

April 19, 1938.

G. P. WARD

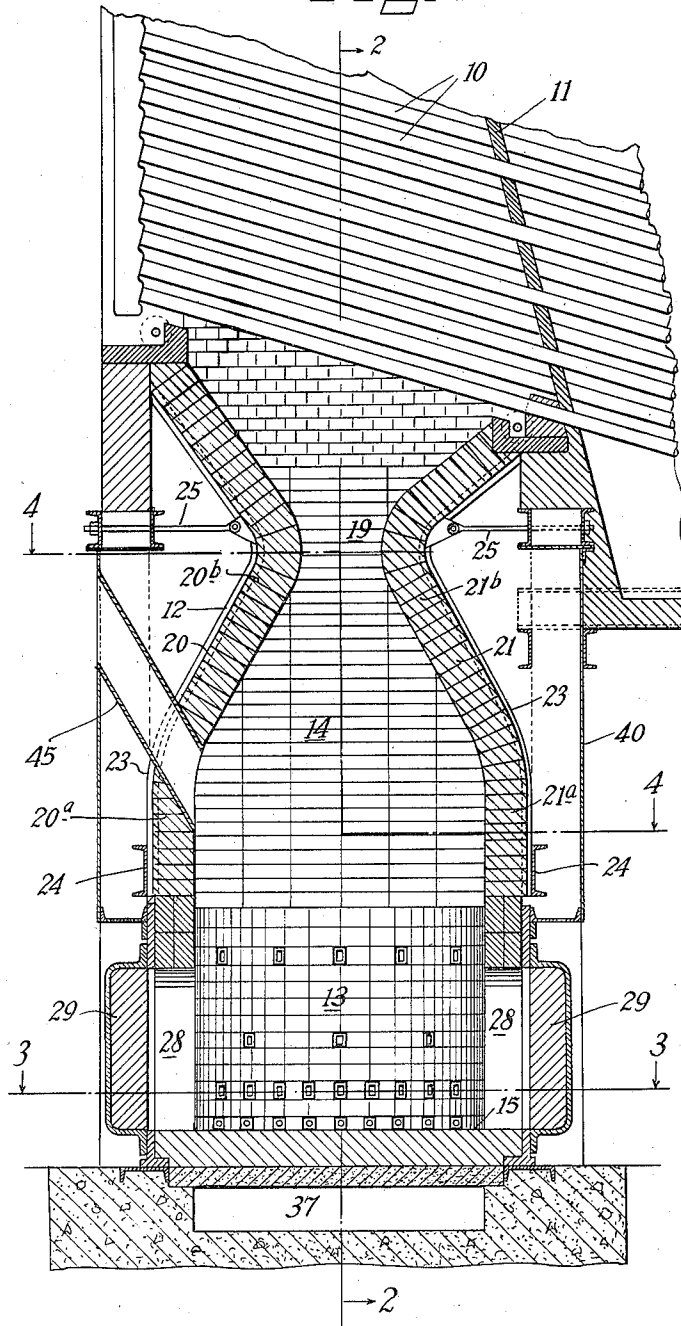
2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 1

Fig. 1



INVENTOR.  
George P. Ward  
BY *Ben R. Kautz*  
ATTORNEY.

April 19, 1938.

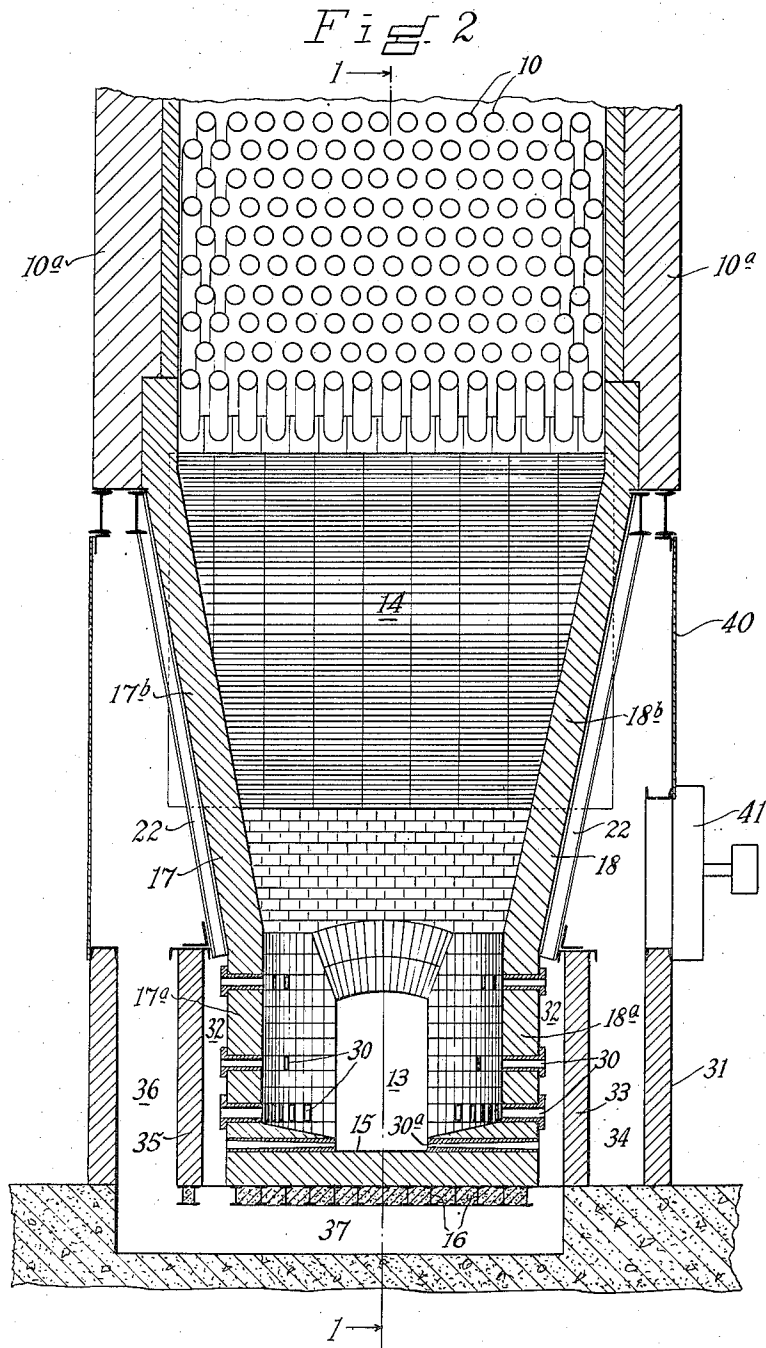
G. P. WARD

2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 2



INVENTOR.  
George P. Ward  
BY *Benj. R. Kewenau*  
ATTORNEY.

April 19, 1938.

G. P. WARD

2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 3

Fig. 3

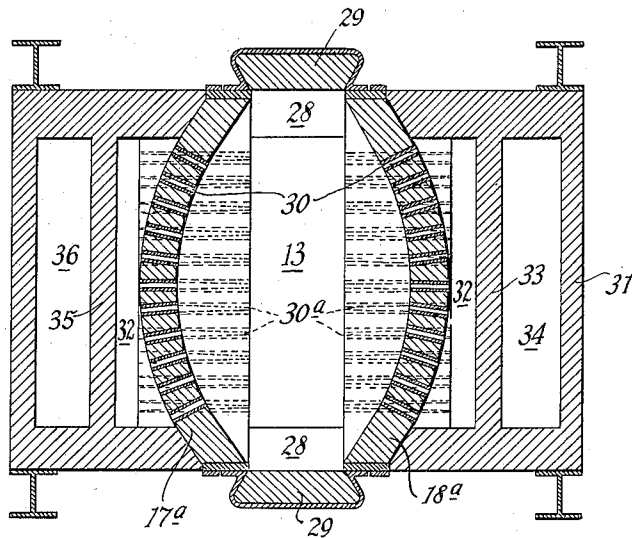
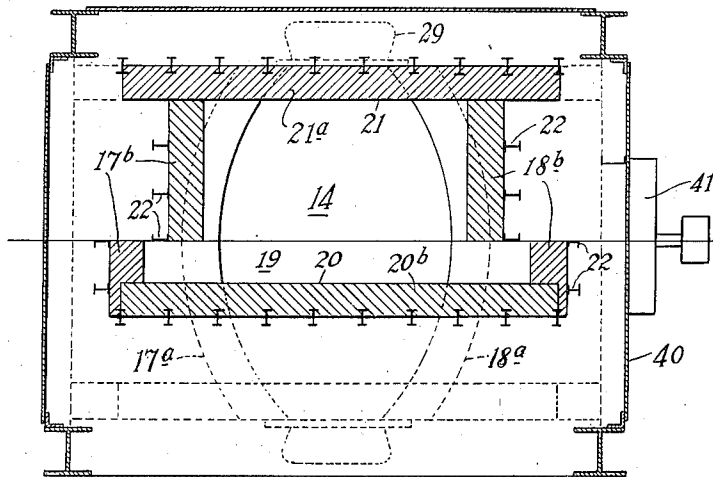


Fig. 4



INVENTOR.  
George P. Ward  
BY *Raymond M. Newcomb*  
ATTORNEY.

April 19, 1938.

G. P. WARD

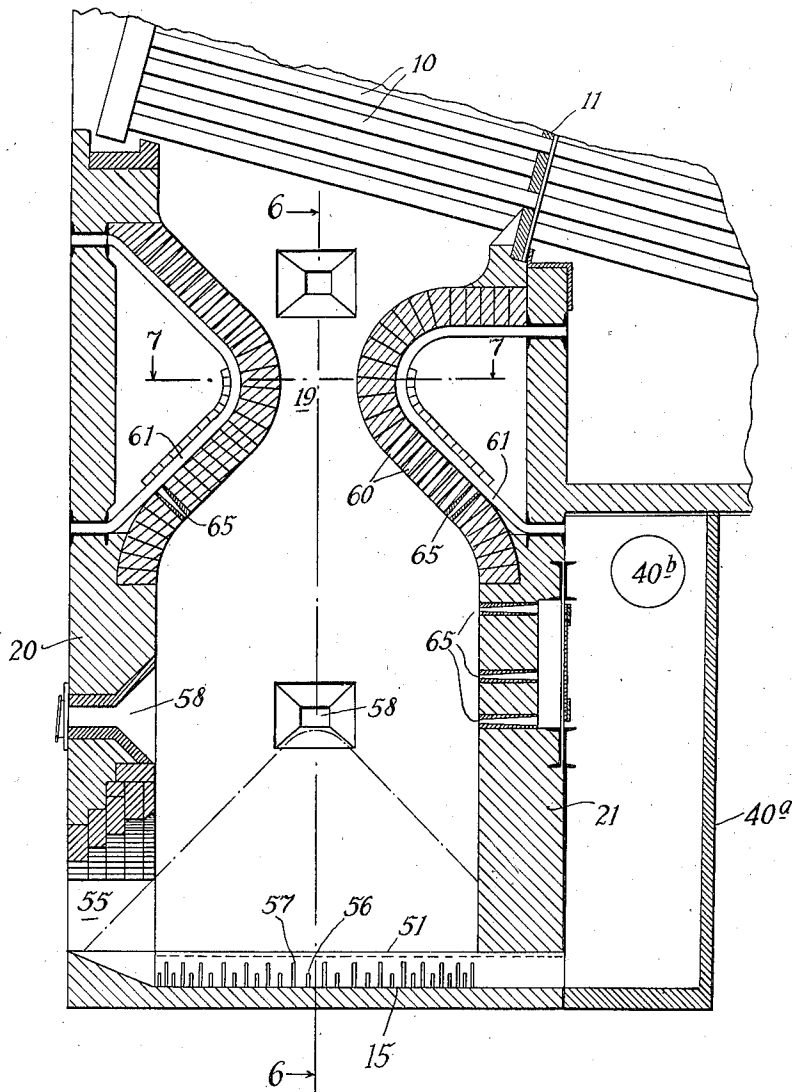
2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 4

Fig 5



INVENTOR.

George P. Ward

BY

Paul R. Kucak

ATTORNEY.

April 19, 1938.

G. P. WARD

2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 5

Fig. 7

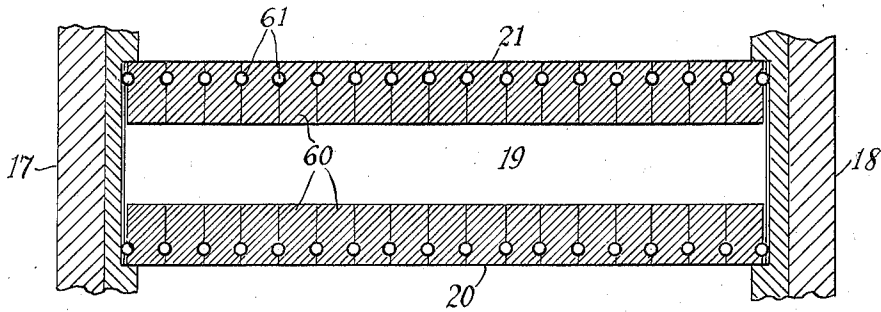
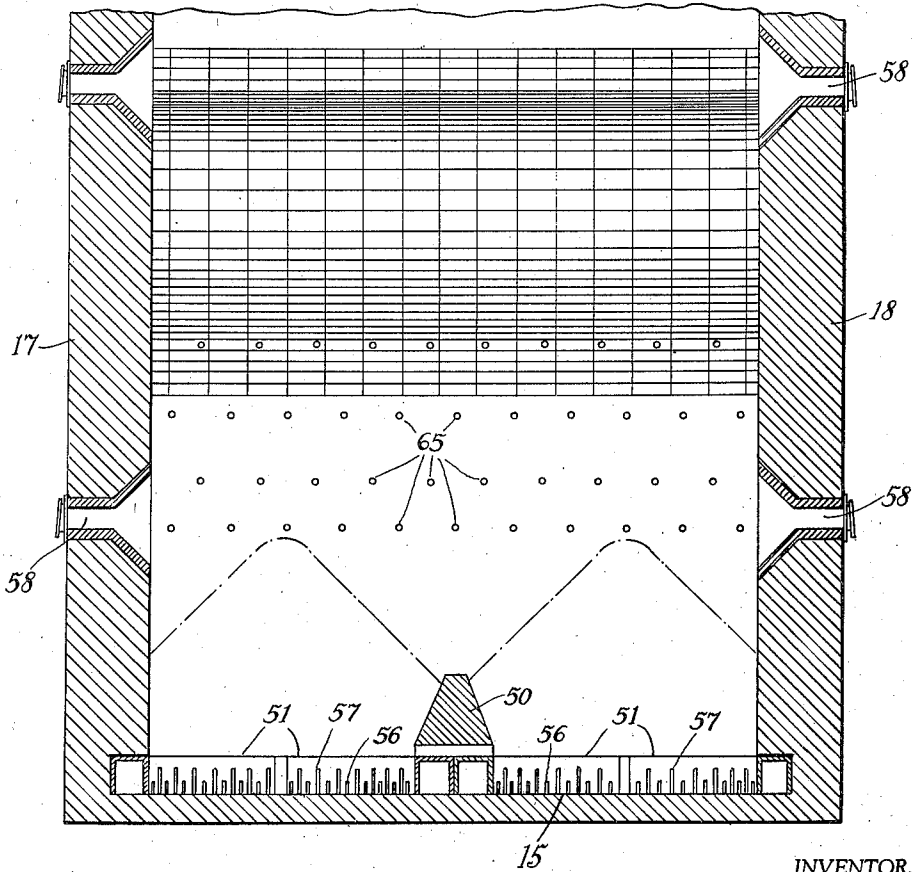


Fig. 6



INVENTOR.  
George P. Ward  
BY *Raymond R. Newcomb*  
ATTORNEY.

April 19, 1938.

G. P. WARD

2,114,619

APPARATUS FOR BURNING BAGASSE AND LIKE FUELS

Filed Dec. 23, 1936

6 Sheets-Sheet 6

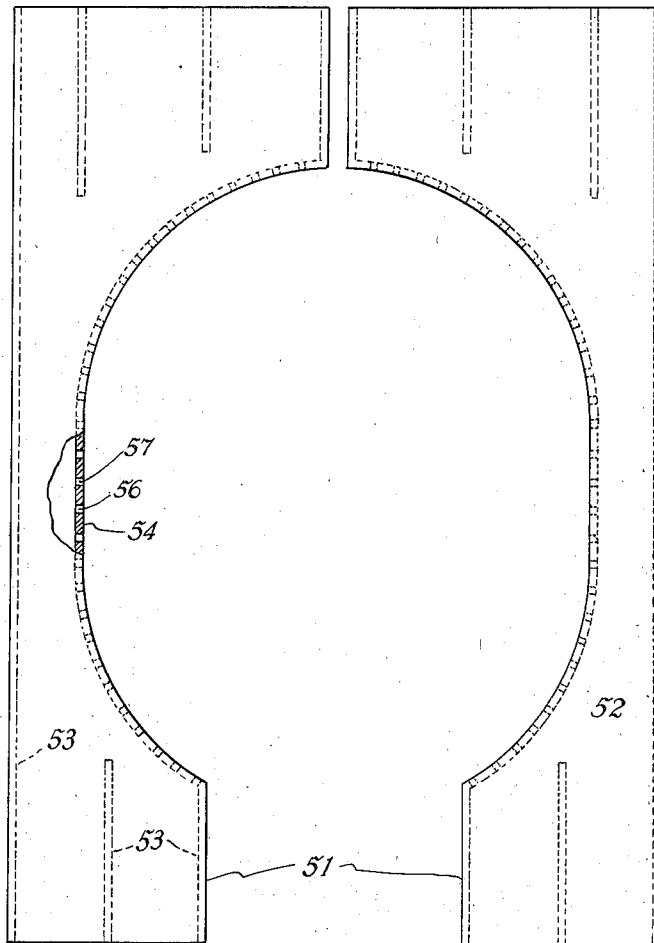


Fig. 8

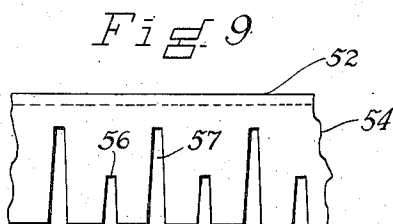


Fig. 9

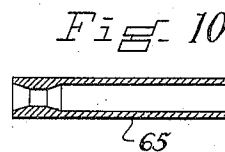


Fig. 10

INVENTOR.  
George P. Ward  
BY *Earl R. Newcomb*  
ATTORNEY.

## UNITED STATES PATENT OFFICE

2,114,619

APPARATUS FOR BURNING BAGASSE AND  
LIKE FUELS

George P. Ward, Marianao, Cuba, assignor to The  
Babcock & Wilcox Company, Newark, N. J., a  
corporation of New Jersey

Application December 23, 1936, Serial No. 117,320  
In Cuba March 24, 1936

9 Claims. (Cl. 110-7)

This invention relates in general to the construction and operation of vapor generators especially adapted for the burning of bagasse and similar high moisture fuels, and more particularly to the construction and relative arrangement of the furnace portion of such units.

In my prior joint patent with H. G. Gregory, No. 1,952,010, is illustrated a general type of refractory furnace which is in extensive use in such generating units. In these units the furnace is arranged mainly at one side of a steam boiler so that the main combustion chamber is effectively screened from the heat absorbing surface of the boiler by a bridgewall and a drop nose arch, beneath which the burning gases pass and turn upwardly into the steam boiler. This furnace construction and arrangement was considered essential for the maintenance of satisfactory combustion conditions with fuels having the high percentage of moisture which bagasse contains when delivered to the furnace directly from the mill. This construction and relative arrangement of the furnace with respect to the steam boiler has many inherent practical disadvantages, such as large floor space requirements, high first cost and maintenance due to the expensive roof, arch and bridgewall construction, and substantial radiation losses. While such disadvantages are recognized as substantial, they are usually considered of secondary importance when compared to the cost and inconvenience of the shutdown periods required every few days to remove the ashes from the furnace. Frequent cleaning, particularly of the portion of the combustion chamber below the nose portion of the arch is required because of the abrupt change of direction of the gases while passing through this section and the consequent substantial deposition of fly ash therein.

The main object of my invention is the provision of an improved vapor generating unit for burning bagasse and like fuels which is particularly characterized by the arrangement of a vertical furnace directly below the first gas pass of the steam boiler whereby a substantial reduction in radiation losses, floor space requirements, initial cost, maintenance and operating cost is effected, increased efficiency and capacity obtained, and ash accumulations in the furnace reduced to such an extent that the period between cleaning operations may be greatly increased.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of my invention.

Of the drawings:  
Fig. 1 is a vertical section taken on the line 1-1 of Fig. 2 of a bagasse furnace constructed in accordance with my invention;  
Fig. 2 is a vertical section taken on the line 2-2 of Fig. 1;  
Figs. 3 and 4 are horizontal sections taken on the lines 3-3 and 4-4 of Fig. 1 respectively;  
Fig. 5 is a view similar to Fig. 1 illustrating a modified furnace construction;  
Fig. 6 is a vertical section taken on the line 6-6 of Fig. 5;  
Fig. 7 is a horizontal section taken on the line 7-7 of Fig. 5;  
Fig. 8 is a plan view of the furnace base plates shown in Figs. 5 and 6 with a part broken away and in section;  
Fig. 9 is a side view of a portion of one of the base plates; and  
Fig. 10 is a longitudinal section through one of the tuyères used in the modified construction.

The vapor generating unit illustrated in Figs. 1-4 comprises a steam boiler of the Babcock & Wilcox type having a relatively narrow bank of horizontally inclined steam generating tubes 10 within a setting having refractory side walls 10<sup>a</sup>. An inclined vertical baffle 11 cooperates with the headers at the upper end of the tube bank to form the first gas pass across the tube bank. In accordance with my invention a refractory walled vertical furnace 12 of substantial height is arranged directly below the tube bank with the furnace outlet registering with the first gas pass of the boiler. The furnace may be considered as divided into a lower hearth section 13 and an upper throat section 14. The hearth section is of internal elliptical cross-section while the throat section is of rectangular cross-section, as indicated in Figs. 3 and 4.

The furnace is defined by a flat refractory floor or hearth 15 supported on I-beams 16, a pair of oppositely arranged refractory side walls 17 and 18 having lower convex portions 17<sup>a</sup> and 18<sup>a</sup> respectively defining opposite sides of the hearth section and upper diverging inclined portions 17<sup>b</sup> and 18<sup>b</sup> respectively defining opposite sides of the throat section, and a pair of oppositely arranged front and rear refractory walls 20 and 21 respectively having lower vertical sections 20<sup>a</sup> and 21<sup>a</sup>

55

respectively between which the side walls 17 and 18 extend, and upper portions 20<sup>b</sup> and 21<sup>b</sup> respectively first symmetrically converging to define a transversely elongated furnace throat 19 and then diverging at a relatively steep angle to form a flaring outlet from the furnace. The wall portions 17<sup>b</sup> and 18<sup>b</sup> are supported on inclined I-beams 22 and the walls 20 and 21 by I-beams 23 held in position by channels 24 and rod supports 25 extending from the boiler supporting steel work. The front and rear ends of the hearth section are provided with relatively large access openings 28 closed by doors 29.

The walls 17<sup>a</sup> and 18<sup>a</sup> of the hearth or fire box section of the furnace have vertically spaced rows of tuyères 30 extending therethrough and arranged normal to the inner side of the corresponding wall, as shown in Figs. 1-3. As shown in Figs. 2 and 3, at opposite sides of the hearth section is provided a refractory chambered structure 31 having passages 32 alongside of the side wall portions 17<sup>a</sup> and 18<sup>a</sup> which are closed at their upper ends and communicate with the outer ends of the tuyères 30. Alongside the passage 32 adjacent the wall 18<sup>a</sup> and separated by a wall 33 is a similarly shaped larger chamber 34 closed at its lower end. Along the side wall portion 17<sup>a</sup> and separated by a wall 35 from the corresponding passage 32 is a similar chamber 36 opening at its lower end to a chamber 37 below the floor. The lower ends of the passages 32 open to the chamber 37. A steel casing 40 entirely surrounds the throat section of the furnace from the chambered structure 31 to the boiler setting. A blower 41 is mounted in the casing wall adjacent the chamber 34, so that air is forced around the throat section and then down through the chamber 36 to the chamber 37, from which it passes upwardly through the passages 32 to the tuyères 30. The air for combustion is thus preheated by and cools the furnace walls and is discharged by the tuyères in a multiplicity of spaced high velocity horizontal streams into the hearth section over a substantial portion of its wall area.

Bagasse is fed to the furnace through an inclined chute 45 which extends through the casing 40 and the front furnace wall 20. The bagasse falls onto the furnace floor 15 and accumulates thereon in a substantially conical low pile. Preheated combustion air is discharged into the base of the fuel pile through the lowermost tuyères 30<sup>a</sup> and towards the sides of the pile through the upper tuyères. In normal operation combustion will take place at a rapid rate and a relatively high furnace temperature can be easily maintained due to the refractory wall surface enclosing the furnace chamber and the relatively high radiating effect from the converging wall portions 20<sup>b</sup>, 21<sup>b</sup> to the burning fuel. The symmetrical arrangement of the furnace walls relative to the hearth facilitates the maintenance of a hot furnace as substantially all of the heat radiated inwardly contributes to this effect. The heat radiated inwardly by the diverging portions of the walls 20, 21 is mainly absorbed by the boiler tubes. The furnace wall arrangement also eliminates any pockets wherein separated ash might collect and provides in effect a self-cleaning furnace. The arrangement also provides a relatively straight vertical flow path for the heating gases, minimizing the pressure drop through the furnace and avoiding the presence of eddy currents. Stratification of the ascending gases is minimized by the successive

restricting and expanding actions of the furnace throat. The throat also facilitates the mixing and combustion of any unburned gases tending to escape from the lower furnace section. The full volume of the furnace chamber is thus utilized for combustion purposes. The throat size is designed to permit a predetermined amount of radiant heat transfer from the furnace to the superposed boiler tube bank while preventing radiation in an amount which would result in excessive cooling of the furnace. A throat length about one-quarter the hearth length, as shown in Fig. 1, has been found suitable. The relative furnace arrangement has been found to also reduce the pressure drop through the furnace, provide a more uniform heat output and greater flexibility and ease of control, permit the use of fewer operators, and results in a substantial increase in the overall efficiency of the unit. These operating advantages in a furnace having a lower cost of construction and maintenance and a substantially longer interval between cleaning periods are of great practical importance in the burning of high moisture fuels. In one test of a boiler unit such as illustrated, bagasse having 48% moisture was successfully burned with only 25% excess air and at 165% rating and the boiler and furnace efficiency found to be 66%.

In Figs. 5-10 is illustrated a modified construction in which two hearths are used in the furnace below a single tube bank. In this construction the floor 15 is rectangularly shaped and divided into two rectangular sections by a fire brick wall 50. A pair of similar cast iron base plate members 51 are arranged in spaced relation in each floor section. Each base plate has a flat upper surface 52 supported on parallel leg flanges 53 and a concavely curved leg flange 54 along its inner side. The plates are arranged so that the curved flanges 54 define a substantially elliptical hearth area open at its front end in register with the bottom of the door opening 55. The curved leg flanges have a multiplicity of upwardly tapered narrow slots 56 and 57 of staggered heights through which air delivered to the underside of the base plates will discharge into the relatively low conical fuel pile resting on the hearth and base plates, as indicated in broken lines in Figs. 5 and 6. Bagasse may be supplied through all or part of the openings 58 in the side and end walls of the furnace.

As shown in Figs. 5 and 7, the lower part of the throat front and rear walls is formed by the tile 60 which are supported by bent pipes 61 having their ends fixed in position. Additional air is supplied to the furnace through tuyères 65, of the form shown in Fig. 10, arranged in vertically spaced rows along the rear wall and in single rows in the front and rear walls below the throat. Combustion air is delivered to the tuyères 65 and interior of the base plates 51 from a casing 40<sup>a</sup> along the rear wall 21. The casing has an air inlet 40<sup>b</sup>.

The operation of the modified construction is substantially the same as that shown in Figs. 1-4. Each of the fuel piles receives an adequate supply of combustion air to its base with additional secondary air supplied above the normal fuel level and below the throat 19. The use of metallic base plates of the type described is advantageous in reducing the amount of floor space required for the separate hearths. The division of the fuel between separate hearths substantially increases the combustion rate and provides more uniform furnace conditions.

While in accordance with the provisions of the statutes I have illustrated and described herein the best forms of my invention now known to me, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features. In the claims the term "bagasse" is intended to generically cover bagasse and similar high moisture content fuels.

I claim:

1. A vapor generator comprising a setting, a bank of inclined vapor generating tubes within said setting, a single pass furnace for burning bagasse having pairs of opposite refractory walls defining a lower hearth section and a superposed throat section, a floor at the bottom of said hearth section, an opening in one of said refractory walls for the introduction of bagasse onto said floor in a substantially conical pile, means for supplying streams of air into the base of said pile of bagasse, one of said pairs of opposite refractory walls converging to form a transversely elongated throat and diverging above said throat to form a flaring chamber directly below a portion of said tube bank, a casing forming air passages surrounding said throat section and communicating with said hearth section, and an access opening in said hearth section at approximately the level of said floor.

2. A vapor generator comprising a setting, a bank of inclined vapor generating tubes within said setting, a single pass furnace for burning bagasse having pairs of opposite refractory walls defining a lower hearth section and a superposed throat section, a floor at the bottom of said hearth section, a metallic plate structure on said floor surrounding a substantially elliptical floor area and having air discharge openings in the sides thereof adjacent said floor area, an opening in one of said refractory walls for the introduction of bagasse onto said floor area, one of said pairs of opposite refractory walls converging to form a transversely elongated throat and diverging above said throat to form a flaring chamber directly below a portion of said tube bank, and an access opening in said hearth section at approximately the level of said floor.

3. In a bagasse furnace, a hearth section having a floor, a pair of complementary plate members on said floor, each plate member having an upper surface supported on flanges including an inner flange having a series of openings therein communicating with the interior of said plate member, said plate members being oppositely arranged with their inner flanges bounding a predetermined floor area therebetween for the accumulation of bagasse.

4. In a bagasse furnace, a hearth section having a floor, a pair of complementary plate members on said floor, each plate member having an upper surface supported on flanges including an inner flange having a series of openings therein communicating with the interior of said plate member, said plate members being oppositely arranged with their inner flanges defining a floor area therebetween for the accumulation of bagasse and being spaced apart at one end for the withdrawal of material from said floor area.

5. In a bagasse furnace, a hearth section having a refractory floor, a pair of complementary metallic plate members on said floor, each plate member having a flat upper surface supported

on spaced leg flanges including an inner curved flange having a series of air discharge openings therein communicating with the interior of said plate member, said plate members being oppositely arranged with their curved flanges defining a curved floor area therebetween for the accumulation of bagasse.

6. In a bagasse furnace, a hearth section having a refractory floor, a pair of complementary metallic plate members on said floor, each plate member having a flat upper surface supported on spaced leg flanges including an inner curved flange having a series of air discharge slots therein communicating with the interior of said plate member, said plate members being oppositely arranged with their curved flanges defining a substantially elliptical floor area therebetween for the accumulation of bagasse.

7. In a bagasse furnace, a hearth section having a refractory floor, a pair of complementary metallic base plate members on said floor, each plate member having a flat upper surface supported on spaced leg flanges including an inner curved flange having a series of upwardly tapered slots therein communicating with the interior of said plate member, said plate members being oppositely arranged with their curved flanges defining a substantially elliptical floor area therebetween for the accumulation of bagasse and being spaced apart at one end for the withdrawal of material from said floor area.

8. A vapor generator comprising a setting, a bank of vapor generating tubes within said setting, a vertically elongated single pass furnace for burning bagasse having pairs of oppositely arranged refractory walls defining a lower hearth section and a superposed throat section arranged directly below a portion of said setting, one of said pairs of oppositely arranged refractory walls having upper portions converging to form a transversely elongated narrow throat and diverging above said throat to form a flaring chamber of substantially less height and volume than the furnace portion below said throat, a refractory floor forming the bottom of said hearth section, an opening in one of said refractory walls below said throat for depositing bagasse onto said floor, means for introducing streams of combustion air through the walls of said hearth section, and an access opening in one of the walls of said hearth section at approximately the level of said floor.

9. A vapor generator comprising a setting, a bank of vapor generating tubes within said setting, a vertically elongated single pass furnace for burning bagasse having pairs of oppositely arranged refractory walls defining a lower hearth section and a superposed throat section arranged directly below a portion of said setting, one of said pairs of oppositely arranged refractory walls having upper portions converging to form a transversely elongated narrow throat and diverging above said throat to form a flaring chamber of substantially less height and volume than the furnace portion below said throat, a refractory floor forming the bottom of said hearth section, an opening in one of said refractory walls below said throat for depositing bagasse onto said floor, combustion air inlet openings through the walls of said hearth section, and air casing surrounding said throat section and communicating with the air inlet openings to said hearth section, and an access opening in said hearth section at approximately the level of said floor.

GEORGE P. WARD.