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Jilbert

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[45] **May 20, 1975**

[54] **IONIZATION CHAMBER**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **250/385;** 250/374; 313/93

[51] **Int. Cl.** **G01t 1/00**

[58] **Field of Search**....... 250/83.6 R, 380, 374, 385; 313/93

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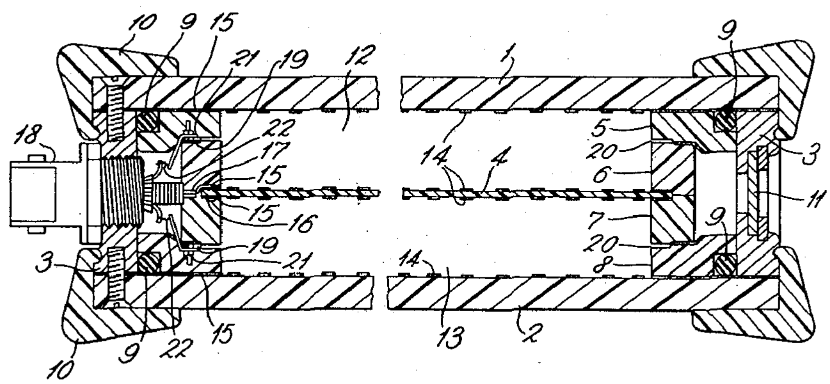
[57] **ABSTRACT**

The invention concerns ionisation chambers with particular reference to air-equivalent ionisation chambers. In order to ensure that similar chambers have similar sensitivities and responses the surface of the chamber bounding the active volume carries a conducting material, which may be a colloidal graphite, arranged in the form of lines so that the area of the conducting material occupies only a small proportion of the area of said surface.

5 Claims, 3 Drawing Figures



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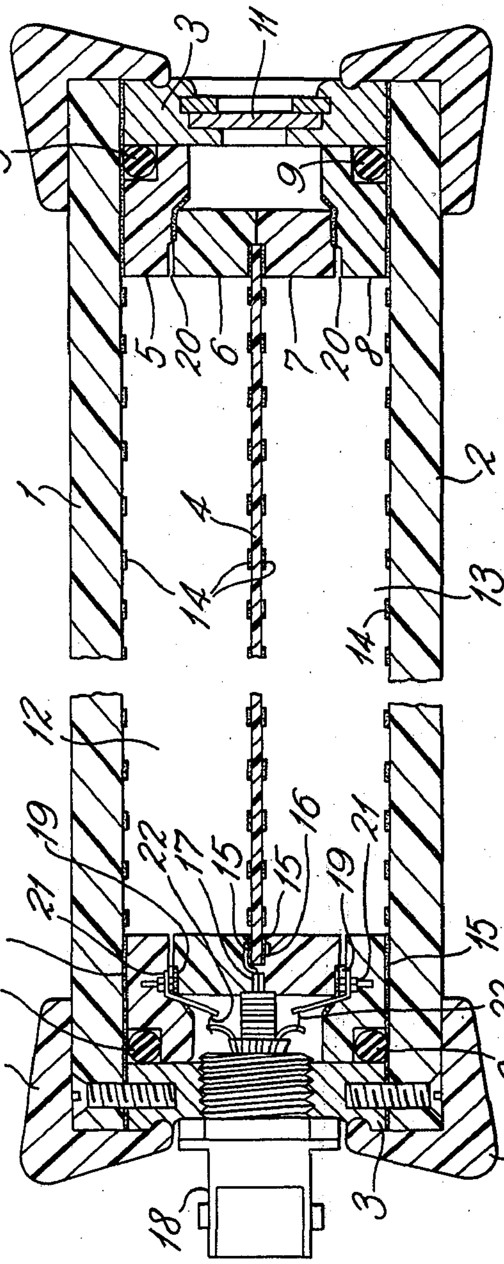
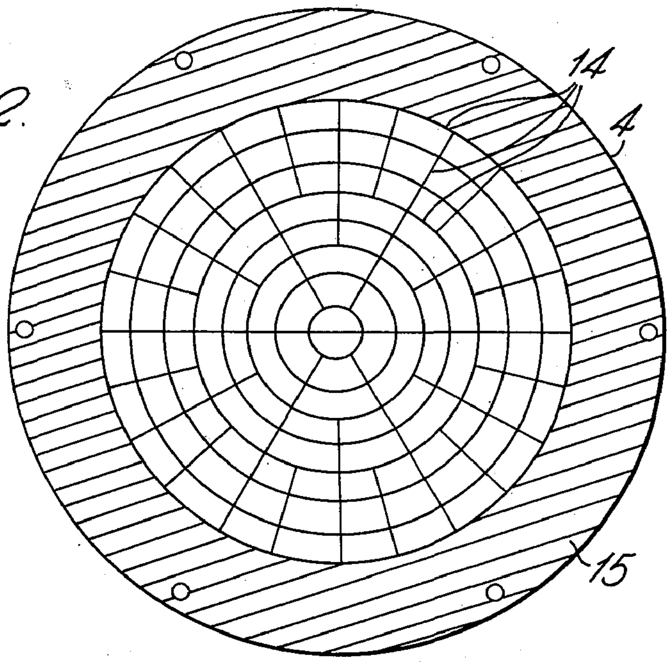
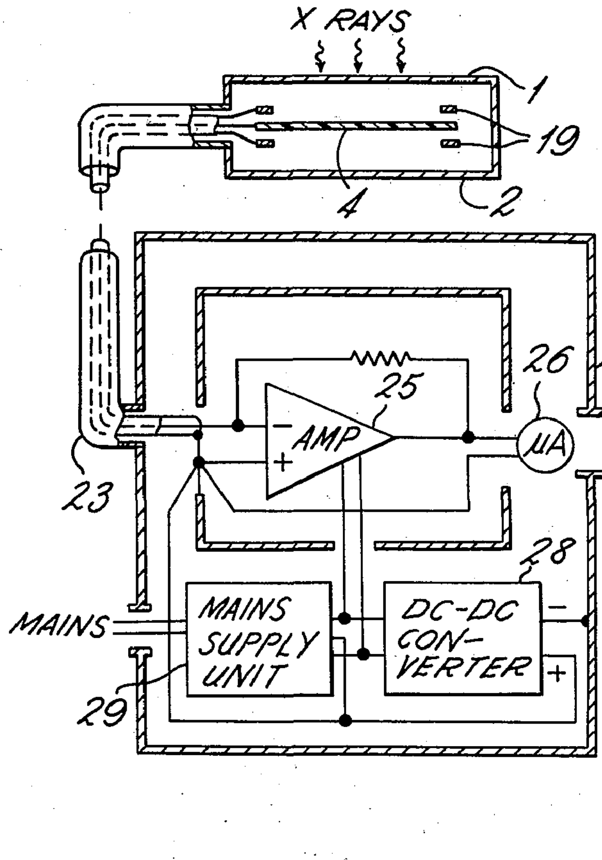


Fig. 1.

Fig. 2.


14
4
15


X RAYS
1
19
4
2
24
26
25
AMP
μA
23
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MAINS
MAINS SUPPLY UNIT
DC-DC CON-VERTER
29

Fig. 3.

IONIZATION CHAMBER

This invention relates to ionisation chambers, and has one application in air-equivalent ionisation chambers.

In an air-equivalent ionisation chamber the walls, which may also constitute the electrodes, are made of a material having a mean atomic number which approximates to that of the air (approx. 7.4) which fills the chamber, so that the response of the chamber to ionising radiation approximates to that of air. Such chambers can be used, for example, for measuring the output of a medical X-ray source. The walls and electrodes may be made of a plastics material such as methyl methacrylate. As the latter is electrically insulating a conducting coating must be provided if they are to act as electrodes, and this may be a thin coating of graphite applied in colloidal form.

Graphite has atomic number 6, and it has been found that although at high X-ray energies, say 200 keV-1.25 MeV, this has little effect, at lower energies the thickness of the graphite layer can have a critical effect on the sensitivity of the chamber. In particular it has been found difficult to produce apparently identical chambers having the same sensitivities at low energies, because the thickness of the graphite coating becomes the critical factor and it is difficult to make the thickness uniform from chamber to chamber.

According to the present invention, in an ionisation chamber whereof the active volume contacts a surface made of electrically insulating material and having an electrically conducting material on said surface, the conducting material is arranged as a pattern of lines, which lines occupy only a small proportion of the area of said surface.

In one form of the invention an air-equivalent chamber of flat cylindrical shape is formed by two discs of methyl methacrylate having insulatedly spaced between them a third disc of the same material. The first two discs constitute the polarising electrodes of the chamber, and the third disc the collector electrode of the chamber. In accordance with the invention both surfaces of the third disc, and the inner surfaces of the first two, are provided with a pattern of thin concentric and radial conducting lines which intersect in the manner of a spider's web and to which the usual electrical connections are made. The conducting lines may be formed, for example, by engraving the patterns on the surfaces with a sharp instrument and filling the engraved lines with a conducting material such as colloidal graphite, but other methods of applying the pattern may be used.

It is found, surprisingly, that the small conducting areas provided by the lines are sufficient to polarise the chamber to saturation and to collect all the current produced by ionisation.

As the thin lines occupy only a small proportion of the electrode surface area, for example 6 percent, it follows that any variations in sensitivity between chambers resulting from nonuniformity of the thickness of the conducting material can only arise from this small proportion of the surface, and hence any such variations are correspondingly small.

Electrical contact may be made to the pattern of lines by means of a conducting coating applied to the surface outside the pattern of lines and in contact therewith. This conducting coating should not form part of a surface bounding the active volume of the chamber, otherwise part of the advantage of the invention is lost.

Although particularly applicable to air-equivalent chambers, the invention is applicable to other ionisation chambers whose walls are made of insulating material, for example tissue-equivalent chambers. Nor need the chamber have flat cylindrical geometry.

To enable the nature of the present invention to be more readily understood, attention is described, by way of example, to the accompanying drawings wherein:

FIG. 1 is a diametral sectional elevation of an ionisation chamber embodying the present invention,

FIG. 2 is a plan view of either polarising electrode of FIG. 1 showing the conductor pattern, and

FIG. 3 is a schematic circuit diagram showing the electrical connections to the chamber of FIG. 1.

Referring to FIG. 1, an air-equivalent ionisation chamber comprises two methyl methacrylate discs 1 and 2, secured to opposite ends of a flat cylindrical aluminium casing 3. A third methyl methacrylate disc 4 is equispaced between discs 1 and 2 by means of rings 5, 6, 7 and 8 of the same material, the disc 4 being clamped in an annular recess formed between rings 6 and 7. Compressible O-rings 9 ensure rigidity of the assembly. Protective polythene rings 10 are fitted to each end of the chamber. Casing 3 is provided with a filtered vent 11 which allows atmospheric air to enter the chamber, as rings 5 – 8 do not form a perfect seal.

The two volumes 12 and 13 defined between discs 1 and 4 and 2 and 4 respectively constitute the active volume of the chamber. It will be seen that all walls of the active volume are thus made of methyl methacrylate.

Disc 4 constitutes the collector electrode and the inner surfaces of discs 1 and 2 constitute the polarising electrodes of the chamber. In accordance with invention electrically conducting coatings are provided on both surfaces of disc 4 and on the inner surfaces of discs 1 and 2 of the form shown in FIG. 2. FIG. 2 shows discs 1 or 2, but the spider's web-like pattern of lines 14 thereon is repeated on both surfaces of disc 4. In the present embodiment the pattern comprises eight concentric circles having diameters increasing by 1 cm to 8 cm, together with the radial lines shown. The lines are formed by engraving with a sharp instrument to form approximately V-shaped grooves about 0.25 mm wide and 0.25 mm deep which are filled with colloidal graphite. Electrical contact is made to the pattern 14 by an annular graphite coating 15 which contacts the outer concentric circle of the line pattern. The resistance from the centre ring to the coating 15 is about 100 kohm, but this value is not critical, nor is the pattern of lines. Suitable line patterns are readily found by simple experiment.

As will be seen in FIG. 1, the coatings 15 on discs 1 and 2 are in electrical contact with the casing 3. The corresponding, though narrower, coatings 15 on disc 4 are connected via a stud 16 and wire 17 to the central pin of a tri-axial plug 18 whose outer case is mounted on casing 3. A guard-ring is provided between the polarising electrodes 1 and 2 and the collector electrode 4 by graphite coatings 19 on the abutting surfaces of rings 5 and 6, and 7 and 8 respectively, in association with the annular recesses 20 formed between these pairs of rings. Any leakage current from discs 1 and 2 across the surfaces of rings 5 and 8 flows to the coatings 19. The latter are connected by studs 21 and wires 22 to the intermediate contact of plug 18.

FIG. 1 is approximately to scale. The discs 1 and 2 are about 11.4 cm in diameter and 4 mm thick, and the disc 4 about 1 mm thick. The diameter of the active volume of the chamber is about 7.6 cm and the spacing between each disc 1 and 2 and disc 4 is about 1.2 cm to give a total active volume (12 plus 13) of about 108 cc.

Referring now to FIG. 3, the ionisation chamber is connected by a tri-axial cable 23 to a metal case 24 which contains the associated electronic circuitry. The conducting patterns on discs 1 and 2 (the polarising electrodes) are connected by the outer conductor of cable 23 directly to case 24. Disc 4 (the collector electrode) is connected by the innermost conductor to the input terminal of a conventional resistor-feedback operational amplifier 25 whose output is displayed on a meter 26. Amplifier 25 is contained in a metal screening box 27 to which the guard rings 19 (via the intermediate conductor of the cable) and the "earthy" amplifier input terminal are connected. The polarising voltage for the chamber is provided by a DC-to-DC converter unit 28 which maintains the box 27, and hence amplifier 25 and disc 4, a positive potential of +150 V with respect to case 24 and discs 1 and 2. Converter 28 is supplied from a mains-driven power supply unit 29 which also powers amplifier 25.

In the described chamber it is estimated that the lines 14 occupy only about 6 percent of the total surface enclosing the active volume of the chamber. The responses and sensitivities of such chambers are found to be substantially identical, from chamber to chamber, for X-rays between 68 keV and 1.25 MeV, and at 32 keV are within 5 percent of one another.

I claim:

1. An ionisation chamber comprising housing means enclosing and defining an active volume, said housing means including walls having inner surfaces contacting the active volume, said walls comprising spaced apart circular discs formed of an insulating material having a mean atomic number approximating that of air, said circular discs having an electrically conducting material of an atomic number different from said mean atomic number approximating that of air formed on the inner surface thereof, said electrically conducting material being arranged on said circular discs inner surfaces as a pattern of lines in order to occupy only a small proportion of the area of said wall surfaces whereby the effect of the thickness of said electrically conducting material on the sensitivity of the ionisation chamber is minimized.

2. An ionisation chamber as claimed in claim 1 wherein the conducting material is colloidal graphite.

3. An ionisation chamber as claimed in claim 1 wherein said walls comprise two spaced apart discs of insulating material and having a third disc of the same material mounted between them and insulated from them, the first two discs constituting the polarising electrodes of the chamber and the third disc the collector electrode of the chamber.

4. An ionisation chamber as claimed in claim 3 in which the three discs are made of methyl methacrylate.

5. An ionisation chamber as claimed in claim 4 wherein the conducting lines are formed by engraving the patterns on the surfaces with a sharp instrument and filling the engraved lines with a conducting material.

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