June 14, 1960 J. S. COOK 2,941,114

SLALOM FOCUSING STRUCTURES

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FIG. 1A

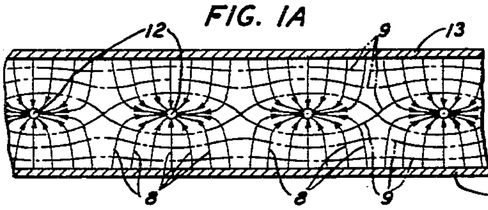


FIG. 1B

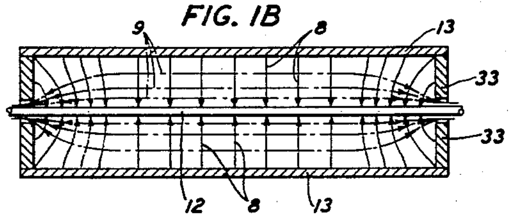


FIG. 5

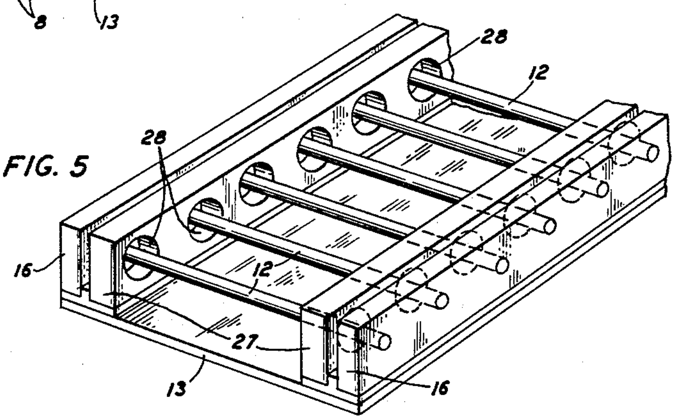
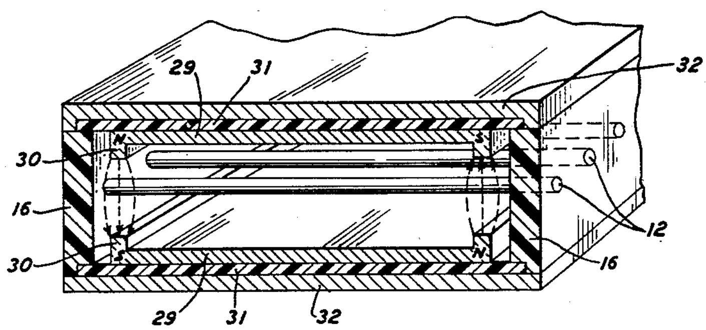


FIG. 6



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SLALOM FOCUSING STRUCTURES

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FIG. 2

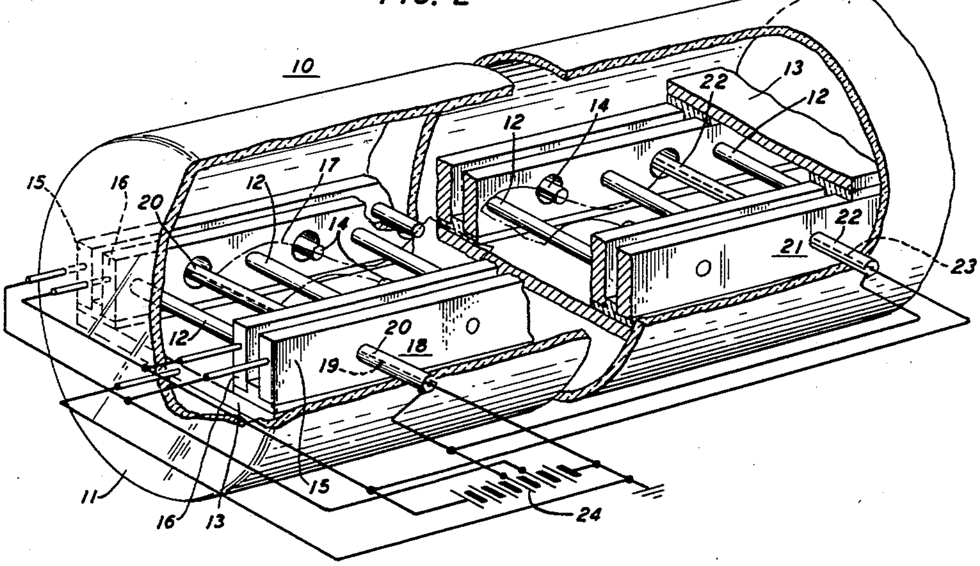


FIG. 3

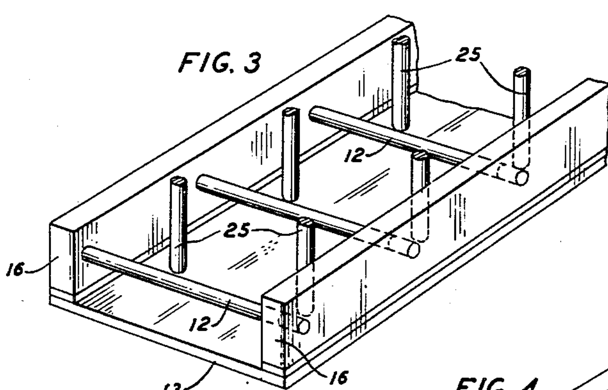
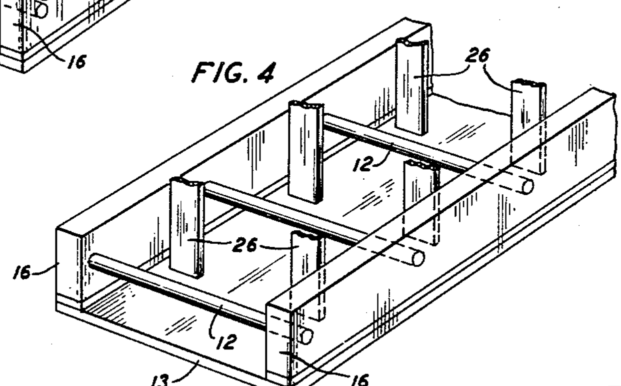


FIG. 4



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SLALOM FOCUSING STRUCTURES

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Filed Jan. 9, 1958, Ser. No. 707,916

18 Claims. (Cl. 315—3.5)

This invention relates to electron beam focusing arrangements and, more particularly, to apparatus for controlling the broad dimensions of a sheet or ribbon beam.

In United States Patent 2,857,548, issued October 21, 1958 of R. Kompfner and W. H. Yocom, there is disclosed an electrostatic focusing structure for ribbon or sheet beams which does not require the longitudinally time constant, spatially alternating fields commonly used in electrostatic focusing arrangements heretofore. Rather, there is disclosed in that application a structure comprising two spaced planar conductive plates with a longitudinal array of spaced positively biased conductive elements positioned intermediately therebetween. This structural arrangement gives rise to a pair of "singular" equipotential surfaces which wind sinuously past the linear array of conductive elements. These surfaces substantially form the trajectories for the electrons in the beam, provided that the electrons are injected substantially along one of the surfaces at the correct velocity which is dependent upon the specific geometry of the electrode system and the voltages applied thereto. The charged particles once having been projected along either of the two equipotential surfaces continue substantially along that equipotential surface inasmuch as the counteracting electrostatic and centrifugal forces are in balance. Such a focusing structure has become known as the "slalom" system since the electron beam follows a sinuous path through the linear array of conductive elements in the manner of a skier in a slalom race.

While slalom structures have proven very successful in containing the thickness dimension of a ribbon beam, the technique usually employed for containing the width, or broad dimension, of such a beam in a slalom structure has not proven to be completely effective. This results from the fact that the beam edge focusing systems normally employed heretofore inherently limit the otherwise effective usable beam width for a given dimensioned slalom structure which, correspondingly, prevents optimum beam focusing and circuit efficiencies to be realized, the reasons for which will become more apparent hereinafter.

The beam edge focusing structure most generally employed in slalom systems heretofore has comprised two longitudinal edge plates extending from the slalom focusing planar side plates toward the linear array of conductive elements, being spaced apart a distance somewhat wider than the broad dimension of the beam. These edge plates have either been of insulative material so as to support the linear array or have comprised conductive members parallel to but isolated from the support members. In the latter case, a small gap on either side of the individual elements of the linear array has usually been employed. In either of the above-mentioned systems, the beam edge focusing members are at a negative potential with respect to the conductive elements of the array; this potential has been established in the case of insulative members by electrostatic charging and in the case of conductive members by a direct negative potential applied thereto. An electrostatic field is thus established between the beam edge focusing members and the individual elements of the linear array, the greatest concentration of transverse lines of force being established therebetween immediately adjacent the ends of the conductive elements of the array. This arises from the fact that in a slalom structure, as will become more apparent hereinafter, the transverse component of the electrostatic field between the planar side plates and the linear array decays from a maximum directly above and below the individual elements of the array, where the singular equipotential surfaces are furthest removed from the axis thereof, to a minimum intermediate adjacent elements of the array where the equipotential surfaces cross the axis thereof. Accordingly, with the two beam edge focusing plates being much closer in proximity to the edges of the linear array than are the planar side plates, the electrostatic lines of force bend outwardly to the inner surfaces of the beam edge focusing plates rather than extend between the elements of the array and planar side plates in a uniform manner laterally across the entire length of the individual elements of the array. This bending or distorting of the lines of force near the ends of the individual elements of the array results in the longitudinal edges of the singular equipotential surfaces bending inwardly in these regions where they are furthest removed from the axis of the linear array. This type of distortion results in the otherwise effective beam width being considerably reduced.

A reduction in the effective beam width directly affects the efficiency in discharge devices incorporating such a beam focusing system. More particularly, the efficiency is lowered since a particular transverse field configuration is required in order to constrain the ribbon beam thickness along the structure. Accordingly, if such a field is distorted by a concentration of the electrostatic lines of force between the beam edge focusing side plates and the ends of the individual elements of the linear array, an appreciable portion of the beam energy near the edges of same may be diverted to, and dissipated in the form of heat upon, various parts of the focusing structure. Correspondingly, in slow wave circuits, when the effective width of the beam is reduced, the maximum surface area capable of being in coupling relation with an electromagnetic wave propagated therealong is reduced.

It is, therefore, a general object of this invention to improve the edge focusing of sheet or ribbon beams projected along a sinuous path in a slalom structure.

A more specific object of this invention is to minimize distortion of the field normal to the beam thickness along the longitudinal edges of the linear array and thereby enable ribbon beams of maximum width to be effectively focused therealong for a given dimensioned slalom structure.

In one embodiment of my invention, there is provided a longitudinal array of linearly and uniformly spaced conductive elements. These elements, which for convenience will often be referred to as "wire-like" hereinafter, even though other than cylindrical shapes may be equally effective, are supported at their respective ends by two edge plates normal thereto and spaced apart a distance slightly greater than the width of a sheet beam which is projected along the array. Two planar plates are positoned equi-distant from and on opposite sides of the linear array of conductive elements. With suitable potentials applied to the linear array of conductive wire-like elements and the planar plates, transverse electrostatic fields are established which will, with the proper electron beam velocity, substantially contain the thickness dimension of a sheet beam initially injected along one of the two singular equipotential surfaces.

In analyzing the behavior of, and effects resulting from, slalom focusing, I have determined that optimum beam edge focusing is realized when the beam edge focusing field is either uniform or concentrated intermediate adjacent elements of the linear array. Advantageously, in the latter case, as pointed out above, it is in these intermediate regions where the transverse electrostatic field between the linear array and planar side plates is minimum. Accordingly, by positioning suitable beam edge focusing elements in these intermediate regions, in accordance with the principles of this invention, distortion of the transverse electrostatic fields along the edges of the array will be minimized with a consequent increase in effective beam width and focusing efficiency realized therefrom.

In accordance with one aspect of my invention in one embodiment thereof the width, or broad dimension, of a sheet beam projected along a slalom structure is contained by an electrostatic field established between a linear array of wire-like elements and a plurality of short conductive stubs isolated from, but extending through the edge plates of the slalom structure intermediate the spaced conductive elements of the linear array. These short conductive stubs are attached to two side wall support members which are insulated from, but adjacent to and extending parallel with the edge support plates to which the parallel array of wire-like elements are attached. Advantageously, these conductive stubs with the proper potentials applied thereto, effectively concentrate the beam edge focusing field along a short longitudinal region on either side of the cross-over point, the latter being defined as that point where the two singular equipotential surfaces cross each other intermediate the array of spaced conductive elements. It is in these regions where the transverse component of the electrostatic field between the linear array and planar side plates is minimum. Accordingly, the presence of these focusing stubs in a slalom system will not appreciably affect the electrostatic lines of force which establish the singular equipotential surfaces as is occasioned with previously known beam edge focusing elements that are positioned continuously along the edges of the slalom structure.

In certain other of the embodiments of this invention, the electrostatic beam edge focusing elements comprise a plurality of vertical fins or wires which extend transversely from either or both of the planar plates. These wires or fins are positioned intermediate adjacent wire-like elements of the array and in close proximity to but isolated from the support members to which the wire-like elements are attached.

In still another embodiment of my invention, two beam edge focusing plates extend longitudinally along the sides of a sheet beam and are apertured for passage of the linear array of wire-like elements therethrough, the diameter of the apertures being considerably larger than the diameter of the conductive elements of the array. As described in greater detail hereinafter, this results in the electrostatic beam edge focusing fields having the greatest number of lines of force in a region between adjacent apertures and the respective ends of the conductive elements of the linear array. With such a focusing arrangement, as with the previously mentioned embodiments, distortion of the edges of the singular equipotential surfaces which are furthest removed from the axis of the linear array of wire elements will be minimized.

In still another embodiment of my invention, two thin bar magnets serve as the planar side plates and are magnetized in a direction normal to the path of electron flow, but are of opposite polarity along their respective longitudinal edges. Accordingly, the magnetic field established between these side plates effectively contains the broad dimension of a sheet beam which may be considerably wider than was possible heretofore in a given dimensional R.-F. slalom structure.

Accordingly, it is a feature of this invention to utilize at least two beam edge focusing elements positioned in close proximity to the edges of a sheet beam in a slalom structure for establishing a beam edge focusing field which least distorts the desired transverse electrostatic fields in the immediate vicinity of the wire-like elements of the linear array.

It is another feature of this invention to utilize at least two beam edge focusing elements positioned in close proximity to the edges of a sheet beam in a slalom structure for establishing a beam edge focusing field which has a concentrated field of flux at least as great in the regions intermediate adjacent elements of a linear array as in the regions immediately adjacent the elements of such an array.

It is another feature of this invention to utilize beam edge focusing elements which are insulated from and biased independently of the edge plate support members for the linear array.

A complete understanding of this invention and the various features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Figs. 1A and 1B are schematic representations of the electrostatic field and singular equipotential surfaces in a conventional slalom focusing structure;

Fig. 2 is a perspective cutaway view of one illustrative embodiment of an electron beam system utilizing slalom focusing and incorporating the beam edge focusing features of the present invention;

Figs. 3 through 5 are partial perspective views illustrating various other embodiments of the beam edge focusing structure of my invention depicted in Fig. 2; and

Fig. 6 is a cross-sectional perspective view of still another illustrative embodiment of a beam edge focusing structure which utilizes a magnetic focusing field.

Referring now to the drawing, Fig. 1A is a schematic representation of the electrostatic lines of force **8** which exist between a linear array of conductive elements **12** and planar side plates **13** in a slalom structure. As is well known, the electrostatic lines of force **8** are always at right angles to the various singular equipotential surfaces **9** that may exist. It is seen by the cyclical variations in the number of lines of force **8** that exist between the linear array **12** and planar side plate **13**, hereinafter spoken of as the transverse component, that the greatest concentration of lines of force therebetween are established in those regions directly above and below the individual elements of the linear array. In those regions intermediate adjacent elements of the array, the transverse component of the electrostatic field is minimum. Accordingly, in those regions where the transverse component of the electrostatic field is maximum, the sinuous singular equipotential surfaces are furthest removed from the plane of the linear array, and in those regions where the transverse component of the field is minimum, the equipotential surfaces cross the plane of the linear array.

Fig. 1B is a schematic representation in cross section showing the effect that one type of conventional beam edge focusing structure comprising members **33**, described above, have upon the longitudinal edges of the equipotential surfaces. Since these beam edge focusing members, which may also serve as supports for the wire-like elements if insulated therefrom, are at a negative potential with respect to the wire-like elements of the linear array, usually being at the potential of the planar side plates **13**, a highly concentrated electrostatic field is established therebetween. The resultant bending or distorting of the equipotential surfaces, because of the nature of the conventional beam edge focusing members **33**, results in the otherwise effective beam width being substantially reduced.

Accordingly, I have discovered that by positioning electrostatic beam edge focusing elements in those regions intermediate adjacent wires of the linear array where the electrostatic field is minimum, and by aligning these elements a short distance inwardly along the longitudinal boundaries of the wire support members, the distortion along the longitudinal edges of the equipotential surfaces may be minimized and increased beam width realized therefrom.

The illustrative embodiment of this invention shown in Fig. 2 comprises an electron beam tube **10** enclosed within an evacuated envelope **11**, which may be of glass. Extending longitudinally within envelope **11** is a linear array of uniformly spaced conductive wire-like elements **12** which are transverse to the axis of envelope **11**, these elements being positioned between and equidistant from two conductive planar side plates **13**. Each of the wire-like elements **12** is maintained at a positive potential with respect to the two planar side plates **13**, such as by battery source **24**.

In accordance with an aspect of this invention, a plurality of conductive stubs **14** extend from two longitudinally extending support plates **15** and pass through two wire support members **16** from which they are isolated. These conductive stubs **14** are positioned intermediate the linear array of wire-like elements **12** and in alignment therewith. Advantageously, this permits the wire support members **16** to be at the same potential as the individual wire-like elements which they support. Accordingly, with a potential applied to the conductive stubs **14** which is either equal to or slightly less than the planar side plates **13**, an electrostatic field is established between the conductive stubs **14** and the wire-like elements **12** such that the greatest concentration of beam edge focusing lines of force is realized in the regions intermediate the ends of adjacent wire-like elements **12**. In this way, the two singular equipotential surfaces are not distorted near the edges, as defined by the distance between corresponding opposite ends of stubs **14**, by a crowding of the electrostatic lines of force as is normally experienced with previously mentioned slalom structures.

An electron source **18** is positioned intermediate two adjacent wire-like elements **12** near the left-hand side of envelope **11**, as viewed in Fig. 2. Such an electron source is specifically disclosed in the aforementioned patent of R. Kompfner and W. H. Yocom. Briefly described herein, such an electron source comprises a filamentary cathode **19** extending parallel to the individual wire-like elements **12** and surrounded by an anode **20**. Advantageously, the anode is positioned at the cross-over point of the two singular equipotential surfaces associated with the linear array so as least to affect the potential distribution in the interspace and particularly the singular equipotential surfaces. The anode **20** is slit such that a sheet beam is injected substantially along one of the desired singular equipotential surfaces and with the correct velocity, will have a trajectory substantially corresponding to the singular equipotential surface, the sinuous path of which is identified by the broken lines **17**.

Alternatively, in certain applications it may be desirable to utilize an external cathode to inject an electron beam along a trajectory substantially following a singular equipotential surface, as taught in the copending application of J. S. Cook, R. Kompfner and W. H. Yocom, Serial No. 514,421, filed June 10, 1955.

The electrons are collected by a target electrode **21** positioned at a point along the path of flow beyond which the beam has completed its desired function for the particular application intended. This target electrode includes a collector housing **22**, which is slit in much the same way as anode **20** of the electron source, with a target collector **23** being axially positioned within the collector housing **22**.

For simplicity and convenience of illustration, a slalom structure comprising only a simple linear array of wire-like elements **12** is disclosed in Fig. 2. As previously mentioned, however, a slalom focusing system readily lends itself to beam type switching tubes, as disclosed in United States Patent 2,899,597, issued August 11, 1959, of R. Kompfner, or a slow wave interdigital R-F circuit for use in traveling wave devices, such as disclosed in the aforementioned patent of R. Kompfner and W. H. Yocom.

The manner in which operating potentials are supplied to the circuit is schematically illustarted by lead-in connections shown from the battery source **24** to the various elements of the device. The cathode **19** and the planar side plates **13** are maintained at the reference level, which may be ground corresponding to the negative terminal of voltage source **24**. The accelerating anode **20** and the target collector housing **22** are advantageously maintained at slightly higher positive potentials than are the cathode **19** and side plates **13**. The target collector **23** within the housing **22**, as well as the wire-like elements **12** of the linear array and their support members **16**, are maintained at the highest positive potential with respect to the reference level, this corresponding to the most positive terminal of voltage source **24**.

In accordance with an aspect of this invention, the beam edge focusing stubs **14** are maintained at a potential considerably less positive than the wire-like elements **12** of the linear array and planar side plates **13**, but slightly more positive than the cathode **19**. This results in the electrostatic field established between the wire-like elements **12** and focusing stubs **14** being the only beam edge focusing field that exists and it is concentrated intermediate the wire-like elements **12**. Advantageously, the conductive stubs **14** extend inwardly from the support members **16** a distance which assures that the longitudinal edges of the beam will not be affected by any bending or distorting of the transverse lines of force between the support members **16** and the planar side plates **13** in those regions of maximum transverse field. While such distortion is not appreciable in the beam edge focusing arrangement depicted in Fig. 2, it could be further substantially reduced, if desired, by making the support members **16** of insulative material. The individual wire-like elements **12** would then be connected directly to the voltage source or through a conductive member extending longitudinally along the outer side of either or both of the insulative support members. Alternatively, the outer conductive members could be utilized to support the array and the insulative members would act merely as electrostatic shields. These modified structural arrangements could similarly be employed in the focusing structures depicted in Figs. 3 and 4, as it is in Fig. 6, all of which are described in detail hereinafter. Since, in either case, there is no potential difference between the ends of the wire-like elements **12** and their support members **16**, the singular equipotential surfaces will not be distorted by a concentrated electrostatic field therebetween as experienced heretofore and as illustrated in Fig. 1B.

Fig. 3 shows a partial sectional view of an alternative beam edge focusing arrangement. For convenience, structural elements which are similar to those appearing in Fig. 2 will be designated by corresponding reference numerals in Fig. 3, as well as in the figures to be described hereinafter. In place of the stub-like wire elements **14** depicted in Fig. 2, there is shown a plurality of conductive wire elements **25** extending transversely from either or both planar side plates **13** and positioned intermediate the wire-like elements **12** near their respective support members **16**. Advantageously, this type of structural arrangement, as in the case for the structure depicted in Fig. 2, permits the support members **16** to be at the same potential as the wire-like elements **12**. Further, since the transversely extending wire elements **25** are attached to either one of the side plates **13**, they may be positioned intermediate the previously and independently fabricated linear array of wire-like elements

12 as a final and single step in the assembly of such a structure.

Fig. 4 is a modification of the structure illustrated in Fig. 3, being distinguished therefrom by a plurality of fins **26** replacing the transversely extending wire elements **25** depicted in Fig. 3. The utilization of fins rather than wires as the focusing elements in Fig. 4 provides a more rigid structural arrangement with equal beam edge focusing characteristics being realized therewith.

It should be noted that in both Figs. 3 and 4 the focusing elements do not extend inwardly an appreciable distance which would tend to impair the usable beam width for a given dimensioned structure. By way of example, the fins **26**, depicted in Fig. 4, might extend inwardly approximately one-twelfth of the distance between the edge support members **13**. These focusing elements have been made to appear considerably larger in the drawings for purposes of better illustration. As previously mentioned, the important requirement is that the beam edge focusing elements depicted in Figs. 2 through 4, which define the effective usable beam width, should be longitudinally aligned inwardly from the support members **16**, a distance such that any bending of the transverse lines of force between the support members **16** and planar side plates **13** will not appreciably affect the focusing along the edges of the beam.

Fig. 5 is a partial sectional view of still another beam edge focusing arrangement in accordance with the principles of my invention. In place of the various conductive beam edge focusing elements depicted in Figs. 2 through 4, beam edge focusing plates **27** are utilized and characterized by having apertures **28** therethrough for passage of the wire-like elements **12**. These focusing plates **27** may be at the same potential as the conductive beam edge focusing stubs depicted in Fig. 2. In accordance with an aspect of this invention, the apertures **28** through the beam edge focusing plates **27** are of a diameter substantially greater than the diameter of the wire-like elements **12**. Advantageously, this forces a concentration of effective beam edge focusing lines of force to be established between the ends of the wire-like elements **12** and those regions of the focusing plates **27** intermediate adjacent apertures **28**. With this arrangement, a sheet beam may have a width just slightly less than the distance between the beam edge focusing plates **27**.

In Fig. 6 a cross section of a magnetic beam edge focusing system is illustrated for containing the width of a sheet beam in a slalom structure. In place of the conductive planar side plates **13**, which bound the linear array as disclosed in Figs. 2 through 5, there are utilized two permanent bar magnets **29**, polarized in a direction normal to the desired path of electron flow. In other words, the north and south poles of the side plate bar magnets **29** extend along their respective longitudinal edges. In order to set up the requisite magnetic beam edge focusing field to contain the width dimension of a sheet beam, the polarity along corresponding edges of the respective side plate bar magnets **29** is reversed. In this manner, the proper force relationships are established and characterized in that such a field is uniform along the respective edges of the linear array of wire-like elements **12**. Further, to minimize leakage flux and to assure maximum concentration of flux along the respective edges of a sheet beam, the side plate bar magnets **29** advantageously have rib-like protrusions **30** which extend inwardly toward each other a short distance and furnish a desired magnetic flux path therebetween. It is this feature which permits a beam of maximum width for a given dimensioned slalom structure to be effectively focused with a minimum of magnetic field intensity. These bar magnets are also biased with respect to the linear array in the same manner as the planar side plates described above in regard to Fig. 2. Two thin insulator members **31** may advantageously be employed to support the bar magnets **29**. It is particularly advantageous in this structure to utilize insulative material for the support members **16**. In certain slow wave R.-F. circuit applications, two conductive planar side plates **32** may be advantageous for purposes of securing a particular propagation characteristic as well as for structural reasons. Such a beam edge focusing arrangement permits a high current, high density sheet beam having a width just slightly less than the distance between the insulative wire-like support members **16** to be effectively focused along a slalom course. High beam efficiency is also assured since distortion of the singular equipotential lines, which the beam substantially follows, is minimized near the edges because of the uniform beam edge focusing field and because of the insulative character of the support members **16** with respect to both the wire-like elements **12** and the planar side plate bar magnets **29**. Potentials could be applied to the individual wire-like elements by direct leads thereto or through conductive edge members which could also be utilized as the wire-like supports in a manner similar to members **16** depicted in Fig. 5.

It is to be understood that the specific embodiments described herein are merely illustrative of the general principles of the present invention. For example, in place of the conductive beam edge focusing elements disclosed herein, a sinuous conductive sheet could extend longitudinally along the respective edges of the linear array of wire-like elements and would provide an equally effective beam edge focusing system. Similarly, in place of the side plate permanent bar magnets, two ferrite side plates could be utilized with a thin metallic coating on the inner surface and along their respective edges so as to afford a means for establishing the proper electrostatic and magnetic field relationships desired. Further, beam edge focusing elements such as depicted in Figs. 2 through 4 could be of a suitable insulative material; this permitting electrons near the edges of the beam to impinge upon and charge electrostatically these elements to the proper biasing potential. Various other structural arrangements and modfiications may be similarly devised in the light of this disclosure by one skilled in the art without departing from the spirit and scope of this invention.

What is claimed is:

1. An electron beam system comprising a spaced pair of planar conductive bounding means, a plurality of spaced conductive elements forming a linear array which extends longitudinally in the interspace between said planar conductive bounding means, means for biasing the elements with respect to said planar conductive bounding means for establishing a pair of singular equipotential surfaces which extend longitudinally along and wind sinuously past the elements of said array, means for projecting an electron beam substantially along at least one of said equipotential surfaces, and means for confining the edges of said beam, said last-mentioned means including at least two beam edge focusing elements positioned in close proximity to the edges of said beam for establishing a concentrated field of beam edge focusing flux at least as great in the regions intermediate adjacent elements of said array as in the regions immediately adjacent the elements of said array.

2. An electron beam system in accordance with claim 1 wherein said beam edge focusing elements comprise two longitudinally extending edge members apertured for passage of the elements of said array therethrough and biased with respect to the elements of said array such that the greatest concentration of beam edge focusing lines of force exists between the elements of said array and the regions intermediate adjacent apertures of said longitudinally extending edge members.

3. An electron beam system in accordance with claim 1 wherein said beam edge focusing elements comprise

longitudinally extending rib-like protrusions facing inwardly toward the linear array and defining the outer edges of the path of electron flow, said rib-like protrusions forming the respective poles of bar magnets and arranged such that adjacent edges of said rib-like protrusions are of opposite polarity for establishing a uniform and concentrated magnetic beam edge focusing field therebetween.

4. An electron beam device comprising a longitudinally extending focusing electrode system which establishes two sinuous singular equipotential surfaces having at least one point of intersection, an electron source and collector positioned at opposite ends of said focusing electrode system for projecting a ribbon beam therethrough and substantially along one of said singular equipotential surfaces, and means for containing the width dimension of said beam comprising at least two beam edge focusing elements positioned in close proximity to the edges of said beam, said focusing elements establishing a concentrated field of beam edge focusing flux at least as great in the regions near the edges of said equipotential surfaces where said surfaces intersect as in those regions where said equipotential surfaces are furthest removed from the common axis thereof.

5. An electron beam device in accordance with claim 4 wherein said beam edge focusing elements comprise a plurality of conductive elements positioned near the longitudinal edges of said focusing electrode system and spaced uniformly therealong at points coinciding with those regions at which the equipotential surfaces intersect along the common axis of said sinuous paths, and means for establishing a potential difference between the longitudinally extending focusing electrode system and said beam edge focusing elements such that a concentrated electrostatic field is established therebetween for effectively containing the broad dimension of said ribbon beam.

6. An electron beam device in accordance with claim 4 wherein said beam edge focusing elements comprise two longitudinally extending conductive side members which define the effective beam width along said longitudinally extending focusing electrode system.

7. An electron beam device comprising a longitudinally extending linear array of conductive elements, a pair of planar conductive side plates extending longitudinally an equidistance of either side of said array, means for biasing the elements of said array with respect to said side plates for establishing a pair of singular equipotential surfaces which extend longitudinally along and wind sinuously past the array of elements bounded by said side plates, means for injecting an electron beam onto at least one of said equipotential surfaces, means for collecting said beam, and means for confining the edges of said beam, said last-mentioned means including a plurality of conductive beam edge focusing elements positioned near the ends of and intermediate adjacent elements of said array and means for biasing said focusing elements with respect to said linear array for establishing an electrostatic beam edge focusing field therebetween which has the greatest concentration of lines of force in the regions intermediate the elements of said array.

8. An electron beam device in accordance with claim 7 wherein said beam edge focusing elements comprise a plurality of short conductive stubs extending inwardly from at least one side of said linear array intermediate the elements of said array and in alignment therewith.

9. An electron beam device in accordance with claim 7 wherein said beam edge focusing elements comprise a plurality of short conductive members extending transversely from at least one of said side plates and positioned intermediate adjacent elements of said array and in close proximity to the outer longitudinal edges of said array.

10. An electron beam device in accordance with claim 9 wherein said transversely extending elements are in the form of wires.

11. An electron beam device in accordance with claim 9 wherein said transversely extending conductive members are thin conductive fins with the broad dimension being in alignment with the elements of said array.

12. An electron beam device comprising a plurality of spaced conductive elements forming a linear array, means for biasing said linear array of elements with respect to means bounding said array for establishing two singular equipotential surfaces which extend longitudinally along and wind sinuously past the elements of said array, an electron source and collector for projecting a ribbon beam through said linear array of elements with at least one of said equipotential surfaces forming the trajectory along which the electron beam will substantially traverse, and means for confining the edges of said ribbon beam, said last-mentioned means including said means bounding said array which comprises two thin bar magnets having a magnetic axis transverse to the desired direction of electron flow and positioned such that adjacent longitudinal edges of said bar magnets are of opposite polarity for establishing a uniform and concentrated magnetic beam edge focusing field therebetween.

13. An electron discharge device utilizing slalom focusing comprising a longitudinally extending array of conductive elements, a pair of planar conductive side plates extending longitudinally an equidistance on either side of said array, means for projecting a flat electron beam to wind sinuously past the array of elements bounded by said side plates, means for collecting said beam, and means for confining the edges of said beam, said last-mentioned means including an outer edge plate to which said conductive elements are attached and an inner edge plate having apertures therein through which said conductive elements extend.

14. An electron discharge device utilizing slalom focusing comprising a longitudinally extending array of conductive elements, a pair of planar conductive side plates extending longitudinally an equidistance on either side of said array, means for projecting a flat electron beam to wind sinuously past the array of elements bounded by said side plates, means for collecting said beam, and means for confining the edges of said beam, said last-mentioned means including an outer and an inner edge plate and a plurality of short stub members projecting intermediate said conductive elements, one of said stub members and said conductive elements being attached to the outer and the other to the inner edge plate.

15. An electron discharge device utilizing slalom focusing in accordance with claim 14 wherein said conductive elements are attached to said inner edge plate and said stub members to said outer edge plate, said inner edge plate being apertured for passage therethrough of said short stub members.

16. An electron discharge device utilizing slalom focusing in accordance with claim 15 wherein said stub members are positioned equidistant from adjacent conductive elements and in alignment therewith.

17. An electron discharge device utilizing slalom focusing comprising a longitudinally extending array of conductive elements, a pair of planar conductive plates extending on either side of said array, means for applying slalom focusing potentials to said conductive elements and said plates, means for projecting a flat electron beam to wind sinuously past the array of elements bounded by said plates, means for collecting said beam, and means for confining the edges of said beam, said last-mentioned means comprising conductive means positioned midway between adjacent of said conductive elements and aligned with said elements and means for applying a potential to said conductive means negative with respect to the potential of said conductive elements.

18. An electron discharge device utilizing slalom focusing comprising a longitudinally extending array of conductive elements, a pair of planar conductive side plates extending longitudinally and equidistant on either side of said array, means for projecting a flat electron beam to

wind sinuously past the array of elements bounded by said side plates, means for collecting said beam, and means for confining the edges of said beam, said last-mentioned means comprising magnetic means positioned directly adjacent the ends of said conductive elements and having a magnetic axis transverse to the direction of said electron beam for establishing a uniform and concentrated magnetic beam edge focusing field solely in the vicinity of said conductive element ends.

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