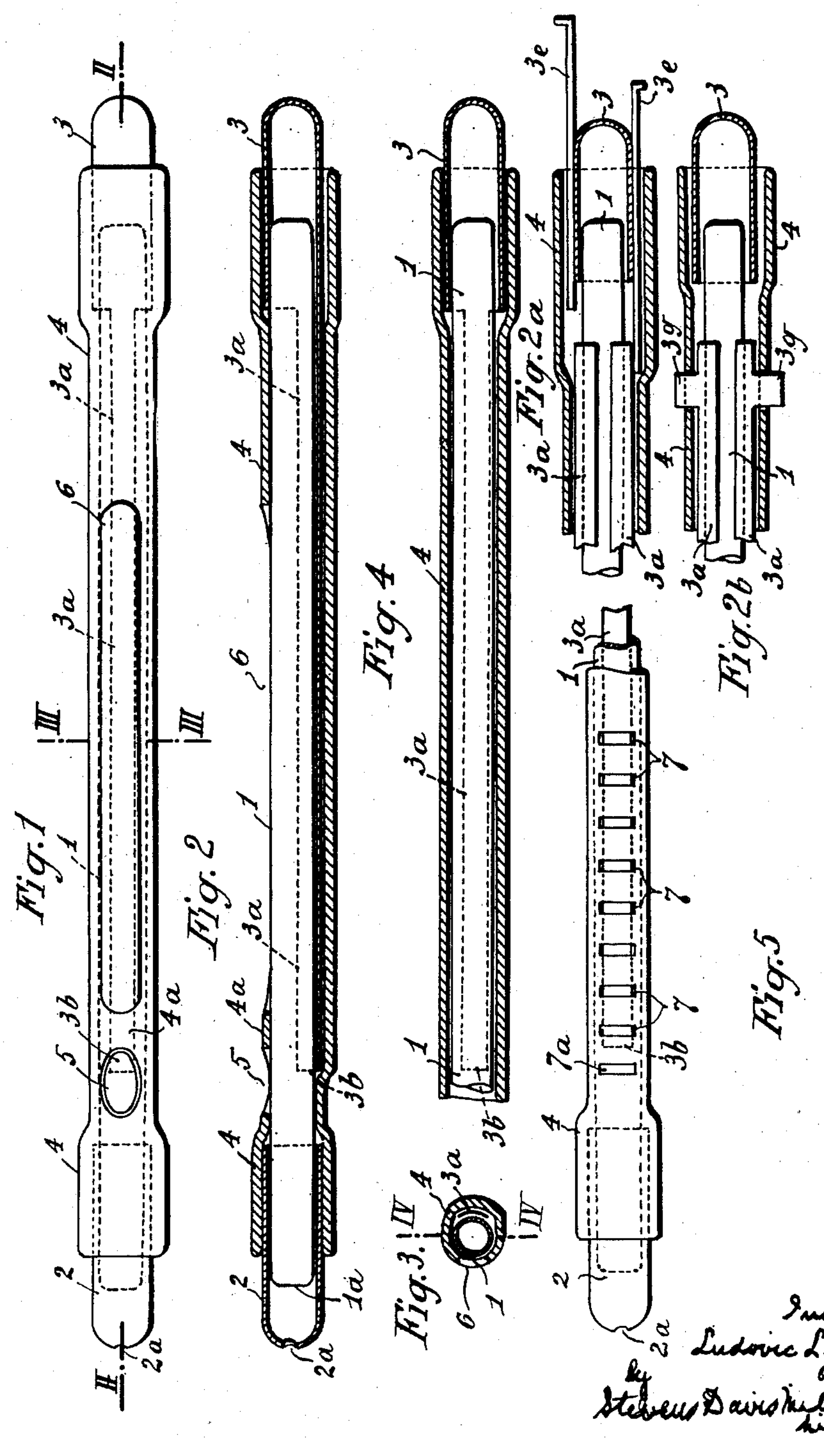
May 15, 1951 L. L. J. HIRBEC 2,552,678

INSTRUMENT FOR EXPLORING ELECTRIC FIELDS

Filed Aug. 31, 1949 2 Sheets-Sheet 1

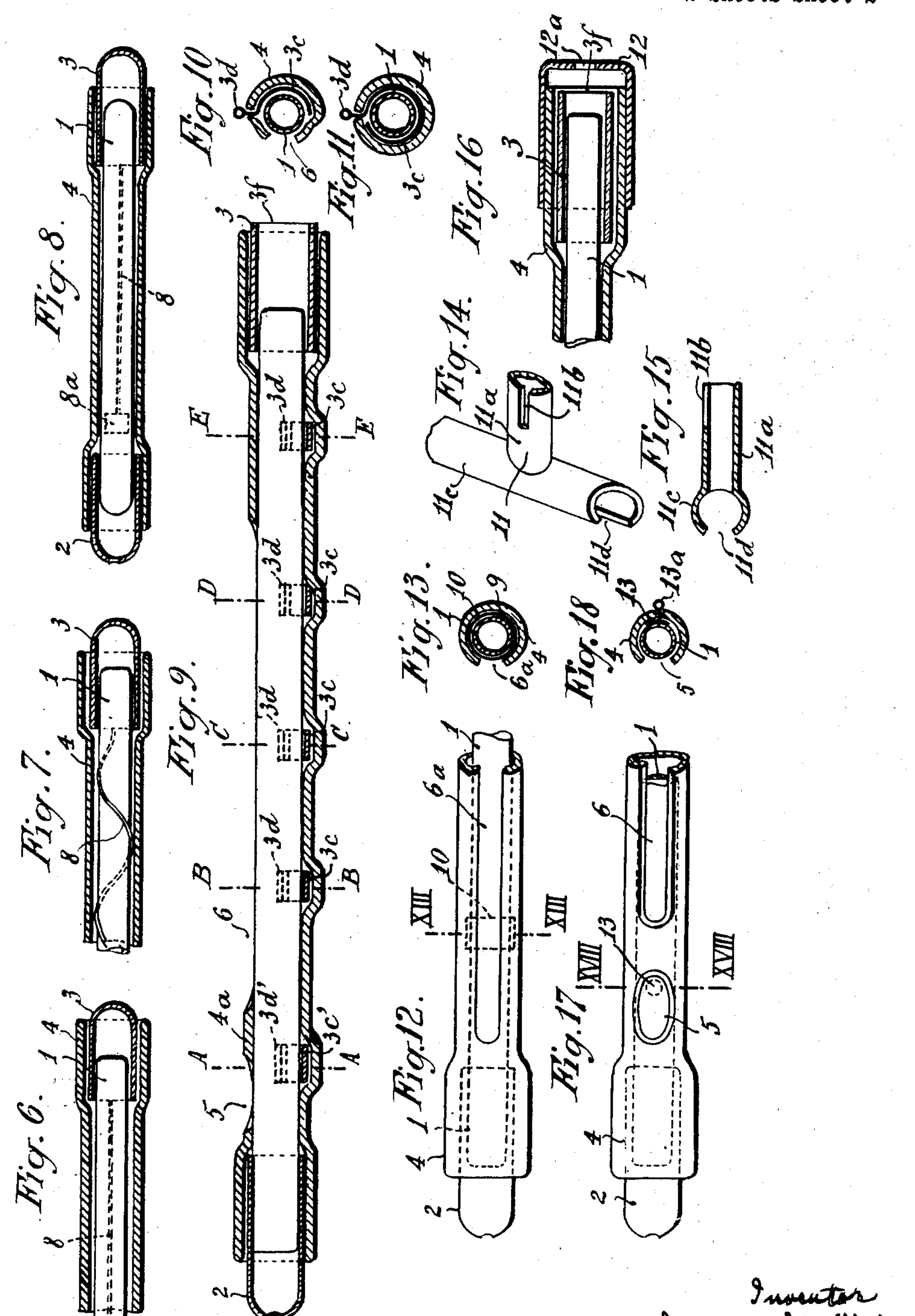


Inventor
Ludovic L. J. Hirbec
by Stevens Davis Miller & Mosher
his attorneys

May 15, 1951 L. L. J. HIRBEC 2,552,678

INSTRUMENT FOR EXPLORING ELECTRIC FIELDS

Filed Aug. 31, 1949 2 Sheets-Sheet 2



Inventor
Ludovic L.J. Hirbec
by
Stevens Davis Miller & Mosher
his attorneys

Patented May 15, 1951

2,552,678

UNITED STATES PATENT OFFICE

2,552,678

INSTRUMENT FOR EXPLORING ELECTRIC FIELDS

Ludovic L. J. Hirbec, Paris, France

Application August 31, 1949, Serial No. 113,414
In France September 20, 1948

6 Claims. (Cl. 176—122)

1

Apparatuses are already known which enable of ascertaining the presence of a high electric voltage and in which a discharge in a rarefied gas tube is employed; with such tubes the minimum voltage to be applied between the ends thereof to start luminescence is usually referred to as "starting critical potential".

It is an object of this invention to provide an apparatus or instrument for detecting electric fields, in which the starting critical voltage is lowered by reason of a particular construction of the electrodes in a rarefied gas tube.

According to this invention, I provide an apparatus or instrument for exploring electric fields which comprises a rarefied gas discharge tube having electrodes at least one of which surrounds one of the tube ends, an insulating sheath around the tube having at least one sight zone, and means for sensitizing the discharge tube to potentials lower than one sight zone, and means for sensitizing the discharge tube to potentials lower than the normal critical potential so as to strengthen luminescence and visibility thereof, and causing the dimensions and shape of the luminescent column to vary as a function of the potential difference and the polarity thereof with respect to the reference potential.

Preferably, the sheath is generally opaque for an easier observation, internally polished for reflecting luminous rays towards the user, coloured for contrast with the colour of light rays emitted by the tube, and the electrodes are fitted for sliding movement along the tube and resilient grip thereon where a flexible insulating sheath is provided.

Several embodiments of my invention will now be particularly described with reference to the appended drawing given solely by way of example to illustrate how my invention may be carried into effect.

Fig. 1 is a plan view of an instrument according to a first embodiment of my invention.

Fig. 2 is a longitudinal section along line II—II on Fig. 1.

Figs. 2*a* and 2*b* are sections similar to Fig. 2, showing portions of modified detectors with multiple strips.

Fig. 3 is a cross-section along line III—III on Fig. 1.

Fig. 4 is a longitudinal section of a part of the instrument, along line IV—IV on Fig. 3.

Fig. 5 is a plan view of a portion of a detecting instrument having a scale provided by parallel, cross slots in the sheath.

Fig. 6 is a partial longitudinal section of a modified detector.

Fig. 7 is a similar view relating to still another modification.

Fig. 8 is a longitudinal section of a modification of the detector of Fig. 6.

2

Fig. 9 is a longitudinal section of a modified detector having auxiliary conductors distributed between the electrodes and a cylindrical electrode for easier endwise observation.

Fig. 10 is a cross-section along one of the lines AA, BB etc. on Fig. 9.

Fig. 11 is a similar cross-section of a detector, showing another construction of the auxiliary conductors.

Fig. 12 is a part plan view showing a detector equipped with a runner.

Fig. 13 is a cross-section along line XIII—XIII on Fig. 12.

Fig. 14 is a perspective view showing an attachment particularly designed for exploring field around single wires.

Fig. 15 is an axial cross-section of the attachment shown on Fig. 14.

Fig. 16 is a longitudinal section through an end of the detector, showing a cap which provides a camera obscura having an axial aperture, and covers a cylindrical electrode.

Fig. 17 is a part plan view showing a tablet-shaped auxiliary conductor.

Fig. 18 is a cross-section along line XVIII—XVIII on Fig. 17.

Referring to the simple embodiment illustrated by Figs. 1 to 4, the detector comprises a closed light transmissive and dielectric rarefied gas discharge tube 1 which may have a length of about 8 to 25 centimeters and a diameter of about 8 to 25 millimeters for example. Arranged on the ends thereof are a metal cap 2 having an axial aperture 2*a* and a metal cap 3 which are fitted for sliding movement on the tube but are not pushed home and provide electrodes.

A flexible sheath or casing 4 made of a material having a high dielectrical rigidity such as polyvinyl chloride tightly surrounds the discharge tube 1. The ends of sheath 4 are preferably extended to engage electrodes 2 and 3 so as resiliently to hold them, so that in the event of an end blow, the electrodes 2 and 3 can slide inwardly on tube 1, thereby protecting it securely. Provided in sheath 4 in close proximity to cap 2 is a sight aperture 5; an elongated slot 6 coaxial with aperture 5 and spaced apart therefrom by a solid portion 4*a* extends over the major part of sheath 4.

A conducting strip 3*a* forms an extension of electrode 3 along the generatrix of tube 1 opposite apertures 5 and 6 to a distance of about 12 millimeters from cap 2 (Figs. 1 and 2) within sheath 4. The strip 3*a* may have a width of one third of the outer circumference of tube 1.

The detecting instrument above described may be employed as follows:

(1) The instrument being held in the hand through electrode 3, electrode 2 is brought near a conductor under a high voltage; a luminescence is

then seen through aperture 5 between cap 2 and the end 3b of strip 3a for a potential considerably below the normal starting critical potential of tube 1 (this may be ascertained by placing an identical tube devoid of any extending strip at the same distance from the field producing conductor) and as electrode 2 is brought nearer, the intensity of luminescence increases, after which gradual development thereof along strip 3a takes place; the extension is relatively slow over a considerable voltage range; finally luminescence eventually prevails over the whole tube with an increasing intensity and becomes particularly bright as contact occurs. A reverse phenomenon is observed as electrode 2 is moved away.

(2) Should the same manipulation effected with the instrument held through electrode 2, a luminescence is observed between electrode 2 and the end 3b of the extending strip 3a as in preceding case then it develops gradually along the whole strip 3a eventually to prevail throughout tube 1.

Where observation is effected in a strongly lit place, incipient luminescence between cap 2 and extension 3b is the best perceived endwise through aperture 2a in electrode 2 operating as a camera obscura. For that purpose it is desirable to provide tube 1 with a flat end at 1a (Fig. 2).

A similar mounting may be provided with several strips 3a starting from the same electrode.

As shown on Fig. 2a, I may also provide one or more strips 3a which are separate from electrode 3 but adapted to be functionally connected therewith by movable contacts such as conducting slides 3e, so that they can be rendered inoperative if need be. In such a case, the slides 3e may be mounted with a sliding fit between, electrode 3 and sheath 4, operation thereof being effected through their outer ends protruding from the sheath as shown on Fig. 2a.

Alternatively the strip or strips 3a may themselves be mounted for sliding movement and have an outer extension like slides 3e for manual control.

One or more strips 3e insulated from electrode 3 may also be connected by bridging portions passing through sheath 4 to an outer conducting contact 3g (Fig. 2b) on which the user may lay a finger to start gradual luminescence as above described.

With a detector as set forth, I provide a sensitive instrument enabling of effecting measures, in view of the gradual extension of the luminescent column, and in that respect, I may furnish the strip or strips, the tube, the sheath therefor or any support between the sheath and tube with a scale.

For the purpose of facilitating measurements and rendering the same more accurate, it may be desirable to provide a series of parallel cross slots 7 (Fig. 5) through sheath 4 instead of two longitudinal apertures 5, 6; the first slot 7a is located in the neighbourhood of electrode 2 for detecting luminescence as soon as it is started between electrode 2 and end 3b of strip 3, the series of slots 7 providing a graduated scale which is illumined on part. The lit slot which is the more remote from electrode 2 affords an approximate estimation of the potential at the explored point.

According to the embodiment illustrated by Figs. 6 to 8, the extension of electrode 3 is restricted to a conducting wire 8 arranged along discharge tube 1 within sheath 4, either to follow a generatrix (Figs. 6 and 8) or to form a coil (Fig. 7). Furthermore it is of advantage to provide a

wider surface 8a (Fig. 8) at the end of wire 8 proximate to electrode 2, for an easier starting of luminescence. The surface 8a may be arranged to surround tube 1 wholly or partly.

In a detector as described with reference to Figs. 6 to 8, luminescence takes place as in the detector of Figs. 1 to 4 and proceeds along the tube but only a very small potential increase is necessary to cause luminescence to proceed from an end to the other end of the wire. After illumination of the wire throughout, luminosity develops around the luminescence prevailing along the straight or coiled wire, eventually to occupy the whole tube. The bright luminescence setting off the wire that seems to be luminous, is still perceptible when luminosity in the tube has become very strong.

It is to be remarked that the above phenomena take place for one polarity of the potential.

Should the conductor building up an electrical field have a potential of such a polarity that the phenomena do not occur, it is only necessary to employ the instrument through its opposite end, for obtaining occurrence of the phenomena but in a reverse direction.

Where the voltage on examination comprises successive, equal, opposite polarities (for example sinusoidal alternating current), a combination of both phenomena is found, luminescence along the wire being more diffuse and less strong than with one or a predominant polarity. Hence with my instrument, it is further possible to identify a potential polarity.

If the length of strip 3a is reduced, the end of the strip being shifted to BB, CC, DD, EE (Fig. 9), it is found that the tube is less and less sensitive as the strip is shorter, while still being more sensitive than a tube without any extension strip.

In one detector, provision may be made whereby any potential between the normal critical starting potential of the tube in use and the potential corresponding to maximum senstiveness (as secured by a strip extended to AA, Fig. 9) can be explored. To this effect, those portions of the strip which do not lie in zones AA, BB, CC, DD, EE for example are omitted, and instead of earthing electrode 3 through remaining sections 3c, the latter are electrically connected with contacts 3d arranged outside sheath 4 (Figs. 9 and 10) on which the user will lay a finger.

Such conductors 3c, 3d can easily be produced from small metal tongues, passed through suitable slits in sheath 4 and extending around substantially the whole periphery of tube 1 (Fig. 11) or a portion thereof (Fig. 10). The outer end of each tongue may be rolled outside sheath 4 into a small cylinder providing a contact 4d.

For employing the detector as just described, the user holds it through electrode 3 which he thus earths. Upon bringing electrode 2 near a conductor under a high voltage, he finds that from a certain distance from the conductor, i. e. for a predetermined potential level, a glimmer appears through apertures 5 and 6, the brightness of which increases as a result of potential rise, while electrode 2 is being brought nearer to the conductor.

If he moves the detector away from the conductor until any luminescence disappears, i. e. until the potential at the explored point is lower than the normal critical starting potential for the tube, he finds that by laying a finger on a contact 3d connected to a conductor 3c, slits are lit again and luminosity persists while the instrument is moved farther away as the contact employed is nearer to electrode 2, a maximum sensitiveness being experienced with that contact 3c' located at AA, preferably partly under window 5 and partly under solid portion 4a of sheath 4. The luminosity disappears only when the explored point has a potential considerably below the normal critical starting potential.

A detector equipped as described is thus also adapted to detect a lower electric field or even an electric field located farther than can be done with a tube having no additional conductor as provided in accordance with this invention.

Should the detector have only one auxiliary conductor 3c', it is possible by measuring the distances between electrode 2 and the points under voltage at which luminescence of the tube employed with such a maximum sensitiveness is started, to estimate voltage at said points.

Where the detector has a series of auxiliary conductors distributed over the whole length of the discharge tube as illustrated by Fig. 9, various sensitivenesses are available, all of which are greater than the self-sensitiveness of the tube proper. By employing such conductors successively, it is thus possible to estimate and compare potentials lower than the normal critical starting potential of the tube.

The auxiliary conductors may have any shape provided that display a substantial operative surface; but they may be metal tablets 13 (Figs. 17 and 18), electrically connected with an outer contact such as a metal knob 13a for example.

One of the conductors 3c may be located in cross plane EE (Fig. 9), wholly under sheath 4, so that luminescence generated between electrode 3 employed as an explorer and said conductor can be observed on a black background by looking obliquely.

It should be remarked that observation through oblique sight on an obscure background may also be effected with the arrangement illustrated by Fig. 1 and relying on the use of a strip; it is only necessary to omit window 5.

It is further possible to obtain a continuously varying sensitiveness by providing a movable auxiliary conductor. In such a case (Figs. 12 and 13), sheath 4 is preferably rigid in order that a space 9 can be provided between the inner surface of sheath 4 and tube 1, and a conducting ring or runner of any suitable shape 10 is movably housed in space 9 to slide freely on tube 1 within sheath 4. In this embodiment of my invention it is desirable that runner 10 can be brought as near as possible to electrode 2 and preferably just a longitudinal slot 6a, extending to a point proximate to electrode 2 will be provided in sheath 4.

When it is intended to explore an electrical field around a single conducting wire, a simple means for increasing the intensity of luminescence comprises placing at least partly around said wire, a conductor which is connected electrically with the exploring electrode or with which said electrode will be contacted.

By way of illustration, Figs. 14 and 15 show such a conductor in the form of a hollow attachment 11 which is arranged for removable fitting, is shaped as a T (Fig. 14) and is adapted to be connected electrically with electrode 2. The attachment as shown comprises a hollow cylinder 11a, having an inner diameter equal to the outer diameter of electrode 2 and a slit 11b for clamping on said electrode. Providing a cross extension of cylinder 11a, is a further cylinder 11c

having a longitudinal gap 11d which is wide enough to allow of introducing the field producing wire.

If a detector without any such attachment is brought near a wire the potential of which causes but a slight luminosity, it suffices to cap electrode 2 with the attachment 11 and pushing it to have said wire housed in cylinder 11c, for observing a very substantial amplification of luminescence.

With a view to enabling an easier axial observation to be effected by means other than described with reference to Figs. 1 and 2, I may in some cases employ cylindrical electrodes which are open at both ends as shown at 3f (Fig. 9). Luminescence can then be observed axially throughout the end surface of the tube in a zone fairly sheltered against extraneous light.

In order to clamp sheath 4 on electrode 3, a cap 12 (Fig. 16) which may be conducting or not and covers the corresponding detector end may be employed. Where an end of a detector provided with a cylindrical electrode as shown on Fig. 9 or an electrode having a sight aperture such as 2a (Fig. 1) is covered with such a cap, the cap may desirably be constructed to form a camera obscura with a sight hole such as 12a so that luminescence can be observed in better conditions. The cap may also be fitted directly on the electrode.

If the cap is conducting, it may be connected electrically with electrode 3 thereby increasing conductibility of the detector, or alternatively it may be insulated therefrom.

The metal conductors with which the tube is equipped and also the electrodes may be made of a material covered with a conducting surface on one or both faces thereof, for example with metallised paper or with metal or a conducting paint deposited directly on the tube glass or the sheath.

For improving visibility of luminescence, the inner surface of the sheath may be polished to reflect light rays towards the user.

Observation may be made easier by colouring the inner portion of the sheath and even the electrode and the conductors with a shade contrasting with the main radiations emitted by the tube, so that in particular the extent of luminescence can be appreciated accurately. Thus in the case of a tube emitting an orange red light, a sheath which is polished interiorly and is coloured in blue or green improves light perception through contrast.

An opaque sheath may be employed which has transparent sight zones instead of cut-out windows or apertures so that the sheath has a better firmness and the discharge tube is better protected. A windowless sheath may be made of a translucent or transparent insulating material, for example a plastic such as polyvinyl chloride, polyvinyl acetate and chloride copolymer, polyvinyl acetal, polyethylene, polystyrol, acrylic resin, silicone and the like.

The invention thus provides a light-weight, compact apparatus or instrument which by means of a discharge tube enables of detecting electric fields having widely different values, much lower than could be detected conveniently up to this time; it further enables of detecting a given field from a longer distance, and comparing and estimating electric potentials with an increased accuracy either as a consequence of the critical distance at which they are detected, or the luminous column length which varies as a function of the potential difference; it also enables of ascertaining the polarity and observing luminescence in improved conditions of light perception and visibility.

Then it will be possible to detect and compare more easily than before, voltage variations along conductors, which show defects in a circuit or abnormal conditions of use of electric energy, for example, in spark devices for internal combustion engines.

It will be obvious that the detector above described may be altered, particularly by substituting equivalent technical means without departing from the spirit of this invention as comprehended within the following claims.

What I claim is:

1. An electric field exploring instrument comprising in combination a pair of members, one of which is a closed light transmissive and dielectric tube containing a rarefied gas and the other an insulating sheath surrounding said tube and coextensive with a portion of the length thereof, said sheath being adapted to let luminescent rays emitted by said tube in operation pass therethrough at least at a point thereof intermediate its ends, a pair of tubular end electrodes surrounding the end portions of said tube respectively and supported from at least one of said members, at least a portion of at least one of said electrodes being left in outwardly exposed position, and electric conducting means held from at least one of said members, externally to said tube, between said first named electrodes.

2. An electric field exploring instrument comprising in combination a pair of members, one of which is a closed light transmissive and dielectric tube containing a rarefied gas and the other an insulating sheath surrounding said tube and coextensive with a portion of the length thereof, said sheath being adapted to let luminescent rays emitted by said tube in operation pass therethrough at least at a point thereof intermediate its ends, a first tubular electrode supported from at least one of said members and surrounding one of the end portions of said tube, at least a portion of said electrode being left in outwardly exposed position, a second tubular electrode inserted round the other end portion of said tube between said tube and said sheath, a cap-like member fitted on said sheath at said other end of said tube for providing a cover for said end; and electric conducting means, held from at least one of said first named members externally to said tube, between said first-named electrodes.

3. The combination of claim 2 wherein said cap like member is made of electric conducting material.

4. An electric field exploring instrument comprising in combination a pair of members, one of which is a closed light transmissive and dielectric tube containing a rarefied gas and the other an insulating sheath surrounding said tube and coextensive with a portion of the length thereof, said sheath being adapted to let luminescent rays emitted by said tube in operation pass therethrough at least at a point thereof intermediate its ends; a first tubular electrode slidably supported from at least one of said members, surrounding one of the end portions of said tube and having its outer end portion in exposed position, a second tubular electrode inserted round the other end portion of said tube between said tube and said sheath, an electric conducting cap-like member fitted on said sheath at said other end of said tube for providing a cover for said end; and at least an electric conducting element fitted between said tube and said sheath at least at a place between said tubular electrode and protruding through said sheath so as to have a portion thereof in outwardly exposed position.

5. An electric field exploring instrument comprising in combination a closed light transmissive and dielectric tube containing a rarefied gas, a sheath of insulating opacous material surrounding said tube and coextensive with the major portion of its length, a first tubular electrode slidably inserted over one of the end portions of said tube, between said tube and the corresponding end portion of said sheath and having its outer end portion in exposed position, a second tubular electrode fitted over the other end portion of said tube between said tube and the corresponding end of said sheath, said sheath being provided, between said tubular electrodes, with a first sight aperture located in close proximity to said first tubular electrode and with a second sight aperture coaxial with said first sight aperture and extending over the major part of said sheath between said first aperture and said second tubular electrode; an electric conducting strip like element fitted between said tube and said sheath at a place substantially between said sight apertures and protruding through said sheath so as to have a portion thereof in exposed position; and a cap like member of conducting material fitted on said sheath at said other end of said tube and providing a cover for said end.

6. The combination of claim 5 wherein the inner face of said sheath is adapted to reflect luminescent rays emitted by said tube in operation through said sight apertures.

LUDOVIC L. J. HIRBEC.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,531,301	Metzger	Mar. 31, 1925
2,132,427	McCauley	Oct. 11, 1938
2,252,638	McCauley	Aug. 12, 1941