

April 8, 1924.

1,489,247

C. W. HILL

FURNACE INDICATOR

Filed Jan. 14, 1921

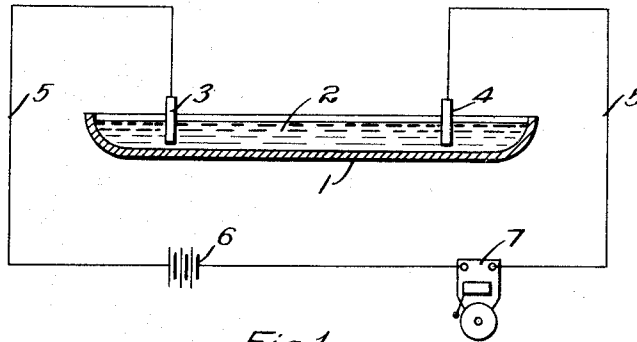


Fig. 1.

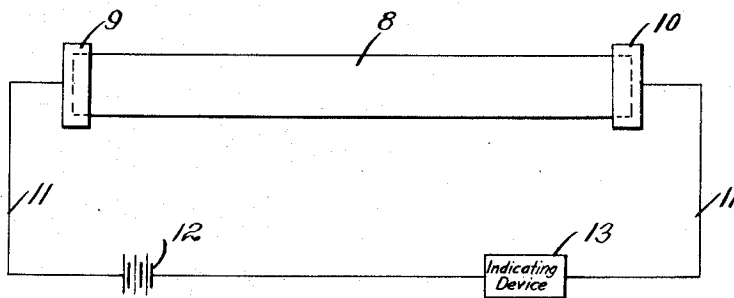


Fig. 2.

WITNESSES:

*A. L. Jeffrey*  
*H. C. Bierman*

INVENTOR

*Charles W. Hill*

BY

*Verly & Co.*

ATTORNEY

## UNITED STATES PATENT OFFICE.

CHARLES W. HILL, OF PERTH AMBOY, NEW JERSEY.

## FURNACE INDICATOR.

Application filed January 14, 1921. Serial No. 437,280.

*To all whom it may concern:*

Be it known that I, CHARLES W. HILL, a citizen of the United States, and a resident of Perth Amboy, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Furnace Indicators, of which the following is a specification.

This invention relates to furnace or flue indicators, more especially to indicators adapted to inform the operator as to the condition of the atmosphere, either reducing or oxidizing, in the furnace.

My invention has for its object the provision of a furnace indicator of simple construction which is very sensitive in operation and is capable of accurately and quickly indicating the true condition of the atmosphere in a furnace or in a flue.

I have found that an element may be constructed of certain materials which are affected by the reducing or oxidizing atmosphere in a furnace to change the character thereof, which change may be recorded by a variety of means. More specifically, I provide an element including a suitable oxide of a metal which is easily reducible to the metal under certain conditions of temperature and reducing atmosphere. The change in condition of the material may be detected in a variety of ways but I, in practically all cases, confine myself to the utilization of such material either in an electrical circuit where the change of resistance of the material is recorded by a warning signal, on a permanent record, or is transmitted to relays to operate control valves. Another method of detecting the change in the material consists in balancing the oxide and utilizing the change in weight to make electrical contact or, in any other manner, to operate the signal or the like. In either case, the change in the material should be reversible.

I may utilize any suitable oxide which is adapted for the particular temperature of the furnace, the conditions of which are to be recorded. For low temperatures, about 150° C. to 900°, I prefer to use copper oxide; for temperatures of about 500° C. to 1000°, I utilize iron oxide and for temperatures of 1050° or more tungsten ox-

ide. One or more of these oxides, in powdered form, may be placed, in a layer of suitable depth, in a silica or porcelain dish or trough, and metallic electrodes be secured at each end thereof. The electrodes are connected to a suitable signalling, recording, or valve-controlling circuit.

Instead of using the oxide in powdered form, I may make a resistance rod including the oxide, a non-conducting refractory material, such as porcelain or clay, and a suitable binder, sodium silicate, or the like. The material is molded to the proper form and then baked. The sizes of the particles used should be so regulated as to make the rod porous after baking to allow the atmosphere of the furnace, into which the rod is placed for indicating its condition, to penetrate into the central portions of the rod.

I have prepared excellent indicators by forming a rod of a clay body, such as terra cotta, coating the same with material containing the desired oxide (or a compound, such as carbonate which on heating yields the oxide), and then baking. The active material is thus deposited on the surface of the material where it comes into contact with the reducing or oxidizing gases very readily, and the entire structure has great mechanical strength because of the clay body. When the oxide is incorporated in the body, the structure is weakened, the sensitiveness of the element is somewhat lessened and a much longer time is required for the reversal than if the surface only of the material consists of the oxide.

Clay bodies contain their own binding constituents, making it unnecessary to add binders. I avoid the use of carbonaceous binders such as pitch, tar, glucose or the like, since they are decomposed by heat to form carbon which is an electrical conductor and interferes with the conductivity of the indicator element. Furthermore, such binders, as well as the carbon resulting from their decomposition, have a reducing action and produce the same effect on the oxide as that obtained from a reducing atmosphere.

I have found that the reduction of such oxide may be accelerated by the addition of a small quantity of one or more other oxides,

such as of cobalt, which catalyze the reduction of the indicator oxide by gases, such as carbon monoxid. I generally add to the indicator oxide a small percentage, usually  
 5 less than 1%, of the catalyzer oxide.

Referring to the accompanying drawing constituting a part hereof and in which like reference characters denote like parts,

Fig. 1 is a diagrammatic view of one  
 10 form of my invention, and

Fig. 2 is a similar view of a slightly modified form thereof.

In one embodiment of my invention there is provided a boat 1 of porcelain or other refractory material, and a suitable oxide  
 15 2 is placed therein. Electrodes 3 and 4 are inserted in the boat 1 and are connected by conductors 5 to a circuit comprising a source of energy, such as a battery 6, and  
 20 an alarm device, such as a bell 7.

Instead of placing loose oxide in a suitable receptacle, I may form the material into a rod 8 and secure the ends thereof in suitable metallic holders 9 and 10 which  
 25 are connected by conductors 11 into a circuit containing a battery 12 and an indicating device 13 of any suitable type.

In utilizing my invention to indicate furnace conditions, I place the porcelain boat  
 30 1 or the rod 8 in the furnace and note the changes produced in the oxide by means of the alarm or indicating device connected in the circuit. It is obvious that various accessories may be added to the apparatus  
 35 shown diagrammatically in the drawings and that devices other than the indicating and alarm mechanisms shown may be utilized to indicate the furnace conditions.

The electrical connections for my furnace indicator should be arranged in accordance with the conditions to be indicated. When the element is placed in a reducing atmosphere, the change resulting from the reduction of the oxide would require a certain series of connections and the opposite  
 45 connections when the reaction was the oxidation of the metal to the oxide. In the one case, an open-circuit arrangement would be used and, in the second, a closed  
 50 circuit. The change in condition of the indicator material would, in each case, operate a valve or actuate a signal.

I may utilize the change in weight of such oxides, resulting from reduction by  
 55 furnace atmosphere, to indicate the condition of such atmosphere. I may use any suitable oxide, such as those above mentioned and other compounds which are decomposed under the conditions existing in the furnace, and attach a rod or other form  
 60 of such material to the arm of a balance or to a jolly balance so that the reduction of the oxide to the metal by the furnace gases will cause an arm or pointer to move  
 65 and make electrical contact, thereby clos-

ing a circuit to operate a signal-recording device or valve-controlling means.

My invention is not confined to the use of the oxide mentioned herein, since other  
 70 suitable oxides will suggest themselves to those skilled in the art. I may utilize compounds other than oxides which, on reduction, are changed in electrical resistance or in weight. I may utilize substances  
 75 which volatilize at the desired temperature, such as zinc oxide, which is first reduced at a suitable furnace temperature (500 to 600° C.) to the metal and then vaporizes, the  
 80 change in weight being utilized to operate an arm or pointer to make electrical contact, as above stated.

The sensitiveness of the element may be varied by selecting the proper oxide, by the temperature at which the element is subjected to the gases, by the fineness of  
 85 sub-division of the oxide, and by the addition of catalyzers. The source of the oxide also determines the sensitiveness of the element to a certain degree. For instance, the reducibility of copper oxide varies, depend-  
 90 ing upon whether it is produced by oxidation of finely divided copper in the air or by decomposition by heat of a copper salt. The oxide formed by decomposition differs  
 95 in reducibility, depending upon the compound from which it is produced. For instance, that produced from the carbonate differs from the oxide obtained from the nitrate or sulphate.

I claim as my invention:—

1. A furnace indicator comprising resistance material capable of changing its resistance under reducing conditions. 100
2. A furnace indicator comprising a metal oxide capable of changing its resistance under reducing conditions. 105
3. A furnace indicator comprising a reducible oxide capable of changing its resistance under reducing conditions.
4. A furnace indicator comprising a resistance rod including a reducible oxide. 110
5. A furnace indicator comprising a porous resistance rod including a reducible oxide.
6. A furnace indicator comprising a porous resistance rod including a reducible oxide, refractory material, and a binder. 115
7. A furnace indicator comprising material capable of changing its character under reducing conditions. 120
8. A furnace indicator comprising an oxide capable of changing its character under reducing conditions.
9. A furnace indicator comprising a reducible oxide capable of changing its character under reducing conditions. 125
10. A furnace indicator comprising resistance material capable of changing weight under reducing conditions.
11. A furnace indicator comprising an 130

oxide capable of changing its weight under reducing conditions.

12. A furnace indicator comprising an oxide capable of changing its character and  
5 mixed with a catalyzer.

13. A furnace indicator comprising an oxide capable of changing its character and mixed with a small amount of cobalt oxide.

14. A furnace indicator comprising inert  
10 material and an oxide on the surface thereof.

15. A furnace indicator comprising clay and a coating of an oxide thereon.

16. A furnace indicator comprising an oxide capable of being reduced to the metal 15 which is in turn capable of again being changed into the oxide under oxidizing conditions.

In testimony whereof, I have hereunto subscribed my name this fifth day of Jan- 20 uary, 1921.

CHARLES W. HILL.