May 1, 1951 M. S. FREEDMAN 2,551,531

RADIATION COUNTER

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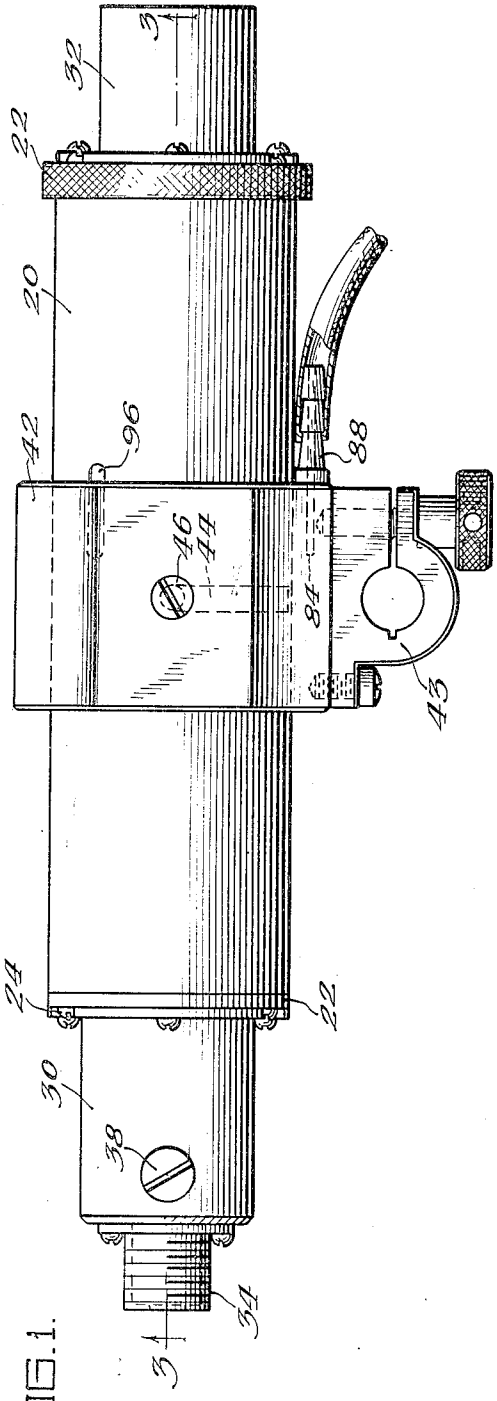


FIG. 1.

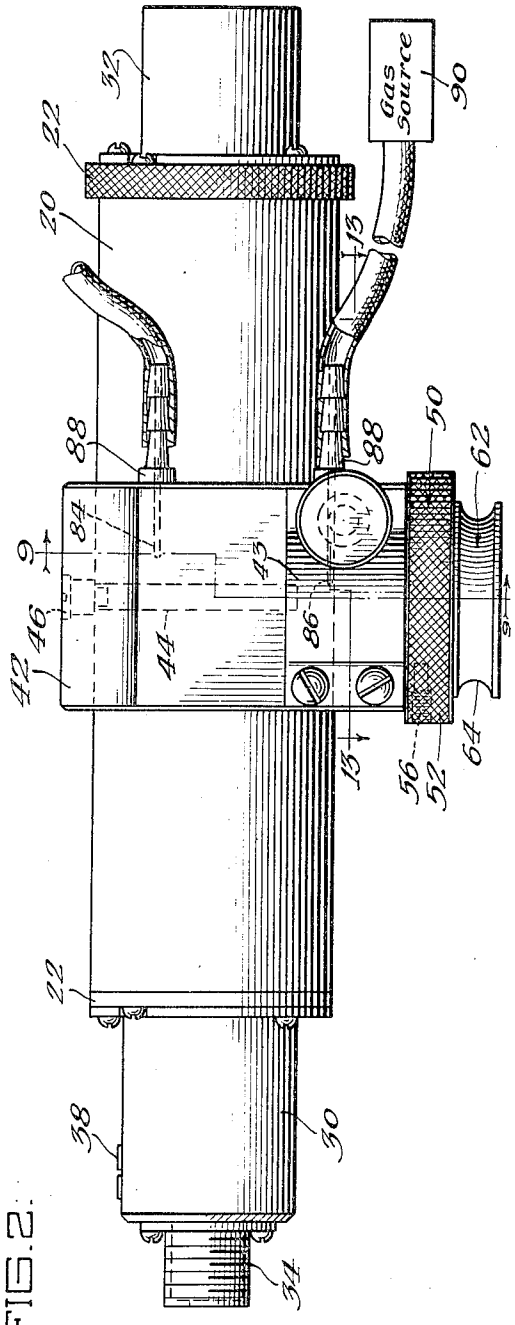


FIG. 2.

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RADIATION COUNTER

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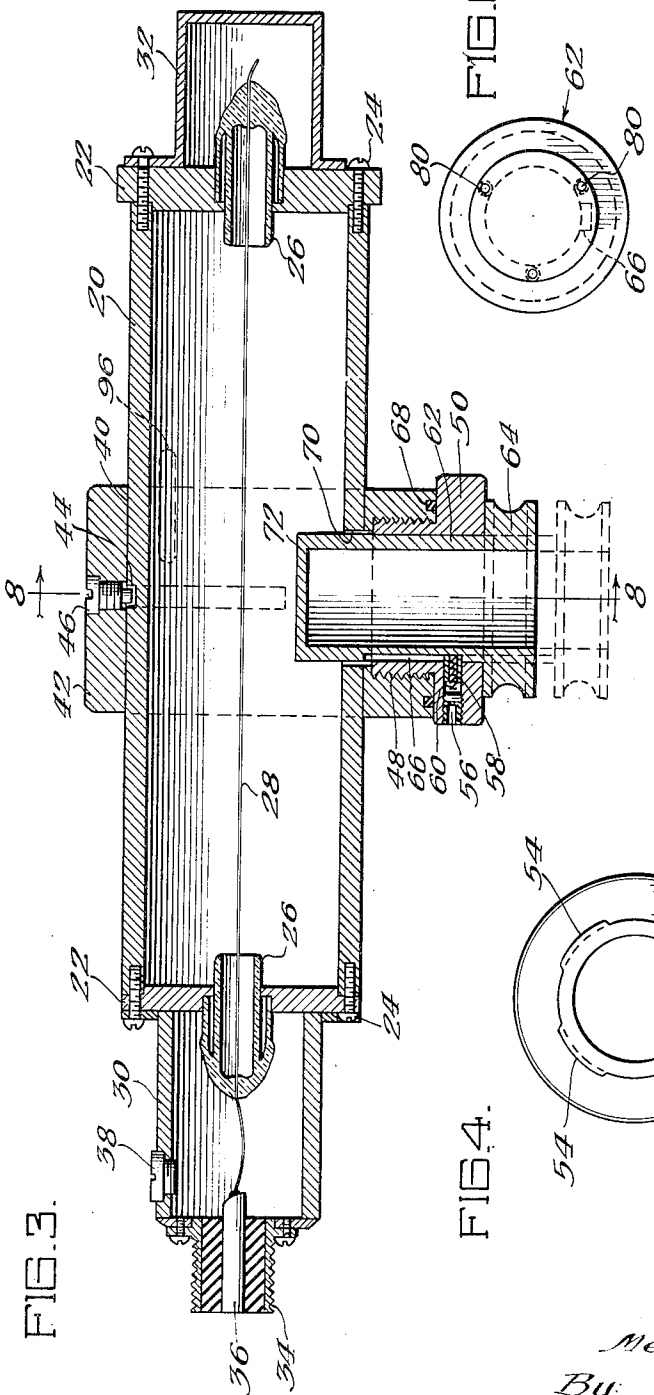


FIG. 3.

FIG. 6.

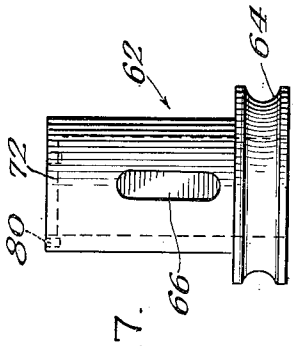


FIG. 7.

FIG. 4.

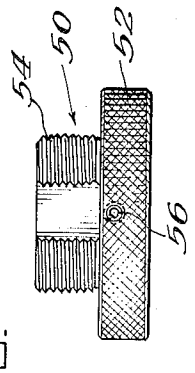


FIG. 5.

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RADIATION COUNTER

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FIG. 8.

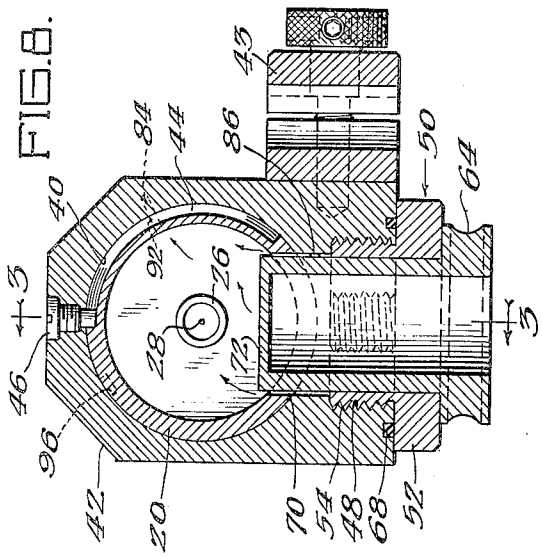


FIG. 9.

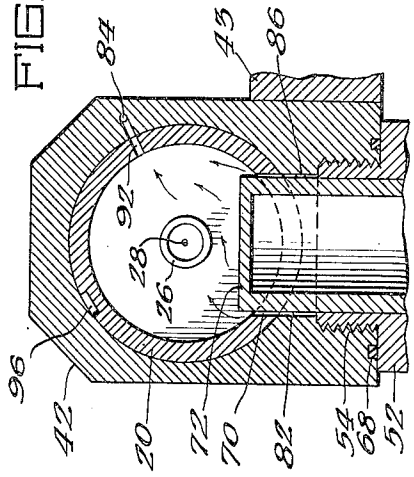


FIG. 10.

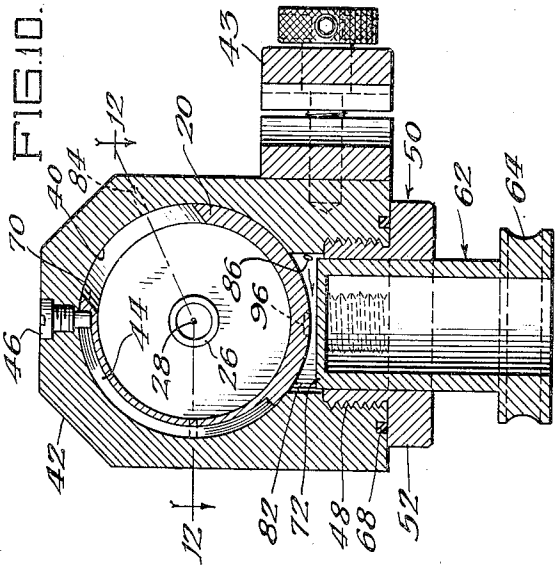
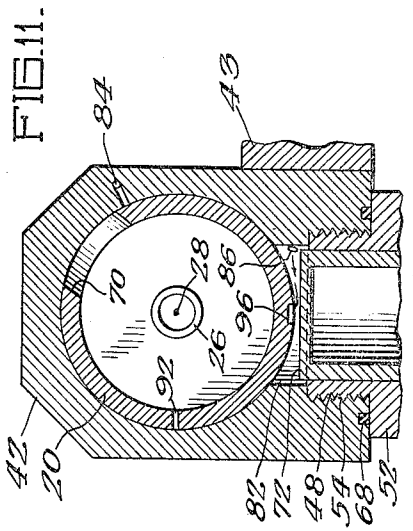


FIG. 11.



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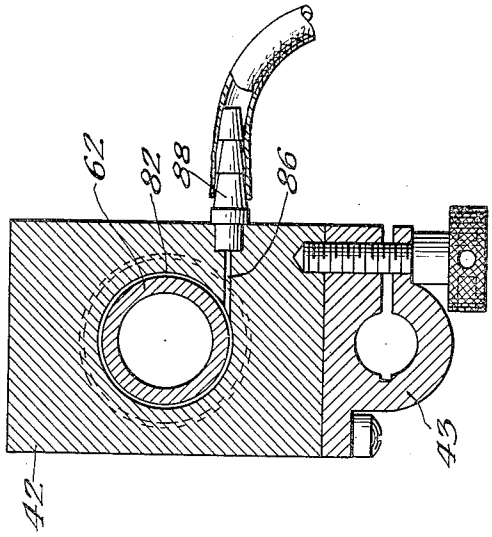


FIG. 13.

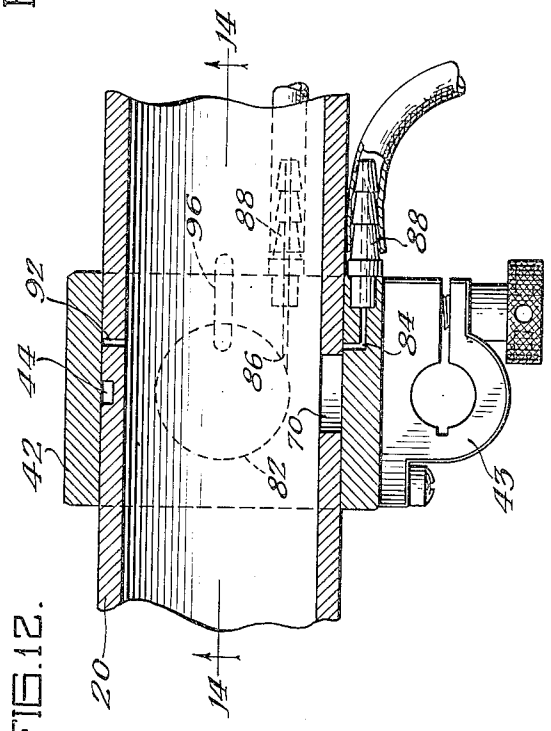


FIG. 12.

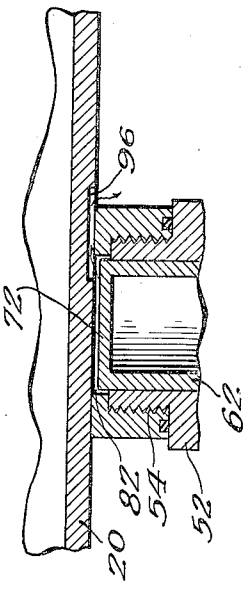


FIG. 14.

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Patented May 1, 1951

2,551,531

UNITED STATES PATENT OFFICE

2,551,531

RADIATION COUNTER

Melvin S. Freedman, Chicago, Ill., assignor to the United States of America as represented by the United States Atomic Energy Commission

Application July 8, 1947, Serial No. 759,526

21 Claims. (Cl. 313—93)

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This invention relates to an improvement in radiation counters such as ionization chambers, proportional counters and Geiger-Müller tubes. This invention is concerned with counters of the gas-filled type and is particularly concerned with gas-filled counters wherein the gas flows continuously through the counter body.

Radiation counters comprising a plurality of electrodes with a gaseous ionizing medium therebetween are well known in the art of measuring radioactivity. Such counters are commonly filled with a gas. This invention relates to an improvement in counters whereby a radioactive sample may be inserted into the counter without introducing air, the introduction of which would interfere with the proper operation of the counter. In the most advanced embodiment of the invention to be described hereinafter, means are provided not only for insertion of the sample into the counter without the introduction of air, but also for so arranging the gas flow that the counter body is sealed during the operation of loading the sample into the counter, and gas is continually flowed through the counter body when the sample has been inserted and the counter is in operation. It will be understood that a counter wherein the ionizing medium is a gas which is flowed through the counter during the operation thereof is not in itself the invention of the present inventor. Such a counter, and the advantages thereof, are disclosed in the co-pending application of John A. Simpson, Jr., filed in the U. S. Patent Office on May 22, 1045, Serial No. 595,192. It will further be understood that although the embodiment hereinafter to be described is particularly suitable for a counter through which gas flows in operation, a number of features of the invention are equally applicable to counters, including ionization chambers, wherein the gaseous ionizing medium is static. In particular, the aspects of the invention dealing with the insertion of the sample without introducing air are equally applicable to such counters.

It will be seen from the above introduction that the principal object of the invention is to provide a radiation counter into which a radioactive sample may be introduced without the introduction of air or other foreign gases.

A further object of the invention is to provide a novel radiation counter into which a sample may be so inserted, but through which gas flows continuously during operation of the counter.

Another object is to provide a novel system of gas ports and an intermediate gas-lock cavity

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whereby the objects above stated may be accomplished.

It is a further object of the invention to provide a radiation counter of the type described which is simple both to construct and to operate.

For an understanding of the invention, reference is made to the preferred embodiment illustrated in the drawing, in which:

Fig. 1 is a plan view of a novel proportional counter embodying the teachings of the invention;

Fig. 2 is a side elevation of the proportional counter of Fig. 1, together with a schematically illustrated source of gas;

Fig. 3 is a longitudinal vertical section of the counter of Fig. 1;

Fig. 4 is a plan view of a bushing constituting a portion of the proportional counter;

Fig. 5 is a side elevation of the bushing of Fig. 4;

Fig. 6 is a plan view of a piston sample-holder which is incorporated in the proportional counter;

Fig. 7 is a side elevation of the sample-holder of Fig. 6;

Fig. 8 is a central cross-section taken along the line 8—8 of Fig. 3 in the direction indicated by arrows;

Fig. 9 is a cross-section taken along the broken line 9—9 of Fig. 2 in the direction indicated by arrows;

Fig. 10 is a view corresponding with that of Fig. 8 except that the parts are illustrated in the loading position, rather than in the operating position;

Fig. 11 is a view corresponding with that of Fig. 9 except that the parts are illustrated in the loading position, rather than in the operating position;

Fig. 12 is a fragmentary section taken along the broken line 12—12 of Fig. 10 in the direction indicated by arrows;

Fig. 13 is an offset horizontal section taken along the line 13—13 of Fig. 2 in the direction indicated by arrows; and

Fig. 14 is a fragmentary vertical section taken along the line 14—14 of Fig. 12 in the direction indicated by arrows.

The counter body 20 is a tube of brass or stainless steel for example 1½ inches in diameter and 6 inches long, with capping plates 22 (Fig. 3) sealing the ends thereof and secured thereto by screws 24. Each capping plate 22 has centrally thereof a conventional glass-to-metal seal 26 insulatingly supporting and holding taut a

central wire electrode 28. Caps 30 and 32 cover and protect the glass-to-metal seals 26 at the opposite ends of the counter body 20. A polystyrene-insulated coaxial cable connector 34, for connection of the counter to a conventional voltage source, amplifier and counting circuit, is mounted on the cap 30 and the end of the central electrode 28 is soldered to the center conductor 36 of the connector 34. A removable plug 38 is provided in the wall of the cap 30 for insertion of a tweezer and heat source to make this solder connection in assembly, thus avoiding the necessity of excessive sag or pigtailing of the central electrode wire 28 within the end cap 30.

The counter body 20 is journalled in an aperture 40 through a collar block 42. The collar block 42 is substantially rectangular in shape, with beveled edges for convenience in handling, and has attached thereto a clamp 43, for mounting of the counter on, for example, a vertical rod support (not illustrated). The aperture 40 traverses the block and is of a diameter to slideably receive the counter body 20. The counter body 20 has a circumferential groove 44 extending about 130° around the exterior circumference of the central portion. A key-plug 46 in the top of the block 42, cooperating with the groove 44, locks the counter body 20 against longitudinal motion and acts as a stop defining two rotational positions of the counter body 20.

At the bottom of the block 42 is an aperture 48 in which is inserted a removable bushing 50. As illustrated in Figs. 4 and 5 the bushing 50 is a tubular member with an enlarged knurled flange 52 at the lower end thereof. The bushing 50 has external threads 54. The threads 54 are divided into 4 equally spaced sectors, with gaps slightly greater than 45° therebetween, to constitute a bushing thread which cooperates with a similar internal threading of the block 42 so that the bushing 50 may be inserted into the aperture 48 with the threads out of alignment and tightened into position by slightly twisting the bushing 50 to mesh the threads. The flange 52 has a radial aperture through which extends a setscrew 56 which presses against a key-pin 58 through the medium of a spring 60.

A cylindrical piston sample-holder 62, illustrated in detail in Figs. 6 and 7, having an outer diameter corresponding to the inner diameter of the bushing 50, extends upward therethrough, and has a flange 64 at the bottom to facilitate manual reciprocation of the sample-holder 62 in the bushing 50. The sample-holder 62 has a vertical slot 66 on the exterior surface thereof which cooperates with the key-pin 58 to define a raised and lowered position of the sample holder 62 in the bushing 50, the spring 60 exerting sufficient pressure to prevent the sample-holder from falling to the lowered position from the raised position, but not to interfere with easy manual reciprocation of the sample-holder in the bushing 50. An annular gasket 68 within an annular slot in the lower surface of block 52 is compressed between the flange of the bushing 50 and the block 42 to form a gas-tight seal.

The counter body 20 has a radial aperture 70 somewhat larger than the diameter of the sample holder 62. In the rotational position of the counter body 20 herein called the operating position, the table 72 of the sample-holder 62 may be inserted into the counter body, or may be withdrawn therefrom as illustrated by the dotted position of the sample-holder 62 in Fig. 3. The upper portion of the aperture 48 in the block 42 is of the same diameter as the aperture 70 in the counter body 20, as more clearly appears in Figs. 8 and 9.

The table 72 of the sample-holder 62 has threaded bores 80 in the surface thereof to permit fastening of a radioactive sample thereto. The sample-holder 62 is hollow beneath the table 72 so that the counter illustrated may be used in counting neutron-induced fissions in a sample placed on the table 72; the hollow sample-holder permits relatively free passage of neutrons from a source disposed below the sample-holder 62 to the sample placed on the table 72, and fission fragments are ejected within the gaseous ionizing medium of the counter.

When the sample-holder 62 is in the withdrawn position, the counter body 20 may be rotated to the other extreme position defined by the key-plug 46 and groove 44, herein called the loading position. In this position the aperture 70 is out of alignment with the aperture 48, and there is thus formed between the table 72 and the counter body 20 a cavity 82 as more clearly shown in Figs. 10 and 11. The cavity 82 is preferably sealed by a grease which is smeared lightly on the inner surface of the aperture 40 and of the bushing 50 prior to assembly. A gas port aperture 84 communicates with the aperture 40 in the block 42 at a position rotationally remote from the bushing 50. A second gas port aperture 86 enters the block 42 from the exterior and communicates with the aperture 48 at a point above the bushing 50. Each of the gas ports 84 and 86 is provided externally with a nipple 88, the port 86 being connected to a gas source 90 of a pressure slightly greater than atmospheric, illustrated schematically in Fig. 2. The exhaust port 84 is connected to the atmosphere through a flow meter, which is not illustrated because it constitutes no part of the present invention. The counter body 20 has in the wall thereof a port 92 circumferentially spaced from the sample-receiving aperture 70 by an angle corresponding to the angular spacing between the port 84 and the aperture 48 in the block 42. The counter body 20 also has on the exterior surface thereof a longitudinal groove port 96 having an inner end which is well within the aperture 40 in the block 42 and an outer end which extends beyond the face of block 42.

When the counter body is in the operating rotational position, the sample-receiving aperture 70 and the port 92 in the counter body 20 coincide with the aperture 48 and the gas-port 84 in the block 42, respectively, as illustrated in Figs. 8 and 9. In this position the groove port 96 is connected only to the outer atmosphere.

When the counter body 20 is in the other position, the loading position, the sample-receiving aperture 70 and the port 92 in the counter body 20 are sealed, thus completely sealing the interior of the counter body 20 as illustrated in Figs. 10, 11, and 12. In this position the groove port 96 connects the cavity 82 with the exterior.

The structure of the embodiment of the invention having now been described, the operation and advantages may readily be understood. Prior to loading of a sample into the counter, the counter body 20 is in the loading position so that the interior is sealed. The bushing 50 and the piston sample-holder 62 are removed and the sample whose radioactivity is to be measured is placed on the table 72. The bushing 50 is then locked into place by means of the threads 54, with the sample-holder 62 in the withdrawn or

lowered position. A certain amount of air will be trapped in the cavity **82** when the sample is inserted. However, the volume of the cavity **82** is extremely small compared with the volume of the counter body **20** and the gas entering through the port **86** and being exhausted through the groove port **96** will accordingly sweep out the air so introduced in a time extremely short compared to the time which would be required to sweep out the same amount of air from the interior of the counter body **20** at the same rate of flow. It has been found that the sweeping-out action is sufficiently fast so as to require virtually no waiting by the operator before proceeding to place counter body **20** in the operating position.

When the counter body **20** is rotated to the operating position, the sample-holder **62** may be pushed upward to its raised position to maximize the efficiency of the counter in counting the particles emitted by the sample. The flow of gas is then from the port **86** through the interior of the counter body **20** and out through the port **92** and the port **84** to the exterior. Thus a constant flow of gas occurs during the counting operation.

Upon conclusion of the counting operation, the sample-holder **62** is pulled to its lower position and the counter body **20** rotated to the loading position, thus again sealing up the counter. The bushing **50**, bearing the sample holder **62**, is again removed and a new sample may be loaded into the counter. There is thus afforded by the invention a counter which is susceptible of extremely rapid operation, requiring no waiting after insertion of a sample for the flushing out of air which is introduced during the insertion of the sample.

Although there is illustrated in the drawing and described above a proportional counter embodying the invention in a form in which it is believed that its advantages are maximized, it will readily be seen that many of the features can readily be adapted to other uses and purposes than that herein described without departing from the spirit and teachings of the invention. For example, the provision of a small cavity similar to cavity **82** for introduction of the sample without the introduction of air into the counter body may obviously be utilized in counters which do not require the continuous flowing of gas therethrough, but have a static gaseous ionizing medium. Likewise it is obvious that although the circular configuration of the sliding contact between the counter body and block is considered to be the most simple and convenient, nevertheless other forms of sliding block and counter body may be employed, as may other types of valves. It is equally obvious that although the novel bushing and sample-holder illustrated are considered to be of great advantage, persons skilled in the art will readily devise analogous apparatus for accomplishing the same purpose. Many other modifications and improvements of the invention, some equally obvious, and others apparent on study, will be devised by persons skilled in the art for use of the invention under various conditions of service. Accordingly the scope of the invention should not be limited by the embodiment or equivalents herein described, but shall be deemed to be limited only by the appended claims.

What is claimed is:

1. In a radiation counter, in combination: an electrode-containing counter body; a sample-holding assembly having a cavity adjoining the counter body and adapted to receive a radioactive sample; a closeable gas-sealing connection between the cavity and the interior of the counter body; and means for flowing gas through the cavity; whereby air entering said cavity during the insertion of a radioactive sample therein is flushed out of said cavity and prevented from entering the counter body.

2. In a radiation counter, in combination: an electrode-containing counter body and a slide block in gas-tight sliding abutment therewith and having a loading position and an operating position with respect thereto; a cavity in the slide block adapted to receive a radioactive sample, said cavity communicating with the interior of the counter body only in the operating position; and gas flow ports connecting the cavity and the counter body in series flow connection with the exterior in the operating position and connecting only the cavity in series flow connection with the exterior in the loading position; whereby air entering said cavity during the insertion of a radioactive sample therein is flushed out of said cavity in the loading position.

3. In a radiation counter, in combination: an electrode-containing counter body and a slide block in gas-tight sliding abutment therewith and having a loading position and an operating position with respect thereto; a cavity in the slide block adapted to receive a radioactive sample, said cavity communicating with the interior of the counter body only in the operating position; and gas flow ports in the slide block providing a gas flow path through the cavity in the loading position; whereby air entering said cavity during the insertion of a radioactive sample therein is flushed out of said cavity in the loading position.

4. In a radiation counter, in combination: an electrode-containing counter body and a slide block in gas-tight sliding abutment therewith and having a loading position and an operating position with respect thereto; a cavity in the slide block adapted to receive a radioactive sample, said cavity communicating with the interior of the counter body in the operating position; and gas flow ports in the counter body and in the slide block connecting the cavity and the counter body in series flow connection with the exterior in the operating position, and providing a gas flow path through only the cavity in the loading position; whereby air entering said cavity during the insertion of a radioactive sample therein is flushed out of said cavity in the loading position, the sample may thereafter be inserted into the counter body without introducing air, and gas is flowed through the counter body in the operating position.

5. In a radiation counter, in combination: a counter body; a slide block in gas-tight sliding abutment with the exterior of the counter body and having an operating position and a loading position with respect thereto; an aperture in the wall of the counter body; a cavity in the slide block, said cavity in the slide block communicating with the aperture in the wall of the counter body only in the operating position; means for inserting a radioactive sample into said cavity; a gas inlet passage communicating with said cavity in at least the loading position; and a gas escape port communicating with said cavity in only the loading position.

6. In a radiation counter, in combination: a cylindrical electrode-containing counter body; a

collar block; the cylindrical body being journalled in the collar block and having at least two rotational positions therein; at least one gas inlet aperture in the counter body and in the collar block; and at least one gas outlet aperture in the counter body and in the collar block; said inlet apertures and outlet apertures being respectively aligned in the first rotational position to provide a gas flow path through the body and being out of alignment in the second rotational position to seal the body.

7. In a radiation counter, in combination: a gas filled electrode-containing counter body; a slide block in gas-tight sliding abutment therewith and slideable between at least two positions with respect thereto; at least one gas inlet aperture in the counter body and in the slide block; and at least one gas outlet aperture in the counter body and in the slide block; said inlet apertures and outlet apertures being respectively aligned in the first position to provide a gas flow path through the body and being out of alignment in the second position to seal the body.

8. In combination with a radiation counter body containing a plurality of electrodes and a gas as the ionizing medium: an intermediate chamber adjoining said body; a closeable opening in said chamber for introducing a radioactive sample into said chamber; means for removing from the chamber air entering in each introduction; and a closeable opening between the chamber and the counter body.

9. In combination with a radiation counter body containing a plurality of electrodes and a gas as the ionizing medium: an intermediate chamber adjoining said body; a closeable opening in said chamber for introducing a radioactive sample into said chamber; a closeable gas outlet from the counter body; a gas inlet to the chamber; a closeable gas outlet from the chamber; a closeable opening between the chamber and the counter body and valve means having two positions; said closeable gas outlet from the counter body and said closeable opening between the chamber and the counter body being closed, and said closeable gas outlet from the chamber being opened, in one of said positions; said gas outlet from the counter body and said opening being opened, and said gas outlet from the chamber being closed in the other of said positions.

10. In combination with a radiation counter having a sample-receiving aperture in a wall thereof: a bushing fastenable in the aperture and having an axial aperture and a piston slideably reciprocable in the said axial aperture and having an end adapted to bear a radioactive sample, whereby the position of the sample within the counter may be adjusted by reciprocation of the piston.

11. In combination, a radiation counter having an aperture in the wall thereof and a piston slideably reciprocable in the aperture and having an end adapted to bear a radioactive sample, whereby the position of the sample within the counter may be adjusted by reciprocation of the piston.

12. The combination of claim 11 wherein the piston is cup-shaped so that bombardment of the sample with nuclear particles from the exterior is relatively unobstructed.

13. In a radiation counter, in combination: a counter body; a gas outlet port in the wall of the counter body; a slide block in gas-tight sliding abutment with the exterior of the counter body and having an operating position and a loading position with respect thereto; an aperture in the wall of the counter body; a cavity in the slide block; said cavity in the slide block communicating with the aperture in the wall of the counter body in the operating position; said cavity in the slide block being out of communication with said aperture in the wall of the counter body in the loading position; means for inserting a radioactive sample into said cavity; a gas inlet passage communicating with said cavity in both of said positions; a gas escape port communicating with said cavity in only the loading position; and a gas outlet port in the slide block communicating with the gas outlet port in the counter body in only the operating position.

14. In a radiation counter, in combination; a counter body; a slide block in gas-tight abutment with the exterior of the counter body and having an operating position and a loading position with respect thereto; a sample-holder; an aperture in the wall of the counter body adapted to receive the sample-holder; an aperture in the slide block adapted to slideably receive the sample-holder; said aperture in the slide block being aligned with the aperture in the wall of the counter body in the operating position; said aperture in the slide block being out of alignment with said aperture in the wall of the counter body in the loading position so as to form a closed cavity within said aperture in the slide block in said position when the sample-holder is partially inserted; a gas inlet port in the slide block connecting the exterior with said cavity in both of said positions; a gas escape port connecting the exterior with said cavity in only the loading position; and a gas outlet port in the counter body, said port communicating with the exterior only in the operating position.

15. In a radiation counter, in combination: a counter body; a gas outlet port in the wall of the counter body; a slide block in gas-tight abutment with the exterior of the counter body and having an operating position and a loading position with respect thereto; an elongated sample-holder; an aperture in the wall of the counter body adapted to receive the sample-holder; an aperture in the slide block adapted to slideably receive the sample holder; said aperture in the slide block being aligned with the aperture in the wall of the counter body in the operating position; said aperture in the slide block being out of alignment with said aperture in the wall of the counter body in the loading position so as to form a closed cavity within said aperture in the slide block in said position when the sample-holder is partially inserted; a gas inlet port communicating between the exterior and said cavity in both of said positions; a gas escape port communicating between the exterior and said cavity in only the loading position; and a gas outlet port in the slide block communicating between the exterior and the outlet port in the counter body in only the operating position; said gas outlet port in the counter body being blocked by said slide block in the loading position.

16. In a radiation counter, in combination: a counter body; a gas outlet port in the wall of the counter body; a slide block in gas-tight abutment with the exterior of the counter body and having an operating position and a loading position with respect thereto; an elongated sample-holder; an aperture in the wall of the counter body adapted to receive the sample-holder and of a size greater than the sample-holder to form a gas-flow passage around the sample-holder when it is inserted in said aperture; an aperture in the slide block

adapted to slideably receive the sample holder; said aperture in the slide block being aligned with the aperture in the wall of the counter body in the operating position; said aperture in the slide block being out of alignment with said aperture in the wall of the counter body in the loading position so as to form a closed cavity within said aperture in the slide block in said position with the sample-holder partially inserted; a gas inlet port communicating with said cavity in both of said positions; a gas escape port communicating with said cavity in only the loading position; and a gas outlet port in the slide block communicating with the gas outlet port in the counter body in only the operating position.

17. In a radiation counter, in combination: a cylindrical counter body; a mounting block having an aperture corresponding to the outer diameter of the counter body; the counter body being mounted within said aperture and rotatable between an operating position and a loading position; an aperture in the counter body and a cavity adapted to receive a radioactive sample in the mounting block, said aperture and cavity being connected in the operating position and unconnected in the loading position, the sample being enclosed in the cavity in the loading position; a gas inlet passage connected to said cavity in both positions; and a gas exhaust passage connected to said cavity in only the loading position; whereby said cavity is flushed out by gas in the loading position, and the radioactive sample may be introduced without the introduction of air into the counter body.

18. In a radiation counter, in combination: a cylindrical counter body; a mounting block having an aperture corresponding to the outer diameter of the counter body; the counter body being mounted within said aperture and rotatable between an operating position and a loading position; a gas outlet port in the counter body and a gas outlet port in the mounting block, said ports being aligned in the operating position and out of alignment in the loading position; an aperture in the counter body and a cavity adapted to receive a radioactive sample in the mounting block, said aperture and cavity being connected in the operating position and unconnected in the loading position, the sample being enclosed in the cavity in the loading position; a gas inlet passage connected to said cavity in both positions; and a gas exhaust passage connected to said cavity in only the loading position; whereby said cavity is flushed out by gas in the loading position, and the radioactive sample may be introduced without the introduction of air into the counter body.

19. In a radiation counter, in combination: a cylindrical counter body; a mounting block having an aperture corresponding to the outer diameter of the counter body; the counter body being mounted within said aperture and rotatable between an operating position and a loading position; an aperture in the counter body and an aperture in the mounting block, said apertures being aligned in the operating position and out of alignment in the loading position; a bushing

insertable in the aperture in the mounting block and adapted to bear a radioactive sample, whereby the sample is enclosed in a cavity defined by the bushing, the aperture in the mounting block, and the wall of the counter body in the loading position; a gas inlet passage connected to said cavity in both positions; and a gas exhaust passage connected to said cavity in only the loading position; whereby said cavity is flushed out by gas in the loading position, and the radioactive sample may be introduced without the introduction of air into the counter body.

20. In a radiation counter, in combination: a cylindrical counter body; a mounting block having an aperture corresponding to the outer diameter of the counter body; the counter body being mounted within said aperture and rotatable between an operating position and a loading position; a gas outlet port in the counter body and a gas outlet port in the mounting block, said ports being aligned in the operating position and out of alignment in the loading position; a radial aperture in the counter body and a radial aperture in the mounting block, said apertures being aligned in the operating position and out of alignment in the loading position; a bushing insertable in the aperture in the mounting block and adapted to bear a radioactive sample, whereby the sample is enclosed in a cavity defined by the bushing, the aperture in the mounting block, and the wall of the counter body in the loading position; a gas inlet passage connected to said cavity in both positions; and a gas exhaust passage connected to said cavity in only the loading position; whereby said cavity is flushed out by gas in the loading position, and the radioactive sample may be introduced without the introduction of air into the counter body.

21. In a radiation counter, in combination: a counter body; a slide block abutting the counter body and being slideable thereon between an operating position and a loading position; a gas outlet port in the counter body and a gas outlet port in the slide block, said ports being aligned in the operating position and out of alignment in the loading position; an aperture in the wall of the counter body and an aperture in the slide block, said apertures being aligned in the operating position and out of alignment in the loading position; a bushing insertable in the aperture in the slide block and adapted to bear a radioactive sample, whereby the sample is enclosed in a cavity defined by the bushing, the aperture in the slide block, and the wall of the counter body in the loading position; a gas inlet passage connected to said cavity in both positions; and a gas exhaust passage connected to said cavity in only the loading position; whereby said cavity is flushed out by gas in the loading position, and the radioactive sample may be introduced without the introduction of air into the counter body.

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