L. L. SUMMERS.

FURNACE.

APPLICATION FILED DEC. 22, 1906.

1,127,824.

Patented Feb. 9, 1915.

4 SHEETS—SHEET 1.

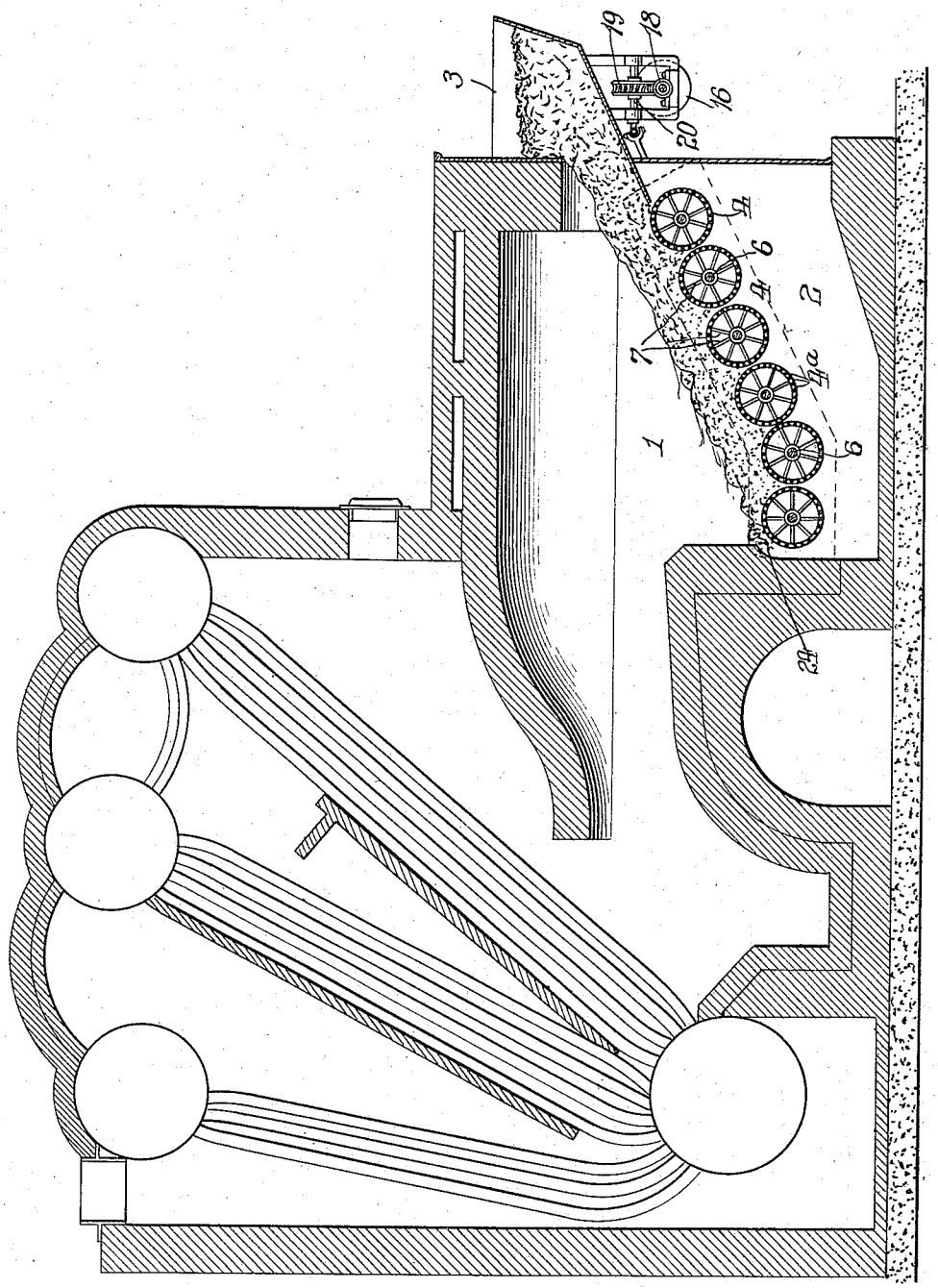


Fig. 1.

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4 SHEETS—SHEET 2.

Fig. 2

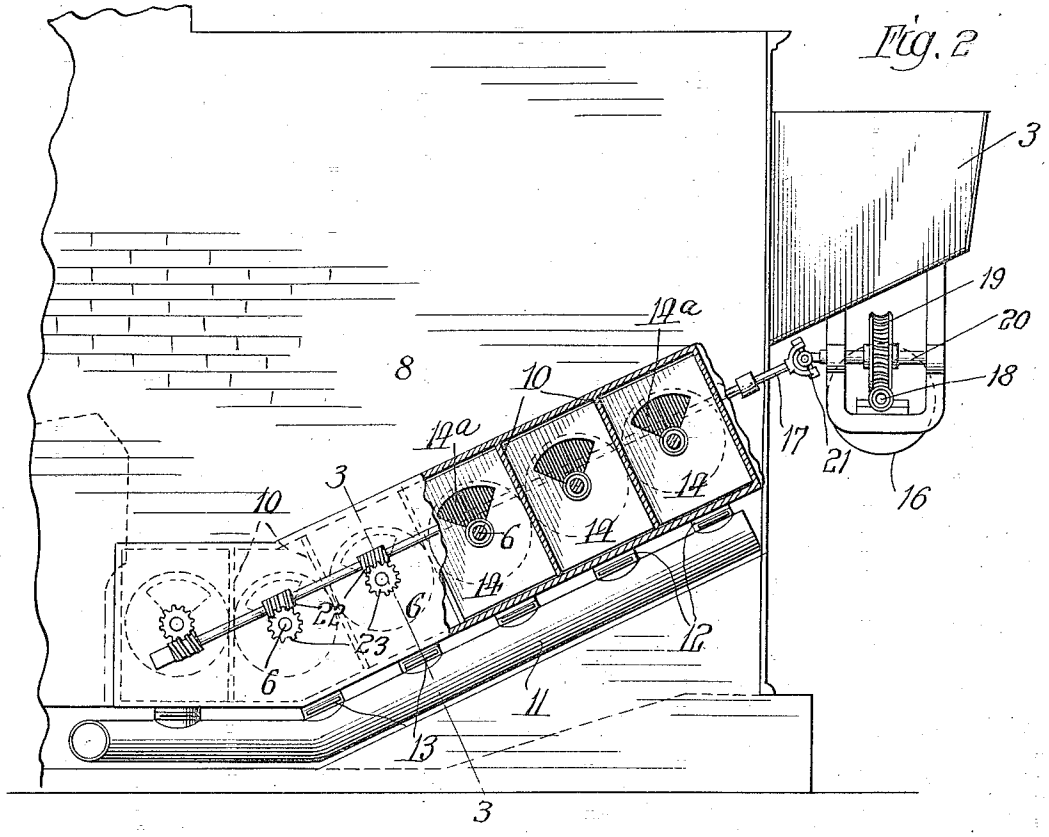


Fig. 3

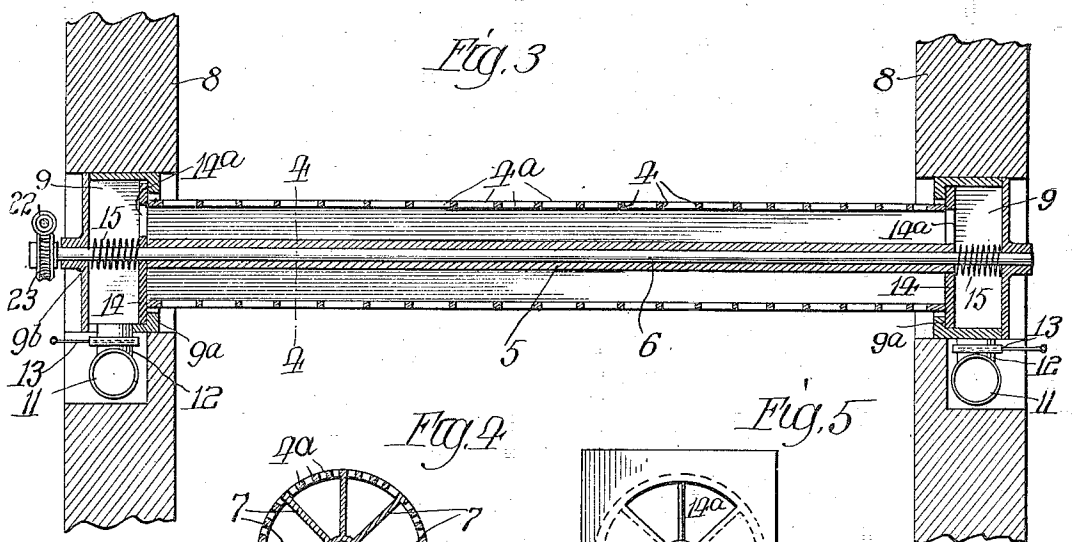


Fig. 4

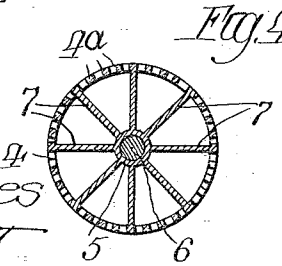
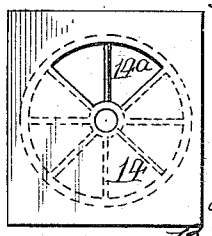


Fig. 5



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4 SHEETS—SHEET 3.

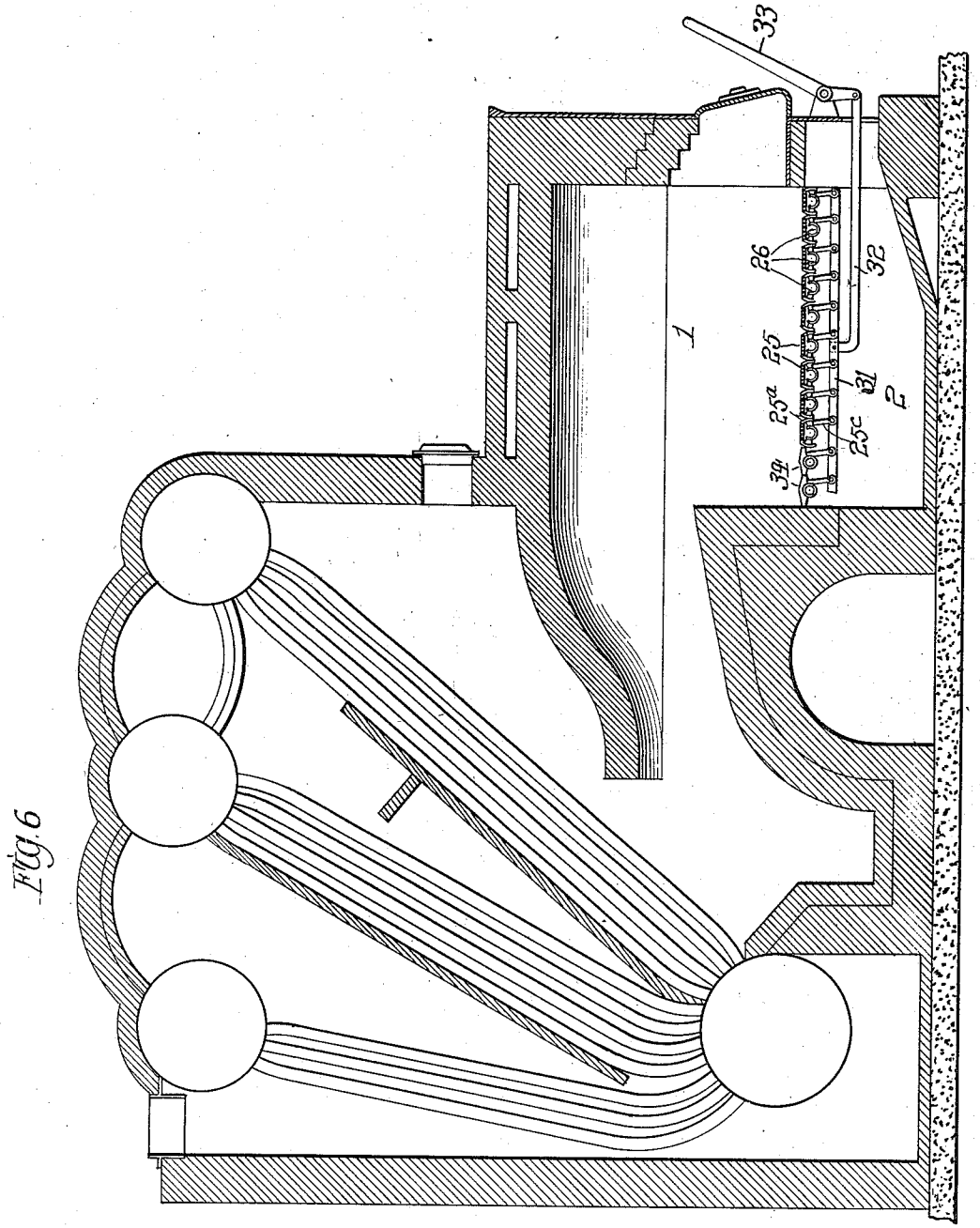


Fig. 6

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4 SHEETS—SHEET 4.

FIG. 7

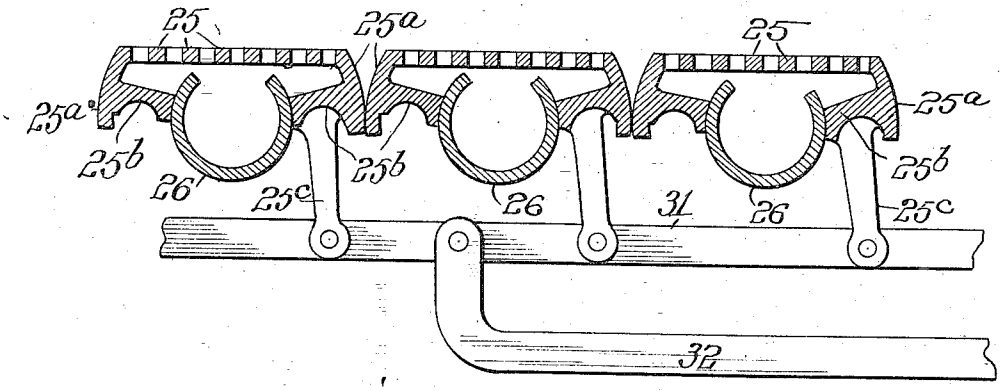
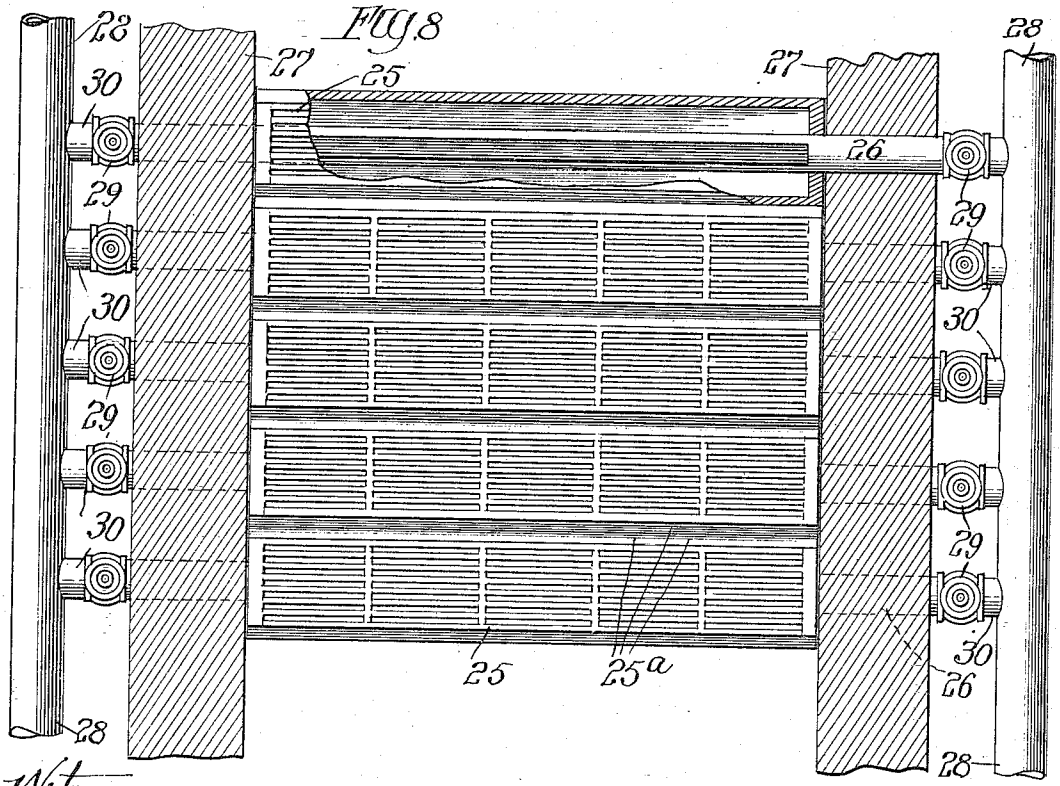


FIG. 8



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UNITED STATES PATENT OFFICE.

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1,127,824. Specification of Letters Patent. Patented Feb. 9, 1915.

Application filed December 22, 1906. Serial No. 349,087.

To all whom it may concern:

Be it known that I, LELAND L. SUMMERS, a citizen of the United States, residing at Chicago, Cook county, Illinois, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

My invention relates to furnaces and the like such as usually employed in connection with steam boilers and the object is to provide for the more thorough utilization of the fuel, such as coal, coke, and wood, by providing complete combustion under all conditions of use.

In general terms, my invention consists in providing a construction and arrangement of furnace and grates whereby the draft pressure in the furnace as well as the pressure in the ash pit is maintained at practically atmospheric pressure, and in providing means whereby the supply of air may be varied at will for different portions of the fuel bed according to the depth thereof or amount of resistance offered by the particular character of the fuel used, or to meet other conditions that may require such variations in air supply, with the result that the proper amount of air is supplied to insure complete combustion over the whole grate area and the ash and refuse is permitted to be discharged into the ash pit without causing any inrush of air therefrom to the furnace chamber which would interfere with or disturb the processes of combustion therein. As a further result, a continuous process of combustion is maintainable in a furnace of any construction and mode of operation, unaffected by the cleaning of the fire or the addition of fresh fuel in the manually fed type of boiler, as any opening of the fire doors for the addition of fuel will not cause any inrush of air as the layer of fresh coal and semi-consumed coal is maintained between the source of air pressure and the furnace and the atmosphere.

The various features of advantage and utility in my form and construction of furnace will be apparent from the description hereinafter given.

In the drawings Figure 1 is a sectional elevation of my improved form of furnace as shown applied to a well-known type of steam boiler, the particular furnace illustrated being of the automatic feed or stoker type; Fig. 2 is an end elevation partly in section of the grate bars and associated parts, this view being on an enlarged scale as compared with Fig. 1; Fig. 3 a section on the line 3—3 of Fig. 2 illustrating the construction of one of the grate bars and the air boxes at the ends thereof; Fig. 4 a cross-section on the line 4—4 of Fig. 3; Fig. 5 an elevation of the plate 14 and an end of a grate bar; Fig. 6 a sectional elevation of a modified construction of my furnace shown applied to the same type of steam boiler as in Fig. 1; Fig. 7 a cross-section on an enlarged scale of the grate bars of said modified form of construction; and Fig. 8 a plan view of the grate bars illustrated in Fig. 7 but on a smaller scale and showing the setting of the boiler in section.

My invention is applicable to different forms or types of furnaces, for instance the same may be applied to the automatic feed or stoker type of boiler furnace illustrated in Fig. 1 of the drawings or to the ordinary manually fed furnace illustrated in Fig. 6. Moreover, as is obvious, my furnace may be used in connection with any type or character of steam boiler or may be put to other uses than the mere generation of steam, but for convenience I have shown the same applied to a steam boiler which is of such well-known construction that it need not be further referred to, especially as my invention is not concerned with the type or character thereof.

Referring first to the type of furnace illustrated in Figs. 1, 2 and 3 in which the fuel is fed in an automatic manner, I provide a furnace chamber 1 of suitable dimensions and arrange therein a series of transverse grate bars having the peculiar construction and mode of operation about to be described. Below the grate bars is formed an ash pit 2 into which the ash and refuse may be discharged.

Any suitable number of the grate bars may be employed but in the present instance I have illustrated six of the same which, with the exception of the innermost one, are arranged at an angle so as to provide for the proper feed of the fuel from a fuel hopper 3 to the furnace chamber. Inasmuch as all of these grate bars are similar in construction a description of one of them will suffice for all.

Each grate bar consists of a tubular portion 4 which constitutes the grate surface proper and while I have shown these grate bars as cylindrical in form and will herein-

after refer to them as of that form, yet it will be understood that my invention is not limited thereto but that other forms such as an oval or cam form may be adopted, especially for the purpose of slicing or breaking up the bed of such fuel as tends to form a hard or impervious clinker. Each grate bar proper is provided with a central longitudinal sleeve 5 which fits upon and is suitably secured to a central shaft 6. The cylindrical grate bar 4 is connected with its sleeve by means of a series of radial partitions 7 which are, in the present instance, eight in number and extend from end to end of the grate bar thereby dividing the interior of the grate bar into a series of eight compartments segmental in cross-section, such compartments communicating with the walls of the grate bar through air spaces or openings such as the series of openings 4^a. It will be understood that different characters or designs of air spacing may be adopted and also that if desired the grate bars may be provided with projections or teeth to better convey the coal forward and to assist the slicing or breaking up of the bed of coal if occasion should require. The grate bars, by reason of their hollow construction, are arranged to deliver a supply of air which is admitted thereto at either or both ends, the latter arrangement being the one herein illustrated and moreover the arrangement is such, resulting from the provision of the compartments and mechanism to be hereinafter referred to, that the air is supplied only to that portion of the grate bars or to the particular compartment or compartments which are at the time upwardly presented so that the air is supplied to the furnace chamber only and cannot be supplied to the space or ash pit below the grate bars. To this end and referring to the particular construction herein illustrated, I arrange preferably within the opposite walls or setting 8 of the furnace air boxes 9, located at the ends of the grate bars and therefore having the general inclination of the series of grate bars as illustrated in Fig. 2. These air boxes are separated from each other by partitions 10, there being as many of them as there are grate bars so that each grate bar is supplied with air from its own air box, or air boxes in case that air boxes are provided at both ends of the grate bars. The air boxes are independently supplied with air through an air supply pipe 11 by means of a series of pipe connections 12 leading from the supply pipe 11 to the air boxes.

In order to attain one of the objects of my invention provision is made for supplying variable quantities of air to different portions of the fuel bed and in the present instance this result is obtained by providing means for regulating the supply of the air into the different air boxes. According to the present construction illustrated in Figs. 2 and 3 I provide independent valves 13 in the pipe connections 12 so that the amount of air admitted to the different boxes may be independently regulated at the will of the operator to suit the depth of fire or fuel bed carried on the grate bars. By this means the supply of air may be proportioned to the depth of the fuel bed. For instance over that portion of the grate where the fuel is in excess, a certain sufficient amount of air is required and is supplied in the proper quantity as determined by the operator while over that portion where the fuel is partially consumed a smaller quantity of air is supplied and over that portion where the ash is in excess the supply is restricted, thus preventing an excess of air from entering the furnace or fire chamber which would diminish the efficiency by lowering the temperature of the furnace and also causing an increased amount of heat to be carried away as waste heat in the stack, due to increased quantity of the gases diluted with the air.

In order to provide for the delivery of the air upwardly only from the grate bars into the furnace chamber and prevent delivery of the air downwardly into the ash pit I provide the air boxes with means whereby the air is delivered therefrom to the upper portion only of the grate bars, and in fact only to one or more of the particular compartments thereof which are presented upwardly at the time. Under the present construction as herein shown such means consists of plates 14 arranged one in each air box and adapted to be held with a yielding pressure against the end of its grate bar, to which end each plate is strung upon its shaft 6 and held in working position by means of the coiled spring 15, encircling said shaft toward its outer end. Each plate is solid or imperforate except as to a segmental opening 14^a formed in its upper half above the line of the shaft 6 and arranged to register with the particular compartment or compartments which are presented thereto when the same are in position to deliver their air upwardly into the furnace chamber. The air supplied from the air boxes thus finds exit only through the segmental openings 14^a in these plates inasmuch as the latter are held against the ends of the grate bars as well as against the inturned flanges 9^a forming a part of the air boxes.

The plurality of compartments in each grate bar is provided for the purpose of compelling the air supply to be directed upwardly only and preventing the admission of the air into the ash pit. As shown and by preference I provide eight of these compartments and each segmental opening

14ª is made of a size corresponding to the cross-sectional area of two of the compartments so that the full area of two of the compartments is always effective and so that also a compartment is always fully shut off from the air supply before it has been rotated sufficiently to communicate with the ash pit. Consequently the full effective area necessary for the adequate supply of air to the bed of fuel remains practically constant without any possibility of delivery of the air to the ash pit. The grate bars may be actuated in any suitable manner, a driving mechanism sufficient for the purpose being illustrated herein. Such driving mechanism consists of a driving pulley 16 arranged to drive the inclined shaft 17 through the medium of the worm 18, worm-gear 19 and shaft 20, which latter is connected with the shaft 17 by means of the universal joint 21. The shaft 17 is provided at intervals along its length with worms 22 adapted to mesh with worm-gears 23 secured to the outer ends of the shafts 6. By these means the grate bars are all rotated in unison so as to feed the fuel from the hopper 3 inwardly into the furnace and to discharge the ash through a suitable opening 24 formed adjacent the bridge wall of the furnace and emptying into the ash pit below. If desired the innermost grate bar adjacent the bridge wall may be unprovided with the air-supplying arrangement and be formed merely as an ash bar for discharging the ash and refuse into the ash pit. As hereinbefore stated my invention may also be applied as well to the shaking grate type of furnace as to the conveying grate type, to illustrate which other adaptation I have shown in Figs. 6, 7 and 8 of the drawings a modified form of construction in which a series of shaking grates 25 are employed in coöperation with a series of transverse air pipes 26. Each grate is provided with a suitable number and design of air spaces for the purposes of delivering to the fuel bed the air which is supplied from the air pipes through openings in the upper portions thereof immediately adjacent the grate bars proper. These air tubes, in the present instance, extend through the brick work or setting 27 of the boiler and are arranged to communicate with an air-supply pipe 28. If desired, as indicated in Fig. 8 these air pipes may be connected at both ends with supply pipes so as to assure a more even distribution of air over the entire width of the grate surface. Each air pipe 26 is formed continuous at those portions passing through the setting and is open only at that intermediate portion which is exposed to the grate surface as illustrated clearly in Fig. 8. The different air pipes are independently governed as to their air supply for the purposes hereinbefore mentioned and in the present instance such control is had through the medium of a series of hand valves 29 which control the supply of air from the supply pipes 28 to the ends of the air pipes through the short connections 30.

The grate bars which form the grate surface are of any desired number but in the present instance I have illustrated a series of nine thereof which are connected by means of a connecting bar 31 which is in turn connected to and operated by the usual shaking bar 32 extending to the front of the furnace and arranged to be operated by the hand lever 33. Each grate bar is so constructed as to oscillate around the central axis of its air pipe and the adjacent grate bars are arranged to coöperate with each other for the purpose of slicing or breaking up the bed of fuel, especially in cases of certain kinds of fuel tending to form a clinker. To this end the grate bars have on their longitudinal edges depending flanges 25ª formed on an arc described from the center of oscillation of the grate bars with the result that the adjacent flanges 25ª will bear against each other and break or slice the clinkers.

Each of the flanges 25ª of each grate bar is provided with an inwardly directed and substantially radial flange or web 25ᵇ whose inner edge corresponds to the curvature of its air tube and bears against and slides upon the same in the oscillation of the grate bars. One of the radial flanges 25ᵇ of each grate bar is connected by a depending extension 25ᶜ with the connecting bar 31 hereinbefore described. According to this construction, the air which is supplied to the air pipes 26, in the manner hereinbefore explained, is delivered upwardly and passes through the grate bars and through the fuel bed in amounts proportionate to the depth of the fuel or fire carried in the furnace chamber, as may be determined by the operator, who fits the series of valves 29 in the proper adjusted position to supply the necessary amount of air. Also, according to the described construction, the air which is supplied through the air pipes 26 is compelled to pass upwardly through the grates inasmuch as the grates proper are cut off from the ash pit below by the closed portion of the air pipes and by the radial webs 25ᵇ which are always in contact with the air tubes as clearly indicated in Fig. 7, so that a pressure will be maintained beneath the fuel bed and between such fuel bed and the bar, thereby providing a cooling influence on the grate bar and at the same time preventing the air pressure from equalizing so that the effect will be to maintain a series of varying air supplies in the fuel-bed while the ash pit pressure and the furnace pressure above the fuel bed will be approxi-

mately equal to the atmospheric pressure. Under this construction and arrangement, it is possible to have a series of ordinary grate bars such as the two bars 34 (Fig. 6), which may be termed ash removing bars, also connected to the shaking device described and arranged in the rear of the furnace so as to permit the ash and refuse to be emptied into the ash pit through wide and unobstructed openings, for owing to the described adjustment of the air pressures there will be no inrush of air from the ash pit into the furnace, but if the furnace pressure should be slightly in excess there will be a slight discharge of the gases into the ash pit with the ashes and refuse tending to assist in cleaning the fires. The process of combustion can thus be maintained continuously, unaffected by the cleaning of the fire or by the addition of fresh fuel, inasmuch as any opening of the fire doors for the addition of fuel will not cause an inrush of air. In practice the fresh fuel is preferably deposited near the front of the furnace and is gradually worked toward the rear of the furnace as combustion proceeds, the light ash and some clinkers being removed by the shaking grates without allowing an inrush of air owing to the design of the grate bar and the heavy clinker and refuse being removed through the ordinary grate bars 34 through which a free discharge is permitted either by means of a wider range of movement or by a wider spacing of the grate bar fingers. It will be understood that the character of the fuel consumed will determine the detail of these ash removing bars.

It will be evident that in the application of my invention to either the shaking grate type or the conveying grate type of furnace, it is not necessary that the entire air supply should be admitted through the grates, for in the combustion of certain fuels having a considerable proportion of volatile combustible it is an advantage to arrange the furnace as a semi-gas-producing furnace in which case only sufficient air, or a mixture of air and steam, will be admitted through the grate as will consume the fixed combustible and drive off the volatile combustible, the principal supply of air being admitted over the fire or through the bridge wall and being preferably previously heated by the waste heat of the fuel gases or by other means.

It will be understood that the resistance to the passage of air through the grates and through the fuel bed is overcome by the application of the pressure through the grates while a negative air-induced pressure may be applied beyond the furnace by means of a stack or fan (not shown), this induced pressure overcoming the frictional losses through the boiler or other apparatus utilizing the heat beyond the furnace, the same not being of sufficient amount to maintain a negative pressure or suction in the furnace where the pressure is preferably maintained at atmospheric pressure or slightly in excess thereof. By so proportioning the pressure and volume of the air supplied through the grates, the frictional losses of the grates and bed of fuel may be overcome and the greater amount of air may be supplied to those portions of the fuel bed requiring it while the portion of the grates having either less fuel or a bed of fuel offering less resistance to the passage of the air may have the pressure correspondingly reduced, the air furnished through the hollow grate bars thus supplying the furnace as the products of combustion are removed by the chimney and preventing the draft from the chimney lowering the furnace pressure.

I claim:

1. In combination with a furnace, a series of hollow grate bars therein arranged transversely of the direction of supply of the fuel and communicating with a supply of air under pressure, and a series of independently operated valves for governing the air supplied to the grate bars and arranged to vary the pressure or volume of the air supplied to the different grate bars from the front to the rear of the furnace.

2. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments adapted to communicate with a source of air under pressure, and means for supplying such air to a compartment only when presented toward the fuel bed so as to deliver its air thereto.

3. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments adapted to communicate with a source of air under pressure, and means for interrupting said communication with a compartment except when presented toward the fuel bed.

4. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments adapted to communicate with a source of air under pressure and means for admitting the air successively to those compartments which are exposed to the fuel bed.

5. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments adapted to communicate with a source of air under pressure and means for successively cutting off the supply of air to those compartments exposed to the ash pit.

6. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure,

and means for admitting the air successively to the compartments.

7. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, and plates, each provided with an opening through which the air passes into the compartments as the latter are successively presented to such opening.

8. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure and a plate arranged at the end of each grate bar and provided with an opening through which the air passes into the compartments as the same are successively presented to such opening.

9. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, and means for admitting the air to the compartments successively through an opening substantially segmental in form and corresponding in area substantially with the cross sectional area of two compartments of the grate bar.

10. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, a series of separate air boxes located at the end of the grate bars and communicating with said source of air supply, each of said air boxes having on its inner side adjacent its grate bar an opening for admitting the air to the compartments successively.

11. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, a series of separate air boxes located at the end of the grate bars and communicating with said source of air supply, each of said air boxes having on its inner side adjacent its grate bar and in the upper portion thereof a segmental opening for admitting the air to the compartments successively as they are exposed to the fuel bed.

12. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, a series of separate air boxes located at the end of the grate bars and communicating with said source of air supply, a plate 14 located in each air box and held with a yielding pressure toward the inner side thereof, each plate having an opening for admitting the air to the compartments successively as the grate bar rotates to expose the compartments to the fuel bed.

13. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, a series of separate air boxes located at the end of the grate bars and communicating with said source of air supply, a plate 14 located in each air box and spring pressed against the end of its grate bar, each plate having an opening for admitting the air to the compartments successively as the grate bar rotates to expose the compartments to the fuel bed.

14. In combination with a furnace, a series of rotatable grate bars, each divided into separate longitudinal compartments segmental in cross section and adapted to communicate with a source of air under pressure, a series of separate air boxes located at the end of the grate bars and communicating with said source of air supply, each of said air boxes having on its inner side adjacent its grate box and in the upper portion thereof a segmental opening for admitting the air to the compartments successively as they are exposed to the fuel bed, a main supply pipe 11, individual connecting pipes 12 therefrom to the air boxes, and independently operated valves 13 in the connecting pipes, whereby the supply of air to the different grate bars may be varied at will.

15. In combination with a furnace, a series of rotatable grate bars, each comprising a tubular grate surface 4, a longitudinal sleeve 5, a series of radial partitions dividing the grate bar into a series of separate compartments which are segmental in cross-section, a shaft or spindle 6 which passes through the sleeve 5 and on which the grate bar is mounted to rotate, and means for introducing a supply of air into said compartments successively.

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