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GAS ANALYZING APPARATUS

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Fig. 1.

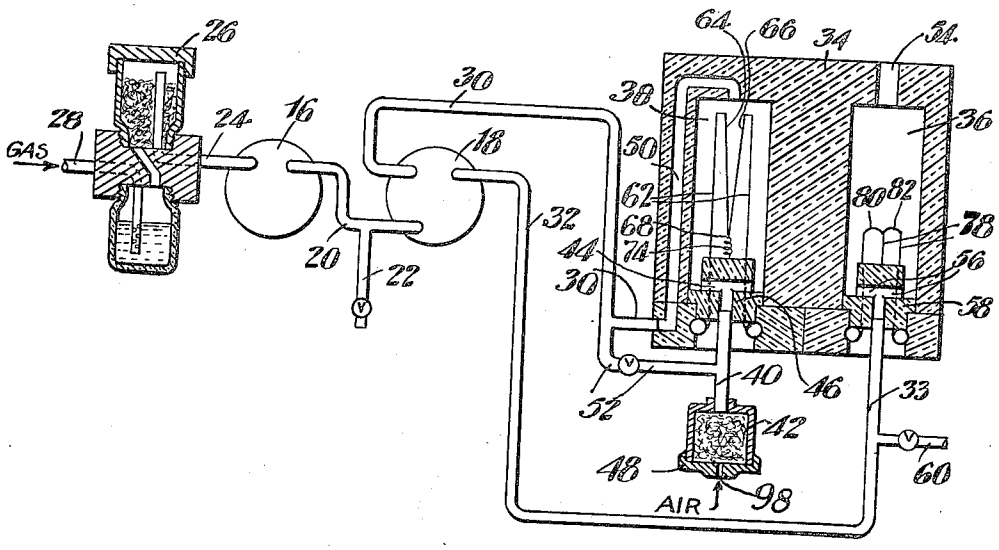
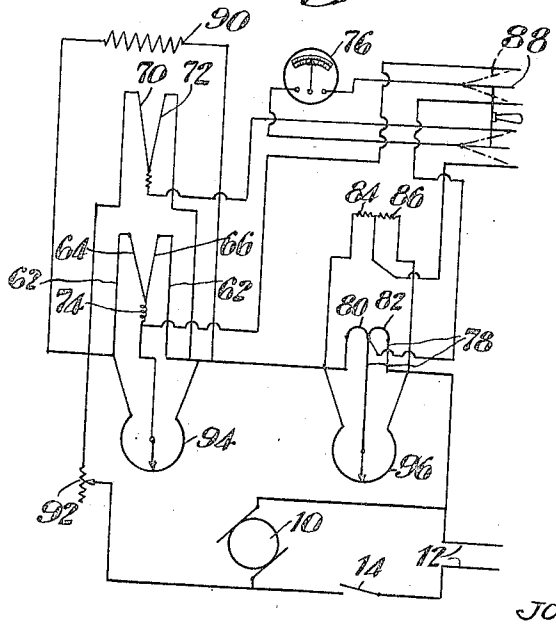


Fig. 2.



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GAS ANALYZING APPARATUS

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2 Claims. (Cl. 23—255)

The present invention relates to gas analyzing apparatus, and is particularly concerned with apparatus for making quantitative measurements of the combustible components of gaseous mixtures.

The invention is primarily concerned with measurement of combustibles in gaseous mixtures by the catalytic combustion of such gases within a combustion cell, with prior admixture therewith of a combustion supporting fluid. The invention herein described represents an improvement on the apparatus which is disclosed in our United States Patent No. 2,057,246 patented October 13, 1936.

The primary object of the present invention is to provide gas analyzing apparatus which is adapted for making accurate quantitative measurements of the combustible components both of gas mixture such as automotive exhaust gases which may contain up to 20% combustible, as well as of mine gases or garage atmospheres contaminated with as little as .0015 part of carbon monoxide and/or methane.

A more specific object is to provide a gas analyzer of the combustion type which is adapted for measuring both high and low concentrations of combustible in gas mixtures passed thereover, and the accuracy of which is not affected by substantial variations in the rate of flow of the gases over the catalyst.

With the above and other objects and features in view the invention consists in the improved gas analyzing apparatus which is hereinafter described and more particularly defined by the accompanying claims.

The invention will be hereinafter described more particularly by reference to the accompanying drawing, in which—

Figure 1 is a somewhat diagrammatic view of the gas circulating part of a preferred design of the apparatus; and

Fig. 2 is a wiring diagram embodying the catalyst heating elements of the analyzer shown in Fig. 1.

Referring to the drawing, numeral 10 (Fig. 2) designates an electric motor which is energized by current supplied thereto from a 6-volt D. C. circuit 12 controlled by a switch 14. Although not illustrated, the motor 10 is operatively connected with two coacting positive pressure rotary blowers or pumps 16 and 18 (Fig. 1). The discharge port of pump 16 is communicably connected to the suction port of pump 18, as by a conduit 20, and a valved relief pipe 22 is ported out of conduit 20 to atmosphere for the purpose of permitting free discharge from the pumping system of any excess volume of gas over that desired to be charged to the pump 18. The suction side of pump 16 is provided with a gas inlet pipe 24 which in turn communicates with the interior of a gas filter 26. The gas enters the filter 26 through a pipe 28. Another pipe 30 communicably connects with the suction side of pump 18 for the purpose of supplying air from atmosphere to this pump. Pump 18 functions to continuously mix regulated proportions of a gas which is to be analyzed for combustible and a combustion supporting gas, such as air, which mixture is discharged at a uniform regulated pressure from the pump discharge port through a conduit 32.

The gas analyzer element consists of a housing 34 preferably comprising a block of Bakelite or other dielectric material, this housing being partitioned into separate non-communicating combustion cells 36 and 38. The cell 36 is in permanent communication with the atmosphere surrounding the block 34 through a pipe 40, air filter 42, and radial apertures 44 in a dielectric plug 46 which forms an end closure for the bottom of cell 38. Filter 42 has an apertured removable base 48 and is filled with a loose packing of cotton, glass wool, or other dry filtering medium. The upper end of cell 36 is connected in permanent communication with the suction side of pump 18 through a continuation of pipe 30 in the form of a channel 50 which is formed in the block 34. Air conduit 40 is also connected with pipe 30 through a valved by-pass 52. This arrangement is such that by adjusting the valve in by-pass 52 a corresponding adjusment is made of the relative proportion of the incoming air which is drawn by pump 18 respectively through the cell 38 and through the by-pass 52.

The upper end of analyzer cell 36 is ported to atmosphere through a passage 54. The lower end of cell 36 is in permanent communication with the discharge pipe 32 from pump 18 through a vertical extension 33 of pipe 32, and through radial apertures 56 which are formed in a plug 58 which serves as the removable base closure for cell 36. A valved pressure relief conduit 60 is ported out of pipe 32 between the pump 18 and the combustion cell 36.

Within the cell 38, on a pair of parallel electric conductor supporting posts 62 extending upwardly into the cell from the removable plug closure 46, there is mounted a pair of catalyst and non-catalyst wires 64 and 66 arranged in the form of a V with their lower ends connected at

the point 68 to form the apex of the V in approximately the vertical axis of the cell 38. Wires 64 and 66 form the active and inactive legs of a Wheatstone bridge electric circuit, the other two legs of which are designated in Fig. 2 by the numerals 70 and 72. Legs 64 and 66 are preferably constructed of approximately 1"–$1\frac{1}{16}$" lengths of pure platinum wire having a diameter of about .001". The inactive leg 66 is preferably covered with a thin gold plating. It will be observed that both the catalyst and non-catalyst wires 64, 66 are mounted in balanced relation within the cell 38 and are interconnected in the same Wheatstone bridge circuit. A fine coil spring 74 is arranged in the Wheatstone bridge circuit as one of the leads to a galvanometer 76. The coil spring 74 has another function, however, and that is to hold the wires 64 and 66 under uniform tension to prevent distortion thereof under the wide temperature changes to which the wires are subjected in use.

Mounted in the cell 36 on conductor supporting posts 78 is another pair of catalysts and non-catalyst wires 80 and 82, which are further illustrated in Fig. 2 as two of the legs of a second Wheatstone bridge circuit, the other legs of which are designated by the numerals 84 and 86. The legs 80 and 82 of this second Wheatstone bridge circuit are preferably constructed of platinum alloy wire. Because of the fact that the cell 36 is designed to measure quantitatively by combustion contents of combustible up to 20% in gas mixtures pass therethrough, the catalyst leg 82 in the second Wheatstone bridge circuit is relatively insensitive in comparison to the catalyst leg 64 in cell 38. The catalyst leg 80 in cell 36 is preferably constructed of platinum-5% iridium alloy, and the non-catalyst leg 82 is preferably constructed of platinum-5% rhodium alloy plated with nickel oxide. Preferred dimensions for the legs 80 and 82 are wires $\frac{3}{8}$" in length and .0035" diameter. Nickel oxide coating is used for wire 82 because the operating temperature of this wire is preferably in the neighborhood of 1400°–1500° F. Wire 82 is constructed of a rhodium alloy of platinum, rather than an iridium alloy, because rhodium alloy is heated up to a higher temperature by a given unit of electric current passing therethrough, but this higher heating temperature is counteracted by the nickel plating which is used as most suitable for the high operating temperature, because a nickel plated catalyst seems to radiate more rapidly than does a clean platinum or platinum alloy wire at operating temperatures in the neighborhood of 1400°–1500° F.

As illustrated in Fig. 2, galvanometer 76 is provided with two scales, one of which is calibrated to give a full scale reading in the event that air containing as little as .15% of CO or other combustible contacts with the catalyst wire 64 in cell 38. The other scale of galvanometer 76 is calibrated to give a full scale reading when automobile engine exhaust gases, or other gas mixtures containing approximately 20% combustible, are passed over the catalyst 80 in cell 36. A double pole double throw switch 88 is provided for alternatively connecting the galvanometer 76 either with the Wheatstone bridge circuit embodying catalyst wire 80, or with the Wheatstone bridge circuit embodying catalyst wire 64. Because of the sensitive character of the catalyst 64 and its low maximum current carrying capacity, the Wheatstone bridge embodying this catalyst is provided with a shunt circuit 90 whereby current of approximately 1.10 amperes which is delivered by the supply circuit 12 to the Wheatstone bridge embodying the wires 80 and 82 in cell 36, is reduced to a current of approximately .42 ampere in the Wheatstone bridge circuit embodying the wires 64 and 66 in cell 38. A rheostat 92 is provided whereby to adjust the current supply to the Wheatstone bridge circuit from the main circuit 12, and additional rheostats 94 and 96 are provided for respectively adjusting the zero settings and calibrations of the respective Wheatstone bridges embracing catalysts 64 and 80.

The operation of the apparatus will now be described briefly as adapted for use in making substantially simultaneous determinations of the combustible content of automotive engine exhaust gases and of atmospheric contamination at the point where the measurements are made. The end of a sampling pipe (not shown) is inserted into the exhaust pipe of the engine under test, and the switch 14 is closed, thus causing the motor 10 to function and supplying current to energize the two Wheatstone bridge circuits embodying catalysts 64 and 80. Under the action of pump 16 the automotive exhaust gases are drawn from the sampling device into filter 26 and thence into the pump. The pump forces a measured portion of the gases through the pipe 20 into the suction side of pump 18. Action of pump 18 simultaneously serves to draw air thereto through the filter 42 and combustion cell 38. An inlet orifice 98 of the filter is of such size that a substantial portion of the air drawn into the system uniformly passes through conduit 40 and radial apertures 44 into combustion cell 38 in contact with the heated catalyst wire 64, the temperature of which is normally in the neighborhood of 1200° F. Part of the air drawn into pump 18 may flow through by-pass connection 52. The air entering the pump 18 through pipe 30 is thoroughly mixed with the gas entering through pipe 20, and at a subsequent part of the pump rotor cycle this mixture of exhaust gases and air is expelled from the pump through conduit 32, and a measured portion thereof flows continuously into combustion cell 36 through pipe extension 33 and radial apertures 56. After passing through the cell the gas makes its exit to atmosphere through the port 54. The valve in the relief pipe 60 is provided to release excess pressure built up by the pump 18 over that at which the analyzer has been calibrated to function.

The analyzer with its two combustion cells 38 and 36 forms a compact readily portable unit having a demountable set of base closures 46 and 58 respectively carrying the catalyst legs 64 and 80, so that any replacement of the delicate catalytic elements of the two Wheatstone bridge circuits can be easily made by an unskilled workman, as by simply substituting a new demountable unit comprising the plug closure 46, the wires 62, 64, 66, and 74 and the wiring which is integral therewith, in place of the unit removed.

By mounting the catalyst and non-catalyst legs of a bridge in the same cell and in balanced relation, the flow of gas over these wires at a uniform rate is insured, thereby eliminating or minimizing variations in cooling effect of convection currents such as might occur in case the legs were mounted in separate cells. The elements 70 and 72 are preferably constructed of the same metal and with the same dimensions as the opposite legs 64 and 66 in the Wheatstone bridge circuit which is operatively associated with the sensitive air analyzer cell 38. However, the

balancing legs 84 and 86 of the Wheatstone bridge circuit which is operatively associated with cell 36 need not be constructed of the same material as the legs 80 and 82. These wires may advantageously be constructed of a base metal or alloy such as manganin.

The invention having been thus described, what is claimed as new is:

1. In a gas analyzer, a combustion cell having mounted therein catalyst and non-catalyst legs of a Wheatstone bridge electric circuit, said legs comprising platinum alloy wires of substantially identical dimensions with a heat radiating nickel plating on the non-catalyst leg.

2. A gas analyzer unit comprising an air analyzer cell, a gas analyzer cell, a combined pump and mixing chamber, means for introducing to said pump at a uniform pressure and rate a stream of gas to be analyzed, means for conducting a stream of air to be analyzed from atmosphere successively through the air analyzer cell and into the pump, means for conducting a mixture of air and gas at a controlled rate from the pump into the gas analyzer cell, catalyst wires mounted in each cell adapted to promote combustion of combustible components in the air and gas streams respectively passing therethrough, and means for heating said catalyst wires electrically to temperatures at which combustion of combustible components will take place within the cells.

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