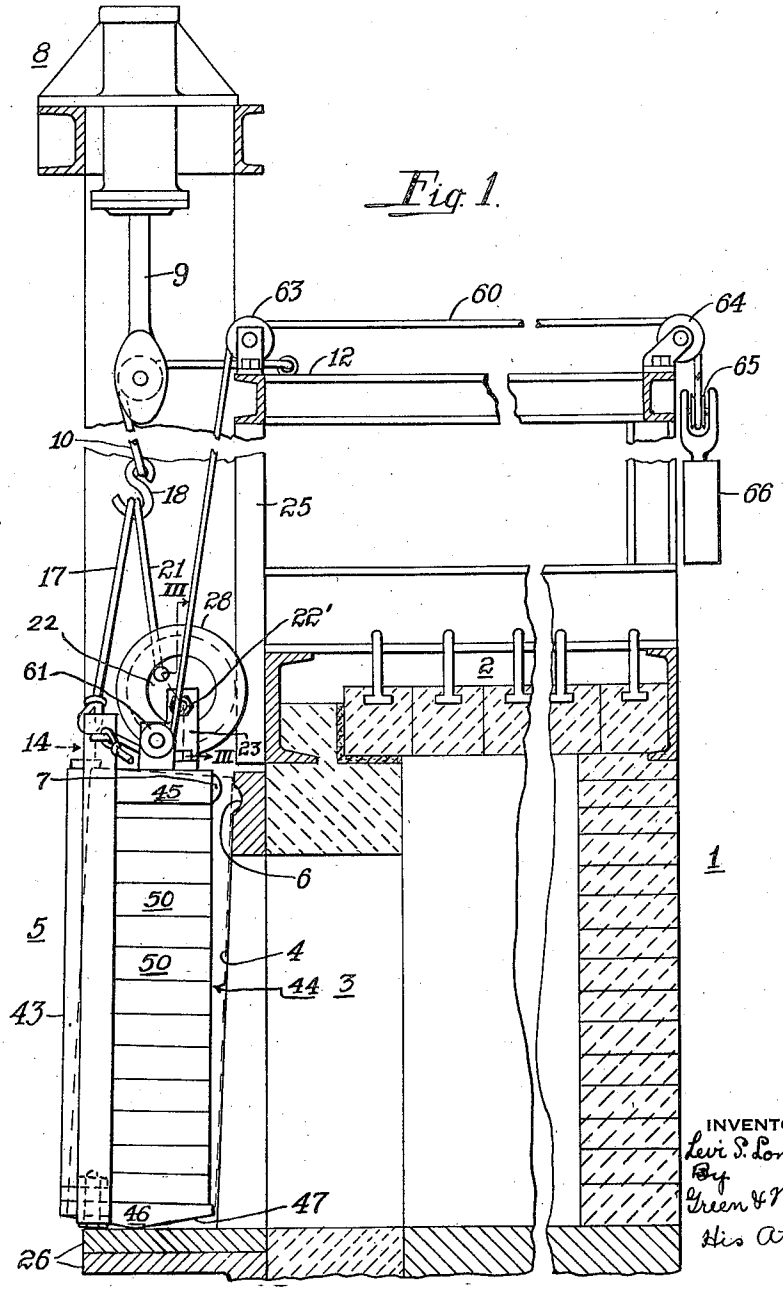
June 30, 1936. L. S. LONGENECKER 2,045,662

FURNACE DOOR AND OPERATING MECHANISM THEREFOR

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Fig. 1.



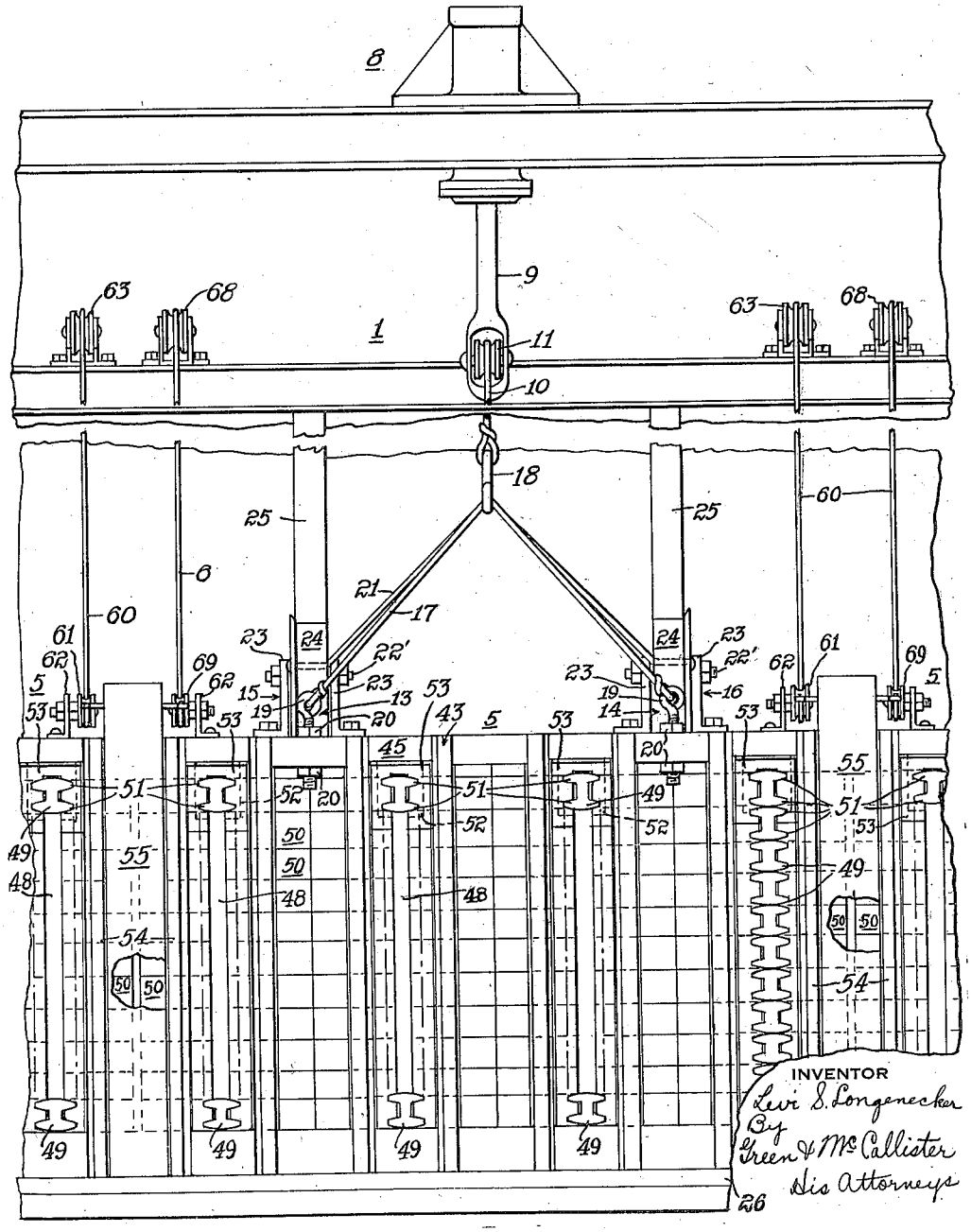
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Fig. 2.



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Fig. 3.

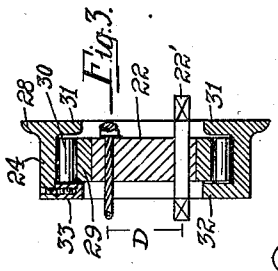
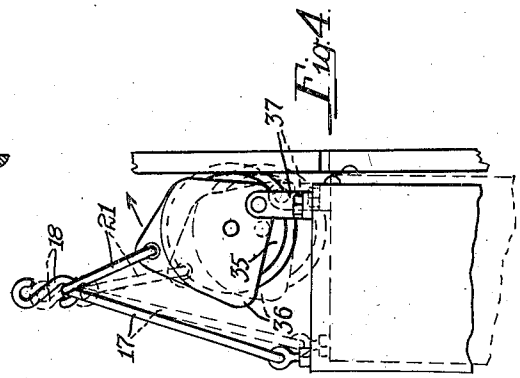


Fig. 4.



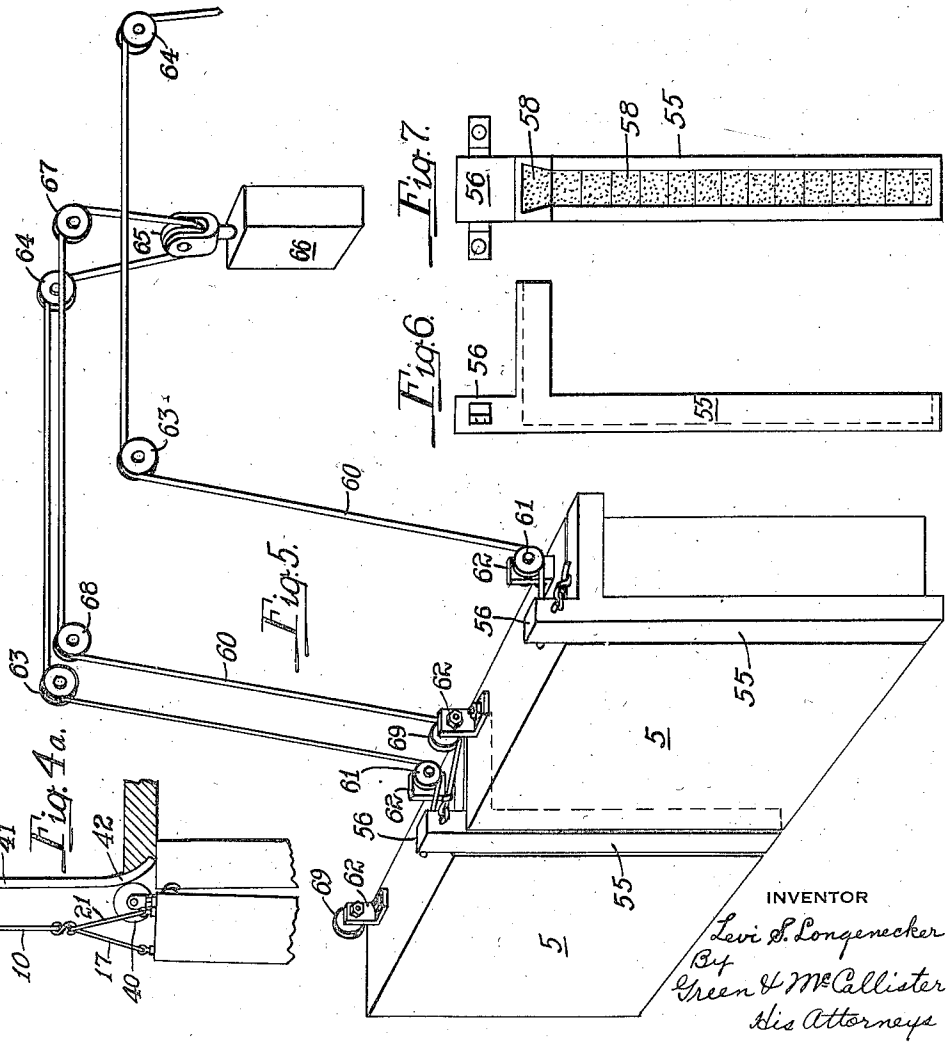


Fig. 7.

Fig. 6.

Fig. 5.

Fig. 4a.

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UNITED STATES PATENT OFFICE

2,045,662

FURNACE DOOR AND OPERATING MECHANISM THEREFOR

Levi S. Longenecker, Pittsburgh, Pa.

Application June 4, 1934, Serial No. 728,846

16 Claims. (Cl. 110—173)

This invention relates to doors and more particularly to doors for metallurgical furnaces and to operating mechanisms therefor.

Heretofore doors for metallurgical furnaces have been mounted and operated in such fashion as to slide on the furnace walls and door jambs as they were raised and lowered. This mode of operation required considerable power to overcome the friction involved between the sliding surfaces and subjected the lining of the doors as well as the door jambs and arches to considerable wear and damage.

An object of this invention is to provide a door and operating mechanism therefor that shall prevent sliding frictional contact between the door and the furnace or any part thereof when raised or lowered.

Another object of the invention is to provide a door operating mechanism that shall provide for the travel of the door on rollers or wheels operating on vertical or substantially vertical tracks as it is raised or lowered.

A further object of the invention is to provide a door operating mechanism that shall cause the door, when closed, to lean against the furnace in tight or sealed position, and, to shift the door out of contact with the furnace so as to break the seal, before the door starts to raise towards open position.

A still further object of the invention is to provide doors which shall be designed for use with furnaces having a door opening that is continuous for a length equal to the over-all width of at least two doors, and operating mechanism therefor whereby the doors may be individually operated without interference from the others.

A further object of the invention is to provide a seal for the joints between adjacent doors that shall, in addition to its sealing function, effectively maintain the proper spacing between such doors.

And a further object of the invention is to provide a seal that shall not interfere with or obstruct the door opening.

Other objects of the invention will, in part, be apparent and will, in part, be obvious from the following description taken in conjunction with the accompanying drawings in which:

Figure 1 is a fragmentary view of a furnace in transverse section showing a door, and operating mechanism therefor;

Fig. 2 is a fragmentary view in side elevation of the furnace shown in Fig. 1, showing a series of doors disposed in side by side relation and the means for sealing the joints between adjacent doors and illustrating one form of door lifting mechanism as applied to one door, however, it is to be understood that a lift is provided for each door;

Fig. 3 is a view in vertical section of a portion of the door operating mechanism shown in Figs. 1 and 2 taken on line III—III of Fig. 1;

Fig. 4 is a fragmentary view in end elevation of a door showing a modified form of means for shifting the door away from the furnace and permitting it to roll on tracks as the door is raised or lowered;

Fig. 4a is a fragmentary view in side elevation showing a further modified form of door operating mechanism;

Fig. 5 is a more or less diagrammatic view in perspective of two doors showing the sealing means between adjacent doors and the means of operating the seals of such doors;

Fig. 6 is a view in side elevation of a door seal; and

Fig. 7 is a view in rear elevation of a door seal showing the refractory lining therein.

Throughout the drawings and the specification, like reference characters indicate like parts.

In Fig. 1 of the drawings, a furnace 1 is shown, which may be either an open hearth or heating furnace, and includes an arch or roof 2.

The particular roof or arch illustrated is of the flat suspended type such as shown in my United States Letters Patent No. 1,913,168, dated June 6, 1933.

The front wall of the furnace is provided with a continuous charging opening 3, the opposite ends of which are sloped inwardly as at 4 from the bottom towards the top and against which doors 5 may lean when in closed position to tightly seal the opening. Across the top of the door opening a groove 6 may be formed for the reception of a shoulder or flange 7 provided on each door to tightly seal the joint formed between the furnace structure and the top of the door.

The invention herein disclosed is directed more particularly to mechanism for raising and lowering the doors and to the means for sealing the joints between adjacent doors. The sealing means, as stated above, would be used where a long charging opening is employed and requiring two or more doors placed end to end as shown in Fig. 2. However, it is to be understood that the operating mechanism may be utilized also with single doors, that is doors which are not placed end-to-end, but used primarily with furnaces having individual charging door openings

formed between buckstays usually employed with furnaces of the sprung arch type. Since the door operating mechanism is applicable to single or multiple doors, a description of such mechanism will be followed by a description of the sealing means employed to seal the joints between adjacent doors of the multiple type.

The door operating mechanism comprises a lift 8 (one for each door) of the cylinder piston type, having its piston rod 9 operatively connected by a chain or rope 10 to the top of its associated door at a plurality of points. This chain operates over a pulley 11 carried by the piston rod and has one end thereof secured to a crossbeam 12 carried by the superstructure of the furnace. As shown, the chain or rope 10 is connected at four points to the door, as indicated at 13, 14, 15, and 16. The connection from the chain or rope 10 to points 13 and 14 is made by means of a chain or rope 17 which is attached to a hook 18 secured to chain or rope 10, and having its opposite ends connected to eye-bolts 19. These eye-bolts are disposed along the outer edge of and at the top of the door and adjacent the ends thereof, and are adjustably secured to the door by means of nuts 20 threaded on the shanks of the bolts.

The connection of the chain or rope 10 to points 15 and 16 is effected by means of a chain or rope 21 carried by hook 18 and having its opposite ends secured to cranks or lever arms 22 (see Figs. 1 and 3). These cranks or arms are pivotally secured by axles or pins 22' to brackets 23 mounted on the top of each door along its inner edge and adjacent the ends thereof. A wheel or roller 24 is rotatably mounted on each crank or lever arm and these wheels, in turn, are disposed to engage and run on substantially vertical tracks 25 carried by the furnace framework.

The lengths of chains or ropes 17 and 21 are so adjusted that when the lift 8 starts upwardly to raise a door, rope 21 pulls on the cranks or lever arms 22 turning them clockwise as seen in Fig. 1. Since the wheels or rollers bear against the tracks 25, they cannot shift with the crank arms in a lateral direction; consequently the axles or journal pins 22' thereof act as fulcrums and cause the top of the door to shift outwardly and away from the furnace, thereby breaking the seal between the furnace and the door. When this seal is broken, chain or rope 17 is made taut so that the weight of the door is carried by both ropes or chains 17 and 21; therefore the door will move up or down with the lift and be supported in a more or less inclined position, as indicated in full lines in Fig. 1. The amount of outward shift of the top of each door may be predetermined by the relative lengths of chains or ropes 17 and 21, and in practice, the adjustment in the lengths thereof is so made that the door will be supported in such a tilted position, when traveling up or down with the lift that it will automatically fall against the furnace in a leaning position as soon as the bottom thereof rests upon hearth plates 26. This leaning position of the door when closed is indicated by broken lines in Fig. 1.

The mechanism for shifting the door away from the furnace before it is raised by the lift may take various forms, and in the drawings, three forms are shown, one being illustrated in Figs. 1, 2, and 3, another in Fig. 4 and another in Fig. 4a.

In the form shown in Figs. 1, 2, and 3, the crank or lever arm 22 is in the form of a circular disc and the wheel or roller is in the form of a rim or ring having a guide flange 28 thereon. A race 29 and roller bearings 30 are interposed between the wheel and the crank arm disc so that they may turn relatively to each other. The wheel is provided with inwardly projecting flanges 31 and 32 that hold the roller bearings and the race in place on the crank disc. A removable insert 33 is attached to flange 32, and when removed, uncovers a passage, through which the bearings may be inserted. This feature, however, forms no part of this invention.

The center of the crank disc represents the center or axle about which the wheel rotates as these are concentric. However, the disc is mounted eccentrically on pin 22' while the chain or rope 21 is attached to the disc at the opposite side thereof; therefore, the distance D between the pin or shaft 22' and the points of attachment of the chains or ropes to the crank disks represents the length of each lever arm or crank on which each roller or wheel 24 is mounted. The length of these crank arms, it will be understood, determines, more or less, the extent of the outward throw or travel of the top of the door when the lift is moving upwardly.

When the door has been shifted outwardly at its top as above described, the wheel or rollers run on the tracks 25 so that the door, instead of sliding against the furnace front wall, runs on the tracks thereby eliminating the wear and tear on the refractory lining of the door and the furnace front wall that would be occasioned if the door slid on the furnace front wall. By employing rollers and tracks, the door may be lifted and lowered easily and efficiently, and the flanges 28 coacting with the sides of rails 25, guide the door in its vertical movement.

In the form shown in Fig. 4, a flanged wheel 35 is journaled on a lever arm or crank 36 which is pivoted at one end to a support bracket 37 secured to the top of the door along its inner edge, and connected at its other end to the rope or chain 21. A wheel and crank, of course is provided at each side of the door. Thus as the cranks are turned clockwise, or in the direction of the arrow in Fig. 4, the wheels, because they bear against rails 25, act as fulcrums, causing the door to be shifted outwardly at the top until it clears the furnace brickwork which defines the charging door opening (in case single door openings are used) or the top of the charging door opening in the case one large opening is provided in conjunction with a number or series of doors placed end to end. While the door is being raised or lowered, it is supported in a more or less inwardly inclined position, so that, when the door is lowered and resting on the hearth plates shown in Fig. 1, it will automatically fall inwardly against the furnace front.

Instead of employing cranks and rollers, as disclosed in Figs. 1 to 4, for tilting the door or doors outwardly, wheels 40 may be stationarily mounted on the top of the door, one adjacent each end and along the inner edge thereof and in position to engage and cooperate with substantially vertical rails 41 having inwardly curved portions 42 at their lower ends, as shown in Fig. 4a. Thus, when the lift starts to raise, the top of the door is tilted outwardly by the thrust between the wheels and the curved portions of the rails, out of sliding contact with the furnace front wall. As in the case of the modifications previously described, the door is supported, while it is opening or closing, in a more or less inwardly tilted position so that when it comes to rest on the hearth plate (see Fig. 1), the door auto-

matically falls into a leaning position against the top and/or sides of the charging door opening, depending upon the type of opening employed. The normal leaning position in which the door is supported while it is being raised or lowered, is determined by the relative lengths of the connections from the lift hook 18 (see Fig. 1) to the points at which these connections are made to the top of the door.

Where the door operating mechanisms described above are employed for operating an arrangement of doors such as shown in connection with Figs. 1 and 2, it is preferred to utilize a special door construction in order that the sealing means employed to seal the joints between adjacent doors may be more effectively utilized. As shown in Figs. 1 and 2, each door 5 comprises a metallic frame 43 preferably of cast steel, which forms the main support for a refractory lining 44 thereof. The top of this frame is provided with an inwardly extending flange or top plate 45 to which the lift mechanism 8 is coupled as is clearly shown in the drawings. The bottom of the door frame may be provided with a shoe plate 46 which is bolted or otherwise secured to the main frame. In order to assist or effect positive leaning of the door against the furnace front wall when the door is closed, the shoe plate may be provided with a beveled surface 47 which slopes downwardly from its inner edge towards the hearth plate. Thus, when the door comes to rest on the hearth plate, the point of bearing is to the left of the center of mass of the door so that it is unbalanced towards the right, which causes the top of the door to tip to the right and come to rest against the furnace front wall.

The main frame of the door is provided with spaced vertically extending slots 48 for the reception of hangers 49 that are interlocked with the refractory blocks 50 of the lining. These hangers have vertically spaced transverse lugs 51 which are wider than the slots and thereby positively lock or secure the refractory blocks of the lining to the door frame.

The upper ends of these slots terminate in widened portions 52 that are wider than the lugs 51 of the hangers, so that when attaching the lining to the door, each block with its attached hanger may be lifted to the top of the frame where the lugs of the hanger can be inserted through the wide portion of a slot and then lowered until it comes to rest on a refractory block which has already been placed. After the vertical rows of refractory blocks have been laid up and anchored to the door frame, a retaining key 53 of substantially inverted U shape is inserted over the uppermost hanger of each course and between the lugs 51 thereof and the door frame. These keys lock the uppermost blocks of the courses to the door frame. The type of refractory block and hanger preferred in these doors is disclosed in my United States Patent No. 1,913,168 dated June 6, 1933.

As may be seen in Fig. 1, the door frame is open at the sides so that the outermost or end vertical courses of blocks extend beyond the frame. As may be seen in Fig. 2, the vertical end courses of blocks of adjacent doors do not touch as there is a space between them to prevent rubbing of the blocks of one door on the blocks of another. The sealing means employed seals the vertical joint as well as the joint across the top of the doors thereby preventing the escape of burning gases from the furnace.

As may be seen in Fig. 2, also, the end of each door frame is provided with a vertical outwardly extending rib or flange 54 between which the sealing means is disposed. These flanges cooperate with the sealing means to maintain the proper spacing between adjacent doors and assist in maintaining the doors in alignment as they are raised or lowered.

The sealing means for each joint is arranged to be raised or lowered with a door as is apparent in the drawings.

The sealing means is best illustrated in Figs. 5, 6, and 7, and comprises a metallic frame 55 of inverted L shape and provided with an upwardly extending projection or leg 56 to which a counterweighted cable system is connected for a purpose to be hereinafter set forth. The vertical and horizontal legs of each frame are of substantially channel shape in section to receive a refractory lining 58. These linings may be made of refractory blocks or of a plastic refractory heat resisting material.

The lower end of the vertical leg of the seal frame 55 is closed so as to retain the vertical column of refractory lining in place. The vertical and horizontal legs of the frame may be provided with tapered surfaces on the side flanges to form keyways that retain the linings in place (see Fig. 7).

When the sealing means is mounted in place between the ends of adjacent doors as shown in Figs. 2 and 5, the vertical leg of the seal lies between ribs 54 of adjacent door frames and bears against the adjacent vertical rows of refractory blocks of the doors so as to overlap and seal the joint vertically. The horizontal leg of the seal lies on top of these vertical courses, thereby overlapping and sealing the tops of these joints.

When the doors are closed, each seal is held tightly in place by means of a cable 60, one end of which is secured to one side of the upwardly extending portion 56 of the seal frame. The cable runs from the extension under a pulley 61 mounted on a bracket 62 secured to the top of a door at one end thereof, over pulleys 63 and 64 carried by the superstructure of the furnace, under a pulley 65, to which is connected a counterweight 66, over pulleys 67 and 68, under a pulley 69 mounted on the top and at the end of an adjacent door, to extension 56 of the seal frame to which it is secured.

As may be seen in Fig. 1 and also in Fig. 5, the points at which the ends of the cables 60 are connected to the extension 56 of the respective seal frames are above the points where the cables pass under pulleys 61 and 69 so that when the doors are closed, and also while any door or doors is or are moving upwardly, the seals are urged downwardly against the refractory blocks of the doors so that the seal is held firmly in contact therewith. If two doors are being raised simultaneously, the pulleys at adjacent ends of such doors and the seals therefor move together so that the counterweights move downwardly. However, if only one door is raised at a time, the counterweights connected to the seals at the ends of such door remain substantially stationary because the pulleys on the doors, disposed on opposite sides of the door which is moving upwardly, do not move.

The type of seal used in connection with the doors herein disclosed does not obstruct the charging door opening, and moves with the doors, regardless of whether one or more is operated at the same time, maintains a positive seal for the joints formed between the end courses of vertical

blocks of the individual doors, and maintains the proper spacing between doors. The seal frames also cooperate with the flanged rollers or wheels 24 that run on tracks 25 to maintain exact vertical alignment of the doors.

While various forms of the invention have been shown and described herein, it will be appreciated by those skilled in this particular art, that various modifications and changes may be made therein without departing either from the spirit or the scope of the invention. It is desired, therefore, that only such limitations shall be placed on the invention as are imposed by the prior art and the appended claims.

What I claim as new and desire to secure by Letters Patent is:—

1. The combination with a furnace having a vertically movable door, and a lift for raising or lowering the door, of a track mounted entirely above the furnace door, wheels carried by the top of the door and positioned to run on said track, and means operated by the lift and cooperating with said wheels for shifting the top of the door away from the furnace wall before the door starts to rise with the lift.

2. The combination with a furnace having a vertically movable door, and a lift for raising or lowering the door, of a track mounted above the furnace door, wheels carried by the top of the door and positioned to run on said track, and means operated by the lift and cooperating with said wheels and track for shifting the top of the door relatively to the wheels and track to position it away from the furnace wall before the door starts to rise with the lift, said means allowing said door to lean against the furnace to close the door opening when the same has been lowered to a position in which the lift is relieved of the weight thereof.

3. The combination with a furnace having a vertically movable door, and a lift for raising or lowering the door, said door having means for allowing it, when closed, to lean against the furnace, of a track mounted above the furnace door, rollers on the door cooperating with said track to guide and facilitate movement of the door, and means for shifting the door out of leaning position before it starts to rise with the lift, thereby to prevent sliding of the door on the furnace.

4. The combination with a furnace, a door for said furnace, and a lift for raising and lowering said door, of thrust rails mounted entirely above the door, wheels on said door arranged to run on said rails, and means coacting with said wheels, rails and lift for shifting the top of the door outwardly from the furnace prior to its rising with the lift.

5. The combination with a furnace having a door and a lift for raising or lowering the door, said door being normally supported in inclined position against the furnace when closed, of thrust rails mounted on the furnace above the door opening, wheels on said door arranged to run on said rails, and means coacting with the lift and wheels for moving the door to substantially vertical position prior to its being raised by the lift so that in the vertical travel of the door it is spaced from and out of sliding engagement with the furnace.

6. The combination with a furnace, having a door and a lift for raising and lowering the door, of rails mounted above the furnace door opening, lever arms on the top of and hinged to said door, wheels carried by the lever arms and disposed to run on said rails, the lift being connected to said lever arms so that as the lift tightens to raise the door, the door is shifted outwardly out of contact with the furnace by said lever arms and the reaction of the wheels on the rails, and means for limiting the outward travel of the door.

7. A furnace having a charging opening, a door, a lift connected to said door at such points as to allow it, when lowered to a position in which the lift is relieved of the weight of the door, to lean with the top of its inside face against the top of the frame of the charging opening and with its bottom spaced outwardly from the plane of the top of the door frame of said opening, and means for tilting the top of the door outwardly and out of contact with the frame of said opening prior to the raising of the door by the lift.

8. A furnace having a charging door opening of a length at least equal to the width of at least two charging doors, charging doors disposed edge to edge across said opening, said doors each having a metallic frame and a refractory lining secured thereto, the lining projecting beyond the edges of the frame at the top and sides, and a seal mounted between said door frames and overlapping the joints between the refractory lining of adjacent doors, the seals associated with each such joint being carried by a single door when it is raised or lowered, or by the doors forming a joint when such are raised or lowered together.

9. A furnace having a charging door opening of a length at least equal to the width of at least two charging doors, charging doors disposed edge to edge across said opening, said doors each having a metallic frame and a refractory lining secured thereto, the lining of each door projecting beyond the edges of its frame at the top and sides, a seal mounted between said door frames and overlapping the joints between the refractory linings of adjacent doors, the seals associated with each such joint being carried by a single door when it is raised or lowered, or by the doors forming a joint when such are raised or lowered together, and a system of counterweights and cables connected to said seals and doors for holding the seals positively against the doors and the joints between them when closed.

10. A furnace having a charging door opening of a length at least equal to the width of at least two charging doors, charging doors disposed edge to edge across said opening, said doors each having a metallic frame and a refractory lining secured thereto, the lining projecting beyond the edges of the frame at the top and sides, a seal mounted between said door frames and overlapping the joints between the refractory lining of adjacent doors, the seals associated with each such joint being carried by a single door when it is raised or lowered, or by the doors forming a joint when such are raised or lowered together, and means for holding the seals in operative relation to the doors.

11. A seal for closing the joint between the sides of adjacent vertically movable doors for furnaces comprising a frame having a leg adapted to lie against the back of such doors and overlap such joint, and an inwardly projecting leg adapted to lie on the tops of said doors at the ends thereof to overlap the top of said joint.

12. A seal for closing the joint between the sides of adjacent vertically movable doors for furnaces comprising a frame having a leg adapted to lie against the back of such doors and over-

lapping such joint, an inwardly projecting leg adapted to lie on the tops of said door at the ends thereof to overlap the top of said joint, and an extension projecting above said inwardly projected leg to which a system of counterweights and cables may be attached for anchoring the seal in operative relation to the joint.

13. In a furnace provided with a door adapted to be raised and lowered to open or close a charging opening, and upwardly extending track rails disposed above said opening, the combination with a lift, lever arms pivoted to the top of said door adjacent the inner edge thereof, support means connecting the lift to the free ends of said lever arms and to the top of said door adjacent the outer edge thereof, and wheels disposed to run on said rails and carried by said lever arms between the connection of the lift thereto and the pivot points thereof, whereby when the lift moves upwardly the lever arms are turned in such direction as to force the wheels against the tracks and shift the top of the door outwardly as the lift rises until the weight distribution on the connections between the lift and door is equalized at which time the door moves upwardly with the lift but in spaced relation to the furnace wall containing the charging opening.

14. In a furnace provided with a door adapted to be raised and lowered to open or close a charging opening, and upwardly extending track rails disposed above said opening, the combination with a lift, swinging arms secured to the top of said door and inwardly of the sides thereof, wheels journaled in said arms and disposed to run on said rails, a connection between the lift and said arms which, when the lift starts moving upwardly causes the arms to turn in such direction that a reaction is set up between the wheels and rails that shifts the top of the door outwardly and away from the furnace, and means connected with the lift and door for limiting the outward shift of the top of the door.

15. In a furnace having a charging door opening of a length substantially equal to the width of two or more charging doors, charging doors disposed edge to edge across said opening, each of said doors having a metallic frame and a refractory lining, the latter forming the inner face and entire side edges of said doors, means cooperating with said frame and lining to hold the latter in fixed position on the frame, the contiguous refractory edges of adjacent doors being vertical and in spaced relation to prevent rubbing, and means cooperating with the doors for vertically raising and lowering selected ones of said doors.

16. In a furnace having a charging door opening of a length substantially equal to the width of two or more charging doors, charging doors disposed edge to edge across said opening, each of said doors having a metallic frame and a refractory brick lining, the latter forming the inner face and entire side edges of said doors, means cooperating with the back of said frame and each brick of said lining to hold the latter in fixed position on the frame, the contiguous refractory edges of adjacent doors being vertical and in spaced relation to prevent rubbing, and means cooperating with the doors for vertically raising and lowering selected ones of said doors.

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