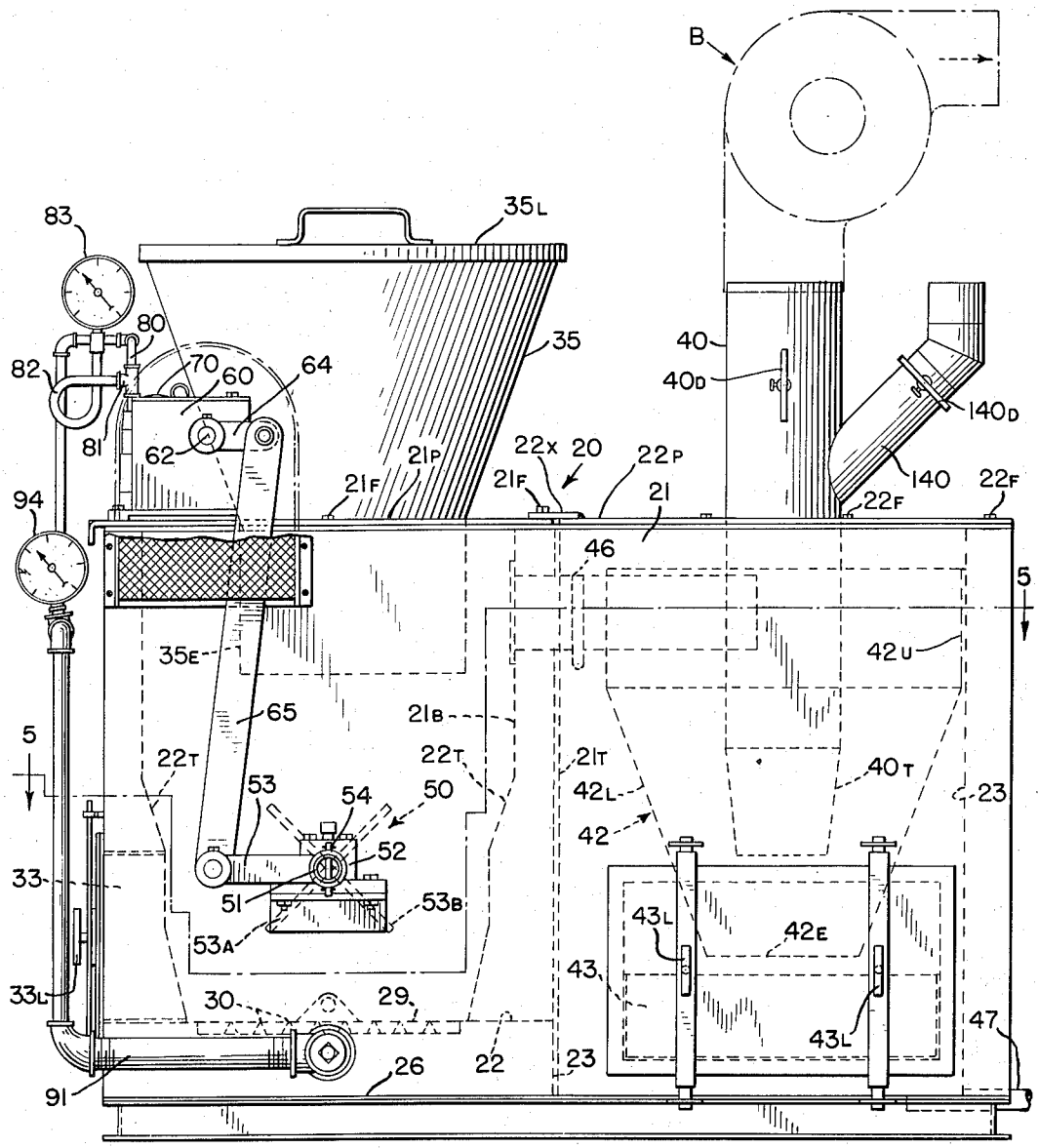
Jan. 31, 1956 S. R. PORWANCHER ET AL 2,732,837

SMOKE GENERATOR

Filed March 3, 1952 6 Sheets-Sheet 1

FIG. 1



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DAVID WEISSMAN

BY:
Wallace and Cannon

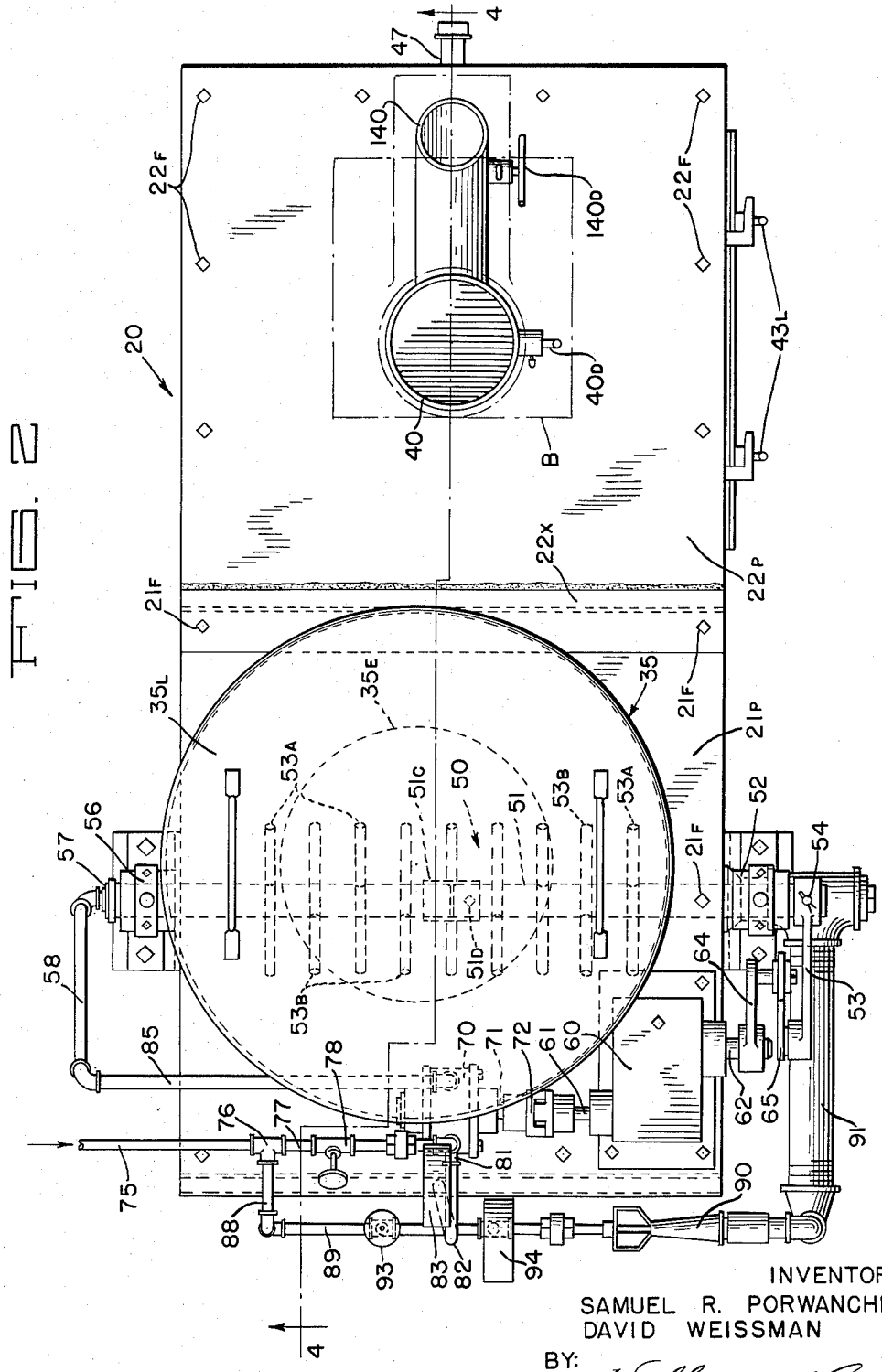
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SMOKE GENERATOR

Filed March 3, 1952 6 Sheets-Sheet 2

FIG. 2



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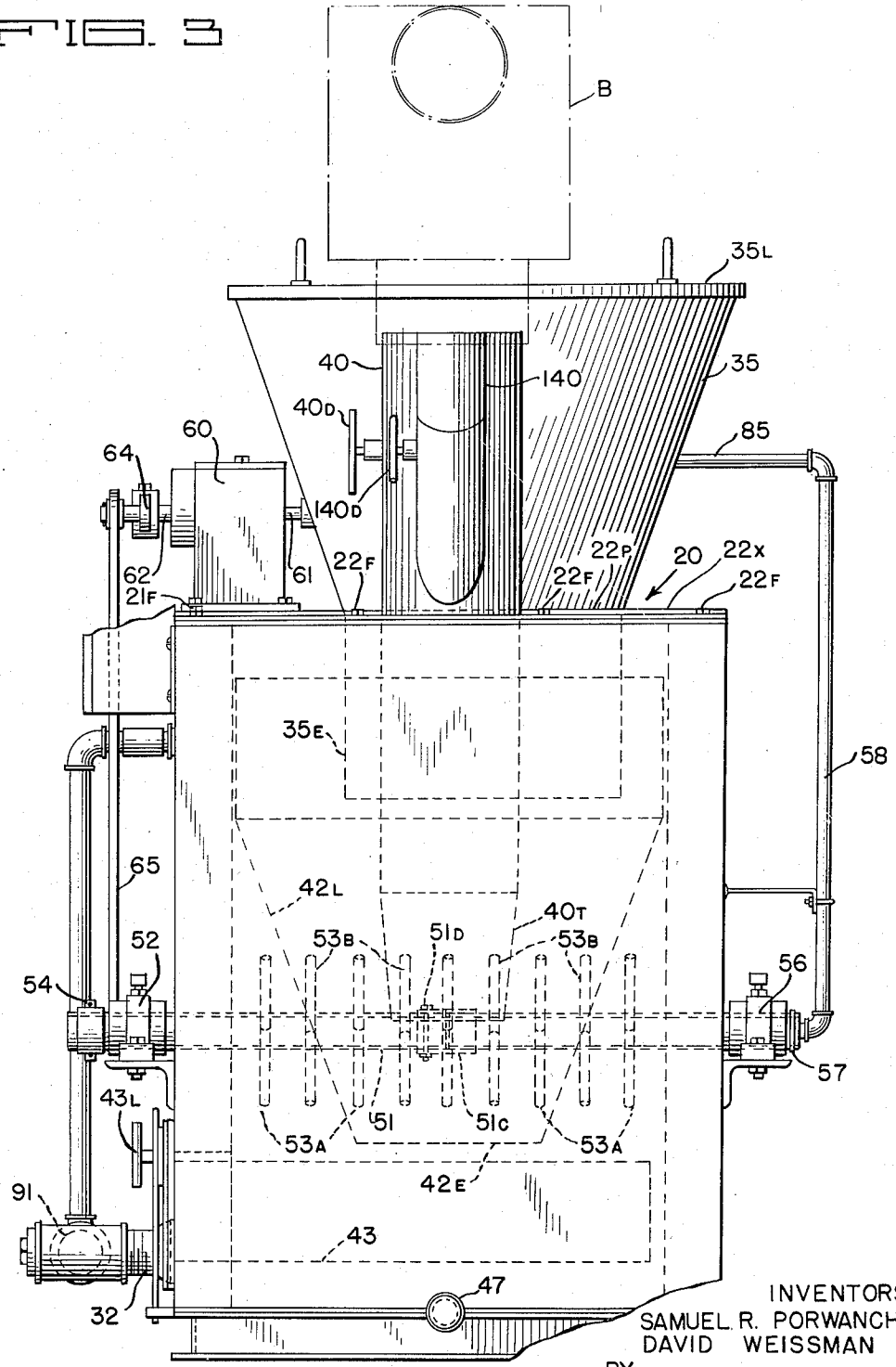
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SMOKE GENERATOR

Filed March 3, 1952 6 Sheets-Sheet 3

FIG. 3



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SMOKE GENERATOR

Filed March 3, 1952 6 Sheets-Sheet 4

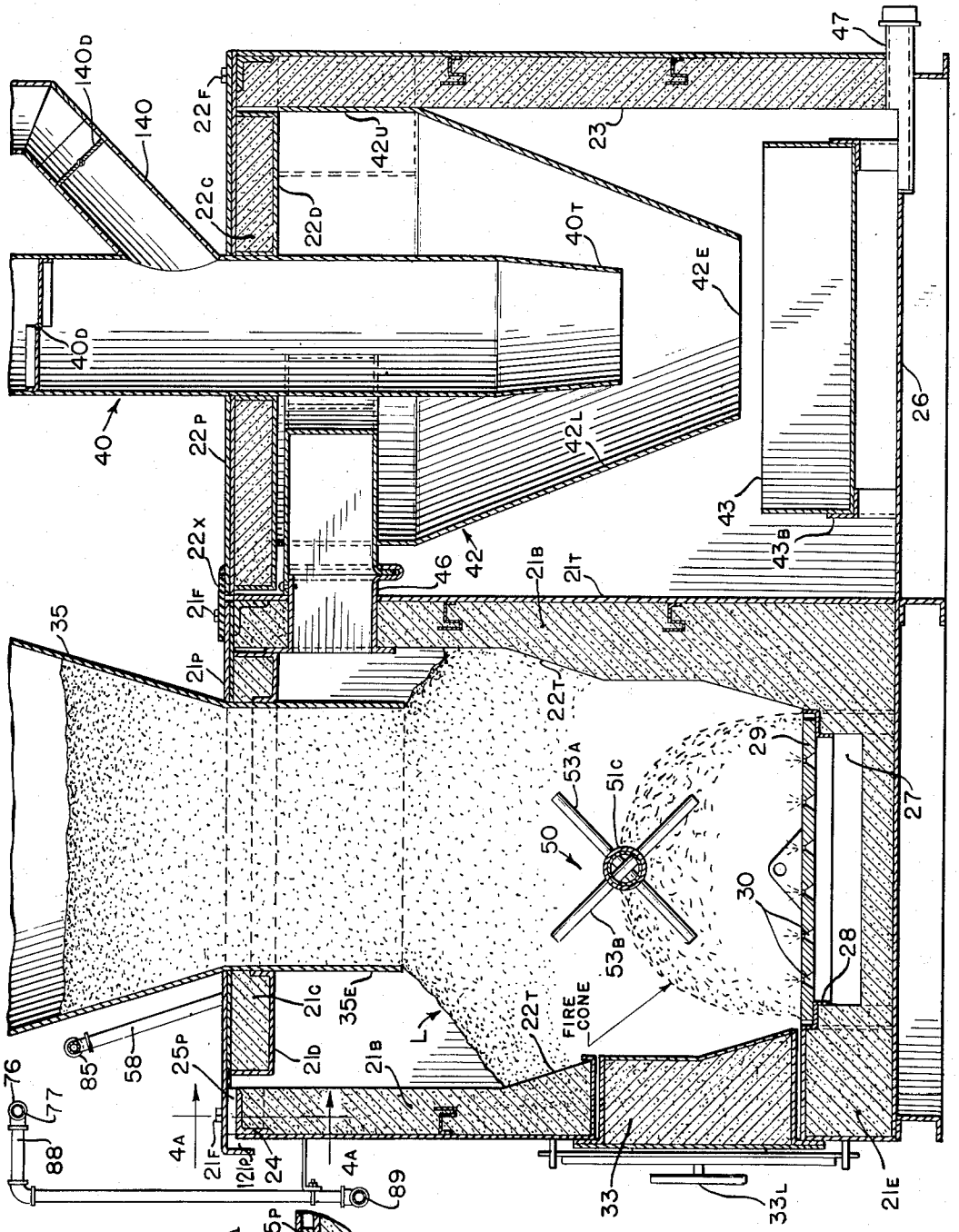


FIG. 4

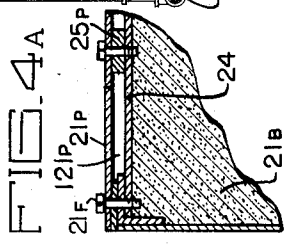


FIG. 4A

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SMOKE GENERATOR

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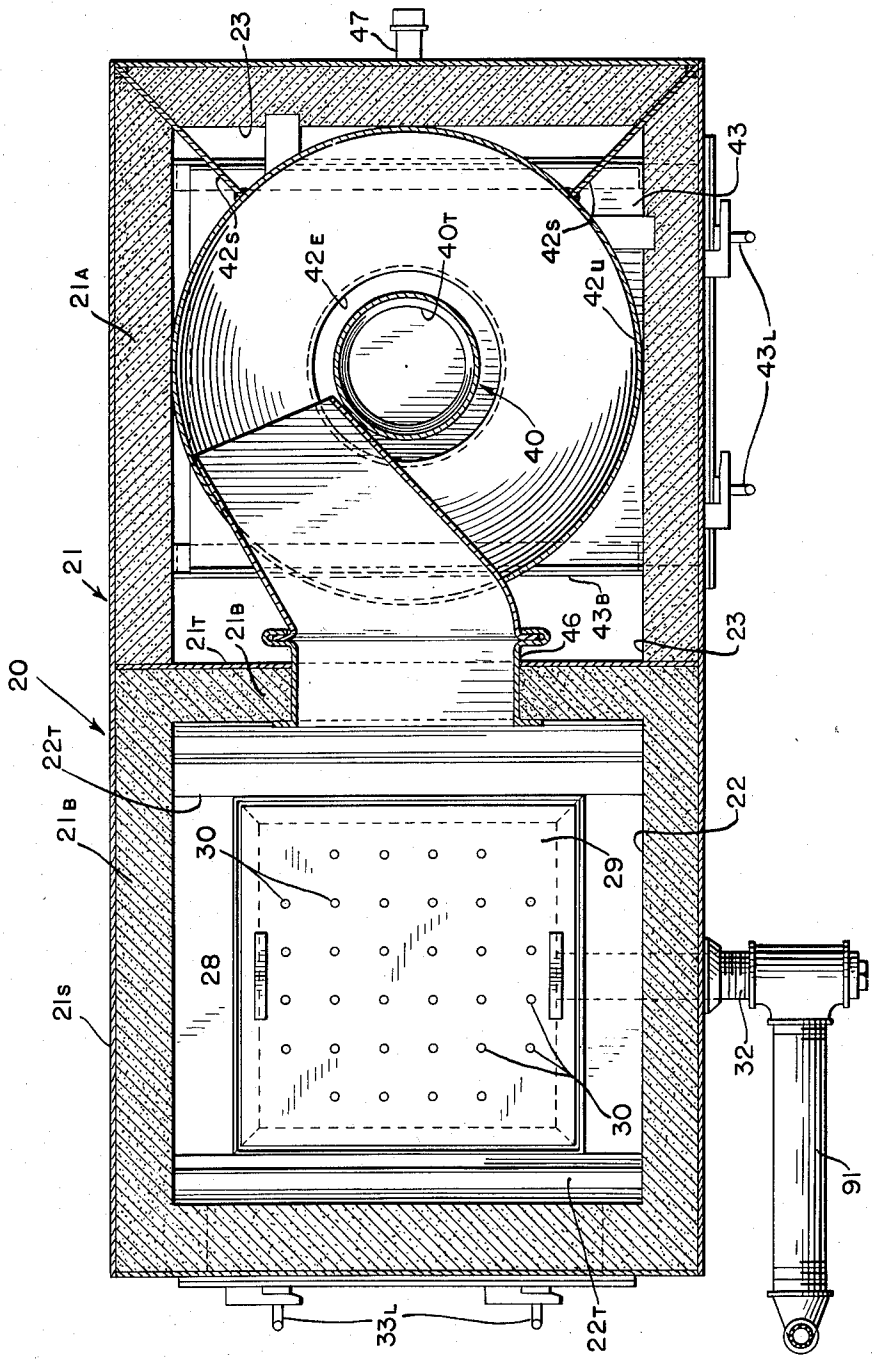


FIG. 5

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SMOKE GENERATOR

Filed March 3, 1952 6 Sheets-Sheet 6

FIG. 7

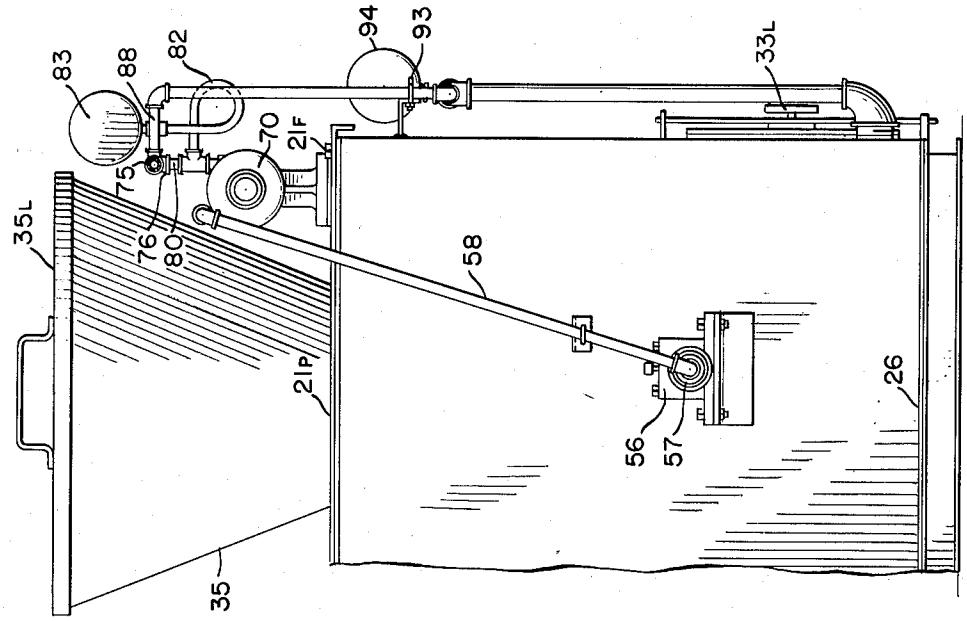
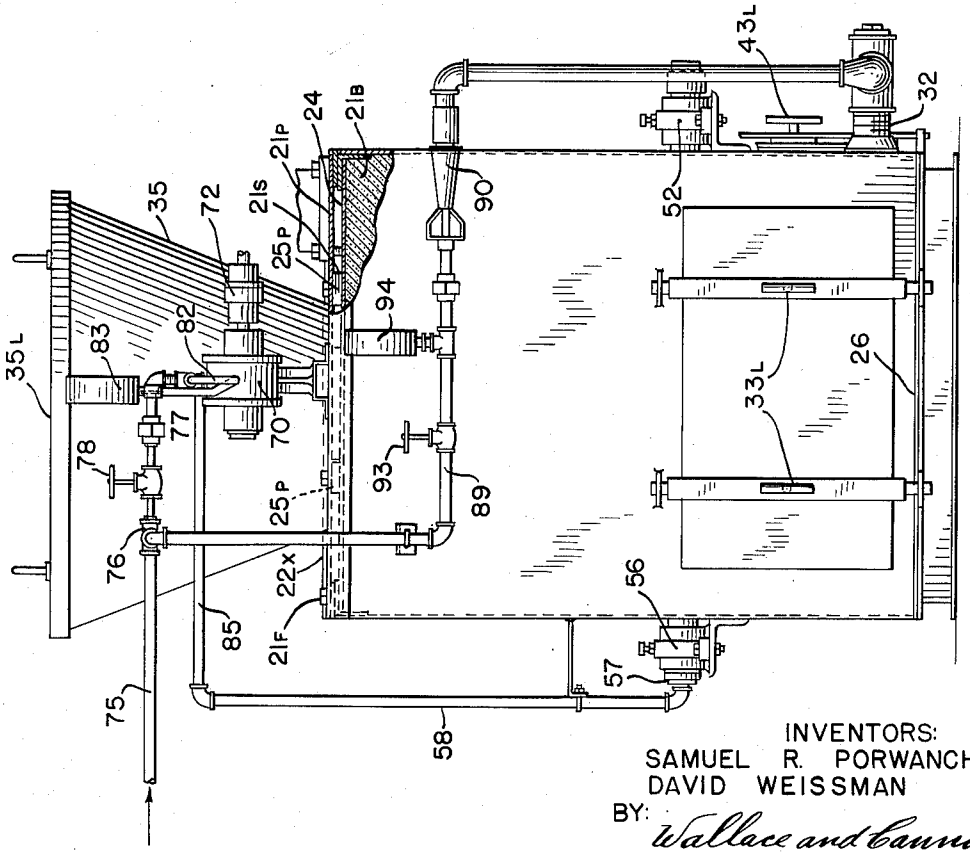


FIG. 6



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United States Patent Office 2,732,837 Patented Jan. 31, 1956

2,732,837

SMOKE GENERATOR

Samuel R. Porwancher and David Weissman, Chicago, Ill., assignors to Drying Systems, Inc., Chicago, Ill., a corporation of Illinois

Application March 3, 1952, Serial No. 274,617

6 Claims. (Cl. 126—59.5)

This invention relates to smoke generating apparatus and particularly to such apparatus that is adapted for use in supplying smoke to smoke houses in the meat packing or curing industry.

In the past, it has been a practice to supply smoke to the smoke houses in packing plants through the use of a smoldering fire fed with hickory wood sawdust as a fuel, and many different types of smoke generating apparatus have been utilized. In some instances, it has been necessary to supply the sawdust to the combustion chamber manually, and at frequent intervals, and to tend to the fire by shaking or stirring the fuel at relatively frequent intervals. In other instances, provision has been made for what can be termed a semi-automatic feed of the fuel to the combustion chamber, and for stirring the fuel in the combustion chamber automatically at predetermined intervals. Also, it has been found in instances where such smoke generators have been used, that the smoke tends to carry a fly-ash which is undesirable in the smoke house in that it deposits upon the meat that is being cured. In the past it has been customary to remove this fly-ash by washing and/or screening the smoke as it passes from the smoke generator to the smoke house.

The smoke generators of the kind that have been utilized heretofore in a commercial smoke house have been considered to be objectionable in several respects and the primary object of the present invention is to enable a smoke generator to be provided for such use which will avoid the objections that have heretofore arisen in connection with prior apparatus of this character. More specifically it is an object of the present invention to afford a smoke generator that is adapted to use sawdust as a fuel and which will operate at a uniform combustion rate and supply a constant and uniform smoke output. Another object is to enable a smoke generator of the automatic type to deliver clean smoke without the necessity of washing and the output of the generator, thus to allow all the flavoring and curing elements normally embodied in such smoke to be carried with the smoke into the curing or smoking chamber. Another and related object is to afford a smoke generator of the automatic type that is safe in its operation in that it avoids all tendency toward explosion or the like, and which is simple insofar as installation is concerned and which is rugged in use and operation.

Another object of the smoke generator and such a smoke generator having a reciprocating-finger type agitator that operates with sawdust over and relatively close to the grate in the combustion chamber so as to provide for a constant flow or movement of the sawdust into the fire area over the grate thereby to prevent formation of blow-holes and flaming jets over the bed of sawdust as have occurred in many prior smoke chambers. Another object is to afford such a reciprocating-finger-type agitator that is driven by a variable speed drive means so that by using a variable speed of agitation, a uniform flow of well mixed, lump-free sawdust into the combustion area may be attained at a rate coordinated with the rate of combustion.

Another object of the present invention is to afford an agitator arrangement in the smoke generator so that the agitator may be operated by an air motor and thus to enable the speed of operation of the agitator to be readily and easily varied as required. The use of an air motor in such a relationship is, of course, advantageous in that it enables the smoke generator unit to be installed without electric wiring of any kind, and the characteristics of an air motor are such that it can be stalled without harm to the mechanism.

Another object of the present invention is to afford an agitator of the aforesaid character in the combustion chamber of the smoke generator and to arrange this agitator so that it may be cooled during operation of the generator, thereby to prevent excessive heating of the agitator and tending toward the attainment of longer useful life in such agitator. More specifically, it is an object of the present invention to afford such an agitator that is mounted on a tubular shaft so that the cooling means may be effective upon the internal surfaces of the shaft during operation of the mechanism. More specifically it is an object of the present invention to accomplish this cooling action by compressed air and to utilize the exhaust air from the air motor that drives the agitator, it having been discovered that by reason of the expansion of such air during the working cycle of the motor, such air is cooled and there is somewhat of a refrigerating effect, thus to attain an improved cooling action in the agitator.

A further object of the present invention is to afford a smoke generator of the aforesaid character wherein the fly ash that results from the burning of the sawdust is eliminated from the stream of smoke by mechanical means, and more specifically it is an object to associate a cyclone-type collecting means with the smoke generator, thus to allow the smoke to be supplied to the smoke house without removal of any flavoring or curing elements that are present in the smoke as it is produced in the combustion chamber.

Another object of the present invention is to afford a combustion chamber in a smoke generator of the aforesaid type that is so constructed that the space within the combustion chamber and above the supply of sawdust therein will be continually exhausted as an incident to the withdrawal of the smoke from the combustion chamber, thus to insure that explosive or combustible gases will not accumulate in the upper portion of the combustion chamber.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principle thereof and what we now consider to be the best mode in which we have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principle may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a front elevational view illustrating a smoke generator embodying the features of the invention;

Fig. 2 is a plan view of the smoke generator shown in Fig. 1;

Fig. 3 is a right-hand end elevational view of the smoke generator;

Fig. 4 is a vertical sectional view taken substantially along the line 4—4 of Fig. 2;

Fig. 4A is a fragmentary sectional view taken along the line 4A—4A of Fig. 4;

Fig. 5 is a plan sectional view taken substantially along the line 5—5 of Fig. 1;

Fig. 6 is a left-hand end elevation view illustrating the details of the air supply system and the driving means for the agitator; and

Fig. 7 is a fragmentary rear elevational view illustrating the way in which the cooling air is supplied to the agitator.

For purposes of disclosure, the invention is herein illustrated as embodied in an automatic smoke generator **20** that has a rectangular box-like casing **21** in which two vertically extending chambers **22** and **23** are provided, these chambers being generally square in horizontal cross section as will be evident in Fig. 5 of the drawings. The left hand chamber **22** as viewed in Fig. 1 constitutes the combustion chamber of the apparatus, while the right hand chamber **23** constitutes a separating chamber in which fly ash that is entrained with the smoke is removed before the smoke is delivered to a smoke house.

The outer walls of the housing **21** are formed from sheet metal as indicated at **21S** in Fig. 5 of the drawings, and in dividing the casing **21** into two chambers, a transverse sheet metal wall **21T** of sheet metal is also afforded. The walls of the chamber **23** are insulated as at **21A** by any suitable high temperature resistant insulating material such as a cast cementitious insulating material that extends along the three sides of the chamber other than the wall **21T** while the combustion chamber **22** has all of its internal side surfaces insulated by similar insulating material **21B**, and has a similar insulating material across the major portion of its top wall as indicated at **21C**, this insulating material being carried in what amounts to metal pan **21D** as shown in Fig. 4 of the drawings. It will be noted that at the right hand edge of the pan **21D** as viewed in Figure 4, such pan extends relatively close to the insulating material **21B** that is adjacent to the metal cross wall **21T**, but at the other or left hand edge of the pan **21D**, the pan is spaced slightly from the internal face of the insulating material **21B**, thereby to form a downwardly extending slot which will allow entrance of the controlled amount of air along this edge as will be described in greater detail hereinafter. The chamber **22** has the top thereof similarly insulated by material **22C** carried in a pan **22D**.

It will be observed that the outer portions of the top walls of the two chambers are formed by individual metal plates **21P** and **22P** as shown in Fig. 4 of the drawings, and these plates have the top insulating sections **21C** and **22C** secured thereto. The plate **22P** has an edge flange **22X** welded along its left hand edge so as to overlie the adjacent edge of the plate **21P**, and cap screws **21F** extend through the plate **21P** and the flange **21X** to removably hold the plate **21P** and the adjacent edge of the plate **22P** in position and additional cap screws **22F** hold the other edges of the plate **22P** in position. At the left hand edge of the plate **21P** that covers the top of the combustion chamber **22**, it will be noted that the plate **21P** is supported in spaced relation to a top angle **24** of the end wall by means of relatively small spacer plates **25P** disposed at the points where the bolts **21F** pass through the cover plate **21P** to the angle **24**, so that a slot **121P** is provided between the angle **24** and the top late **21P** and thus air may enter through this slot and move downwardly, between the pan **21D** and the insulation **21B**, into the combustion chamber as will be described in some detail hereinafter. The bottom wall of the combustion chamber **22** has a relatively thick body of insulating material supported on a bottom plate **26** of the cabinet and centrally of this insulating material.

The air for supporting combustion in the combustion chamber is supplied through a lower or bottom recess **27** that is formed in the insulating material **21E** centrally of the combustion chamber, this recess **27** being bordered about its upper edge by a Z-bar **28** which forms a seat for a grate **29**. This grate **29** has upwardly opening air-discharge perforations **30** formed therein at spaced points so that air may be fed upwardly into a combustion zone that is located as indicated in Fig. 4 over the grate **29**. The combustion air is supplied by means including an inlet pipe **32** that extends through the forward wall and through the insulating material **21E** and into the side of the chamber **27**. The combustion chamber **22** has an access door **33** in its left hand side as viewed in Fig. 4, and this door is adapted to be held in this closed position by a latch mechanism **33L**.

The fuel such as sawdust is fed to the combustion chamber through a supply hopper **35** that extends downwardly through the top wall of the combustion chamber, and this supply hopper has a lower end **35E** that extends for a substantial distance downwardly into the combustion chamber. The hopper **35** has a lid **35L** which is put in position thereon after the fire has been lighted in the combustion chamber so as to afford proper draft. The fire is started by means of paper or the like, and is gradually supplied with sawdust until a burning mass has been formed on the grate **29**, and this mass is then gradually covered with sawdust so as to produce a smoldering mass beneath such sawdust. After the fire has been started the hopper **35** is filled substantially to the top thereof, and the sawdust runs down progressively into the combustion chamber so as to maintain a level within the combustion chamber as indicated at L in Fig. 4, and it will be observed that the lower portions of the side walls of the combustion chamber are tapered inwardly and downwardly as at **22T** so that the lower portion of the chamber conforms with the area of the grate.

The separating chamber **23** has a cyclone-type separator therein which includes a vertical stack **40** and a concentric downwardly tapered, funnel-like member **42**, the upper portion **42U** thereof being cylindrical in form, while the lower portion tapers inwardly at **42L** so as to terminate in a reduced lower end **42E**. This member **42** is located by means of mounting members **42S** so that the lower end thereof is disposed over a collecting drawer **43** which is mounted on supporting brackets **43B** within the separating chamber for removal through the front wall of the separating chamber. Latch members **43L** are provided for holding the drawer **43** in its closed position. The stack **40** extends downwardly and has its lowered end tapered inwardly as at **40T**, and this end **40T** is located a substantial distance above the end **42E**.

A blower B is connected to the upper end of the stack **40** and when a damper **40D** in the stack is opened, the blower B acts to suck air or smoke from the combustion chamber through a connecting pipe **46** which passes through the wall **21T** from the combustion chamber at substantially the upper end thereof and which enters upper portion **42U** of the separator structure in tangential direction as shown in Fig. 5 of the drawings. The smoke and any entrained fly-ash will thus be drawn into the section **42U** and will move downwardly through the tapered portion **42L** along a spiral path until it reaches the lower end **40T** of the stack, and at this point the smoke and vapors will be drawn upwardly through the stack **40** while the fly-ash or other foreign matter will continue its downward movement in the collecting drawer **43**. Since it is desirable to wash this chamber **23** from time to time, a drain **47** is provided at the bottom of the right hand end wall as shown in Fig. 4 of the drawings.

It will be clear therefore that under the present invention foreign particles such as fly-ash are removed from the smoke by mechanical means, and all of the flavoring

and other desirable elements of the smoke will be fed to the smoke house for use in the manner intended.

It will be observed that the stack 40 is one through which the smoke is normally fed to the smoke house, but there are instances when it is desired to feed the smoke through another path so that it does not pass to the smoke house and for this purpose an auxiliary stack 140 is provided so as to extend from the stack 40 below the damper 40D, and this stack 140 has a damper 140D that is normally closed, as shown in Figs. 1 and 4, it being observed that during the periods when smoke is to be fed to the smoke house, the damper 40D that is on the main stack 40 is moved from the closed position of Fig. 4 to an open position that is indicated by the position of the outside handle in Fig. 1 of the drawings.

It will be recalled that a slot 121P is provided along the left hand edge of the upper portion of the wall at the left hand end of the chamber 22, so that air may enter in this area, and in the operation of the smoke producing apparatus of the present invention the action of the suction fan or blower B is such that there is an appreciable flow of air through this slot 121P and across the lower face of the top wall 21C, this air moving about the inwardly extended lower end 35E of the fuel hopper 35 and then moving into the transverse conduit 46. This action insures that there will be no accumulation of dangerous combustible gases in the upper portion of the combustion chamber 22, and thus safety and continuity of operation of the present smoke consuming apparatus is assured.

In attaining a uniform mixture and flow of sawdust to the combustion area, and to elimate the formation of lumps or packed sections of fuel in the combustion area, means are provided for agitating the fuel and the burning or smoldering sawdust at periodic intervals, and under and in accordance with the present invention this is attained in such a way that the agitation may be varied as to frequency, thereby to enable the operation of the apparatus to be coordinated with the air feed rate and the desired smoke output rate.

Thus, the present apparatus is provided with a rocking mechanical agitator 50 that includes a hollow horizontal shaft 51 that extends from front to rear through the combustion chamber 22 centered directly over the front to rear center line of the grate 29 and at a level that is substantially at the top of what may be termed the fire cone that will be defined by the combustion or fire zone within this combustion chamber, this fire zone being indicated in Fig. 4 of the drawings. The hollow shaft 51 is preferably formed in two sections that are joined near the center of the combustion chamber by a coupling sleeve 51C that is permanently fixed to one section in surrounding relation, and which is removably fixed in surrounding relation to the adjacent end of the other section by a transverse bolt 51D. At its forward end, the hollow shaft 51 is supported on a bearing 52 so as to extend entirely through this bearing, and at its outer end, which is open for purposes that will hereinafter appear, this shaft has a radially extending operating arm 53 secured thereto by means including a transverse pin 54, and it is through actuation of the arm 53 that rocking movement is imparted to the agitator 50 as will hereinafter be explained. Within the combustion chamber 22 the shaft 51 is provided with a plurality of transversely extending arms 53A and 53B, the arms 53A being located in a common plane that passes through the axis of the shaft 51, while the arms 53B are located in another plane that is displaced 90° from the plane in which the arms 53A are located. Thus, these arms 53A and 53B extend alternately in different directions from the axis of the shaft 51, and the arms effective to impart downward to the sawdust so as to force the same into the fire zone, as well as upward stirring movement to the sawdust in or above the fire zone in the combustion chamber so as to prevent formation of blow holes in the overlying supply of sawdust. The shaft 51 is supported at its rear end in a bearing 56, and here again the shaft extends entirely through the bearing and the open end thereof has an air injection nipple 57 extended thereinto so that air from a connected air supply pipe 58 may be forced as a cooling media to the interior of the shaft 51 for the purpose of maintaining this shaft and the associated arms 53A and 53B at a suitably low temperature at all times during operation of the smoke producing apparatus. The manner in which the cooling air 58 is supplied under the present invention will be described hereinafter.

The desired rocking movement is imparted to the agitator 50 by means including a speed reducer 60 that has an input shaft 61 and an output shaft 62, and this speed reducer 60 may be of any desired form or construction. The output shaft 62, of the speed reducer has a transversally extending crank arm 64 fixed thereto, and by virtue of the continuous rotating movement of this crank arm 64, by means of the output shaft 62, this arm is effective through means such as a link 65 to impart rocking movement to the arm 53 and the shaft 51 of the agitator 50.

Under and in accordance with the present invention, means are afforded for driving the speed reducer 60 at varying rates, and this is accomplished under the present invention in such a way that the installation of the smoke producing apparatus is simplified and the motive power may be supplied without the necessity for the use of electric motors and the like which require special wiring and which would be damaged in case the apparatus becomes stalled. Thus, an air motor 70 of the rotating type is provided, and this motor may be of any commercially available type. The motor 70 is illustrated in Fig. 2 of the drawings as having a power output shaft 71 that is connected by means including a universal coupling 72 to the input shaft 61 of the speed reducer 60, and thus the air motor 70 is effective through the speed reducer 60 to drive the agitator 50 through the desired rocking movements. Through the use of an air motor as the drive means for the agitator, the speed or rate of operation of the agitator 50 may be varied readily and easily so as to attain the most efficient operation of the apparatus.

In the installation of the present apparatus, it is only necessary to afford a supply pipe 75 from a source of compressed air, and the various pipe connections that are required to supply compressed air to the air motor 70 and to supply air to the agitator 50 and to the combustion chamber may be incorporated in the unit when it is delivered to the ultimate user. Thus, the balance of the piping that will be described are included in the unit, and it is only necessary to connect this piping to a supply pipe 75 such as that shown in Fig. 2 of the drawings. Thus the pipe 75 is connected to one end of a T-fitting 76, the other or opposite end of which is connected through a pipe 77 to a valve 78 from which the passage is extended by means including a pipe 79 and a vertical pipe 80, to the inlet of the air motor 70, and as will be evident in Figs. 1 and 2 of the drawings, a T-fitting 81 in the vertical pipe 80 has an extension pipe 82 extended therefrom to a pressure gauge 83 so that the amount of air flowing to the motor 70 may be judged and the valve 78 may be adjusted so as to attain the desired speed of operation of the motor 70 and agitator 50. The outlet of the air motor 70 is under the present invention connected to a discharge pipe 85 that is connected to the pipe 58, and thus to the hollow shaft 51 of the agitator 50, and the exhaust air from the motor 70 is fed through the agitator shaft 51 and is discharged from the open forward end thereof. This air, of course, serves to cool the shaft 51 and the transverse arms thereof, and it has been found that by reason of the expansion of the air in the air motor 70 this air is substantially cooled or refrigerated so as to thereby increase the cooling action of this air upon the agitator 50.

The other arm of the T-fitting 76 is connected by pipes

88 and 89 to an inspirator 90 whereby the flow of compressed air into the inspirator induces flow or entry of additional air into and through the inspirator, and the output of this inspirator is fed by means including a pipe 91 to the inlet end of the pipe 32, thus to supply air through the grate 29 to support a combustion in the combustion zone of the combustion chamber 22. The pipe line 89 is illustrated as including a valve 93 whereby the amount of air flowing through the pipe to the inspirator 90 may be varied, and this air flow may be judged through the provision of an air gauge 94 located between the valve 93 and the inspirator 90. Thus, the combustion rate of the fuel may be varied as required, and the rate of operation of the agitator may be readily coordinated with the combustion rate so that the desired smoke output may be attained with maximum efficiency.

With the smoke producing apparatus that has thus been afforded it has been found that the installation and operation of the apparatus is quite simple, and the smoke output is unusually satisfactory in that it contains all of the originally produced flavoring elements. It will be apparent, of course, that the smoke output may be controlled and adjusted by adjustment of the air input and the agitation rate, and through the attainment of a proper agitation rate, uniformity of combustion may be attained while at the same time preventing the formation of blow holes through the supply of sawdust in the combustion chamber. Moreover, it will be evident that the apparatus of the present invention may be operated without fear of explosion.

Thus, while we have illustrated and described the preferred embodiment of our invention, it is to be understood that this is capable of variation and modification, and we therefore do not wish to be limited to the precise details set forth, but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

We claim:

1. In a smoke producing apparatus of the aforesaid character, a cabinet affording a combustion chamber having a side, top and bottom walls, a fuel supply hopper extended downwardly through said top wall and terminating in a discharge end disposed downwardly a substantial distance below said top wall, said bottom wall having a grate formed therein through which air for combustion may be supplied, an agitator comprising a hollow shaft extended transversely through opposite walls of said combustion chamber and disposed over and in upwardly spaced relation with respect to said grate, said hollow shaft having a plurality of arms extending radially therefrom at spaced intervals so that, upon rocking movement of said hollow shaft, said arms will impart stirring movement to the fuel above said grate, an outlet duct extended through one of said side walls above the lower end of said supply hopper and through which smoke from within said combustion chamber may be withdrawn, said cabinet on the side opposite said duct being formed with at least one air inlet opening disposed adjacent to the lower surface of said top wall so that, as smoke is withdrawn from said duct, air will be drawn into said opening and across the lower surface of said top wall to purge the upper portions of the combustion chamber of gases that might accumulate there, means for imparting rocking movement to said agitator including an air driven motor, said air driven motor having an exhaust duct connected to one end of said hollow shaft so that air exhausted from said air motor will pass through said hollow shaft to cool the same, means including an inspirator for feeding air at a controlled rate to said grate and upwardly therethrough, means for supplying compressed air to said inspirator to induce air flow therethrough, means including a valve for regulating the flow of compressed air to said inspirator, and means including a valve for supplying and regulating the flow of compressed air to said air motor at a controlled variable rate.

2. In a smoke producing apparatus of the aforesaid character, a cabinet affording a combustion chamber having a side, top and bottom walls, a fuel supply hopper extended downwardly through said top wall and terminating in a discharge end disposed downwardly a substantial distance below said top wall, said bottom wall having a grate formed therein through which air for combustion may be supplied, an agitator comprising a shaft extended transversely through opposite walls of said combustion chamber and disposed over and in upwardly spaced relation with respect to said grate, said shaft having a plurality of arms extending radially therefrom at spaced intervals so that, upon rocking movement of said shaft, said arms will impart stirring movement to the fuel above said grate, an outlet duct extended through one of said side walls above the lower end of said supply hopper and through which smoke from within said combustion chamber may be withdrawn, said cabinet on the side opposite said duct being formed with at least one air inlet opening disposed adjacent to the lower surface of said top wall so that, as smoke is withdrawn from said duct, air will be drawn into said opening and across the lower surface of said top wall to purge the upper portions of the combustion chamber of gases that might accumulate there, means for imparting rocking movement to said agitator, means including an inspirator for feeding air at a controlled rate to said grate and upwardly therethrough, means for supplying compressed air to said inspirator to induce air flow therethrough, and means including a valve for regulating the flow of compressed air to said inspirator.

3. In a smoke producing apparatus of the aforesaid character, a cabinet affording a combustion chamber having a side, top and bottom walls, a fuel supply hopper extended downwardly through said top wall and terminating in a discharge end disposed downwardly a substantial distance below said top wall, said bottom wall having a grate formed therein through which air for combustion may be supplied, an agitator comprising a shaft extended transversely through opposite walls of said combustion chamber and disposed over and in upwardly spaced relation with respect to said grate, said shaft having a plurality of arms extending radially therefrom at spaced intervals so that, upon rocking movement of said shaft, said arms will impart stirring movement to the fuel above said grate, an outlet duct extended through one of said side walls above the lower end of said supply hopper and through which smoke from within said combustion chamber may be withdrawn, means for imparting rocking movement to said agitator including an air driven motor, said air driven motor having an exhaust duct connected to one end of said shaft so that air exhausted from said air motor will pass through said shaft to cool the same, means including an inspirator for feeding air at a controlled rate to said grate and upwardly therethrough, means for supplying compressed air to said inspirator to induce air flow therethrough, means including a valve for regulating the flow of compressed air to said inspirator, and means including a valve for supplying and regulating the flow of compressed air to said air motor at a controlled variable rate.

4. In a smoke producing apparatus of the aforesaid character, a cabinet affording a combustion chamber having a side, top and bottom walls, a fuel supply hopper extended downwardly through said top wall and terminating in a discharge end disposed downwardly a substantial distance below said top wall, said bottom wall having a grate formed therein through which air for combustion may be supplied, an agitator comprising a shaft extended transversely through opposite walls of said combustion chamber and disposed over and in upwardly spaced relation with respect to said grate, said shaft having a plurality of arms extending radially therefrom at spaced intervals so that, upon rocking movement of said shaft, said

arms will impart stirring movement to the fuel above said grate, an outlet duct extended through one of said side walls above the lower end of said supply hopper and through which smoke from within said combustion chamber may be withdrawn, means for imparting rocking movement to said agitator, means including an inspirator for feeding air at a controlled rate to said grate and upwardly therethrough, means for supplying compressed air to said inspirator to induce air flow therethrough, and means including a valve for regulating the flow of compressed air to said inspirator.

5. In a smoke producing apparatus of the aforesaid character, means affording a combustion chamber and having a grate at the bottom thereof and having a supply hopper at the upper portion thereof opening downwardly into said combustion chamber and through which fuel such as sawdust may be gravity fed in said combustion chamber, an agitator located in the combustion chamber above said grate and comprising a horizontally positioned hollow shaft extended through said combustion chamber and mounted for rocking movement, said hollow shaft having arms extending radially therefrom for imparting agitating and downward feeding movements to the fuel above said grate when said shaft is rocked, means for imparting rocking movements to said hollow shaft including an air-driven motor, said motor including an air inlet port and an air outlet port, and means connecting said air outlet port of said motor to one end of said shaft so that the exhaust air that has been cooled by expansion in said motor is supplied to said one end of said shaft and passes through said shaft to cool said agitator.

6. In a smoke producing apparatus, means affording a combustion chamber and having a grate at the bottom thereof and having a supply hopper at the upper portion thereof opening downwardly into said combustion chamber and through which fuel such as sawdust may be gravity fed in said combustion chamber, an agitator located in the combustion chamber above said grate and comprising a horizontally positioned shaft extended through said combustion chamber and mounted for rocking movement, said shaft having arms extending radially therefrom for imparting agitating and downward feeding movements to the fuel above said grate when said shaft is rocked, means for imparting rocking movements to said shaft including an air-driven motor, said motor including an air inlet port and an air outlet port, and means utilizing the air discharged from said air outlet port of said motor for cooling said agitator.

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