United States Patent

[11] 3,629,643

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[21] Appl. No. **769,857**
[22] Filed **Oct. 23, 1968**
[45] Patented **Dec. 21, 1971**
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[32] Priority **Oct. 31, 1967**
[33] **France**
[31] **126662**

[54] **DEVICE FOR PRODUCING BURSTS OF CHARGED PARTICLES**
4 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **315/18,** 315/3.5
[51] **Int. Cl.** **H01j 29/76**
[50] **Field of Search** 315/18, 3, 3.5, 3.6, 5.41, 5.42

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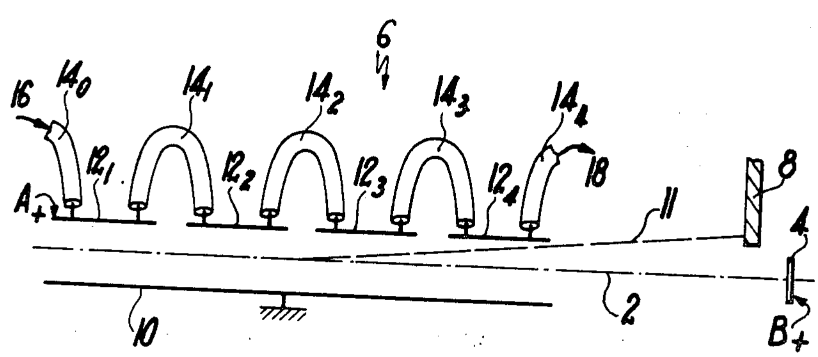
ABSTRACT: Device for producing bursts of charged particles issuing from an accelerator of the type in which the beam is alternatively directed onto a target, said active target, and onto a nonreactive target in a shifted position with respect to the active target, under control of a beam deflecting device that comprises essentially two members symmetrically disposed with respect to an axis: a plate parallel to said axis and brought to a reference potential and a plurality of identical small plates parallel to said axis, regularly distributed along it and brought to a bias potential, and sections of coaxial cable connecting the adjoining small plates whose the length is so chosen that the pulses propagating through the second member has the same propagating velocity as the beam.



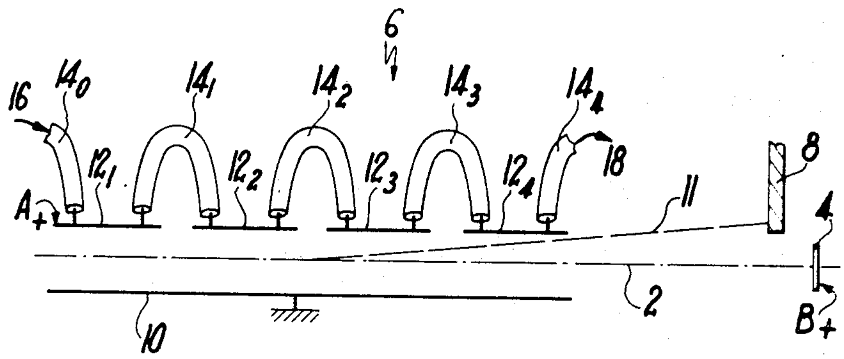


FIG. 1

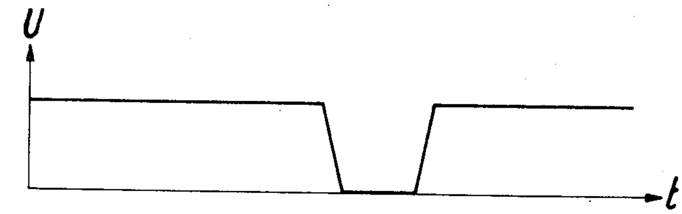
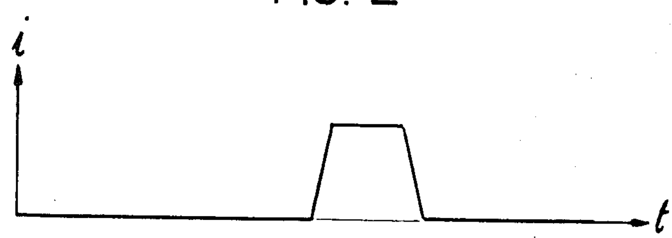


FIG. 2

FIG. 3



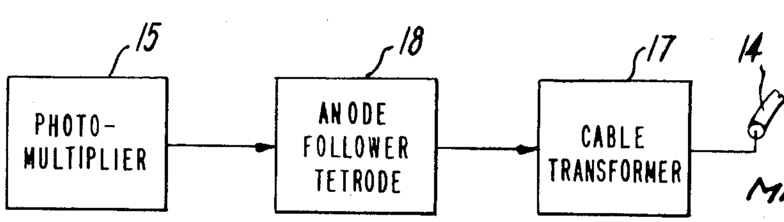


FIG. 4

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DEVICE FOR PRODUCING BURSTS OF CHARGED PARTICLES

The present invention relates to a device intended for the time modulation of a beam of charged particles.

Such devices have been constructed wherein a beam of charged particles is alternatively directed onto an axial active target and onto a nonreactive target in a nonaxial position. Such a result is obtained by applying to the beam a pulse-modulated electric field whose direction is perpendicular to the usual direction of the beam. To this end, it has been proposed to direct the beam between two deflecting plates fed with a square wave voltage. For improving the rising edge of the so-formed pulses, it has been also proposed to make use of a delay line through which the pulse edge propagates with the same velocity as the particles: for instance, a helical travelling waveline is disposed within a metallic cylinder through which the beam is longitudinally directed; said helical line has its axis parallel to the usual direction of the beam, but the latter does not pass through it, and a square wave voltage is applied between the line and the metallic cylinder acting as an electrical ground terminal.

Such a process makes it possible to make an apparatus whose travelling waveline comprises a helix surrounded with a metallic box and has a high impedance so that the pulse generator connected to it delivers a weak current. Unfortunately, the above-described circuit does not make it possible to obtain beam pulses with sufficiently short rise-times.

The object of the present invention is to provide a device of the above-described type that makes it possible to obtain beam pulses whose rise-times are very short.

The device according to the invention intended for producing bursts of charged particles is characterized in that the device for deflecting the beam onto a nonreactive target or a diaphragm comprises essentially two members symmetrically disposed with respect to an axis: one plate parallel to said axis and brought to a reference potential, and a plurality of identical small plates parallel to said axis, regularly distributed along it and brought to a bias potential, the small plates being connected through sections of coaxial cable having each a predetermined length for delaying the pulses transmitted through the assembly of small plates and cable sections, of a time interval equal to the one taken by the beam for passing between corresponding points on adjacent small plates. Preferably, the extremity of the first small plate opposed to the target is connected to a generator of pulses whose the amplitude is equal to the difference between the bias potential and the reference potential.

Inasmuch as the large transmission range of a coaxial cable may be equal to 1,000 mHz. and the insertion of the small plates in the coaxial structure results in only a light loss of performance, the rise-times of the produced bursts of particles can have a duration in the range of 1 nsec.

The invention will be now described by way of a nonlimitative example with reference to the accompanying drawings in which:

FIG. 1 shows a device according to the invention for deflecting a beam of charged particles in an accelerator,

FIGS. 2 and 3 are graphs for illustrating the variations in time of the voltage U applied between the plate and the deflecting small plates and the ones of the current I of the active target, and

FIG. 4 is a schematic diagram of a generator for use with the device of FIG. 1.

The FIG. 1 illustrates the application of the invention to a low-energy electrostatic accelerator. The deflecting device 6 is intended to direct the beam alternatively onto a nonreactive target 8 or diaphragm (path 11) and onto an active target 4 (path 2).

The deflecting device comprises two members symmetrically disposed with respect to the axis of the beam: a long plate 10 brought to the reference potential and a plurality of small plates 12_1, 12_2, 12_3, 12_4 regularly distributed along the axis of propagation of the beam and brought to the bias potential +A.

The small plates are interconnected through the inner conductor of sections of coaxial cable 14_1, 14_2, 14_3, 14_4. The length of each section of coaxial cable is chosen for delaying the pulses transmitted by the assembly of small plates 12 and of cable sections 14, of a time interval equal to the one taken by the beam for crossing the space between corresponding points on two small plates.

The first section of coaxial cable 14_0 is connected to a pulse generator 16 (not shown) while the last section 14_4 is connected to a matched load 18 (not shown).

In operation, the voltage applied between the plate 10, on one hand, and the assembly of small plates 12, on the other hand, is equal to the sum of two components: one of them is the bias voltage +A applied to the small plates 12, the other is the voltage corresponding to the amplitude of the pulses issuing from the generator 16. The absolute amplitude of said pulse is equal to the one of the bias voltage, but the polarity is reversed.

As a result, a positive voltage is applied to the plates during the time interval separating two pulses. The beam is therefore deflected and stopped by the nonreactive target or diaphragm 8. On the contrary, during every pulse, the voltage applied to the plates falls to zero: the beam is no longer deflected and reaches the active target 4. It will be noted that the bias voltage can be adjusted for allowing the beam to reach the center of the active target during the pulse.

The FIG. 2 illustrates the variations with time of the voltage U applied between the plate 10 and the small plates 12, and the FIG. 3 illustrates the variations of the ionic current on the active target in the same time.

The transmission range of the assembly of small plates 12 and of coaxial cables 14 is, of course, slightly reduced, but the rise-time of the transmitted pulses is kept at a value approximating 1 nsec. and remains attractive for the application under consideration.

In other respects, the impedance presented to the generator 16 is very low, which conduces to the design of a high-power pulse generator.

The applicant has constructed a deflecting system of the described type. The small plates 12 are placed at a distance equal to about one-third of their length. They are held in the correct position by means of supports made of a plastic material having a low-dielectric constant. The sections of coaxial cables are long with respect to the sizes of a small plate; the characteristic impedance of the cable is comprised between 80 and 120 Ω.

The generator comprises essentially an electron multiplying tube 15 whose the output current controls the grid of an anode follower tetrode 18 with a relatively low-anode load constituted by an insulating cable-transformer 17, as seen in FIG. 4.

Such a device is the most attractive with a neutron producing target for it is possible to obtain a pulsed beam by interaction and, from said target, bursts of neutrons with very short edges.

For instance, rise- and fall-times of 1.4×10^{-9} s are easily obtained and easily reproducible.

It is understood that the present invention is not limited to the details given herein and that it may be modified within the scope of the appended claims.

What we claim is:

1. A device for producing bursts of charged particles from a particle beam issuing from an accelerator, in which successive sections of the beam are alternately directed onto an active target and onto a nonreactive target positioned at a shifted position with respect to the active target, under control of a beam deflecting device, said beam deflecting device comprising two members symmetrically disposed with respect to an axis, one member being formed by a plate parallel to said axis and brought to a reference potential, and the other member being formed by a plurality of identical small aligned plates disposed parallel to said axis in regularly spaced relation and brought to a bias potential, said small plates being connected

through sections of coaxial cables having each a predetermined length for delaying pulses transmitted through the member formed of the small plates and the cable sections, said time delay of said cable sections being equal to the time taken by the beam for passing between corresponding points on adjacent small plates.

2. A device according to claim 1, for producing bursts of charged particles issuing from an accelerator, in which the extremity of the first plate, opposed to the target, is connected to a pulse generator.

3. A device according to claim 2, for producing bursts of charged particles issuing from an accelerator, in which the generator generates pulses with an amplitude equal to the difference between said bias potential and said reference potential.

4. A device according to claim 2, for producing bursts of charged particles issuing from an accelerator, in which the pulse generator comprises an electron multiplying tube and a tetrode whose load is constituted by an insulating cable-transformer.

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