March 20, 1956 V. H. FERGUSON 2,738,967

INDUSTRIAL FURNACE SAFETY DEVICE

Filed May 27, 1952 2 Sheets-Sheet 1

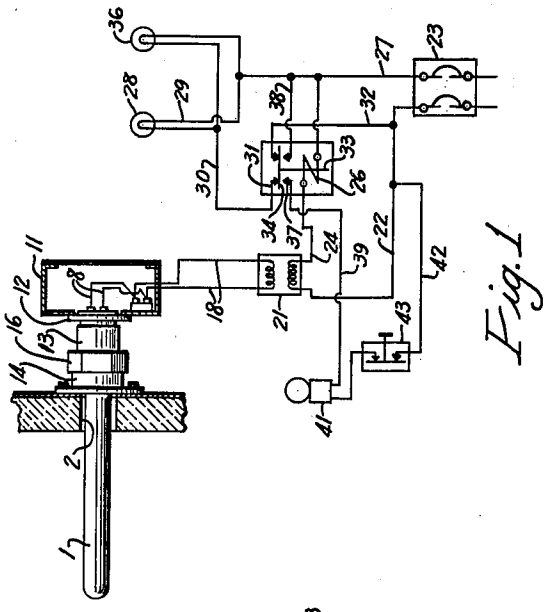

Fig. 1

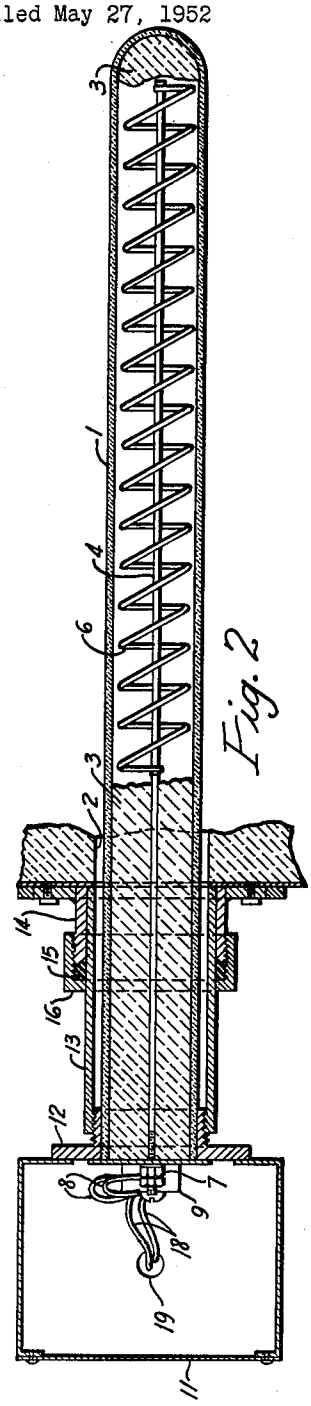

Fig. 2

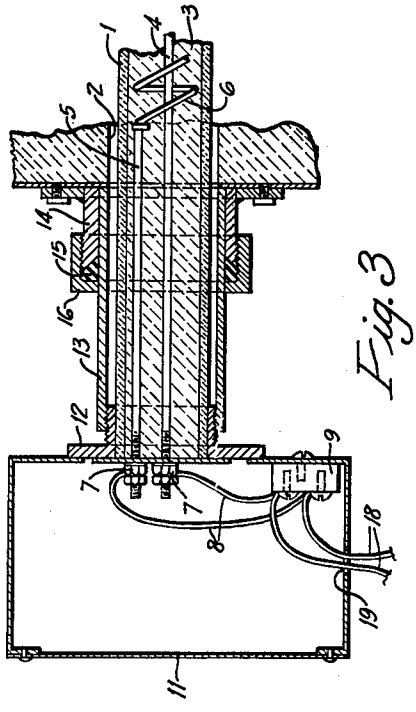

Fig. 3

INVENTOR.
VERNON H. FERGUSON
BY
Brown, Critchlow, Flick & Peckham
His ATTORNEYS

March 20, 1956 V. H. FERGUSON 2,738,967

INDUSTRIAL FURNACE SAFETY DEVICE

Filed May 27, 1952 2 Sheets-Sheet 2

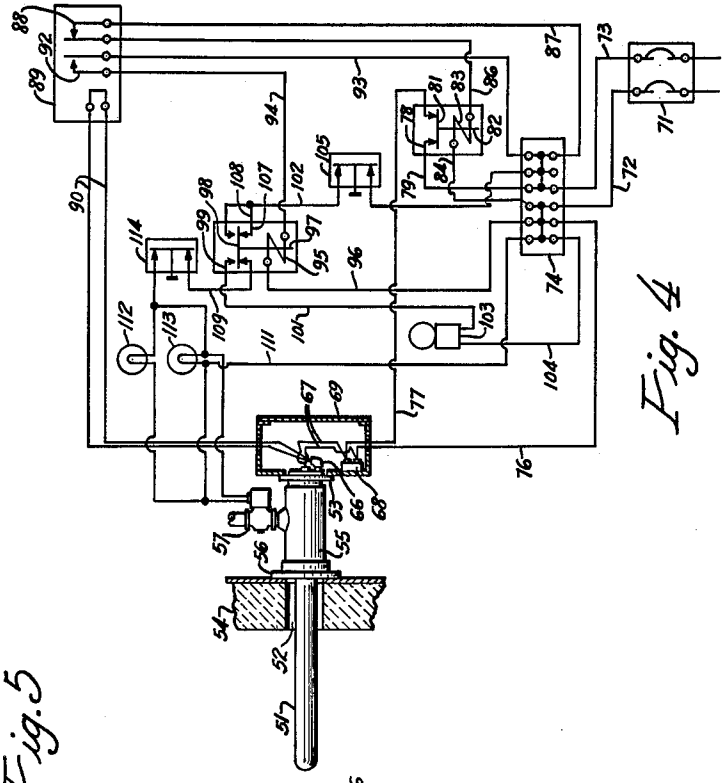

Fig. 4

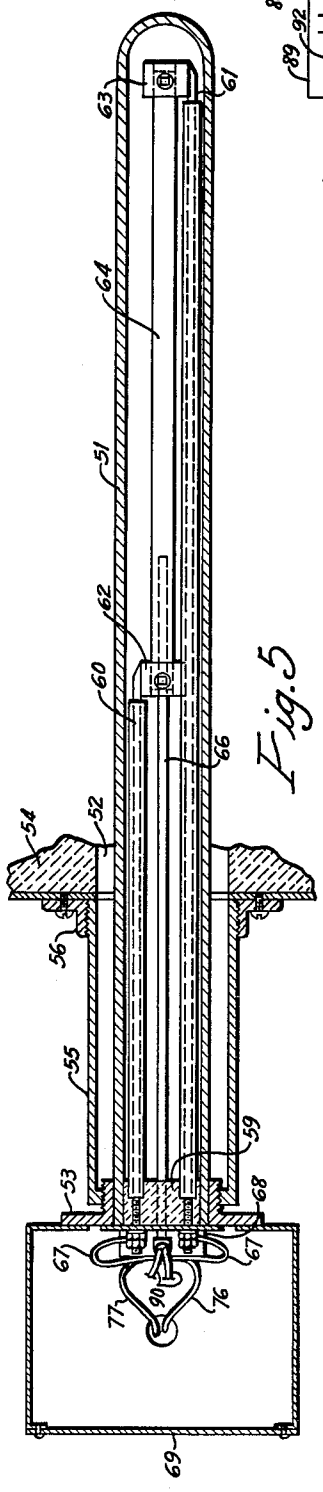

Fig. 5

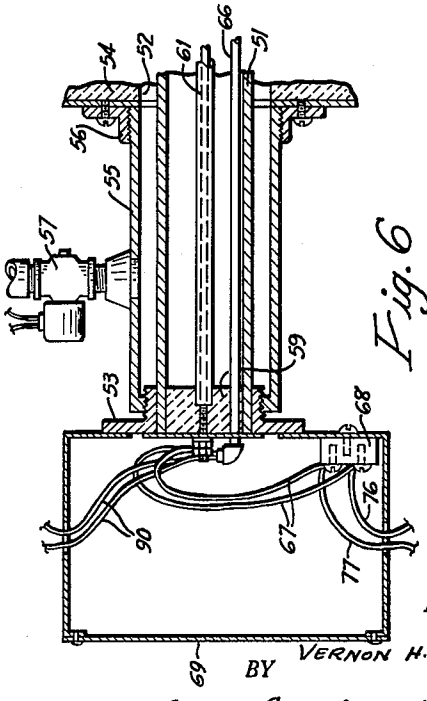

Fig. 6

INVENTOR.
VERNON H. FERGUSON
BY
Brown, Critchlow, Flick & Peckham
His ATTORNEYS

United States Patent Office 2,738,967 Patented Mar. 20, 1956

2,738,967

INDUSTRIAL FURNACE SAFETY DEVICE

Vernon H. Ferguson, Pittsburgh, Pa.

Application May 27, 1952, Serial No. 290,269

8 Claims. (Cl. 263—1)

This invention relates to safety devices for industrial furnaces, and more particularly to a method and means for preventing undesired combustible mixtures from accumulating in furnaces in explosive quantities.

It is not a rare occasion for a fuel fired industrial furnace to explode when a workman inserts a torch to light the furnace. Such explosions are due to the accumulation of fuel that leaked into the furnace while it was shut off. In a protective atmosphere type furnace, the chamber is completely filled with the protective atmosphere during operation because any air inside the chamber has previously been purged or burned out. Since the protective atmosphere is not mixed with air it is not combustible, but if air leaks into the furnace and combines in proper proportions with the atmosphere therein before the furnace is brought up to temperature, there will be an explosion when the interior surfaces of the furnace reach the ignition point of the mixture. Sometimes such an explosive mixture will accumulate in the vestibule of a controlled atmosphere furnace, and when the furnace chamber door is opened the heat of the furnace causes an explosion. Wherever the word "atmosphere" is used herein, it means a gas or mixture of gases containing either no oxygen or insufficient oxygen for burning.

It is among the objects of this invention to provide an industrial furnace safety device which will burn any undesired combustible mixture of gases in the furnace as it accumulates, which will signal in case the temperature of the mixture burner falls below the ignition temperature of such a mixture, which will not become overheated, and which may be formed to admit a controlled atmosphere to the furnace around the ignition element that burns the dangerous mixture of gases.

In accordance with this invention, an ignition element is placed in a furnace in a location where an undesirable combustible mixture of gases may occur. This may be at the top of some types of furnaces and at the bottom of others. Means, preferably an electric circuit, is provided for maintaining the temperature of the element above the ignition temperature of such a mixture. Consequently, the mixture will burn as it forms and not be permitted to accumulate in sufficient quantity to cause an explosion as it would when exposed to its ignition temperature. It is highly desirable that means be operatively connected with the ignition element for signaling if the temperature of the element falls below the ignition temperature of the combustible mixture. The circuit that operates the alarm can also be used to shut down the furnace or perform other safety measures. Provision also may be made for opening the circuit to the ignition element in case the element starts to overheat, whereby to prevent damage to the element. If the ignition element is located at the bottom of the furnace, a controlled atmosphere can be admitted to the chamber around the element, and a valve in the atmosphere line can be closed automatically if the temperature of the element drops below a certain point.

The invention is illustrated in the accompanying drawings, in which Fig. 1 is a side view of the ignition element projecting into a furnace and connected to the electric circuit of the safety device; Fig. 2 is a horizontal central section through the ignition element; Fig. 3 is a fragmentary vertical central section through the outer part of the ignition element; and Figs. 4, 5 and 6 are views similar to Figs. 1, 2 and 3, respectively, showing a modification of the safety device.

Referring to Figs. 1, 2 and 3 of the drawings, the ignition element of the safety device includes a ceramic tube **1** that extends into a furnace, either its chamber or vestibule depending on the circumstances, through an opening in its wall **2**. The inner end of the tube is closed and the entire tube is filled with refractory material **3** which has a high coefficient of thermal transmission. Embedded in this material is a pair of laterally spaced electrical conducting rods **4** and **5** of different lengths, one of which is disposed at the axis of the tube and extends to a point near its inner end. The inner end of this rod is connected to an electric resistance coil **6** that encircles the rod and extends back along it to the shorter rod. The outer ends of these two rods project from the tube and are threaded and provided with nuts **7** for holding wires **8** that connect them to a terminal block **9**. The block and nuts are disposed in a box **11** which is supported by a flanged ring **12** mounted on the outer end of the tube. This ring is screwed into the outer end of a sleeve **13**, the inner end of which is slidably mounted in a flanged collar **14** secured to the furnace wall. Suitable sealing material **15** is forced against this collar and the sleeve by means of a nut **16** screwed on the outer end of the collar. This arrangement permits the distance that the tube projects into the furnace to be adjusted.

Connected to terminal block **9** is a pair of wires **18** which extend out of the bottom of box **11** through an opening **19** and are connected to the secondary of a transformer **21**. The primary of the transformer is connected by a wire **22** to a circuit breaker **23** and by a wire **24** to the solenoid coil **26** of a coil current relay. The coil is connected by a wire **27** to the circuit breaker, which is connected to an electric power line so that the resistance element **6** in tube **1** will be heated electrically. A resistance is chosen which will heat the tube to a temperature high enough to ignite any combustible mixture that may start to accumulate in the furnace. This will prevent an explosive mixture from accumulating and causing an explosion.

In order to show that the ignition element is operating and is up to temperature, a light **28** is connected by a wire **29** to wire **27**, and by a wire **30** to one contact of a switch **31** at the top of the relay. The other contact of this switch is connected by a wire **32** to wire **22**. As long as the ignition element is drawing the prescribed amount of current, solenoid **26** will be energized sufficiently to hold the relay armature **33** in its upper position, where it holds a bridging contact member **34** against the contacts of switch **31** to complete the circuit through light **28**. A second light **36** can be connected in parallel with the other light so that if one burns out the other will remain lighted. It will be seen that if for any reason, except a short circuit, the ignition element begins to draw less current that it should, which would cause a reduction in its temperature and thereby render it inoperative for its intended purpose, the relay solenoid will allow the armature to drop and both lights will be extinguished. At the same time, the bridging member **34** engages the contacts of a lower switch **37** and closes it. One of these contacts is connected by a wire **38** to one side of the circuit breaker, and the other is connected by a wire **39** to an electrically operated audible alarm **41**, such as a horn or bell. This alarm is connected to the other

side of the circuit breaker by a wire 42, in which there is a normally closed switch 43. To keep the alarm from sounding when this safety device is first turned on, this switch is held open manually for a few moments. It will be seen that if an attendant does not observe the lights going out in case the temperature of the ignition element has fallen, his attention will be called to the dangerous condition by the audible alarm.

If this safety device is to be used with a furnace that is heated by gas, the ignition element, or several of them, is placed in the upper part of the furnace where any leaking fuel gas would tend to accumulate. The safety device is always on guard to prevent the accumulation of a dangerous amount of such gas, however, because the hot ignition element will burn the gas as fast as it comes in contact with that element. Of course, the ignition element is in addition to any pilot lights that the furnace may have.

The ignition element disclosed in Figs. 4, 5 and 6 is designed primarily for use at the bottom of a furnace which contains a protective atmosphere. Any air leaking into the furnace, being heavier than the protective atmosphere, would accumulate and mix with that atmosphere at the bottom of the furnace, so that is where the ignition element should be located. In this case the tube 51 extends into the furnace through a passage 52 in wall 54. The outer end of the tube is mounted in a flanged ring 53 that is screwed in a sleeve 55 which is supported at its inner end by a collar 56 attached to the furnace wall. By making the wall passage considerably larger than the tube a space is provided between the sleeve and tube, and the sleeve can be provided with an inlet opening to which a solenoid valve 57 can be connected. This valve is intended to be connected by a pipe to the source of protective atmosphere, and that atmosphere is introduced into the furnace through the valve, sleeve and wall passage.

The outer end of tube 51 is filled and sealed with refractory material 59 which supports two parallel insulated rods 60 and 61 of different lengths. The shorter of the two rods supports a metal block 62 just inside the furnace wall, and the other rod supports a metal block 63 near the inner end of the tube. These two blocks support the opposite ends of a silicon carbide resistor 64. Projecting into the outer end of this resistor is a thermocouple 66, which extends out through the end of the tube. The ends of the two rods are connected by wires 67 to a terminal block 68 in a box 69 supported by flanged ring 53.

A circuit breaker 71, which is connected to a power line, has wires 72 and 73 attached to the center terminals of a distribution panel 74. Wire 72 is connected by a wire 76 to terminal block 68. The terminal block also is connected by a wire 77 to one contact of a solenoid operated switch 78, the other contact of which is connected by a wire 79 to wire 73 at the distribution panel. The bridging member 81 for this switch is carried by the upper end of an armature 82 which is slidable in a solenoid coil 83. One side of the coil is connected by a wire 84 to one side of the panel, and the other side of the coil is connected to the other side of the panel by means of wires 86 and 87 and a normally closed switch 88 in a relay 89, forming part of a pyrometer (not shown), which is controlled by thermocouple 66 through wires 90. As long as current is flowing through the solenoid, the switch 78 above it will remain closed and electric current will be supplied to the resistor in the ignition tube. Ordinarily, a transformer is not necessary with this type of resistor. In case the ignition element starts to overheat, due to a higher than usual temperature in the furnace, the relay switch 88 in the solenoid circuit will open, whereupon solenoid switch 78 will open and the current to the resistor will be cut off temporarily until switch 88 closes again.

The relay also contains a normally open bimetallic switch 92 that is connected by a wire 93 to one side of the distribution panel, and by a wire 94 to the solenoid coil 95 of a second relay. This coil is connected by a wire 96 to the panel. The switch 92 is preset to close, due to cooling of thermocouple 66, in case the temperature of the ignition element falls below the ignition temperature of a mixture of protective atmosphere and air that may occur in the bottom of the furnace. When this happens, the armature 97 of the second relay is raised and causes a bridging contact member 98 to close an upper switch 99 that is connected by wires 101 and 102 to an audible electric alarm 103 and to the panel, respectively. The other side of the alarm also is connected to the panel by a wire 104. When switch 99 is closed, the alarm is sounded to warn that the ignition element no longer is functioning. The alarm circuit contains a normally closed switch 105 which is opened manually while the ignition element is first heating up.

In its normal lower position, the bridging member 98 closes a lower switch 107 that is connected by a wire 108 to wire 102, and by a wire 109 to one side of solenoid valve 57. The other side of the valve is connected by a wire 111 to the distribution panel. Current thus supplied to the valve holds it open, but when solenoid 95 is energized to sound the alarm, the valve circuit is opened and the valve closes to cut off further delivery of atmosphere to the furnace. A pair of signal lights 112 and 113 are shunted across the valve circuit to show by their burning that the valve is open. The circuit may also contain a normally closed switch 114 that can be opened manually any time that it is desired to close the valve.

It is important that the ignition element used in a protective atmosphere furnace be heated by other than a flame exposed to the atmosphere in the furnace, because such a flame would affect the protective atmosphere.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. An industrial furnace safety device comprising an ignition element adapted to project into the lower part of a furnace, said element including an electrical resistor sealed in a tube, conduit means associated with said element for introducing a predetermined atmosphere into the furnace, a valve in said conduit means, an electric circuit connected with said resistor for maintaining the temperature of said tube above the ignition temperature of a mixture of said atmosphere and air, whereby the mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, and means responsive to the temperature of said tube for closing said valve if that temperature falls below said ignition temperature.

2. An industrial furnace safety device comprising an electric resistance ignition element adapted to be placed in a furnace in a location where an undesired combustible mixture of gases may occur, an electric circuit connected with said element for maintaining its temperature above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, an electric alarm, an electric circuit connected with the alarm, an electric switch in the alarm circuit biased towards closed position, and an electric coil in the first circuit for holding said switch open only as long as the said element draws enough current to keep it above said ignition temperature.

3. An industrial furnace safety device comprising an electric resistance ignition element adapted to be placed in a furnace in a location where an undesired combustible mixture of gases may occur, an electric circuit connected

with said element for maintaining its temperature above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, an electric alarm, an electric circuit connected with the alarm, a normally closed electric switch in the alarm circuit, an electric light, an electric circuit connected with said light, a normally open electric switch in the light circuit, and an electric coil in the first circuit for holding the alarm circuit switch open and the light circuit switch closed only as long as the temperature of said element is above said ignition temperature.

4. An industrial furnace safety device comprising an electric resistance ignition element adapted to be placed in a furnace in a location where an undesired combustible mixture of gases may occur, an electric circuit connected with said element for maintaining its temperature above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, a normally closed switch in said circuit, and means responsive to the temperature of said element for opening the switch if that temperature exceeds a predetermined maximum.

5. An industrial furnace safety device comprising an electric resistance ignition element adapted to be placed in a furnace in a location where an undesired combustible mixture of gases may occur, an electric circuit connected with said element for maintaining its temperature above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, a switch in said circuit, a solenoid coil for closing the switch, a normally closed electric circuit connected with said coil, and means responsive to the temperature of said element for opening the last mentioned circuit if that temperature exceeds a predetermined maximum, whereby the first-mentioned switch will open.

6. An industrial furnace safety device comprising an electric resistance ignition element adapted to be placed in a furnace in a location where an undesired combustible mixture of gases may occur, an electric circuit connected with said element for maintaining its temperature above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature, an electric alarm, an electric circuit connected with the alarm, a normally open electric switch in the alarm circuit, an electric light, an electric circuit connected with said light, a normally closed electric switch in the light circuit, a solenoid coil associated with said switches, a normally open electric circuit connected with said coil, and means responsive to the temperature of said element for closing the last-mentioned circuit if that temperature falls below said ignition temperature, whereby said coil will open the light circuit switch and close the alarm circuit switch.

7. The combination with an industrial furnace having a passage through its wall near its bottom, of a conduit connected to the outer end of said passage for delivering a predetermined atmosphere to the inside of the furnace, an ignition element extending through said passage and projecting from both ends of it, the outer end of said element being supported by said conduit spaced from the walls of the conduit and passage, and means for maintaining the temperature of the ignition element above the ignition temperature of a mixture of said atmosphere and air, whereby the mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature.

8. The combination with an industrial furnace having a passage through its wall near a location where an undesirable combustible mixture of gases may occur, of a sleeve mounted on said wall around the outer end of the passage, a ring adjustable axially in the outer end of the sleeve, a tube extending through the sleeve and passage and into the furnace and having its outer end mounted in said ring, an electrical resistor sealed in the tube inside the furnace, and an electric circuit connected with said resistor for maintaining the temperature of the tube above the ignition temperature of said mixture, whereby any such mixture will burn before it can accumulate in sufficient quantity to be exploded when exposed to its ignition temperature.

References Cited in the file of this patent

UNITED STATES PATENTS

1,535,240	Morris	Apr. 28, 1925
1,670,819	Morris et al.	May 22, 1928
2,095,253	Heyroth	Oct. 12, 1937
2,474,941	Hasselhorn et al.	July 5, 1949
2,487,752	Cohn	Nov. 8, 1949
2,506,913	Baker	May 9, 1950
2,575,113	Lennox	Nov. 13, 1951