J. CARTIN.

APPARATUS FOR PRODUCING COMPLETE COMBUSTION.

APPLICATION FILED DEC. 26, 1907.

916,996.

Patented Apr. 6, 1909.

4 SHEETS—SHEET 1.

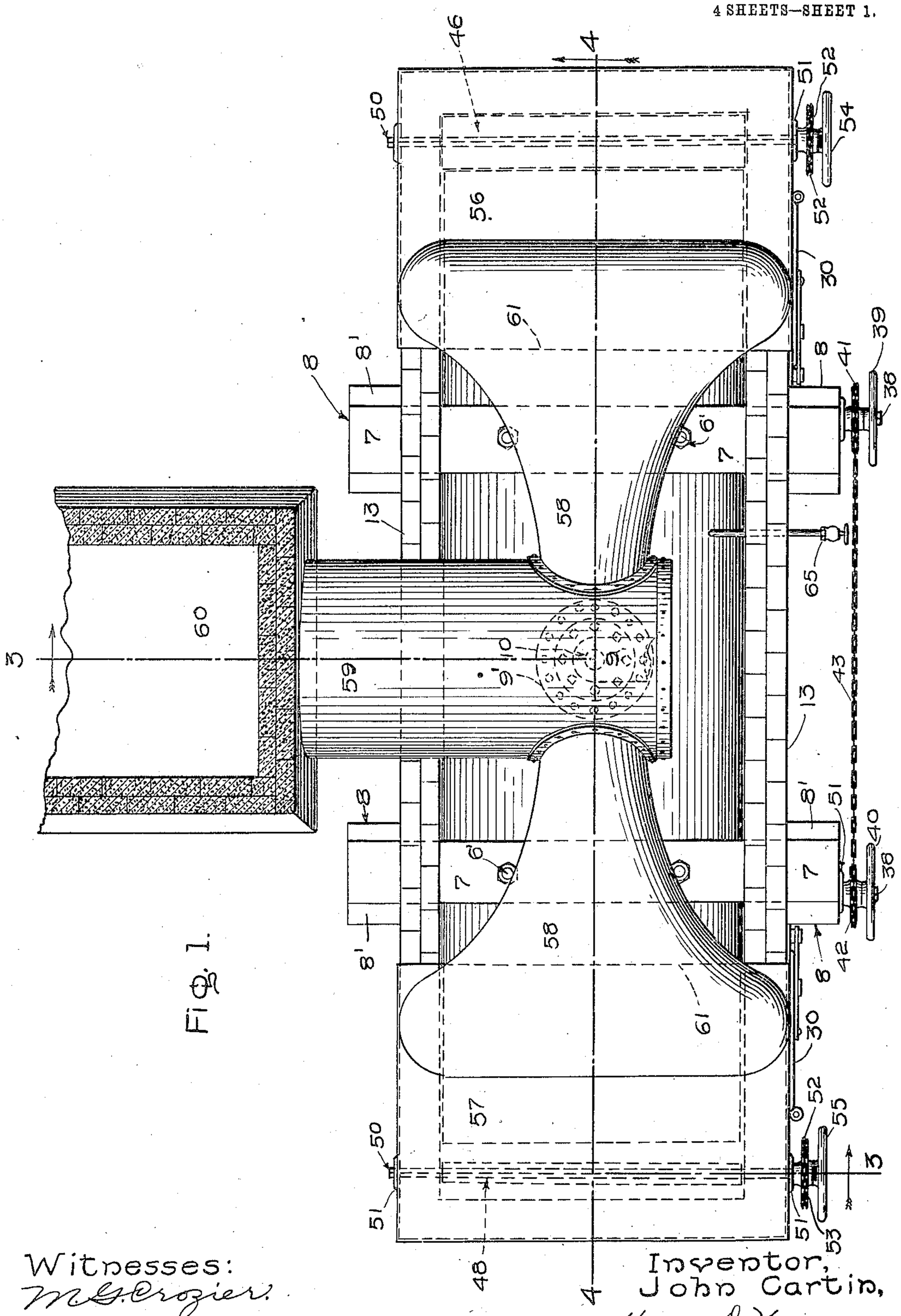

Fig. 1.

Witnesses:
M. S. Crozier.
H. N. Henderson.

Inventor,
John Cartin,
by Harry D. Wallace
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4 SHEETS—SHEET 2.

Fig. 3.

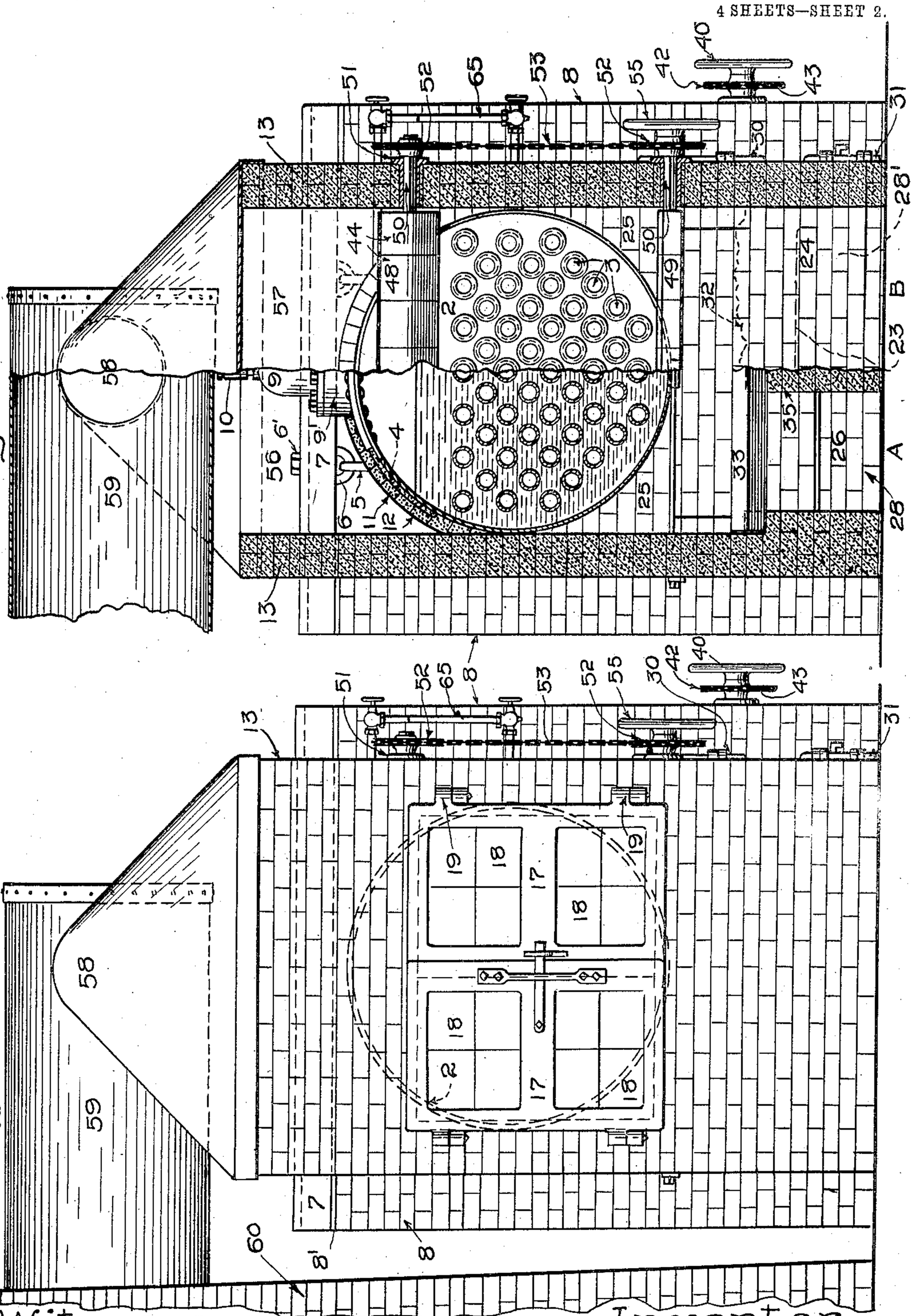

Fig. 2.

Witnesses:
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4 SHEETS—SHEET 3.

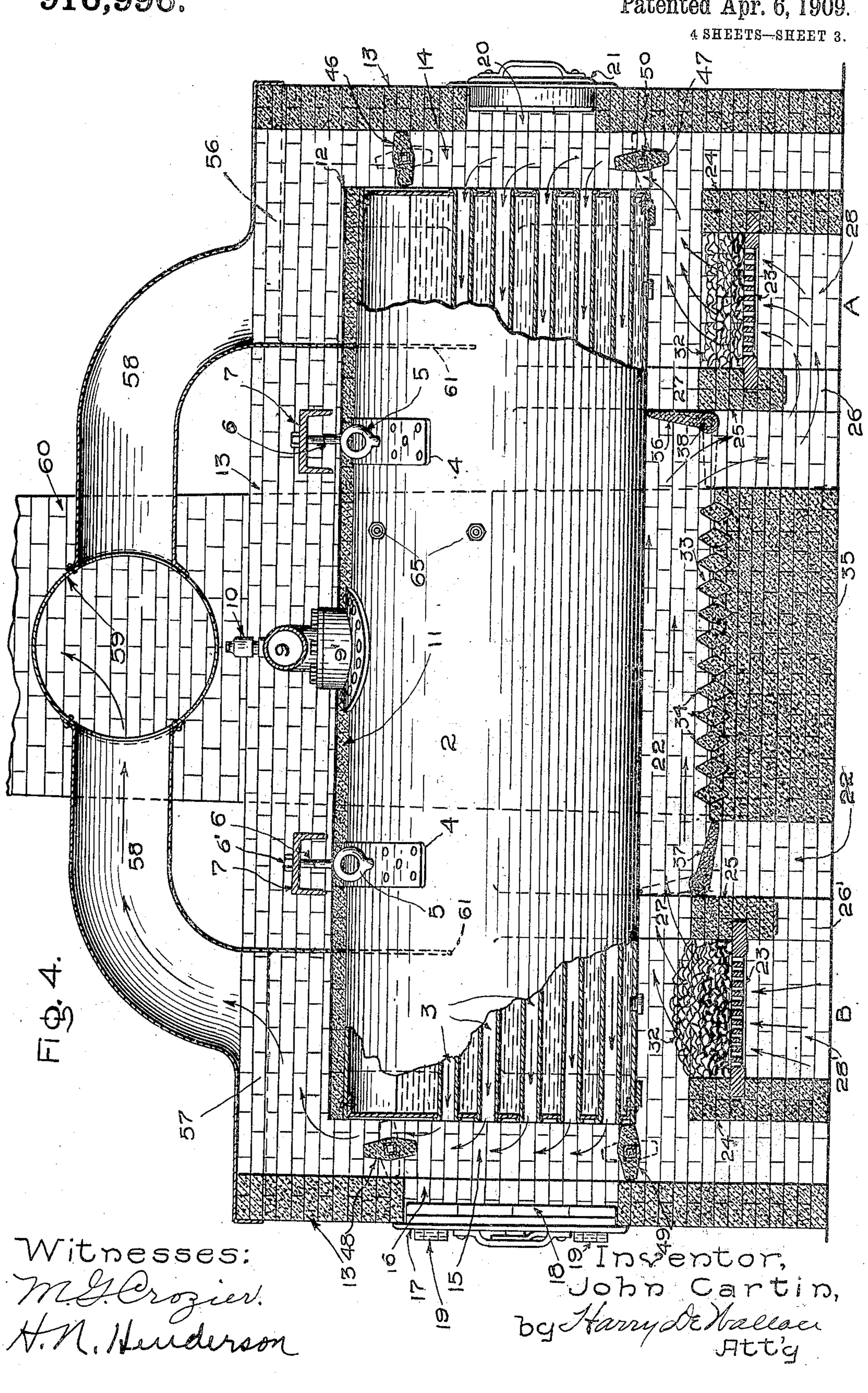

Fig. 4.

Witnesses:
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4 SHEETS—SHEET 4.

Fig. 7.

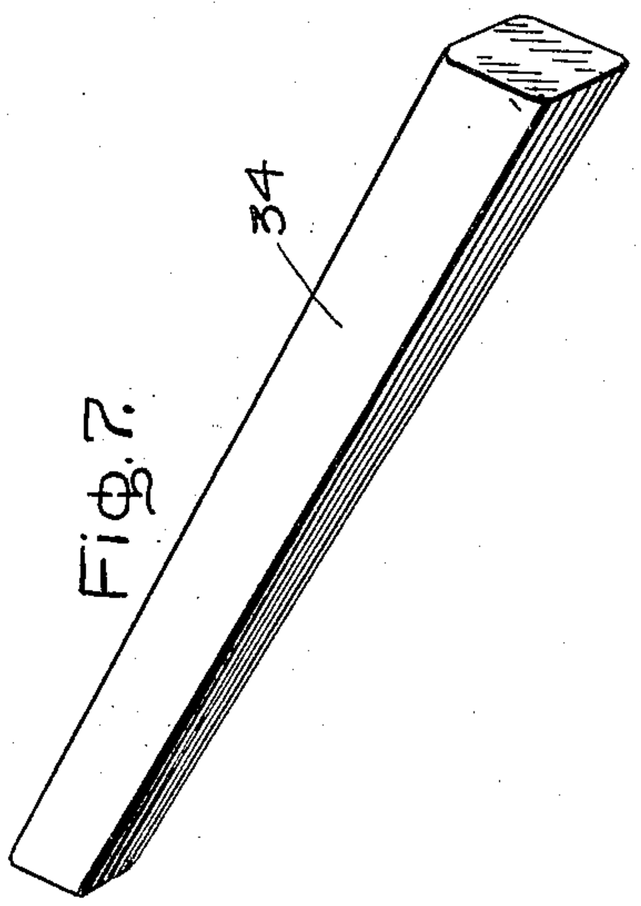


Fig. 6.

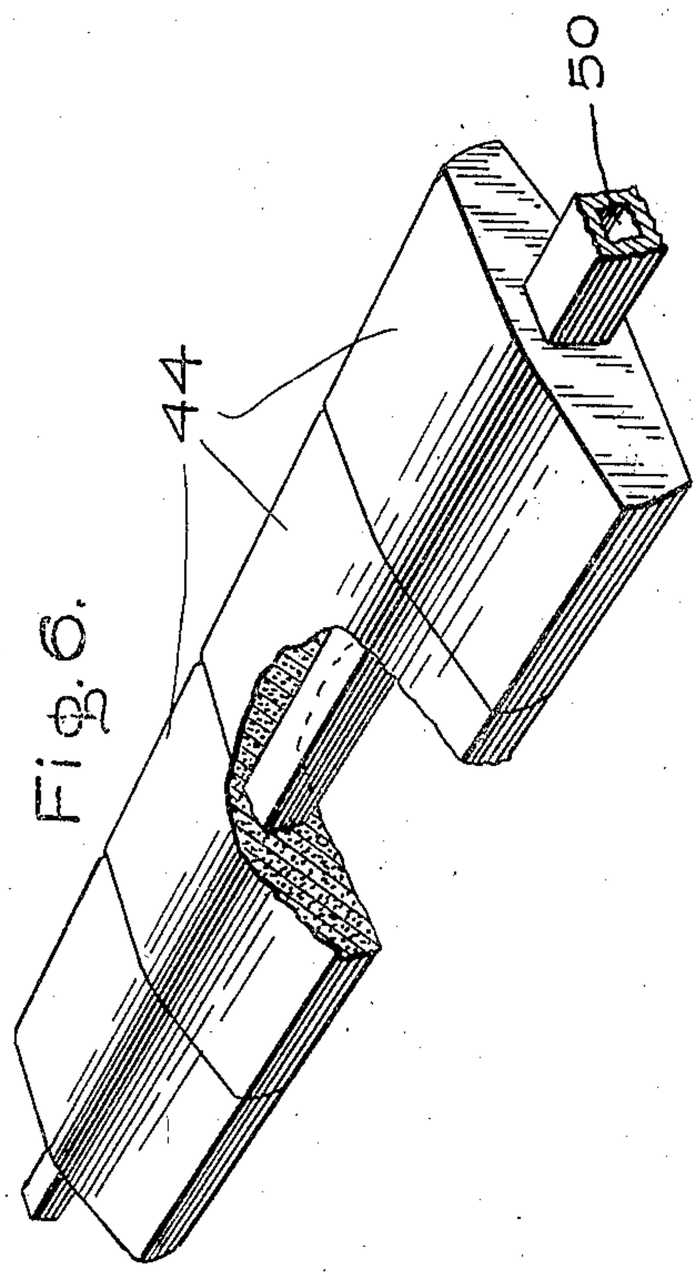
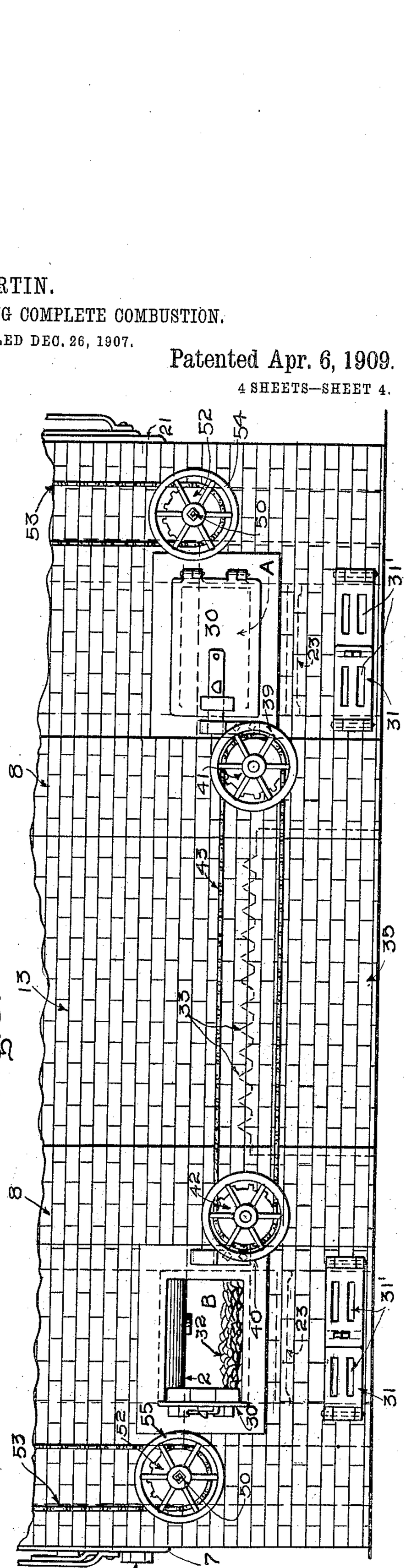


Fig. 5.



Witnesses:
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A. N. Henderson.

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UNITED STATES PATENT OFFICE.

JOHN CARTIN, OF OGDENSBURG, NEW YORK, ASSIGNOR OF ONE-TENTH TO J. WILLIAM EMOND, ONE-TENTH TO WILLIAM EMOND, ONE-TENTH TO JOSEPH EMOND, AND ONE-TENTH TO WILLIAM P. KAUFMANN, OF CARDINAL, CANADA, ONE-TENTH TO ANTHONY WHITE AND ONE-TENTH TO PHILIP J. CARTIN, OF WATERTOWN, NEW YORK, AND ONE-TENTH TO THOMAS J. HALL, ONE-TENTH TO FRANK P. CARTIN, AND ONE-TENTH TO JOHN H. CARTIN, OF OGDENSBURG, NEW YORK.

APPARATUS FOR PRODUCING COMPLETE COMBUSTION.

No. 916,996. Specification of Letters Patent. Patented April 6, 1909.

Application filed December 26, 1907. Serial No. 408,136.

To all whom it may concern:

Be it known that I, JOHN CARTIN, a citizen of the United States, residing at Ogdensburg, in the county of St. Lawrence and State of New York, have invented certain new and useful Improvements in Apparatus for Producing Complete Combustion, of which the following is a specification.

This invention relates to improvements in apparatus for producing complete combustion of fuel, designed for use in connection with steam boilers and the like, and the invention relates particularly to an apparatus or furnace to be employed for producing the complete or perfect combustion of bituminous or soft coal, wood or other suitable fuel, which is largely used for making steam and for heating purposes generally.

Heretofore many attempts have been made to devise furnaces, to be operated in connection with steam boilers and other heating apparatus, for effecting the complete combustion of the fuels employed, particularly the more common variety known as bituminous or soft coal, but so far as I am aware, none of these have been entirely successful. Bituminous coal, differs from the anthracite or glance coal of commerce, in that when heated, it yields a considerable amount of volatile and bituminous matter, the latter called mineral pitch, a black tarry substance, which burns with a bright flame, but when heated to a point below the temperature of ignition of its decomposition products, invariably gives off a black or yellowish-black smoke, which is heavily charged with fine particles of carbon called soot, and other matters of hydro-carbon nature. The presence of the black smoke in the atmosphere in the vicinity of heating and other furnaces is held to indicate that the fuel has not been perfectly combusted or burned. It is commonly believed that the soft or bituminous coal burned in most of the furnaces, under the methods heretofore employed, has not yielded the full measure or benefit of its energy, in the way of making steam, or producing heat for other purposes, which it is capable of producing, chiefly because complete combustion of the said fuel has not been effected within the furnaces.

It is an object of the present invention to provide an apparatus or furnace, in connection with a steam boiler or other heating parts, in which bituminous or soft coal, wood, or other suitable fuel may be burned, and wherein practically all of the volatile hydro-carbon matter, as well as the gases and other combustible properties yielded or given off by the fuel, during the different stages of the heating and burning thereof, will be efficiently consumed, in the fire-boxes and in a combustion-chamber of peculiar and novel construction and arrangement, before the still combustible reek is allowed to pass away from the boiler, and wherein the entire heat energy of said fuel may be obtained and utilized for making steam, or for other forms of heating, before it is allowed to escape or become wasted.

A further object of the invention is to provide an apparatus of the class, which is simple, compact, durable and inexpensive, and wherein the construction and arrangement of the several parts of the furnace, and the disposition and relation of the boiler are such that a greater amount of heat may be produced and then employed for making steam or for other purposes, from the same or a less amount of fuel, than is capable of being produced by any other furnace or system of the class known to me.

The invention consists principally in providing a boiler for use in making steam, or heating water, and suspending the same by means of independent supports, within a walled inclosure or casing having an open top. The boiler being disposed in the said inclosure or casing in such manner that a compartment or chamber of considerable depth intervenes between the under side of the boiler and the floor of the inclosure, which comprises a large combustion-chamber of substantially the same width and length as the boiler.

The invention further consists in providing two fire-boxes or furnaces and disposing them in the compartment or chamber directly beneath the opposite ends of the boiler, which are intended to be fired at the same time, or may be fired alternately, for the purpose of producing an intense heat,

which may be distributed in a novel manner equally to all sections of the under half of the boiler, which forms the upper boundary of the said chamber.

The invention further consists in providing a heat reflector in the form of a bridge and disposing the same in the combustion-chamber centrally beneath the boiler and between the two fire-boxes, over which the heat currents from one fire may be compelled to flow on their way to the other end of the chamber, and which, from the nature of its material, and its arrangement and proximity to the under surface of the boiler, is capable of absorbing and then reflecting and radiating an intense and steady heat upwardly against the mesial portion of the boiler.

The invention further consists in providing means for regulating and shifting the drafts to and from the two fire-boxes and fires in such manner, that the smoke and hot gases of one fire may be drawn or forced lengthwise under the boiler from one end to the other, and directed over the said bridge, and over, or under and upward through the second fire, in order to complete the combustion begun in the first fire.

The invention further consists in providing means for compelling the products of combustion from the combustion-chamber and both of said fires to pass through the flues of the boiler in different directions alternately, and thence into independent smoke-boxes or like parts disposed above the opposite ends of the boiler, which connect with a common chimney.

A further feature of the invention consists in providing a combustion-chamber, in which the inner lining and all of the fittings comprise a refractory material or substance which is capable of absorbing and retaining heat of an extremely high degree without fusing. And the invention further consists in providing a series of novel and simple dampers or heat deflecting parts, and disposing them in different parts of the apparatus or furnace, in a manner which will permit of their being manipulated from the outside of the casing or inclosure, for the purpose of regulating and changing the direction of the flow or movement of the currents of products of combustion in different directions, both within the combustion-chamber and through the boiler.

Other features and parts of the invention will be readily understood from the detail description which follows, and by reference to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a plan view of the complete apparatus. Fig. 2 is a front end elevation. Fig. 3 is a vertical cross sectional view, substantially on the line 3—3 of Fig. 1. Fig. 4 is a central longitudinal section, substantially on the line 4—4 of Fig. 1. Fig. 5 is a part side elevation, showing the location of the fire-box and ash-pit doors; also showing location and arrangement of the hand-wheels for operating the several series of dampers. Fig. 6 is a detail perspective view of one of the dampers disposed in the flues at each end of the boiler. Fig. 7 is a detail perspective view of one of the earthen bars which form the bridge.

Similar characters of reference are assigned to corresponding parts throughout the several views.

In the drawings, 2 represents a steam boiler, which for the purpose of illustrating my invention, is preferably a plain cylinder adapted for use as a horizontal type of boiler, and having a number of flues or tubes 3, applied and arranged in the ordinary way. Instead of mounting the boiler upon a foundation or supporting base, such as commonly employed, I prefer to suspend the boiler in a manner to leave its under side entirely free from supports of any kind, and for this purpose, I provide a pair of saddles 4, which are securely riveted or bolted to the upper side of the boiler; each saddle having a pair of loops or eyes 5 extending upwardly, one disposed on each side of the center of the boiler.

6 represents a pair of loops or eyes similar to and interlinked with the loops 5, but each having a threaded stem to receive a nut 6′ employed for attaching the loops to supporting beams 7, which are preferably the well-known channel-beams, and these are disposed at right-angles to and directly above the boiler, as shown.

8 represents a series of piers or buttresses which may consist of any suitable material, as brick, of sufficient strength to support the heavy boiler. Four of the piers 8 are shown, one disposed beneath each end of the beams 7, the latter preferably resting upon a suitable metal cap or plate 8′ mounted on top of the piers.

9 represents a steam conducting-pipe connected centrally to the top of the boiler, for carrying steam to different parts of a plant.

10 represents a safety puppet or blow-off valve, connected to pipe 9, directly over the boiler.

The surface of the upper half of the boiler is preferably covered with a layer of fire-brick 11, laid next to the iron, and over this covering is then spread a coating of asbestos or like substance 12, to prevent the escape of the heat, or the chilling of the boiler by contact with the atmosphere.

13 represents a walled inclosure or casing, preferably rectangular in shape, which rests upon the floor or ground, and completely surrounds the boiler in its suspended position, as described. This inclosure is preferably open at its top, and is formed so that the side walls substantially meet the sides of

the boiler, while the end walls are disposed in such manner as to leave free spaces or flues 14 and 15, between the ends of the boiler and said walls. In height, the walls of the casing 13 preferably extend a foot or more above the top of the boiler, as shown in Figs. 2, 3 and 4, and the ends of the beams 7 pass through the opposite side walls to reach the piers 8 which are disposed outside said walls. At one end of the casing 13 a large square opening 16 is provided, to afford access to the interior, particularly for the purpose of cleaning or blowing out and repairing the flues of the boiler. This opening is closed by a pair of doors having metallic frames 17, which are preferably protected or shielded from the heat within the inclosure by a lining of fire-brick or like refractory substance 18. These doors are hinged to the wall 13 at 19, and are provided with suitable handles and latches or other fastening means. 20 represents a circular manhole or opening formed in the opposite end of the casing 13. This opening is fitted with a circular cap or part 21, which preferably consists of an outer metal part lined on its hollow inner side with fire-brick, the same as doors 17.

In order to carry out the object of my invention, and effect the complete combustion of the fuel employed for heating the boiler, I dispose the boiler in the walled inclosure 13 in such manner, that the under side of the boiler is preferably thirty to forty inches above the floor or bottom, and by this means provide a large chamber or furnace, which has a plan area substantially equal to the inside dimensions of the inclosure, the lower half of the boiler forming the upper side of the said chamber. In this space or chamber, I dispose two fire-boxes or furnaces A and B, preferably located beneath and at or near the opposite ends of the boiler. These furnaces are preferably constructed and arranged exactly alike, each having a grate 23, which may be of any of the well-known patterns, and each grate is mounted between a pair of parallel walls or piers 24 and 25, which are preferably made of fire-brick. These walls or piers extend cross-wise in the main chamber, at right-angles to the boiler. The outer piers 24 are preferably plain and solid and extend to within about one foot of the boiler, as shown. The piers 25 are each provided in their lower central portions with an arch 26, extending from a point near the grate to the floor, while their upper edges are formed into inverted arches 27, disposed centrally beneath the bottom of the boiler. The opposite ends of piers 25 extend upwardly to close the angle between the sides of the boiler and the walls 13, as shown in Fig. 3.

22 represents the combustion-chamber proper, which comprises the space between the piers 25, from each end of which communication may be had with the fire-boxes A and B, through the respective archways 26 and 27. Beneath the grates 23 are disposed ash-pits or chambers 28 and 28′, which have direct communication with the combustion-chamber 22 through the arches 26. Fire-boxes A and B are each provided with a door 30, for use in supplying coal to the fires, and the ash-pits are each provided with doors 31 for removing the ashes. The doors 30 and 31 are disposed on the front side of the casing instead of at the ends, and may be constructed and operated in any suitable manner. The doors 31 are preferably provided with check-drafts 31′ for supplying fresh air to the under side of the grates 23, in suitable volume to effect the proper burning of the fuel 32, which covers the grates in the two furnaces.

33 represents a bridge, heat distributer, and heat reflector, disposed centrally across the combustion-chamber 22, at right-angles to the boiler. This bridge comprises a series of earthen bars or parts 34, preferably made of fire-clay, the same as all the other masonry and parts of the furnace and chamber, and these bars are preferably formed diamond-shaped in cross-section, as shown in Figs. 3, 4 and 7. These bars are preferably arranged in two sets disposed horizontally, end to end, each set extending from the side walls 13, where they may be supported in any suitable manner, then meeting in the middle of chamber 22, where the inner ends rest upon a fire-brick pier 35. The bars 34 are preferably spaced about one inch apart, so as to prevent the serrated surface of the bridge from becoming covered or laden with dead or non-heat-absorbing substances, such as ashes and cinders, the sharp sloping upper surfaces of the bars serving the purpose of increasing the heating surface of the bridge as well as rendering the same self-cleaning. Bridge 33, in practice will extend each way from the center of chamber 22 to within about one foot of the piers 25 which form the inner limits of fire-boxes A and B. The object of the bridge is to provide a broad surface or field of the refractory bars, which is capable of absorbing and retaining heat, which it receives alternately from the fires A and B, and then to reflect or radiate the said heat upwardly against the under portion of the boiler. Bridge 33 is disposed within about one foot of the under surface of the boiler, and in such manner that the products of combustion produced by the fire last stoked may be directed over the top of the bridge and made to mingle with the products of combustion of the other fire, at the will of the fireman. In order to compel the currents of hot air to pass through the narrow space between the boiler and the bridge, I provide a pair of rocking or oscillating dampers 36 and 37, preferably made of fire-clay so as to stand

the intense heat and mounted upon tubular shafts 38, the ends of which preferably pass through and have suitable bearings in the opposite side walls of the casing 13. To the outer ends of the shafts 38, which project through the front side wall of the casing 13, are fitted hand-wheels 39 and 40 (shown in Figs. 1, 2, 3 and 5). The dampers 36 and 37 are both preferably operated at the same time, by means of sprocket-wheels 41 and 42, which are connected by means of a chain 43. As illustrated in Fig. 4, dampers 36 and 37 are so positioned, that either one may be shifted or set to close the passage through the inverted arch 27, and at the same time to open the passage or space between the ends of the bridge and the piers 25, and thereby deflect or compel the currents of hot gases after traversing bridge 33, to pass downwardly and through the arches 26 in piers 25 into the ash-chambers, from whence they will be drawn upwardly through the grates and through the fires A or B, as the case may be. In Fig. 4, the damper 36 is shown in full lines disposed vertically, thus closing the archway 27 leading directly from the bridge to fire A, and damper 37 is shown disposed horizontally, so as to close the passage leading downwardly between the bridge and wall 25 of fire-box B. Under this arrangement of the dampers 36 and 37, all of the products of combustion given off from fire B, must pass to the right between bridge 33 and the boiler, thence downwardly through arch 26 into ash-pit 28, thence upwardly through grate 23 and fire A, where it is intended that all of the uncombusted particles of the fuel of fire B will ultimately be consumed by the fire A, an appropriate regulation of fresh air draft being arranged for through dampers 31 under furnace A. From the latter fire, the products of combustion will pass directly into the space or flue 14, and then through the flues of the boiler, as will be more fully explained below. The fire A, as illustrated in Fig. 4, represents what is called by engineers a "white fire", from which black smoke or soot is no longer given off. While fire B, is shown to have been freshly coaled or stoked, and represents what is termed a "green fire," which is in condition to yield a heavy black or yellowish-black smoke and considerable gas, which in order to carry out the purpose and object of my invention, must not be allowed to pass directly into the smoke space 15 and through the boiler, but must first be directed, as indicated by the arrows in said Fig. 4 along the underside of the boiler, across the highly heated bridge, thence downwardly into ash-pit 28, and so on as last described.

In order to regulate the flow of the products of combustion after they leave either of the fires, as described, and to direct them in either direction through the flues of the boiler, a pair of rotatable dampers 46 and 47 are disposed in the space or flue chamber 14, and a pair of similar dampers 48 and 49 are disposed in the same manner in the space or flue chamber 15, at the opposite end of the boiler (see Fig. 4). Each of these dampers are preferably comprised of sections of fire-clay 44 (see Figs. 3 and 7) mounted upon square hollow shafts 50, through which air may circulate to prevent overheating of the said parts. These several dampers are preferably formed to substantially the length and width of the flues 14 and 15, as shown. The ends of the hollow shafts 50 pass through the opposite side walls 13 of the casing, and have bearings in round bushings 51, to permit them to be rotated to shift the dampers to different positions. On the ends of shafts 50 which project through the front wall 13, are mounted sprocket-wheels 52, which are operatively connected at each end of the boiler by a sprocket-chain 53. The lower dampers 47 and 49, at the opposite ends of the casing are fitted with hand-wheels 54 and 55 respectively, by means of which, and by the coöperation of the sprocket gearing, the pair of dampers at each end of the boiler may be operated in unison. When connecting up the sprocket chains, the dampers of each set or pair are disposed at right-angles to each other and thereafter maintained in such relation, so that when the hand-wheels are rotated a quarter of a turn, one damper will be opened, and the other will be closed (see Figs. 3 and 4). Therefore, to permit the products of combustion to reach the boiler flues from the fire A, as last described, the hand-wheel 54 had been operated a quarter turn, which opened the lower damper 47, and at the same time closed the upper damper 46. The closing of damper 46, closed the passage leading upwardly from space 14 into a smoke-box or like part 56, disposed directly above said space, and which communicates with a chimney 60, by means of an integral neck or throat 58 and a tubular smoke-pipe 59, the latter entering the chimney a short distance above and rearwardly of the center of the boiler. The shifting of the dampers 46 and 47, as described, compels the products of combustion then to enter and pass through the flues 3 of the boiler, from right to left, as indicated by the arrows, after which they emerge into the opposite flue 15, in which the dampers 48 and 49 are disposed. The dampers 48 and 49 are constructed, applied and operated in exactly the same manner as the dampers at the other end of the boiler, but in order to conduct the products of combustion to the atmosphere, these last named dampers had been set, by manipulating the hand-wheel 55, in such manner as to close the lower damper 49 and open the

upper damper 48 (as shown in Figs. 3 and 4). The products of combustion are then compelled to flow upwardly, and in doing so, may pass on either side of damper 48, they next enter a smoke-box 57 (which is exactly like the box 56, and also connects with the smoke-pipe 59) and pass off into the chimney, and thence to the atmosphere, as indicated by the arrows in Fig. 4. The smoke-boxes 56 and 57 are preferably made of heavy sheet metal in the form shown, the outer ends tightly fitting the top of the walls 13, like a cap, while the inner vertical side 61 of each box, extends downwardly to meet the lagging or covering of the boiler, where it is cut away to conform to the curvature of the boiler, so as to make a tight closure to prevent the escape of smoke or gases into the boiler-room.

65 represents a water-gage and related parts, such as commonly employed on steam boilers, which may be of any suitable construction, but is preferably connected to the side of the boiler, instead of the end, which is the usual practice.

As explained, the coal in fire-box A has been burning for some time, and has advanced to the "white" stage, while fire-box B, is shown to have been but recently stoked with fresh coal. With the two fires in the condition shown and described, all of the dampers and draft courses are arranged (see Fig. 4) to correctly show the working of my improved apparatus, and all of these parts should be left in the position as thus shown, until one of the fires requires restoking. After fire B has burned for a certain time, it will become "white", and by that time fire A will have burned out to such extent that it will require a fresh supply of coal. Before the fireman begins the stoking of fire A, he should first change all of the dampers, so that when the new coal is thrown on the fire, the black smoke and other matter which may be given off from that fire may be carried across the combustion-chamber 22 and through fire B, before it is allowed to reach and pass through the boiler. In order to make ready for the next stoking of fire A, the fireman should first operate hand-wheel 55, which shifts dampers 49 and 48, opening the former and closing the latter; then he should operate hand-wheel 54 to shift dampers 46 and 47, closing damper 47 and opening damper 46. After this has been done, he should next operate either one of the hand-wheels 39 or 40, whichever one happens to be nearest to him, in the direction to change damper 36 from its vertical to the horizontal position, and at the same time by the same operation, change damper 37 from the horizontal to the vertical position. The latter dampers may be changed from one position to the other by simply rocking the shafts back and forth. The upper dampers may be shifted from one position to the other by rotating the shafts in the same direction each time. The shifting of the several dampers as just described, will set them all in the positions indicated by dotted lines in Fig. 4. The fireman may then add fresh coal to fire A. As soon as the new coal strikes that fire, all of the smoke and gases thrown off will then be carried by the draft received through the grates of fire A toward the left, passing through upper archway 27 and across the bridge thence downwardly, through ash-pit 28′, thence upwardly through fire B, thence into chamber 15 and through the boiler flues into flue 14, thence upwardly into smoke-box 56, and from the latter into the chimney. After fire A has been stoked, all of the dampers should be left in the position last described, until fire A has burned "white", and by that time fire B will have burned out sufficiently to require a fresh supply of coal. The fireman will then reshift all of the dampers back to the positions shown in full lines Fig. 4, and recoal fire B, and so on, changing all of the dampers each time either of the fires are fired anew.

By providing a combustion-chamber of considerable length, and disposing a fire-box or furnace at each end with the bridge arranged between them, the products of combustion from the "green" fire at one end, in passing to the other end of the chamber toward, and over or through the "white" fire, will have a tendency to increase, rather than diminish in degree, because the portions of the fuel from the "green" fire, such as soot and combustible gases, which are not completely consumed within the fire-pot, or in the superheated space directly above it, will, after the fires have burned for a short time, continue burning during their passage over the intensely heated bridge and along the hot inner walls of the chamber, and finally, whatever remains unconsumed from the first fire, will become perfectly combusted while passing through the second fire and through the hot air chamber at the end of the boiler.

The entire combustion-chamber being lined with fire-brick, the fire-boxes, the bridge and also the dampers being constructed of the same material, all of which are capable of absorbing and retaining heat to a greater extent than any other form of brick or composition available for the purpose, it is possible to produce a temperature sufficiently high to effect the complete combustion of the bituminous coal, wood, or other suitable fuel, and also to prevent black or offensive smoke from escaping from the furnaces, after the first fire has advanced to the "white" state. After the fires have been burning for a short time, the whole interior of the inclosure beneath and at the ends of the boiler, will become white with

heat and effectively overcome the chill from the boiler, the heating surface of which, in any case, is little, if any hotter than that of the steam within it, which is said to be less than 350° F., for a pressure of 100 lbs. per square inch. Since the temperature of the boiler is normally low, as compared with the temperature necessary for the most efficient combustion, I have found that by constructing and arranging the furnaces, combustion-chamber and other related parts, in the manner as shown and described herein, will not only counteract the resistance to heat offered by the boiler, but will also render it impossible for the boiler, having a lower temperature than the furnaces beneath it, to draw the heat from the burning gases, before the combustion of the latter is completed. After the two fires are gotten under full headway and the furnaces and whole plant become heated, owing to the peculiar construction and arrangement of the interior of the apparatus, as described, there is little or no danger of either the boiler or the central chamber 22 becoming chilled each time the fire-box doors are opened for the adding of fresh coal.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is—

1. In an apparatus of the class described, the combination with a boiler suspended in horizontal position and having flues therein, of a fire brick casing disposed around the boiler and having an open top, the ends of the casing being spaced from the ends of the boiler to form flues and the space below the boiler and between the side walls of the casing forming a combustion-chamber connected to said flues, a smoke box mounted upon each end of said casing above the ends of the boiler and communicating with the adjacent flue, a chimney to receive the discharge from the smoke box, a fire-box disposed near each end of said combustion chamber beneath the adjacent end of the boiler each firebox having a grate, an ashpit beneath each grate, a flue to connect each ashpit with said combustion chamber, a bridge comprising a heat distributer disposed centrally in said combustion chamber between said fire boxes, oscillating dampers pivotally mounted in the opposite side walls of said casing disposed between the ends of the bridge and said fire-boxes and serving to control the flow of the products of combustion through the fuel of the fireboxes alternately, a chain connecting said dampers, a hand-wheel carried by each damper adapted for operating them simultaneously, a pair of rotatable dampers disposed in the flue at each end of the boiler adapted to cause the products of combustion to pass through the flues of the boiler alternately, a chain to connect each pair of rotatable dampers, and a hand-wheel carried by one of each pair of dampers adapted for operating the same simultaneously, substantially as described.

2. The combination with a boiler having flues therein, of a fire-brick inclosure in which said boiler is suspended, the said inclosure having a width substantially the same as the diameter of the boiler and having a length greater than the boiler forming a flue at each end thereof, a smoke box mounted upon the inclosure above each end of the boiler and communicating with the adjacent flue, a chimney, a smoke pipe connected to each of the smoke boxes and leading to said chimney, a combustion chamber being formed beneath the boiler between the walls of the inclosure and connecting with said flues, two fire-boxes, one beneath each end of the boiler, each fire-box having a grate, parallel piers to support each grate, arched openings being formed in the inner pier of each fire-box, the upper arch-ways for communication from the combustion chamber to the spaces above the grates, the lower arch-ways for communication from the combustion chamber to the ash-pit, there being a passage to connect each fire-box with the corresponding flue, a pair of dampers in each flue disposed perpendicular to each other, each pair of dampers adapted to permit or prevent the flow of products of combustion from either or both of the fires directly to said flues, said dampers also adapted to permit or prevent the flow of products of combustion from said flues directly into said smoke boxes, and means for operating said dampers, substantially as described.

3. In an apparatus of the class described, the combination with a boiler suspended in horizontal position and having a series of boiler flues extending through the same, of a casing surrounding the boiler and having an open top, said boiler being spaced at its ends from the ends of the casing to form flues and having a space beneath the same between the walls of the casing forming a combustion chamber, a smoke-box mounted upon each end of the casing above the ends of the boiler and communicating with the said flues, two fire-boxes beneath the boiler communicating with the said flues and the said combustion chamber, a bridge disposed centrally in said combustion chamber, said bridge comprising a plurality of bars supported at their ends by the walls of said casing, an oscillating damper disposed at each end of the bridge adapted to permit or prevent the flow of products of combustion from either fire to the combustion chamber, the said dampers being operable to compel the products of combustion from either of the two fire boxes to pass over the bridge, thence beneath and thence upwardly through the opposite fire box, a pair

of dampers disposed one above the other in each of said flues, each pair of dampers operable simultaneously to open the lower end and to close the upper end of the flue and vice versa, the said dampers adapted to be operated to compel the combined products of combustion from the fire boxes to pass through the flues of the boiler in opposite directions alternately, each pair of dampers normally disposed perpendicularly to each other, and means for operating each pair of dampers, substantially as described.

4. In an apparatus of the class described, the combination of a tubular boiler and a fire-brick inclosure surrounding the same, the said inclosure having an open top and a hollow compartment beneath the boiler, a smoke chamber being formed opposite each end of the boiler and connected with said hollow compartment, a fire-box beneath each end of the boiler, each fire box comprising a grate and a plurality of walls and connected with the corresponding smoke chamber, an upper and a lower arch-way being formed in the inner wall of each fire-box, the central portion comprising a chamber, the said hollow compartment being formed between said fire boxes and connecting with each fire box by way of said arch-ways, a bridge disposed in said chamber in a manner to provide a free passage for products of combustion from the top of the bridge to the lower arch of each fire box, a rock damper disposed in each of said free passages adapted to control the flow of products of combustion to and from each fire-box, and to and from the said arch ways, the said dampers being pivotally mounted in the opposite side walls of said inclosure and capable of being operated simultaneously for setting the dampers in different positions, the said dampers being normally disposed perpendicularly to each other, and a hand-wheel carried by one damper for shifting both dampers, substantially as described.

5. In an apparatus of the class described, the combination with a tubular boiler and a four wall casing surrounding the same, the said casing having an open top and a hollow compartment beneath the boiler and spaced from the ends of the boiler to form flues, a fire-box disposed in each end of said hollow compartment beneath the ends of the boiler, each of said fireboxes connecting with the corresponding flue and comprising a pair of parallel piers, the inner pier of each fire box having an upper and a lower arch way, that portion of said hollow compartment between the said inner piers of the fire-boxes constituting a chamber, said chamber communicating with each fire-box and with each flue by way of said arch ways, a bridge disposed in said chamber, the opposite sides thereof being spaced equally from said inner piers of the fire-boxes, a rocking damper disposed in the space at each side of said bridge adapted to permit and prevent the flow of products of combustion to and from said fire-boxes through said upper arch ways and also to prevent or permit the flow of products of combustion from the upper side of said bridge to said fire boxes through said lower arch-ways, and means for operating said dampers simultaneously to set them in different positions, substantially as described.

6. In an apparatus of the class described, the combination with a boiler suspended in a horizontal position and a casing surrounding the same, the said casing having an open top and being spaced from the ends of the casing to form flues, the space between the side walls of the casing beneath the boiler forming a hollow compartment, a fire box disposed near each end of said hollow compartment and communicating with said compartment and the adjacent flue, each fire-box comprising a pair of parallel piers, one of said piers having an upper and a lower arch way formed therein adjacent to said hollow compartment, the said compartment communicating with each fire-box and with the adjacent flue by means of said arch ways, and means within said compartment to cause the products of combustion to pass from one fire-box through one upper arch way and thence through the opposite lower arch way through the other fire-box, substantially as described.

7. The combination of a boiler suspended horizontally and having flues therein, a casing surrounding said boiler and being spaced therefrom at its ends to form flues, the space between the side walls of the casing below the boiler forming a combustion chamber, a pair of dampers journaled for rotation in each of said flues, said dampers being normally at right angles to each other, means to operate each pair of dampers simultaneously to control the flow of products of combustion through the boiler flues, a fire-box beneath each end of the boiler, each fire-box comprising a pair of partitions and a grate, one of the partitions being formed with an upper and a lower arch-way, a bridge located centrally in said chamber beneath the boiler, said bridge comprising a plurality of spaced refractory bars, and means within said chamber to control the passage of products of combustion from one fire box to the other by way of either of said arch-ways, substantially as described.

8. An apparatus of the class described, comprising a tubular boiler suspended horizontally, a casing guarding said boiler and having its end walls spaced therefrom to form a plurality of flues, and said casing and boiler forming a combustion chamber beneath the boiler, a smoke box above each end of the boiler communicating with the adjacent flue, a fire-box adjacent each end of the combustion chamber, each fire-box

serving to connect the combustion chamber with the flue at one end of the boiler, a pair of dampers in the combustion chamber adapted to direct the products of combustion from one fire-box through said chamber into a second fire-box, a pair of dampers within the flue adjacent the second fire-box adapted to direct the products of combustion from both of said fires through the boiler flues in one direction, and a pair of dampers within the other flue adjacent the first mentioned fire-box adapted to direct the products of combustion received from the boiler flues into one of said smoke boxes.

9. In a device of the character set forth, the combination with a casing and a horizontal tubular boiler suspended therein, of a fire-box beneath each end of the boiler and spaced therefrom, each fire-box comprising a grate and supporting means therefor, a bridge beneath the boiler and spaced from the supporting means for the fire boxes, said bridge comprising a plurality of spaced horizontal bars, means comprising a pair of dampers guarding the space between the bridge and the fire-boxes, whereby the products of combustion from either fire-box will be caused to pass therefrom over the bridge and thence through the second fire box, and means to direct the products of combustion from the latter fire box through the boiler flues from which they are discharged at the end adjacent to the first mentioned fire-box.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN CARTIN.

Witnesses:
JOHN M. BARR,
JOHN M. MORLEY.