

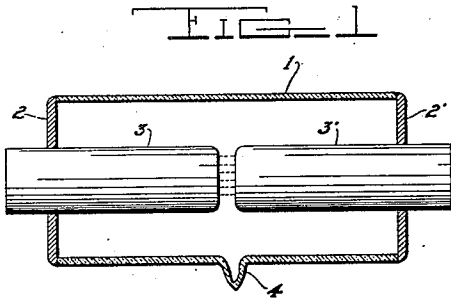
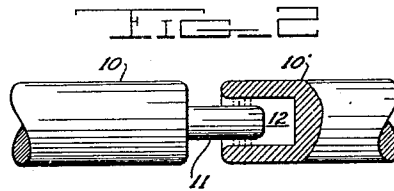
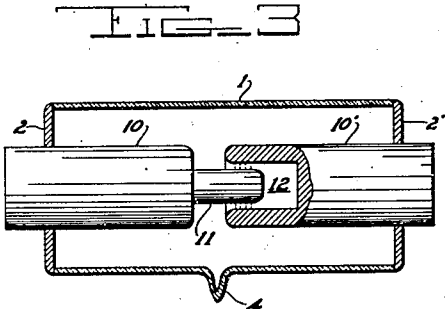
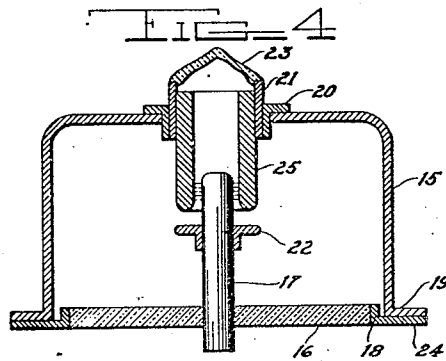
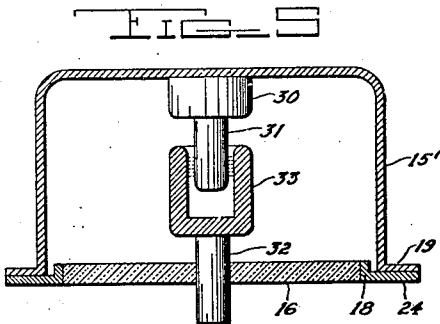
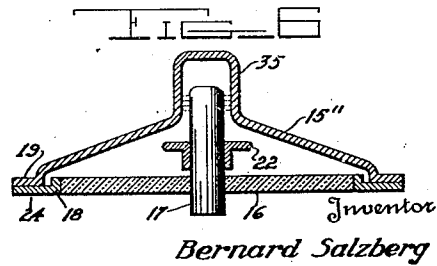
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SPARK GAP TUBE

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SPARK GAP TUBE

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This invention relates to spark gap tubes of the type employed in the duplex operation of antennas.

It is an object of this invention to lengthen the useful life of such tubes.

It is a further object of this invention to render the manufacture of such tubes simpler and cheaper than before.

It is a further object of this invention to provide a spark gap tube so constructed that it will not be subject to the sputtering of electrode material to the non-conducting walls of the tube.

It is a further object of this invention to provide a spark gap tube in which the spark or arc is enclosed by the electrodes.

It is another object of this invention to provide a spark gap tube constructed in a manner which does not necessitate the employment of glass blowers but can be machine made.

It is still another object of this invention to provide a spark gap tube which can be produced in large quantities and at low cost.

Other objects of the invention will become apparent from a careful consideration of the following description when taken together with the accompanying drawing in which:

Fig. 1 is a side elevational view of a known type of spark gap tube in cross section;

Fig. 2 is a fragmentary sectional view of an electrode assembly constructed in accordance with the invention;

Fig. 3 is a view similar to Fig. 1 illustrating the employment of the electrode assembly of Fig. 2 in a spark gap tube of the type shown in Fig. 1.

Fig. 4 is a side elevational view in cross section of a tube constituting one embodiment of the invention, and

Figs. 5 and 6 are views similar to Fig. 4 showing other embodiments of the invention.

Fig. 1 illustrates the main structural features of a conventional spark gap tube which has heretofore been employed for the duplex operation of radio antennas. It consists of a glass tube at the ends of which are sealed metal caps 2, 2'. Spark electrodes 3, 3' pass through the central portions of these metal caps in a gas-tight manner, connection to the external circuits being made at the projecting portions of the caps. The tube is exhausted through the side pipe 4, this pipe being closed off before the tube is removed from the exhausting manifold.

Tubes of this general type suffer from several disadvantages. In the first place it is difficult to maintain close tolerances on the small gap distance required without running into an excessive

percentage of manufacturing rejects. This difficulty is caused by the fact that the two electrodes cannot be held rigidly in position when the seals are made without causing glass strains. Secondly, the useful life expectancy of the tube is considerably reduced by the sputtering of electrode material to the inside wall of the glass envelope during operation of the tube. This tends to form a coating on the inside of the glass wall of the tube which results in increased and objectionable radio frequency losses.

In order to circumvent these difficulties a new electrode assembly has been invented, one form of which is illustrated in Fig. 2. According to the invention the electrodes are so shaped and positioned that the discharge takes place in a radial direction. This is accomplished in Fig. 2 by providing electrode 10 with an end portion 11 of reduced diameter and electrode 10' with a cup-shaped recess 12 in its end portion of a size to receive the reduced end portion 11. The diameter of the portion 11 is smaller than the diameter of the cup-shaped recess by an amount sufficient to form an annular spark gap between the lateral walls of the portion 11 and the cup-shaped recess. As shown in the figure the electrodes are relatively positioned so that this radio distance is much less than the distance between the end of the end portion 11 and the bottom of the cup-shaped recess 12. This feature has two main advantages. There is no difficulty in maintaining the radial spacing between the electrodes during exhaustion of the tube since they may be held within very close tolerances in any device such as a glass worker's lathe which has axial symmetry. Since the discharge takes place in a radial direction it is no longer necessary accurately to control the relative spacing of the two electrodes along the axis. The second advantage derives from the fact that one of the electrodes now surrounds the other in the region where the spark gap is located so that the sputtered material can no longer be deposited on the glass envelope. Instead this material is deposited on the walls of the electrodes where it can have no deleterious effect on the r. f. properties of the tube. The unreduced portion of electrode 10 acts as an effective shield against the deposition on the walls of the tube of the material escaping from the discharge region. This region does not extend out to the end of electrode 10', due to the rounding off of the end edges of that electrode, as shown.

Fig. 3 shows the employment of an electrode assembly of the type shown in Fig. 2 in a tube of the general configuration shown in Fig. 1. The

electrode assembly of the invention can be used in this manner with very satisfactory results in tubes of this general type utilizing a wide range of gases and gas pressures.

Fig. 4 illustrates a novel spark gap tube employing the basic principles of electrode assembly shown in Fig. 2 and embodying further features of the invention which result in a form of tube adaptable to mass production in great quantities and at low cost. In this tube the glass envelope has been replaced by a metal envelope 15 having the shape of an inverted cup. The base of the tube is formed of a glass disc or button 16 through the central portion of which extends a rod-shaped electrode 17 of conventional form. Secured to the rim of the glass disc 16 is an annular metal member 18 of L-shaped cross-section having a relatively wide horizontally extending flange 24 upon which, when the tube is assembled, rests a flange 19 formed on the rim of the cup-shaped envelope 15. It will be noted that the inner diameter of the envelope 15 at its rim is substantially larger than the outer diameter of the vertically extending portion of member 18. This is for a purpose which will appear presently. Formed in the central portion of the dome of envelope 15 is a circular opening into which is fitted an eyelet 20 secured in a gas-tight manner to a tube 21. The horizontally extending portion of the eyelet 20 is likewise secured in a gas-tight manner to the rim of the opening in the envelope 15. Fitted inside tube 21 in a gas-tight manner and extending downwardly into the spark gap tube is a tubular electrode 25. The tube 21 is sealed to the electrode 25. The manner of securing the eyelet 20 to the tube 21 and to the envelope 15 and of forming the other gas-tight metal seals referred to in this application may be by soldering or welding or any other conventional process usually employed for this purpose. It will be noted that a portion of the tube 21 extends above the envelope 15 and that the lower portion of electrode 25 surrounds the upper end of electrode 17. The spark gap is formed between the lateral walls of the enclosed portion of electrode 17 and the portion of the electrode 25 surrounding it. To prevent sputtering of electrode material on to the base 16 an eyelet 22 may be employed as a shield on electrode 17. The metal envelope may have its interior surface silver or copper-plated to reduce r. f. losses.

In assembling the tube, the hole for the reception of electrode 25 is first drilled or punched in the metal envelope 15 and the electrode assembly including tube 21 and eyelet 20 is welded or soldered in place. The disc 16 with its electrode 17 and member 18 already secured in place are next placed under the envelope 15 and a spacing jig consisting of a tubular member having a wall thickness equal to the spark gap distance is inserted in electrode 25 with which it makes a sliding fit. The envelope 15 is then positioned so that the upper end of the electrode 17 extends upwardly within the end of the jig. The internal diameter of the rim of envelope 15 is larger than the external diameter of the vertically extending portion of member 18 by an amount such that considerable play is allowed between envelope 15 and base 16 in accurately aligning the two electrodes. The flange 19 is now secured in a gas-tight manner to the flange 24 by welding or soldering. Exhaustion of the tube is now carried out through tube 21 and when

completed the upper end of the tube is sealed off, usually by glass as shown in 23.

Fig. 5 illustrates another embodiment of the invention. This tube preferably employs the same base 16 with its member 18 and a metal envelope 15' similar to the one of Fig. 4 but having no hole in its upper portion. Instead an electrode 30 having a lower end 31 of reduced diameter is secured in a gas-tight manner to the central portion of the top of envelope 15'. A rod-shaped electrode 32 extends upwardly through the central portion of base 16 through which it passes in a gas-tight manner and has integrally secured to its upper end a cup-shaped member 33 of such size that a spark gap of the proper size is formed between its lateral walls and the lateral walls 31 of the electrodes 30.

In assembling this tube the electrode 30 is first welded or soldered to the envelope 15' and the electrode 32 and member 18 are assembled on the base 16. The envelope and base units are then placed in a centering jig in a bell jar which is then exhausted to the desired amount. Gas is admitted to the bell jar at any desired pressure and a soldered seal is made by high frequency induction between the flanges 24 and 19.

Fig. 6 illustrates an embodiment somewhat similar to that of Fig. 4 but employing a portion of the metal envelope 15' as the second electrode. The envelope is formed in the shape of an inverted shallow conical cup with a tubular upward extension formed in the central portion, the inner diameter of the extension being sufficiently larger than that of the electrode 17 to form the proper sized spark gap. The shielding means 22 and the details of the connection between the envelope and the base are the same as those of the embodiment shown in Fig. 4.

The use of this invention produces a spark gap tube which not only possesses the advantages of a radial enclosed spark gap with its freedom from metal deposits on the non-conducting walls of the tube and its increased ease of assembly with accuracy, but which is also susceptible to high speed manufacture on a mass production basis and at a greatly reduced cost. It also eliminates the necessity for the employment of glass blowers in its manufacture. This is a considerable advantage since the art of glass blowing is known but to comparatively few people whose services are always at a premium. The tubes lend themselves to machine production so that they can be supplied in large quantities and at low cost.

While the disclosure has been limited to only a few embodiments of the invention many changes in form and proportion coming within the scope of the invention as defined by the appended claims will be apparent to those skilled in the art. For example, many variations in the shape of the glass base are possible and satisfactory. Several have been satisfactorily employed, such as dished plates and spherical segments. The latter may be sealed direct to the flange found on the rim of the metal envelope. The scope of the invention is not therefore to be considered as limited by the embodiments herein illustrated and described but only by the scope and limitations of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. A spark gap tube comprising a non-con-

ducting base, a flange or conducting material extending around the outer rim of said base and secured thereto in a gas-tight manner, an electrode passing in a gas-tight manner through said base, an inverted cup-shaped envelope having its rim secured in a gas-tight manner to said flange, and an electrode conductively secured to the top of said envelope and extending in such proximity to said first mentioned electrode as to form a spark gap therewith.

2. A spark gap tube comprising a non-conducting base, a flange of conducting material extending around the outer rim of said base and secured thereto in a gas-tight manner, an electrode passing in a gas-tight manner through said base, said electrode being formed with a cup-shaped recess in its inner end, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said flange, and an electrode conductively secured to the top of said envelope and having its inner end extending into the cup-shaped recess in said first mentioned electrode and so positioned that the region of greatest proximity between said electrodes is that between the side walls of said cup-shaped recess and the side walls of the portion of the other electrode enclosed thereby.

3. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, said electrode having its inner end formed with a cup-shaped recess, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to the rim of said base, an electrode conductively secured to the top of said envelope and having its inner end extending into the cup-shaped recess in said first-mentioned electrode, and being so positioned that the region of greatest proximity between said electrodes is that between the side walls of said cup-shaped recess and the side walls of that portion of the other of said electrodes enclosed thereby.

4. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metallic flange extending around the rim of said base and being connected thereto in a gas-tight manner, said flange extending substantially in the plane of said base, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said flange, said envelope being formed with an opening in its top, a cylindrical tube extending downwardly from and conductively connected to the rim of said opening in a gas-tight manner, said cylindrical tube being coaxial with and surrounding a portion of said electrode and constituting a second electrode and means sealing said opening in a gas-tight manner.

5. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metallic flange extending around the rim of said base and being connected thereto in a gas-tight manner, said flange extending substantially in the plane of said base, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said flange, said envelope being formed with an opening in its top, a cylindrical tube extending downwardly from and conductively connected to the rim of said opening in a gas-tight manner, said cylindrical tube being coaxial with and surrounding a portion of said electrode and constituting a second electrode, a tubular member coaxial with said cylindrical tube extending upwardly from said envelope and

means sealing said upwardly extending member in a gas-tight manner to complete the gas-tight periphery of said spark gap tube.

6. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said base, said envelope being formed with an opening in its top, a cylindrical tube extending downwardly from and conductively connected to the rim of said opening, said cylindrical tube being coaxial with and surrounding a portion of said electrode and constituting a second electrode and means sealing said opening in a gas-tight manner.

7. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said base, said envelope being formed with an opening in its top, a cylindrical tube extending downwardly from and conductively connected to the rim of said opening, said cylindrical tube being coaxial with and surrounding a portion of said electrode, a tubular member coaxial with said cylindrical tube extending upwardly from said envelope and means sealing said upwardly extending member in a gas-tight manner to complete the gas-tight periphery of said spark gap tube.

8. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metallic flange extending around the rim of said base and being connected thereto in a gas-tight manner, said flange extending substantially in the plane of said base, a metal envelope having the shape of an inverted cup and having a flange formed on its rim, an electrode extending downwardly from the dome of said envelope, said last named flange when said envelope is positioned on said base, extending in a plane parallel to that of said first named flange, the diameter of said cup-shaped envelope at its rim being slightly greater than that of said non-conducting base, said flange being connected to form a gas-tight seal around the rim of said base, the difference in diameter of the rim of said envelope and said base allowing relative lateral movement between said base and said envelope for the accurate alignment of said electrodes without impairing said seal.

9. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metal envelope having the shape of an inverted cup and having its rim secured in a gas-tight manner to said base, said envelope being formed with an opening in its top, a cylindrical tube extending downwardly from and conductively connected to the rim of said opening, said cylindrical tube being coaxial with and surrounding a portion of said electrode and constituting a second electrode, a radially extending annular flange carried by the first mentioned of said electrodes below the lower end of said cylindrical tube and shielding said base from metal deposits resulting from sputtering of the spark, and means sealing said opening in a gas-tight manner.

10. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metal envelope secured in a gas-tight manner to said base and forming with said base the boundaries of said tube, said envelope being formed with an opening thereon, a cylindrical tube extending inwardly from and

conductively coupled to the rim of said opening, said cylindrical tube surrounding a portion of said electrode and constituting a second electrode and means sealing said opening in a gas-tight manner.

11. A spark gap tube comprising a non-conducting base, an electrode passing in a gas-tight manner through said base, a metal envelope secured in a gas-tight manner to said base and forming with said base the boundaries of said tube and constituting a second electrode, said envelope being so shaped as to closely surround the upper portion of said electrode in a manner such that the region of closest proximity between the inner surface of said surrounding envelope and the surface of said electrode forms an annular band surrounding the upper end of said electrode in which band the distance between said inner surface and said electrode forms a spark gap of predetermined size.

12. In a gas-filled spark gap tube comprising a hermetically-sealed vessel, an electrode assembly supported by and extending within said vessel, said assembly comprising a pair of electrodes, one of said electrodes having a portion fitting

within and surrounded by a portion of the other of said electrodes, the region of closest proximity between the surfaces of said electrodes being that between the telescoped portions of said electrodes, said one of said electrodes being enlarged in the vicinity of, but outside, said region of closest proximity, to a cross-sectional area greater than that of the interior of said surrounding portion of said other electrode.

13. In a gas-filled spark gap tube comprising a hermetically-sealed vessel, an electrode assembly supported by and extending within said vessel, said assembly comprising a pair of electrodes, one of said electrodes having a portion fitting within and surrounded by a portion of the other of said electrodes, the region of closest proximity between the surfaces of said electrodes being that between the lateral faces of the telescoped portions of said electrodes, said one of said electrodes being enlarged in the vicinity of, but outside, said region of closest proximity, to a cross-sectional area greater than that of the interior of said surrounding portion of said other electrode.

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