

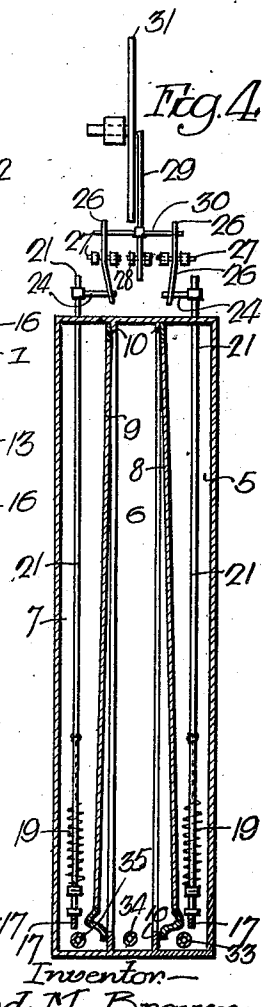
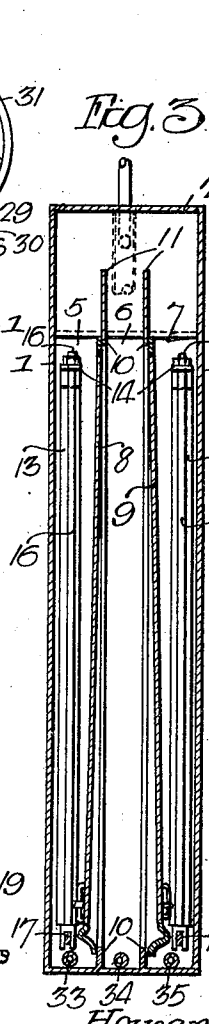
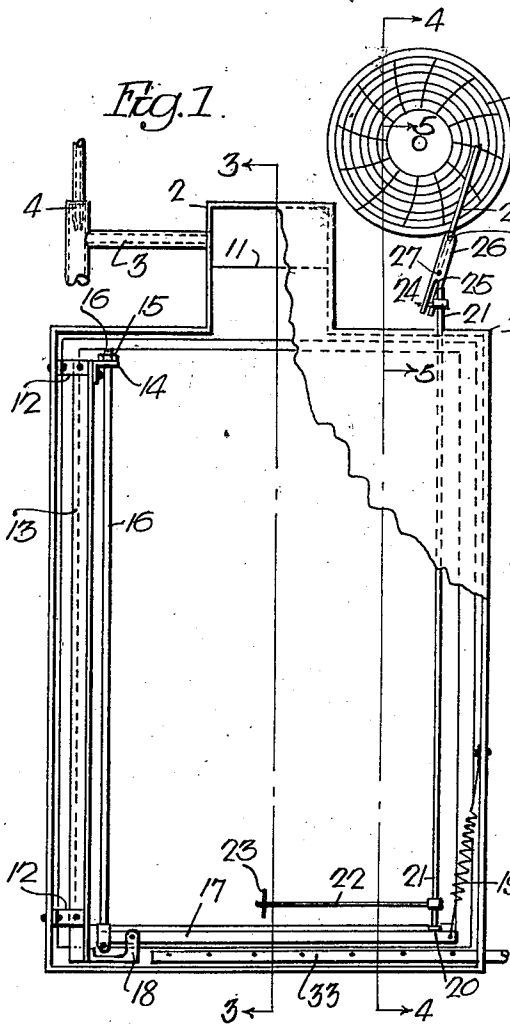
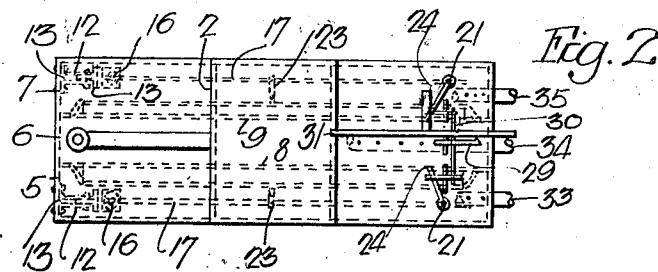
Oct. 25, 1927.

H. M. BROWN
RECORDER AND INDICATOR

Filed June 29, 1922

1,646,474

2 Sheets-Sheet 1



Inventor—
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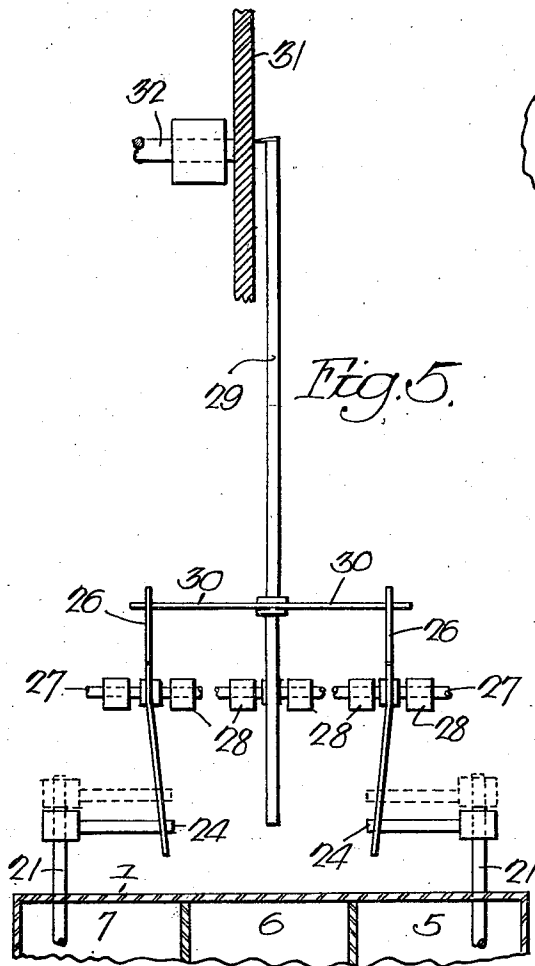
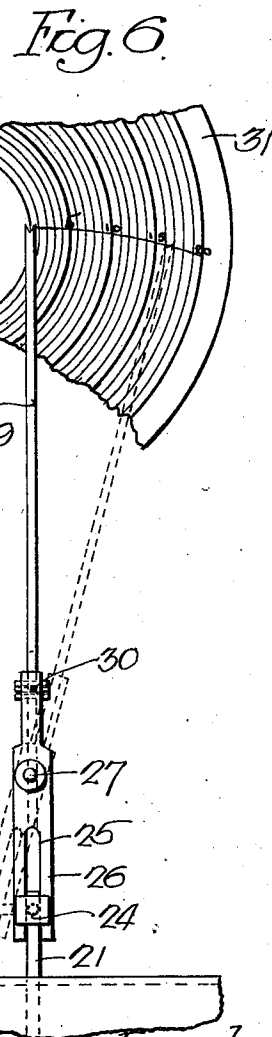
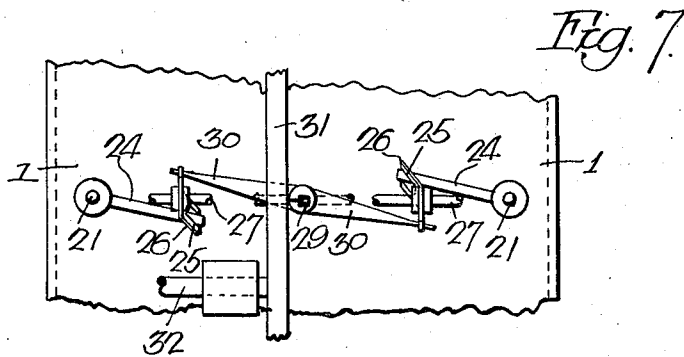
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UNITED STATES PATENT OFFICE.

HOWARD M. BROWN, OF PHILADELPHIA, PENNSYLVANIA.

RECORDER AND INDICATOR.

Application filed June 29, 1922. Serial No. 571,690.

This invention relates to improvements in indicating and recording apparatus of the type disclosed in my co-pending application, Serial Number 366,476, the object of the present invention being to provide instruments of this type with means compensating automatically for inequalities in the indications of the instrument due to temperature changes.

Another object of the invention is to provide means compensating for difference in temperature existing at opposite sides of the instrument.

A further object of the invention is to make the instrument more compact.

In the attached drawings:

Figure 1, is a side elevation of an indicator made in accordance with my invention, with a portion of the side of the casing removed;

Fig. 2, is a plan view of the instrument;

Fig. 3, is a vertical section on the line 3—3, Fig. 1;

Fig. 4, is a vertical section on the line 4—4, Fig. 1;

Fig. 5, is a vertical section on the line 5—5, Fig. 1, showing a detail of the mechanism of the indicator and recorder;

Fig. 6, is a fragmentary front view of that portion of the mechanism shown in Fig. 5, and

Fig. 7, is a fragmentary plan view of that portion of the mechanism shown in Fig. 5.

With reference to the drawings, the apparatus in the present instance comprises a substantially rectangular casing 1 having at the top and centrally of the main portion of the casing and extending laterally thereacross a manifold 2, from which extends a pipe 3 which communicates with an aspirator 4 of well known construction. The aspirator may be operated either by air, steam or water, for a purpose to be described hereinafter.

The interior of the main portion of the casing 1 is divided into three longitudinal chambers 5, 6 and 7, by two laterally movable partitions 8 and 9, said partitions being suspended at the top from flanges 10, 10, projecting inwardly from the top wall of the casing, and underneath the manifold 2 from a pair of cross plates 11, 11, the lower portions of which constitute a continuation of the said flanges 10. The flanges 10 are continuous around the inside of the casing except where broken by the manifold 2, extending down each of the side walls and across

the bottom of the casing, and the partitions 8 and 9 are secured to these lugs over their entire length. At the top of the casing the partitions are suspended by means of a flexible and air-tight material and are connected to the sides and bottom of the casing by a thin flexible fabric or thin rubber, thus allowing the partitions or diaphragms to swing laterally without any appreciable friction, said partitions at the same time being practically air-tight.

Mounted in one end of each of the outer compartments 5 and 7 and held in a vertical position by means of brackets 12, 12, secured to the end wall of the casing is a post 13, in the present instance in the form of a T-bar, which posts are preferably of iron. Suspended from a bracket 14 at the top of each of the posts 13 and supported in the bracket by an adjustable nut 15 is a rod 16 of zinc or some metal or material with a considerably higher coefficient of expansion than iron or the material of which the post 13 is made. The bar 16 attaches at the bottom of the casing to a lever 17 which is pivotally supported near the lower end of the bar 16 in a suitable bracket 18 attached to the lower end of the post 13. A spring 19 is attached to the outer end of the lever 17 and to the wall of the casing 1, and tends to retain the free end of the lever in an elevated position. On the lever 17 is a bearing element 20 which is adapted to be occupied by the lower end of an upright rod 21 which is guided at the top in the top wall of the casing, and which is operatively connected by means of an arm 22 to that diaphragm which constitutes the movable wall of the particular one of the chambers 5 and 7 which the said rods may occupy. As clearly illustrated in Figs. 1 and 3, that end of the arm 22 which attaches to the partition is slidably attached to a vertical staple 23 projecting from the lower end of the partition, this arrangement providing for a vertical movement of the rod 22 for a purpose to be described hereinafter.

At the top of each of the rods 21 is a lateral arm 24, these arms being respectively adapted to occupy a longitudinal slot 25 in one of a pair of arms 26 pivotally mounted on a fixed shaft 27 suitably supported at 28, 28, at the top of the casing 1. Also free to oscillate on the shaft 27 is a rod 29 which has loosely mounted thereon a cross bar 30, the opposite ends of which project through openings in the arms 26, 26, the rod 29 in the

present instance constituting the pointer arm of an indicating and recording instrument of well known construction, and including a dial plate 31 which is continuously
5 rotated on a shaft 32 through predetermined units or periods of time.

Extending through the side of the casing 1 and into the bottom of each of the chambers 5, 6 and 7, are pipes 33, 34 and 35,
10 respectively, said pipes preferably being perforated in that portion projecting into the chamber, as shown in Fig. 1.

In employing this device for determining the relative amounts of CO_2 in flue gases of
15 furnaces or boilers, for which purpose the instrument is primarily intended, the pipe 34 is connected with a line tapped from the flue at a favorable point, the pipes 33 and 35 merely constituting a means for estab-
20 lishing communication between the outer air and the chambers 5 and 7 respectively, and for obtaining a more or less even distribution of the air in the chambers as it enters. By means of the aspirator 4, a mild suction
25 is placed upon the interior of the manifold 2 of the casing, which creates a circulation of air through the two outer chambers 5 and 7 and of the flue gases through the inner chamber 6, the circulation in all the cham-
30 bers being substantially uniform by reason of the common aspirator.

As clearly set forth in my aforesaid copending application, the difference in the
35 densities between the air and the flue gases causes a difference of pressure in the chambers with a resulting movement of the partitions or diaphragms, the extent of movement of the latter from the normal position assumed in the present instance by gravity
40 affording an indication of the amount of CO_2 in the flue gases. The diaphragms may be weighted to afford any resistance to lateral displacement that may be required for purposes of proper calibration.

It has been found, however, that there occurs a difference in the readings of the instrument at varying temperatures even
45 though the other conditions and the CO_2 content is constant. At 32°F. the difference in weight per cubic foot of gases containing 12% CO_2 and of air is approximately 4/1000
50 of a pound, while at 72°F. the difference is approximately 37/10000 of a pound, and at 112°F. is 35/10000 of a pound. It, therefore, becomes evident that the difference in the weight of the gas as compared
55 with the weight of the air becomes less as the temperature increases, but that the difference is not directly proportional to the temperature.

To compensate for the decrease in the difference of the weights of the air and flue
60 gases, I employ the aforescribed mechanism, consisting of the zinc rods 12 supported on the iron post 13. As the air

passes into the chambers 5 and 7, its temperature will be quickly passed to the rod 16 and to the post 13, increase in the temperature of the incoming air being immediately followed by a relatively large ex-
70 pansion of the rod 16 as compared with the expansion of the post 13; the lengthening of the rod causing an elevation of the outer free end of the lever 17, the spring 19 assisting this elevation, and a resulting elevation
75 of the rod 21. The rod 21 in elevating carries with it the arm 22, which connects it to the diaphragm, such vertical movement of the rod 22 being permitted by reason of the
80 aforescribed staple connection between the arm and the diaphragm.

As the rod 21 is elevated, it also elevates the arm 24 at the top, causing it to move upwardly in the slot 25, and decreasing the distance of the said arm 24 from the shaft
85 27 upon which the arms 26, 26, are mounted. By reason of the approach of the arms to the shaft 27, rotational movement of the shaft 21 is transmitted in increased ratio to the pointer 29, which will accordingly traverse
90 the face of the dial plate 31 to a greater extent than previously under the same oscillation of the rod 21. It will be apparent, therefore, that any variation in the temperature will be transmitted through these elements
95 to the arm 29 which with the chart upon the dial plate 31 constitutes the indicating and recording mechanism.

By reason of the vertical alignment of the shaft 27 and the zero point on the chart
100 carried by the dial plate 31, as shown in Fig. 6, it will be apparent that at the zero reading on the chart any rise or fall of the arm 29 will have no effect upon the zero point on the chart.

As before mentioned, the difference in weight of the gases and air due to temperature changes is not proportionate to the temperature change, and to correct this irregularity, the arms 26 are bent or curved,
110 as shown in Fig. 5. As indicating the operation of the device, I have in Fig. 6 shown in dotted lines the pointer arm 29 in the position which it will occupy when indicating good furnace performance.

It may occur when this instrument is placed in service that one side is exposed to a higher temperature than the other, as by reason of heat radiating from steam pipes,
120 the side wall of a boiler or the like. For proper operation of this instrument, the gases and air passing through should be about the same temperature, or in the absence of this condition, be provided with some compensating arrangement. To provide for
125 this, I have, as previously described, provided the casing with three chambers and a pair of swinging partitions, the air being drawn in through the two outer chambers and the flue gases through the inner cham-
130

ber. The column of flue gases being heavier than the columns of air, will dispose the swinging partitions laterally towards the outer sides of the casing.

5 As illustrating the operation of the instrument under uneven temperatures, we will describe what will take place when the instrument is indicating a zero reading, meaning that air or gases of uniform density
10 are passing through all three chambers. We will assume, for example, that one side of the instrument is exposed to a source of heat, the temperature on that side of the instrument accordingly being elevated and there
15 developing a progressive drop of temperature through the instrument to the opposite side. The air in the outer chamber on that side of the casing exposed to the heat will become heated and less dense than the air
20 in the middle chamber, which in turn will be less dense than the air in the outer chamber on the cool side of the instrument. The result of this variance in temperature will be that the diaphragm nearest the warm side
25 of the casing will be moved towards that side due to the heavier air in the middle chamber, while the swinging diaphragm nearest the coolest side of the casing will be moved towards the warmer side. There will
30 accordingly result a movement in opposite directions of the arms 24 on the respective bars 21.

As previously described, the arm 30 is loosely mounted on the arm 29, and has its
35 ends, which pass through apertures in the tops of the respective arms 26, 26, rounded, these apertures being large enough to permit a slight angular misalignment of the arms 30 and 26. Now with the movement in
40 opposite directions of the arms 26, 26, the cross piece 30 will be given a rotational movement in no way affecting the arm 29 nor moving it off the zero point. If at this
45 point flue gas is passed through the middle chamber, it will dispose both swinging partitions towards the outer sides, which will cause movement of the arms 26, 26, in the same direction, which reacting on the ends
50 of the cross piece 30 would effect a movement of the arm 29 across the face of the chart, while still compensating for any temperature difference of the gases or air in the chambers.

As still further assisting in the compensation or elimination of changes or variations
55 due to differences in temperature in the casing, it is desirable to encase the latter in a casing of some heat-resisting material, such as hair felt, magnesia, or other covering.
60 ing.

By using three chambers and two swinging partitions in the aforescribed manner, it is also possible to get double the power applied to the recording pen than would
65 be obtained from a double chamber and one

swinging partition. Obtaining double the effective power in this manner permits a considerable reduction in the size of the casing and a more compact instrument.

I claim:

70 1. In an instrument for determining the relative densities of gases, the combination with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operative-
75 ly connected with said element, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the relative pressures of said gases
80 due to changes in the temperature of either of said gases.

2. In an instrument for determining the relative densities of gases, the combination
85 with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means including a thermosensitive
90 element arranged to be affected by the temperature of the respective gases and operatively connected with the indicator so as to compensatingly affect the indications in accordance with the variations in the pressures of said gases due to the changes in
95 temperature.

3. In an instrument for determining the relative densities of gases, the combination
100 with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means including at least two
105 thermosensitive members arranged to be affected respectively by temperature changes in the gases and adapted to modify the operative connection between the indicator and
110 said element in accordance with temperature changes in the said gases whereby the indications are compensated for variations in the relative pressures of said gases due to said temperature changes.

4. In an instrument for determining the relative densities of gases, the combination
115 with a casing comprising two gas chambers separated by a movable partition, of an indicator operatively connected with said partition, and compensating means including a thermosensitive element mounted within the
120 casing and operatively connected with said indicator so as to compensatingly affect the indications in accordance with variations in the relative pressures of said gases due to temperature changes.

5. In an instrument for determining the
125 relative densities of gases, the combination with a casing comprising two gas chambers separated by a movable partition, of an indicator operatively connected with said
130 casing, and compensating means including a

thermosensitive element mounted within the casing and adapted to modify the operative connection between the said partition and the indicator in accordance with temperature changes in said gases whereby the indications are compensated for variations in the relative pressures of said gases due to said temperature changes.

6. In an instrument for determining the relative densities of gases, the combination with a casing comprising a movable partition, of means for subjecting said partition to the pressure effects of equal columns of gases on opposite sides of the partition, an indicator operatively connected with said partition, and at least one thermosensitive element mounted in the casing and operatively connected with the indicator so as to compensatingly affect the indications in accordance with variations in the relative pressures of said gases due to temperature changes.

7. In an instrument for determining the relative densities of gases, the combination with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the relative pressures of said gases due to temperature changes in one of said gases.

8. In an instrument for determining the relative densities of gases, the combination with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the relative pressures of said gases due to temperature changes in both of said gases.

9. The combination of a casing having independent chambers separated by a movable partition, a movable element operatively connected with said partition and adapted to be actuated thereby, and a thermosensitive element arranged to be affected by the temperature in at least one of the chambers and controlling the extent of movement of said element.

10. In an instrument for determining the relative densities of gases, the combination with a pair of elements movable under the effect of the same differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with both of said elements, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the relative pressures of said gases due to temperature changes.

11. In an instrument for determining the relative densities of gases, the combination with a pair of elements movable under the effect of the same differential gas pressures exerted on the respective opposite sides thereof, of an indicator operatively connected with both of said elements, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the pressures of said gases due to differences of temperature of the respective gases.

12. An instrument for determining the relative densities of gases comprising indicating means controlled by the relative pressures of equal columns of said gases, and thermosensitive means arranged to be affected by the temperature of at least one of said gases and associated with the indicating means for compensating for relative variations in the densities of the gases at different temperatures.

13. An instrument for determining the relative densities of gases comprising indicating means controlled by the relative pressures of equal columns of said gases, and a thermosensitive element arranged to be affected by temperature changes in the gases and associated with the indicating means for compensating for the effect on said densities of different temperatures in the respective gases.

14. An instrument for determining the relative densities of gases comprising a freely movable member adapted to be subjected on opposite sides to the pressures of equal columns of said gases, means controlled by the position of said member for indicating the relative pressures, and means operatively associated with the indicating means and with the gases for compensating for relative variations in the pressures at different temperatures.

15. An instrument for determining the relative densities of gases comprising a freely movable member adapted to be subjected on opposite sides to the pressures of equal columns of said gases, means controlled by the position of said member for indicating the relative pressures, and means operatively associated with the indicating means and with the gases for compensating for inaccuracies due to different temperatures in the respective gases.

16. An instrument for determining the relative densities of gases comprising a freely movable member adapted to be subjected on opposite sides to the pressures of equal columns of said gases, means controlled by the position of said member for indicating the relative pressures, and thermosensitive means in each of said columns operatively associated with the indicating means and adapted to compensate for in-

accuracies due to relative variations in the pressures at different temperatures.

17. An instrument for determining the relative densities of gases comprising a
5 freely movable member adapted to be subjected on opposite sides to the pressures of equal columns of said gases, means controlled by the position of said member for indicating the relative pressures, and thermo-
10 sensitive means in each of said columns operatively associated with the indicating means and adapted to compensate for inaccuracies due to a difference of temperature in the respective columns.

18. The combination with a plurality of
15 adjacent chambers, of a movable partition separating each adjoining pair of chambers, means for indicating the movement of said partition due to a difference of pressure within the chambers, and thermosensitive means in the chambers controlling the operation of the indicating means, substantially
20 as described.

19. The combination of a casing having
25 independent chambers separated by a movable partition, a movable element operatively connected with said partition and adapted to be actuated thereby, and a thermosensitive element in one of the chambers controlling the extent of the movement of said
30 element, substantially as described.

20. The combination with a casing having
independent chambers separated by a movable partition, of an element operatively
35 connecting the pointer arm with the partition, and a thermosensitive element in one of the chambers operatively connected with the said connecting element and adapted by movement of the latter to control the
40 movement of the pointer arm when actuated by the partition.

21. An instrument comprising a casing, movable partitions dividing said casing into
45 three chambers, means for introducing gases to said chambers, an indicating instrument operatively associated with said partitions, and means whereby equal movements of the partitions in the same direction have no effect upon the indicating instrument.

22. An instrument comprising a casing, movable partitions dividing said casing into
50 three chambers, means for introducing gases to said chambers, an indicating instrument operatively associated with said partitions, and a thermosensitive compensating element operatively associated with each diaphragm.
55

23. The combination with a substantially
60 air-tight casing, of a plurality of movable partitions dividing the interior of the casing into equal chambers, an intake port in each chamber, a common exhaust means for the chambers, and indicating means operatively connected with the partitions.

24. The combination with a substantially

air-tight casing, of a plurality of movable partitions dividing the interior of the casing into equal chambers, an intake port in each chamber, a common exhaust means for the chambers, an indicator operatively
70 connected with the partitions, and thermosensitive compensating means for each partition operatively associated with the indicator.

25. In an instrument for determining the
relative densities of gases, the combination
75 with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means operatively connected with said
80 indicator whereby the accuracy of the indications is relatively unaffected by variations in the relative pressures of said gases due to temperature changes.

26. In an instrument for determining the
85 relative densities of gases, the combination with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means including a thermosensitive
90 element positioned so as to be affected by temperature changes in at least one of said gases and operatively connected with the indicator so as to compensatingly affect the
95 indications in accordance with variations in the relative pressures of said gases due to temperature changes.

27. In an instrument for determining the
relative densities of gases, the combination
100 with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and compensating means including a thermosensitive
105 element arranged to be affected by temperature changes in the gases and operatively connected with the indicator so as to compensatingly affect the indications in accordance with variations in the relative pressures
110 of said gases due to temperature changes.

28. In an instrument for determining the
relative densities of gases, the combination
115 with an element movable under the effect of differential gas pressures exerted on opposite sides thereof, of an indicator operatively connected with said element, and means for modifying said operative connection in accordance with temperature changes in said
120 gases whereby the indications are compensated for variations in the relative pressures of said gases due to said temperature changes.

29. In an instrument for determining the
125 relative densities of gases, the combination with a pair of movable elements arranged to be acted upon on their adjacent faces by the same column of gas and on their outer faces by columns of another gas equal to the first-
130

named column, of an indicator operatively connected with both of said elements, and compensating means operatively connected with said indicator whereby the accuracy of the indications is relatively unaffected by variations in the pressures of said gases due to a difference of temperature in the columns.

30. In an instrument for determining the relative densities of gases, the combination with a pair of movable elements arranged to be acted upon on their adjacent faces by the

same column of gas and on their outer faces by columns of another gas equal to the first-named column, of an indicator operatively connected with both of said elements, and compensating means including a thermosensitive element located in said outer columns and operatively connected with the indicator so as to compensatingly affect the indications in accordance with variations in pressure due to different temperatures in the said columns.

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