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GASEOUS DISCHARGE TUBE

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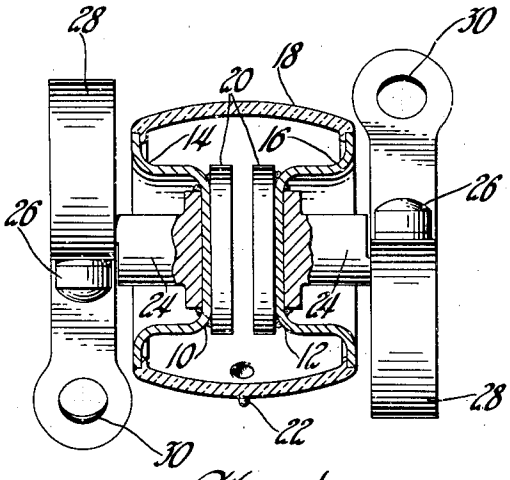


Fig. 1

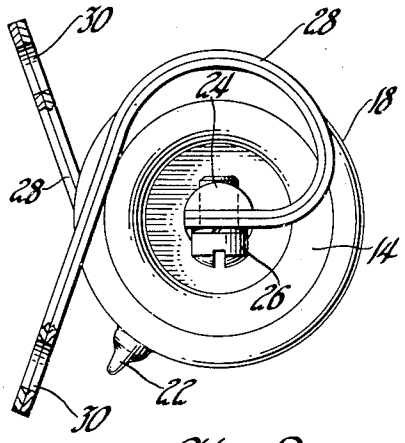


Fig. 2

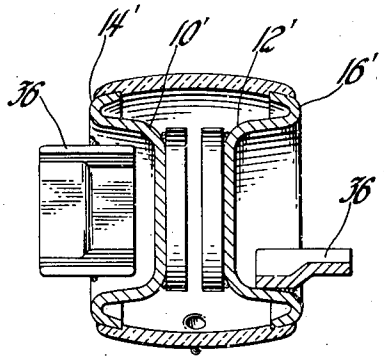


Fig. 3

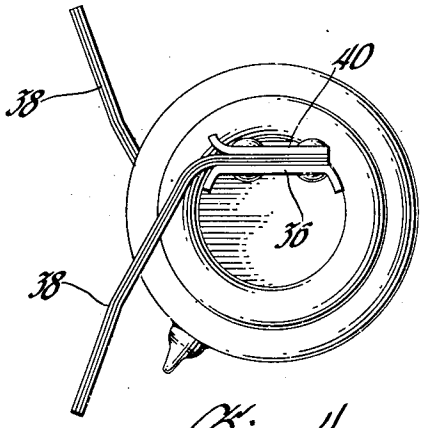


Fig. 4

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GASEOUS DISCHARGE TUBE

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6 Claims. (Cl. 250—27.5)

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This invention has to do with a gaseous discharge tube for use in a high frequency ignition system of the type disclosed in Randolph, Duffendack and Wolfe Patent No. 2,030,228, granted February 11, 1936, and in Randolph and Rabezzana Patent No. 2,071,573, granted February 23, 1937.

The tube consists essentially of two electrodes in a gaseous atmosphere and is preferably designed to discharge upon application of a predetermined voltage. In a particular application the tube was designed for discharge on application of approximately 700 volts. This is accomplished by employing suitably spaced electrodes of a special alloy or composition characterized by low work function in an atmosphere of inert gas, the pressure of the gas and the spacing of the electrodes being such as to permit discharge at the desired voltage.

The tube is characterized by rugged construction so that it will withstand severe vibration such as is encountered in high powered aviation engines. It is also so constructed as to permit effective cooling of the electrodes.

In the drawings:

Figure 1 is a view partially in vertical section and partially in elevation of one form of tube embodying my invention.

Figure 2 is an end view of the tube of Figure 1.

Figure 3 is a view corresponding to Figure 1 showing a modified embodiment.

Figure 4 is an end view of the tube shown in Figure 3 with the supporting straps secured in place.

The tube comprises a pair of dished end members 10 and 12 arranged with their convex sides adjacent each other and in opposed relation as shown. The end members are provided with out turned flanges 14 and 16 connected by glass envelope 18. The end members 10 and 12 are preferably made of an alloy having substantially the same coefficient of expansion as the glass of the tube, so that the metal and glass may be fused or bonded together to form a gas-tight seal. Other metals with matching glass may be used.

There is secured to the inner surface of each of said dished portions, preferably by welding, a disc-shaped electrode 20, the electrodes being spaced apart as shown to provide a spark gap. The discs 20 are preferably made of a fused or sintered mixture of a finely pulverized base metal such as iron, nickel, or alloys thereof, and a salt of a metal of low work function, preferably barium or strontium. The preferred composition is a mixture of iron and barium. As disclosed in said

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application this material may be readily machined to the desired size, is homogeneous and characterized by low work function and resistance to sputtering.

The glass envelope 18 is provided with a stem 22 through which it may be exhausted of air and thereafter supplied with inert gas. Thereafter the stem may be sealed off in accordance with usual practice. The stem is preferably arranged in line with the gap between the electrodes 20 so as to permit insertion of a gauge to measure the gap and insure accuracy of assembly.

An important advantage of the construction described is that it facilitates conduction of heat away from the electrodes 20. The heat created by arcing at the electrodes is conducted away by the dished end members 10, 12 and through them is dissipated in the surrounding air.

The tube is, of course, made as small as possible so as to reduce its weight as well as the space it occupies to a minimum. Inasmuch as glass is a poor conductor of heat it is also desirable in the design of the tube to reduce the size of the glass envelope to the minimum necessary to insure that the tube will not be shortcircuited by the depositing on it of material sputtered from the electrodes.

The tube is designed for use in high frequency ignition systems for modern high powered aviation engines and when so used will of necessity be mounted on or adjacent the engine and will be subject to severe vibration. As this vibration might result in damage to the tube it has been found desirable to mount it on cushioned supports, the supports preferably also serving as terminals through which current is supplied to it. Several forms of support have been illustrated.

There is welded to the exterior of each of the end members 10 and 12 a terminal 24 to the outer flattened end of which is secured by any suitable means such as bolt 26, a conductor 28, preferably in the form of superposed strips of metal as shown which also function as a support for the tube. The outer ends of these strips are apertured as indicated at 30 to receive securing means to mount the tube and connect it in circuit. When so secured the tube is to a considerable extent insulated from vibration and the glass envelope and its joints with the end members are relieved of strain.

The modification shown in Figures 3 and 4 differs from that described chiefly in the design of the terminals and supporting conductors. As shown in Figure 3 there are secured, preferably by welding, to the sides of the dished portions of

the end members 10' and 12', clips 36 to the outer ends of which are riveted laminated metal supporting conductors 38. If desired, stampings 40 may be provided to overlie the terminals 36 and receive the rivets. As shown in Figure 3, the out turned flanges 14' and 16' are provided with axial extensions overlapping the glass of the envelope. This facilitates welding or fusing of the envelope to the end members and also provides flexibility in metal parts to relieve strain on glass during temperature changes.

After being exhausted of air the tubes are filled with inert gas. Various mixtures may be employed, for example, the high resistance gas mixture commonly used in neon signs in cold climates, consisting of approximately 18% neon, 54% argon and 28% helium. The use of pure argon has been found satisfactory, but requires a somewhat narrower gap, i. e., .024'' compared with .041'' for the gas mixture referred to. Consequently, the voltage across the gap is more sensitive to variations in the length of the gap.

The breakdown voltage of a tube of the construction shown is dependent on the length of the gap between the electrodes, the pressure and composition of the gas, and the composition of the electrodes. With the mixture of gases referred to above, and with electrodes, consisting of a sintered mixture of iron and barium in the proportions of 93% iron and 7% barium, a gap distance of .041'' has been found satisfactory.

In order to insure that the tube will break down at 700 volts it is necessary to accurately control the pressure of the gas in the tubes. A difference of one centimeter of mercury in pressure produces a difference of approximately 12 volts in the breakdown voltage of the tube. It has been found most convenient to employ gas at approximately atmospheric pressure. If the pressure is substantially greater than atmospheric it is more difficult to seal off the glass tube from the system employed to exhaust it. If the gas pressure is too low a less satisfactory type of electrical discharge is obtained. If in the assembly of the tube the gap distance is somewhat too long, for example, .043'', this can be compensated for by reducing the gas pressure by a small amount.

It has been found that the tube is sensitive to light so that the breakdown voltage varies considerably depending upon whether the tube has been in a light or dark place, and also upon the length of time it has been so kept. To overcome this so that the tube will always break down at substantially the same voltage, there may be introduced into it a small quantity of radio active material such as a solution of radium bromide in alcohol. Approximately one microgram of radium bromide per tube has been found adequate. While a greater amount is not harmful no advantage is obtained from using more.

Another method which has proven satisfactory is to paint the outside of the glass envelope with radio active or luminescent paint.

It has been found unnecessary to employ a getter in the tube, although one may be used if desired. Residual gases such as oxygen and nitrogen are cleaned up by the arc, the theory being that they are absorbed or adsorbed by the glass envelope and electrodes.

In some instances it may be desirable to design the tube for operation at lower or higher voltages. This may be accomplished by employing a different gaseous atmosphere, by adding metallic vapor such as caesium, by reducing or increasing the gas pressure, by employing electrodes of lower or higher work function, or by reducing or increasing the length of the gap between the electrodes. In some cases it will be found most practical to combine reduction or increase in gap with the use of different gas mixtures. Reference is made to prior Patent 2,122,932 granted to Duffendack and Wolfe on July 5, 1938, for disclosure of a low voltage tube adapted for use in the ignition circuit referred to. An advantage of the high voltage tube herein disclosed is the fact that it permits the use of a smaller condenser in the ignition circuit as well as smaller transformer coils in the circuit leading to the plugs, the latter advantage being particularly important since the transformer coils are preferably assembled in the spark plug insulator so as to confine the high voltage part of the ignition circuit to the vicinity of the plugs.

Tubes made as here disclosed have operated satisfactorily for many hundreds of hours. The discharge between the electrodes is in the form of a small arc. Because of the greater current carried, this type of discharge has been found preferable to the glow discharge produced at lower gas pressures. It is estimated that in the circuit described, upon application of 700 volts, the peak tube current is approximately 35 to 50 amperes.

Tubes of the construction referred to have proven particularly satisfactory in the improved ignition circuit described and claimed in the copending application of Lucian B. Smith, Serial No. 625,245, filed October 29, 1945, which issued Jan. 18, 1949 as U. S. Patent No. 2,459,297 in which the tube voltage was supplied by a conventional magneto provided with a transformer to step up the generated voltage and with a breaker in the primary circuit to interrupt the current at approximately the peak voltage.

I claim:

1. A gaseous discharge tube comprising a pair of dished, metal disks having their bottom portions in opposed spaced relation, flanges extending outwardly from said bottom portions and away from each other in generally axial directions and terminating in peripheral portions lying radially outward beyond said bottom portions, an envelope of electrical insulating material connecting said peripheral portions and sealed thereto, electrodes containing material of low work function to reduce the breakdown voltage secured to the adjacent faces of the bottoms of said disks in spaced relation to provide a gap, the distance between said peripheral portions being large compared with the gap distance to prevent short circuiting by deposition of material on the envelope, the opposed faces of said electrodes being parallel to provide a substantial area for arc discharge, said tube being filled with inert gas at approximately atmospheric pressure.

2. A gaseous discharge tube comprising a pair of dished metal disks having their bottom portions in opposed spaced relation, flanges extending outwardly from said bottom portions and away from each other in generally axial directions and terminating in peripheral portions lying radially outward beyond said bottom portions, a glass envelope connecting said peripheral portions and sealed thereto, electrodes consisting of a substantially homogeneous mixture of iron and a salt of barium with resultant low work function to reduce the breakdown voltage secured to the adjacent faces of the bottoms of said disks in spaced relation to provide a gap, the distance between said peripheral portions being large com-

pared with the gap distance to prevent short circuiting by deposition of material on the envelope, the opposed faces of said electrodes being parallel to provide a substantial area for arc discharge, said tube being filled with inert gas at approximately atmospheric pressure.

3. In the combination defined in claim 2, the inert gas consisting of a mixture of approximately 18% neon, 54% argon and 28% helium.

4. A gaseous discharge tube comprising spaced metallic end members including low work function electrodes consisting of a homogeneous mixture of iron and a salt of barium, said electrodes having opposed, parallel, closely adjacent discharge faces, and an insulating glass envelope connecting said end members and sealed thereto to form a gas-tight enclosure, said envelope being filled with gas consisting of a mixture of approximately 18% neon, 54% argon and 28% helium at substantially atmospheric pressure.

5. A gaseous discharge tube comprising a pair of opposed dished metallic end members arranged with their convex faces adjacent each other, an electrically non-conductive envelope connecting the outer portions of said end members and sealed thereto to form a gas-tight enclosure, a pair of durable metal electrodes having low work function secured to the inner surfaces of said dished portions in spaced relation to each other and having parallel, closely adjacent, opposed faces forming a gap, and a sealable stem for exhausting said envelope and filling it with gas extending from said envelope in line with said gap so as to permit insertion of a feeler gage to gage the gap distance during assembly.

6. A gaseous discharge tube comprising a pair of opposed dished metal end members, a glass envelope connecting the peripheries of said end members and bonded thereto, said glass including a sealable stem portion extending outwardly therefrom and permitting exhausting said envelope and filling it with gas, and disk-shaped metallic electrodes of low work function secured to the inner surfaces of said dished portions with their flat faces in closely adjacent parallel relation to provide a gap, the said sealable stem portion lying in a plane extending outward in line with the space between said electrodes thereby permitting insertion of a feeler gage between the electrodes to gage the gap distance during assembly.

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