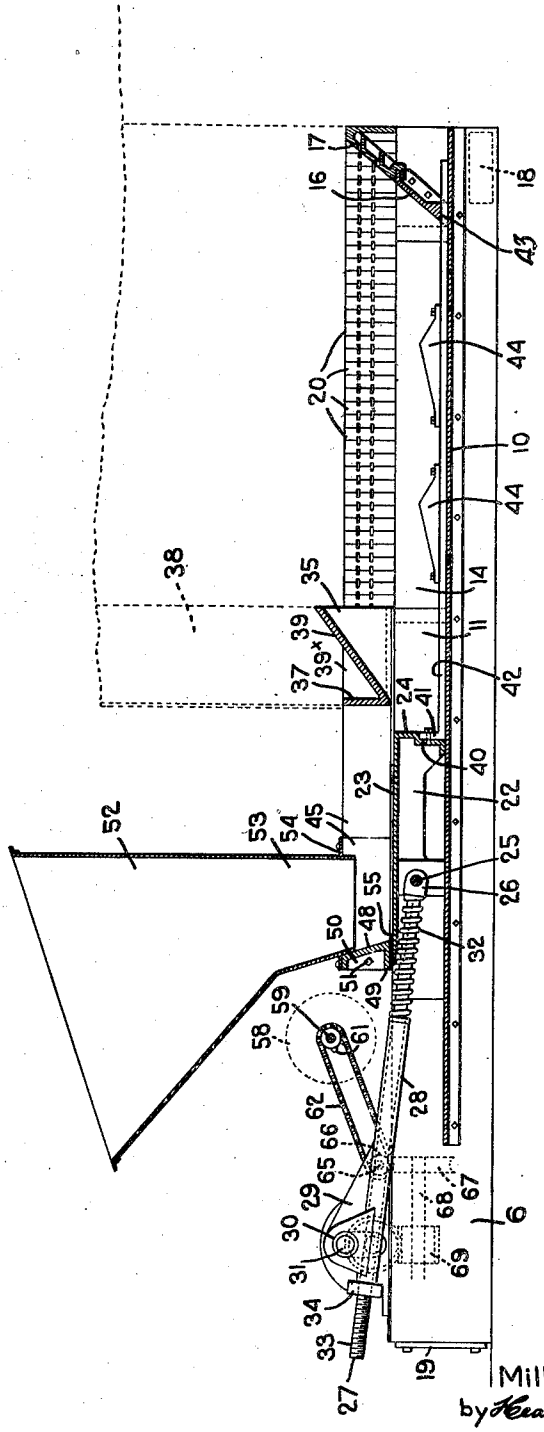
Dec. 6, 1938. M. E. YEAGER 2,139,144

UNDERFEED STOKER EQUIPMENT

Filed June 30, 1934 7 Sheets-Sheet 1

Fig. 1.



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UNDERFEED STOKER EQUIPMENT

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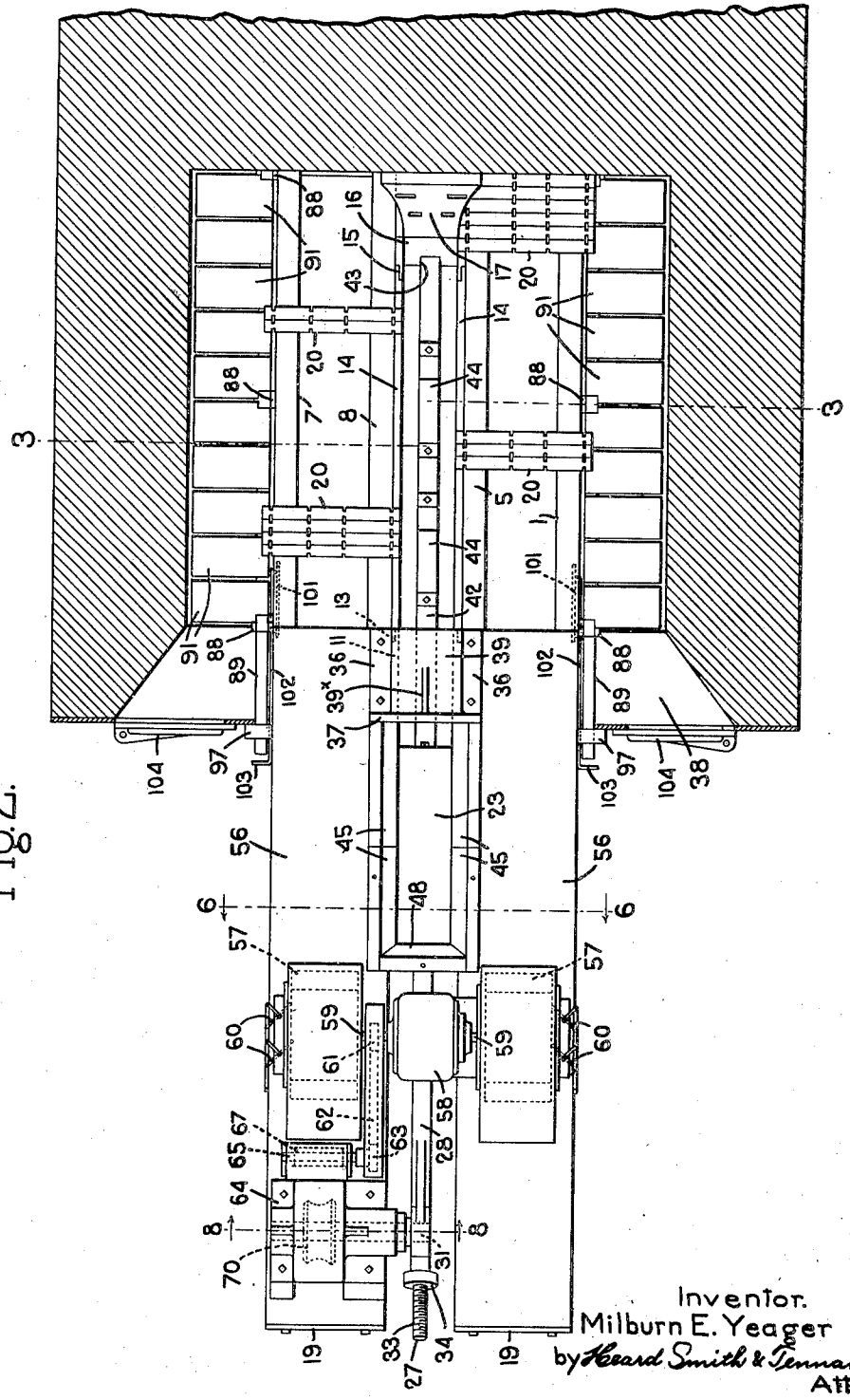

Fig. 2.

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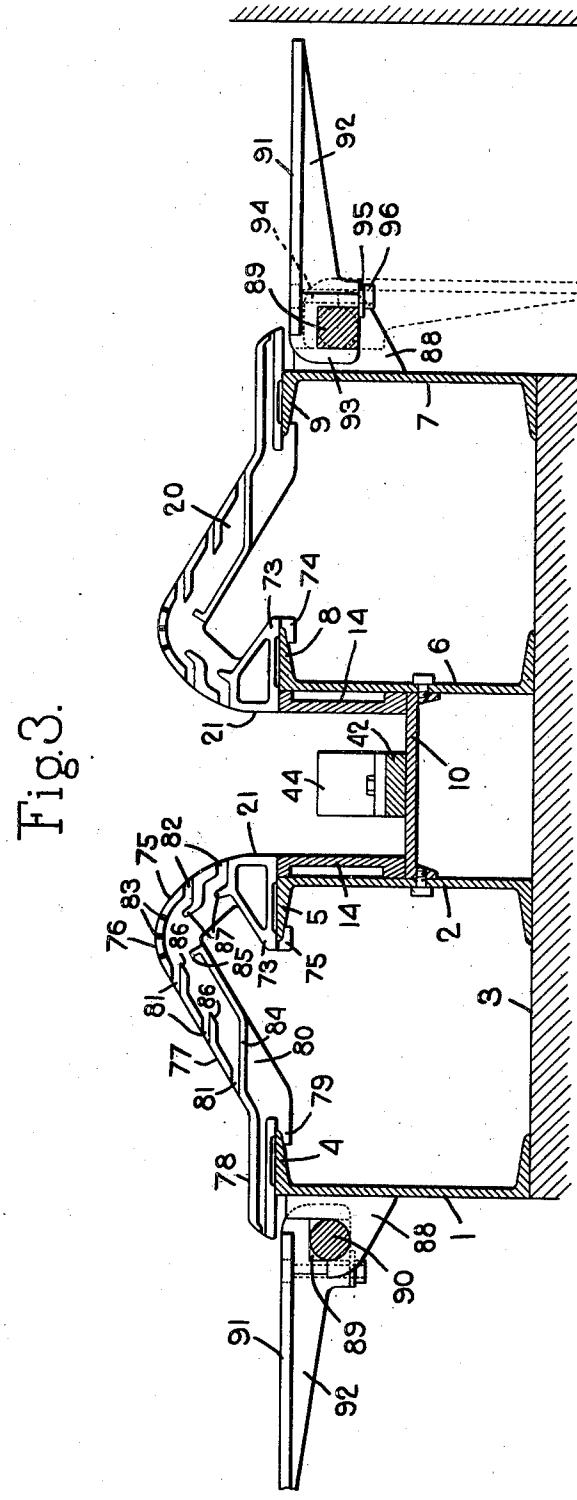

Fig. 3.

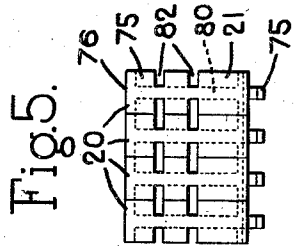

Fig. 5.

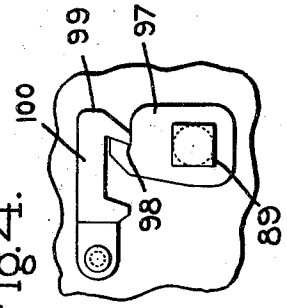

Fig. 4.

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Fig.6.

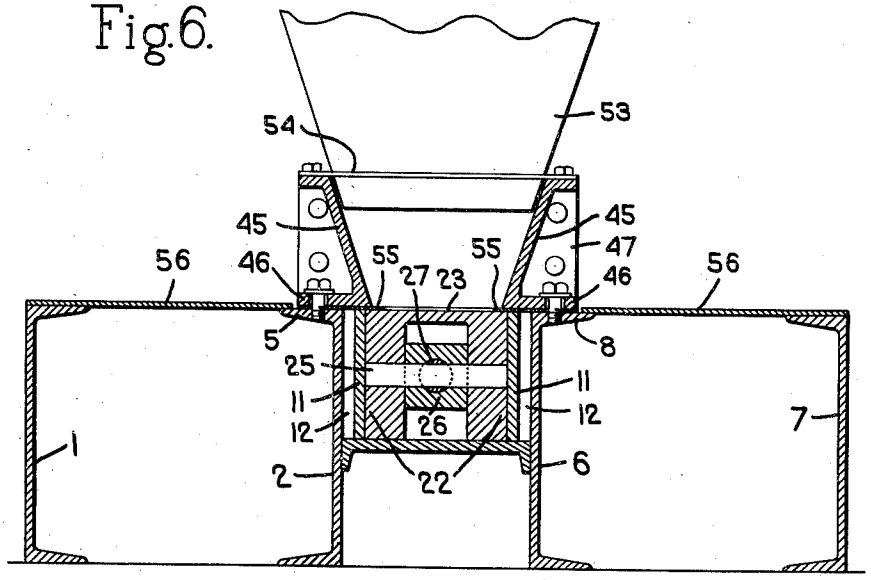

Fig.7.

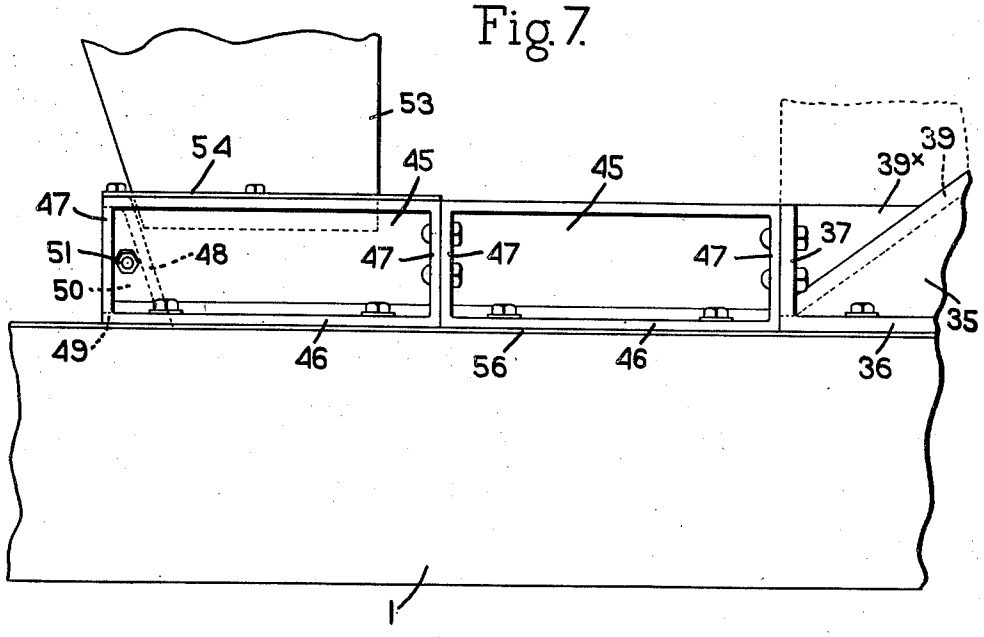

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Fig.8.

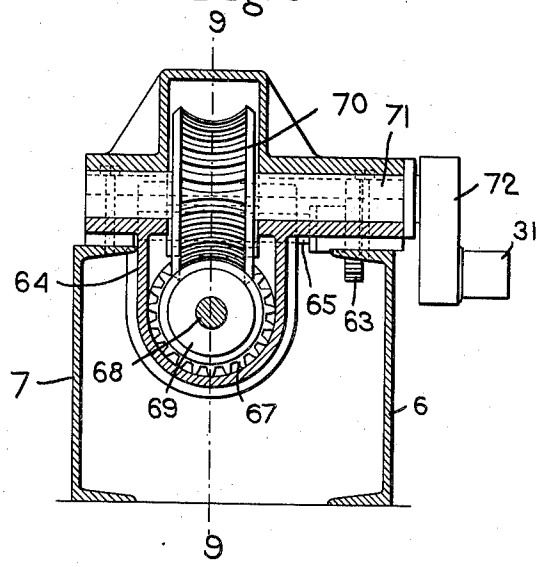
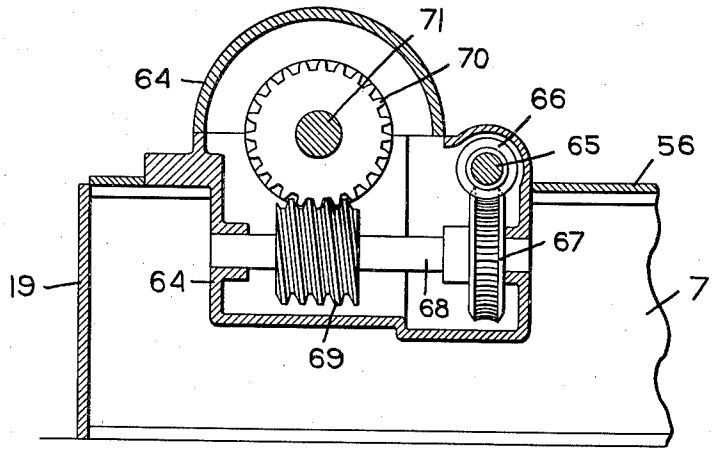


Fig.9.



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UNDERFEED STOKER EQUIPMENT

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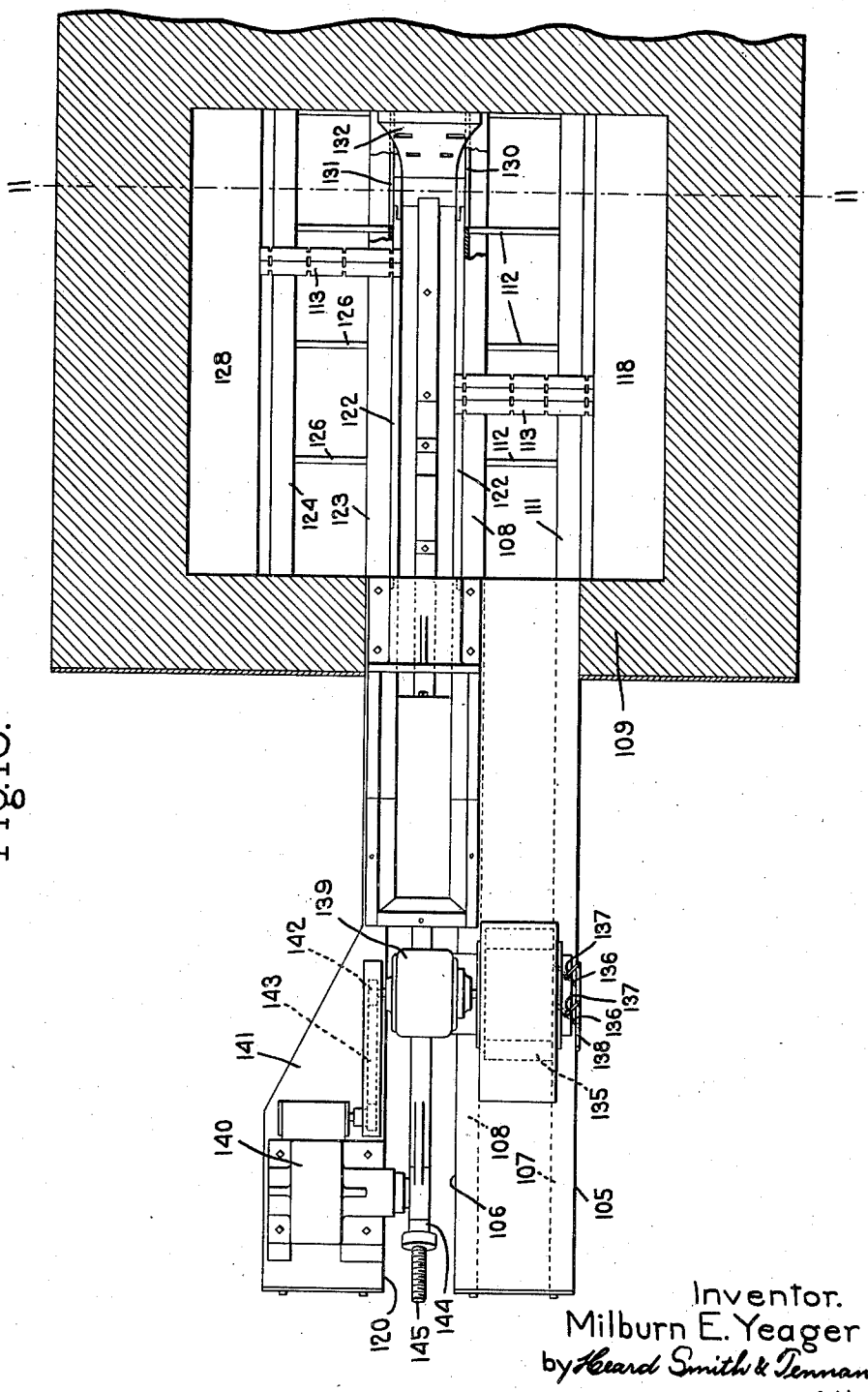

Fig. 10.

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UNDERFEED STOKER EQUIPMENT

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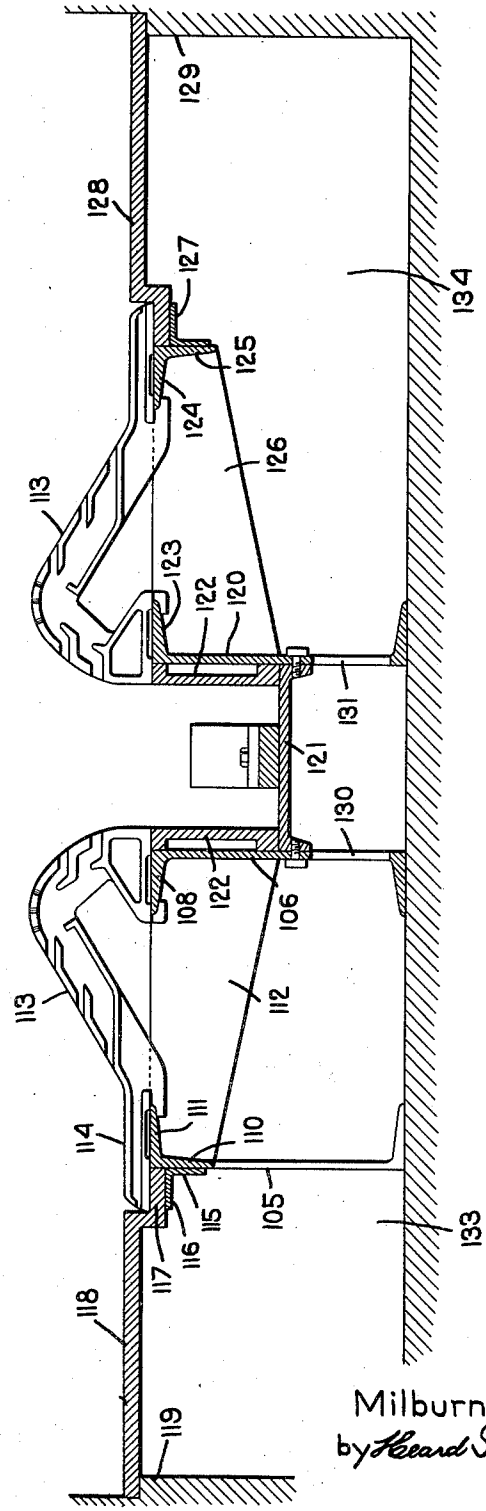
Fig. 11.



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Patented Dec. 6, 1938

2,139,144

UNITED STATES PATENT OFFICE

2,139,144

UNDERFEED STOKER EQUIPMENT

Milburn Edgar Yeager, West Somerville, Mass., assignor to National Engineering & Manufacturing Company, a corporation of Rhode Island

Application June 30, 1934, Serial No. 733,238

13 Claims. (Cl. 110—47)

This invention relates to improvements in stokers for furnaces and the general object thereof is to provide a stoker construction, for supplying air and for feeding fuel to a furnace, which will be of simplified construction and of economical operation.

A further object of the invention is to provide a stoker construction which can be built and assembled as a unit and applied to usual furnace constructions.

More specifically one of the objects of the invention is to provide a ram box and ram with power applying means for reciprocating the ram and means intermediate of the power applying means and ram yieldable in the feeding movement of the ram to resistance in excess of a predetermined amount by means of which the amount of fuel fed to the furnace will be automatically and accurately controlled and which, by yielding to unusual resistance, will prevent injury or breakage of the power applying or power transmitting means.

Another object of the invention is to provide a novel wind box construction in which the vertical sides of the wind box are formed of wide structural bars, such as channel bars, preferably of structural steel, adapted to extend through the furnace and to project beyond the front wall thereof to provide within the furnace a support for the tuyères and outside of the furnace a support for the hopper, the fan or fans for supplying air to the burning fuel in the furnace and also to support the motor and the power transmitting mechanism for actuating the ram.

Another object of the invention is to provide a pair of parallel wind boxes of the character described with a plate, preferably in the form of an inverted channel, connecting adjacent sides of two parallel wind boxes intermediate of their width and providing outside of the furnace the base of a ram box and within the furnace the base of a retort for an under-feed furnace.

Another object of the invention is to provide an under-feed stoker construction of the character described in which the actuating mechanism for the ram may be mounted upon the channels of the wind box at a greater distance from the front of the furnace than that upon which the fan or fans are located, thereby permitting the use of a long connecting rod mechanism between the ram and its actuating mechanism which will permit the application of power to the ram in approximately the horizontal plane of the ram.

A further object of the invention is to provide a construction of the character specified in which a driving motor may be mounted upon the channels forming the sides of the wind box and a power transmission unit also mounted upon said channel bars in such manner as to apply power to the ram in proximity to the median horizontal plane of reciprocation of the ram.

Another object of the invention is to provide an improved hopper and hopper throat plate construction which will enable the hopper to be placed adjacent to or more remote from the front of the furnace as conditions require.

A further feature of the invention consists in providing means for effectively sealing the passage from the hopper to the ram which will prevent fuel from entering the ram box outside of the fuel-receiving portion thereof.

Another object of the invention is to provide an under-feed stoker mechanism having a plurality of wind boxes with a fan for supplying air to each wind box and means for independently regulating the amount of air delivered to the respective wind boxes.

Another object of the invention is to provide a ram box having a ram presenting flat upper surfaces forming a bottom for the hopper with a shouldered portion to engage and advance the fuel into the retort and a supplemental ram having means for advancing and for agitating the fuel in such manner as to insure uniform delivery of fuel to the fuel bed of the furnace.

Another object of the invention is to provide an improved form of tuyère bar construction which will effectively prevent fuel and ashes from entering the wind box and which comprises means providing a Venturi-like action to increase the force of the air supplied to the ports of the assembled tuyère bars.

A further feature of the invention comprises a novel construction and assemblage of dump grates so associated with the tuyères as to insure complete combustion of the fuel and convenient dumping of the ash.

Another object of the invention is to provide a construction of the character described comprising parallel wind boxes with the ram box and tuyère therebetween of the character above described in which the air may be supplied to both the wind boxes from a single fan and which comprises dead plates to receive the ashes delivered from the fire-bed from which they may be raked out through the front of the furnace.

These and other objects and features of the invention will more fully appear from the following description and the accompanying drawings and will be particularly pointed out in the claims.

Preferred embodiments of the invention and details of construction are illustrated in the accompanying drawings, in which,

Fig. 1 is mainly a vertical longitudinal central sectional view through the ram box, the hopper for supplying fuel thereto, and the retort, illustrating certain portions of the driving mechanism and the tuyères in elevation;

Fig. 2 is a plan view of the construction shown in Fig. 1 as assembled in a furnace, the hopper not being shown;

Fig. 3 is a vertical transverse sectional view on line 3—3 Fig. 2, through the wind box, the retort therebetween and the shafts for the dump grates, the latter being shown in elevation;

Fig. 4 is a detail view showing the latch mechanism for locking the dump grates in horizontal position;

Fig. 5 is a detail end view of the portion of the assembled tuyères;

Fig. 6 is a transverse sectional view on line 6—6 Fig. 2 through the wind box, the ram box and ram therebetween and the hopper plates;

Fig. 7 is a side elevation of one of the wind boxes, the hopper plates, and a portion of the hopper mounted thereupon;

Fig. 8 is a vertical sectional view on line 8—8 Fig. 2 of the power transmitting mechanism mounted upon the channel bars forming the sides of the wind box;

Fig. 9 is a vertical sectional view of the power transmitting mechanism on line 9—9 Fig. 8;

Fig. 10 is a plan view similar to Fig. 2, illustrating a modified under-feed stoker construction embodying the invention; and,

Fig. 11 is an enlarged detail sectional view on line 11—11 Fig. 10.

The invention is illustrated in the accompanying drawings as embodied in an under-feed stocker, although certain features of the invention, particularly the mechanism for feeding fuel to the furnace, the tuyères, etc., may be embodied in other types of furnaces.

One of the objects of the invention as above pointed out is to provide an under-feed stoker construction which when assembled is of a unitary character adapted to be embodied in a usual type of furnace, such as a water tube or fire tube furnace, or other heating apparatus, and comprises a base frame of rigid construction in which the side walls of the wind boxes are formed of wide structural bars, preferably structural steel channel bars, which serve to support the ram box, a ram and its actuating mechanism, the hopper for feeding fuel to the ram box, the retort, tuyères, and dump grates, and which also supports the fan or fans for supplying air to the wind boxes, as will more fully appear.

As illustrated in the drawings two parallel wind boxes are provided which extend from outside of the furnace through the front wall of the furnace and preferably to the rear wall thereof. One of the wind boxes has side walls 1 and 2 formed of wide channels, preferably of structural steel, with the lower flanges thereof facing each other and resting upon a suitable rigid bed 3, such as concrete, with the upper flanges 4 and 5, which face each other, supporting certain mechanisms hereinafter described. The other wind box is formed of similar wide channel bars 6 and 7, preferably of structural steel, with the flanges thereof extending inwardly and having lower flanges resting upon the bed 3 with upper flanges 8 and 9 similarly supporting other mechanisms.

The adjacent channels 2 and 6 of the parallel wind boxes are spaced apart and a plate 10, preferably in the form of a structural steel channel having downwardly extending flanges, is bolted or otherwise secured to the webs of the channels 2 and 6 intermediate of the width thereof to provide outside of the furnace the bottom of a ram box, and within the furnace the bottom of a retort into which the fuel is fed by the ram and from which it is forced into the burning bed of fuel and over the tuyères and the unconsumed material finally delivered to dump grates or to a bed plate, as will hereinafter more fully appear.

The sides of the ram box desirably are provided with steel lining plates 11, which are spaced apart at their ends by blocks 12, which desirably are welded to the plates 11 and welded or otherwise secured to the webs 2 and 6 of the wind box. The rear ends of the plates 11 are provided with recesses 13 (see Fig. 2) which are engaged by complementary projections upon cast iron liners 14 for the sides of the retort. The opposite ends of the liners 14 are provided with projections to engage complementary recessed portions in the sides 15 of a tuyère box end which is located at the rear end of the retort as shown in Figs. 1 and 2, and has an inclined web 16 connecting the sides 15 and provided at its upper edge with a rearwardly extending flange which is engaged by a complementary transverse recess in an apertured extension plate 17 which extends outwardly over and is supported upon the upper flanges 5 and 8 of the channels forming the side walls of the wind boxes.

By reason of this construction the tuyère box end may be removed and the liners 14 drawn rearwardly a short distance to disengage the joint formed by the projection and recesses 13 so that the liners for the retort may be conveniently removed and replaced.

The side walls of the channel bars may be cut away beneath the tuyère box end to provide apertures 18 through which air under pressure may be forced through the tuyère box end when both bars are apertured and serve to provide communication between the wind boxes at the rear end of the furnace. The rear ends of the wind boxes are closed with suitable plates and the front end of the wind boxes provided with suitable detachable doors 19.

Suitable tuyères, formed of juxtaposed tuyère bars 20, preferably of a character hereinafter to be more fully described, are slidably and detachably mounted upon the upper flanges 4, 5, and 8, 9, of the respective wind boxes within the furnace, and form the tops of the wind boxes. The inner end portions 21 of the tuyère bars preferably are in alinement with the upper edges of the liners 14 of the retort and form extensions thereof as shown particularly in Fig. 3.

One of the principal features of the invention comprises novel mechanism for feeding fuel to the retort and while the feeding mechanism forming an essential feature of the present invention is shown herein as applied to an under-feed stoker, it is adapted to be embodied in other types of furnaces as will be readily understood by those skilled in the art.

The principal object of the feeding mechanism of this invention is to provide means, such as a ram for forcing the fuel into the retort or into the furnace, with yieldable means interposed between the ram and the actuating mechanism therefor of such character that it will serve to maintain an even fuel bed and will yield to unusual resistance of the fuel bed or to an obstruc-

tion without danger of breaking the ram, the actuating mechanism or the means for transmitting power therefrom to the ram.

The feeding mechanism illustrated herein comprises a ram having vertical sides 22 (see Figs. 1 and 6) connected by an integral top plate 23, adapted to form the bottom of the hopper throat, and a vertical fuel engaging and feeding face 24. A shaft 25, which extends through the sides 22, forms the pivot for the head 26 of a connecting rod 27 which is slidably mounted in a sleeve 28 which has a web 29 provided with a journaled bearing 30 for a crank 31 of power transmitting mechanism for reciprocating said sleeve and said connecting rod. A spiral spring 32, which is coiled about the connecting rod 27, is interposed between the head 26 of the connecting rod and a flange or collar on the adjacent end of the sleeve 28.

By reason of this construction the ram is forced forward by pressure of the sleeve against the spring which transmits said pressure to the ram. The ram therefore is enabled to yield to resistance in excess of a predetermined amount, whether such resistance is by reason of accumulation of material in the retort or caused by an obstruction in the retort throat or otherwise. The danger of breakage of parts which has been a serious defect in stokers heretofore constructed is thereby eliminated.

In order to control the rate of feed of fuel to the retort or furnace means are provided for controlling the effective length of reciprocation of the ram by the power applying mechanism. This is accomplished by providing an adjustable abutment adapted to be engaged by the other end of the sleeve during the portion of the rotation of the crank 31 which withdraws the ram after its feeding movement. Any suitable adjustable abutment may be provided. In the preferred construction illustrated the end portion 33 of the connecting rod 27, which projects beyond the sleeve, is screw threaded and provided with a nut 34 which may be positioned to give any desired amount of lost motion between the nut 34 and the adjacent end of the sleeve. It will, therefore, be obvious that by adjusting the amount of lost motion the distance which the ram will be withdrawn from its maximum feeding position may be accurately determined.

In the construction illustrated the ram is forced during its normal feeding movement to a position in which the vertical face 24 of the ram reaches or enters slightly into the throat of the retort. The retort is provided with a throat plate preferably comprising a casting having vertical sides 35 having flanges 36 which rest upon the flanges 5 and 8 of the channel bars 2 and 6 forming the inner walls of the respective wind boxes. The retort throat also comprises an integral vertical wall 37 the outer side of which is flush with the face of the front wall 38 of the furnace and has an upwardly and rearwardly inclined integral top 39 to permit the fuel to be forced upwardly and rearwardly into the fire-bed. Desirably the top 39 is provided centrally with a vertical web 39x extending to and formed integral with the vertical wall 37 of the throat plate.

The central portion of the vertical wall 24 of the ram is offset inwardly to provide a recess 40 which receives the upturned end 41 of a supplemental ram 42, preferably in the form of a rectangular bar, which lies upon the base 10 of the retort and is guided in a recess 43 in the lower inclined plate 16 of the tuyère end.

The supplemental ram bar has secured to it and at intervals wedges 44, the rear faces of which are considerably more abrupt than the front face. These wedges act during the reciprocation of the ram to agitate the material and by reason of the more abrupt inclination of the front edges thereof to force the fuel upwardly and rearwardly in the retort and over the tuyère bars which extend laterally from the edges of the retort, as illustrated in Figs. 2 and 3.

Any suitable means may be provided for supplying fuel to the ram box. In the present invention fuel is supplied by a hopper to a chamber formed by hopper plates located below the hopper and so constructed that a short or a long hopper throat may be employed in accordance with the requirements of the installation. As illustrated in Figs. 1 and 2 a long hopper throat is provided. The hopper throat in this construction comprises two pairs of alined hopper plates, one plate of each pair abutting end to end with a transverse plate closing the forward end of the hopper throat. Each of these hopper plates, as illustrated more particularly in Fig. 6, comprises a casting having a downwardly inclined side wall 45 which extends to or slightly beyond the vertical plane of the ram box lining 11. The hopper plates are provided at their lower sides with laterally extending flanges 46 which extend over and are supported by the flanges 5 and 8 of the inner vertical channel bars 2 and 6 of the wind boxes. Each of these hopper plates is provided at its ends with vertical flanges 47 adapting the same to be secured to each other and to the vertical flange 37 of the hopper throat. The outer end of the hopper throat is provided with an end throat plate having an inclined wall 48, a bottom flange 49 and vertical side flanges 50 which lie between and are secured by bolts 51 to the outer hopper side plates 45.

In the construction shown the hopper comprises a downwardly tapering body portion 52 and a more abruptly downwardly tapering lower portion 53 which is supported within a cover plate 54 which is bolted to the upper flanges of the pair of hopper plates farthest from the wall of the furnace and to the upper flange of the hopper throat plate 48 as shown in Figs. 1, 6 and 7.

If it is desired to provide a short hopper throat the hopper throat plates more remote from the furnace are removed, the hopper throat cover plate 54 placed over the hopper plates adjacent the end and the hopper throat plate 48 moved up to close the end of the hopper throat chamber as will be readily understood. This adjustability to provide either a long or short hopper throat is advantageous in installations where there is not sufficient room for the long hopper throat on the one hand, and upon the other where it is desired that a long hopper throat shall be used in order that the atendant may observe the flow of fuel from the hopper into the retort.

In order to prevent any of the fuel from sifting into the hopper box down the sides or over the rear end of the flat top of the ram a thin plate forming a seal is interposed between the lower flanges of the hopper throat plates and the flanges of the wind box channel bars to which the hopper throat plates are secured. This sealing plate 55 desirably comprises a flat sheet of thin sheet metal having the central portion cut out to provide a recess of somewhat less width than the distance between the hopper throat plates and projecting over the edges of the ram. The inner edges, which project over the ram box at the sides and

end, are preferably bent downwardly and upon assembly forced into frictional engagement with the flat plate 23 which forms the top of the ram and provides an effective seal for preventing fuel from sifting into the ram box as the ram is reciprocated.

In the present construction fans for supplying air to the wind boxes are located in front of and in proximity to the hopper while the power applying mechanism for actuating the ram is located in front of the fans. This is permitted by the provision of a long connecting rod for transmitting the power from the power applying means to the ram and is of great advantage over prior constructions in which the means for actuating the ram have been located between the fans for supplying air to the wind boxes and the furnace. One of the advantages obtained is in the employment of a long connecting rod which is in substantially the median horizontal plane of the ram during the feeding movement so that a substantially direct thrust is imparted from the crank of the power applying means to the ram, thereby lessening friction between the ram and the base of the ram box and enabling a maximum amount of power to be transmitted from the actuating mechanism to the ram.

The channel bar construction of the sides of the wind boxes enables a fan unit or units to be mounted directly upon the channel bars and also permits the mounting of a power transmitting unit directly upon the wind box channel bars. In the construction illustrated in Figs. 1 and 2, the cover plates 56 extend from the front wall of the furnace over each of the wind boxes to the end thereof and form closures for the wind boxes. Fan housings 57 having suitable base flanges are supported by and secured to the upper flanges 4, 5, and 8, 9, on the side channel bars of the wind boxes. A motor 58, which may be an electric motor, turbine, or other power producing unit, is located between the fan housings and supported by a suitable frame which rests upon and is bolted to the flanges 5 and 8 of the inner channel bars of the wind boxes. Suitable fans (not shown) are mounted upon the ends of the motor shaft 59 and recesses are cut in the cover plates 56 to coincide with the outlets of the fan housings and thereby permit the air from the fan to be forced into the respective wind boxes.

One of the features of the invention comprises means for controlling the amount of air delivered to the respective wind boxes. In the construction disclosed the outer walls of the fan boxes are recessed to provide an inlet for the fans which desirably are of the squirrel cage type and suitable adjustable dampers 60 placed in the inlets enable the amount of air drawn into the fan, and consequently delivered to the wind boxes, to be accurately controlled.

As illustrated herein the motor shaft 59 is provided with a sprocket gear 61 from which a sprocket chain 62 drives the sprocket pinion 63 upon a power transmitting mechanism for actuating the crank which reciprocates the ram. This power transmitting mechanism is of the speed reducing type and preferably is in the form of a unit having a suitable casing 64 which is supported upon and bolted to the upper flanges 8 and 9 of the channels 6 and 7 forming the sides of one of the wind boxes. The sprocket pinion 63 drives a shaft 65 mounted in bearings in the casing having a worm 66 which engages the worm wheel 67 upon a shaft 68 which is mounted in bearings in a portion of the housing depending into the wind box. The shaft 68 has upon it a worm 69 which drives a worm gear 70 upon a shaft 71 which is located above the wind box and is provided at its end with a crank arm 72 having at its end a crank 31 which engages the bearing 30 in the web 29 of the sleeve 28 through which power is transmitted to the ram. By reason of this construction therefore a standard motor for operating fans of a standard type can be readily utilized and power transmitting units of a suitable design may be employed, thereby enabling a great economy in expense over usual types of mechanisms requiring specialized construction as has hitherto been necessary.

It has heretofore been stated that the tuyères form the covering for the wind boxes within the furnace. In the present construction the tuyères are of a novel and improved construction and comprise a series of similar or reversely arranged tuyère bars 20 for the tops of the respective wind boxes. Each of these tuyère bars is of skeletonized construction having an inner base 73 which rests upon the flange 5 or 8 and has a downwardly extending under-cut portion 74 which is slidably mounted upon the upper flange 5 or 8 of the channel bar side 2 or 6 of the respective wind box. The body of the tuyère bar extends upwardly from the base presenting a substantially vertical face 21 as before described and therefrom an outwardly inclined curved flat surface 75 having a crown 76 from which it extends less abruptly downwardly to present a substantially flat face 77 which merges into a horizontal foot portion 78 which projects over the outside flange 4 or 9 of the channel bar 1 or 7 and is provided with an under-cut portion 79 which slidably engages the flange 4 or 9 of the outer channel bar 1 or 7 of a wind box.

Each of the tuyère bars has a depending reenforcing web 80 extending throughout its length and effectively dividing the tuyère bar into two compartments which when assembled with contiguous tuyère bars provides a pair of air passages. Each of the tuyère bars preferably is provided with recesses extending inwardly from the edges thereof providing a series of ports 81 and 82 and at the crown smaller ports 83. A web 84 extends from the central web 80 beneath the ports 81 and along the lower edge of the tuyère bar and has upwardly extending flanges 85, while other flanges 86 extend from the web 80 throughout the width of the plate substantially horizontally beneath the ports 81 in the straight flat face 77 of the tuyère bar. Similar flanges 87 having upwardly turned end portions similarly extend from the web 80 to the edges of the plates beneath the ports 82 along the inner curved wall 75 of the tuyère bars.

By reason of this construction apertures of a restricted area are provided between the end flanges 85 and adjacent flanges 86 leading to the ports 81 in the inclined flat surface 77 which produce a Venturi-like action upon the air which is forced from the tuyère box to the passages leading to the ports 81, thereby increasing the velocity of the air as it is forced into the fire-bed. The flanges 87 likewise provide restricted passages which produce a Venturi-like action upon the air which is forced through the ports 82.

It has heretofore been mentioned that the invention also comprises dump grates which are supported upon the outer walls 1 and 7 of the channel bars which form the sides of the wind boxes. In the particular construction illustrated a series of brackets 88 are welded, or otherwise

secured, to the upper portions of the vertical webs 1 and 7 forming the outsides of the respective wind boxes. A dump shaft 89 of rectangular construction is provided with cylindrical portions 90 which are rotatably mounted in the brackets 88. The dump grate bars are of novel construction each comprising a flat plate 91 having a central reenforcing web 92 merging into an enlarged inner end portion 93 which is provided with a rectangular recess to fit upon the squared portion of the dump grate shaft. The dump grate bars are secured to the dump grate shaft by bolts 94 which extend downwardly through the enlarged portions 93 of the dump grates and are provided with a collar or washer 95 which underlies the portion of the lower face of the dump grate shaft and is clamped thereupon by a nut 96.

The end of the dump grate shaft 89 extends beyond the front wall of the furnace and has secured to it a collar 97 (see Fig. 4) having a notch 98 which is engaged by the hook end 99 of a latch 100 which serve to secure the grate bars in horizontal position, as illustrated in Fig. 3. A suitable crank may be applied to the end of the dump grate shaft and upon release of the locking hook 100 from the collar 97 the crank may be operated to swing the top grate bars into vertical position, as illustrated in Fig. 3, to dump the ashes into the ash pit.

Desirably means are provided for admitting air beneath the dump grates if the ash supported thereby contains unburned fuel and in the present invention apertures, which are cut through the webs of the channel bars 1 and 7, are provided with sliding dampers 101 connected to rods 102 which may be adjusted by means of handles 103 located beyond the front wall of the furnace. The front wall of the furnace is provided with suitable hinged doors 104 which may be opened to permit the ashes in the ash pit to be raked out.

It will be observed that the under feed stoker mechanism comprising the present invention is of simple and rigid construction adapted to be assembled as a unit with all parts thereof, including the fans and their driving mechanisms, and the power applying and transmitting mechanism mounted upon the channel bars forming the sides of the wind boxes. The parts outside of the furnace are easily accessible and within the furnace the linings for the retort and tuyère bars and the dump grates are readily removable and replaceable.

The fuel feeding mechanism is of a particularly novel character in that the ram is yieldable to resistance in excess of a predetermined amount without danger of breakage of the ram, its connecting rod, or power applying mechanism through which great force is imparted to the ram in its feeding movement. The long flat surface of the ram, which forms the bottom of the hopper throat, is of novel construction and is adapted to permit the placing of the hopper in close proximity to or at a distance from the front wall of the furnace, thereby enabling the stoker construction to be adapted to the requirements of different installations.

In the operation of the device the fuel in the hopper 52 descends by gravity upon the top surface 23 of the ram which forms the bottom of the hopper throat. Upon the reciprocating movement of the ram the fuel drops in front of the vertical end 24 of the ram and during the forward movement of the ram is forced through the ram box into the retort. At the same time, during the forward movement of the ram, the fuel resting upon the upper flat surface 23 is advanced into contact with the front wall 37 of the hopper throat plate. The advancing movement of the ram also causes the wedges 44 of the supplemental ram to forward the fuel in the retort and at the same time to agitate and raise it. When the retort has been filled with fuel continued operation of the ram causes the fuel to be carried upwardly over the crown of the tuyère bars and over the downwardly inclined flat surface thereof. Such portion of the fuel as is thus supported by the tuyères is subjected to blasts of air issuing from ports in the tuyères and proper combustion insured. The ashes from the burned fuel pass from the ends of the tuyère bars on to the dump grates where it accumulates until the dump grates are dumped. Any fuel which remains in the ash after it is deposited upon the dump grates may be burned by admission of air beneath the dump grates and its passage through the narrow spaces between adjacent dump grates.

Figs. 10 and 11 illustrate the invention as applied to a modified form of under-feed stoker construction in which dead plates are provided at the outer ends of the tuyères to receive the ashes and other unconsumed material delivered from the fire-bed. In the construction illustrated in Figs. 10 and 11 a single fan is employed which supplies air under pressure to a single wind box which extends through the front wall of the furnace and delivers air under pressure to a chamber beneath the tuyères on one side of the retort and the dead plate extending from the outer ends of said tuyères and forming the top closure for said chamber. The chamber beneath the tuyères and dead plate is in effect an enlarged extension of the wind box. A suitable passage or conduit located at the rear end of this chamber communicates with a similar chamber upon the other side of the retort the top of which is likewise formed by the tuyères and a dead plate.

The mechanism for supplying air to the wind box may be and desirably is the same or similar to that heretofore described. The construction of the ram box, ram, and the mechanism for actuating the ram also may be and desirably is the same or similar to that heretofore described.

In the construction illustrated in Figs. 10 and 11 the wind box comprises side walls 105 and 106 formed of wide channels, preferably of structural steel, with the lower flanges facing each other and resting upon a suitable rigid bed, such as concrete, and with the upper flanges 107 and 108 which also face each other, serving to support the fan housing and fan and also serving as one of the supports for the motor.

The channel bar 106 desirably extends through the furnace to the rear end thereof, while the channel bar 105 terminates preferably at the inner face of the front wall 109. An angle bar 110 having an upper flange 111 of the same width as the flange 107 abuts against the end of the channel 105 and extends through the furnace in parallelism with the channel 106 and is supported upon suitable brackets 112 welded or otherwise secured to the channel bar 106.

Tuyère bars 113, which may be and desirably are the same or similar to the tuyère bars 20 heretofore described, are slidably mounted upon the flange 108 of the channel bar 106 and the flange 111 of the angle bar 110. The lower ends 114 of the tuyère bars extend horizontally across and preferably beyond the angle bar 111. An angle bar 115 relatively lighter than the angle bar 110 extends longitudinally thereof and is welded

thereto with its horizontal flange 116 sufficiently lower than the plane of the upper surface of the flange 111 to receive the offset edge 117 of a flat dead plate 118, the upper surface of which desirably is flush with the upper surface of the tuyère bar ends 114. The outer edge of the dead plate 118 may be supported in any suitable manner as by brick-work 119 built against the side wall of the furnace.

The ram box and ram and the retort are of the same construction as that heretofore described differing only in that a single channel bar 120 of the same width and equal in length to the channel bar 106 extends in parallelism with the channel bar 106 throughout its length and is spaced apart therefrom by a horizontal plate 121 preferably in the form of a channel bar having downwardly extending flanges secured to the webs of the channel bars 106 and 120.

The channel bar 121 forms the base of the ram box and also forms the base of the retort as heretofore described. The ram box may be and desirably is provided with steel lining plates (not shown) and the retort with cast iron liners 122 which may be constructed and secured in place in the manner heretofore described. The tuyères 113 at the opposite side of the retort than those heretofore described are slidably mounted at their inner ends upon the upper flange 123 of the channel bar 120 and at their outer ends are slidably mounted upon the horizontal flange 124 of an angle bar 125 which is supported upon suitable brackets 126, similar to the brackets 112, welded or otherwise secured to the channel bar 120. A smaller angle bar 127 extends longitudinally of and is secured to the angle bar 125 and serves to support the offset edge of a dead plate 128, the outer edge of which rests upon a suitable support 129, such as brick-work extending along the wall of the furnace.

The webs of the channels 106 and 120 are provided near the rear of the furnace with apertures 130 and 131 beneath a tuyère box end 132 which desirably is the same or similar to that previously described. Air under pressure supplied from the wind box to the chamber 133 will, therefore, be forced through the apertures 130 and 131 beneath the tuyère box end 132 into the chamber 134. The chamber 134 has a dead front end and the air under pressure accumulating in the chamber 134 will therefore be forced through the ports of the tuyères 113 forming a portion of the top of said chamber into the portion of the fuel bed resting thereupon.

As heretofore stated the fan mechanism for supplying air to the wind box, the driving motor and the power transmission mechanism actuated thereby to reciprocate the ram, may be in all respects the same as that heretofore described. As illustrated in Fig. 10 a fan housing 135 is mounted upon the webs 107 and 108 of the channels 105 and 106. A fan, preferably of the squirrel cage type, is mounted in the housing and is supplied with air through an air inlet at the eye of the fan.

Suitable means for regulating the effective area of the air inlet are provided. As illustrated in Fig. 10 two dampers 136 of the butterfly type are mounted upon vertical pivots in the fan housing and provided with arms 137 which are connected to a link 138 by means of which they may be simultaneously adjusted to vary the effective area of the fan inlet. A motor 139 is mounted upon the flanges 108 and 123 of the channel bars 106 and 120 and the motor thereof desirably is directly connected to the fan.

Suitable power transmitting mechanism 140, such as that above described, is mounted upon a base plate 141 which is supported by suitable brackets (not shown) from the channel bar 120. The motor 139 is provided with a suitable sprocket gear 142 for transmitting power through a sprocket chain 143 to the power transmitting mechanism which reciprocates a sleeve 144 which is slidably mounted upon a connecting rod 145, the opposite end of which is connected to the ram, and the power applied thereto through a spring interposed between the sleeve and the head of the connecting rod, as heretofore described, in respect to the construction illustrated in Fig. 1.

The construction of the hopper and the hopper throat providing for either a long or a short throat, and other elements of the feeding mechanism, may be and desirably are the same as those heretofore described.

It will be understood that various modifications in form, construction and arrangement of parts may be made and that many features of the invention may be employed in stokers for other forms of furnace than those herein specifically described, and therefore that the particular embodiments of the invention are of an illustrative character and not restrictive of the meaning and scope of the following claims.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of the said adjacent sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace.

2. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of the said adjacent sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a tuyère box at the end of said retort communicating with said wind boxes and having a surface inclined upwardly to permit fuel from said retort to flow over the sides of said retort.

3. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of the said adjacent sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a tuyère box at the end of said retort communicating with said wind boxes and having a surface inclined upwardly to permit fuel from said retort to flow over the sides of said retort, lining plates secured to and spaced apart from the sides of the ram box, and liners for said retort.

4. An underfeed stoker assembly, a furnace

having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of the said adjacent sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, an end hopper throat plate and a plurality of pairs of hopper throat plates mounted upon the said adjacent wind box sides in front of said furnace, and a hopper mounted upon said hopper throat plates remote from the front wall of the furnace leaving a space between the hopper and the front wall of the furnace for observation of and access to the fuel being fed to the furnace, said hopper communicating with said ram box.

5. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, one of said wind boxes and the adjacent side of the other wind box extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of said adjacent sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a hopper mounted on the adjacent wind box sides in front of the front wall of said furnace and communicating with said ram box, a motor mounted on the adjacent wind box sides in front of said hopper, a fan driven by said motor mounted in a casing communicating with the wind box which extends through the front wall of said furnace, a ram reciprocably mounted in said ram box, and power transmitting means driven by said motor for actuating said fan mounted in front of said motor, thereby permitting the use of a long pitman rod for reciprocating said ram and consequent application of power to the ram substantially in the direction of the axis of its reciprocation.

6. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes within said furnace, and extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of said adjacent wind box sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a hopper mounted in front of said front furnace wall, said hopper communicating with said ram box, a motor mounted in front of said hopper, fans mounted upon the shaft of said motor, housings enclosing said fans communicating with the respective wind boxes, and means for adjusting the areas of the inlets to said housing whereby the pressure of the air in the respective wind boxes may be regulated.

7. An underfeed stoker assembly, a furnace having a flat floor and a front wall, comprising two spaced parallel wind boxes, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of said adjacent wind box sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a series of contiguous tuyère bars forming the tops of said wind boxes within the furnace having end portions slidably and detachably mounted upon the adjacent wind box sides, and means for supplying air under pressure to said wind boxes.

8. An underfeed stoker assembly, a furance having a flat floor and a front wall, comprising two spaced parallel wind boxes, the adjacent sides of said wind boxes extending through and well beyond the front wall of the furnace, a horizontal plate extending longitudinally of said adjacent wind box sides and secured thereto and forming with the sides of said wind boxes a retort within the said furnace and a ram box outside said furnace, a series of contiguous tuyère bars forming the tops of said wind boxes within the furnace having end portions slidably and detachably mounted upon the adjacent wind box sides, and at their inner ends extending upwardly and curving outwardly forming extensions of the walls of said retort and thence extending more gradually downwardly and outwardly to provide supporting surfaces for the burning fuel and having means to prevent admission of fuel or ash to the wind boxes.

9. In an underfeed stoker assembly for furnaces, a wind box, tuyères positioned on said wind box, a retort associated with said wind box, a ram box in alignment with and communicating with said retort, a ram movable in said ram box, power means for reciprocating said ram, a coal hopper, and a conveyor device operated by said ram for receiving coal from said hopper, said conveyor device comprising means whereby movement of said ram towards the furnace carries one charge of coal forwardly towards the retort and also forces another charge of coal from the ram box into the retort, and movement of the ram in the opposite direction permits passage of the conveyor charge into the ram box.

10. In an underfeed stoker assembly for furnaces, a wind box, tuyères positioned on said wind box, a retort associated with said wind box, a ram box in alignment with and communicating with said retort, a ram movable in said ram box, power means for reciprocating said ram, a coal hopper, and a conveyor device secured to said ram and forming the upper portion thereof for receiving coal from said hopper, whereby movement of said ram towards the furnace carries one charge of coal in said conveyor device forwardly towards the furnace and also faces another charge of coal from the ram box into the retort, and movement of the ram in the opposite direction permits passage of the conveyor charge from the conveyor device into the ram box.

11. In an underfeed stoker assembly for furnaces, a wind box, tuyères positioned on said wind box, a retort associated with said wind box, a ram box in alignment with and communicating with said retort, a ram movable in said ram box, power means for reciprocating said ram including a pressure member contractible upon excessive ram resistance, a coal hopper, and a conveyor device secured to said ram for receiving coal from said hopper and including means whereby movement of said ram towards the furnace carries one charge of coal forwardly towards the furnace and forces another charge of coal from the ram box into the retort, and movement of the ram in the opposite direction permits passage of the conveyor charge into the ram box.

12. In an underfeed stoker assembly for furnaces, a wind box, tuyères positioned on said wind box, a retort associated with said wind box, a ram box in alignment with and communicating with said retort, a ram movable in said ram

box, power means for reciprocating said ram, including a pressure member yieldable upon excessive ram resistance, a coal hopper, and a conveyor device secured to said ram and forming the upper portion thereof, for receiving coal from said hopper and having means whereby movement of said ram towards the furnace carries one charge of coal forwardly towards the furnace and also forces another charge of coal from the ram box into the retort, and movement of the ram in the opposite direction permits passage of the conveyor charge into the ram box.

13. In an underfeed stoker assembly for furnaces, a retort, a ram box communicating therewith, a ram in said ram box, and reciprocating means for said ram comprising a sleeve, a rod slidable therein and having one end secured to the ram, and a cylindrical coil spring mounted on said rod and having an internal diameter slightly in excess of the rod diameter, said coil spring ends engaging the contiguous sleeve end and rod end, the end of said rod having a lock member adjustably mounted therein and engaging the other end of the sleeve.

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