of the pipe to the high velocity air currents. The straight line steam unit or booster, has been found to be a practical remedy. This fitting is generally located midway between the riser and the farther end of the suction line, spaced about 50 ft. from the main steam unit. The booster has two nozzles of a size large enough to create sufficient vacuum in the suction line behind. The use of the small nozzles in the booster allow for a smaller nozzle at the base of the riser than would be otherwise required. This effects a minimum maintenance and a more satisfactory

operation of the system, and is recommendable, although it would seem that one larger rather than three smaller nozzles would be more efficient.

There are instances where this type of ash conveyor has not conformed to plant conditions. These cases generally are in boiler plants where an exceedingly large quantity of coal is consumed or a low pressure is maintained. This equipment has been found to be adaptable to nearly all manufacturing and steam generating plants. To keep down the time element and the maintenance, limitations for any one system have been restricted to approximately 50 tons of ashes removed in 24 hours. In the larger stations it is advisable to install more than one system, each properly arranged to receive its percentage of the ashes.

TABLE III. FUEL COST PER 1000 LB. OF STEAM

	COST OF COAL PER TON				
LB. STEAM PER LB. COAL	$2.00	$2.50	$3.00	$3.50	$4.00
4	0.250	0.312	0.376	0.438	0.500
5	0.200	0.250	0.300	0.350	0.400
6	0.166	0.208	0.250	0.292	0.334
7	0.142	0.178	0.214	0.250	0.284
8	0.126	0.156	0.186	0.218	0.250
9	0.113	0.142	0.170	0.196	0.222

	$4.50	$5.00	$5.50	$6.00
4	0.562	0.625	0.687	0.750
5	0.450	0.500	0.550	0.600
6	0.375	0.417	0.458	0.500
7	0.321	0.357	0.393	0.429
8	0.281	0.312	0.344	0.375
9	0.250	0.284	0.312	0.340

Examples of successful systems representative of operating costs are cited as follows:

1. From the LaSalle Hotel, Chicago, Illinois, Walter Bird, Chief Engineer, volunteers the following information pertaining to his plant: Six-inch steam jet conveyor purchased in 1913 at an initial cost of $572.00. The average coal consumption is 42 tons per day and analyses show 12% refuse. The time required to remove the daily average quantity 4.8 tons of ashes is 1-1/2 hours. One 5/8 in. nozzle is used, operating at 150 lb. boiler pressure. Referring to Table I, 43.3 lb. of steam per min. is discharged from the nozzle. In 90 minutes, the steam consumption is 3897 lb., which reduces to 812 lb. per ton of ash. At the present writing (March 10, 1919), the cost of the steam in

this plant is 35¢ per 1000 lb., so that the steam cost per ton of ashes removed is 28.4¢.

The average maintenance per year equals $50.00, averaging 2.88¢ per ton of ash. Interest at 6% on $572.00 amounts to $34.32 or 2¢ per ton of ash. Thus the operating cost per ton exclusive of labor is 33.28¢. One man is retained exclusively for the removal of ashes, at a salary of $75.00 per month. When not actually operating the system his duties consist in the removal of ashes from the bin into industrial cars, which are hauled through the subway; cleaning of ashpits and miscellaneous boiler room duties. The above salary reduces to 52¢ per ton of ash handled. Only 20% of this in amount $10.40 should be charged directly against operation of the system and the balance to incidental boiler room expense. Adding the direct labor charge increases

the cost per ton ash handled to 43.68¢.

Mr. Bird states that the cost of the ash removal previous to the installation of this system was considerably higher than the contained figures. He is perfectly satisfied with the results and feels that the plant could not get along satisfactorily without it, as this particular type of apparatus conforms to the conditions at the hotel.

2. A large power station desires to remove part of its ashes through a steam jet ash conveyor, with the intention of building a 60-ton concrete bin on a pile trestle paralleling the banks of a river. The original investment of $10,000 is to include a steam jet ash conveyor, a 60-ton concrete bin, piling for the concrete bin, repairs or rebuilding of dock fill, etc.

The boilers served will produce about

15 to 18 tons of ashes per day or a total of 6570 tons per year. The boiler pressure equal 125 lb. per square inch and the nozzle pressure 115 lb. per square inch. The nozzles used are one 11/16-in. at the base of the riser and two 5/16-in. at the booster. The latter is used one-half of the time required for the total operation of the system, so that from Napier's formula the average steam used equals 50 lb. per minute, or 3000 lb. per hour. The system will remove 6 tons of ashes per hour and will require 500 lb. of steam per ton of ash removed. The cost per ton of ash may be summarized:

Steam, 500 lb. at 30c per 1000 lb.	$0.15
Labor, $4 for 8hr. & 6 tons per hr.	0.08
Interest on investment, 6%.......	0.09
Maintenance......................	0.03
Depreciation.....................	0.02
Total cost per ton...............	0.37

3.It has been decided experimentally that a system which has a suction line not longer than 60 ft., a riser of 50 ft., or less and a horizontal discharge of 50 ft., and boiler pressure of 150 lb. per sq. in. will remove approximately six tons of ashes per hour, using a 5/8 in. nozzle at the base of the riser. This quantity is determined by a speed sufficient to conveniently keep the ashes in motion without the probability of overloading the system. A steam consumption of 43.3 lb. per minute would be required, or 433 lb. per ton of ashes removed.

With steam costing 30c per 1000 lb.,the steam charge per ton of ash would be 13¢. The charge for maintenance should not exceed 2-1/2¢ per ton. Labor charged against actual operation of the system would be 8-1/3¢ per ton, based on a wage of $4 per 8-hour day.

4. In the new Northwestern Elevator at South Chicago, operated by the Armour Grain Co., two systems have been installed, one under each row of boilers. They have been in operation since March 1918. The boilers are of the Stirling type operating at 200 lb, pressure and 150° superheat, equipped with Westinghouse forced-draft underfeed stokers. The average coal consumption is 56 tons per 24 hours. The quantity of ash removal per day amounts to 8.4 tons, on a 15% basis. Its removal requires the use of steam for a total of three hours in both systems. The cost of coal is $4.50 per ton at the bunker and the highest evaporation is 9 lb. of water per pound of coal. The fuel cost per 1000 lb. of steam would be 25¢. One 1/2-in. nozzle at 200 lb. pressure uses 36.13 lb. of steam per minute. Per ton of ash the steam requirement would then be 774 lb., and the steam fuel

cost 19.35¢. There have been no maintenance charges since the installation has been in operation. The time of one man is exclusively required to remove the ashes.

ADVANTAGES OF THE STEAM JET ASH CONVEYOR

Labor saving - This apparatus eliminates considerable labor, as its operation requires the service of but one man. The wheelbarrow method is eliminated. There has been too much interference between firemen and ash men in most plants. The method of wheeling out and discharging the ashes upon the ground near the boiler room has been found unsatisfactory. Additional labor is also required in the shoveling of the ashes from the ground on to wagons or trucks.

Difference of Elevation - Where there is a difference of elevation between the boiler room floor and the disposal point the ashes are handled in one operation. Office build-

ings and industrial plants necessitating the elevation of the ashes have given this point consideration.

Use of Steam. - The steam could be restricted to periods of light loads or sudden throwing off of heavy loads, that is, noon and evening, in a manufacturing plant. The load curve would determine the convenient time. It is considered more economical to utilize the steam at these periods than to allow its escape to the atmosphere through safety valves.

Railroad Car Discharge. - When it is essential to discharge ashes into a railroad car because of the lack of ash storage facilities, the steam jet ash conveyor is an economical type of apparatus to employ. The removal from the bin into the cars is generally easily accomplished. The time for filling a car varies from 15 to 60

minutes, according to the condition of the ash and the temperature of the outside atmosphere.

DISADVANTAGES OF THE STEAM JET ASH CONVEYOR

Utilization of Live Steam. - The operation of the system depends fundamentally on the expandability of live steam directly from the boilers. Inasmuch as the steam is discharged into the atmosphere it is wasted and should be charged against the operation of the system.

High Pressures Required. - A boiler pressure of over 75 lb. per sq. in. must be continually maintained for economical operation. It has been found that heating plants operating on a pressure less than stated require an exceedingly large nozzle, and inasmuch as there is considerable condensation in a plant of this character, the

results obtained have been unsatisfactory.

Nozzle Diameter Must be Correct. - A boiler plant operating with a variable boiler pressure in either direction means either a waste of steam due to increased capacity or sluggishness of operation should the boiler pressure drop. The nozzles as installed by the engineer are correct only for a constant boiler pressure, and conform to the conditions at the time they are installed. The nozzle is located in the main steam unit and is not readily interchangeable.

Dryness of Ashpit and Ashes. - The boiler room operator must keep his ashpit and ashes absolutely dry to secure efficient and economical ash removal.

Time Required. - Large abrasive clinkers must be broken before they can be conveyed into the system. In the operation of the

larger boiler plants considerable preliminary work is required to break the ashes and put them into condition for removal through the system. The fine ashes, dust, soot, etc., cannot be conveyed in the same system designed for larger clinkers, but require a special 3 to 4-in. low-capacity system.

Interruptions due to Plugging. - Plugging of the system frequently occurs, attributed frequently to two clinkers wedging together. Live steam is always required in the removal of ashes when plugged, as there is no way of picking up the vacuum unless the system is in operation when the plug is being removed.

The following illustrations indicate representative and recommendable installations of the suction line for the removal of refuse from the ash pits.

PLATE I.

This installation of Stirling Boiler and Westinghouse forced-draft underfeed stoker actually exists at the Northwestern Elevator, South Chicago, Illinois, operated by the Armour Grain Company.

The clinker is discharged by the dumping mechanism of the stoker, In the ash hopper two large slide gates are provided, allowing the refuse to drop to the tray. The operator stands immediately in front of the system and hoes the ashes into the suction pipe.

The soot conveyor is provided for the removal of combustion ash and soot accumulated and blown from the tubes and mud drum.

PLATE II

A typical representation of a chain grate stoker and Stirling Boiler. The position of the ash conveyor can be located in either location as shown in accordance with the quantity desired for removal. The soot conveyor has been used in actual practice and found particularly adaptable for this type of boiler.

PLATE III

A B & W cross-baffled boiler and forced-draft underfeed stoker is represented. The operation of the ash conveyor is very convenient, as considerable of the refuse will avalanche into the system when the ash pit door is opened. The soot conveyor is particularly advantageously located. This type of installation is entirely self-cleaning from both an ash and soot standpoint.

PLATE IV

This illustration offers a suggestion for flexibility in ash, soot and sifting conveyance. Inasmuch as a Riley Stoker sifts to some extent, the siftings are allowed to accumulate and may be discharged directly into the coal bunkers above.

PLATE V

The labor saved through the installations of ash conveyors in connection with the Murphy type of stoker has proven remarkable in nearly all instances. The clinker grinder allows the refuse to discharge into the ash pit in quantities of suitable size to be readily removed through the system.

PLATE VI

The ash conveying system in connection with a Roney Stoker is not always profitable because of the large quantity of siftings mixing with the ashes and being frequently discharged through the apparatus. However, this stoker has not been on the market recently and the steam jet ash conveyor is only considered in the stokers operating for some time.

The soot conveyor proposal indicates that the boiler would be entirely self-cleaning should a soot blower be installed.

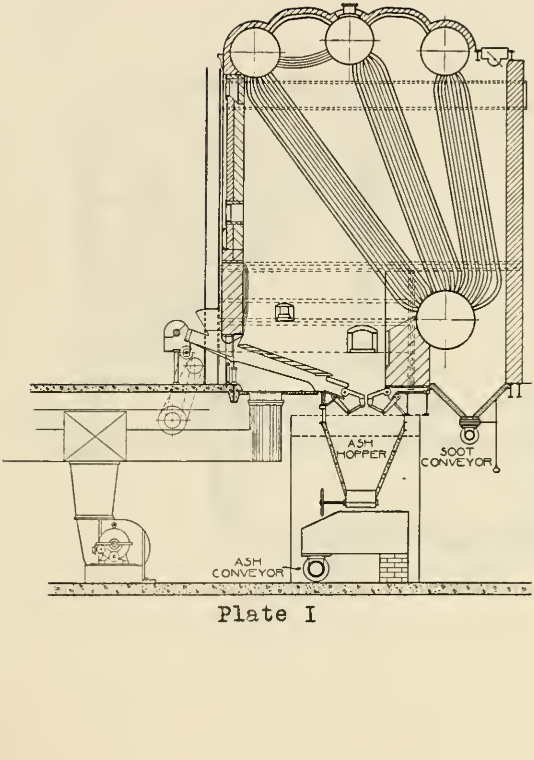

Plate I

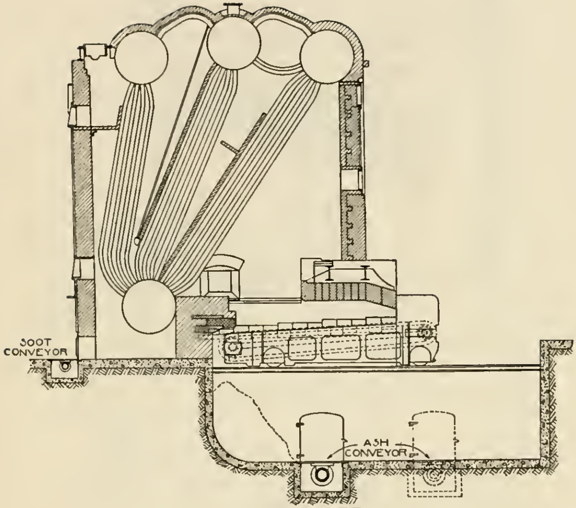

Plate II

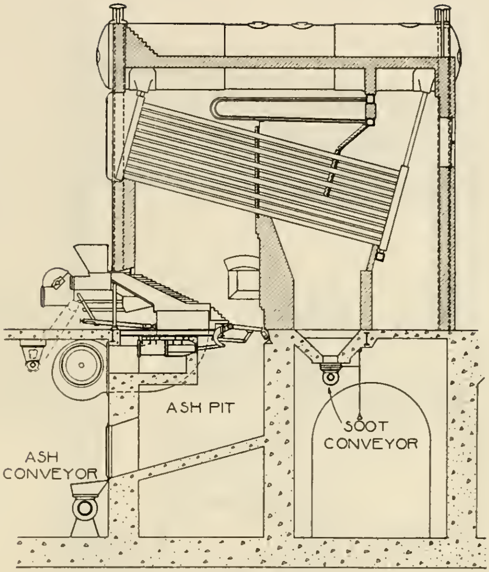

Plate III

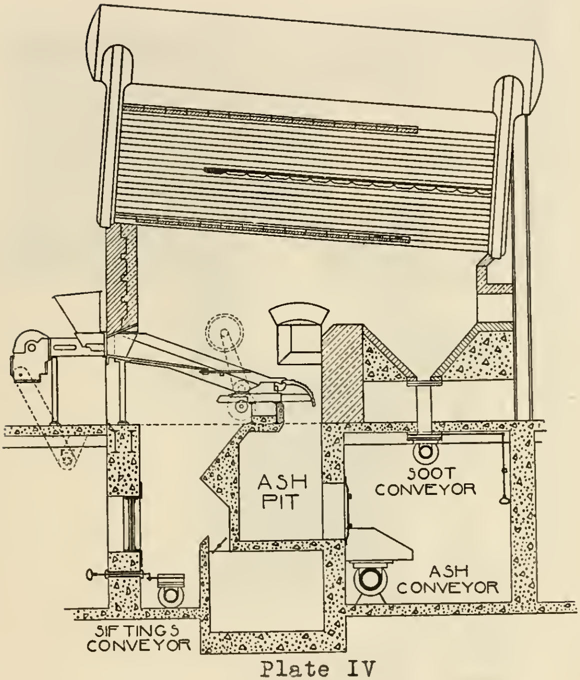

Plate IV

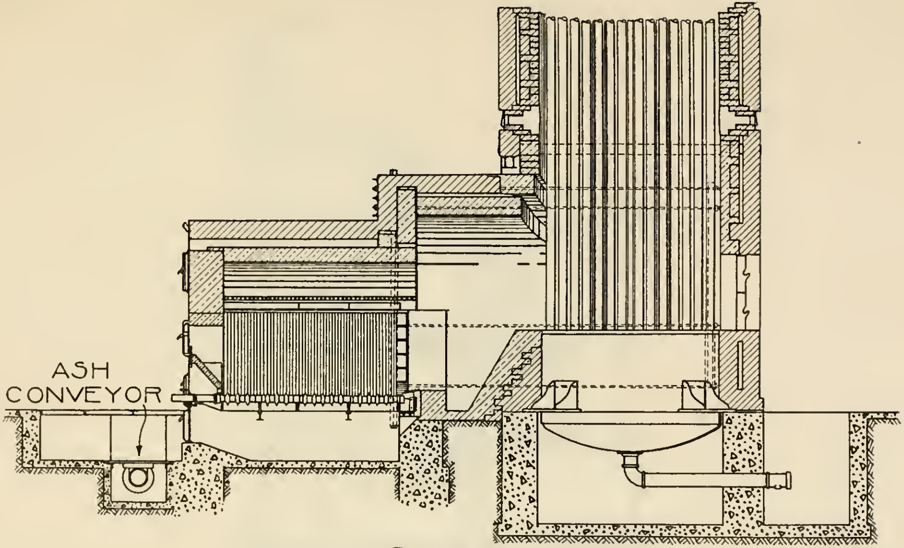

Plate V

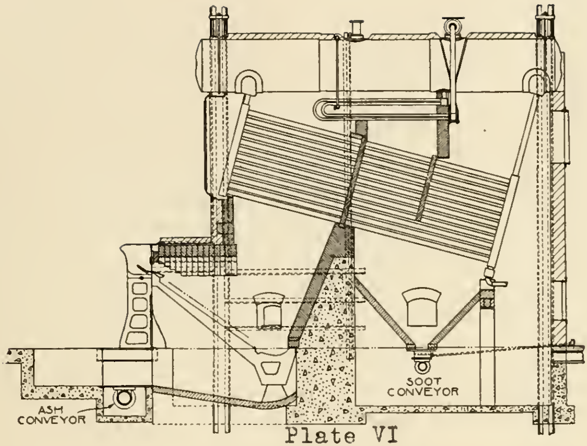

Plate VI