Nov. 12, 1968 I. P. BIELEFELDT 3,410,547

DOOR ASSEMBLY FOR HEAT TREATING FURNACES

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Fig. 1

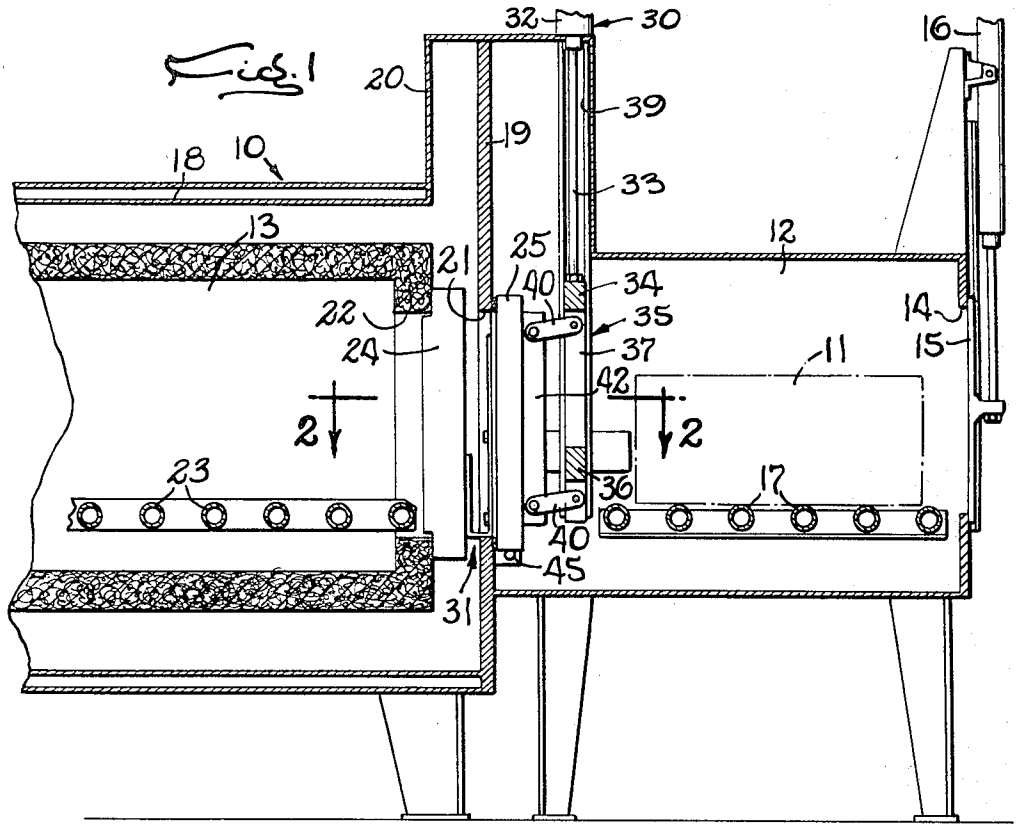
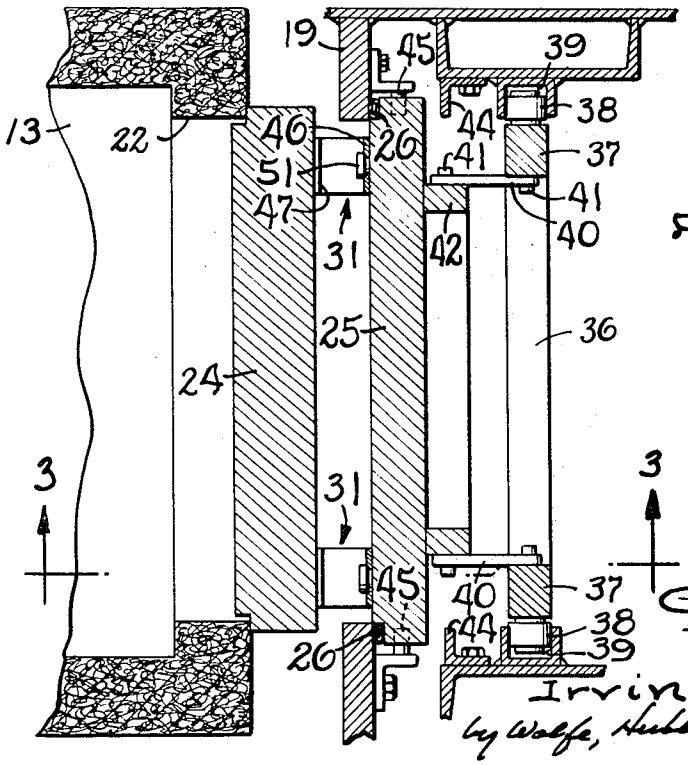



Fig. 2




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Fig. 3

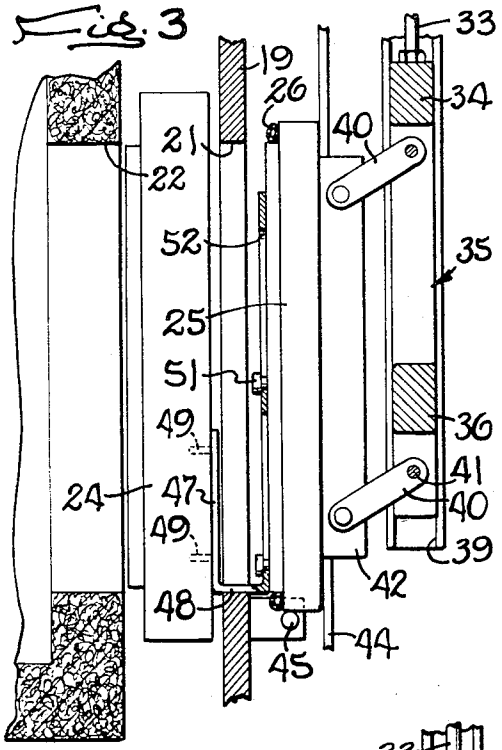



Fig. 4

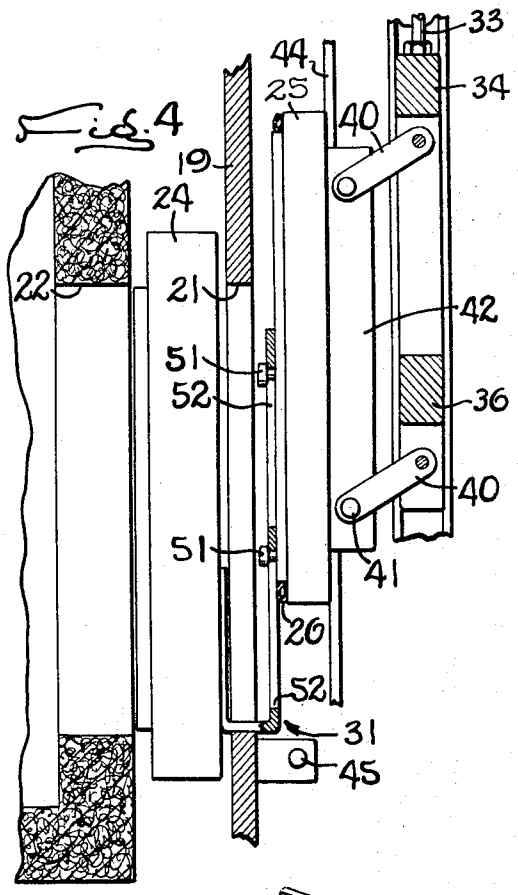



Fig. 5

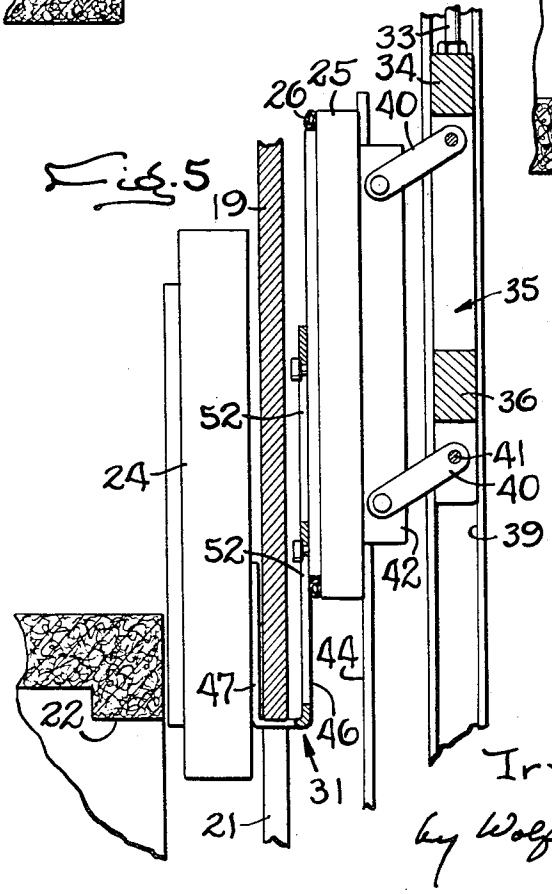
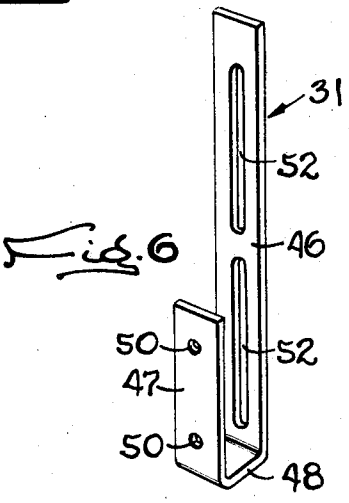



Fig. 6




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# 3,410,547
# DOOR ASSEMBLY FOR HEAT TREATING FURNACES

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10 Claims. (Cl. 266—5)

This invention relates to a heat treating furnace of the type in which workpieces moved into a heating chamber are heated in the presence of either a vacuum or a non-oxidizing atmosphere maintained in the chamber. More particularly, the invention pertains to a heat treating furnace in which the heating chamber is enclosed by an air-tight walled casing and the workpieces are moved into the heating chamber through passageways formed in the chamber and the casing. In this furnace, the chamber passageway is controlled by a heat insulating door for retaining the heat in the chamber and the casing passageway is controlled by a sealing door for maintaining the chamber and the casing in an air-tight condition.

The general object of the present invention is to provide in a furnace of the above character a new and improved door assembly which is considerably simpler in construction and yet more rugged and trouble-free in service use than prior arrangements.

A related object is to utilize the opening movement of the sealing door for opening the insulating door, and at the same time, to use the insulating door for shielding and protecting the sealing door from the heat of the chamber.

A more detailed object is to open and close both doors with a single operator acting directly on the sealing door and acting on the insulating door through a lost-motion connection to open and close the insulating door in predetermined sequence with the sealing door.

Another object is to obtain a tighter seal between the insulating door and the heating chamber.

Other objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

FIGURE 1 is a fragmentary longitudinal cross-section of a heat treating furnace embodying the novel features of the present invention.

FIG. 2 is an enlarged fragmentary cross-section taken substantially along the line 2—2 of FIG. 1 and showing the doors in tight-sealing positions.

FIG. 3 is a fragmentary cross-section taken substantially along the line 3—3 of FIG. 2 and showing both doors in closed positions.

FIG. 4 is a view similar to FIG. 3 showing the sealing door being opened.

FIG. 5 is a view similar to FIG. 3 showing both doors in open positions.

FIG. 6 is a perspective view of the lost-motion connection.

As shown in the drawings for purposes of illustration, the invention is embodied in a heat treating furnace **10** in which metal work pieces **11** to be heated are moved from a cooling chamber **12** into a heating chamber **13**, heated in either a vacuum or a controlled non-oxidizing atmosphere, and then returned to the cooling chamber for quenching. Heating of the workpieces within a vacuum or controlled atmosphere prevents oxidation from accumulating on the heated surfaces, while quenching with a cooling gas in the cooling chamber improves the physical properties of the metal of the workpieces.

Herein, the cooling chamber **12** comprises an air-tight walled enclosure formed with an entryway **14** at one end for admitting the workpieces **11** into the chamber, the



entryway being opened and closed by a vertically slidable door **15** operated by a reciprocating hydraulic actuator **16**. To facilitate movement of the work into and out of the chamber, each workpiece usually is supported on a tray (not shown) adapted to be placed on and moved along rollers **17** journaled in the side walls of the chamber. The heating chamber **13** is defined by top, bottom and side walls made of refractory material and spaced from the walls of an air-tight casing **18** substantially surrounding the heating chamber. Adjacent ends of the casing and the cooling chamber are welded to and separated by a vertical partition **19** which extends upwardly from the bottoms of the casing and the chamber to the underside of a raised hood **20** connecting the adjacent upper ends of the casing and the chamber.

After each workpiece **11** has been loaded into the cooling chamber **12**, it is pushed through a rectangular passageway **21** formed in the partition **19** and then into the heating chamber **13** through an alined rectangular passageway **22** formed in one end of the heating chamber. As in the cooling chamber, a series of rollers **23** in the heating chamber support the workpiece while it is being heated, the heating being effected in this instance by electrical heating elements (not shown) disposed within the heating chamber and capable of raising its temperature to above 2500 degrees Fahrenheit. To limit heat loss from the heating chamber, the chamber passageway **22** is adapted to be closed by a relatively heavy insulating door **24** formed of material capable of withstanding the heat within the chamber. In addition, the passageway **21** in the casing **18** is closed by a sealing door **25** fitting tightly against the partition **19** to maintain pressure or vacuum within the casing and the cooling chamber **12**. The face of the sealing door adjacent the partition **19** is formed with a peripheral recess which receives a flexible gasket **26** (FIG. 3) of rubber or plastic adapted to seat snugly against the surfaces of the partition bordering the casing passageway **21** to insure an effective seal.

In accordance with the present invention, the opening and closing movements of the sealing door **25** are utilized to open and close the insulating door **24** and, at the same time, the movements of the doors are correlated in a novel manner so that the insulating door shields the sealing door from the heat radiating from the heating chamber **13** and thus prevents the sealing gasket **26** from being exposed to and damaged by intense heat. To these ends, the sealing door is opened and closed by a fluid-operated actuator **30** and is connected to the insulating door by a lost-motion connection **31** allowing limited relative movement between the doors when the actuator is energized. The sealing door first opens independently of the insulating door until the gasket **26** is fully shielded by the insulating door whereupon the lost-motion in the connection is taken up and the insulating door also begins to open. As the doors are closed, they initially move in unison with the insulating door preceding the sealing door and closing the chamber passageway **22** to prevent the sealing door from being exposed to heat radiation. The protected sealing door then moves relative to the insulating door to close the casing passageway **21**. With this arrangement, a single actuator may be used for opening both doors and yet the sealing door and the gasket are shielded by the insulating door at all times.

In the present instance, the fluid-operated actuator **30** comprises a double-acting hydraulic cylinder **32** (FIG. 1) secured to the hood **20** and operable to reciprocate a piston rod **33** slidable within the cylinder. The rod extends downwardly into the cooling chamber **12** and is connected at its free end to an upper cross-bar **34** of a rectangular frame **35** which also includes a lower cross-bar **36** and upstanding side bars **37**. Journaled at vertically spaced

points on the side bars are small rollers **38** (FIG. 2) guided by vertical channels **39** welded to the side walls of the cooling chamber **12**. As the piston rod reciprocates, the frame rolls upwardly and downwardly within the channels and its vertical motion is transmitted to the doors **24** and **25** to open and close the latter.

As shown in FIGS. 1 and 2, the sealing gasket **26** tightly engages the partition **19** when the sealing door **25** is closing the casing passageway **21** completely. To open this passageway, the sealing door first is moved horizontally and away from the partition (FIG. 3) to release the gasket, and then is moved upwardly across the passageway (FIG. 5) to expose the latter. In closing the passageway, the sealing door moves downwardly into vertical alinement with the passageway and then horizontally toward the passageway to seal the gasket once again against the partition. Movement of the door in this manner prevents wear and deformation of the gasket and also achieves a tight pressing seal against the partition. To produce such compound movement of the sealing door, pairs of parallel links **40** are pivotally attached at opposite ends by pins **41** to the side bars **37** of the frame **35** and to vertical bars **42** fastened to the outer side of the sealing door **25**.

When the sealing door **25** is disposed tightly against the partition **19**, the links **40** are nearly horizontal as shown in FIG. 1, and the frame **35** is disposed in its lowermost position in the channels **39**. Upon energization of the actuator **30**, the frame moves upwardly with the links pivoting counterclockwise about the pins **41** thus pulling the sealing door horizontally and away from the casing passageway **21** (FIG. 3). Such horizontal movement continues until the outer side of the sealing door abuts against a pair of vertically disposed angle bars **44** (FIGS. 2 and 3) extending along opposite side walls of the cooling chamber **12** and located between the sealing door and the channels **39**. Continued upward movement of the frame after the sealing door engages the bars causes the door to move upwardly and across the casing passageway to expose the latter (FIG. 5).

Similarly, when the direction of operation of the actuator **30** is reversed, the frame **35** and the sealing door **25** move downwardly in parallel paths until the sealing door is alined vertically with the casing passageway **21** (FIG. 3). When the sealing door reaches this position, the lower corners of the doors engage stops **45** (FIG. 2) bolted to the partition **19** thus causing the links **40** to swing clockwise about the pins **41**. Thus, in response to continued downward movement of the frame, the sealing door moves horizontally toward the casing passageway, and the gasket **26** seals tightly against the partition with the links acting somewhat like a toggle to urge the gasket into sealing engagement with the partition.

In this instance, the lost-motion connection **31** for transmitting the opening and closing movements of the sealing door **25** to the insulating door **24** comprises a pair of substantially U-shaped members (FIGS. 5 and 6) each formed with a long vertical leg **46** interconnected with a shorter leg **47** by a horizontally extending strap **48** integral with the lower ends of the legs. The shorter leg of each connecting member **31** is fastened securely to the outer side of the insulating door **24** by a pair of screws **49** (FIG. 3) extending through holes **50** (FIG. 6) formed through the short leg. The strap **48** of each connecting member extends through the casing passageway **21**, and each long leg **46** is fastened to the inner side of the sealing door by a pair of headed screws **51** slidably received in a pair of vertically spaced and elongated upright slots **52** formed through the long leg.

With this arrangement, the sealing door may move upwardly and downwardly independently of the insulating door until the screws engage the upper or lower edges of the slots thus causing the motion of the sealing door to be transmitted through the connecting members **31** to the insulating door to move the latter. In addition, the connecting members transmit the horizontal sealing and releasing movements of the sealing door directly to the insulating door so that the insulating door also moves into and out of relatively tight engagement with the walls around the heating chamber passageway **22** to prevent heat loss from the chamber.

Accordingly, initial upward movement of the frame **35** causes both doors **24** and **25** to move horizontally out of sealing engagement with the walls around their respective passageways **22** and **21**. Then, as the sealing door moves upwardly, the screws **51** slide upwardly in the slots **52** in the connecting members **31** and the insulating door **24** remains stationary thus closing the heating chamber passageway and shielding the sealing door **25** from direct exposure to the radiant heat directed out of the heating chamber **13**. Upward movement of the sealing door relative to the insulating door continues until the lowermost segment of the flexible gasket **36** is spaced well above the lower edge of the insulating door and the screws **51** engage the top edges of the slots as shown in FIG. 4. Upon this occurrence, the motion of the sealing door is transmitted to the insulating door to raise the latter upwardly across the chamber passageway (FIG. 5) with the lower portion of the insulating door remaining below the lower segment of the gasket to shield the gasket from the intense rays of heat radiating outwardly and upwardly from the open chamber passageway.

After a workpiece **11** has been moved into or out of the heating chamber through the open passageways **21** and **22**, the doors **24** and **25** again are closed and initially move downwardly in unison, the insulating door preceding the sealing door to protect the gasket **36**. When the insulating door moves into vertical alinement with the chamber passageway **22**, the straps **48** on the connecting members **31** engage the bottom edge of the casing passageway **21** (FIG. 4) thereby preventing further downward movement of the insulating door. With the chamber passageway substantially closed, the screws **51** slide downwardly in the slots **52** in the connecting members thus enabling the sealing door to move downwardly relative to the insulating door and into alinement with the casing passageway (FIG. 3). The lower edges of the sealing door then engage the stops **45** and both doors shift horizontally toward their respective passageways and into their sealed positions (FIG. 1) as the frame **35** completes its downward stroke.

From the foregoing, it will be apparent that a new and improved door assembly constructed in accordance with the principles of the present invention not only requires but a single actuator for controlling both doors **24** and **25** but also utilizes the insulating door for shielding the sealing door. In addition, the insulating door moves horizontally into tight engagement with the chamber passageway **22** thus more effectively preventing the escape of heat from the heating chamber **12**. As a result, the assembly is extremely simple in construction while being durable, efficient and trouble-free in operation.

I claim as my invention:

**1**. In a heat treating furnace, the combination of, a walled enclosure defining a chamber for raising the temperature of workpieces and having a passageway in one wall for admitting workpieces into the chamber, a hollow airtight walled casing surrounding said chamber and having a workpiece-admitting passageway alined with and spaced from said chamber passageway, an insulating door disposed between said passageways and movable back and forth across said chamber passageway along a predetermined path between positions opening and closing the chamber passageway, a sealing door movable toward and away from said casing passageway and laterally of said path between a tight-sealing position engaging the wall around said casing passageway and a released position spaced from the wall, said sealing door also being movable back and forth across said casing passageway and parallel to said path between said released position and a

position opening the casing passageway, mechanism connected to said sealing door for moving the latter first from said tight-sealing position to said released position and then to said open position, and a lost-motion connection between said doors for moving said insulating door toward its open position only after said sealing door has moved a predetermined distance toward its open position thereby maintaining the insulating door between the chamber opening and the sealing door to shield the latter from the heat of the chamber.

2. A heat treating furnace as defined in claim 1 in which said lost-motion connection includes a member extending between said doors, and means mounting said member for bodily movement with one of said doors and for limited sliding movement relative to the other of said doors.

3. A heat treating furnace as defined in claim 1 in which said insulating door is movable toward and away from said chamber passageway and laterally of said path between a tight-sealing position engaging the wall around the chamber passageway and its closed position spaced from the wall, and said mechanism acts through said sealing door and said lost-motion connection to move said insulating door between its tight-sealing and closed positions in timed relation with the movement of said sealing door between its tight-sealing and released positions.

4. A heat treating furnace as defined in claim 1 in which said mechanism includes a fluid-operated actuator connected to said sealing door for moving the latter between its positions and acting through said lost-motion connection to move said insulating door between its positions.

5. A heat treating furnace as defined in claim 1 further including a flexible sealing gasket on said sealing door and operable to seal against the wall around said casing passageway when the sealing door is in said tight-sealing position.

6. A heat treating furnace as defined in claim 5 in which said doors are disposed in upright planes and move upwardly toward said open positions and horizontally toward said tight-sealing positions.

7. A heat treating furnace as defined in claim 6 in which said sealing gasket is disposed alongside the bottom



margin of said sealing door, the distance between said bottom sealing gasket and the bottom edge of said insulating door first increasing during the initial movement of said sealing door toward its open position and then remaining constant after said insulating door begins movement toward its open position.

8. In a heat treating furnace, the combination of, a walled structure enclosing a heating chamber and including a passageway for admitting workpieces into said chamber, first and second doors disposed on opposite sides of said passageway and movable back and forth across the passageway between positions opening and closing the passageway, mechanism connected to said first door for moving the latter toward its open position, and means connected to said second door and responsive to movement of said first door through a predetermined distance toward its open position for moving the second door toward its open position.

9. A heat treating furnace as defined in claim 8 in which said mechanism includes a single fluid-operated actuator and said means includes a lost-motion connection between said doors.

10. A heat treating furnace as defined in claim 9 in which said structure includes a stop engageable with said lost-motion connection, said actuator being operable to move said doors simultaneously from said open toward said closed positions until said second door engages said stop, and then moving said first door relative to said second door until the first door reaches its closed position.


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