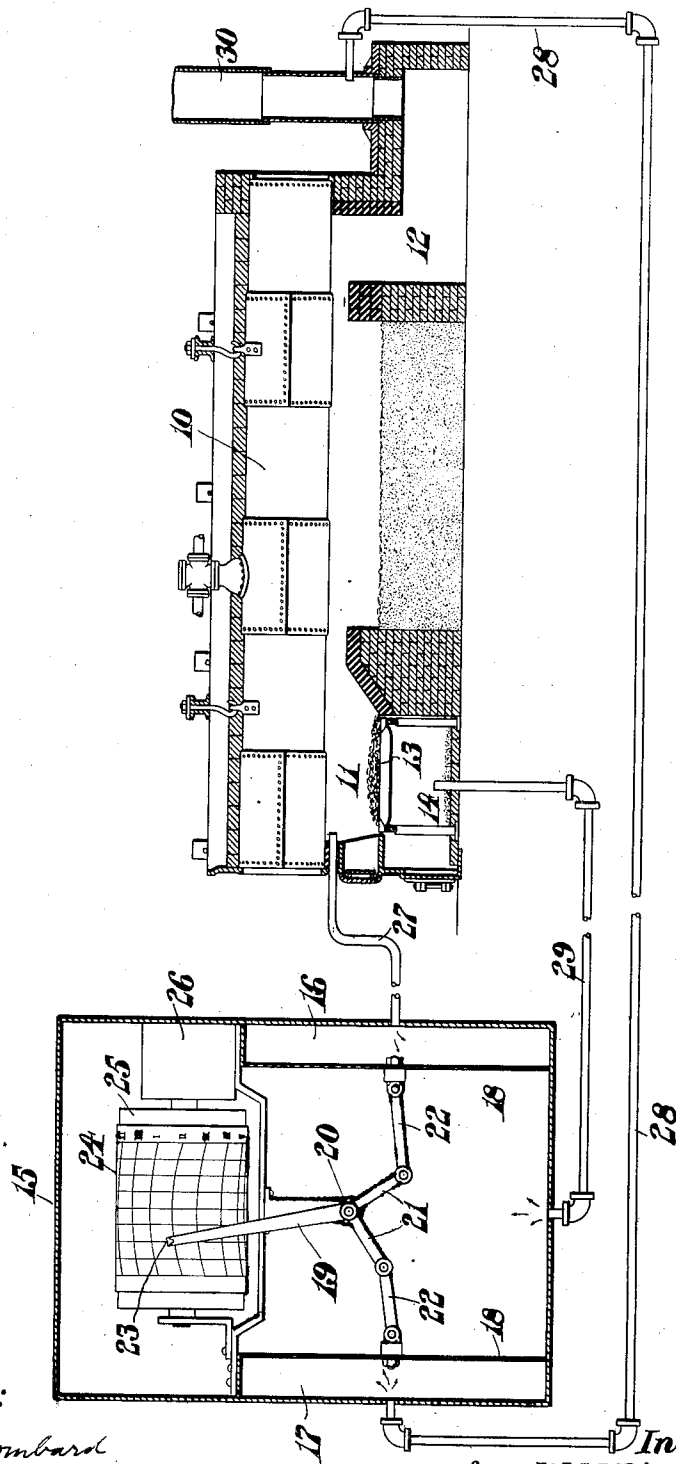


A. W. K. BILLINGS.
 COMBUSTION INDICATOR AND RECORDER FOR HEATING DEVICES.
 APPLICATION FILED MAR. 15, 1909.

1,050,332.

Patented Jan. 14, 1913.



Witnesses:
Nathan C. Lombard
Howard Hanson

Inventor:
Asa W. K. Billings:
by Walter C. Lombard,
Atty.

UNITED STATES PATENT OFFICE.

ASA WHITE KENNEY BILLINGS, OF HABANA, CUBA.

COMBUSTION INDICATOR AND RECORDER FOR HEATING DEVICES.

1,050,332.

Specification of Letters Patent.

Patented Jan. 14, 1913.

Application filed March 15, 1909. Serial No. 483,664.

To all whom it may concern:

Be it known that I, ASA WHITE KENNEY BILLINGS, a citizen of the United States of America, and a resident of Habana, in the Province of Habana and Republic of Cuba, have invented certain new and useful Improvements in Combustion Indicators and Recorders for Heating Devices, of which the following is a specification.

10 This invention relates to an apparatus adapted to be used in connection with the regulating of the combustion in boilers, furnaces, or other heating devices provided with a fire-box, an exit for the products of
15 combustion, and a passage for the supply of air to said fire-box, and consists in providing a suitable indicator and recorder connected to different parts of the heating device in such a manner that the differences
20 of pressure existing in two different parts of said heating device relative to another part will operate the indicator and recorder and cause a visual indication to be made of the ratio of the said pressure differ-
25 entials and a permanent record made of the same.

Ordinarily in the process of fuel combustion no attempt is made to keep track of the actual condition of the combustion process,
30 the fireman regulating the fire in the heating device in accordance with his best judgment. Under such conditions a material source of loss is caused by the lack of regulation of the amount of air entering the furnace, for if this is too large, as is usually the
35 case, fuel is wasted by the unnecessary heating of a mass of cold air to the temperature of the chimney. If the amount of air is insufficient an equally important loss occurs through imperfect combustion with a
40 consequent liberation of soot and combustible gases which pass out through the chimney. When attempts have been made to control these losses it has generally been
45 made by chemical analysis of the products of combustion which is very inconvenient, more or less costly and the results obtained are not suited to a prompt and continuous control of the operation of the furnace or
50 other heating device.

The present invention offers a very simple and effective apparatus for indicating to the fireman, and making a permanent record thereof, the ratio of the two pressure
55 differentials existing between any two parts of the heating device, such, for instance, as

the fuel-bed and the flue-passages or other exit through which the products of combustion pass and a third part of said heating device, such, for instance, as the passage
60 through which air is supplied to the fire-box.

The invention also consists in providing a casing containing a suitable record-receiving member and an indicating or marking
65 member co-acting with the record-receiving member to indicate to the fireman the ratio of pressure differentials between any two parts and a third part of the heating device, these two parts, as, for instance, the fuel-
70 bed, and the flue-passages or other exit, being connected by means of tubes or pipes to inclosed chambers contained within said casing, one wall of each of the inclosed
75 chambers being movable and connected to the pivoted indicating or marking member, and subjected to the pressure in the third part, as, for instance, the passage through which the air is supplied. Any change of
80 pressure in any of these three parts of the heating device will act upon these movable walls, such, for instance, as the diaphragms shown in the drawings, to operate the pivoted marking or indicating member. By
85 such a device the approximate relation of the rate of combustion of the fuel to the amount of the gases leaving the furnace may be readily indicated and a permanent record made thereof from which the fireman
90 may secure such information as will assist him in efficiently controlling the operation of said heating device.

The invention further consists in certain novel features of construction and arrangement of parts which will be readily under-
95 stood by reference to the description of the drawings and to the claims hereinafter given.

The drawing shows a section of a boiler and a vertical section of an indicator and recorder connected to said furnace, the entire drawing being diagrammatical with the indicator and recording devices greatly enlarged in proportion to the furnace to more
105 clearly show their construction.

In the drawing, 10 represents any well-known form of boiler beneath one end of which is a fire-box 11 with flue-passages 12 conducting the gaseous products of combustion to the stack or chimney 30.
110

While in the drawing, a boiler as a means of generating steam is shown, it is obvious

that the invention might be applied equally as well to any other form of heating device in which a fire-box 11 and flue-passages or other exit 12 for the products of combustion are used.

Beneath the grate 13 of the fire-box is a chamber 14, as, for instance, the usual ash-pit, which serves as a passage for the supply of air to the fire-box 11. At some convenient point adjacent to the heating device is located a casing 15 in which are placed or formed two inclosed chambers 16 and 17, one wall 18 of each of which is made movable, as, for instance, in the form of a thin flexible diaphragm.

The diaphragms or movable walls 18 face one another and centrally disposed between the same is a pivoted indicating member 19 mounted upon a pivot 20 and provided at its lower end with two arms 21 diverging outwardly in opposite directions, the ends of each of which are connected by a link 22 with the center of one of the diaphragms 18.

The indicating end of the pivoted member 19 is provided with a marking device 23 such as a pen, this marking device 23 cooperating during the operation of the indicator with a record-receiving strip or member 24 mounted upon a suitable roller 25 and when the indicator is in operation this record-receiving member 24 is caused to move at a uniform rate in the path of the marking member 23 by means of any well-known form of clock mechanism 26.

The inclosed chamber 16 is connected by a suitable pipe 27 to the fire-box 11, the end of said pipe 27 being situated so that it is not in the direct path of the currents of gases in said fire-box 11. In a similar manner the inclosed chamber 17 is connected by means of a pipe 28 with the farther part of the flue-passages, or exit from the heating device, the end of this pipe 28 being situated so that it is not in the direct path of the gases passing through said flue-passages or exit.

The casing 15 is connected by means of a pipe 29 with the chamber or air passage 14 beneath the fire-box 11, its end being situated so as not to be in the direct path of the currents of air in said chamber or air passage 14, so that any pressure existing in said chamber or passage 14 is transmitted to the interior of the casing 15, at a point intermediate the diaphragms 18 thereby causing the diaphragm 18 of the chamber 16 to be affected by the difference of pressures above and below the fuel-bed and the diaphragm 18 of the chamber 17 to be affected by the difference of pressures between that in the ash-pit or air passage 14 and the farther portion of the flue-passages or exit 12.

It is obvious that, in the arrangement described, the difference of pressure between the ash-pit or air passage 14 and the fire-box

11, which varies with rate of combustion, other conditions of the fuel-bed remaining the same, and affects the diaphragm 18 of the chamber 16, is always less than the difference of pressure between the ash-pit or air passage 14 and the farther portion of the flue-passages or exit 12, which affects the diaphragm 18 of the chamber 17, by an amount which is equal to the difference of pressure due to friction in the fluid-passages or exit, the latter varying with the amount of gases passing through the device. As long as the ratio of these two pressure differentials remains the same, even though the total draft varies, the indicating arm 19 will be held in one position by the action of the diaphragms 18, and as the record-receiving strip 24 is moved beneath the marking device 23 a straight line will be drawn. Should, however, the amount of gases passing through the flue-passages vary in relation to the rate of combustion of the fuel, due, for example, to the formation of holes in the fuel-bed, or to the admission of air through the firing doors, the difference of pressure affecting the diaphragm 18 of the chamber 17 will increase or decrease in relation to the difference of pressure affecting the diaphragm 18 of the chamber 16 and will cause the indicating member 19 and its marking device 23 to be moved about the pivot 20 into a new position, thus causing a corresponding variation in the line drawn on the record-receiving strip 24.

When a uniform quality of fuel is used with a given thickness in the fuel-bed, the difference in the pressure above and below the fuel-bed is a measure of the rate of combustion while the difference of pressure between the fire-box and the farther portion of the flue-passage or exit is a measure of the amount of gases passing. As long as the air supply is limited to that necessary for the most efficient combustion the indicating arm and marking device will remain in the position corresponding to the best efficiency. Any departure from these most efficient conditions will be made evident at once and recorded by the indicator and recorder. This provides a ready means for indicating the conditions of combustion within a furnace or other heating device, particularly in relation to the proportionate amount of air supplied for the combustion of the fuel and affords a means of informing the fireman, and of keeping a record, when the air supply is insufficient, resulting in a loss of efficiency due to the resulting imperfect combustion, or is too great, resulting in a loss of efficiency due to the useless heating of this excess amount of air.

While this invention is adapted for use in connection with furnaces or other heating devices, it is principally intended for use in connection with steam boilers, in order to

obtain the maximum efficiency in the consumption of the coal or other fuel, and to enable a permanent record to be kept of the departure from maximum efficiency.

It is believed that the operation of the invention and its many advantages will be fully apparent without any further description.

Having thus described my invention, I claim:

1. In a device of the class described, the combination with a heating device having a source of air supply thereto; of an indicator communicating with said source of air supply; and means interposed between said indicator and two different parts of said heating device simultaneously permitting the transmission of pressures to said indicator whereby the ratio of pressure differentials between said two parts of said heating device and said source of air supply may be visually shown.

2. In a device of the class described, the combination with a heating device having a source of air supply thereto; of a recording device communicating with said source of air supply; and means interposed between said recording device and two different parts of said heating device simultaneously permitting the transmission of pressure to said recording device whereby the ratio of pressure differentials between said two parts of said heating device and said source of air supply may be permanently recorded on said recording device.

3. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a source of air supply; of an indicator; and means interposed between said indicator and said fire-box, said exit, and the source of air supply, simultaneously permitting the transmission of pressure whereby the ratio of the pressure differentials between the source of air supply and said fire-box and between the source of air supply and said exit may be visually shown.

4. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a space beneath the grate through which air is supplied to said grate; of an indicator including a movable indicating member and two diaphragms articulated thereto and subjected to the air pressure within the space beneath said grate; and means interposed between one of said diaphragms and said fire-box and between the other diaphragm and said exit whereby said diaphragms may be operated respectively by the differences of pressure between said fire-box and air space beneath the grate and between said exit and air space beneath the grate.

5. In a device of the class described, the

combination with a heating device provided with a fire-box, an exit for the products of combustion, and an air passage beneath the grate; of two inclosed chambers, one wall of each of which is subjected to the pressure in said air space; a pipe extending from one chamber to said fire-box; a second pipe extending from the other chamber to said exit; and means cooperating with said inclosed chambers for visually indicating the ratio of the pressure differential between said air space and said fire-box and the pressure differential between said air space and said exit.

6. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a space through which air is supplied to said fire-box; of two inclosed chambers, one side of each of which is provided with a diaphragm subjected to the pressure in said space; pipes leading from said chambers to said fire-box and said exit; and means cooperating with said diaphragms for visually indicating the ratio of the pressure differential between said air space and said fire-box, and the pressure differential between said air space and said exit.

7. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a space through which air is supplied to said fire-box; of two inclosed chambers, one side of each of which is provided with a diaphragm subjected to the pressure in said space; pipes leading from said chambers respectively to said fire-box and said exit; and a pivoted member cooperating with said diaphragms for visually indicating the ratio of the pressure differentials between the said air space and said fire-box, and between said air space and said exit.

8. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a space through which air is supplied to said fire-box; of two inclosed chambers, one side of each of which is provided with a diaphragm subjected to the pressure in said space; pipes leading from said chambers respectively to said fire-box and said exit; a pivoted member including a marking device; and a movable record-receiving member co-acting therewith adapted to receive a record of the operations of said diaphragms.

9. In a device of the class described, the combination with a heating device provided with a fire-box, an exit for the products of combustion, and a space through which air is supplied to said fire-box; of two inclosed chambers, one side of each of which is provided with a diaphragm subjected to the

- pressure in said space; pipes leading from said chambers respectively to said fire-box and said exit; a pivoted member including a marking device; a link connected to said
- 5 pivoted member and to each of said diaphragms; and a movable record-receiving member co-acting therewith adapted to receive a record of the operations of said diaphragms.
- 10 10. In a device of the class described, the combination with an apparatus in which the pressures at different parts thereof are different, of an indicator including movable members; and means interposed between
- 15 said indicator and said different parts of said apparatus whereby the said different pressures act in opposition on said movable members and visually show the ratio of pressure differentials existing in two portions of said apparatus.
- 20 11. In a device of the class described, the combination with a heating device; of a movable member carrying a graduated strip; a pivoted arm one end of which is
- 25 adapted to be moved transversely of said strip; a diaphragm on each side of said pivoted arm, one of which is actuated by one pressure differential in said heating device while the other is actuated by another
- 30 pressure differential in said heating device, and a connecting link between said arm and each diaphragm whereby the ratio of said pressure differentials will be indicated by said pivoted arm.
- 35 12. In a device of the class described, the combination with a heating device; of a movable member carrying a graduated strip; a pivoted arm, one end of which is
- 40 provided with a marking device adapted to be moved transversely of said strip; a diaphragm on each side of said pivoted arm, one of which is actuated by the difference in pressures existing at two points in one portion of said heating device, while the other
- 45 diaphragm is actuated by the difference in pressures existing at one of said points and a third point in a different portion of said heating device; and connecting links between said arm and said diaphragms whereby
- 50 by the ratio of said pressure differentials will be recorded by said marking device upon said graduated strip.
13. In a device of the class described, the combination with a heating device; of a
- 55 movable member carrying a graduated strip; two diaphragms; a connecting link adapted to be moved transversely of said strip; two diaphragms; a connecting link between each diaphragm and said arm; a
- 60 means for subjecting one face of each diaphragm to the pressure of the source of air supply to said heating device; means for simultaneously subjecting the opposite face of one diaphragm to the pressure existing
- 65 at a point in one portion of said heating device; and means for simultaneously subjecting the opposite face of the other diaphragm to the pressure existing at a point in another portion of said heating device whereby an indication on said graduated strip will be made by said movable arm of the ratio of pressure differentials in said two portions relative to the pressure of the source of air supply.
14. In a device of the class described, the combination with a heating device having a source of air supply; of a movable member carrying a graduated strip; a pivoted arm one end of which is adapted to be moved transversely of said strip; two diaphragms; a connecting link between each diaphragm and said arm; a means for subjecting one face of each diaphragm to the pressure of the source of air supply to said heating device; means for simultaneously subjecting the opposite face of one diaphragm to the pressure existing in the fire-box of said heating device; and means for simultaneously subjecting the opposite face of the other diaphragm to the pressure existing in the flue-passage of said heating device whereby an indication on said graduated strip will be made by said movable arm of the ratio of pressure differentials between the pressure in said fire-box and flue-passage and the pressure of the source of air supply.
15. In a device of the class described, the combination with a heating device; of a movable member carrying a graduated strip; a pivoted arm one end of which is adapted to be moved transversely of said strip; three compartments separated by two diaphragms; a connecting link between each diaphragm and said movable arm; a pipe leading from the central compartment to the source of air supply; a pipe leading from one of the side compartments to one portion of said heating device; and a pipe leading from the other side compartment to another portion of said heating device, said pipes simultaneously admitting the pressures from these points to said compartments whereby the diaphragms are subjected to varying pressures and thus cause the movable member to indicate the ratio of their pressure differentials.
16. In a device of the class described, the combination with a heating device having a source of air supply; of a movable member carrying a graduated strip; a pivoted arm one end of which is adapted to be moved transversely of said strip; three compartments separated by two diaphragms; a connecting link between each diaphragm and said movable arm; a pipe leading from the central compartment to the source of air supply; a pipe leading from one of the side compartments to the fire-box of said heating device; and a pipe leading from the other side compartment to the flue-passage of said

heating device, said pipes simultaneously admitting the pressures from these points to said compartments whereby the diaphragms are subjected to varying pressures and thus
5 cause the movable member to indicate the ratio of their pressure differentials.

17. In a device of the class described, the combination with a heating device; of a movable member carrying a graduated strip;
10 a pivoted arm one end of which is adapted to be moved transversely of said strip; three compartments separated by two diaphragms; a connecting link between each diaphragm and said movable arm; a pipe leading from
15 the central compartment to the ash-pit of said heating device; a pipe leading from one

of the side compartments to the fire-box of said heating device; and a pipe leading from the other side compartment to the flue passage of said heating device, said pipes admitting the pressures from these points to
20 said compartments whereby the diaphragms are subjected to varying pressures and thus cause the movable member to indicate the ratio of their pressure differentials.
25

Signed by me at Habana, Cuba, this eighth day of March, of the year nineteen hundred and nine.

ASA WHITE KENNEY BILLINGS.

Witnesses:

HENRY P. STARRETT,
AUGUSTIN ROGERS.