July 28, 1964 H. PHILLIPS ETAL 3,142,272

SAFETY CLOSURE MEANS FOR PRESSURIZED FURNACES

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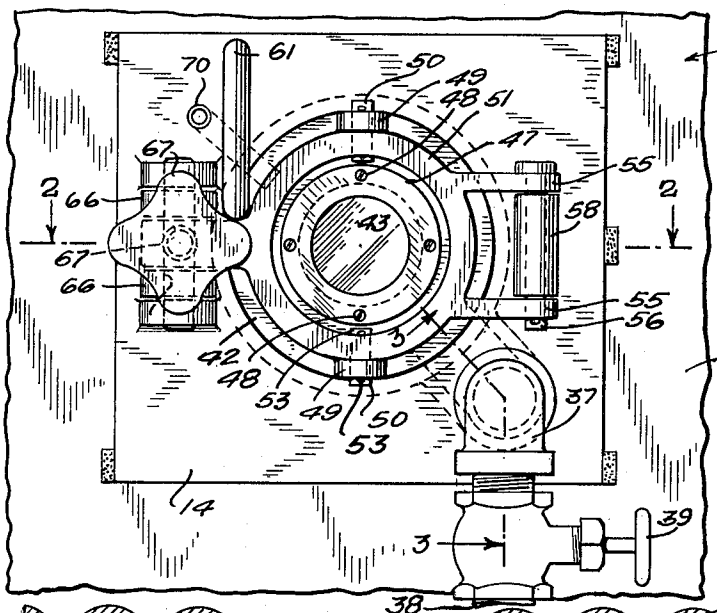

Fig. 1.

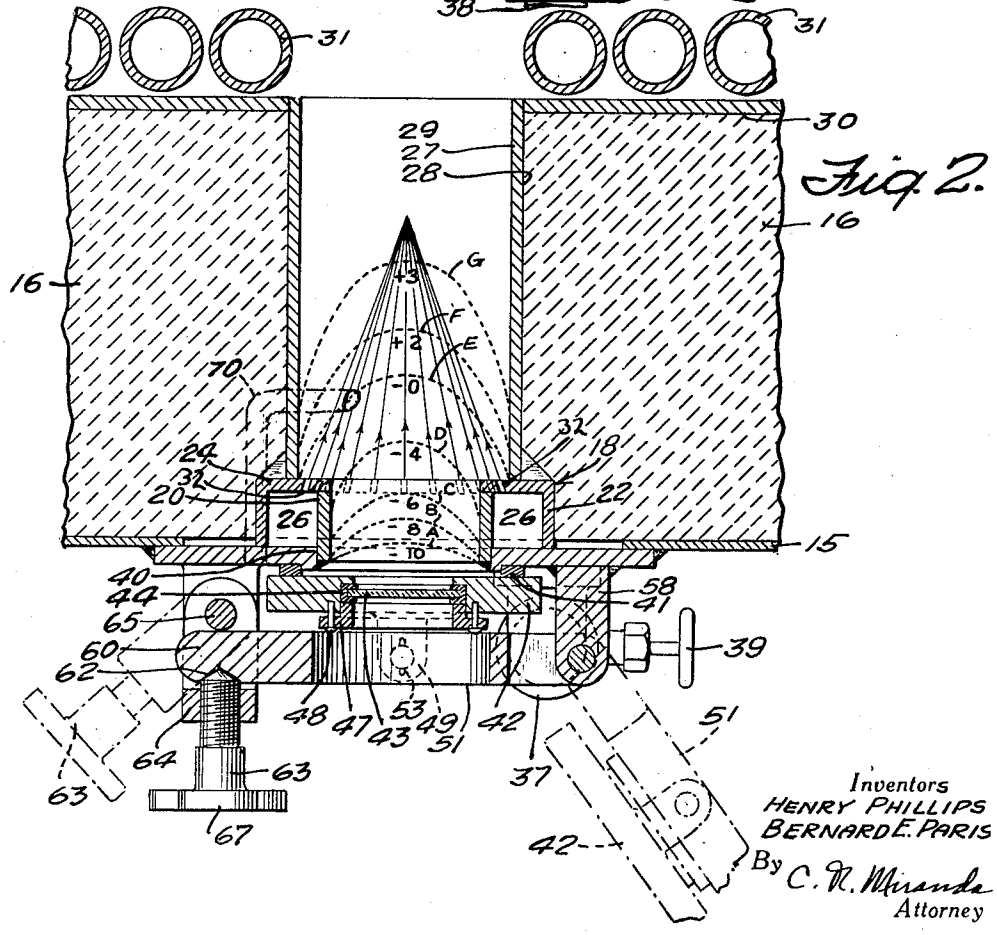

Fig. 2.

Inventors
HENRY PHILLIPS
BERNARD E. PARIS
By C. N. Miranda
Attorney

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Fig. 3.

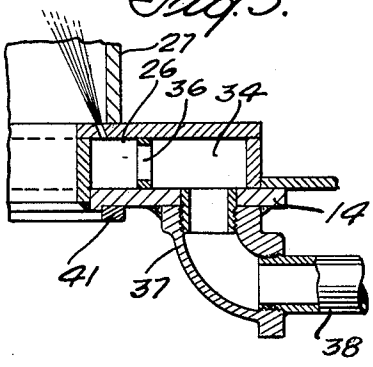
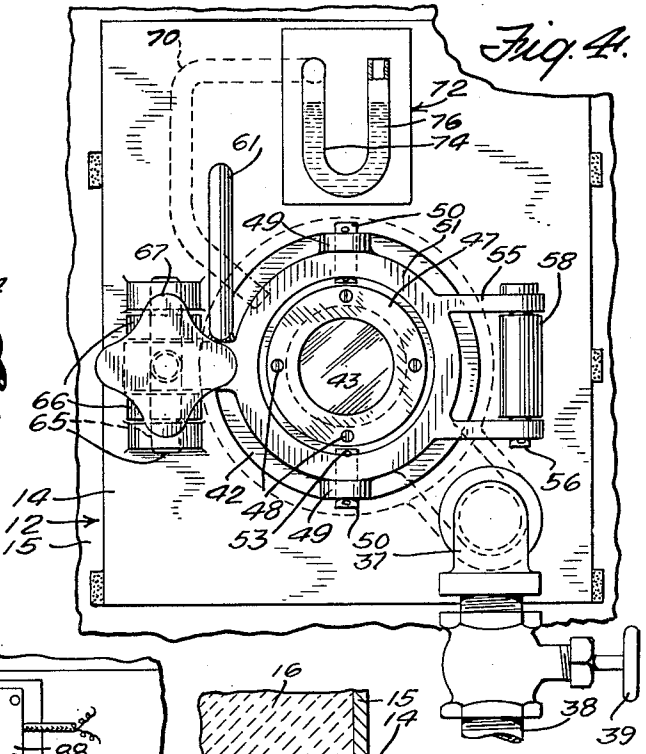


Fig. 4.



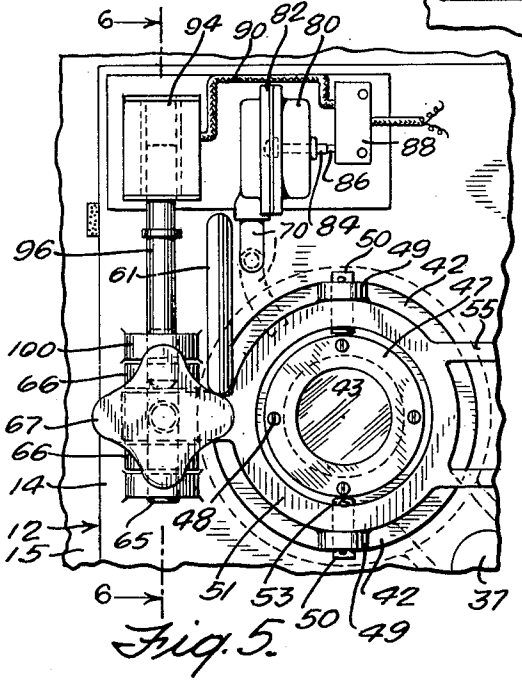


Fig. 5.

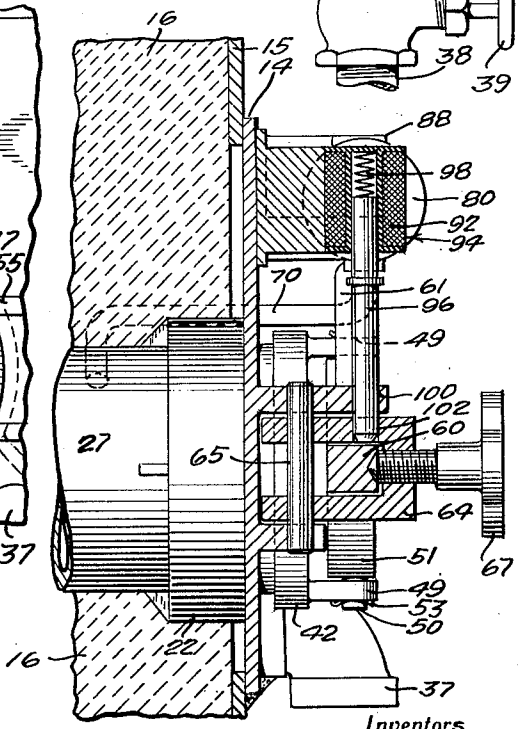


Fig. 6.

Inventors
HENRY PHILLIPS
BERNARD E. PARIS
By C. N. Miranda
Attorney

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SAFETY CLOSURE MEANS FOR PRESSURIZED FURNACES

Henry Phillips, Metuchen, and Bernard E. Paris, Brooklyn, N.Y., assignors to Foster Wheeler Corporation, New York, N.Y., a corporation of New York

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The present invention relates to closure means for pressurized furnaces, and more particularly to safety arrangements for indicating safe and unsafe conditions of operation of the closure means, and/or preventing operation of the closure means when unsafe conditions exist.

Pressurized furnaces generally include passages or openings in the walls thereof in order to enable an operator to gain access to the interior of the furnace for cleaning and other purposes. Such passages are covered by a door or cover and since the cover is opened during operation of the furnace, means are provided for protecting an operator from the outward rush of the hot products of combustion through the passage. Present furnace installations employ a jet-like curtain of fluid or air which originates near the cover and is directed into the passage towards the interior of the furnace to provide a fluid barrier to combustion gases tending to escape through such passages. This fluid barrier principle has been effective on the whole, but other factors have entered into the above which present a dangerous condition at times. On occasion, the operator has neglected to initiate the flow of fluid causing the barrier and, as a result, the operator suffers injury when the cover is removed to obtain access to the passage. At other times, the supply of fluid is disrupted through mechanical failure, or the ports through which the fluid flows becomes clogged or plugged so that the supply of fluid is either non-existent or insufficient. A number of arrangements have been provided to overcome the foregoing conditions and have taken the form of mechanical interlocks to prevent operation of the cover unless the fluid supply valve has been turned on, or, means for sensing the pressure of flow of fluid passing to the ports have been employed which prevent operation of the cover when safe conditions are not detected. These arrangements have sufficed more or less for the purpose, but they have not proved completely satisfactory in some instances as for example, when the flow of fluid through the ports, or the pressure within the manifold, is of the designed value but the amount or pressure of such fluid is not sufficient to prevent flow of combustion gases in the event of an increase of the furnace pressure above the normal operating value.

It is an object of the present invention to provide a novel safety arrangement for closure means of pressurized furnaces which operates effectively over a wide range of conditions of operation of the furnace to indicate the presence of safe conditions for operating the cover to access passages and/or to prevent operation of the cover when unsafe conditions exist.

The present invention therefore, contemplates a novel safety arrangement for closure means which comprises in one form thereof, the combination of a safety device with a cover for an access passage in the wall of a pressurized furnace wherein a curtain of fluid is injected into said passage. The safety device indicates the presence or absence of fluid in the access passage sufficient to prevent flow of combustion gases therethrough when the cover is opened. The safety device comprises pressure detecting means which is exposed to the pressure conditions within the access passage and such pressure conditions result from the flow of fluid into the passage and the presence of combustion gases therein. The pressure detecting means is connected to an appropriate location in the access passage and detects a resultant pressure which is a function of the flow and pressure of the injected fluid into the passage and the pressure of the combustion gases in the passage. The resultant pressure in the access passage is transmitted by the pressure detecting means to outside the furnace where it serves to indicate to an operator either safe or unsafe conditions, or, it may be employed in another form of the invention to control the operation of mechanism which restrains operation of the cover under certain conditions.

The above and other objects and advantages of the present invention will appear more fully hereinafter from a consideration of the detailed description which follows taken together with the accompanying drawings wherein one embodiment of the invention is illustrated.

In the drawing wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a front elevational view of the closure means with which the present invention may be employed;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1 and shows in particular, the location of the pressure detecting member in the access passage;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is an elevational view of the closure means similar to FIG. 1 and particularly shows an indicator for use with the pressure detecting member;

FIG. 5 is a front elevational view of the cover means of FIG. 1 which incorporates a modified form of the present invention and illustrates the use of the pressure detecting member with mechanism for restraining operation of the cover; and

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5.

Referring now to the drawing and more particularly to FIG. 1, a cover assembly generally designated by the numeral **12** comprises a cover frame **14** which is adapted for mounting on a vertical outer casing **15** (partly shown) disposed on an insulated wall **16** (FIG. 2) of a furnace (not shown). Disposed on the side of cover frame **14**, toward the furnace interior, is a manifold **18** (FIG. 2) which includes a pair of concentric annular members **20** and **22**, and said members abut an annular plate **24**, extending transversely thereof, to define a manifold chamber **26**. A sleeve **27** is secured normal to plate **24** and is disposed in an opening **28** of wall **16**; the sleeve and opening constitute an access opening **29**. The inner surface of wall **16** is lined with a sheet **30** and arranged in front of the latter are fluid conducting tubes **31**. A plurality of holes or ports **32** are drilled in plate **24** and are arranged in a circular row, preferably at equal circumferential distances. Holes **32** are provided for injecting a gaseous medium under pressure, as for example air, into access opening **29** in a direction away from cover frame **14**. The high pressure air is supplied to manifold chamber **26** via a connecting chamber **34** (FIG. 3) which communicates with chamber **26** through an opening **36** in annular member **22**. An elbow coupling member **37** is mounted in frame **14** and communicates connecting chamber **34** with a source of high pressure air (not shown) through a conduit **38** and a control valve **39** connected thereto. The air injected into access opening **29** through ports **32** provides a fluid barrier to the flow of combustion gases toward the cover frame **14**.

One end of the annular member **20** extends into an opening **40** formed in frame **14**. A sealing ring **41** is disposed in a recessed portion of frame **14**, which encom-

passes the opening 40, and the ring is adapted to be engaged by a cover 42 for sealing access opening 29 from the outside of the furnace. A transparent member or window 43 is provided in cover 42 and is mounted in a resilient insert 44 in a recess formed in cover 42. Insert 44 is engaged by a retainer member 47 which is secured to cover 42 by a plurality of threaded members 48. Diametrically opposed lugs 49 are provided on and adjacent the outer edge of cover 42 and each lug has an opening to accommodate a stud 50. The studs 50 extend through openings formed in a lifting ring 51 and opposite ends of the studs are provided with limiting pins 53 to secure the cover 42 to ring 51. A pair of hinge members or ears 55 are secured at corresponding ends to lifting ring 51 and the other end of the hinge members are provided with openings to receive a hinge pin 56 which is journalled in a hinge block 58 secured to frame 14.

A latch bar 60 is secured, as by welding, to lifting ring 51 and is provided adjacent the ring with an upstanding hand-gripping handle 61. Latch bar 60 has a depression 62 (FIG. 2) which is engaged by one end of a threaded clamping member 63, and threaded portion of said member cooperating with the threaded portion of a latch yoke 64. Latch yoke 64 is substantially U-shaped and is adapted for pivotal movement on a pin 65 which extends through both arms of the yoke adjacent the lower portions thereof. The opposite ends of the pin 65 are mounted for rotation in bearing blocks 66 secured to frame 14.

Considering the structure thus far described, when air is injected through ports 32 and it is desired to displace cover 42 to an open position, as shown in broken lines in FIG. 2, a finger-gripping portion 67 of clamping member 63 is rotated in the proper direction to elevate the lower end of said member out of recess 62 and above the upper surface of latch bar 60, as seen in FIG. 2. The operator then pivotally displaces yoke 64 to the broken line position shown in FIG. 2 and thereafter handle 61 is grasped to swing cover 42 away from cover frame 14.

As indicated earlier, the closure means along with the fluid-jet structure of the type described, has operated successfully with mechanical interlocks between the cover and fluid control valve, and with pressure and flow responsive operable means. However, there are times when for example, the pressure of the combustion gases in the furnace and in the access passage 29 exceeds a determined design operating value so that if cover 42 were opened at such time, the pressure of the injected fluid would not suffice to prevent flow of the combustion gases through the passage to the furnace exterior. The present invention has for an object, among others, to provide an indication to an operator of an unsafe condition existing in the passage and/or prevent the operator from moving cover 42 to an open position.

It is known that when jets of air are directed into access passage 29 in the manner shown in the drawings (FIG. 2), that a partial vacuum exists in the access passage and such vacuum is greatest in the space encompassed by member 20 and is at a minimum going toward the apex of the cone of the injected air. Beyond the last-mentioned point and going further in the passage towards the furnace interior, the pressure commences to become positive and increases in value. The value of the pressure in the access passage is a function of the pressure and flow of the injected air and of the pressure of the combustion gases in said passage, whereby the resulting pressure may be referred to as the resultant pressure. Thus, if a graphical representation of the pressure conditions existing in access passage 29 could be shown, a plurality of pressure gradient lines A to G, inclusive, exist as illustrated in FIG. 2. In practice, the accurate measurement and exact contours of the pressure areas in the passage are extremely difficult to obtain and, therefore, most of the values as disclosed hereinafter for the pressure should be considered as approximate rather than as exact.

In an actual installation of the closure means and jet-air structure described above, the furnace pressure or that of the combustion gases was maintained at approximately 20 inches of water above atmospheric pressure, while the injected air pressure was 60 p.s.i.g. with a flow of 235 s.c.f.m. At such conditions of operation the pressure gradient lines E and G actually were determined and measured and were found to have the values of 0 inch of water and +3 inches of water respectively, above atmospheric pressure. It was found that if the furnace pressure was increased above the value stated above, the area of vacuum behind the 0 pressure line E would be compressed in the direction of cover 42, or a shifting of the line E in that direction would occur. Consequently, if in actual operation the furnace pressure would rise sufficiently to bring about the shifting of line E toward adjacent cover 42 combustion gases would rush out of the access passage to the furnace exterior when the cover was opened. On the other hand, there is a shifting of line E in a direction away from the cover 42 when the furnace pressure is reduced so that no danger exists for the operator when cover 42 is opened.

The foregoing description of the pressure conditions in access passage 29 is important in understanding the principle upon which the present invention operates and is utilized by the present invention to accomplish its useful function. As shown in FIG. 2, pressure detecting and transmitting means as for example hollow tubular member 70, is provided and has one end projecting through sleeve 27 so as to be exposed to the pressure conditions in passage 29. The tube 70 extends through wall 16 and cover frame 14 (FIG. 1) where the other end of the tube is exposed to the atmosphere. As seen in FIG. 2, the end of tube 70 in passage 29 is on the pressure gradient line E which is equal to 0 inch of water above atmospheric pressure when the pressures of the furnace and the injected air are of the desired designed values. The end of tube 70 in passage 29 is subjected to a resultant pressure of 0 inch of water above atmospheric pressure and the other end is subjected to atmospheric pressure whereby no flow occurs through tube 70. In the event the furnace pressure exceeds the designed value, or the flow of injected air should cease, the inside end of tube 70 would be exposed to a positive pressure above atmospheric and warmed fluid will commence to flow out through the tube. On the other hand, if the furnace pressure decreased below the designed value, the inside end of the tube will be exposed to a partial vacuum whereby air outside the furnace will be drawn into the tube. Thus, if an operator wishes to determine whether it is safe to open cover 42, he places his hand adjacent the outside end of the tube and if no flow exists therethrough he may open the cover. Conversely, if the operator feels a warm flow of fluid issuing from the tube, he then knows it is unsafe to open the cover before appropriate steps may be taken to correct the unsafe conditions. If the operator feels air being drawn into the tube, he will realize that it is safe to open the cover.

In FIG. 4, a visual indicator, as for example a manometer 72 is employed in conjunction with tube 70. The outside end of tube 70 is connected to one leg 74 of the manometer, while the other leg 76 is subjected to atmospheric pressure. Thus, if it is assumed that the inside end of tube 70 is on the pressure gradient line E, or exposed to 0 inch of water above atmospheric pressure, in the normal operation of the furnace, the level of the liquid in legs 74 and 76 would be at the same height. On the other hand, if the furnace pressure should increase, or the flow of injected air is interrupted, the level of the liquid in leg 76 will be higher than the liquid level in leg 74, thereby indicating an unsafe condition for opening cover 42.

FIGS. 5 and 6 diagrammatically illustrate a modifica-

tion of the present invention insofar as the tube 70, may if desired, be employed to govern the operation of automatic control means which restrains or permits opening of cover 42 under certain conditions. In FIG. 5, the control means is shown as including a pressure capsule or device 80 which is provided with a flexible diaphragm 82. One side of diaphragm 82 is subjected to the pressure in tube 70 and the other side of the diaphragm carries a pin 84 which extends through the casing of device 80 for engagement with an actuating switch member 86 of a switch 88. Switch 88 is electrically connected by leads 90 to the winding 92 of a solenoid 94 having an armature 96 biased outwardly of the solenoid by a spring 98. Armature 96 extends through an opening in a bracket 100 and is adapted for entry in an opening 102 in yoke 64 (FIG. 6) when the latter is in the closed or full line position.

Considering now the operation of the structure disclosed in FIGS. 5 and 6, diaphragm 82 is calibrated and designed to assume an unflexed position under normal operation of the furnace which results in pressure conditions in the access passage adjacent the end of tube 70 being at 0 inch of water above atmospheric pressure. Under this condition, the end of pin 84 adjacent switch 88 is just touching or out of engagement with switch member 86 whereby the switch contacts (not shown) in switch 88 are closed so that solenoid 94 is energized. It will be apparent that upon energization of the solenoid, the end of armature 96 in yoke 64 moves away from the latter and out of opening 102, whereby member 67 may be rotated to permit movement of yoke 64 to a broken line position as seen in FIG. 2. Thus, an operator may open cover 42. Also, if the pressure in tube 70 is below atmospheric the solenoid will be energized to permit opening of cover 42 because diaphragm 82 flexes to the left as seen in FIG. 5, thereby moving the free end of pin 84 away from switch member 86. Conversely, when the furnace pressure exceeds the designed value so as to present an unsafe condition for operation of cover 42, the pressure within tube 70 is above atmospheric pressure and, consequently, diaphragm 82 flexes to the right. Pin 84 engages and moves switch member 86 in a direction to disengage or break the switch contacts (not shown) in switch 88, whereby the winding 92 of solenoid 94 is deenergized. As a result, spring 98 maintains the external end of armature 96 in opening 102 of yoke 62 so that the latter cannot be pivoted to permit opening of cover 42.

It will now be apparent that the present invention provides a novel safety arrangement for closure means of pressurized furnaces. By employing means for detecting the pressure conditions within the access passage, an effective safety device is provided for indicating visually, and otherwise, the unsafe and safe conditions for operating the closure means. In addition, the present invention, by using the indicated pressure, may be effectively employed to prevent operation of the closure assembly by an operator when an unsafe condition exists within the access passage.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the arrangement of parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed is:

1. In a pressurized furnace having a furnace wall and an access passage in said wall, a safety arrangement including a cover for said passage and means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through said passage to the outside of the furnace when said cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, the combination with said cover of a safety device comprising a tubular member connected at one end to the access passage to expose said one end to a resultant pressure which is equal to or less than atmospheric pressure, said tubular member extending outside said furnace and having its other end exposed to atmospheric pressure, and means at said other end to show the relationship between said resultant pressure and atmospheric pressure, the showing of a pressure at said other end greater than atmospheric indicating an unsafe condition for opening said passage.

2. In a pressurized furnace having a furnace wall and an access passage in said wall, a safety arrangement including a cover for said passage and means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through said passage to the outside of the furnace when said cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, the combination with said cover of a safety device comprising a tubular member connected at one end to the access passage to expose said one end to a resultant pressure which is equal to or less than atmospheric pressure, said tubular member extending outside said furnace, and a manometer connected to the other end of the tubular member extending outside the furnace, the detection of a pressure greater than atmospheric indicating an unsafe condition for opening said passage cover.

3. In a pressurized furnace having a furnace wall and an access passage in said wall, a safety arrangement having a cover assembly for said access passage comprising a cover movable relative to said wall and said access passage for permitting entry to said passage in an opened position of the cover and for sealing said passage in a closed position of the cover, fluid directing means for injecting fluid into said access passage to prevent flow of combustion gases therethrough and outside the furnace when the cover is opened, said fluid being injected in a manner to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure within said furnace, pressure transmitting means connected to the access passage and subjected to the pressure conditions therein for exposure to a resultant pressure which is equal to or less than atmospheric pressure, latching means operable for locking the cover in the closed position and for unlocking said cover to permit movement thereof to the opening position, and actuating means operably connected to the latching means for rendering the latter effective or ineffective for locking said cover, said actuating means being connected to the pressure transmitting means and operable in response to a departure of the resultant pressure in the access passage from a predetermined value to render the latching means ineffective to unlock the cover.

4. The safety arrangement of claim 3 wherein the pressure transmitting means comprising a tubular member having one end at the access passage and the other end extending outside the furnace wall, said other end of the tubular member being connected to the actuating means to transmit thereto variations in the resultant pressure values in the access passage.

5. The safety arrangement of claim 4 wherein the actuating means comprises a pressure actuated device and a solenoid having a plunger engageable with and disengageable from the latching means to render the latter ineffective and effective, respectively, for opening the cover, said pressure actuated device being connected to receive the resultant pressure in the access passage and further connected for actuating the solenoid to disengage the plunger from the latching means upon departure of the resultant pressure in the access passage from a predetermined value.

6. In a pressurized furnace, the combination with a

furnace wall and access passage in the wall, a safety arrangement comprising a cover for said access passage, means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through the passage to the outside of the furnace when the cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, and pressure transmitting means leading into said access passage positioned so as to detect under normal operating conditions a resultant pressure in the passage which is equal to or less than atmospheric, the detection of a pressure greater than atmospheric indicating an unsafe condition for opening said passage cover.

7. In a pressurized furnace, the combination with a furnace wall and access passage in the wall, a safety arrangement comprising a cover for said access passage, means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through the passage to the outside of the furnace when the cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, and pressure transmitting means leading into said access passage positioned so as to detect under normal operating conditions a resultant pressure in the passage which is equal to or less than atmospheric, said means extending through the wall of the furnace to the exterior thereof to render said detected resultant pressure available for use outside the furnace, the detection of a pressure greater than atmospheric indicating an unsafe condition for opening said passage cover.

8. In a pressurized furnace, the combination with a furnace wall and access passage in the wall, a safety arrangement comprising a cover for said access passage, means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through the passage to the outside of the furnace when the cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, and pressure transmitting means

leading into said access passage positioned so as to detect under normal operating conditions a resultant pressure which is less than atmospheric pressure, said means extending through the wall of the furnace to the exterior thereof and being subjected to atmospheric pressure to provide a differential pressure which is the difference between the resultant pressure within the access passage and atmospheric pressure, the transmission of a pressure other than said differential pressure indicating an unsafe condition for opening said passage cover.

9. In a pressurized furnace, the combination with a furnace wall and access passage in the wall, a safety arrangement comprising a cover for said access passage, means for injecting fluid into said passage under a predetermined pressure and flow to prevent the flow of combustion gases through the passage to the outside of the furnace when the cover is opened, said fluid being injected so as to produce a pressure gradient in said passage from a negative pressure adjacent said cover to a positive pressure in said furnace, and pressure transmitting means including a tubular member leading into said access passage one end of said tubular member being positioned so as to detect under normal operating conditions a resultant pressure in said passage which is equal to or less than atmospheric, the detection of a pressure greater than atmospheric indicating an unsafe condition for opening said passage cover.

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