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Veith

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[54] **ELECTRON-BEAM TUBE AS SYMBOL-PRINTING TUBE**

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[51] **Int. Cl.** **H01j 29/56**

[58] **Field of Search** ..... 315/13, 14, 31, 31 TV

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[57] **ABSTRACT**

An electron tube for the continuous translation of electrical data into characters of scanning pattern points to be reproduced on a fluorescent screen, preferably an ultraviolet screen, employs a raster structure of insulated metal strips which may be scanned to determine the data passing the raster structure in the form of electron beams. Cylindrical lenses are employed in the raster structure to overcome distortions at the edges of the picture.

4 Claims, 4 Drawing Figures

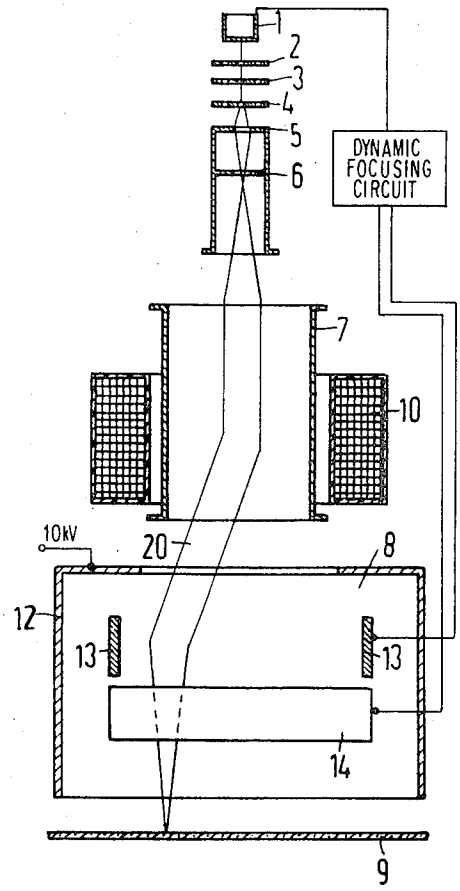


Fig.1

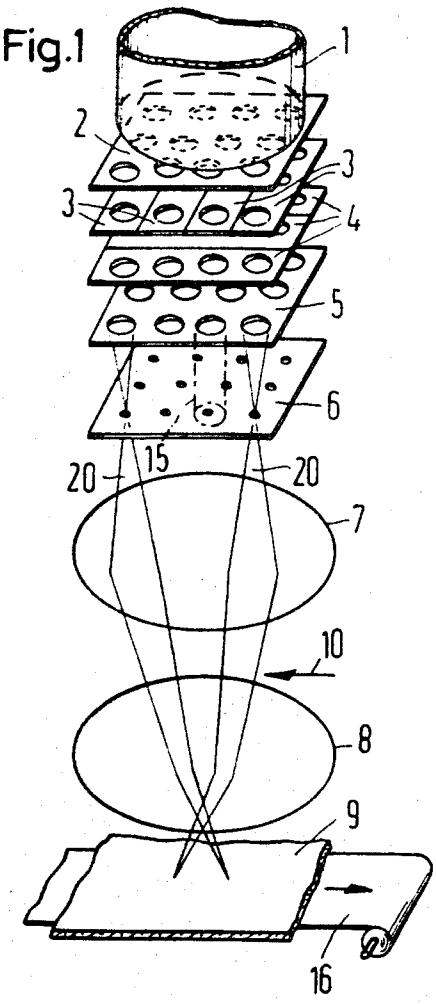


Fig.2

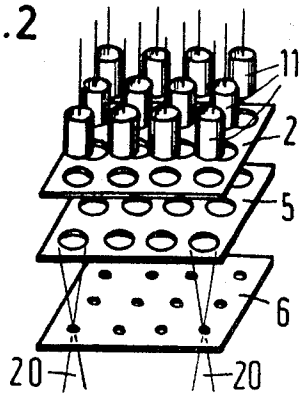


Fig.4

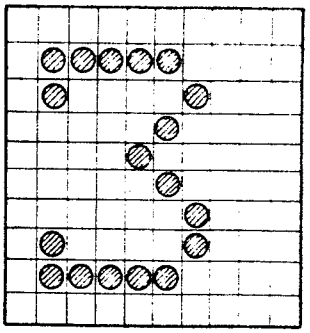
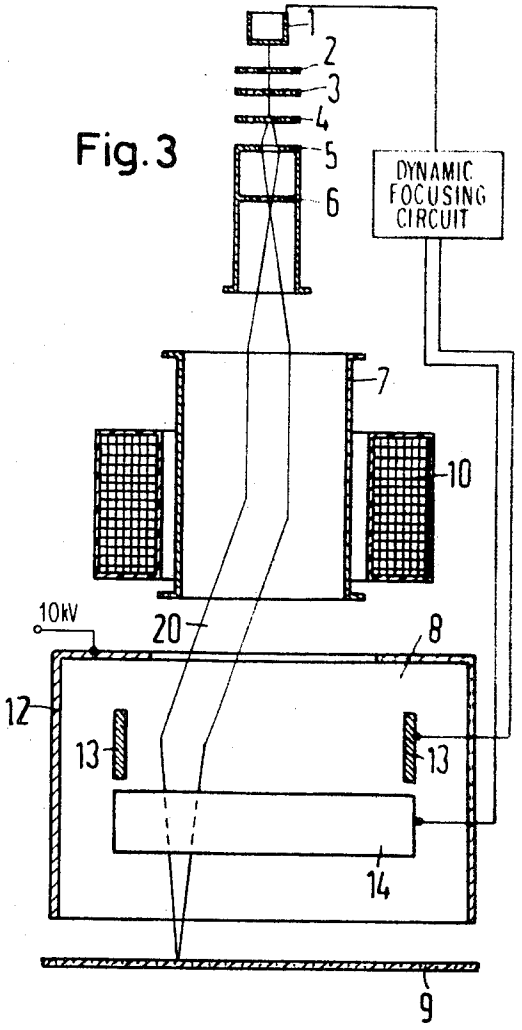


Fig.3



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ELECTRON-BEAM TUBE AS SYMBOL-PRINTING TUBE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the continuous translation of electrical data into any kind of written characters, symbols of such, which are to be reproduced on a fluorescent screen for instance, arranged in lines and in particular to an electron ray tube for such reproduction in which several electron rays arranged in a plane can be deflected parallel and black and white scanned individually or several together and which comprises among other things a ray producing system, a controllable ray forming arrangement (matrix, scanning pattern), a simple electron-optical acceleration lens, a deflecting system working for instance, magnetically and a collecting fluorescent screen (target).

2. Description of the Prior Art.

For the reproduction of texts and numerical values as they occur, especially with data processing machines and calculating machines, there are required relatively fast electronic devices which work almost noiselessly. The problem may be solved in many ways with the help of electron beams of electrical discharge tubes.

There has been known the writing of characters by means of a simple cathode ray tube in such a way that the electron beam carries out — one after the other — the lines, for instance, of a letter or of a number. Besides the fact that the selecting arrangement is quite complicated for complicated characters, the procedure requires relatively a large amount of time.

For another familiar tube, ready charaters are used in the tube where an electron beam is faded out by letter and number patterns and is reproduced on the fluorescent screen. The process works very fast; however, the tube is complicated because the electron beam requires the provision of a two-dimensional deflection arrangement for its deflection from the pattern. The electron beam must first pick out the desired letter pattern for which the first deflection is required; then the beam must be guided back to the center of the tube and be projected on the picture screen by a second deflecting arrangement. It is understandable that the complicated deflection arrangement causes a degradation in the quality of the picture, especially at its edge. Moreover, only a limited number of characters can be utilized with such a tube.

Furthermore, there has been known the reproduction of the individual character in form of scanning elements by the fading out of parts of the total electron ray by means of an aperture scanning pattern while the remainder similarly as for the reproduction of a television picture, is directed over a certain part of the picture screen where the character is to be reproduced. For this purpose, each aperture of the scanning pattern has an electrically conducting ring to which electrical signals are applied from the outside by way of a line leading to it. Aside from the difficult realization of the lines, the steering of the electron beam, for instance, for white scanning, is relatively costly since the white scanning takes place in form of individual time delays which must be very accurate.

It is the primary object of the present invention to avoid the above-mentioned difficulties and disadvantages.

There is also another problem. The types of tubes mentioned herein before do have a reproduction system where the picture screen is at a relatively great distance from the electron lens so that generally an enlarged picture originates. However, in order to be able to put as many characters as possible on a given picture screen, small sharply designed characters are therefore required which can possibly be enlarged optically; these characters are located outside the tube.

SUMMARY OF THE INVENTION

For an electron beam tube according to the present invention — especially for the continuous translating of electrical data into any kind of written characters, symbols or such, which are constructed of scanning points and are to be reproduced on a fluorescent screen, for instance, arranged in lines — means are provided to produce several electron rays arranged in a plane which can be deflected parallel and can be black and white scanned individually, or several together, and which comprises among other things, a beam producing system, a controllable ray forming arrangement (matrix, scanning pattern), a simple electron-optical acceleration lens, a deflecting system working, for instance, magnetically and a collecting fluorescent screen (target). The main objective of the invention is solved according to the invention by the fact that between the deflection system and the collecting screen (target) there are arranged at least two lenses forming a common electron-optical reproduction system in such a way, and that their focusses are dimensioned in such a manner, that the reproduction on the target obtained by them is reduced; and wherein two of these lenses arranged directly in front of the target form a correcting system consisting of cylindrical lenses for correcting distortions, especially at the corners of the picture.

The individual parallel electron beam bundles used here, which extend from the beam producing system, are arranged by the deflecting system to the individual letters, written characters, or such in a line and the thus formed lines are transposed vertically one after the other. Here the individual electron ray bundle enters, for instance, with considerable deflection slantingly into the space behind the deflection system, i.e., into the range of the cylindrical lenses and consequently it experiences a more or less considerable distortion corresponding to a spherical aberration. The cylindrical lenses provided for the elimination of this blurredness comprise, in an especially advantageous manner, a metal housing and in each case two metal strips placed there electrically separated. The metal housing is open toward the fluorescent screen and has a large entrance aperture partition toward the beam producing system. From the beginning, cylindrical lenses have a slight aberration and their tension can also be changed in order to balance the otherwise occurring reproduction faults in connection with the deflection of the electron beam.

In front of the deflecting arrangement and the cylindrical lens system arranged behind it, there is provided a beam forming arrangement for the development of an electron beam matrix which, in the simplest case, comprises electrodes arranged parallel to each other and formed primarily of level metal sheets, such as the Wehnelt electrode, and of anodes. These electrodes as well as their partial electrodes have an aperture raster (structure) which is the same for all pertaining elec-

trodes. Besides these electrodes, namely the first pull anode and the main anode which together with the Wehnelt electrode form the first acceleration lens, there is provided at a distance behind it in the direction of the beam still another aperture scanning pattern with the same arrangement of apertures but with smaller apertures, which constitutes in an especially advantageous manner the respective object plane for the following acceleration lens. By means of small tubes, for instance, made of metal, the apertures pertaining to each other are preferably put at a distance from this additional aperture raster and from the main anode arranged in front of it. This measure has the purpose that, by the formation of narrow channels, any slantingly running electron beams especially can be registered on the collecting screen. Only the electron beams getting through the fine openings of the aperture raster are used for further reproduction; here, the aperture raster itself functions as an object level for an electron-optical system arranged therebehind. Such an inserted acceleration system prevents the spreading of the electron rays and steers them furthermore to a common spot of another reproduction system following behind. The individual lines of this reproduction system comprising two lenses are arranged with respect to each other in such a way, and are laid out regarding their focusses in such a way, that a reduced picture of the aperture raster originates on the fluorescent screen.

The aperture raster matrix or the aperture raster structure, respectively, of the individual electrodes belonging to the beam forming arrangement can have up to 20 × 30 circular holes; thereof the holes — corresponding to each other — of the electrodes or partial electrodes arranged one after the other coincide. In most cases, an aperture raster matrix with about 5 × 7 holes is sufficient to reproduce letters, written characters or such of perhaps typewriter quality. For the selection of the points on the vertical lines and horizontal lines of the point matrix there is provided — in an especially simple example of design — as the first pull anode a system of crossed, perforated anode bands which can be individually selected. These perforated sheet metal strips, which are galvanically separated and have an electrical connection toward the outside, are in each case arranged in two planes behind each other according to the number of columns. The electrons emitted by a common cathode, which mostly has large surfaces and is productive are first, by means of the Wehnelt electrode arranged in front of it, on the basis of its aperture raster structure subdivided into a corresponding number of areas. Thereupon a selection for the particular columns, for instance for the vertical lines, takes place in each case by means of the individually selectable perforated strips of the partial anode arranged in the formost plane. By means of the second perforated band group behind it, the introduced electron beam course, is so-to-speak allowed belatedly, or is entirely prevented. The electrode arrangement as well as the execution of the black and white scan, is especially simple with this form of electron beam since for each perforated band of the anode there is needed only one electrical connection from outside. However, this method has one disadvantage which consists thereof that not all points can really be selected simultaneously or black and white scanned, respectively.

In an advantageous further development, the cathode is divided into a number of individual cathodes corresponding to the point scanning pattern. Each of these individual cathodes has a separate line from outside by way of which in each case the potential of the individual cathode, with respect to the common Wehnelt electrode, can be raised or lowered. In this case a subdivision of the anodes into perforated strips is not required but in place of it perforated metal sheets are provided, so-to-speak, in one piece.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will be explained below with the aid of drawing examples of the described electron ray tube. Parts, which do not absolutely contribute to the understanding of the invention, have been omitted from the drawings or have been left unmarked. In the drawings:

FIG. 1 shows a schematic picture of the electrode arrangement and of the electron beam course, especially in the case of a common cathode;

FIG. 2 shows the production system for simultaneous scanning with separate cathodes;

FIG. 3 shows schematically a possible technical design example of a tube regarding the electron formation and arrangement; and

FIG. 4 shows the scanning pattern of the number "3" as an example of the possible formation of the numbers and characters to be reproduced.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, there is marked by 1 a common cathode which must be designed with especially large surfaces and must be productive. Before it, there is arranged the Wehnelt electrode 2, which is already designed as an aperture raster and before which there is arranged again the first pull anode 3 and 4 consisting of crossed anode bands. The size of the point raster on which these electrodes are based can vary, for instance, between 7 × 5 and 20 × 30 picture points. Experience has shown that, for the writing of letters of a good typewriter quality, the aperture arrangement mentioned last is by far sufficient.

The crossed aperture bands 3 and 4, separated electrically from each other, serve as the electrodes of the first pull anode in order to select the points on the vertical and horizontal lines of the point matrix. They can be selected individually and thus provide the selection for one column, for instance, a vertical line. Thus a positive voltage of only a few volts, for instance of 10 to 50 volts, is sufficient to obtain, with a distance of a few tenths, of a millimeter, a current of the magnitude of 1 mA per picture point. The second row of anode bands 4 of a similar form is arranged in the beam direction behind the group of anode bands 3 described before. In FIG. 1, the bands run parallel to the character plane. By putting a positive voltage on these anode bands 4, the ray passage achieved by the first anode bands 3 is delayed; while by the application of a small negative voltage of only a few volts below zero (cathode potential) the passage of the beam is prohibited. By this measure it is possible to select individual points of the scanning pattern at will, for instance, for writing the number 3 in a form as it has been shown separately in FIG. 4. According to the point raster of the drawing, in the case of the number 3 the first column is switched — blocked — in all rows. In the second column only the 2nd, 3rd, 8th and 9th rows are opened, in the third col-

umn only the 2nd and 9th row are opened and this is done immediately. The example of the design shows that point rasters with less than 20 × 30 points already make possible sufficiently clearly recognizable numbers. However, with this steering technique of the anode bands not every point can be selected simultaneously as it can be done by means of the further development shown separately in FIG. 2.

Following the anode bands 4, there is a plate 5 as the main anode, for instance, a square plate which, according to the scanning pattern selected in connection with the Wehnelt electrode and the first pull anode, is provided, for instance, with 5 × 7 = 35 circular holes and which are made to coincide with the openings of the anode bands 3 and 4. Between the anode bands 4 and the main anode 5, lenses develop during operation which focus the electron beams, which pass through the holes, on very small openings in the aperture raster plate 6 arranged at a distance behind. The electrodes 5 and 6 can be connected by small tubes 15 in such a way that channels are formed between the holes — corresponding tp each other — of the two electrodes. With these small tubes 15, for instance made of metal, it is intended that slantingly running electrode beams cannot be registered during the reproduction. The focussed electron beams passing vertically through the fine openings of the aperture raster plate 6 are used for further reproduction in such a way that the electrode 6 itself functions as the object plane for a following electron-optical lens 7. Such a lens 7, for instance, in the form of an acceleration lens, prevents namely the spreading of the electron beams and furthermore steers the 5 × 7 = 35 individual beams to a common spot of the following lens system 8. Lens 7 and lens system 8, both are arranged with respect to each other in such a way and their focusses together are laid out in such a way that a reduced picture of the aperture raster of plate 5 appears on the fluorescent screen (target) 9.

While the lens 7 can be a simple acceleration lens as it is common for electron beam systems, the lens system 8 consists of two electron-optical cylindrical lenses. Between lens 7 and the lens system 8, there is the deflecting system 10 which, for instance, works magnetically. It serves to arrange the individual letters, numbers or such in a line and thereupon to move the individual lines vertically one after the other. For this reason the deflecting angle of the deflecting system must be relatively large and therefore it is again required that the diameter of the lens system 8 is very much larger than the diameter of the diaphragm electrodes 3, 4, 5 and 6 as well as of lens 7.

By means of the especially favorable electrode arrangement shown in FIG. 2, it is possible, in contrast to the arrangement described before, to select each individual point of the point screen. For this purpose there is provided a number of individual cathodes 11 corresponding to the number of scanning pattern points. Each of these individual cathodes has a separate line from outside by way of which — for the purpose of black and white scanning — the respective potential can be raised or lowered. A partition of the partial electrodes of the first pull anode into so-called crossing anode bands is not required. In place of it, there is provided in each case only a single massive aperture plate 5 as an anode. The other electrodes following it are the same ones as described before in FIG. 1.

FIG. 3 shows a picture of the described tube, approximately correct as to scale, where, however, deviating from the lower part, the electrodes 1 to 7 from the schematic sketch in FIG. 1 are drawn at a much smaller scale. The same is true also for the deflection system 10.

After leaving the deflecting system 10, the respective electron beam bundle 20 enters slantingly, fo instance, with considerable deviation, on its further course the space in which the cylindrical lenses are placed. To this system of cylindrical lenses, there belongs in particular the metal tube casing (housing) 12 and two band-shaped metal bars 13 and 14 arranged therein vertically to each other. The cylindrical lenses are necessary because the unavoidable spherical aberration of a normal lens would cause considerable blurredness in the picture edge. Cylindrical lenses, on the other hand, have from the start less spherical aberration and their tension can also be changed in order to make up for the reproduction errors in connection the deflection of the electron beam in dependence of the deflection voltage in order to thereby provide dynamic focussing. While the housing 12 is on a high positive potential of abour 10 kV, the potential of the bands 13 and 14, for instance, for the central beam bundle, must assume values in the range of about 0 volts, referring to the cathode. With steering of the electron beam into one of the corners of the housing which is for instance, square, both band pairs 13 and 14 are then switched to a positive potential in order to give a weaker refractive power to the individual lines forming in each case between the housing 12 and the bands 13 or 14. Thus the tube works with dynamic focussing, i.e., the electric potential or the voltage of the electrodes of the individual lenses 13 and 14 is changed according to the steering of the electron beam.

The described tube is intended, for instance, for the reproduction of written characters within the framework of a document of the size of a typewritten page. But it can also be converted relatively easily into a tube for non-mechanical printing. In this case only one line is needed so that the deflecting system for the entire range of the fluorescent screen is simplified. Such a printer thus works as series or line printer by using the advancing of the provided paper feeder 16 for the writing of additional lines. Since the character appears first only on the fluorescent screen (target) 9, light sensitive paper is preferably used in this case. Such paper, as it is generally obtainable today in a satisfactory quality, however, works especially with ultraviolet light. For this reason, a UV phosphorus as well as a UV transparent front glass plate must be provided for the printer. Here, however, the front glass plate 9 has merely the form and size of a single line. A normal size letter is advantageously chosen, i.e., approximately 2.5 to 3 mm high, and the light sensitive paper is brought into direct contact with the front plate. If an additional reproducing optical system is used, a loss of light must be accepted but, on the other hand, it has the quite considerable advantage that the size of the letters can be selected about as desired thus, for instance, it can be enlarged to a desired size or also reduced accordingly for microfilms.

Another alternative for the character writing tube consists thereof that the horizontal deflection of the entire beam bundle is also used for the writing of the letters. In such a case, only one column of points which

are vertical one above the other, is needed. While the electron beam of a line runs horizontally over the picture screen, the respective 7 or 30 points of a vertical column are — during the advancing of the deflected switched black and white, as desired, automatically by the width of one picture point. In this manner, there originates a character writing tube with the same writing speed as described before, but with a considerably simpler construction. It has a special significance always where it is important to write a continuous text where the deflection speed of an electron beam bundle is constant. In this sense the same arrangement is valid also for the use of the described tube as a printer.

Essential advantages of the described tube in comparison to other tubes consist thereof that, for the composition of the characters from a point raster, there is used a matrix of electron beams which either originate from a common cathode and are black and white scanned by the use of crossed anode bands or which originate from a corresponding number of individual cathodes which themselves are black and white scanned. The points required in each case are simultaneously written by these electron beams. With the possibility of a reducing reproduction, every desired character — thus also Greek and Arabic letters — can be reproduced merely by a change of the selecting sytems located outside of the tube and drawings with curves with different line marking can be presented.

Many changes and modifications may be made in my invention by one skilled in the art, and I intend to include in the patent warranted hereon, all such changes and modifications that may reasonably and properly be included within the scope of my contribution to the art.

I claim:

1. An electron beam tube for continuous conversion of electrical data signals into characters, symbols or the like composed of scanning pattern points arranged in lines and to be reproduced on a fluorescent target, comprising: cathode means for providing a plurality of parallel electron beams; a controllable beam forming arrangement disposed adjacent said electron beams; an electron-optical acceleration lens disposed adjacent said controllable beam forming arrangement; a beam deflecting system disposed adjacent said electron-optical acceleration lens; a plurality of lenses disposed between said deflecting system and said target having focal lengths dimensioned to provide a reduced image upon said target, said plurality of lenses including a pair of cylindrical abberation correcting lenses disposed directly adjacent said target for effecting distortion correction; and a cylindrical metal housing having an open end directed toward said target and a large aperture directed toward said deflecting system, said pair of cylindrical lenses disposed within said housing and each consisting of a metal strip electrically isolated from the other.

2. An electron beam tube according to claim 1, wherein said metal housing is connected to a high potential of about 10 kV, and comprising means for applying approximately the same potential to said cathode and to said metal strips and changing the potentials so applied to provide dynamic focusing.

3. An electron beam tube for continuous conversion of electrical data signals into characters, symbols or the like composed of scanning pattern points arranged in lines and to be reproduced on a fluorescent target, comprising: cathode means for providing a plurality of parallel electron beams; a controllable beam forming arrangement disposed adjacent said controllable beam electron beams; an electron-optical acceleration lens disposed adjacent said controllable beam a beam deflecting system disposed adjacent said electron-optical acceleration lens; and a plurality of lenses disposed between said deflecting system and said target and having focal lengths dimensioned to provide a reduced image upon said target, said plurality of lenses including a pair of cylindrical abberation correcting lenses disposed directly adjacent said target for effecting distortion correction, said beam forming arrangement corresponding to an electron beam matrix and including electrodes arranged parallel to each other and each comprising flat metal sheets, each of said sheets including a plurality of holes therein to form the same aperture raster matrix, the aperture raster matrix consisting of up to 20 × 30 holes with the holes of each sheet being aligned with the holes of the other such sheets.

4. An electron beam for continuous conversion of electrical data signals into characters, symbols or the like composed of scanning pattern points arranged in lines and to be reproduced on a fluorescent target, comprising: cathode means for providing a plurality of parallel electron beams; a controllable beam forming arrangement disposed adjacent said electron beams; an electron-optical acceleration lens disposed adjacent said controllable beam forming arrangement; a beam deflecting system disposed adjacent said electron-optical acceleration lens; and a plurality of lenses disposed between said deflecting system and said target and having focal lengths dimensioned to provide a reduced image upon said target, said plurality of lenses including a pair of cylindrical abberation correcting lenses disposed directly adjacent said target for effecting distortion correction, said cathode means including a plurality of cathodes each operable to provide a separate electron beam and each including a respective line for receiving a respective scanning potential.

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