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IONIZATION VACUUM GAUGE HAVING AN EMISSIVE ELECTRODE
SUPPORT MEANS
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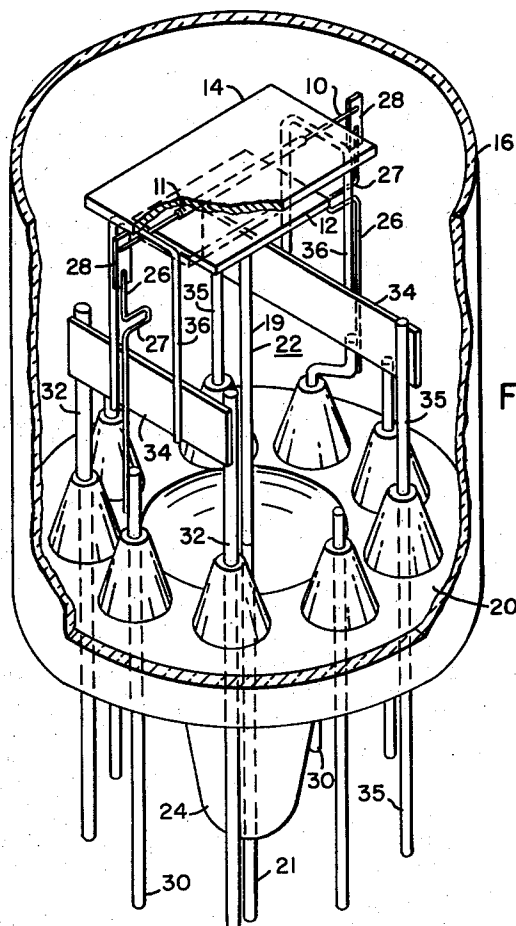


Fig. 1.

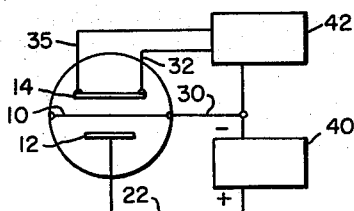


Fig. 2.

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IONIZATION VACUUM GAUGE HAVING AN EMISSIVE ELECTRODE SUPPORT MEANS

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7 Claims. (Cl. 313-180)

This invention relates generally to ionization vacuum gauges and, more particularly, to ionization vacuum gauges that are particularly suitable for measuring pressures in the range of from 10^{-3} torr to 10 torr.

The measurement of gas pressures below 10^{-3} torr is very well taken care of by the Bayard-Alpert type of ionization vacuum gauge described and claimed in U.S. Patent 2,605,431. However, measurement in the pressure range from 10^{-3} torr to 10 torr has been a rather difficult problem in view of critical dimensions and vibration problems within present designs of gauges. One particular ionization vacuum gauge which is suitable within this range of pressures but suffers from other limitations is described in U.S. Patent 2,963,601. The structure described in the U.S. Patent 2,963,601 suffered from several disadvantages in that a large diameter helical filament was used in some embodiments. The filament was difficult to construct and also subject to warping and sagging during operation of the tube. A modified design which is also shown in the U.S. Patent 2,963,601, as well as in the Review of Scientific Instruments, volume 28, No. 12, pages 1051 to 1054, December of 1957, overcame some of the objections to the helical filament by substituting straight wire filaments which were located between the ion and electron collectors of the gauge. This structure is also subject to certain limitations in that the rather long electrode supports for the filament are subject to vibration.

Another type of construction which is also found in the above-mentioned article and referred to as a type A high pressure gauge provides certain structural improvements over the previous design. In this structure, the electron and ion collectors are parallel plates and the electron emitter is a wire filament located between the two plates. The electron collector and filament are symmetrically supported by press leads. The ion collector electrode is mounted with its surface perpendicular to its lead so that vibration of the support changes the inter-electrode spacing by relatively small amounts. The electrode construction described in the above mentioned article has the advantage of simplicity and rigidity and also the possibility of reduced electrode spacing. The reduced electrode spacing, of course, makes possible an increase in the high pressure limits of the gauge beyond that of present designs. Another advantage of the structure set forth in the above mentioned article is that it was found to be easier to outgas the electrodes by electron bombardment than the prior structure since the electrodes are of relatively small area. The problem of outgassing the parallel plate structure described in the article was accomplished by RF induction heating, by the use of auxiliary filaments, or by constructing the electron collector from a tungsten ribbon and using the ribbon as a source of electrons for heating the ion collector by electron bombardment. It was found in this type of structure that the requirement that the filament cross section be small so as to not intercept an appreciable ion current resulting in a filament which is too small to supply the currents required for outgassing the other electrodes by electron bombardment. The use of the electron collector as an electron source in the outgassing operation was found to provide adequate electron current to perform the outgassing operation. However, it was found that the heating of the electron collector resulted in warping of

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the tungsten ribbon as well as generally varying the spacing between the electron collector and the filament. This, of course, resulted in modifying the characteristics of the tube in that the electrode spacings are critical in providing a uniform and linear characteristic.

It is accordingly an object of this invention to provide an improved ionization vacuum gauge.

It is another object to provide improved means of supporting electrode elements within an ionization gauge to obtain uniform spacing under all operating conditions.

It is another object to provide improved ionization gauge with means for providing outgassing of an ionization gauge by means of electron bombardment.

It is another object of this invention to provide an improved ionization gauge in which the ion collector support leads are of an electron emissive material.

Briefly, the present invention accomplishes the above-cited objects by providing U-shaped support elements for the electron collector with the U-shaped elements being a suitable electron emissive material and resilient support of the filament.

Further objects and advantages of the invention will become apparent as the following description proceeds and features of novelty which characterize the invention will be pointed out in particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which:

FIGURE 1 is a perspective view partially broken away of an ionization vacuum gauge embodying the invention; and

FIG. 2 illustrates circuitry associated with the gauge for outgassing the gauge.

In FIG. 1, there is shown an ionization vacuum gauge in accordance with one embodiment of our invention which consists of a filament 10. The filament 10 is located between an ion collector plate 12 and an electron collector electrode or plate 14. The above electrode structure is enclosed in an envelope 16 of a suitable material such as glass. The envelope 16 includes an opening (not shown) for connection into a system for measuring the pressure. The electrodes 10, 12 and 14 are supported within the envelope 16 from a button stem member 20 which is made from a suitable material such as a boron silicate glass which has been marketed under the Corning designation No. 705. A centrally located two piece support lead 22 consists of an upper portion 19 of molybdenum and Kovar alloy and a lower portion 21 extending from button stem member 20. Kovar is a Westinghouse Electric Corporation trademark for an alloy of nickel, iron and cobalt. The lead 22 is provided for supporting the ion collector 12. A tubulation 24 is provided in the central portion of the button stem 20. The tubulation 24 extends to a point below the remaining portion of the lead-in members where the lower portion 21 and support lead 22 is sealed to the tubulation 24.

The ion collector 12 is of a suitable low vapor pressure material such as molybdenum in the shape of a rectangular plate approximately .010 inch in thickness and having dimensions of $\frac{3}{8}$ of an inch on a side. The collector plate 12 is arc welded directly to the upper portion of the lead 22 by forming a rigid structure that can be heated to a high temperature during outgassing without danger of melting or deforming. The plate 12 is perpendicular to the rod 22 and is substantially parallel to the base portion 20 of the envelope 16.

The filament 10 is of a suitable material such as iridium with a coating 11 of thorium oxide of about .002 inch in thickness to provide an electron emitting element of about .009 inch in diameter. The spacing between the ion collector 12 and the filament 10 is about .050 inch. The filament wire 10 is supported at each end by resilient

means of a tungsten wire 26 having a diameter of about .010 inch and having a U-shaped bend 27 near the upper end thereof with the upper end of the wire secured to a tab 28 of a suitable material such as nickel which is in turn secured to the filament wire 10. The lower end of the wire 26 is secured to a lead-in member 30 in tube base 20. This arrangement of supporting the filament wire 10 is such as to place the wire 10 under tension and, therefore, any changes in the length thereof is taken care of by the spring action provided by the U-shaped bend 27 in the two support members 26 so that the filament is maintained at a uniform spacing with regard to the other electrodes. Two lead-ins 30 are used for support of the filament 10 and are spaced apart by about 180°.

The electron collector 14 is a rectangular plate of a suitable low vapor pressure material such as nickel or molybdenum having a thickness of .010 inch to .030 inch and having a dimension of about $\frac{5}{16}$ inch by $\frac{1}{2}$ inch. The electron collector 14 is positioned parallel to the ion collector 12 and spaced at about .045 inch from the filament 10. The electron collector 14 is rigidly supported at the end by means of the two lead-ins 32 which have a cross piece 34 of a suitable material such as Inconel which is about .020 inch in thickness and is welded to the Kovar alloy leads 32. A U-shaped tungsten wire 36 having a diameter of about .010 inch has the ends of its leg portions spot welded to the cross piece 34. The central portion of the U-shaped wire 36 is secured to the under surface of the electron collector 14. A similar support structure is provided at the opposite end of the electron collector 14 secured to the lead-ins 35. The resulting structure provides a long leakage path with regard to the ion collector 12 by locating the ion collector lead-in 22 centrally of the tube base and also sealed to the glass at a point spaced from the tube base.

The circuit connections for outgassing the electrode configuration is illustrated in FIG. 2. A voltage source 40 of about 300 volts is provided with the negative terminal connected to the filament 10 and the electron collector 14 and the positive terminal connected to the ion collector 12. The electron collector 14 is also connected across an A.C. voltage source 42 of about 15 volts to provide about 13 amperes through the lead-ins 32 and 35 and the collector 14. This provides adequate current to heat the wires 36 to electron emission temperature. The lead-ins 32 supporting one end of the collector 14 are connected to one terminal of the source 42 and the lead-ins 35 supporting the other end of the collector 14 are connected to the other terminal. The electron bombardment of the ion collector 12 by electrons emitted from the support wires 36 raises the temperature of the ion collector 12. The electron bombardment raises the temperature of the ion collector 12 to about 1000° C. which is adequate to outgas the electrode 12. The tungsten support members 36 are heated to a temperature of about 2200° C. during this outgassing operation. The electron collector 14 is outgassed simultaneously by being heated to about 800° C. by the current passing through the support wires 36 and the electron collector 10.

In normal operation of the tube, the voltages applied to the electrodes are such that the ion collector 12 is at a fixed potential such as ground potential, the electron collector 14 at positive potential is of about 120 volts with respect to the ion collector 12 and the filament 10 is at a positive potential of about 60 volts with respect to the ion collector 12. In operation, the electrons emitted by the filament 10 are accelerated toward the electron collector 14 which is at a positive potential with respect to the filament 10. Prior to the electron being collected by the collector 14, a certain number of electrons will form positive ions by collision with the gas atoms within the envelope 16. These positive ions

are then accelerated toward the electron emitter 10, but in view of the small size and the positive potential, the field from ion collector 12 penetrates the structure and the positive ions are collected on the ion collector 12. The current due to the collection of these ions may be measured by conventional means and is a measure of the pressure of the gas present in the envelope. The envelope is normally connected into the system where the pressure is to be measured. The resulting structure provides an ionization gauge in which conditions are provided where the electron paths are short and definite and high ion collector efficiency is obtained due to the large area of the ion collector 12. The resulting structure is easily constructed and the structure is simple and rugged.

While the present invention has been shown in only a single form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit and scope thereof.

We claim as our invention:

1. An ionization low pressure gauge adapted to be disposed in an atmosphere to measure the pressure therein, comprising a planar ion collecting means, a planar electron collecting means positioned parallel to said ion collecting means and spaced therefrom, an elongated electron emitting means positioned between said ion collecting means and said electron collecting means, said electron collecting means supported from a base member by means of members capable of emission of electrons upon passage of current therethrough, said last-mentioned members being so positioned with respect to said ion collecting means that the electrons emitted by said last-mentioned members strike and thereby degas said ion collecting means.

2. An ionization low pressure gauge adapted to be disposed in an atmosphere the pressure of which it is desired to measure, comprising a planar ion collecting means, a planar electron collecting means positioned parallel to said ion collecting means and spaced therefrom, an elongated electron emitting means positioned between said ion collecting means and said electron collecting means and parallel thereto, said ion collecting means, electron collecting means and electron emitting means supported from a base member, said electron collecting means supported by members capable of emission of electrons upon passage of current therethrough, said last-mentioned members being so positioned with respect to said ion collecting means that the electrons emitted during the assembly of said gauge by said last-mentioned members strike and thereby degas said ion collecting means.

3. An ionization low pressure gauge adapted to be disposed in an atmosphere the pressure of which it is desired to measure, comprising a thin planar ion collecting member, a rectangular thin planar electron collecting member positioned parallel to said ion collecting member and spaced therefrom, an elongated thin electron emitting member positioned between said ion collecting member and said electron collecting member and parallel thereto, said electron collecting member supported from a base member including a pair of U-shaped members of a tungsten material capable of electron emission with the central region of each of said U-shaped members in electrical and mechanical contact with said electron collecting member, said U-shaped members being so positioned with respect to said ion collecting member that the electrons emitted by said U-shaped members strike and thereby degas said ion collecting member.

4. An ionization low pressure gauge comprising an envelope, a planar ion collector supported within said envelope by a single support member, a planar rectangular electron collector supported within said envelope parallel to said ion collector and spaced therefrom, an elongated filament for emission of electrons positioned

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between said ion collector and said electron collector and parallel thereto, said electron collector supported at opposite edges by U-shaped wire members having their central region mechanically and electrically secured to said opposite edges of said electron collector, said U-shaped wire members of a material capable of emission of electrons on passage of current therethrough and being positioned in such proximity to said ion collector that the electrons emitted by said members will strike and thereby degas said ion collector, and said filament supported by resilient means to permit expansion and contraction of said filament without varying the spacing the spacing with respect to said ion collector and said electron collector.

5. An ionization low pressure gauge comprising an envelope including a base having a plurality of lead-ins, a planar ion collector supported within said envelope by a single support member secured to a centrally located lead-in, a planar rectangular electron collector supported within said envelope parallel to said ion collector and spaced therefrom, an elongated filament for emission of electrons positioned between said ion collector and said electron collector and parallel thereto, said wire members mechanically and electrically secured near opposite edges of said electron collector, said wire members of a material capable of emission of electrons on passage of current therethrough and being positioned in such proximity to said ion collector that the electrons emitted by said members will strike and thereby degas said ion collector, and said filament supported by resilient means to permit expansion and contraction of said filament without varying the spacing with respect to said ion collector and said electron collector.

6. An ionization low pressure gauge adapted to be disposed within an atmosphere the pressure of which it is desired to measure, a thin planar ion collector of a low vapor pressure material and supported by a single centrally located support member, a planar rectangular thin electron collector parallel to said ion collector and spaced therefrom, said planar electron collector rigidly supported within said gauge by means of support members positioned at opposite edges of said rectangular electron collector, said support members being in the form of a U-shaped member with the bight portion of the U-shaped member in mechanical and electrical contact with the electron collector and the leg portions of

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said U-shaped members in close proximity to said ion collector, said support members also exhibiting the property of emission of electrons upon passage of current therethrough at a substantially lower temperature than the electron collector material, an elongated filament for emission of electrons positioned between said ion collector and said electron collector and substantially parallel thereto, said filament supported by resilient means at each end thereof so as to permit expansion and contraction of said filament during operation without substantially varying the spacing with respect to said ion collector and said electron collector.

7. An ionization low pressure gauge comprising an envelope including a base having a plurality of lead-ins, a planar ion collector supported within said envelope by a single support member secured to a centrally located lead-in, a planar electron collector supported within said envelope parallel to said ion collector and spaced therefrom, an elongated filament for emission of electrons positioned between said ion collector and said electron collector and parallel thereto, wire members mechanically and electrically secured near opposite ends of said electron collector, said wire members of a material capable of emission of electrons on passage of current therethrough, and said filament supported by an adjustable, resilient means comprising a filamentary element having a U-shaped bend therein to provide tensioning on said filament and to allow adjustment of said filament between said ion collector and said electron collector.

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