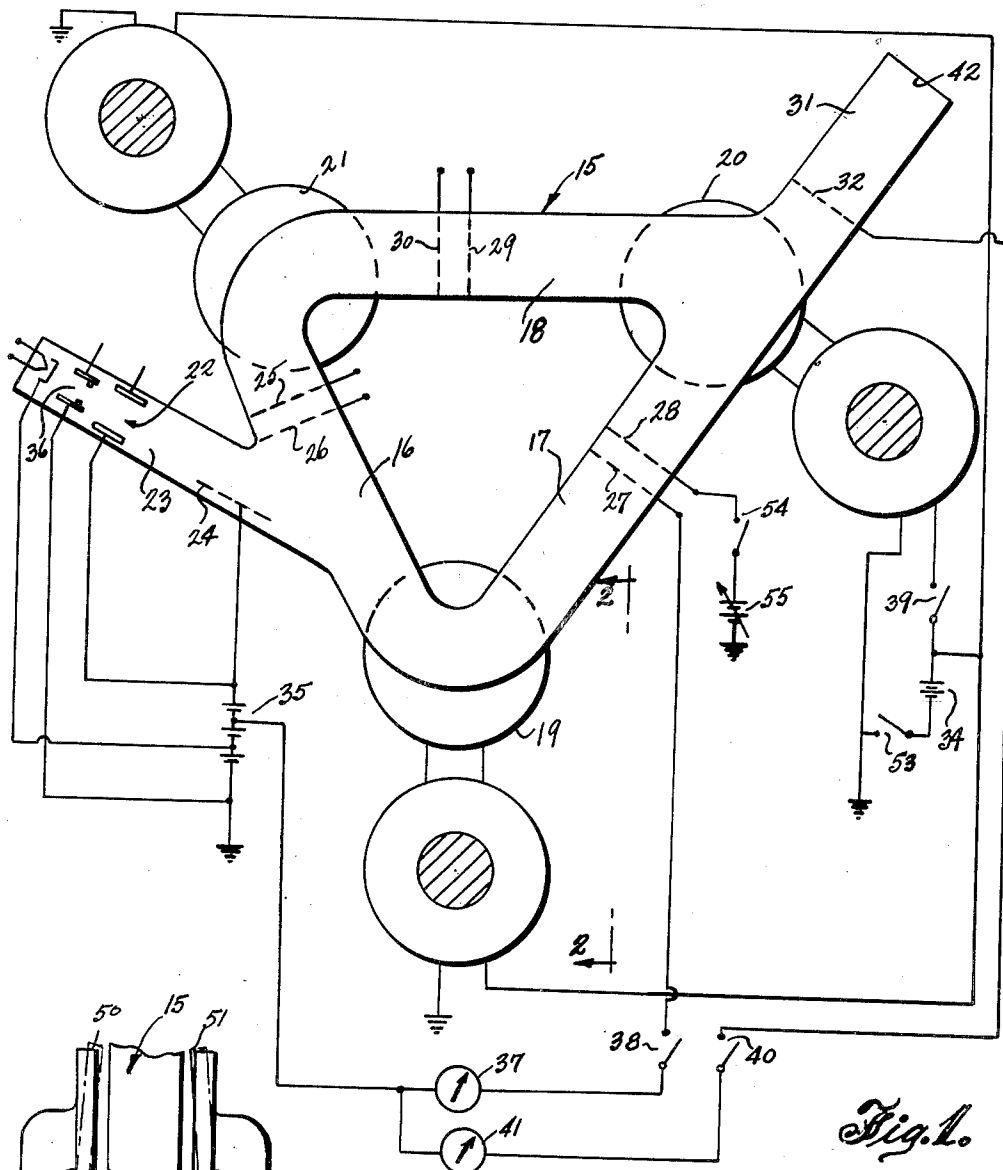
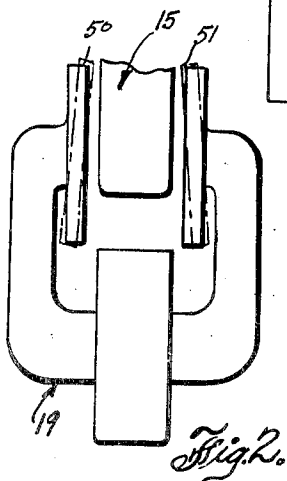
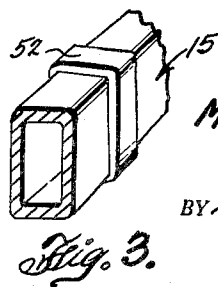


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ELECTRONIC TUBE

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ELECTRONIC TUBE

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The present invention relates to improvements in means for controlling charged particles. The invention contemplates the inclusion of a source for creating a stream of charged particles, as for instance an electron gun as embodied in a cathode ray tube, and means for controlling the motion of the charged particles emanating from such source.

An object of this invention is to provide a novel and improved electronic device having a plurality of functions and hence of uses, as hereinafter mentioned and explained.

A further object hereof is to provide a novel and improved electronic device which will store a charge, so that at any convenient time thereafter, such stored energy may be collected and measured for various purposes. For instance, the device may serve to integrate a given function and be adaptable for use in memory devices, delayed action devices and in electronically operated calculating machines.

Another object of this invention is to provide a novel and improved electronic device of the character mentioned, which will accelerate the charged particles to high velocities, yet will require less iron mass in its associated auxiliary apparatus and be more compact than accelerators of comparable function known heretofore. Such high velocity beams are useful in various practices in therapeutics, photography, irradiation of foods, analysis and study of biological specimens under the influence of beams of radio activity and other applications to which high velocity electronic beams are put.

Another object hereof is to provide a novel and improved device of the kind set forth which will act as an electronic capacitor.

A further object hereof is to provide a novel and improved device of the type set forth, which will act as a mass spectograph for separating charged particles of similar mass more efficiently and accurately than with methods and means heretofore employed.

Another object of this invention is to provide a novel and improved device of the nature described, which is adaptable for use as an oscillator and as an amplifier, to operate at low and high frequencies, and which when combined with the storing and integrating functions of said device, will improve the overall performance of such functions.

Still another object hereof is to provide an electronic device of the character mentioned, and of novel and improved construction and mode of operation, adaptable for the plural uses set forth,

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and which is simple in structure, reasonably cheap to manufacture and efficient in carrying out the purposes for which it is designed.

Other objects and advantages will become apparent as this disclosure proceeds.

In the accompanying drawings forming part of this specification, similar characters of reference indicate corresponding parts in all the views.

Fig. 1 is a diagrammatic front view of an electronic tube device embodying the teachings of this invention. Said device is shown included in a circuit arranged for the operation of said device. Electro-magnets positioned, at points of curvature in a circuitous path for the electron stream, about the envelope affording such path, are shown partly in section.

Fig. 2 is a section taken at line 2-2 in Fig. 1.

Fig. 3 is a fragmentary perspective view of an external grid which may be used in place of any of the internal grids included in the embodiment shown in Fig. 1, in various instances.

In the drawings, the numeral 15 designates generally an evacuated envelope which may be made of glass, non-ferrous metal or other suitable material. Such envelope includes or offers a circuitous path for an electron stream. Such path may be circular, triangular, square or other suitable shape. For convenience, a triangular shaped path is afforded in the embodiment illustrated, comprising the communicatively joined tubular paths indicated by the numerals 16, 17 and 18 respectively. Said envelope, at each vertex of said triangular form, is straddled by an electro-magnet. These are denoted respectively by the numerals 19, 20 and 21. Regardless of the form, at each change of direction of such path, such a magnet is provided. If the path were circular, there would be magnets equi-spaced, near to each other, all around such circular envelope member. It is the function of such magnets to change the direction of electron stream flow. The field of said magnets is perpendicular to the plane of the axis of the tubular structure comprising the envelope 15.

The function of the magnets 19, 20, and 21 is to deviate the beam of charged particles so that the beam travels a circuitous path. It will be recognized by those versed in the art that this function may also be accomplished electrically, without the need for magnets, by appropriately placing one or more electrodes at each point of curvature and applying suitable potentials to these electrodes. It is intended that the embodiment shown shall not be restrictive, but that the

invention shall include electrostatic equivalent of the magnets shown.

The source of charged particles may be a gun as included in cathode ray tubes. Such is here indicated generally by the numeral 22, housed in a branch 23 of the envelope. This branch is communicative with leg 16 of the triangular path, at about midway between the ends of said leg. The location of said branch 23 and its manner of association with leg 16 may be in any-wise suitable just so that the electron stream enter leg 16 in a direction towards the magnet 19. For bending the electron stream to flow in a direction in alignment with the longitudinal axis of leg 16, a control grid 24 may be provided as shown in the branch 23. In each of the legs of the triangular path, there may be one or more control grids. These are indicated respectively by the numerals 25, 26 in leg 16, by the numerals 27 and 28 in leg 17, and by 29 and 30 in the leg 18.

If desired, the envelope 15 may have another branch as indicated by the numeral 31, which is in alignment with and a communicative extension of the leg 17. In said branch, there may be at least one control grid 32.

All the grids are of conductive material. They may be internal or external the envelope 15. Internal grids may be of any shape and structure which will allow part of the beam of charged particles to pass through, as for instance a grid of wires formed in a mesh, a disc having one or more holes, or a ring. External grids may be in the form of a ring as 52, positioned close to or contacting the envelope, and can be used only when the envelope is of dielectric material. At least one lead is electrically connected to each grid. When the grid is of the internal type, the lead passes through the wall of the envelope. Where the envelope is of conductive material, at least some of the internal grids and their respective leads are insulated from the envelope. External grids can only function to deflect or accelerate the beam of charged particles which have been issued from the gun 22, while internal grids may also be used for collecting.

In operation, all magnet coils are actuated by a source of electrical energy 34, and the electron gun 22 is operated. The stream of charged particles issued from the gun in envelope branch 23, will be deflected by the action of the grid 24, suitably charged from battery 35, so that such stream will enter leg 16 and travel therealong in the direction of magnet 19. When the charged particles constituting said stream reach the field of magnet 19, they will be deflected along a radius "r" measured in centimeters, where

$$r = \frac{mv}{eB}$$

In the foregoing equation, "m" represents the mass in grams of the particle; "v" is its velocity in centimeters per second; "e" is its electrical charge in electromagnetic units; and "B" is the flux density in gauss. Thus when the value and polarity of the flux and the flux density is correctly fixed with respect to the particle velocity, charge and mass, the particles will enter leg 17 along its longitudinal axis. Similarly, the particles of the electron stream will be deflected at each curve in the circuitous path afforded by the legs 16, 17 and 18 of the envelope 15, and thus continue to circulate around the triangular path offered by said three legs. It might here be noted, that instead of grid 24, an electromagnet may be substituted at its position, to accomplish its function.

If the gun current is discontinued, which may be accomplished by applying a sufficient negative potential to the control grid 36, the particle stream will continue to circulate around the triangular circuitous path mentioned. The total charge may then be collected and measured at any convenient time. In this way the "tube" acts as a storage, or memory device, by retaining a given quantity of electrical charge, and as an integrating device, by integrating the gun output as described below.

One convenient way of measuring the circulating charge is to connect one of the grids, such as 27 in circuit with a ballistic galvanometer 37 controlled by a switch 38. Another convenient method is to open switch 39 so that magnet 20 is made inactive, and at the same time closing the switch 40 which connects a ballistic galvanometer 41 to the grid 32 in envelope branch 31. De-energization of the magnet 20 allows the electronic beam to travel undeflected into branch 31, and thus to be collected by said grid 32 and measured by galvanometer 41. It should be noted that any grid used as a collector is interior and insulated from the envelope.

Considering the particles constituting the electron stream, circulating along the circuitous path afforded by the envelope legs 16, 17 and 18, it may be noted that their velocity may be progressively increased. Increasing "v" and the flux density "B" in the correct relation so that radius "r" is constantly maintained, it is evident that the particles of the stream will be accelerated. Increase in velocity may be accomplished by applying progressively increasing potentials to one or more of the grids in the legs 16, 17 or 18. For instance, grid 28 may be connected through switch 54 to a variable controlled voltage 55. The flux density may be correspondingly increased by increasing the current through the magnet coils. When the particles have attained the desired velocity, the magnet 20 is de-energized, thereby allowing the particles to enter branch 31 and strike the window 42. To facilitate this, the grid 32 may be connected to a high potential source; such connection being well understood, though not shown.

The window 42 may be of very thin material, of mica, aluminum or beryllium for example, or other suitable material which will not materially diminish the velocity of the emerging beam. The beam may now be employed to uses in therapeutics, photographic process, irradiation of foods, as an artificial radioactivity influence, and for other uses to which high velocity electronic beams are put.

Assuming that the particles that enter the tube and circulate through it are not removed by action of the grids, or by any other cause or means, then, the total circulating charge in the path afforded by the circuitous format in the envelope, at any given time, is determined by:

$$Q = \int i dt = \frac{\int e dt}{R}$$

where Q is the charge in coulombs, i is the instantaneous gun current entering leg 16 in amperes, dt is the time differential in seconds, e is the signal input voltage, and R is the input resistance. The relation is similar to that of a capacitor, so that the tube may be deemed in effect an electronic capacitor.

The circuitous path offered by the legs 16, 17 and 18 of the envelope, is a duct in the form of a ring, a natural incident of which is that the

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inner perimeter of said ring duct is shorter than its outer perimeter.

When the electron stream emanating from the electron gun 22 is composed of particles of varying velocities, or when it is desired to include in the circulating stream, particles of different velocities, it is necessary to produce a variation of flux density from the inner to the outer perimeters aforesaid, so that the slower and the faster particles are deviated the correct amount at each curve in the circuitous path. For instance, in the embodiment shown, the higher velocity particles leaving the gun in branch 23, will not be deflected as much by the action of the grid 24, as will the lower velocity particles, and hence will enter leg 16 nearer to the inner perimeter of the circuitous path, and travel along an inside course parallel to the longitudinal axis of said leg 16. Similarly the slower particles will travel along the outer course. In order to deviate the fast moving inside particles and the slower moving outside particles so that both will continue to circulate around said path, the flux density must be more intense at the inside perimeter and progressively less intense towards the outer perimeter. One method for accomplishing this desired variation, is to introduce a variation in the air gap at each magnet, by setting the pole faces at a slight angle to each other as shown at 50 and 51. For the embodiment shown, the gap at the outer perimeter aforesaid, would be greater than at the inner, so as to produce a greater flux density at said inner perimeter of the circuitous path.

By using as a particle source, an incandescent substance emanating ionized atoms having different masses, the device herein set forth, can be used as a highly efficient separator of particles of a desired mass. The emanated ionized particles are accelerated by suitable charged grid or grids, akin to 25 and 26, but positioned within the branch 23 of the envelope, so that said particles enter leg 16. The magnetic fields are made uniform and held constant, to restrict the particle flow to the one velocity attained by the particles of the desired mass each. Only those particles having the desired mass will circulate around the circuitous path. The more times the beam is circulated around such path, the more uniform will such beam become of particles only of the desired mass. When it is desired to collect the particles so selected, the magnet 20 is deenergized as previously noted, causing the particles in movement to be deposited on window 42. For the use mentioned, said window should be removable and the envelope may be provided with means to evacuate the envelope 15, each time the window is replaced; such means being well known in the art.

In the practice of such separation as mentioned, it is desirable to restrict the beam to the one velocity attained by the desired particles. This can be facilitated by adjusting the magnetic field so that it is more intense at the outer perimeter and least intense at the inner perimeter of the circuitous path in the envelope, so that the higher and lower velocity particles are eliminated from the circulating beam. The central beam will thus be of that velocity of the desired particles, or is made so to be, and hence the beam will be composed only of the particles desired for collection at the window 42.

This invention is capable of numerous forms and various applications and different modes of operation without departing from the essential

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features herein disclosed. It is therefore intended and desired that the embodiment shown herein be deemed illustrative and not restrictive and that the patent shall cover all patentable novelty herein set forth; reference being had to the following claims rather than to the specific description herein to indicate the scope of this invention

I claim:

1. In an electronic device, the combination of an envelope presenting a circuitous path including bends, means to emit a stream of charged particles into the path, a plurality of means to deviate said stream to travel along and around said path more than once around; parts of said deviating means being at each bend, a branch path in said envelope; said branch path being a communicative extension of the circuitous path at a particular bend, means in said branch path to receive particles of the stream which have moved along and around the circuitous path and means associated with the part of the stream-deviating means at said particular bend, operable to deactivate the latter whereby the entire stream approaching the branch path will enter said branch path.

2. In an electronic device, the combination of an envelope presenting a circuitous path including a first straight path portion and a second straight path portion, joined by a bend, means to emit a stream of charged particles into the path, a plurality of means to deviate said stream to travel along around said circuitous path; a part of said deviating means being at the bend, a branch path in said envelope in communicative aligned extension of the first straight path portion and directly communicative with said bend in the circuitous path, means in said branch path to receive particles of the stream which have moved along and around the circuitous path and means associated with the part of the deviating means at the bend, operable to deactivate the latter whereby the stream of particles will enter the branch path directly from the first straight path portion of the circuitous path.

3. An electronic device as defined in claim 1, wherein the stream-deviating means includes a magnetic field transverse the circuitous path; said field being of diminishing intensity through successive points in a line in one direction along said line; such line passing perpendicularly through the line of said path and the lines of force of said field.

4. An electronic device as defined in claim 1, including at least one grid carried within the envelope in the circuitous path and in the branch path respectively; those grids which are in the circuitous path, being between stream-deviating means.

5. An electronic device as defined in claim 1, including at least one grid carried on the envelope.

6. An electronic device as defined in claim 2, including at least one grid carried within the envelope in the circuitous path and in the branch path respectively; those grids which are in the circuitous path, being between stream-deviating means.

7. An electronic device as defined in claim 2, including at least one grid carried on the envelope.

8. An electronic device as defined in claim 3, wherein the stream-deviating means includes a magnetic field transverse the circuitous path; said field being of diminishing intensity through

successive points in a line in one direction along said line; such line passing perpendicularly through the line of said path and the lines of force of said field.

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