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VACUUM TUBE

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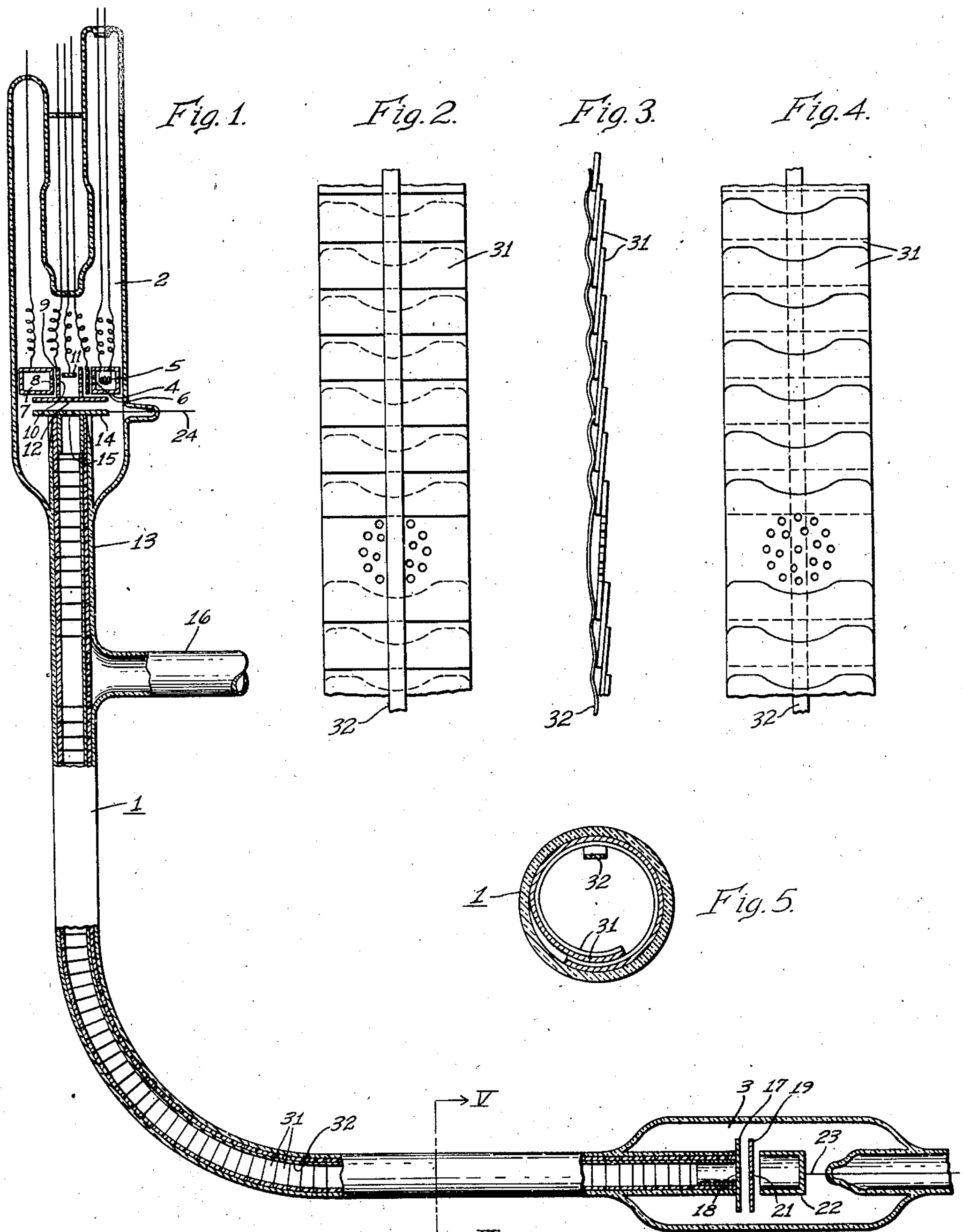

WITNESSES:

C. J. Weller.

INVENTOR

John A. Hipple, Jr.

BY

F. W. Lyle

ATTORNEY

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VACUUM TUBE

John A. Hipple, Jr., Forest Hills, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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My invention relates to vacuum tubes and in particular relates to an arrangement for providing an electrostatic shield adjacent the interior surface of portions of vacuum tube structures.

For many purposes it is desirable to provide a path for electrons or other charged particles travelling in the interior of the vacuum tubes which shall be shielded from the effects of electrical fields set up in the neighborhood of the tube walls. Thus, for example, mass spectrometers are used in which single molecules of various materials are given electric charges and are then accelerated to considerable velocities to move through a magnetic field. The latter causes the charged particles to follow a curved path, the radius of curvature of which is proportional to the square root of the molecular mass. In this way molecules of different gases, or even isotopes of the same gas, which have different masses are caused to move in paths of different radius, and this makes it possible to segregate from a mixture of different molecules any one set having the same mass. Economy of size in the vacuum tube employed for this purpose makes it desirable to make it in the form of a curved tube of length considerable relative to its diameter. But, however, if the charged molecules were allowed to be acted upon by stray electrical fields emanating from objects in the vicinity of the tube they would be deflected from the curve in which molecules of a particular mass would otherwise be caused to traverse by the magnetic field and confusion in the observation and segregation of the charged molecules would result. The action of the molecules of such stray electrical fields emanating from objects in the neighborhood of the tube can be substantially eliminated if the curved tube along the action of which the molecules are to travel is given walls having a substantially electrical conductivity. While it is possible to make such curved tubes to form portions of a high vacuum-tight enclosure, difficulty is nevertheless met with from problems from gas occlusion and other causes which make it desirable to employ glass tubes in place of metal. However, the problem is then encountered of coating the interior of the glass wall with some electrical conductor and this problem has been found by experience one of considerable difficulty. A solution which I have found to prove extremely satisfactory is to provide a metallic ribbon having overlapping turns which can be slipped into place as to form a conductive lining for the interior of the tube wall.

One object of my invention is accordingly to provide a convenient and satisfactory method of forming a conductive coating to lie closely adjacent the interior of an insulating tube.

Another object of my invention is to provide an electrostatic shield of a novel type for the interior of an insulating tube.

Still another object of my invention is to provide a metallic lining for the interior of a curved tube of insulating material.

Other objects of my invention will become apparent when reading the accompanying description when taken in connection with the drawing in which

Figure 1 is a view partly in elevation and partly in section of a vacuum tube embodying a shielding device according to my invention.

Figs. 2 to 5 are detailed views used in illustrating the precise structure of the shielding device according to my invention; Fig. 2 being an elevational view from one side; Fig. 3 an edge view; Fig. 4 an elevational view from the opposite side of the shielding device while in the course of construction; and Fig. 5 an enlarged section on the line V—V in Fig. 1.

Referring in detail to Figure 1, a cylindrical tube 1 which may conveniently be made of glass has its axis bent in the arc of a circle and is provided with electrode chambers 2 and 3 at its opposite ends. For purposes of illustration of my invention I apply it to a mass spectrometer such as has been referred to above. This consists of a cathode chamber 4 containing a suitable thermionic filament 5 or other source of electrons and having a slit 6 in its wall through which such electrons may travel to the exterior of the chamber 4. A hollow anode 7 attracts electrons emerging through the slit 5 these electrons being accelerated by an electrical field due to a difference of potential maintained between the chamber 4 and anode 7. The anode 7 is provided with an aperture or slit 8 aligned with the aperture 6 in chamber 4 and another electrode 9 which has a horizontal base and a pair of walls normal thereto, each such wall being provided with an aperture or slit 10 aligned with the slits 6 and 8. An electrode 11 nearly fills the space between the walls of electrode 9, thus forming a small box through which electrons attracted by anode 7 pass. The electrode 9 is maintained at a potential a volt or so lower than the electrode 11 and so accelerates positive gas ions formed in this box downward toward an aperture 12 in the floor of this box.

The tube 1 is provided with a metal shield or liner 13 which will be described in more detail below, and the end of liner 13 projecting into chamber 2 is capped with a flanged sleeve 14 leaving a slit 15 aligned with slit 12. The space between the electrodes 9 and 11 contains molecules of gas which it is desired to segregate from each other or otherwise test. Electrons emanating through the slit 8 ionize by impact the molecules just mentioned and a negative potential of about 1000 volts on the electrode gives them an acceleration downward. Some of these molecules pass through the slit 15 into the main body of the tube 1.

The tube 1 is maintained at a considerable degree of vacuum, for example, 10^{-6} mm. of mercury by a pump connected to a lead-off 16. The chamber 3 contains a metallic diaphragm 17 having an aperture slit 18, a second metal diaphragm 19 containing a slit 21 and an electrode 22 which is provided with a lead 23 passing through the tube wall.

The tube thus arranged is placed between the jaws of an electromagnet which sets up a field of nearly normal intensity perpendicular to the plane of Fig. 1. The molecules emerging with a considerable velocity through the slit 15 pass into this magnetic field which is made of as constant an intensity as possible throughout the length of the curved portion of the tube 1. This magnetic field causes the molecules to follow curved paths, all the molecules of the same molecular weight having a path of the same radius, but these radii being different for different groups of molecules which have different molecular weights. By properly adjusting the strength of the field, it is possible to cause molecules of any one selected molecular weight to follow paths having a radius substantially equal to the radius of curvature of the tube 1, and molecules of this particular weight will accordingly pass through the slits 18 and 21 to impinge on the electrode 22. Molecules of other molecular weights will either strike the walls of the shield or liner 13 and be discharged thereon in a manner about to be described or will strike portions of the flanged collar 14 and their charges will be returned by the lead 24 connected by an external circuit to the cathode of chamber 4.

In order to provide shielding of the greater portion of the tube 1 from the effects of external electrical fields, the tube 1 is provided with a liner 13 which is made up in the following way. A piece of metal ribbon, for example, a Nichrome V ribbon, 2 mils thick by ⅝″ wide and preferably unannealed, is cut into numerous pieces 31 each having a length slightly greater than the internal perimeter of tube 1. A strap 32 which may be of Nichrome V ⅛″ wide by 3 mils thick is welded to the successive pieces 31, these overlapping each other as shown in Fig. 3 somewhat like the scales of a fish. The pieces 31 will, for convenience, hereinafter be called "scales". The scales 31 are each slightly reduced in width near the point to which it is welded to the strap.

When the welding is complete the scales 31 are bent one by one and slipped into a straight glass tube so that they line its walls somewhat as shown in Fig. 5. The natural spring of the metal ribbon tends to force the scales against the surrounding glass tube. The straight glass tube is of the same internal diameter as the cylindrical portion of the tube 1. Before the end chambers of the tube 1 are fused into place on the latter the straight glass tube is placed in alignment with one end of the cylindrical portion of tube 1, a wire attached to the liner being fed through the tube 1 and out its opposite end. By drawing on the wire just mentioned, it is possible to draw the liner out of the straight glass tube and into the curved cylindrical portion of tube 1 to form a shield therein. Since the successive scales 31 can slide over each other at their edges, the liner can bend into conformity with the curved cylindrical neck of tube 1 and still form a practically continuous metallic lining for the latter. Holes 33 are preferably provided in advance in the position of the liner which will lie opposite the pump lead 16.

I claim as my invention:

1. A vacuum tube comprising a wall portion of insulating material in the form of a cylinder and a metallic lining for said wall portion comprising a flexible metal strap having fastened thereon a series of overlapping metal scales.

2. A vacuum tube comprising a wall portion of insulating material in the form of a cylinder and a metallic lining for said wall portion comprising a flexible metal strap carrying a series of overlapping scales of elastic metal.

3. A vacuum tube comprising a wall portion of insulating material in the form of a cylinder having a curved axis and a metallic lining for said wall portion comprising a flexible metal strap having fastened thereon a series of overlapping metal scales.

JOHN A. HIPPLE, Jr.