June 22, 1948. N. C. FULMER 2,443,677

IGNITER

Filed Oct. 26, 1946

Fig. 1.

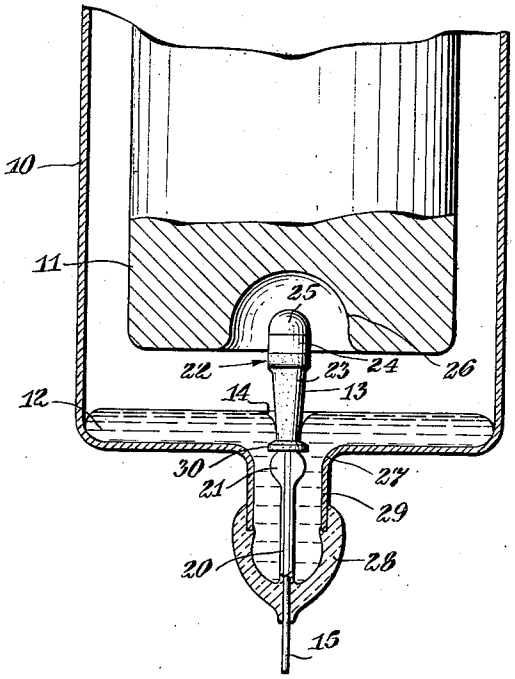


Fig. 2.

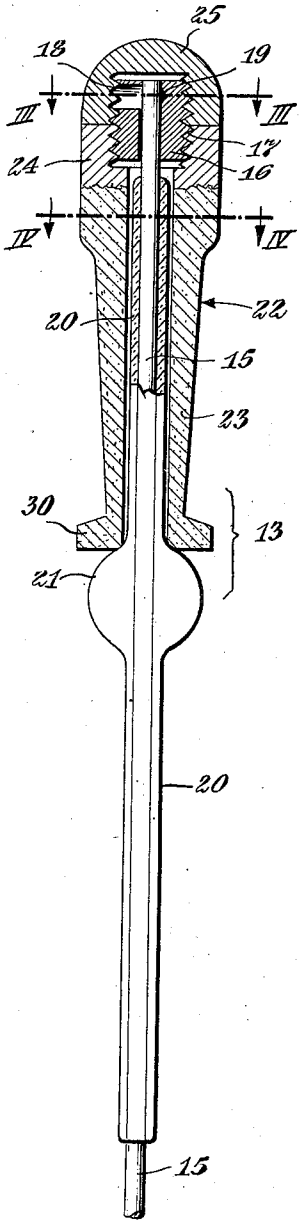


Fig. 3.

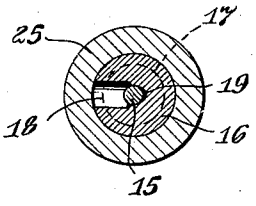
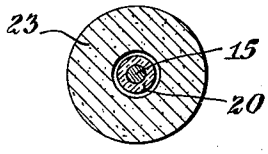


Fig. 4.



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Patented June 22, 1948

2,443,677

UNITED STATES PATENT OFFICE

2,443,677

IGNITER

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Application October 26, 1946, Serial No. 705,868

7 Claims. (Cl. 250—27.5)

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This invention relates to ignitrons and starting devices therefor, and is particularly directed to the construction of starter electrodes of the high resistance type, and method of fabrication thereof.

In most electrical devices, it is found that constructions adaptable for low voltages as well as low frequencies require numerous and material changes for use with high voltages or high frequencies. Utilization of high voltages and high frequencies in ignitrons as proposed in connection with the present invention, necessitates relatively close spacing of the anode to the cathode. There is, likewise, with this high voltage ignitron of the present invention, necessity to provide adequate segregation of the ignitor and its lead-in connection from the anode to prevent voltage break-down or out-of-time firing, and yet the desideratum is of greater importance than with low voltage ignitrons, to have the firing instigated directly between the anode and cathode, which is unobstructed by any ignitor supports or mounting straps that could hinder transfer of the initiated arc to the anode, or which may be a source of material to amalgamate with the cathode material. Inasmuch as high voltage gradients tend to discharge from sharp corners, the invention further contemplates not only the avoidance of sharp corners where undesirable discharges might occur but also provides for equi-distant spacing of the opposed surfaces of the ignitor and anode for equally spreading the electrical charges over considerable areas and thereby reducing charge concentration and likelihood of break-down and undesired discharge or shorting between those electrodes.

The invention accordingly has for its objects the accomplishment of the desirabilities and the overcoming of the difficulties above recited as well as other objects and advantages hereinafter included both by direct reference thereto in the description and by implication from the context.

Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views,

Figure 1 is a vertical diametric section of an ignitron featuring my invention and showing the ignitor therein in side elevation.

Figure 2 is an enlarged view of the ignitor and showing the same largely in longitudinal section.

Figures 3 and 4 are cross sectional views on lines III—III and IV—IV respectively of Figure 2.

In the specific embodiment of the invention illustrated in said drawing, reference numeral 10 designates the sealed shell or container of the

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ignitron wherein is suspended an anode 11 the bottom face whereof is spaced above the bottom of the shell. Normal position of the ignitron in use is vertical so the bottom of the shell is substantially horizontal and supports a pool cathode 12 of some substance, such as mercury, which has preferably a fluid characteristic and constitutes a source of ionizable vapor and which is recurringly vaporizable and condensable. The anode 11 has to be spaced from the upper surface of the pool cathode, but with employment of high voltage or high frequency or both, the spacing must be reduced to a minimum in order that the tube may withstand high voltage between anode and cathode, and so that an arc initiated at the cathode will transfer quickly to the anode. The reason for close anode to cathode spacing enabling the tube to withstand higher voltages is based on the fact that this tube, as well as similar types of arc discharge tubes, operate on the low pressure side of the well known Paschen's law curve.

In order to instigate the firing in the desired region and at the proper moment, a starter electrode, designated in its entirety by numeral 13 is provided in coaxial alignment with the anode and in part in the pool cathode. A surface depression or meniscus 14 forms in the pool cathode next to the starter electrode and according to accepted theory voltage gradient across the meniscus gap from the starter electrode to the pool cathode results in a spark and ionization thereat which immediately spreads to the anode and forms an ionized path from anode to cathode for firing therebetween to occur.

The prior art has provided in general several types of starter arrangement. One arrangement has introduced a lead-in wire from above, suspending an ignitor therefrom to dip into the mercury. To get such an ignitor in the desired region between cathode pool and anode, longitudinal hollowing of the anode is often resorted to but with the ill effect of electrical pick-up by the ignitor lead-in wire because of its capacitative coupling to the high-voltage anode lead. That arrangement also involves complicated and difficult seal constructions. Another arrangement has introduced an ignitor lead from below said lead projecting upwardly through the pool cathode and having a cross-arm or strap at its upper end from which an ignitor is suspended to dip into the pool. Such an arrangement requires too great a spacing of anode and cathode to accommodate the ignitor, and the ignitor and its lead-in connections involve many sharp corners and other likely places of spurious discharge.

For the reasons stated, therefore, both of these prior art arrangements are totally inapplicable to high voltage or high frequency ignitrons of the type here contemplated, and other known arrangements not necessary to mention herein are likewise not usable in the high ranges of voltage and frequency here contemplated.

Starter electrode 13 of the present invention includes a stiff lead-in wire or core 15 of tungsten or other suitable material, which enters at the bottom of the shell or container 10 coaxial therewith. At the upper end of said lead-in wire 15 is a metallic stud 16 of generally cylindrical configuration having screw-threads 17 on its cylindrical surface the full length thereof. Said stud has an axial hole therethrough which receives and substantially fits upon the upper end portion of the lead-in wire and is appropriately held in place thereon as by welding. As shown, said stud has a radial hole 18 therein for temporary introduction of a welding electrode thereby obtaining a welded area 19 inwardly from the end of the wire and stud so as to avoid any metal protrusion on the outer surfaces of the stud and to permit location of the stud at desired position on the lead-in wire before being welded thereto. Below said stud, the lead-in wire is preferably contained within a tube 20 of insulation sealed thereon, the choice for which is preferably a glass having approximately the same coefficient of expansion as the core. In the example given above of use of tungsten for the core, a glass obtainable on the market identified as Corning No. 723 glass has been found satisfactory. There is also an alloy manufactured under the Howard Scott Patent No. 2,062,335 of December 1, 1936 which is acceptable for the lead 15 and the borosilicate glass referred to in that patent is appropriate for use with the "Kovar" lead in the present invention. Other suitable material for lead-in and for sealing thereto may, however, be used. At an appropriate distance below said stud, said insulation tube 20 is enlarged or made bulbous, as at 21, thereby forming an upwardly directed shoulder. It is to be understood, however, that other means may be employed for providing the desired shoulder, the enlargement 21 being shown as a convenient and satisfactory example.

The starter electrode 13 also includes an ignitor 22 as an essential part thereof. As shown, said ignitor comprises an elongated hollow body portion 23 of suitable high resistance or semi-conductive material such as a mixture of boron carbide, boron nitride and carbon suitably consolidated as a rigid entity. The ignitor also includes a head portion 24 unified with the body portion and characterized by better electrical conductivity than the body portion for distribution of the applied voltage to the entire cross-section of the body portion. Said head portion 24 is preferably of graphite and internally threaded and receives the threaded stud in part therein. The skirt 30 at the bottom of the ignitor provides for mechanical strength and serves no electrical function in operation of the ignitor.

In assembling the starter electrode, the insulation tube 20 with its enlargement 21, is first applied to the lead-in wire 15. Then the ignitor 22, comprising body portion 23 and head portion 24, is slid on the upper end of the insulation tube with the upper end of lead-in wire 15 protruding above said head portion. Stud 16 is then slid onto the protruding end of the lead-in wire 15 as far as said head and screwed into said head until tight. This order of operations may of course be

varied as found most expedient, it being particularly pointed out that the stud may be screwed home in said ignitor head prior to application of the ignitor and stud upon the lead-in wire. Suffice it to say that the ignitor rests at its lower end upon the shoulder constituted by enlargement 21 and the stud retains the ignitor from displacement by being thereafter welded in place upon the lead-in wire. The upper end portion of the stud 16 extends above the ignitor head, and a dome-like cap 25 is screwed thereon. Said cap 25, likewise preferably of graphite, is of appropriate shape and dimensions to constitute a continuation of the outer cylindrical surface of the ignitor and thus to provide a structure devoid of sharp edges or corners and consequent concentration of voltage gradients likely to cause the instigation of spurious discharge.

The anode 11 may be hollowed at its under side, as at 26, to provide adequate spacing therefrom of the starter electrode, and yet provide a bottom surface toward and parallel to the cathode surface properly spaced therefrom for the main discharge. The hollow of the anode is substantially semispherical and thus maintains equal spacing in all radial directions from the dome-like end of the starter electrode. It may also be added that it is found necessary to have the starter electrode project a distance as shown above the cathode to avoid covering the electrode with mercury splashings in use. Furthermore it is desirable to provide definite clearance of the ignitor from the insulation tube over which it is mounted and to prevent entry of mercury into the clearance space, and this may be accomplished by seating the end of the ignitor against the enlargement or shoulder of the insulation tube and retaining it seated thereon. However, if the clearance of the ignitor from the insulation tube is sufficiently small so as to prevent mercury from entering said clearance, said shoulder may be dispensed with.

The starter electrode is assembled as a complete unit in the ignitron through a bottom opening 27 thereof. A glass seal 28 between an appropriaate flange 29 around said opening and the insulation tube forms a tight closure and support for the said electrode.

It is sometimes advisable to employ a "graded" glass seal between the flange 29 and insulation tube 20, for example, if the lead-in core 15 is of a material with a widely different coefficient of expansion than that of the flange 29, to each is sealed a section of glass with suitable coefficient of expansion and a glass of intermediate expansion coefficient is sealed betwixt, thus forming a complete seal.

Fabrication of the ignitor may be performed conveniently by the "hot-press" method which briefly consists in introducing a proper mixture of ingredients in a forming die and applying both heat and pressure sufficient to consolidate the ingredients into a rigid integral mass possessing desired electrical characteristics. Head 24 is likewise made an integral part of the ignitor during application of the heat and pressure. This integration is accomplished by inserting the head 24 within the forming die preferably next to the plunger used for applying the forming pressure. The face of the head toward the mixture of ingredients becomes merged with the ingredients under the effects of pressure and heat and definite line of demarcation between head and body portion disappears. Preferably the head is graphite as is also the cap 25. The ignitor blank may then be shaped into the desired con-

tours by common machining operations such as drilling, cutting and grinding.

A criterion of an ignitor's electrical characteristics is known by the terminology "cold resistance," which is the value of resistance obtained between the ignitor head and a pool of mercury when the bottom end of the ignitor is immersed to a given depth in said mercury pool; the cold resistance measurement is made at room temperature.

A desirable order of magnitude of cold resistance for the type of ignitor herein described is 100 ohms for the unshaped blank, which yields a cold resistance of about 500 ohms after shaping and processing. The value of ignitor resistance is a function of the mixture, heat and pressure used in manufacturing the ignitor blank. The above-mentioned values of resistance have been found desirable for ignitors operated in conjunction with high voltage ignitor firing circuits. However, widely different values of ignitor resistance may be found most desirable when operating in conjunction with different types of firing circuits, and for different compositions of ignitor material.

I claim:

1. A starter electrode for ignitrons comprising a core functioning as a lead-in connection, a stud on said core next an end thereof, said stud having a radial hole therein at the upper portion of said stud and said stud having an interior weld to said core in the region of said radial hole, an ignitor carried by the lower portion of said stud and depending around said core, and a cap carried by the upper portion of said stud and overlying the outer end of said radial hole.

2. A starter electrode for ignitrons comprising a hollow ignitor having interior screw threads next one end thereof, a stud having one end portion thereof screwed into said screw threads of the ignitor and having a screw threaded end protruding from said ignitor, and a cap threaded onto said protruding end of said stud and completely overlying the said protruding end of said stud.

3. A starter electrode for ignitrons comprising a hollow ignitor having interior screw threads next one end thereof and having an exterior cylindrical surface next said end, a stud having one end portion thereof screwed into said screw threads of the ignitor and having a screw threaded end protruding from said ignitor, and a domed cap threaded onto said protruding end of said stud with the domed part of the cap constituting a rounded end for the electrode, said cap being cylindrical at its end next ignitor and of equal diameter thereat as said exterior cylindrical surface next the end of the ignitor whereby the cap provides a continuous smooth surface to the exterior cylindrical surface of the ignitor.

4. A starter electrode for ignitrons comprising a core functioning as a lead-in connection, an ignitor having a stud partly therein and partly protruding at an end thereof, said stud being carried on the end portion of said core and having a radial hole therein at the part thereof protruding from the ignitor and said stud having an interior weld to said core in the region of said radial hole, and a domed cap secured on the protruding end of said stud with the domed cap constituting termination of the ignitor and a domed end therefor, said domed cap completely closing said radial hole to the exterior and completely overlying the said protruding end of said stud.

5. A starter electrode for ignitrons comprising a core functioning as a lead-in connection, a tube of insulation on said core, said tube having an enlargement forming a shoulder, an ignitor seated on said shoulder and extending lengthwise of said core and tube around the same, and means on said core engaging said ignitor and retaining said ignitor seated on said shoulder.

6. An ignitron comprising a container, an anode in said container, and a starter electrode directed endwise toward said anode, said starter electrode having a domed end toward the anode and said anode having a hollow into which said domed end of the starter electrode protrudes, said hollow having its surface wall curved substantially in parallelism to the domed end of the said starter electrode with substantially the same center of curvature for both.

7. The hereindescribed method of fabricating a starter electrode for ignitrons comprising covering a conductive core with an insulation tube and forming a shoulder on said tube, seating an ignitor on said shoulder and holding it seated by welding a stud to the core at the other end of the ignitor from the seated end.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,169,015	Bahls	Aug. 8, 1939
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