

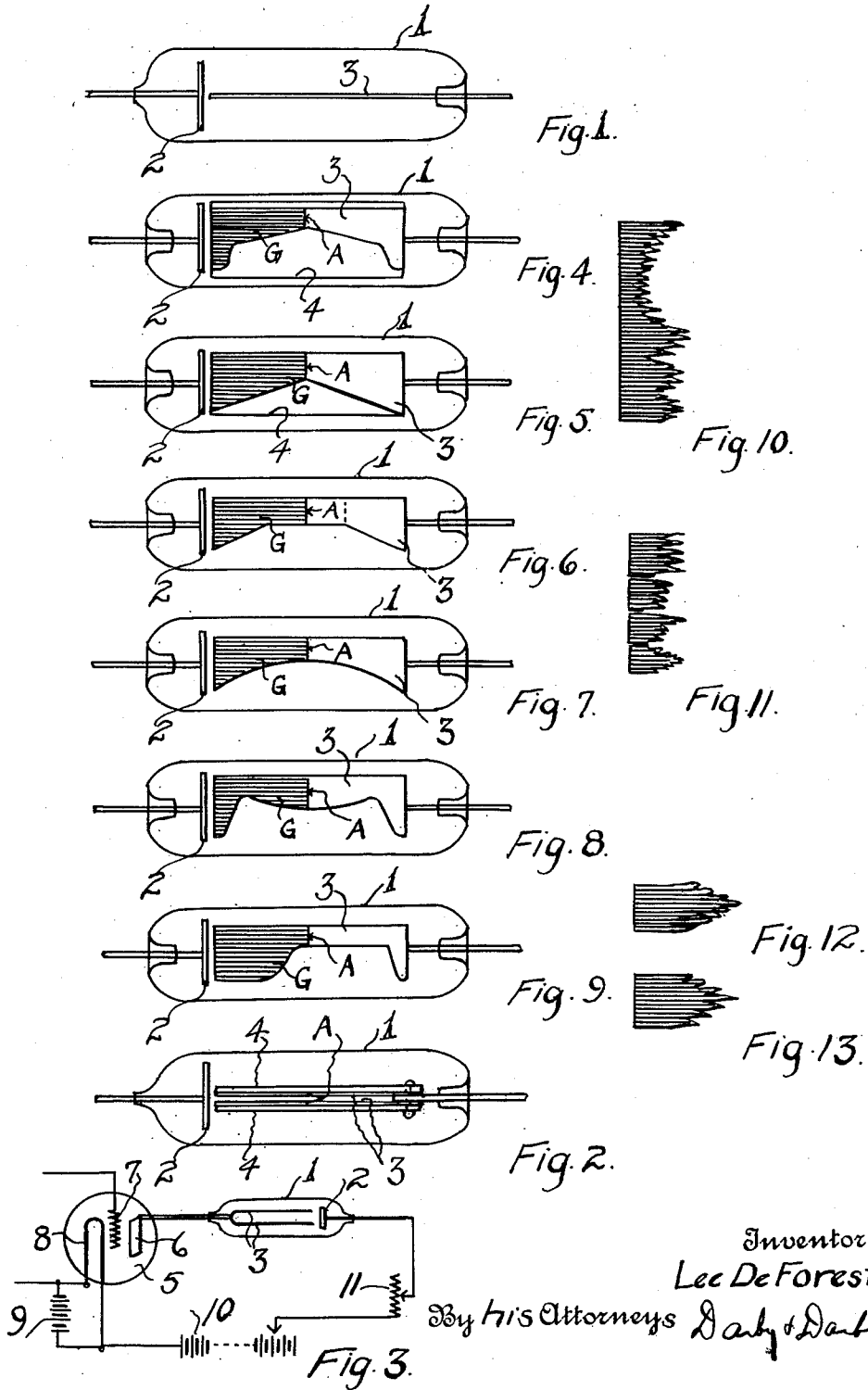
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LUMINOUS DISCHARGE DEVICE

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UNITED STATES PATENT OFFICE

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LUMINOUS DISCHARGE DEVICE

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This invention relates in general to improvements in the construction of luminous discharge devices, such as are employed in photographically recording sounds.

One of the objects of this invention is the construction of a cathode for luminous discharge devices, by means of which the amplitude of the higher sound harmonics when in the form of light are exaggerated.

A further object of this invention involves the construction of a cathode for luminous discharge devices of particular shape in order to insure sufficient light fluctuation to produce exaggeration of the sound harmonics represented by the fluctuating light.

A still further object of this invention involves a cathode for a luminous discharge device of such construction that the cathode is covered for substantially one half of its length under normal excitation, so that the extent of illumination which is fluctuating in accordance with sound waves being recorded will not vary sufficiently to entirely leave or cover the cathode.

These and other objects as will appear from the following disclosure are secured by means of this invention.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, all as will appear more fully hereinafter.

Referring to the drawings in which the same reference numerals will be used to indicate the same or similar parts in the different views,—

Figure 1 is an elevational view of an old type of luminous discharge device.

Figure 2 is an elevational view of a later improvement thereof.

Figure 3 is a diagrammatic representation of one method of connecting the luminous discharge device to an audion amplifier system.

Figures 4 to 9, inclusive, are elevational views of different forms of luminous discharge devices embodying the principles of this invention, as illustrated by the different form of cathodes. The portion of the electrode covered with glow is indicated by the legend G,

Figure 10 is a diagrammatic illustration of the type of sound record secured for luminous discharge devices known before this invention in which practically none of the higher harmonics appear.

Figure 11 is a diagrammatic illustration of a sound record, which has relatively flat tops and blank spaces, produced by known luminous discharge devices having a cathode of regular shape, such as for instance, as that shown in Fig. 1.

Figure 12 is a diagrammatic illustration of a sound record in which the higher harmonics are not sufficiently pronounced, so that the record of the higher harmonics shows rounded tops. Such a record is produced by uniform cathodes of the form shown, for instance in Figure 1.

Figure 13 is a diagrammatic illustration of a sound record produced by means of the device of this invention, in which the harmonics are exaggerated and show pointed tops.

As is well known in this art, there are two general forms of luminous discharge devices when judged in accordance with the form of sound record they produced. With one type the cathode is entirely covered with negative glow and when the device is operating for the purpose of recording sound waves this negative glow varies in intensity. In the other type of luminous discharge device the cathode is not entirely covered with negative glow and when the device is operating to record sound the extent which the cathode is covered with negative glow varies in accordance with the sound waves being recorded.

This invention is particularly related to the form of luminous discharge device in which the fluctuation in the extent of glow over the cathode is employed rather than the fluctuation in intensity thereof.

There has long been known in the art a glow lamp similar to the one shown in Figure 1, where one electrode 2, the anode, is in the form of a circular plate within an evacuated vessel 1, and the other electrode 3, the cathode is in the form of a long, thin and highly polished strip of metal preferably of nickle. As shown the axis of the long electrode 3 lies in the plane at right angles to the

plane of the electrode 2 and arranged so that the two electrodes are separated by a very small distance. It is usual to provide the vessel of such a device with a filling of the proper gas at the proper pressure, as for example, nitrogen at seven or eight millimeters of mercury pressure.

When the device is thus constructed a visible glow will extend from the end of the cathode 3 nearest to the anode 2 down over a portion of the surface of the cathode. The area of the cathode which is thus covered by the glow is directly proportional to the current passing through the tube. In other words, if a certain potential is impressed across the electrodes the visible cathode glow will extend for a certain distance, say for one-half inch over the surface of the cathode. If the potential across the tube is then increased a certain amount so that the amount of current passing through the tube is increased a definite amount, say twenty percent, then the area of the illuminated portion of the cathode is also increased twenty percent. It is understood that a definite direct potential is constantly impressed across the tube so at all time there is a portion of the cathode surface illuminated. This type of tube is known to physicists as a Gehrcke tube.

In the best practice in order to confine the glow to one surface of the cathode only, which is important for photographically recording electrical fluctuations, the lower side of the cathode and the edges also are usually protected by mica, or enameled. It may be pointed out here as is apparent from the drawings that the surface or outline of the cathode 3 is uniform.

A more recent development of this type of tube due to Gehrcke in which the cathode is in the form of a fork consists of two strips of metal 3 arranged parallel to each other and extending longitudinally of the vessel 1 terminating a short distance from the electrode 2. As before the surface of the cathode strips 3 are covered with a suitable insulating material as shown at 4, so that they are only exposed on the two adjacent sides which extend parallel to each other. The strips 3 are separated a short distance, as for example, one or five tenths millimeter. With this construction, the cathode glow is limited to the narrow space between the two exposed polished metal surfaces and is thereby sharply limited as to thickness and also somewhat intensified. The glow has been shown as extending to the point indicated by the letter A. This may for example define the limit of glow under a normal excitation when it is not being varied by sound fluctuations.

In making photographic records of this type of glow light oscillograph it is necessary to place the tube in the camera, so that the long axis of the tube is parallel to the plane of the moving film or photographic

plate on which the photograph of the oscillating glow light is being photographed and extending transversely thereof.

Figure 3 illustrates diagrammatically one method of connecting the luminous discharge device to the audion amplifier. The amplifier is indicated at 5 having a plate 6 connected to the cathode 3. A filament is shown at 8 energized by the current source 9. The output from the microphone or other device for changing sound waves into electrical variations is connected to the grid 7 and the filament 8. A source of high potential is indicated at 10 and is connected at one terminal to the filament 8 and at the other terminal to the electrode 2 through the variable resistance 11. The source 10 is a direct current source and supplies energy for the glow lamp. The current variations from the microphones are amplified by the audion 5 and impressed upon the glow light to vary its luminosity, (which is normally constant) in accordance with the sound waves. It is to be remembered that in this type of device, the extent of the glow on the cathode varies in accordance with the fluctuations caused by the sound currents from the amplifier. In other words, the point A (Figure 2) is moving back and forth longitudinally of the cathode 3 in amount depending upon the strength of the currents representing the sound being recorded.

As a variation, from the method of direct connection between the audion amplifier and the glow lamp the glow lamp may be coupled to the output of the audion amplifier either by a resistance, impedance or capacity coupling as is well known in the audion amplifier art. In all such cases an additional source of electromotive force must be employed for supplying the direct current normally flowing through the glow tube or photion oscillograph. When the glow tube is in series with the anode circuit of the amplifier tube the amount of plate current passing through the amplifier 2 is limited by that which the photion is designed to carry. The tube therefore must be designed, so that the normal current which lights half the cathode surface meets the requirements under which the amplifier tube best operates. When this is the case, however, the electromotive forces impressed across the two in series is then regulated until the glow light covers the cathode up to the middle line thereof as has been described in connection with Figure 2 and will be more particularly pointed out in connection with the other figures.

As indicated this type of Gehrcke oscillator has previously been used for recording high frequency electrical oscillations and sound vibrations when translated into electrical current. It is not intended to lay any claim to the invention of this type of tube

per se, or its application to sound photography.

The feature of this invention resides in the fact that I have discovered that with certain shapes of cathodes, it is possible to automatically emphasize or exaggerate the excursion of the glow back and forth along the surface of the cathode, and in a useful way, so as to thereby advantageously exaggerate the photographic record of certain sound frequencies over certain illuminated areas, which represent definite degrees of sound volumes. For example it has long been known in sound recording whether by phonograph or by photographic means that the higher harmonics are recorded and reproduced with relatively less intensity than are the low frequencies and fundamentals of sound waves. It is chiefly on this account due to the partial or complete suppression of the higher harmonics, that the quality of reproduced sound is so far inferior to the original.

Because there is so little energy in the waves represented by the higher harmonics, it is the purpose of this invention to devise a glow discharge device employing a cathode of such construction that the higher harmonics are exaggerated to overcome this defect.

I have found that by suitably shaping the cathode of the type of tube just described as shown in Figs. 4 to 9, inclusive, I am able to exaggerate or diminish as desired the photographic record of this sound when the volume of the sound as interpreted in electric currents applied across the electrodes of the tube is such as to bring the cathode glow over the certain portion of the cathode. For example, in Figure 4, I have shown the cathode strip 3 narrow at its center, very wide at its two ends and tapering in both directions away from the center, which is the narrowest portion. In the form shown in Figure 5, the cathode 3 is narrowest at its center and increases in width towards the ends in a linear ratio. The cathode in Figure 6 is of a constant width at the center for a short distance and then increases rapidly in width towards each end in a linear ratio. The cathode in Figure 7 is again narrowest at the center and increased in width therefrom to each end to form a circular outline or following a sine curve or exponential law.

In the arrangement of Figure 8, the cathode 3 is reversely curved, providing a greater width at the center, which curve at each end runs into a straight line, which tapers off rapidly towards the ends. But it is desirable to provide a cathode of considerable width at the ends for reasons which are stated hereinafter. As is apparent the central portion is larger than the portion to the right and left, but widens again at either end.

In the form shown in Figure 9, the cathode is shown of constant width intermediate the

ends. At one end the width increases very rapidly according to a linear function and at the other end increases along a curved line for a distance and then continues at a constant width to the end.

The advantage of having one or both ends of the cathode of large area is that with such an arrangement no matter what variations of current may be impressed across the tube the discharge will never seek either to extend beyond the limits of the cathode or to withdraw therefrom entirely. Either one of the above effects would be regarded in the photographic film as the equivalent of a blast or overloading of the system and would be represented as shown in the record in Figure 11, as flat top waves or of blank spaces in the record. Reproduction of sounds from such a record would be very imperfect.

The voltage normally impressed across the tubes to initially energize it should be such that when no sound is being recorded, the limiting line of the glow discharge lies substantially in the center of the cathode as has been indicated at A in various figures. When the current passing through the tube increases or diminishes in accordance with sound variations the travel of the delimiting line A of the cathode glow, right or left, is obviously much more rapid where the cathode is narrow than in the wider portions.

For example, employing a cathode of the type shown in Figure 6, the excursions of the glow, right and left of normal position is very rapid until the points where the electrode begins to widen are reached, whereafter, the movement right and left of the edge of the cathode glow is slower. This means that in the lower range of sound intensity the amplitude of the light excursions are exaggerated relatively to which they are in the higher ranges of sound intensity. In other words, the photographic reproduction of weak sound intensities is proportionally better than for the large sound intensities. The idea is perhaps more clearly expressed in Figures 12 and 13.

Figure 12 represents a photographic record from a tube employing a cathode of uniform cross section. It represents a fundamental sound wave embellished by various harmonics. It is pointed out that the harmonic peaks are rounded, which is not conducive of good sound reproduction.

Figure 13 shows a record of the same sound wave from a non-uniform cathode, such as that shown in Figure 6. It is noted that the harmonic of lower sound volume in Figure 12 are more comprehensive than those in Figure 13 although the amplitude of the fundamental is the same in both cases. Experience teaches that it is necessary in order to secure as perfect sound reproduction as possible, that the higher harmonics should be exaggerated relative to the fundamental in the record.

In a certain type of sound for example from certain forms of musical instruments or of musical compositions, it may be desirable to overemphasize the harmonics or the glow light excursions representing these at the extremes of the excursion of the glow light. In other words, the sound volume is large relative to the record obtained when the sound volume is small. For this purpose a cathode shaped as shown in Figure 8 is employed. Normally the excursion of the cathode glow should not extend right and left beyond the points determining the ends of the curved line, but should an exceptionally loud sound be recorded the sudden enlargement of the cathode area at the ends thereof insures that the excursion of the cathode light will not extend beyond the limits of the cathode. This is because the much larger area at the two ends insure that the cathode light travels relatively very slowly as it approaches either end of the cathode. As a result in a photographic record the peaks of the wave, high or low, will be thereby subdued and rounded off rather than extend beyond the limit of the photographic track, which would result in a square topped wave as illustrated in Figure 11, with a consequent introduction of false harmonics and bad reproduction resulting therefrom. For certain types of sound records it may even be desirable to make the record quite asymmetric relative to the central or normal position of the glow light boundary line when no sound is being recorded.

An arrangement for accomplishing this result is shown in Figure 9, where the excursions to the left of the normal position are relatively small compared with the exaggerated excursions of the light limit above the normal position. This arrangement results in exaggerating the peaks of the photographic record, and minimizes the valleys below the medium line of the record. Also the cathode can be reversed so that the narrow position extends towards the anode and the broad portion away from the same. Such an arrangement as this results in a photographic record where the valleys of the graph are exaggerated below the medium line and the peaks above the medium line are diminished.

For the ordinary recording of the sound I have found that a symmetrically distorted shape of cathode such as those shown in Figures 4 to 8, inclusive is preferable.

As referred to in connection with Figure 2, the cathodes in the various forms shown in Figures 4 to 9, inclusive may be provided on one side with an insulating material, such as mica or enamel to confine the glow to one surface only. It is also to be distinctly understood that in the forms of devices shown in Figures 4 to 9 inclusive, that two metal strips 3 of the same shape may be disposed

parallel to each other and separated by a small distance, in the manner indicated in the construction in Figure 2.

It is obvious that various applications of the principles which I have here explained may be made so that the photographic sound record may be distorted in anyway that may be found desirable, by simply so shaping the cathode area as to produce the desired distortion in the photographic record. The chief advantage of the method which I have outlined is to emphasize the higher harmonics of the recorded sound which are normally of relatively low intensities, and are as a consequence inadequately recorded and inadequately reproduced by the reproducing system, particularly the loud speaker elements thereof.

I do not therefore desire to be limited to the physical forms illustrated in the disclosure, but rather to any form of device employing the principles of this invention and particularly to the scope of the invention as it has been defined in the appended claims.

What I seek to secure by the United States Letters Patent is:

1. In a glow light for use in photographically recording sound waves the combination comprising an evacuated vessel, an anode in said vessel and a cathode of uniform thickness, the width of which varies along its central axis so that a varying voltage across the electrodes will produce a varying negative glow which is exaggerated.

2. A sound recording glow light of the variable extent of glow area type, comprising an evacuated vessel, an anode and a cathode consisting of a flat plate or strip of constant thickness, the width of which varies along the central axis thereof so that the varying glow thereon will be distorted.

3. A sound recording glow lamp of the type described comprising an evacuated vessel, an anode, and a cathode comprising two parallel strips of metal of uniform thickness and of varying width facing each other and separated by a distance which is small relative to the width of the cathode strips.

4. In a sound recording glow light of the type described the combination comprising a vessel and anode in said vessel and a cathode of varying width so as to produce irregular excursions of cathode light over portions thereof with respect to a variable voltage impressed across the electrodes.

5. A sound recording glow discharge device in which the negative glow varies in extent having a cathode of varying width which is wider at the ends than at the center.

6. A sound recording glow discharge tube of the type in which the negative glow varies in extent having a cathode which is wide at the ends and which varies in width from the ends towards the center.

7. In a sound recording glow discharge

tube in which the negative glow varies in extent, a cathode consisting of a metal strip varying in width along regular lines from the center to the ends, so that the ends are of the greater width.

5 8. In a sound recording glow discharge tube in which the negative glow varies in extent, a cathode consisting of a metal strip varying in width along regular lines from the center to the ends so that the cathode is the widest at least at one end.

10 9. In the method of making photographic sound records with a glow discharge, the step of varying the extent of the glow discharge so as to exaggerate its amplitude of variation in certain known and predetermined portions of its movement, independent of the relative amplitude of the original sound waves being recorded.

15 10. In the method of making photographic sound records with a luminous gas discharge device connected to the output of an amplifier which itself may produce distortion, the steps of varying the luminous discharge of the device independent of any distortion produced by said elements in a degree either less than or greater than the degree proportional to the varying sound currents causing the variation.

20 11. A sound recording glow light of the type described comprising an evacuated vessel, an anode and a cathode in said vessel, said cathode varying in width from its center towards both ends.

25 In testimony whereof I have hereunto set my hand on this 30th day of July, A. D. 1928.

LEE DE FOREST.