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ELECTRON TUBE

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Fig. 1

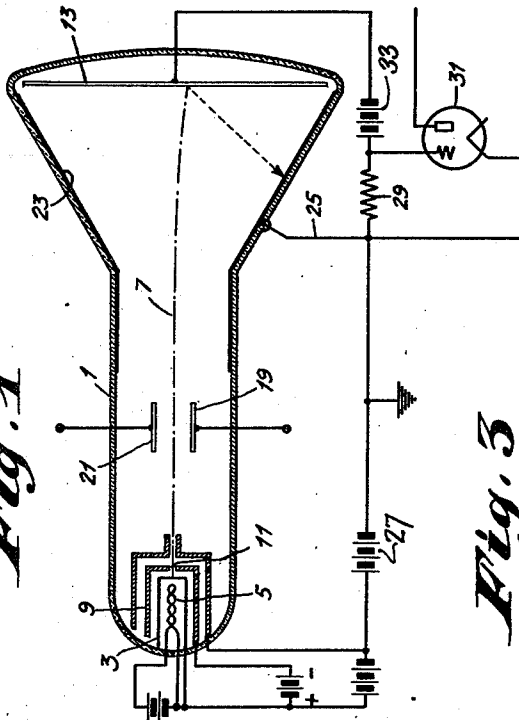


Fig. 2

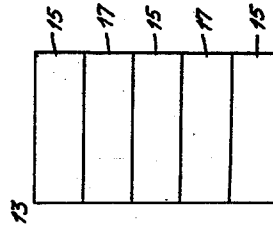
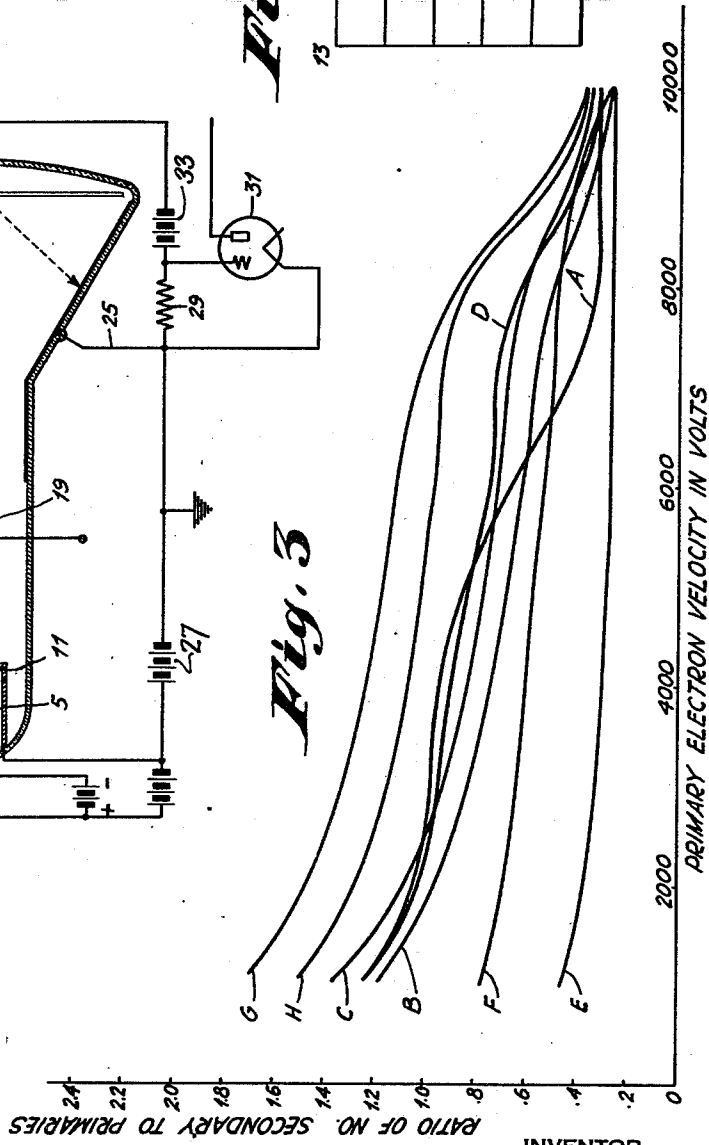


Fig. 3



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ELECTRON TUBE

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6 Claims. (Cl. 250—27.5)

The present invention relates to electron tubes and to methods of constructing and operating the same.

More particularly the invention relates to electron tubes of the cathode ray type which are particularly suited and adapted for use as frequency multipliers. Further, the invention relates to electron tubes wherein the operation is a function of different degrees of secondary emission characteristics of various metals and compounds of metals under the bombardment of cathode rays of primary electrons striking the same at varying voltages, for example, within the range from 1,000 to 10,000 volts, although it is to be understood that the examples herein suggested are in no sense critical and while the voltages above suggested have been found to be satisfactory the voltage variations can be changed throughout wide limits without in any sense affecting the operation or departing from the spirit and scope of this disclosure.

It is known that different substances have widely differing secondary electronic emission properties. In fact, it has been established by this invention that with tubes of the cathode ray type which utilize a cathode ray projected by an electron gun and a circular metal plate, for example, upon which the electrons impinge that tubes constructed with different sectors of carbonized nickel, bright metal surface, metals coated with willemite, carbonized nickel sectors, untreated copper, and the like, cause the production of varying currents. These currents can be made to flow either to or from the plate depending upon whether the electron beam is directed on a sector, such as bright nickel or willemite, giving up more than one secondary electron per primary electron or upon a sector, such as carbonized nickel, giving up less than one secondary electron per primary electron. If the plate of such a type tube is connected in a high resistance circuit of several megohms or more high differences in voltages can be developed at the plate, depending upon the secondary emission properties of the particular sector upon which the electron beam is at the particular instant focused.

From these experiments it is apparent that a tube constructed with a plate or anode member formed with alternate sectors or surfaces of materials having differing secondary electronic emission properties, such as carbonized nickel and willemite or bright nickel, may be used as a frequency multiplier. To produce this frequency multiplication the developed cathode ray stream is caused by means of appropriate scanning con-

trol to pass rapidly over the specially constructed plate member. The frequency developed is then a function of the rapidity at which the cathode ray pencil is caused to shift from one to another of segments of differing electrical properties and of the number of segments traversed by the beam. The generated wave form is dependent upon the shape of the segments used and of the materials of which they are formed.

An important advantage of the type of tube above described over the usual type of frequency multiplier, such as is already known in the art and which has been illustrated and described by United States Patent #1,613,626 granted on January 11, 1927 to Van Der Bijl, resides in its low internal capacity. This is because of the fact that with my new form of tube it is not necessary to have two plates close together and to scan the beam from one to the other but rather by relying upon the differing secondary electron emitting characteristics of different sectors of a single plate it is possible to provide the change in direction of current flow. Secondary electrons are removed by forming the inner tube wall with a conducting coating, such as a silver film, to which a suitable voltage is supplied.

The basic principle involved in the present invention is the generation of specific and various wave shapes through the medium of an electron beam directed upon various substances whose secondary emission activity ratio is more than one and less than one. The shape of the generated wave is controlled by shaping the various substances or materials, by the speed of motion of the electron beam across the surface of the material, and by the circuit in which the impulses so developed and generated will be used. Where desired, the various plates or sectors may be arranged in circular formation and the cathode ray pencil may be caused to rotate by the use of two deflecting fields acting normally at right angles to each other. It also is possible to provide the same results by arranging a plate formed of alternate sections of materials of differing secondary emission properties adjacent one another and to deflect a cathode ray beam across such a plate in one direction only so as to cause the beam to traverse and then to cause the beam to re-traverse the same sections at an identical rate in the opposite direction.

In accordance with the principles outlined in this invention, therefore, it is possible to produce in any type of external circuit differing voltage characteristics. With this thought in mind it is an object of the present invention to provide a

cathode ray tube which is ideally adapted for use as a frequency multiplier, or as a storing device for electricity, which is simple in its construction and arrangement and one in which the effects of inherent capacity between existing electrode members within the tube are completely avoided.

A preferred, although not limiting, form of the invention is shown by way of example in the accompanying drawing, wherein:

Fig. 1 illustrates a cathode ray tube of suitable type and arrangement;

Fig. 2 illustrates in further detail the arrangement of the anode structure formed of adjacent sections of material having differing secondary electronic emission properties; and

Fig. 3 is a graphical representation of the secondary emission activity from different metallic surfaces wherein the ratio of the number of secondary electrons to primary electrons is plotted against the primary electron velocity in volts.

If reference is now made to the drawing, there is provided within the tube envelope 1 a source of electrons in the form of a cathode member 3 which may be suitably heated by means of a heater element 5 supplied with energy either from a direct current or an alternating current source of any suitable type. The electrons developed are caused to flow in the path designated as 7 by applying to the anode member 9 of the tube a suitable operating voltage which may be of the order of 1,000 volts, for example. The electron beam, which may be of any appropriate cross-sectional form is controlled by the aperture 11 within the anode member 9. Preferably, this is of an elongated formation and, similarly, the emitting surface of the cathode 3 is also elongated.

The generated electron beam or stream 7 is directed toward the anode member 13 formed from various segments 15 and 17. Each adjacent segment of the anode has a differing secondary electronic emission property from the adjacent section, as will hereinafter be illustrated more particularly. In cases where the beam 7 is of elongated form substantially the entire transverse width (that is, a strip similar to the cross-section of the electron beam) of the plate 13 may be subjected to the impact of the electron stream. Where desired, however, the electron stream 7 may be in the form of an electron pencil and so arranged as to strike only a predetermined elemental section of the anode member 13. The plate area 13 composed of the two materials of different secondary electronic emission properties may be formed for example, by attaching strips of one type of material to a complete section of another type of material by welding or other suitable means.

If suitable deflecting voltages are applied to the deflecting electrodes, herein conventionally illustrated as electrostatic deflecting members 19 and 21, although electromagnetic deflection might be substituted without departing from either the spirit or scope of the present invention, the cathode ray stream 7 may be caused to move across the anode member 13 at a rate corresponding to the frequency of the control voltage supplied to the deflecting plate members 19 and 21 from any suitable external source of which, for example, it is desired to multiply the frequency.

Within the conical portion of the tube wall and within the area adjacent the secondary anode member 13 there is formed on the inner surface a conducting surface 23, usually in the form of a silver deposit, to which contact is made by way of the terminal point 25. To this area or con-

ducting surface 25 is supplied a high operating voltage from a suitable source 27 which is higher in voltage than the source supplying the first anode member 9. In the operation of a tube of the present type in which the secondary anode member is composed of alternate sections 15 and 17 of materials having different secondary emission properties from which the secondary emission activity is more than one in one instance and less than one in another instance it is possible to form one series of sections, for example, of carbonized nickel and the other series of sections, for example, may be formed of bright nickel. Similarly, other materials such as carbonized nichrome and untreated copper, or any of the other suitable materials, might be used. If, for example, carbonized nickel strips are welded to predetermined sections of a bright nickel screen to form the structure above described it will be understood that the entire structure is so arranged that it is parallel to the cathode member from which the ray emanates and so that a plane surface is presented to the incident beam. The carbonized strips are preferably of equal width and so spaced upon the screen structure as to expose alternately equal mesh sections to the incident beam of electrons.

Several of these materials have been identified by Fig. 3 of the drawing.

Each curve of Fig. 3 represents the ratio of secondary electrons to primary electrons at different electron velocities. In this figure the curve A illustrates the secondary emission activity for an untreated zirconium sheet; curve B indicates the secondary emission activity from bright nickel mesh on nickel; curve C is the same for a bright nickel sheet; curve D is for nichrome fired at 1,000 in H₂; curve E is for carbonized nickel; curve F is for carbonized nichrome; curve G is for an untreated copper sheet; and curve H is for sand blasted treated molybdenum. The curves designated by Fig. 3 of the drawing were obtained after heat treating the entire target in vacuum for approximately five minutes at approximately 700° C.

When a stream of cathode rays is incident upon a carbonized strip a given current will be produced in the external anode circuit including the silvered screen member 23, the conductor 25, the resistor 29, the source of voltage 33 to the electrode structure 13. When the beam is moved so as to intersect the bright nickel segments a reduction of the current from that previously existing in the above outlined circuit takes place by reason of the secondary electrons being attracted to the silvered anode. Therefore, in accordance with the rate at which the electron pencil is moved across the different sections of the secondary anode member 13 depends the rate at which the voltage drop developed across the resistor 29 changes and consequently the change in the current flow through the amplifier tube 31 connected across the resistor 29 is correspondingly proportional. Thus, in the output circuit of the tube 31 a frequency which is equal to the deflection frequency multiplied by the number of separated electrodes 15, 17, 15, 17, etc., can be generated.

The frequency of the developed energy may be expressed mathematically as follows:

$$F = N_e f = (N_o - 1) f$$

where f is the frequency applied to the deflecting electrodes; N_o is the total number of strips or plates 15 and 17 if an even number; N_o is the

total number of screen strips or plates if an odd number; and F is the developed frequency appearing in the external circuit. This equation indicates the great degree of frequency multiplication possible with this type of tube. However, if a special case where $N_0=1$ is assumed the result will be direct current flowing in the anode circuit, which is a condition to be expected from the unidirectional flow of the electrons from the emitting cathode.

If, however, the plates are arranged in a circular order, that is, so each plate is sector-shaped, and alternate plates are of different characteristics, the developed frequency will then be a function of the number of pairs of plates, since for one complete cycle of the impressed frequency the cathode ray beam or pencil will traverse each segment once. This feature may be expressed mathematically by the equation $F=Pf$, where F is the frequency set up or developed in the external circuit, P represents the number of pairs of plates, and f is the frequency applied to the deflecting plates to deflect or sweep the cathode ray beam across the plates.

Many changes in the general characteristics of the invention, of course, may be made without departing from the spirit and scope of the above outlined disclosure and I therefore believe myself to be entitled to make and use any and all of these changes provided they fall fairly within the spirit and scope of the hereinafter appended claims.

Having now described my invention, what I claim and desire to secure by Letters Patent is the following:

1. An electron device comprising an electron source for producing a beam of electrons, a target formed of a plurality of sections of material, each section facing said electron source, each capable of emitting secondary electrons under the influence of a cathode ray, said secondary emission being of different magnitude for dissimilar sections, and means to deflect the electron stream developed to cause the beam to traverse in sequence the sectional target.

2. An electron discharge device having therein an anode electrode formed from a plurality of sets of conducting sections having differing secondary electronic emission properties upon impact of an electron stream thereupon, the emission from one set of sections being greater than one secondary electron per primary electron and the emission from a second set being less than one secondary electron per primary electron.

3. An electronic device comprising a cathode and an anode between which an electron stream

is produced, an auxiliary anode formed of a plurality of adjacent sections, said sections alternately having the property of emitting more than one secondary electron per primary electron impinging thereupon and less than one secondary electron per primary electron impinging thereupon, terminal points for connecting an output circuit to the auxiliary anode, means for deflecting the electron stream developed across all of the sections of the auxiliary anode at a rate corresponding to the frequency of the deflection, and a layer of conducting material upon the inner wall of said tube to receive said emitted secondary electrons.

4. Electron apparatus comprising a cathode and an anode, means for producing therebetween an electron stream, a multi-section auxiliary anode in the path of the developed electronic stream, said auxiliary anode being formed of alternate sections each being adapted to emit secondary electrons under the influence of the developed electron stream, and the respective sections having differing secondary electronic emission properties, and means for causing the developed electron stream to traverse the screen in complete traversals at a rate equal to the frequency of which a sub-multiple frequency is desired.

5. An electron discharge device which comprises means for generating an electron beam and an anode electrode formed from a plurality of sections of material having alternately high and low secondary electronic emission properties and located in the path of the generated beam, said anode sections being such that the emission of secondary electrons from one set of sections of the anode is greater than one secondary electron per primary electron of the beam and so that the emission of secondary electrons from the other set of sections of the anode is less than one secondary electron per primary electron of the beam.

6. An electronic device for producing multiplication frequencies comprising an anode and a cathode between which an electron beam is developed, such anode comprising a plurality of sections, each adapted to emit secondary electrons under the influence of the electron beam, the alternate sections emitting more than one and less than one secondary electron per primary electron impressed thereupon respectively, and means for deflecting the electron stream from one to the other of the sections of the anode in sequence.

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