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VAPOR ELECTRIC DEVICE WITH INSULATORS PROTECTED AGAINST METALLIZATION

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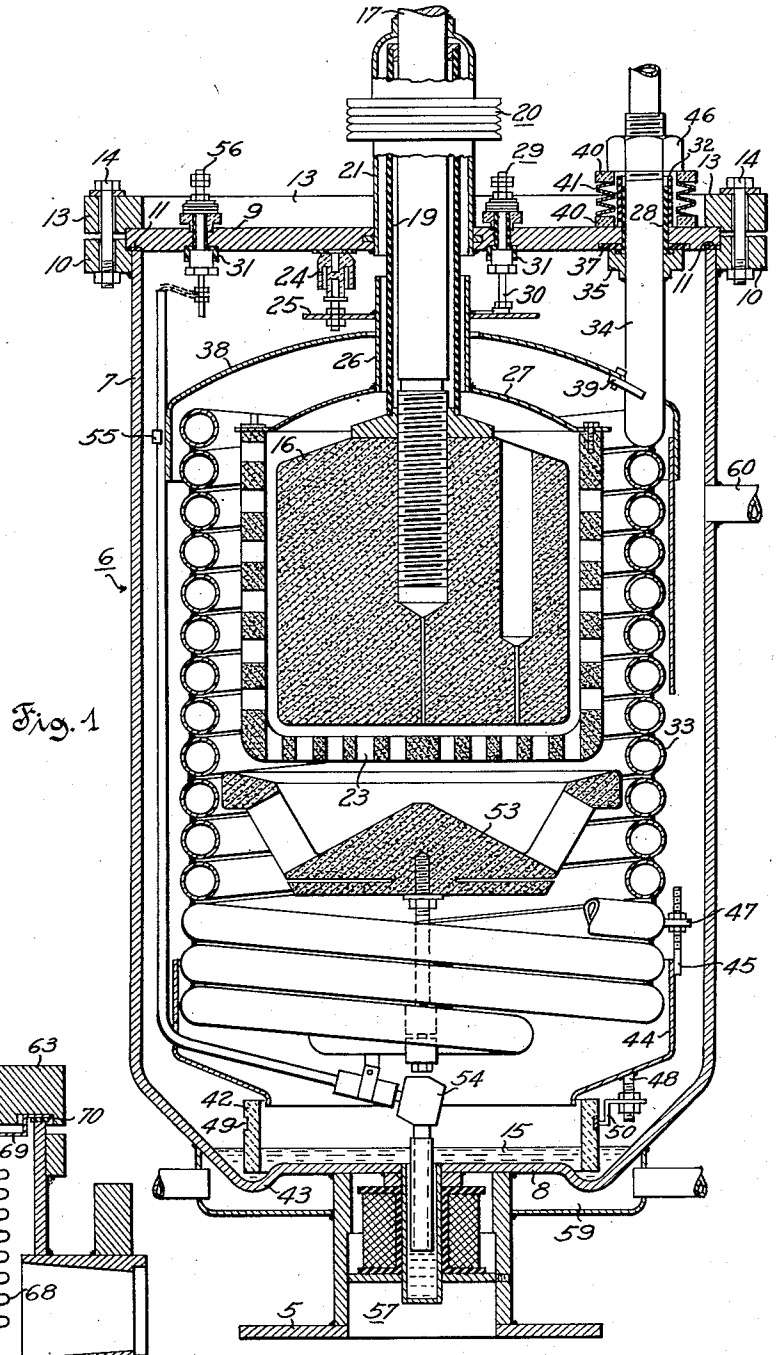


Fig. 1

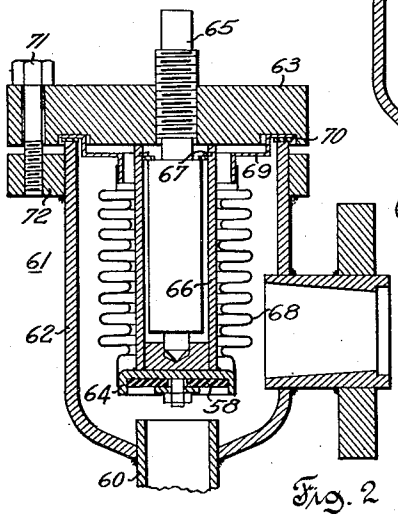


Fig. 2

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VAPOR ELECTRIC DEVICE WITH INSULATORS PROTECTED AGAINST METALLIZATION

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7 Claims. (Cl. 313—33)

This invention relates generally to the construction of vapor electric devices, particularly to electric valves of the single anode, metal enclosed, vapor filled type.

It is an object of the present invention to provide an improved vapor electric device.

Another object of the invention is to provide a vapor electric device having a removable anode plate in which the disposition of the vacuumtight seals substantially precludes leakage through defects in the plate.

Another object of the invention is to provide a vapor electric device of the single anode type in which an insulating ring for the cathode pool is removable from the casing along with the anode plate.

Another object of the invention is to provide a vapor electric device of the single anode type in which insulation for control elements is disposed outside the space wherein arcing may occur.

The novel features of this invention as well as the objects above set forth will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a view in vertical cross section through a single anode type vapor electric device embodying the present invention; and

Fig. 2 is an enlarged view in vertical cross section of a vacuum valve integral with the device shown in Fig. 1.

Referring more particularly to the drawing by characters of reference, the vapor electric device illustrated in Fig. 1 is an electric valve of the single anode type comprising a substantially cylindrical cup shaped tank or casing 6 made of a conducting material such as steel. The casing has a side wall 7, a closed bottom 8, and a top closed by a disk shaped anode plate or cover 9.

A flange 10 welded to the outside of wall 7 extends beyond the open end of the casing. A gasket 11 made of a suitable material such as rubber or polytetrafluoroethylene, is disposed on the top of wall 7, and cover 9 is disposed on the gasket and aligned on the top of the casing by the flange 10. The gasket seals the cover in gas tight relation to the casing wall when the gasket is compressed by means clamping the cover 9 to the wall 7. Such clamping means comprises a clamping ring 13 seated on the top surface of the cover. Ring 13 has an outside diameter larger than that of cover 9 and equal to the outer diameter of flange 10 which it overlies. A plurality of bolts 14 secure ring 13 to flange 10 to hold cover 9 in position and to compress gasket 11 between the top of wall 7 and the bottom of cover 9.

A cathode 15 for the device comprises a pool of mercury or other suitable vaporizable conductive material disposed in the bottom of the casing. The support 5 serves as a cathode terminal. The bottom of the casing is tapered to reduce the diameter of the pool of mercury.

The cover 9 carries a main anode 16 of graphite which depends therefrom into the casing. The electrical lead for the anode 16 comprises a conductor shaft 17 supported in a bushing which extends through the cover 9 and insulates the conductor therefrom. The bushing comprises a tube 19 of ceramic material disposed as a shield about the conductor. A laminated vitreous seal assembly 20 including a steel tube 21 disposed about the tube 19 and welded at its lower end to the bottom surface of the cover 9 provides a gas tight seal therewith and insulates the anode conductor from the cover 9.

A control electrode or basket type grid 23 is arranged spaced about anode 16 for controlling the flow of current between anode 16 and cathode 15. The grid has perforations to permit passage of arc discharge between anode and cathode. The grid is supported from cover 9 by a plurality of grid insulators 24 having studs at opposite ends fastened to cover 9 and to steel plate 25 which is integral with a tubular steel conductor 26 disposed about tube insulator 19. Grid insulators 24 comprise a main body portion receiving the end mounting studs and a petticoat portion which forms a deep narrow slot with the main body portion. The depth of the narrow slot is several times the width of the slot so the slot will prevent deposition therein of a continuous film of conductive material which would connect grid 23 to casing 6. Tubular conductor 26 is made integral with a substantially spherical conductive flange 27 connected to the perforated graphite grid portion and forming the upper unperforated portion thereof.

Potential for grid 23 is furnished from an outside source through a terminal 29 mounted in cover 9. Terminal 29 comprises a conductive stud 30 provided with an enlarged portion within the casing. A sleeve 31 of insulating material, such as polytetrafluoroethylene, shaped to fit about the stud forms an insulating bushing therefor extending through the cover 9. The enlarged portion of the stud forms a shoulder which extends beneath the bottom surface of the cover. The portion of sleeve 31 disposed between the shoulder and the bottom surface of the cover forms a gasket which is compressed when the bushing is secured in position. The stud 30 of terminal 29 is connected to plate 25 to electrically connect it with the grid.

Cooling and condensing means for the electric valve comprise a cooling coil 33 constructed of steel pipe wound as two helixes interleaved with each other and joined by a common connection. The space between adjacent turns is determined so as to make the coil pervious to the flow of mercury vapor across the turns but impervious to arcing. The free ends of the coil connect with conduits 34, only one of which is shown, which support the coil and extend through the cover 9. Means are provided which resiliently support each conduit 34 from cover 9 and secure the conduit in gastight and insulated relation to cover 9. Such means comprise a sleeve 28 of suitable insulating material disposed between the conduit and cover 9. A collar 35, within the casing, is welded along its lower surface to conduit 34 in gastight relation therewith. A gasket 37 of suitable insulating material such as polytetrafluoroethylene is disposed between collar 35 and the bottom surface of cover 9 and is compressed by collar 35 to complete the gastight seal between conduit 34 and cover 9. An insulating tube 32 is disposed about the conduit 34 and the extension of the sleeve 28 above cover 9. Assembled on cover 9 in superposed relation about tube 32 are an insulating washer 40, a spring 41, another insulating washer 40, and a nut 46 threaded to conduit 34. Spring 41 comprises a plurality of dished steel washers stacked one upon the other with their concave sides alternately reversed. Nut 46 is screwed on conduit 34 to compress spring 41 and secure collar 35 against the bottom of cover 9. Gasket 37, sleeve 28, and washers 40 cooperate to insulate conduit 34 from cover 9.

An inverted cup shaped shield 38, which may be made of half sections, is disposed over the grid 23 and extends about the upper portion of coil 33. Conduits 34 extend through shield 38 and by means of suitable clamps 39 provide support for the shield. Shield 38 has a central aperture through which conductor tube 26 extends with a small gap between the shield and grid conductor tube 26. Shield 38 prevents arcing between anode and casing above the uppermost turn of coil 33. In normal operation of the vapor electric device, arcing will cause vaporization of a little iron from some of the elements of the device. Such vaporized iron condenses and settles on various elements and metallizes them by forming a film thereon. This film is conductive and its formation on the grid insulators therefore should be prevented. Shell 38 shields grid insulators 24 and grid terminal insulation 31 from the active space of arc discharge in which iron particles are present.

The cathode area is limited by an arc impervious insulator ring 42, made preferably of quartz, which is partially immersed in the mercury pool 15. The bottom of the tank 8 is formed with an annular depression 43 so the bottom of ring 42 is immersed in mercury below the level of the tank bottom. A collector 44 extends the arc impervious shielding provided by coil 33 and insulator ring 42. Collector 44 is sheet metal in a funnel shape adjustably supported from coil 33 by a plurality of studs 45 welded to the collector and bolted to lugs 47 welded to the coil 33. The converging portion of collector 44 is disposed within insulating ring 42 and serves to return material vaporized from the cathode pool and condensed by coil 33 back to the cathode area.

Means secured to the outside of the collector 44 and to the outside of the insulation ring 42 support the ring 42 from the collector. A gap between the collector and the ring provides insulation therebetween and the gap is small so it restricts the flow therethrough of material vaporized from the cathode pool to prevent deposit of metal particles on the surfaces of the ring facing the collector and on the outside surfaces of the ring. This gap therefore prevents the formation of a continuous film or layer of such conductive particles between ring 42 and collector 44. The means secured to the collector and insulation ring comprise studs 48 welded to the outside of collector 44 and supporting members 50 inserted in an annular groove 49 in the outside wall of ring 42. Members 50 receive studs 48 for supporting and adjusting the axial spacing of the ring 42 from the collector 44.

A baffle 53 of conductive material such as graphite is supported axially below grid 23 on the cross connection of cooling coil 33. Baffle 53 serves to aid in the control of the paths of the arc discharge between anode and cathode and of the flow material vaporized from the cathode.

An excitation anode 54 is pivotally supported from the cross connection of coil 33. The insulated lead in for excitation anode passes through an aperture in collector 44, is supported from shield 38 by a clamp 55, and electrically connects to a stud 30 of a terminal 56, similar to terminal 29, mounted in cover 9. Thus, the cover 9, cooling coil 33, main anode 16, grid 23, baffle 53, excitation anode 54, shield 38, collector 44, and insulation ring 42 constitute an integral subassembly which may be assembled outside of the casing and inserted as a unit within the casing 6.

Below the cathode is a starting device 57 of the electromagnetic type which operates to connect the cathode pool with the excitation anode to ignite an arc at the cathode. The starting device comprises a plunger disposed in a cylindrical well in the bottom of the casing. The plunger comprises a square shaped steel tube with a round graphite rod secured therein which engages the cathode mercury when its upper end contacts the ignition anode. The square shaped plunger in the cylindrical well provides symmetrical spaces therebetween for mercury displaced

by movement of the plunger to flow past the plunger and thus prevent sticking of the plunger in the well.

The cathode is cooled by means of a water jacket 59 on the bottom 8 of the casing 6. This water jacket surrounds the housing for solenoid 57.

Means for evacuating the casing of the device are provided and comprise a conduit 60 penetrating the side of casing 6 and welded thereto. Conduit 60 is connected to a manually operated vacuum valve 61, Fig. 2, which is connected to a suitable evacuating pump, not shown.

Vacuum valve 61 comprises a cylindrical housing 62 having a removable top 63. Housing 62 is integral with conduit 60 which has an end within the housing forming a valve seat closable by a valve head 64 having a gasket seat 53 of suitable material such as polytetrafluoroethylene. Valve head 64 is actuated to open or closed position by a shaft 65 axially aligned with the end of conduit 60 and extending through top 63 in which it is supported in threaded engagement. The lower end of shaft 65 is tapered to a point bearing against the valve head 64. Valve head 64 is supported from a steel tube 66 disposed about shaft 64. A retaining ring 67 secured to the inside of said tube overlies a retaining washer seated on a shoulder of the shaft 64 to support the tube and valve head. The valve head is sealed against the housing 62 by means of a steel bellows 68 disposed about tube 66 and having one end secured to the valve head 64 and the other end secured to a cover 69. Cover 69 is made of a suitable thin sheet material such as spun steel and seats on a gasket 70 disposed on the top of housing 62. Top 63 is clamped on the housing by a plurality of cap screws 71 engaging a flange 72 welded to the outside of housing 62 to compress gasket 70 and cover 69 between housing 62 and top 63 to provide a vacuum tight seal between the housing and the cover. Bellows 68 is secured in vacuum tight relation to flange 69 and valve head 64, thereby enclosing valve shaft 65 in vacuum tight relation to housing 62.

Cover 9 for the device has joints all made vacuum tight by sealing means comprising gaskets or welds in contact with the bottom surface of cover 9 so that laminations or voids within the material of cover 9 cannot bypass the sealing means to impair the vacuum within the casing 6. Laminations or voids within the material of top 63 of vacuum valve 61 cannot impair the vacuum thereof because top 63 serves not as a cover but as part of the clamping means holding cover 69 and gasket, 70 compressed against the valve housing 62. The vacuum-tight enclosure for the valve 60 comprises housing 62, gasket 70, and bellows assembly including cover 69 which is made of material which does not have defects such as laminations or voids.

Although but one embodiment of the present invention has been shown and described, it will be apparent to one skilled in the art that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In a vapor electric device, the combination of an evacuated casing comprising metallic parts including a removable cover, a pool of vaporizable conductive material serving as a cathode disposed in the bottom portion of said casing in conductive relation thereto, an anode disposed above said cathode within said casing and supported from said removable cover in insulated relation thereto, a condenser supported from said cover in insulated relation thereto and disposed about said anode and the space between said anode and said cathode in substantially insulated relation to said casing and said anode, a shield mounted on said condenser about the upper end of said condenser, collector means adjustably supported from the lower portion of said condenser for returning to said pool material vaporized therefrom and condensed by said condenser, and an insulating ring partially immersed in said pool to define the cathode

area of said pool, means secured to said collector means to support said insulating ring spaced therefrom, whereby said insulating ring is removable from said casing with said cover.

2. In a vapor electric device, the combination of an evacuated casing including a tank and a removable cover therefor, a gasket disposed between the bottom surface of said cover and the top surface of the side wall of said tank, means clamping said cover to said tank compressing said gasket to maintain said tank and said cover in vacuumtight relationship, a pool of vaporizable conductive material serving as a cathode disposed in the bottom portion of said casing in conductive relation thereto, an anode disposed above said cathode within said casing, a conductor supporting said anode from said cover and insulated with respect thereto, a condenser having conduits extending through said cover, a flange integral with said conduit within said casing, a gasket disposed between said flange and the bottom surface of said cover, and means causing said flange to compress said gasket against said cover to secure said conduit in vacuumtight relationship and to support said condenser about said anode in substantially insulated relation to said casing and said anode, said condenser being pervious to the flow of vaporized cathode material but impervious to the passage of an arc, a plurality of terminals mounted in said cover and each having a shoulder within said casing, means securing each said terminal in vacuumtight relation with said cover comprising a gasket disposed between said terminal shoulder and the bottom of said cover, a grid disposed between said condenser and said anode, means supporting said grid from said cover comprising a plurality of insulators secured to said cover, a sleeve disposed about said conductor and supported from said insulators, said grid being connected to one of said terminals through said sleeve, an insulating ring partially immersed in said pool of vaporizable material to define the cathode area of said pool, a collector supported from said condenser to return vaporized material condensed by said condenser to said cathode area of said pool, and means comprising said collector for supporting said insulating ring spaced from said collector.

3. In a vapor electric device, the combination of an evacuated casing comprising a removable cover, a pool of vaporizable conductive material serving as a cathode disposed in the bottom portion of said casing in conductive relation thereto, an anode disposed above said cathode within said casing and supported from said removable cover in insulated relation thereto, a condenser supported from said cover in insulated relation thereto and disposed about said anode and the space between said anode and said cathode in substantially insulated relation to said casing and said anode, an insulating ring partially immersed in said pool to define the cathode area of said pool, a collector supported from said condenser for returning to said cathode area of said pool material vaporized therefrom and condensed by said condenser, means secured to the outside of said collector and to the outside of said insulating ring to support said insulating ring about the lower portion of said collector to define a gap therebetween which restricts the flow therethrough of material vaporized from said cathode pool and to prevent the deposit of conductive material on the surfaces of said ring facing said collector and on the outside surfaces of said ring, said support for said insulating ring providing for removal of said insulating ring with said cover from said casing.

4. In a vapor electric device, the combination of an evacuated casing comprising metallic parts including a tank and a removable cover therefor, a gasket disposed between the bottom surface of said cover and the top surface of the side wall of said tank, means removably clamping said cover to said tank to compress said gasket so as to provide a vacuumtight seal between said tank and said cover, an anode, a bushing supporting said anode from said cover in insulated relation thereto, said bushing comprising a member welded to the bottom portion of said cover in vacuumtight relationship therewith, a condenser disposed about said anode, means supporting said condenser from said cover comprising inlet and outlet conduits each provided with a flange below said cover, gaskets disposed between said conduit flanges and the bottom surface of said cover, said supporting means causing said flanges to compress said conduit gaskets against said cover to provide vacuumtight relationship between said conduits and said cover, a terminal stud mounted in said cover, means securing said stud in vacuumtight relationship with said cover comprising a shoulder on said stud within said casing, and a gasket compressed between said shoulder and the bottom surface of said cover, an evacuation valve connected to said casing for removing noncondensable gases therefrom, said valve comprising a housing, a removable cover and a gasket disposed between the bottom surface of said cover and said flange and secured in vacuumtight relationship, whereby said cover for said valve and said cover for said tank casing have joints made vacuumtight at the bottom surfaces of said covers so that laminations or voids within the material of said covers will not impair said vacuum.

5. In combination, a vapor electric device comprising a casing connected to a vacuum valve through which said casing is evacuated, said casing comprising a tank and a removable anode plate closing the top of said tank, a gasket disposed between the bottom surface of said anode plate and the top surface of said tank, means removably clamping said anode plate on said tank causing said gasket to seal said anode plate in vacuumtight relationship to said tank, a plurality of elements extending through said anode plate, each of said elements having a shoulder in said tank and a gasket disposed between said shoulder and the bottom surface of said anode plate, means securing said elements to said anode plate to cause said gaskets to seal said elements in vacuumtight relationship with said anode plate, said vacuum valve comprising a housing and a removable cover, a gasket disposed between the bottom surface of said cover and the top surface of said housing, and means removably securing said cover on said housing to hold said cover in vacuumtight relationship with said housing, whereby laminations or voids in the material of said anode plate and said cover will not impair the vacuum of said vapor electric device.

6. A vapor electric device, comprising a casing in which vacuum is maintained comprising metallic parts including a tank and a removable cover therefor, a gasket disposed between the bottom surface of said cover and the top surface of the side wall of said tank, means removably clamping said cover to said tank to compress said gasket so as to provide a vacuumtight seal between said tank and said cover, a plurality of members extending through said cover, each said member having a gasket disposed against the bottom surface of said cover, and means adjacent said members compressing said gaskets against the bottom surface of said cover, whereby said cover has all joints made vacuumtight at the bottom surface thereof so that laminations or voids within the material of the cover will not impair said vacuum.

7. A vapor electric device, comprising an evacuated casing comprising a removable cover, a pool of vaporizable conductive material serving as a cathode disposed in the bottom portion of said casing in conductive relation thereto, an anode disposed above said cathode within said casing, a conductor supporting said anode and extending through said cover and secured in insulated relation thereto, a condenser having conduits extending through said cover and secured in insulated relation thereto, said conduits supporting said condenser about said anode in substantially insulated relation to said casing and said anode, said condenser being pervious to the flow of vaporized cathode material, a grid disposed between said con-

denser and said anode, means supporting said grid from said cover in insulated relation thereto comprising an insulator secured to said cover and a sleeve supported from said insulator and connected to said grid, said sleeve disposed about said anode conductor and spaced therefrom, a terminal insulatedly secured in said cover connected to said grid through said sleeve, and a shield mounted on said condenser and disposed between said grid and said grid insulator and said grid terminal to form an arc impervious barrier shielding said grid insulator and said grid terminal from the active region of the vapor electric device.

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