To all whom it may concern:

Be it known that I, FREDERICK D. POTTER, a citizen of the United States, and a resident of Linden, county of Union, and State of New Jersey, have invented certain new and useful Improvements in Signal Apparatus for Combustion Control, of which the following is a specification.

My invention relates to signal apparatus for combustion control, and while the invention is illustrated and described herein as applied to a steam boiler and its setting, it is to be understood that the invention may be made use of in connection with a variety of apparatus where it is desired that there be presented indications or signals readily perceptible to a human sense or senses of unfavorable conditions of combustion, in pursuance whereof the undesirable conditions may be remedied or controlled by any appropriate means.

I have found that where the heat of a fire is utilized by passing the flame and heated gases along in contact with the surface to be heated as, for example, in a steam boiler installation, that the efficiency of the apparatus is very closely dependent upon the maintenance of a bed of fuel as nearly uniform throughout its extent as can be secured, and in particular that if there are any places where the layer of fuel is much thinner than at other places, or if, as sometimes happens, there is a "hole in the fire", that is, a space where the incoming air for supplying oxygen to the fire is permitted to pass directly into the combustion chamber without passing through a layer of fuel and becoming heated in such passage, the heating efficiency falls off very rapidly and the temperature throughout the combustion chamber and in the region where the heat is given up to the object or objects being heated is lowered to a marked degree, and this frequently happens without the fireman or attendant being aware of it until it progresses to a noticeable extent as by the lowering of the steam pressure on the gage.

An object of the present invention is the provision of means whereby an indication perceptible to a human sense or senses is given on any such lowering of temperature as soon as or very shortly after it occurs so that the proper remedy may be applied without unnecessary delay as, for example, when the cause of the objectionable condition is a hole in the fire or a thin spot, by applying fuel where such hole or thin spot is formed until it is closed up, causing the air for supporting the combustion to be obliged to pass through the fuel bed before it gets into the combustion chamber.

A further object of the invention consists in the arrangement of the actuating mechanism for the indicating apparatus in a position between regions containing gaseous materials under differing conditions of pressure, speed of travel and the like, which differences are short circuited and the actuating apparatus placed in or in communication with such short circuit to insure the actuation of the indicating apparatus with the greatest possible quickness and certainty.

A further object of my invention consists in the provision of a number of successive indicating means coming into operation successively as the objectionable condition increases as, for example, in the case of a control for a boiler furnace by insuring the ringing of a bell in the fire room as the first indicating means, thus drawing the attention of the fireman or boiler attendant to a condition to be remedied, and if the objectionable condition is not speedily remedied a further signal, as a bell in the superintendent's office, may be rung, thus bringing the condition of the fire to the attention of some person having supervisory authority and insuring the prompt and efficient attention of the fireman or attendant in immediate charge in order to prevent the giving out of subsequent signals which would come to the attention of his superior.

Another object of the invention consists in the arrangement of the signal actuating mechanism in such a manner as that it will respond readily to changes of temperature in the furnace gases, while at the same time it is protected from excessive heat and is insulated from the walls and surfaces in its immediate neighborhood so as not to respond to any considerable extent to the heat conditions prevailing therein and which vary but slowly.

Other and further objects of my invention will appear in connection with the following description thereof and be pointed out in my claims, and with the foregoing and related objects in view, my invention consists in the parts, improvements and combinations herein set forth and claimed.
It is to be understood that the apparatus shown and described herein is for the purpose of illustration only, and that my invention is not confined thereto but is as broad as my claims.

In the drawing forming part of this specification, and wherein the same reference numerals are uniformly used to designate the same parts throughout, Figure 1 is a vertical cross-sectional view illustrating one form of signal operating device in accordance with my invention. Fig. 2 is an elevational view at right angles to Fig. 1 with the cover removed. Fig. 3 is a cross-sectional view taken on the line 3—3, Fig. 1. Fig. 4 is a diagrammatic and cross-sectional view of a boiler setting showing the preferred location of the opening in the bridge wall, and Fig. 5 is a horizontal cross-sectional view taken on the line 5—5, Fig. 4.

Reference numeral 10 designates one type of boiler setting generally, and which is of such character as that the path of travel of the flame and heated air from the fire in reaching the space back of the bridge wall 11 is indirect. In the type of setting shown, the boiler is of the well known Babcock type, and the flame and heated gases travel from the fire on the grate bars 12 upwardly over the baffle 13 and downwardly to the rear of the bridge wall 11 until they pass beneath the baffle 14 and upwardly out of the stack 15. My invention may be used, however, when applied to boiler furnaces, with boilers and settings of different types. With the type shown, the path of travel of the flame and heated air from the fire-box to the space behind the bridge wall is indirect so that there the conditions of pressure, speed and duration of gas travel and the like are different in these two neighborhoods. Means of direct communication from the fire-box to the space behind the bridge wall are provided. Such communicating passage indicated at 16 on the drawings is, however, comparatively small so as that the escape of such small quantity of gas and vapors as passes therethrough does not interfere to any material extent with the combustion and does not detract materially from the heating effect produced by the fire. Such passage being a short circuit, direct from the fire-box to the space behind the bridge wall, whereas the path normally traveled by the flame and gases is circuitous as, for example, up over and back down behind the baffle plate 13, it results that the flame and gases prefer to travel through the opening 16 by reason of the difference of pressure, etc. on the two sides of the bridge wall, so that while the fire is burning there is always a circulation of the flame and heated air or gases through the opening 16 in the bridge wall 11 and into the space 17 back of the bridge wall, and the temperature of the gases passing through such passage changes vary quickly with any changes in the combustion chamber.

Means responsive to temperature changes for actuating an indicating means are provided in or in communication with the passage 16. In order that such heat operable actuating means may be protected somewhat from the extreme heat which is encountered if placed directly in the passage 16, I preferably place such apparatus in a side passage communicating with the passage 16 in the bridge wall. In the form shown such side passage 18 extends from the passage 16 to one of the side walls of the boiler setting, the passage 16 as shown in Fig. 5 being preferably placed fairly close to such side wall 10 of the boiler setting 10 in order that the passage 18 may extend to the outer face of the side wall and still be comparatively short.

Any passage whereby movement is produced by changes of temperature when placed within the passage 18 or otherwise in communication with the passage through the bridge wall 11 may be made use of. In the form shown a tube 19 of material readily expanded by heat as, for example, a copper tube, is provided and serves as a thermostatic or heat expansible member. The tube 19 is anchored at its outer end 20 in any suitable manner. Within the tube 19, and firmly secured thereto at the end 21 opposite the end 20 as by means of a rivet 22, is a rod 23 which is preferably of a material whose coefficient of expansion is zero or as near thereto as possible, and such rod 23 preferably extends beyond the tube 19 and beyond the passage 18 at its outer end 24, said projecting end 24 being moved in or out slightly as the member 19 contracts and expands, and the arrangement serving as a means whereby mechanical movement is obtained responsive to temperature changes in the passages 16 and 18.

This thermostatic means is preferably arranged in the passage 18 in such manner as to be responsive to and readily affected by changes of temperature in the gases contained in the passage, and at the same time to be insulated as thoroughly as possible from the walls of the passage, the temperature at which walls, at least over short periods, remains substantially unchanged. In the form shown the tube 19 is received in an outer tube 26 which is preferably of metal, as iron, and is preferably formed with comparatively thin walls so as to be sensitive to heat changes taking place in the passage 18. The tube 19 preferably rests on the bottom of the tube 26 in which it is contained, as shown in Fig. 1. Any means for insulating the thermostatic member from the side walls of the chamber wherein it is received, as the passage 18, may be resorted
to, as, for example, the surrounding air when it is supported entirely out of contact therewith. In the form of construction shown there are provided for this purpose three tubes 27 which are of material which preferably is as effective a heat insulator as can be secured. For this purpose these tubes may, for example, be made of porcelain, and the tube 26 containing the tube 19 may rest on the top of two of the tubes 27, the third of the tubes 27 resting on the bottom of the passage 18 and serving as a support for the other two of the tubes 27 with the tube 26 resting thereon and out of contact with the wall of the passage 18. When parts are provided and arranged in the manner shown and described, it will be evident that the tubes 19 and 26 are substantially insulated from the walls of the chamber 18 and may therefore respond to changes of temperature of the air and gases contained in such chamber, and at the same time are protected from the excessive heat to which they would be exposed if arranged directly in the bridge wall passage 16.

Any suitable means for utilizing the movement of the end 24 of the rod 23 to operate a signal or indicating device or devices which may be perceptible to a human sense or senses may be resorted to, and any type of signal or indicating devices adapted for such purpose may be used. In the form shown a wall plate 29 is secured to the outer face of the wall 10' and is provided with an opening 30 opposite the outer end of the passage 18, and secured to said wall plate, as by means of the screw 31, is a support 32 upon which parts of the operating mechanism are arranged, and which is preferably formed as a solid metal casting in order to provide a substantially rigid support for the parts mounted thereon, and this support and apparatus are preferably covered, as by means of a cover box 33, and the entire casing is tightly closed when such cover is in place.

In the form of construction shown the thermostatic device is secured to and is removable from the indicator support 32, the end 20 of the tube 19 being firmly anchored in such supporting member 32. The member 32 is provided at its rearward side with an extending sleeve 34, which fits within the opening 30 in the plate 29 and within which sleeve 34 the tube 26 is received and held. The tube 26 is shown as extending beyond the thermostatic device, but may be longer or shorter than as shown, and if desired may be dispensed with altogether along with the porcelain supporting tubes 27. Any deposits of soot or the like which may be produced takes place principally within the passage 18 and may be blown out from time to time, as by inserting a blower nozzle through the pipe 35, the outer end of which is closed at other times as by the cap 35'.

The end 24 of the rod 23 is provided with an adjustable extension 36. In the form shown, a bore 37 is formed in the portion 24 of the rod 23, which said portion 24 is slotted, as shown at 38, and provided with a sleeve or collar 39, serving to grip the slotted portion of the end 24 of the rod 23 upon the rod 36 in the familiar manner, in which drill chucks are held. The collar 39 and the part 24 of the rod 23 may be threaded, if desired to secure an extra firm hold of the extension 36. With such arrangement the extension 36 may be adjusted and secured in any desired relation to the rod 23, as will be understood. The rod 36 has formed therein an elongated slot 40 which receives a cross pin 41 in a lever 42 supported upon a pivot 43, 43, which, in the form shown, are placed a short distance below the axis of the cross pin 41. Spring means, as a leaf spring 43', are applied to the lever 42 and tend to turn it to the right, as the parts are shown in Fig. 1. As will be evident, when the extension 36 is adjusted as shown in Fig. 1, pull on the rod 23 and extension 36 due to expansion of the tube 19, results in the movement of the lever 42 toward the left, as shown in such figure, and as the tube 19 contracts upon the temperature falling the lever 42 turns toward the right under the influence of the spring 43'. When the whole device is cooled off as, for example, when the boiler is out of use, the elongation of the slot 40 permits further contractile movement of the tube 19 and resulting movement to the right of the extension 36 of the rod 23 freely without danger of breakage of the parts. By means of the adjustment which may be obtained by the collar 39, any permanent set in the thermostatic member may be compensated for by adjusting the extension in or out with respect to the rod 23, according to the character of such permanent set.

As will be readily observed, the lever 42 serves to multiply very considerably the movement produced by contraction and expansion of the tube 19, and such lever is provided, preferably toward the end of its longer arm, with means for operating one or more signal or indicating means, this being accomplished in the form of construction shown by closing one or more electric circuits by bringing contact members carried by the lever 42 into contact with cooperating contact members suitably placed in the path thereof.

In the particular form shown, the upper portion of the supporting member 32 is provided with a cylindrical bore 45, wherein is rotatably received a cylindrical rod 46 which may be adjusted lengthwise as by means of set screws 47, 47, one of said screws 47 being arranged in a plate 48.
which is removably secured to the member 32 as by means of a screw 49, which may also serve as a means for attaching a lead wire 50. The rod 46 has a vertical slot 51 formed therein, and an opening 52 is formed in the member 32 opposite the slot 51. Pivotally mounted within the slot 51 is an arm 53. Said arm is extended upward beyond its pivot 54, and provided with a flat face 55 normally resting against a similar flat face 56 on a member 56' firmly secured within the slot 51 in the member 46. As will be seen, the arm 53 is firmly retained with the face 55 and 56 in close contact but is free to swing in the opposite direction, and said arm and the member 46 in which it is carried may be adjusted bodily by means of the screws 47, 47, the arm being preferably inclined somewhat to the right, as shown in Fig. 1, so that the action of gravity results in maintaining the faces 55 and 56 in contact. A spring may be used for this purpose but is ordinarily unnecessary and has not been illustrated.

The arm 53 and member 46 in which it is mounted may also be swung in a direction at right angles to that in which the arm 53 turns on its pivot, the member 46 being cylindrical and received within a cylindrical opening 45. The arm 53 is provided with a plurality of contact screws 58, 59 and 60 and also with a projecting stud 61, the latter being placed laterally of the contact screws, as shown in Fig. 2. Said screws 58, 59 and 60 are preferably placed at different distances from the pivot 54 on which the arm 53 turns, so that the extent of movement of such screws will vary according to the distance thereof from the pivot 54.

The lever 42 is provided with members for cooperating with the contact screws 58, 59, 60 and 61, the objects of the screws 58 and 60 and stud 61, for completing an electric circuit for operating a signal or indicator, as an electric bell or light or the like, whereas when the screw 60 is in contact with the member 42, no such circuit is passed and no signal is given. In the form shown such effect is obtained by securing a plurality of alternately arranged insulating and conducting members on the member 42. As shown immediately adjacent to the lever 42 and at the side thereof next to the arm 53 is a contacting plate or band 62 which is adapted to make contact with the stud 61 when the arm 53 is swung by turning the rod 46 on its axis in the bore 45. The plate or band 62 has a lead wire 63 connected thereto and which may lead to any suitable signal or indicating means which, as is the case with all the indicating means, is in circuit with the lead wire 50. Next to the plate or band 62 is an insulating plate or band 64 which is somewhat shorter than the plate or band 62, and has its upper end opposite the screw 60. Next outward from the lever 42 is a contact plate or band 65 which is still shorter and has its upper end opposite the screw 59 and has connected thereto at its lower end a lead wire 66 leading to a light, bell or the like signal. Next outward from the lever 42 is an insulating plate 67, and finally there is a contact member 68, the upper end whereof is placed opposite the contact screw 58 and which has at its opposite end a lead wire 69 connected thereto and forming part of an electrical circuit including a suitable indicating device. In the case of the last circuit referred to, a signal lamp 69' is shown in Fig. 1, and similar or other signal devices may be made use of in the other circuits.

The operation of the device is as follows. When the fire is burning satisfactorily and a sufficiently high temperature is maintained, the thermostatic tube 19 being expanded by the heat pulls the lever 42 toward the left (Fig. 1) against the spring 43' and maintains it out of contact with all of the contact members on the arm 53. Whenever, for any reason, the temperature in the fire-box and therefore in the passages 16 and 18 falls and the tube 19 contracts, the lever 42 moves to the right under the influence of the spring 43'. The contact screw 58 is preferably set so that it will be first to complete a circuit for operating an indicating device, and such indicating device, as already stated, may be arranged in the boiler room so that only the fireman or boiler attendant will observe it. The action of the indicating device, as the sound of a bell, will bring to his attention the fact that the temperature in the fire chamber is falling, and he may take such steps as are needed to correct the objectionable condition, as by throwing fuel upon the thin space in the fire, or by such other treatment as may be necessary, and when the temperature rises, as a result of proper conditions having been restored, the tube 19 expands by reason of the rising temperature and breaks the circuit, and the alarm is no longer sounded.

If, however, the cause of the falling temperature is not remedied by the fireman or boiler attendant, and the fall in temperature continues, and the tube 19 likewise continues to contract, the screw 59 will next come into contact with its coating member and cause an electrical circuit, and this circuit may be arranged to operate an indicating device, as a bell or lamp, in the office of the superintendent or other person having the plant in charge, and in this manner his attention will be directed to the fact that proper firing conditions are not being maintained for the boiler to which such indicating member belongs, thus giving the man in charge an indication of the need for taking proper action.
charge of the plant an efficient means of determining when the firing is being properly done and when conditions are such as to require his personal attention, and in this way the man in charge can very readily distinguish between competent and incompetent help in the boiler room. By proper adjustment of the screws both the signals operated by the screws 58 and 59 may be made to sound together, or the contact made by the screw 58 may be terminated as the lever 42 and arm 53 are moved to the right, the contacting of the screw 59 throwing the screw 58 out of contact.

If the boiler is shut down it is desirable that the signals shall not be sounded or otherwise actuated, and it is for this reason that the screw 60 opposite the insulating plate 64 has been provided. With such arrangement when the movement of the lever 42 to the right is great enough to bring the insulating plate 64 into contact with the screw 60 the screws 58 and 59 if properly adjusted may be thereby thrown entirely out of contact, thus preventing the further operation of any of the indicating means.

It is desirable that the setting of the arm 53 may be standardized and it be so arranged as that while the arm 42 and its contact members are out of contact with the corresponding members on the arm 53 when proper firing conditions are maintained, yet that they be so close together as that any drop in temperature which requires attention may be readily indicated by proper contacts being made. In order to facilitate such setting of the parts the setting stud 61 herebefore referred to has been provided. By swinging the arm 53 and the rod 46 slightly, each swinging being toward the left, as shown in Fig. 2, the stud 61 may be brought opposite the contact plate 62, and their being brought into contact may be made to operate a signal, as a light or bell, and while such signal is being operated the screws 58, 59 and 60 may be adjusted so that the necessary slight movement of the arm 53 will result in giving the desired signals upon movement of such arm. One such setting of screws 58, 59 and 60 may be made which is substantially permanent, and if the devices should not properly respond to changes in temperature it is only necessary to move the arm 53 and the member 46 in which it is carried, bodily by means of the set screws 47, thus affording simple means for compensating for any changes which may occur and making it readily possible to bring the signal apparatus back to proper position from time to time as may be needed.

It will be seen that my invention may be embodied in a variety of constructions and that it has numerous points of advantage. While I have shown a particular construction in which it may be embodied, the invention is by no means confined thereto, but numerous departures therefrom and changes therein may be resorted to within the scope of my claims without departing from my invention or sacrificing any of its advantages.

Having thus described my invention, I claim:

1. In combination, a combustion chamber, a chamber into which furnace gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, and means for indicating changes of temperature of the gases passing through said passage, substantially as set forth.

2. In combination, a combustion chamber, a chamber into which the combustion gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, thermostatic means in connection with said passage, and signal means operated from said thermostatic means, substantially as set forth.

3. In combination, a combustion chamber, a chamber into which the combustion gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, there being a second passageway communicating with the first passageway, thermostatic means in said second passageway, and signal means operated from said thermostatic means, substantially as set forth.

4. In combination, a combustion chamber, a chamber into which the combustion gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, there being a second passageway in communication with the first passageway and extending therefrom at an angle, thermostatic means in said second passageway, and signal means operated from said thermostatic means, substantially as set forth.

5. In combination, a combustion chamber, a chamber into which the combustion gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, there being a second passageway communicating with the first passageway, thermostatic means in said last named passage and having a heat movable extension projecting therebeyond, and signal means operable by the movement of said extension, substantially as set forth.

6. In combination, a combustion chamber, a chamber into which the combustion gases pass indirectly from the combustion chamber, a passage provided for directly connecting the chambers, there being a second passageway communicating with the first passageway, a casing with which said second passage communicates, thermostatic means in the second passage and having a heat movable member projecting into said cas-
ing, means in said casing for opening and closing an electric circuit, and signal means operable upon the closing of such circuit, substantially as set forth.

7. In combination, two chambers, from one of which heated gases pass to the other indirectly, a short circuit passageway directly connecting the chambers, thermostatic means operable by changes of temperature in said passageway, and signal means operated from said thermostatic means, substantially as set forth.

8. In combination, a pair of chambers through which heated gases are passed, a wall separating said chambers around which the gases pass, a passageway leading directly through said wall, thermostatic means operated by changes of temperature in said passageway, and signal means operated from said thermostatic means, substantially as set forth.

In testimony that I claim the foregoing, I hereto set my hand, this 10th day of February, 1916.

FREDERICK D. POTTER.

Witnesses:

M. A. JOHNSON,
H. TRAUTVETTER.