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A. E. ANDERSON
CATHODE-RAY DEVICE

2,540,835

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2 Sheets-Sheet 1

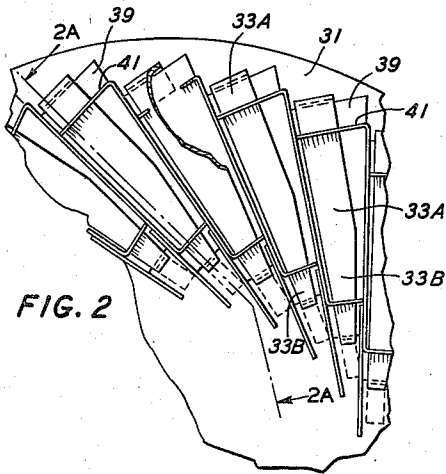
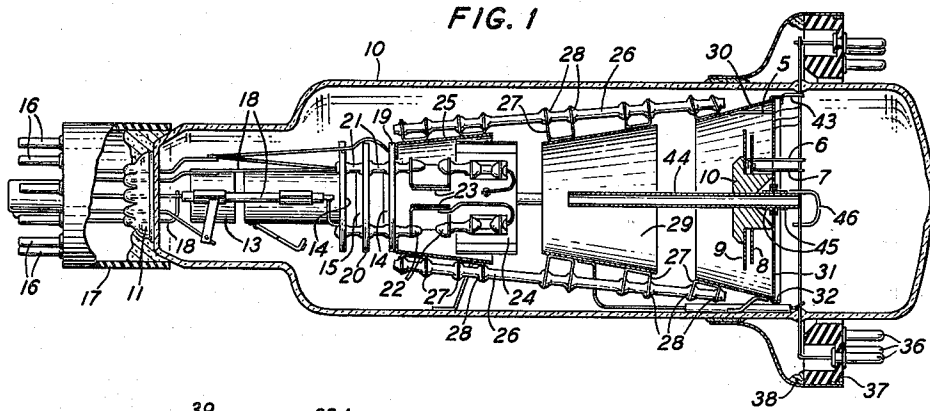


FIG. 2A

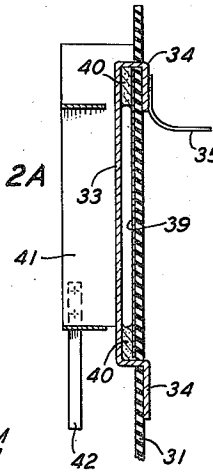
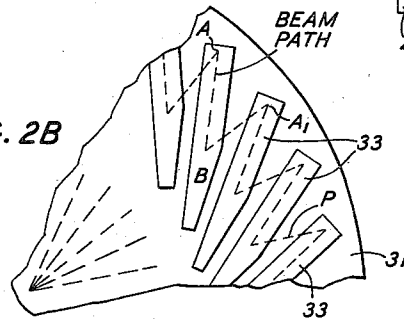


FIG. 2B



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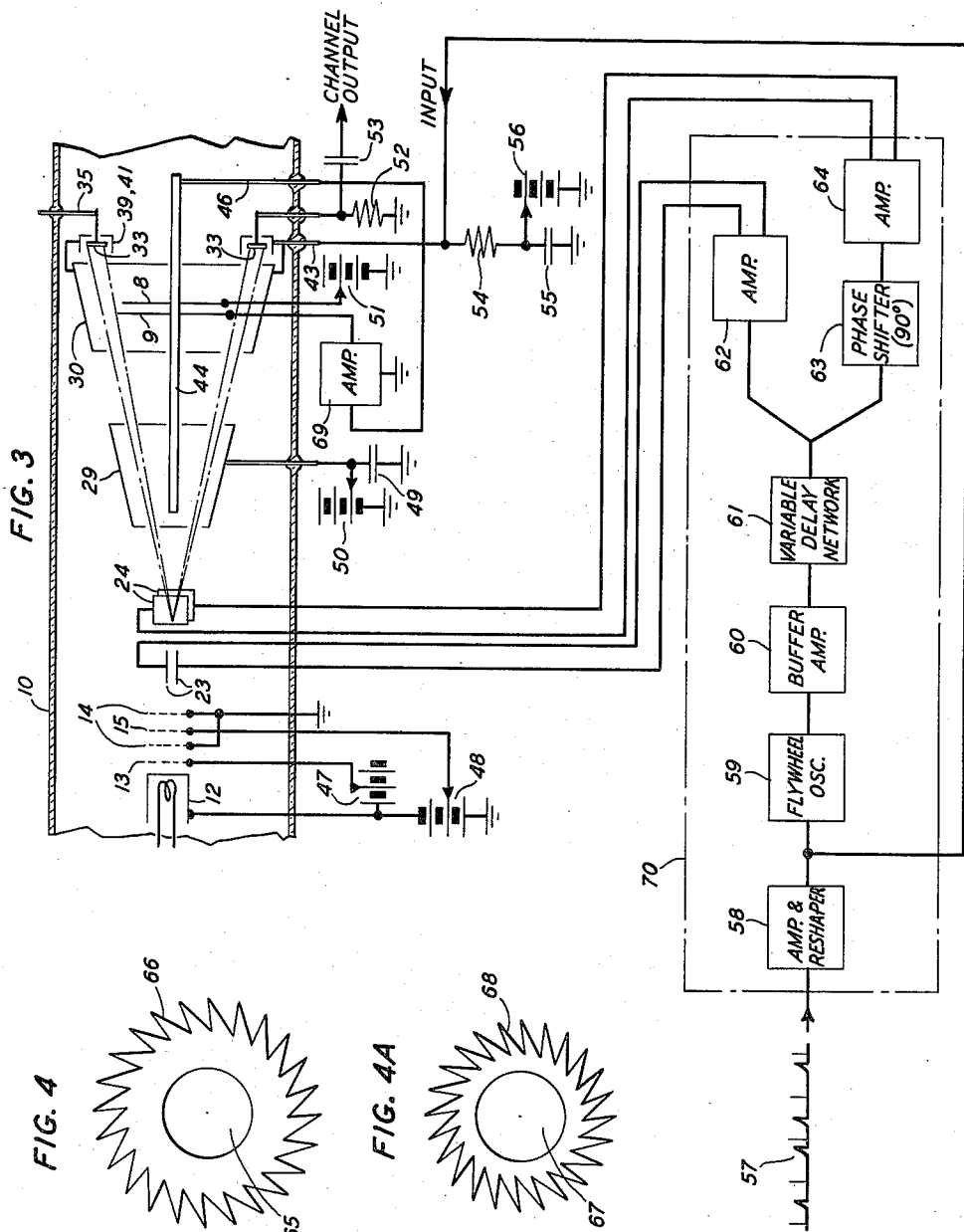


FIG. 4

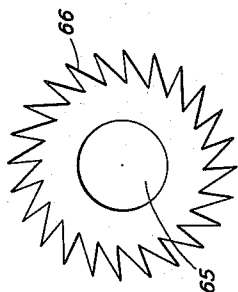
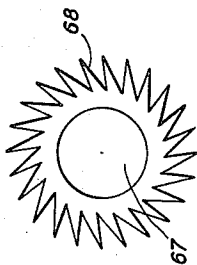


FIG. 4A



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UNITED STATES PATENT OFFICE

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CATHODE-RAY DEVICE

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This invention relates to electron discharge devices and more particularly to devices, such as are utilized in some forms of multichannel or time division multiplex communication systems, wherein the electron beam is guided to follow an exact prescribed path.

There are cathode-ray or electron beam devices in the prior art which require that the beam follow a closely defined predetermined path as it sweeps across the target or targets. Many of these depend on deflection plates to guide the beam over the desired path. This method, however, has been found to have some disadvantages inasmuch as the voltage source energizing the deflection plates has irregularities therein which are manifested in irregularities in the path of the electron beam. The use of a beam guide to intercept part of the beam and thus control the path of the beam by feedback to the deflection system has also been suggested. See, for example, the application Serial No. 715,901, filed December 13, 1946 of R. W. Sears. However, in cases where it becomes necessary to turn the electron beam off for an appreciable portion of its sweep, it has been found that the use of the beam guide is impracticable since a portion of electron stream is required to be continuously intercepted by the beam guide in order to make the beam guide operative. In a time division multiplex communication system, such as pulse position modulation, utilizing a cathode-ray device, it is ordinarily necessary to turn the beam off for a large portion of its sweep.

It is an object of this invention to allow the electron beam to remain on during its entire sweep so that a beam guide may be utilized to cause the beam to follow a closely defined predetermined path.

A further object of this invention is the improvement of cathode-ray devices requiring the electron beam to follow an exact path and more specifically improvement of time division multiplex communication systems utilizing a cathode-ray device.

Another object of the invention is to increase the accuracy of reproduction of intelligence transmitted by multiplex systems.

One feature of this invention involves the simulation of turning off the electron beam when desired by changing the target collector voltage so as to prevent secondary emission electrons from collecting thereon.

In one illustrative embodiment of the invention, a discharge device comprises means for generating an electron beam, means to accelerate

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the beam, deflection means to define the path of the electron beam, and a target unit. This unit may comprise a plurality of individual targets across which it is desired to sweep the beam along a definite path.

A beam guide having a shape geometrically similar to the desired path of the electron beam is placed between the cathode and the target. A portion of the electron stream is intercepted by the beam guide. By means of a feedback network to the deflecting means, the path of the beam is maintained so that a constant portion of beam is intercepted by the beam guide. Secondary electron emission from the targets is collected on collector plates associated therewith. The output of the system can be taken from the targets or, if desired, from the collector electrodes if the collector electrodes are made individual to the associated target. In accordance with a feature of the invention, a circuit is provided which will cause the potential of these collector electrodes to become sufficiently positive to collect secondary electron emission only when an incoming pulse is impressed thereon, thus allowing the beam to remain on at all times.

The invention and the above-noted and other objects and features will be more clearly understood from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is an elevational view mainly in section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is a fragmentary plan view showing details of the target and collector electrode assembly included in the device shown in Fig. 1;

Fig. 2A is a view in section taken along line 2A-2A of Fig. 2;

Fig. 2B is a diagram illustrating the beam path or trace at the target and collector electrode assembly;

Fig. 3 is a circuit schematic illustrating one manner in which the device shown in it may be operated;

Fig. 4 is a front view of the beam guide; and

Fig. 4A is a front view of the collector plate located directly behind the beam guide with respect to the cathode of the device.

Referring now to the drawing, the electron discharge device shown in Fig. 1 comprises an evacuated vitreous enclosing vessel 10 having an external stem 11 at one end from which an electron gun and deflector plate assembly is supported. The electron gun, which may be of generally conventional construction, comprises a

cathode illustrated at 12 in Fig. 3, which is encompassed by a cylindrical control electrode 13 and focusing and accelerating electrodes 14 and 15 in colinear array therewith, the several electrodes being connected to respective terminals 16 upon a base 17 by leading-in conductors 18. The focusing and accelerating electrodes 14 and 15 are associated in colinear relation by discs or platforms 19 and 20 mechanically coupled in fixed relation by insulating masses 21.

Supported from the disc or platform 20 by insulating bodies 22 are two pairs of deflector plates 23 and 24, the two pairs being in spaced quadrature and the plates being connected electrically to respective terminals 16 by associated leading-in conductors 18. Also supported by the disc or platform 20 and coaxial with the gun electrodes is a frusto-conical metallic shield 25.

A plurality of rigid insulating supports or rods 26 are secured to the shield 25 by U-shaped brackets 27 affixed to the shield, as by welding, and to the rods as by masses 28 of insulating cement. The supports or rods 26 mount a frusto-conical deflecting electrode 29 and a metallic shield 30, both coaxial with the electron gun and secured to the rods by brackets 27 and masses 28 of insulating cement.

In the embodiment described herein, the shield 30 mounts a target and collector electrode assembly which, as shown in detail in Figs. 2 and 2A, comprises a circular insulating disc 31, for example of mica, seated upon an internal flange or shoulder 32 on the shield. The assembly also includes a plurality, for example 24, of identical target electrodes disposed at equal angles to corresponding radii of the disc 31, each of the target electrodes comprising a rectangular portion 33A and an inwardly tapered portion 33B and having bent end parts 34 defining locating tabs extending through slots in the disc 31. The target electrodes are of a material such as, for example, silver-magnesium alloy, having a coefficient of secondary emission greater than unity. Alternatively, the faces of the target electrodes toward the electron gun may be coated with a material having a high secondary emission coefficient. Individual electrical connections to these electrodes may be established by leading-in conductors 35 which are sealed through the side wall of the enclosing vessel 10 and are connected to terminals 36 carried by an insulating support 37 within a dished shield 38 secured to the vessel 10.

The assembly includes also a plurality of metallic shield-collector electrode elements, one for each of the target electrodes. Each of these elements comprises a base portion 39 seated upon the insulating disc 31 and affixed to the respective target electrode by masses 40 of insulating cement and comprises also an integral upstanding Z-shaped portion 41, the intermediate part of which as shown in Fig. 2 extends between adjacent target electrodes. The several shield-collector elements are tied together electrically by connecting tabs 42 and are connected to one of the terminals 36 by a leading-in conductor 43.

The target electrodes and shield-collector elements, it will be noted, constitute a plurality, e. g. 24, of substantially identical units mounted in circular array coaxial with the electron gun. As will be pointed out in detail presently, the elements function to collect secondary electrons emanating from the target electrodes. Also, these elements and specifically the upstanding portions 41 thereof shield and segregate adja-

cent target electrodes from one another. Particularly advantageously the elements 39 and 41 are treated or coated to minimize secondary electron emission therefrom.

Extending coaxially within the deflector electrode 29 is a second, cylindrical deflector electrode 44 which is supported from the disc 31 by flanges 45 affixed to the electrode 44 and locking it to the disc 31. Electrical connection to the deflector electrode 44 may be established by way of leading-in conductor 46 connected to one of the terminals 36.

Insulator 10 is secured by electrode 44 which passes therethrough. Supported by insulator 10 are a beam guide 9 and a beam guide shield 8 with attached conductors 6 and 7 respectively. Conductors 6 and 7 are connected to conductor 35 which in turn is connected to one of the pins 36.

In the operation of the device, as illustrated in Fig. 3, the electrodes constituting the electron gun are energized appropriately to produce a concentrated electron beam which is projected between the deflector plates 23 and 24. These plates are energized from a source 70 to produce a circular motion of the beam. Source 70 comprises a fly wheel oscillator 59, the frequency of oscillation of which is controlled by the incoming pulses 57 after they have passed through amplifying and reshaping means 58. The oscillations after leaving means 59 pass through buffer amplifier 60 and then through variable-delay network 61, the function of which is to permit a vernier adjustment of the electron beam sweep with respect to the incoming pulses applied to the collector electrodes 39 and 41, the operation of which will be described in more detail later. From network 61, the voltage signal goes through an amplifier 62 to one set of the deflection plates 23. The voltage is also applied to the other set of deflection plates 24 through 90-degree phase shifter 63 and amplifier 64.

In one preferred embodiment, deflection plates 23 and 24 impart only a very small deflection to the beam barely enough to start a circular trace, and then a radial deflection means 29 and 44 is used to enlarge the envelope to the desired size. In this fashion, the ellipticity of the path of the electron beam due to the colinear arrangement of the deflecting plates 23 and 24 remains but is highly mitigated in proportion to the total amplitude of the sweep since the greatest part of the deflection by far is contributed by the radial deflection field generated by elements 29 and 44.

Element 29 has a variable voltage of from zero to approximately 200 volts from a source 50 applicable thereto by a conductor grounded through capacitance 49. A portion of the beam is intercepted as it passes by beam guide 9 causing secondary emission from said beam guide. This secondary emission is collected by beam guide collector electrode 8 since a positive voltage 51 with respect to the beam guide is applied thereto. Since the coefficient of secondary electron emission of beam guide 9 is larger than unity, the number of electrons leaving beam guide 9 is greater than the number of electrons of the electron beam striking it, and there is therefore a resultant current flowing from the beam guide 9 to beam guide collector electrode 8 through amplifier 69. This current signal is detected by amplifier 69 and impressed after proper amplification upon cylindrical deflector electrode 44 to cause a change of deflection of the electron

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beam as it sweeps around element 44. The polarities involved and the amplifying system utilized are so adjusted that a constant portion of the beam will always be intercepted by beam guide 9 and therefore the electron beam is constrained to the periphery of the beam guide.

The electron beam then strikes the target electrode such as 33 shown in Fig. 3. Secondary electron emission occurs from these target electrodes when they are thus struck by an electron beam and this secondary electron emission will be collected by collector electrodes 39 and 41 as the collector electrodes 39 and 41 are at a sufficiently positive potential with respect to target electrode 33. Ordinarily, when an incoming pulse is not present, the collector electrodes 39 and 41 are at an insufficient potential to collect secondary electron emission from target electrodes 33. Therefore, substantially all of the secondary electron emission from the target electrode 33 caused by the electron beam impinging thereon, will be reclaimed by said target electrode 33 and consequently the current in the associated output channel which is directly connected to the target 33, will be substantially equal to the electron beam current. By the proper use of filters, this small current can be altered so that it is not much more than a small, substantially direct-current voltage in the output.

Assume now that the electron beam is passing over a target 33 when an incoming pulse occurs. This incoming pulse, as shown in Fig. 3, will pass through amplifier and reshaping means 58 and then will be applied to collector electrode 39, 41 and will raise the potential of said collector electrode to a value sufficient to collect substantially all of the secondary emission electrons from target 33 as a result of the electron beam striking said target. This will cause a relatively large current flow, substantially equal to the secondary electron emission minus the electron beam current, in the target electrode circuit 33 and consequently in the channel output circuit. It can thus be seen that the striking of the target by the electron beam is only effective to produce a signal in the output circuit when an incoming pulse is applied to the collector electrodes 39 and 41. Thus, the beam may be left on at all times and, because of the beam guide 9, will always follow a definite predetermined path with a high degree of accuracy.

It is to be noted that it is possible to utilize the current collected by beam guide collector 8 or, with suitable design changes, the current collected by shield 30 with which to change the potential on cylindrical deflector electrode 44 and thus maintain a constant interception of the electron beam by a beam guide 9. Also the collector electrodes 39 and 41 may be individually connected to the channel outputs instead of having the target electrodes 33 so individually connected to the channel outputs.

It will be understood that the specific embodiment shown and described is illustrative of the invention and that various modifications may be made therein without departing from the scope and spirit of the invention.

What is claimed is:

1. An electron discharge device comprising first means to generate a constant electron beam, a plurality of targets arranged in a continuous closed path, deflection plates positioned opposite said first means and arranged in quadrature to deflect said beam, collector means opposite said targets to collect secondary emission electrons

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from said targets, a beam guide positioned between said deflection plates and said targets to hold the beam to a predetermined path at a predetermined distance from said cathode, and switching means responsive to incoming signal pulses for controlling flow of said secondary emission electrons to said collector plate.

2. An electron discharge device comprising a first means to generate an electron beam, a plurality of targets, deflection plate means positioned between said first means and said targets, collector electrodes positioned near said targets to collect secondary emission therefrom, electron beam guide means positioned between said first means and said targets, circuit means responsive to incoming signal pulses to change the difference of potential between said targets and said collector electrodes to change said collector electrodes' capacity to collect secondary emission from said targets.

3. Electron discharge apparatus comprising a plurality of targets arranged in a continuous closed path, a first means for projecting an electron beam toward said targets, collector electrode means positioned to collect secondary emission from said targets, means comprising a deflection system and a beam guide positioned between said first means and said targets for guiding said beam over said targets in a predetermined path, an output circuit connected to each of said targets, and other circuit means responsive to signal pulses to divert the secondary emission current away from said collector electrode and back to said targets.

4. Electron discharge apparatus comprising a plurality of targets arranged in a closed continuous path, a first means for projecting an electron beam toward said targets, beam guide means positioned between said first means and said targets to intercept a portion of said electron beam and hold said beam to a path corresponding to the periphery of the beam guide, collector electrodes associated with and positioned near said targets, said targets having a coefficient of secondary electron emission other than unity, and switching means to cause the secondary electron emission from the targets to return to the targets, said switching means being controlled by incoming signal pulses.

5. Electron discharge apparatus comprising a plurality of targets having a coefficient of secondary electron emission other than unity, a first means positioned near said targets for collecting said secondary electron emission, a second means for projecting an electron beam toward said target, beam guide means positioned between said second means and said target to guide said beam along a predetermined path, circuit means responsive to an incoming pulse to cause a change in the potential of said first collecting means so as to change its capacity to collect secondary electron emission from said targets, and a plurality of output circuits responsive individually to the changes of capacity of said collecting means to collect secondary electron emission from said targets.

6. Electron discharge apparatus comprising a plurality of targets arranged in a continuous closed path and having a coefficient of secondary electron emission greater than unity, means comprising a cathode opposite said targets for projecting an electron beam towards said targets, a first deflection means positioned between said means and said targets for causing said beam to pursue a small substantially circular path, a

second deflection means positioned between said first deflection means and said targets comprising a rod arranged longitudinally between said targets and said cathode and a hollow frusto-conical section substantially coaxial to said rod, means to apply proper potentials to said second means to cause said circular path of the electron beam to become a larger circular path, beam guide means positioned between said second deflection means and said targets so as to intercept a substantially constant portion of said beam at all times, feedback means from said beam guide means to said second means to maintain a substantially constant interception of said electron beam by said beam guide, collector electrodes associated with and positioned near said targets, an output circuit associated with each target, and other circuit means responsive to incoming signal pulses to change the potential on said collector electrodes to make them incapable of collecting secondary electron emission from said target.

7. Electron discharge apparatus comprising a target, a collector electrode associated with said target to collect secondary emission therefrom, first means opposite said target to project an electron beam upon said target, deflection means positioned between said first means and said target to deflect said beam, beam guide means positioned between said deflection means and said target, feedback means from said beam guide to said deflection means to maintain a substantially constant interception of said electron beam by said beam guide, circuit means for changing the potential of said collector electrode in response to signal pulses so that it will collect secondary emission from said target, and output circuit means associated with said target.

8. Electron discharge apparatus comprising a plurality of secondary electron emissive targets arranged in a prescribed array, a first means opposite said targets for projecting an electron beam thereto, means positioned between said first means and said targets for deflecting said beam to direct it over said targets in sequence, collector electrode means adjacent said targets, and means for pulsing said collector electrode means relative to said targets.

9. Electron discharge apparatus comprising a plurality of secondary electron emissive targets arranged in a circle, a first means opposite said targets for projecting an electron beam thereto, means including beam guide means positioned between said targets and said first means for directing said beam over a closed prescribed path passing over said targets in sequence, collector electrode means adjacent said targets, a pulse input circuit coupled to said collector electrode means, and individual output circuits coupled to said target electrodes.

10. An electron discharge device comprising a first means to generate a constant electron beam, a plurality of targets arranged in a closed path array, deflection plates arranged in quadrature to deflect said beam positioned between said first means and said targets, collector means positioned near said targets to collect secondary electron emission therefrom, a beam guide to hold the beam to a predetermined path at a predetermined distance from said first means, and switching means responsive to signal pulses to enable said collector means to collect secondary emission from said targets.

11. Electron discharge apparatus comprising a plurality of targets arranged in a continuous closed path and having a coefficient of secondary electron emission greater than unity, means comprising a cathode for projecting an electron beam towards said targets, a first deflection means positioned between said target and said means for causing said beam to pursue a small substantially circular path, a second deflection means positioned between said targets and said first deflection means comprising a rod arranged longitudinally between said targets and said cathode and a hollow frusto-conical section substantially coaxial to said rod, means to apply proper potential to said second deflection means to cause said circular path of said electron beam to become a larger circular path, beam guide means positioned between said second deflection means and said targets in such a manner as to intercept a constant portion of said electron beam, feedback means from said beam guide means to said second means to maintain a constant interception of said electron beam by said beam guide, a plurality of output circuits, one individual to each target, collector electrode means positioned near said targets, and circuit means responsive to signal impulses to change the potential on said collector electrode means to enable said collector means to collect secondary electron emission from said targets.

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