June 4, 1929. R. H. KRUEGER 1,715,374

ELECTRICAL INSTRUMENT

Filed May 29, 1926

Fig. 2

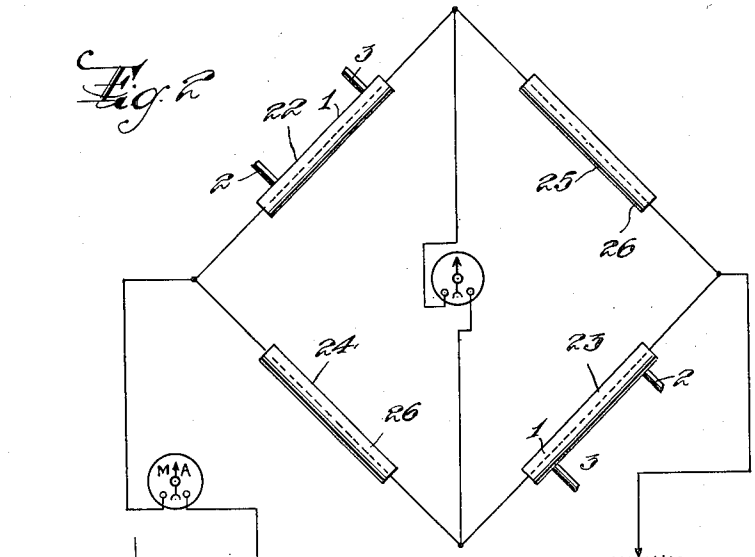


Fig. 1

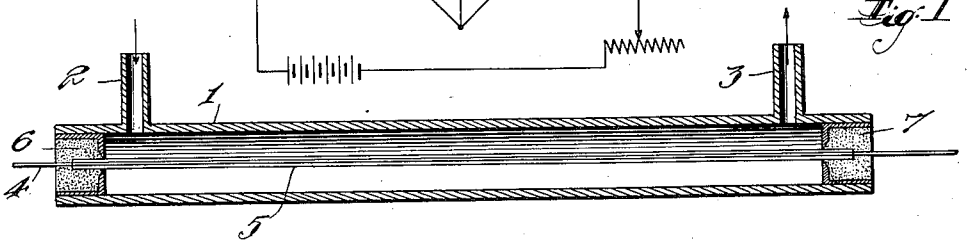


Fig. 3

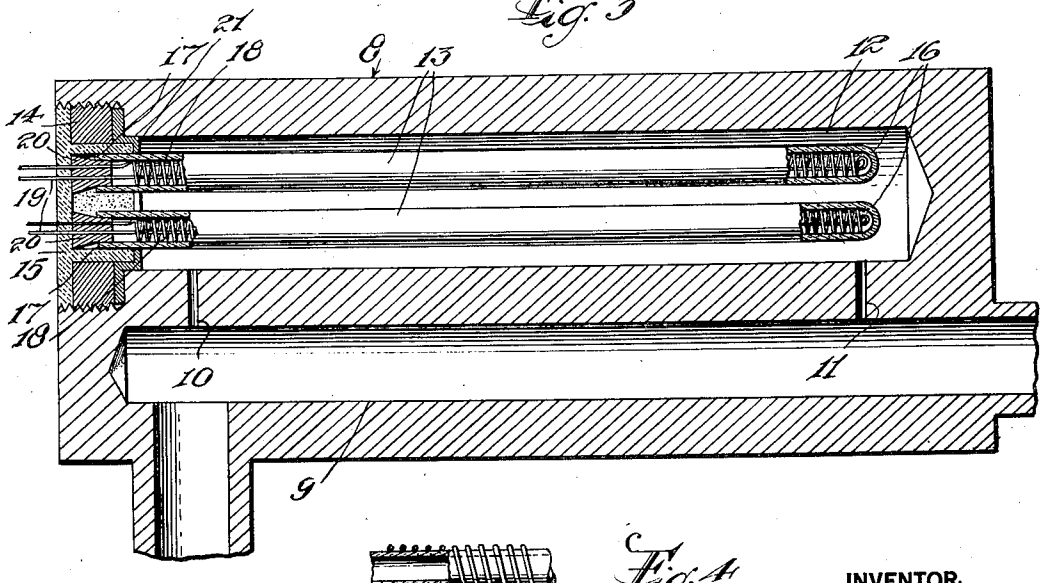


Fig. 4

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UNITED STATES PATENT OFFICE.

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ELECTRICAL INSTRUMENT.

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My invention relates more particularly to a means for protecting electrical conductors used as electrical resistance or heating elements in electrical apparatus of various kinds and more particularly in apparatus used in the thermal-conductivity method for the analysis of gases.

It has been found that in such apparatus the resistance or heating wires, which are directly brought into contact with the gases to be analyzed or with the comparison gases, are subject sooner or later to corrosion and such corrosion not only decreases the sensitivity of the apparatus, but ultimately introduces more or less of an error into the determinations.

In order to reduce the corrosive effect of the gases under the conditions obtaining in gas analysis apparatus, platinum wire, which is the least affected by gases, is ordinarily used, but even platinum wire cannot withstand the corrosive effect for any great length of time.

Therefore, the object of my invention is to enclose the electric resistance wire or heating element in a protective sheath of material, having a thermal-conductivity which will not interfere with the proper transfer of heat. For this purpose, I prefer to use fused crystal quartz or quartz glass. Fused crystal quartz or quartz glass, it is found, has a thermal-conductivity substantially equal to that of platinum and, therefore, by encasing the conducting or heating wire with this material, the wire will last indefinitely, for, without access thereto of the corroding gases there will be no corrosion, and hence, no variation in the original calibration of the instrument.

It has been found that common glass will not give the desired protection to the electric resistance heating elements or electric conductor, but I have found that complete and satisfactory protection thereof may be obtained by the use of quartz glass made by the fusion of crystal quartz.

A further object of my invention is to mount electric resistance units in pairs in adjacent gas cells and connect the pairs of units electrically in a Wheatstone bridge in such a manner that the analyzing units and comparison units alternate in the arms of the bridge. This construction, in connection with the complete enclosure of the respective elements in quartz glass, has enabled me to produce a satisfactory gas analysis apparatus in a simple and exceedingly compact form.

My invention will be more particularly understood from the following description in connection with the drawings, wherein:

Fig. 1 shows the construction of a thermal-conductivity cell, as ordinarily constructed, except that the wire is enclosed in a sheath of quartz glass.

Fig. 2 is a diagram of the Wheatstone bridge connections, showing the arrangement of the cells in my improved apparatus.

Fig. 3 is a vertical sectional view through my improved cell block, showing one of the gas chambers with its pair of quartz glass covered electric resistance units which form the heating elements, and Fig. 4 shows a portion of a tube of high thermal-conductivity material with the resistance wire wound on the outside of the tube.

Referring more particularly to Fig. 1, of the drawings, it will be seen that the gas cell tube 1 is provided with an inlet opening 2 and an outlet opening 3, for the circulation of gas through the tube, in which the resistance or heating wire 4 is mounted. The conducting or resistance wire 4, which forms the heating element in the gas cell, is, in the present instance, enclosed in a sheath 5, or capillary tube, of fused crystal quartz. The ends of the sheath 5, as will be seen in Fig. 1, are preferably hermetically sealed in the sealing plugs 6 and 7, which may be of cement or other suitable material.

It will be seen that, in this construction, that portion of the resistance wire or heating element which is subjected to the heat of the gas in the gas cell 1, is entirely protected from any corrosive effect of the gas by the sheath of quartz glass, which, as previously stated, is particularly resistant to corrosion by chemicals and, therefore, by any of the gases liable to be passed through the tube 1 for test purposes or otherwise.

It has previously been pointed out that platinum wire is ordinarily used for the heating element in gas analysis apparatus, but it will be understood that by enclosing the wire in a protecting sheath of quartz glass, any suitable wire may be substituted therefor, such as nickel, pure iron or the like, which will obviously reduce the cost of the apparatus.

Preferably, however, in the manufacture of apparatus, I have found it desirable to

simplify the construction of the gas cells by forming chambers and passages in a block 8 of copper or the like, which is provided with a conduit 9, through which the gas is adapted to pass, this conduit being provided with shunt passages 10 and 11, forming inlet and outlet openings to the gas cell or chamber 12, substantially as shown in Fig. 3. In this form of my improved apparatus, two such chambers 12 are provided, one for the test gas to be analyzed and the other for the comparison gas. Each of these cells or chambers 12 is preferably provided with a pair of resistance or heating elements, comprising electric resistance units 13 which extend into the chamber 12 and are secured therein by a suitable nut 14 and sealing cement 15, as shown in Fig. 3.

The electric resistance units 13 comprise a tube of fused crystal quartz, the upper end 16 thereof being closed. The lower end 17 of the quartz glass tube 13 is open, to start with, and a coil of resistance wire 18 is inserted therein, so that the convolutions of the coil contact with the wall of the tube, the arrangement being such that the inner end of the coil is carried back through the center of the coil to form one of the terminals 19.

The terminals 19 preferably pass out through a cork or plug 20, in the open end of the quartz tube 13, and the two tubes or electric resistance elements 13, in the chamber 12, are held in place by a flanged copper washer 21 and sealed, as previously pointed out, by the sealing cement 15, which enters the nut 14 and covers the open end of the chamber 12.

In Fig. 2, I have shown a diagram of the ordinary Wheatstone bridge, which is preferably used for gas analysis tests in the thermal-conductivity method. In the present instance, however, the pairs of analyzing cells 13 are arranged in opposite arms 22 and 23 of the Wheatstone bridge, while the alternate arms thereto 24 and 25 are connected up with the resistance coils in the comparison cells 26, which as previously pointed out, are mounted in a chamber 12, substantially identical with that shown in Fig. 3. To those skilled in the art, the Wheatstone bridge and its operation in connection with gas analysis tests by the thermal-conductivity method are well known, and it is not necessary here, to further describe the apparatus or its operation.

It will be understood that while I have described my improvement in the preferred form, I do not wish to be limited to the specific method or apparatus described, for various modifications therein may be made without departing from the spirit and scope of the invention.

I believe that I am the first to protect an electric resistance wire or heating element with a material having a thermal-conductivity which will not interfere with the proper transfer of heat and for that reason desire to claim it broadly, so as to include also winding the electric resistance wire or heating element around a tube of material of high thermal conductivity, as illustrated in Fig. 4 of the drawings, and passing the gas through said tube as distinguished from the structure disclosed in which the resistance wire is enclosed in a sheath of material of high thermal conductivity.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A gas testing apparatus in which a gas is analyzed or tested by comparing its heat conductivity with that of a standard gas by means of a Wheatstone bridge the resistance or heating wires of which are protected by quartz glass, said apparatus being characterized by the arrangement of the resistance units rigidly supported in cells whereby said units are held against vibration and displacement, one for the tested gas and the other for the comparison gas, the two cells being adjacent and the resistance units being so connected in the bridge that the analyzing units alternate with the comparison units in the branches thereof.

2. In a gas testing apparatus comprising resistance units, a Wheatstone bridge in which said units are conductively connected, and a block having cells for said resistance units, each of said resistance units comprising a quartz glass member rigidly supported in its cells and a conductor embedded in said member whereby said unit is held against vibration and displacement in the apparatus.

3. In a gas testing apparatus comprising resistance units constituting analysis and comparison units, a Wheatstone bridge having the analysis and comparison units alternating in the branches thereof, and a block having cells for said resistance units, each of said resistance units comprising a quartz glass member rigidly supported in the cell and a conductor embedded in said member whereby said unit is held against vibration and displacement in the apparatus.

4. In a gas testing apparatus comprising a block having adjacent cells, a resistance unit in each cell, said resistance units each comprising a quartz glass member and a conductor, one end only of the quartz member rigidly attached to the block the conductor being embedded in said quartz member, and a Wheatstone bridge in the branches of which said resistance units are connected.

This specification signed and witnessed this 21st day of May, 1926.

RICHARD H. KRUEGER.