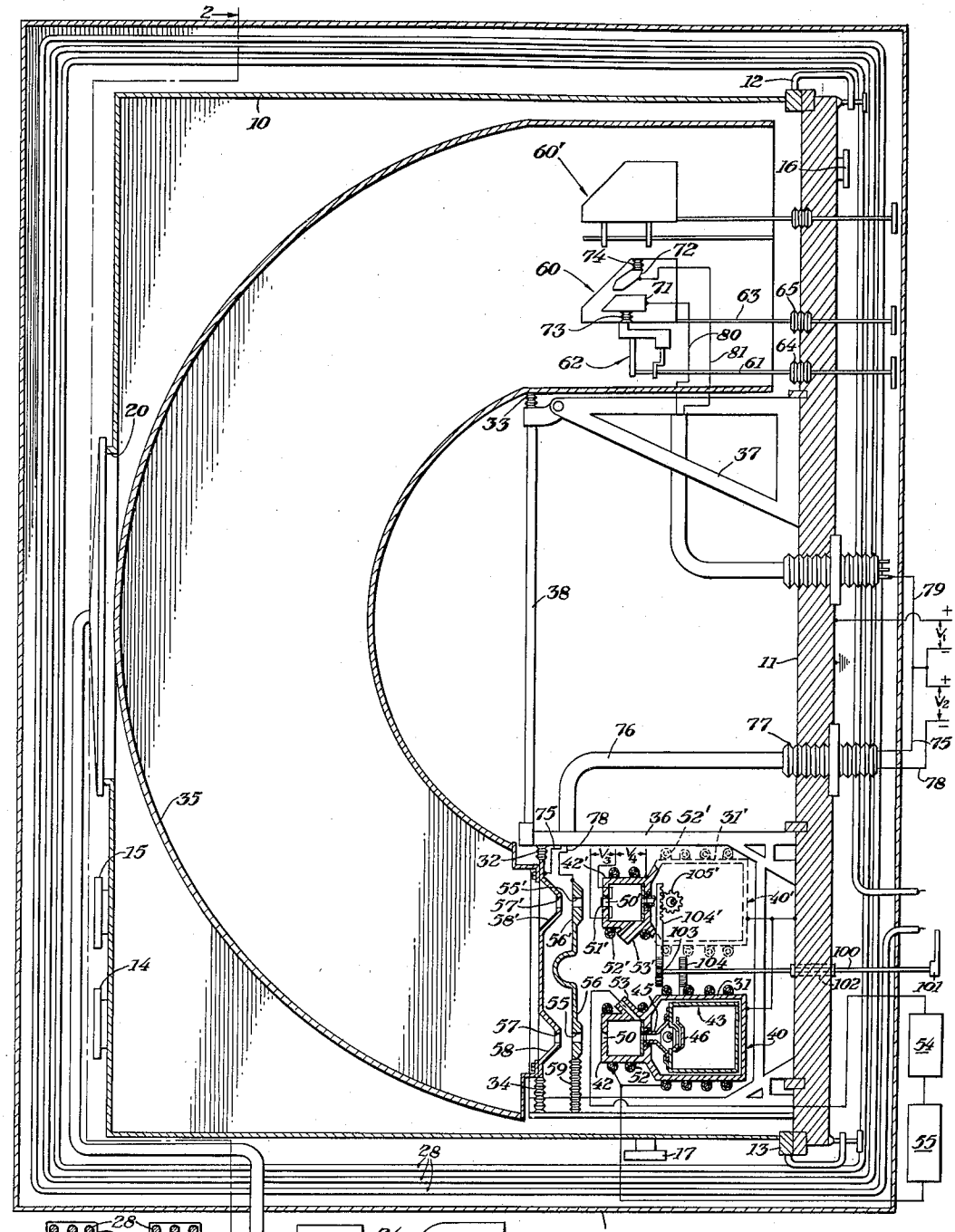
Sept. 20, 1955 P. J. GALBREATH ET AL 2,718,235

VALVE DEVICE FOR ISOTOPE SEPARATING APPARATUS

Filed May 22, 1945 2 Sheets-Sheet 1



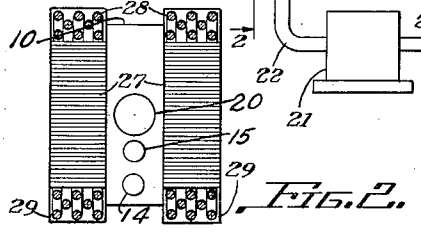


FIG. 1.

FIG. 2.

INVENTORS.
Paul J. Galbreath
William C. Tunnell
BY
Robert A. Lavender
Attorney

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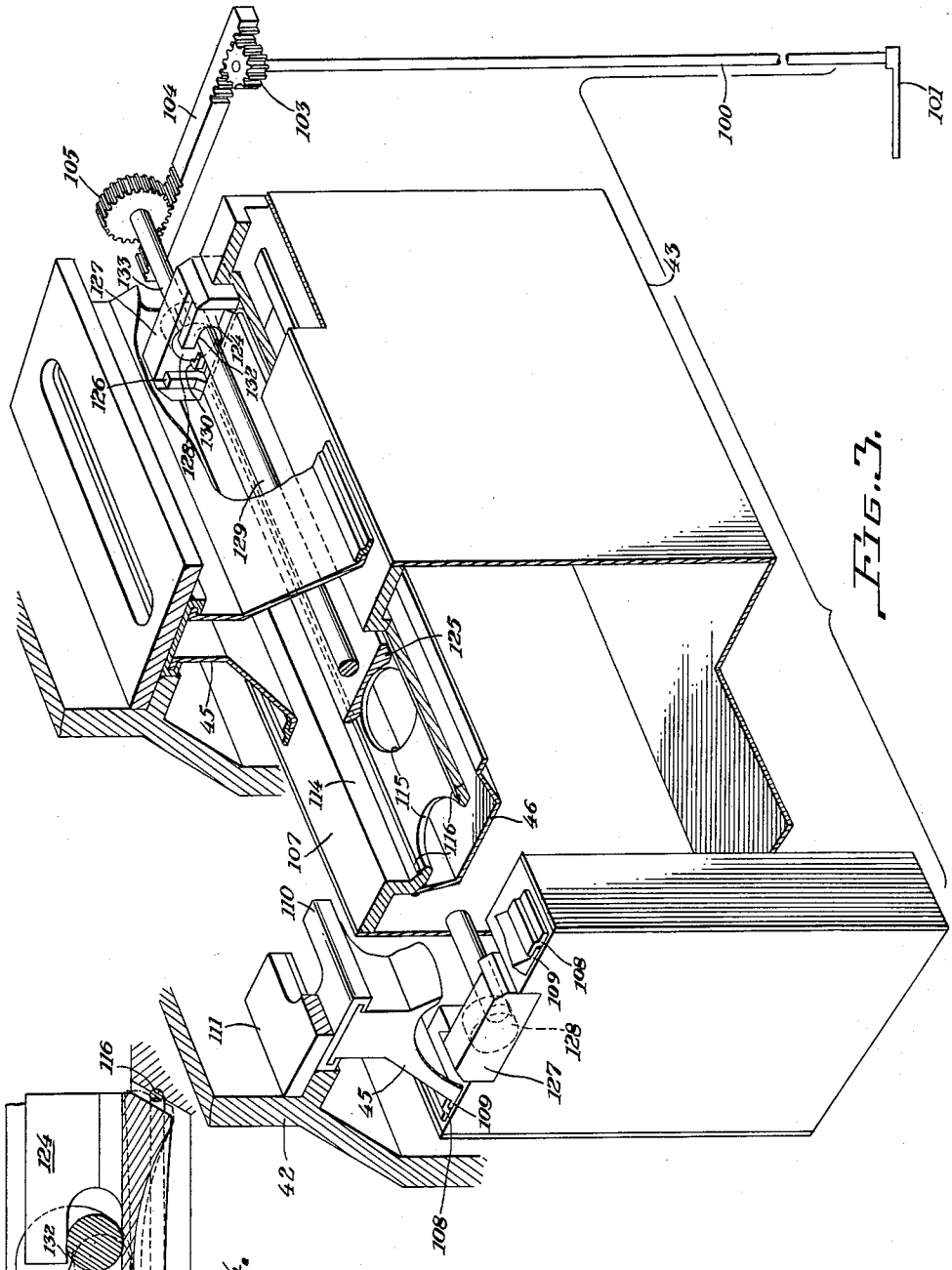


FIG. 3.

FIG. 4.

INVENTORS.
Paul J. Galbreath
William C. Tunnell.
BY
Robert A. Lavender
Attorney

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2,718,235

VALVE DEVICE FOR ISOTOPE SEPARATING APPARATUS

Paul J. Galbreath and William C. Tunnell, Oak Ridge, Tenn., assignors, by mesne assignments, to the United States of America as represented by the United States Atomic Energy Commission

Application May 22, 1945, Serial No. 595,195

4 Claims. (Cl. 137—376)

This invention is concerned with improvements in isotope separating apparatus and particularly involves improved arrangements for regulating the ion source in such apparatus.

In known types of apparatus used for separating the isotopes of a material, for example in the type of apparatus disclosed in detail in the application of Ernest O. Lawrence, Ser. No. 557,784, filed October 9, 1944, now patent No. 2,709,222 the apparatus has embodied therein an ion source comprising a chamber for volatilizing a material therein, the isotopes of which it is desired to separate, the chamber having an elongated opening or slit from which or through which the volatilized material emerges or is emitted during ionization thereof. In order to secure proper and efficient ionization, it is desirable to regulate the flow of volatilized material to the ionization region to an optimum rate dependent upon a number of other variable operating conditions of the system. It is an object of our invention to provide a valve or regulating device for regulating the supply of volatilized material so that it is fed uniformly along the length of the ionization region, at an optimum rate.

Another object is to provide a valve or regulating device as in the preceding object which is built into a charge bottle or container for the material to be ionized, which is removable from the apparatus for recharging, the valve serving as a closure for the charge bottle when it is removed from the apparatus.

Another object is to provide a valve or regulating device as in the previous objects so arranged that it can be conveniently operated from outside of the isotope separating apparatus which is vacuum tight.

Another object is to provide a valve comprising an elongated valve member and operating means attached to the member at spaced points and arranged to be operable to move the valve member uniformly along its length toward and away from the port.

Another object is to provide a valve operator as in the preceding object consisting of an eccentrically mounted shaft parallel to the valve member and attached to it so that by turning the shaft mountings the shaft moves the valve member toward or away from the port.

Another object is to provide a valve member adapted to seat on a valve seat insert and arranged to be sprung or deformed by pressure thereon applied by an overcenter member in such a manner that the overcenter member latches the valve in seated position.

Another object is to provide an arrangement as in the previous object wherein the valve member is elongated and the overcenter member is an eccentrically mounted shaft parallel thereto.

Further objects of the invention and numerous of its advantages will become apparent from the following detailed description and annexed drawing wherein Fig. 1 is a diagrammatic cross-sectional view of an isotope separating apparatus embodying an ion source with the regulating mechanism of our invention associated therewith.

Fig. 2 is a diagrammatic sectional view taken along

the line 2—2 of Fig. 1 showing the relationship of the magnetic field producing means to the chamber within which is the isotope separating apparatus.

Fig. 3 is a perspective view of a charge bottle and the valve regulating mechanism of our invention with the parts rotated to the right substantially through 90° from the position in which they are shown in Fig. 1, and with some of the parts partly broken away.

Fig. 4 is a cross-sectional view of the valve member and seat.

The apparatus of Fig. 1 is of the type disclosed in greater detail in the prior application referred to above. The apparatus of Fig. 1 includes a tank **10**, the interior of which is evacuated to a relatively high degree of vacuum as will presently be described. The tank **10** is shown in cross-section, and one side is closed by a relatively heavy face plate **11** which is attached to the tank by means of screw clamps **12** and **13**, there being provided suitable bearing surfaces on the face plate **11** and on the tank **10** so that when the face plate **11** is clamped in position it engages the tank in sealing relationship so as to insure against loss of vacuum at the joint. All of the mechanism within the tank **10** is attached to and carried by the face plate **11** as will presently be explained.

The tank **10** has windows **14**, **15**, **16** and **17** so as to make it possible to watch operations within the tank and there is a large discharge outlet **20** through which the air and moisture in the tank are evacuated. The discharge outlet **20** is connected to a diffusion pump or pumps **21** by a pipe **22** and the diffusion pump is connected to a mechanical pump or pumps **23** by a pipe **24**. The mechanical pump **23** may be a Kinney pump, for example, which is a rotary type of pump. In practice a liquid nitrogen trap may be used in the tank **10** for freezing out moisture or it may be associated with the pipe **22** connected to the diffusion pump. Also, a trap using solidified carbon dioxide may be used in association with the pipe **24** for freezing out moisture from the air before it reaches the pump **23**.

The tank **10** is disposed between laminated iron cores or pole pieces **27** as shown in cross-section in Fig. 2 and surrounding these pole pieces are electrical windings **28**, the windings being disposed within tanks or housings **29**, one of the housings **29** being shown in cross-section in Fig. 1. The windings **28** are energized with electrical current so that a relatively intense magnetic field is produced which is in a direction transverse to the tank **10**, that is, in a horizontal direction looking at Fig. 2 and in a direction perpendicular to the paper looking at Fig. 1. A cooling medium such as cooled oil or the like is circulated through the housings **29** for the purpose of cooling the coils therein.

Within the tank **10** is a liner structure **35** in the form of an arcuate conduit which forms a passageway for a beam or beams of ions generated at the lower end of the liner and received in a receiver or collector at the upper end of the liner. The liner **35** and the apparatus associated therewith are carried by the face plate **11** by means of a supporting structure designated by the numerals **36** and **37** and the brace member **38**. The liner itself is attached to and spaced from the supporting structure by insulators **34**, **32** and **33**, since, as will presently be disclosed, the liner is maintained at a different potential than the supporting structure. Within the lower right hand corner of the tank **10** there are a pair of castings **40** and **40'** which form containers within which the material to be ionized is vaporized. The castings **40** and **40'** may be supported from the supporting structure **36**. The castings **40** and **40'**, and the apparatus associated with each are identical (except that there is a single manual operating mechanism associated with both of them as will be pointed out), so

that the description of one applies to the other as well. For the sake of clearness, some details are shown in connection with only one of the castings and other details are shown only in connection with the other casting.

The castings 40 and 40' comprise lower portions 31 and 31' and smaller upper portions 42 and 42', the upper portion in each instance being connected to the lower portion by a converging throat as shown. Within the portion 31, referring to casting 40, is a container or bottle 43 which is removable and in which the charge material itself is placed, that is, the charge of material to be ionized. The material to be ionized is vaporized in bottle 43 and it passes around a baffle 46, through a valve built into the upper part of bottle 43 and through a chimney 45 in passing from the lower part 31 of casting 40 into the smaller upper part 42. The valve mechanism in bottle 43 is shown in enlarged perspective in Fig. 3. The valve mechanism associated with each of castings 40 and 40' as will be described, is operable from outside of tank 10 by a handle 101 on stem 100 which extends through Wilson seal 102 in face plate 11. Stem 100 has a pinion gear 103 on its end which can mesh with and operate either of racks 104 and 104'. (See Fig. 3). Racks 104 and 104' also mesh with and operate pinion gears 105 and 105' and the resulting operation of the valve mechanisms will presently be described. Pinion gear 103 can be made to mesh with either rack by sliding stem 100 vertically in Wilson seal 102, rack 104' being over pinion 105' and rack 104 being below pinion 105.

Referring to casting 40', the upper portion 42' has an elongated slit or opening 50', and adjacent this elongated opening 50' is a filamentary cathode 51', across the terminals of which a suitable voltage is impressed when the apparatus is in operation as will presently be described. The function of the cathode 51' in operation is to emit a stream of electrons into and along the slit 50', the electrons being collimated into a beam under the influence of the magnetic field previously described and serving to bombard the vapor passing through the slit for the purpose of ionizing the vapor. Slit 50 of course has a corresponding cathode not shown.

Numeral 52, referring to casting 40, designates an electrical heating element or heating elements associated with casting 40 which supply heat for volatilizing the charge material within the bottle 43. In the side wall of the smaller portion 42 of casting 40 there is a well 53. Electrical controls are provided for electrically controlling the supply of power for energizing the heating elements 52. The electrical controls for heating element 52, as shown, are responsive to a thermocouple which is placed in the well 53, and these controls may preferably include the control known as the Micromax manufactured by the Leeds and Northrup Company; this control is designated by the numeral 54 and the thermocouple in well 53 is connected to it. The instrument 54 is connected to a control instrument 55 which is a type of instrument which operates to control the flow of electric power to the heating elements 52 and it may preferably be the control instrument known as the Reactrol manufactured by the General Electric Company. The control instrument 55 is connected to the heating elements 52 as shown.

Referring to casting 40', there is to the left of it, that is, above it so to speak, a member 56' which may preferably be made of carbon and which has therein a slot or elongated opening 55' parallel to the slit 50' so that ions of the vapor emitted through the slit 50' can pass through the slit 55' in member 56'. The member 56' constitutes an electrode which serves as an accelerating electrode for positive ions emerging through the slit 50', and this electrode is maintained at a relatively high negative potential as will presently be described. It is attached to the corresponding electrode 56 and they both are supported from insulator 59.

The ions which are emitted from slit 50' and which are accelerated by the electrode 56' pass to the left, that is, upwardly through another slit 57' in a member 58' having a throat-like configuration and which also forms an electrode which may preferably be made of carbon. This electrode is also maintained at a relatively high negative potential but lower than the potential of the electrode 56'. Positive ions after passing through the throat of member 58' pass into the liner structure 35, and then travel in arcs of a circle around through the liner to the receiving structure at the opposite side of the liner; the positive ions move in arcs of a circle in this manner under the influence of the magnetic field previously described, and the radii of the arcs depends on the mass-charge properties of the ionized particles. Member 58' and the corresponding member 58 are connected and attached to liner 35 as shown.

There are two identical receiving chambers or collectors at the upper end of the liner structure 35, one of them being designated by the numeral 60. The receiving chamber 60 is in the form of a box having a shape which in cross-section is shown in Fig. 1. The receiver or collector 60 may be adjusted laterally relative to the face plate by a stem 61 operating through linkages 62, and it may be adjusted in and out relative to the face plate by means of stem 63, the stems passing through suitable sealing devices 64 and 65 respectively associated with the face plate 11. The collector 60 has electrodes 71 and 72 therein which are so located as to have certain components of the beam of ions which travels around through the liner 35, impinge therein or thereon, electrode 71 being in the form of a pocket. Electrodes 71 and 72 are supported by insulators 73 and 74 as shown. Different components of the beam, that is, particles thereof having different mass-charge properties travel in circles of different radii as described above and come to a focus at different radial distances from their point of origin. In operation of the apparatus, the magnetic field is so adjusted and the collector 60 is so adjusted relative to the face plate 11 that the isotopes which it is desired to collect impinge upon the desired receiving element. The desired isotopes may be recovered by removing the deposits which collect on or in the electrodes 71 and 72.

The face plate 11 is grounded as shown, as are the castings 40 and 40', and the liner 35 and the electrodes 58 and 58' are maintained at a relatively high negative potential V_1 by conductor 75 which is led into the interior of the tank through a conduit 76 which extends through the face plate 11 through a sealing insulator bushing 77. The electrodes 56 and 56' are maintained at a higher negative potential V_1+V_2 by means of a conductor 78 which is also led into the tank through the bushing 77 and the conduit 76. The electrodes 73 and 74 are maintained at the potential V_1 by means of conductors 79, 80 and 81. The conductors leading to the electrodes in the collector 60 extend through a conduit and bushing similar to those for the conductors 75 and 78 as shown. A potential V_3 is connected across the terminals of cathode 51' and a potential V_4 is impressed between the negative terminal of cathode 51' and ground, that is, the casting 40'. This last potential sustains the arc which is struck within slit 50' during operation.

Various of the parts of the mechanism within the tank 10 may be cooled as desired or necessary by a suitable cooling system and shielding may be provided at appropriate points to protect the mechanism from becoming coated as a result of being contacted by the vapor from the charge bottle, and for protection against deterioration which may necessarily result from the process.

Summarizing the operation of the apparatus as so far described, the operation is that the charge material in the bottles is vaporized by the electric heating elements 52 (and 52', speaking of the casting 40'), and the vaporization is automatically controlled by the thermo-

couples in the wells 53 and 53'. The vapor passes upwardly into the upper portion 42' of the casting (speaking of casting 40') where it is maintained in vapor state by the portion of heating element 52' associated therewith, and the vapor then passes out or upwardly through the slit 50' where it is ionized by the stream of electrons from the cathode 51', these ionizing electrons being in the form of an arc struck in the slit 50' under the influence of voltage V_4. Positive ions are attracted from the region of the slit by electrode 56' which is maintained at a high negative potential, and under the influence of electrode 58', the ions pass into the liner structure 35 and thence travel in arcs of a circle around to the collector 60', the radii of the arcs depending upon the mass-charge properties of the ionized particles. The collector is adjusted as described so that the desired isotopes of the ionized material are received in the collector pockets.

Our invention is primarily concerned with the control of the flow of volatilized material into the ionization region. As previously pointed out the flow of vaporized material into the ionizing region is controlled by the valves built into the upper part of the charge bottles within the castings 40 and 40'. The charge bottle 43 with its built in vapor control valve is shown in detail in Fig. 3. As shown, the charge bottle 43 is a rectilinear container and it has a top designated by numeral 107 which has brackets or ears 108 at its corners which engage flanges 109 at the lower part of chimney 45. The charge bottle 43 is thus removably suspended from chimney 45 by brackets 108 and it may be removed, that is, slid out endwise from within casting 40 and similarly inserted. Chimney 45 has outwardly extending flanges at its top which engage in a channel member 110 which is attached by welding to plate 111. Plate 111 rests on the bottom of portion 42 of casting 40, as shown in Figs. 1 and 3, and channel member 110 is in the opening between portions 31 and 42 of casting 40. Member 110 and plate 111 have openings as shown aligned with the throat in chimney 45 to permit vapor to pass upwardly therethrough.

Member 107 has a central longitudinal depressed portion indicated at 114 and the flat bottom of the depressed portion has a series of ports 115 in it, which constitute valve ports. The depressed portion 114 has vertical side walls, as shown, connected by slanting portions to the flat bottom portion and embedded in the slanting portion is a gold wire 116 which forms a valve seat insert.

Numeral 125 designates a valve member which is an elongated rectilinear member having slanting surfaces on its under side which can engage the valve seat insert wire 116 so as to form a seal preventing flow of vapor through the ports 115 and up into the chimney 45 (See Fig. 4). The valve, as can be seen in Fig. 3, is directly over the baffle 46 previously described. The valve member 125 has upstanding guide legs or posts 126 at opposite ends which engage with and are guided by a channel or way formed in insert blocks as shown at 127 which fit into the depression 114 at the end of the charge bottle 43. At each end of the valve member 125 there is formed a bayonet slot 132 in an upstanding portion 124 which forms the guide like guide post 126 which is guided in the channel formed in block 127. Each of the block members 127 forms a journal or bearing for a disc 128 and numeral 129 designates a shaft which extends between the discs 128 and is eccentrically attached to them, that is, off center of the discs. The shaft 129 engages in slots 132 so that valve member 125 is suspended from the shaft by portions 124 of the valve member. Stops are provided as indicated at 130 to limit movement of shaft 129.

The disc 128 at one end of the charge bottle 43 is connected to pinion 105 by shaft 133 and the pinion 105 meshes with the top side of the rack 104 as shown, the pinion gear 103 meshing with teeth on the side of rack 104.

By moving stem 100 until pinion 103 engages rack 104 and turning the handle 101 from outside of the tank 10 (see Fig. 1), stem 100 is rotated and this rotates pinion gear 103 which moves the rack 104 one way or the other so as to rotate the pinion gear 105. When pinion gear 105 rotates, it rotates the disc 128 through shaft 133 and thus if the pinion gear 105 is rotated counterclockwise looking at Figures 3 and 4, disc 128 rotates similarly and shaft 129 moves to the right and upwardly looking at Fig. 3. By reason of its engagement in bayonet slots at the ends of valve member 125, the valve member 125 is gradually lifted uniformily all along its length so as to permit passage of vapor between the valve member and the valve seat insert 116. In this manner the flow of vapor through the ports 115 can be controlled throughout the length of the charge bottle 43 so that vaporized material to be ionized is uniformly fed to the chamber 42 at the upper part of the castings 40 and into the region in which ionization takes place. The bayonet slots 132 at the ends of valve member 125 permit shaft 129 to move laterally relative to the valve member while the valve member is guided in its movement toward and away from the valve parts by guide posts 126 and portions 124 moving in the channels formed in blocks 127.

When the charge of material in the charge bottle 43 has been fully exhausted the valve can be completely closed by turning handle 101 so that valve member 125 securely fits down on the valve seat insert 116 cutting off all flow through the ports 115. Thus, when discs 128 turn clockwise, looking at Figs. 3 and 4, shaft 129 moves downwardly and to the left, and it engages valve member 125 along its length and springs or deforms its central portion downwardly, the parts having the positions shown in dotted lines in Fig. 4 as shaft 129 moves past the center of valve member 125 against stops 130. In this position the shaft is held by the force exerted by the valve member urging it against the stops and the valve is thus latched closed. The charge bottle 43 can then be removed from within the casting 40 for recharging, the pinion gear 105 disengaging from the rack 104. If desired, the shaft 133 may be square at its end, fitting into a square socket in the disc 128 so that when the charge bottle 43 is removed the shaft 133 merely disengages from the socket. Thus, the valve serves as a closure member for the charge bottle whenever the charge bottle is removed from the isotope separating apparatus for recharging or other purposes.

From the foregoing those skilled in the art will observe that we have provided a valve mechanism whereby the rate of flow of volatilized material to be ionized can be very nicely regulated so that the rate of flow can be set to an optimum value at which the most efficient operation can be had considering the other variable factors on which efficient operation depends. The valve itself serves as a closure member for the charge bottle so that no other closure apparatus is necessary when the charge bottle is removed and the charge bottle can thereby be kept closed at all times except when operating.

The foregoing is representative of the preferred form of our invention. It is intended that the disclosure be interpreted in an illustrative rather than a limited sense, the scope of the invention being determined only in accordance of the claims appended hereto.

We claim:

1. In apparatus of the character described, in combination, means forming a container having an opening therein forming a valve port, a valve cooperable therewith and forming a closure for the container, and means forming an enclosure arranged to have said container removably mounted therein, said enclosure having valve operating means positioned and arranged to operably connect with said valve when the container is mounted in the enclosure.

2. In a valve mechanism, means having an elongated valve port, an elongated resilient valve member cooperable therewith, valve operating means comprising a shaft parallel to said valve member and substantially co-extensive in length therewith, a rotatable drive member and means comprising a crank connecting said drive member to said shaft, a pair of horizontally slotted members fixedly attached to said valve member at its ends, said shaft being engaged by the slots of said slotted member, a pair of fixedly positioned guide members adjacent the ends of said valve member so as to guide its movements toward and away from the valve port, said valve member having an upwardly projecting lug adapted to limit movement of said shaft with respect to said valve member to lock said shaft in an over-center position wherein the valve member is held fixed in seated position.

3. In apparatus of the character described, in combination, a container, means forming an enclosure arranged to have said container removably mounted therein, said container having an opening therein forming a valve port, a resilient valve member operably associated with said valve port, and a valve operating mechanism carried by said container and operable upon actuation to cause said valve member to move toward or away from said port, said mechanism being positioned and arranged to apply pressure to an intermediate portion of said valve member causing said valve member to flex when seated, said mechanism having an over-center position wherein said valve member is held flexed in seated position, said enclosure means having valve positioning control means positioned and arranged to operably connect with said valve operating mechanism when the container is mounted in the enclosure.

4. In apparatus of the character described, in combination, a container, means forming an enclosure arranged to have said container removably mounted therein, said container having an opening therein forming a valve port, a resilient valve member operably associated with said valve port, and a valve operating mechanism carried by said container and operable upon actuation to cause said valve member to move toward or away from said port, said valve operating mechanism comprising a shaft parallel to said valve member and rotatable means having said shaft eccentrically attached thereto so that by rotating the rotatable means the shaft is moved bodily, said shaft being positioned and arranged to apply pressure to an intermediate portion of said valve member causing said valve member to flex when seated, said shaft having an over-center position wherein said valve member is held flexed in seated position, said enclosure means having valve positioning control means positioned and arranged to operably connect with said rotatable means when the container is mounted in the enclosure.

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