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ELECTRON STORAGE DEVICE WITH GRID CONTROL ACTION

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This invention relates to electron discharge devices of the type in which an elemental area of a target electrode is charged to one of two predetermined potentials so as to constitute a memory element for use in electronic computers, and in particular to an improved method of and means for indicating to which potential the memory element has been charged. In a co-pending application of J. A. Rajchman, Serial No. 665,031, filed April 26, 1946, which is now U. S. Patent No. 2,494,670 granted January 17, 1950, an electron discharge device of the storage or memory type has been described.

In accordance with the aforementioned co-pending application, one or more horizontal and vertical grid networks are employed to direct a stream of electrons at a selected elemental area of a target electrode. The target electrode consists of an insulating secondary emissive material which may be coated on a metallic signal plate or otherwise constructed in such a manner that the dielectric surface is capacitively coupled to the signal plate. By applying suitable potentials to the signal plate while controlling the flow of electrons to the selected target area, it was shown in the copending application referred to above that the dielectric element under bombardment may be made to assume either one of two potentials which are stable under continuous electron bombardment. By conditioning successively selected elemental target areas to one or the other of the two possible stable conditions, the device may be made to store or "remember" the information which has been applied to it. The device has utility in connection with computing systems utilizing the binary system of counting wherein one of the two stable conditions represents the figure 0 and the other stable condition represents the figure 1, or any other system of counting in which the numbers are represented by coded combinations of the two conditions. It is thus possible to store in a device of this nature a series of conditions each representative of a number to be used in the process of computation.

In the original arrangement the system employed for subsequently determining the existing condition of a selected elemental area also utilized the signal plate. As a result it was difficult to separate signals produced by the application of pulses to the signal plate for storing information from the signals which were indicative of the condition of the memory elements. In addition, since the indicating system responded to the displacement current required to charge or discharge the capacity of the memory element, the time required to determine its condition was not as short as may be desired.

A modified method of and apparatus for determining the condition of a memory element which utilizes the light emitted from fluorescent material deposited on the surface of each elemental area has been described in copending application of J. A. Rajchman, Serial No. 720,876, filed January 8, 1947, now Patent No. 2,442,985, dated June 8, 1948. This system has certain advantages and permits the condition of the elemental area to be determined independently of the signal plate. However, in order to produce light of sufficient intensity to be useful, it is necessary to cause the electrons to strike the fluorescent surface at a high velocity. This requirement makes it necessary to maintain the dielectric surface at a high potential. Since the dielectric surface of the target is continuous and the selection of elemental areas is effected by causing electrons to impinge on separate adjacent regions, it will be appreciated that as the size of each region and the spacing between adjacent regions is reduced, for the purpose of providing the largest possible number of memory elements in a given area, the problem of preventing leakage from a highly charged elemental area to an adjacent area which is at cathode potential becomes increasingly difficult. The leakage factor determines the time during which the device will maintain its "memory" or charge in the absence of electron bombardment. Consequently, in order to reduce leakage between adjacent elements, it is desirable to charge the elemental areas to the minimum voltage possible. The two requirements mentioned above indicate opposite operating procedures.

It is the primary object of this invention to overcome the disadvantages of the earlier systems by separating the indicating and storing functions.

In brief, the objects of this invention are accomplished by providing one or more holes in the dielectric surface which constitutes each memory element with corresponding holes in the signal plate, and also providing a second target electrode so that at least some of the electrons directed toward the selected area will pass through the first target electrode and impinge on the second target electrode, provided the potential of the dielectric area is sufficiently positive. If, however, the dielectric surface is at cathode potential it will act as a control grid and will block the passage of electrons. Consequently, the electron flow through the storage element, that is, through the first target electrode, depends upon the condition of the memory element. The electrons passing through the first target electrode may then be collected at the second target electrode and. used to indicate the condition of the memory element without interfering with the operation of the element itself.

It is therefore a further object of this invention to provide an improved method and means for indicating the condition of the memory elements of an electron storage tube by means of an electron current which is controlled by the potential of the element and which is therefore indicative of its condition.

It is a further object of this invention to provide alternate forms for the first and second target electrodes.

The proper control and direction of the electrons emitted from the cathode requires their successive passage through a plurality of grid-like or apertured electrodes. If conventional practices are followed in the construction of the various electrodes great difficulty will be encountered in positioning them so that their apertures are in register. In accordance with a further object of this invention, an improved constructional arrangement is provided in which perforated metal plates are employed which may be stacked in spaced parallel relationship on insulating ceramic or glass rods to provide a rigid unitary structure which may be manufactured more readily than previously known arrangements. Additional insulating rods passing through the perforated plates may also be used to space the wires of the selecting grid networks.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a sectional view of an electron discharge storage tube in accordance with the present invention,

Figure 1a is an enlarged sectional view of a portion of the first target electrode of Fig. 1,

Fig. 2 is a view, partly in section, taken on the line II—II of Fig. 1,

Fig. 3 is a schematic diagram illustrating the circuit connections for a tube of the type herein illustrated,

Figs. 4 to 8, inclusive, are sectional views of a portion of modified forms which may be used for the first target electrode, and

Figs. 9 and 10 are sectional views of modified forms of second target electrodes.

Referring to Figs. 1, *la* and 2, in its simplest form the electron discharge storage device in accordance with this invention is constructed as follows:

An elongated cylindrical cathode **21** is centrally located along the axis of the tube which is enclosed in an evacuated envelope **22**. Surrounding the cathode is a first accelerating electrode **23** which consists of a spiral of fine wire and may be mounted on four supporting rods suitably anchored in the base of the tube. The electrode structure may consist of from one to four identical sections, only one of which has been illustrated. Extending radially from the cathode and In register with the four supporting rods of the first accelerating electrode are two focusing electrodes **25** and **27**. These electrodes are metallic plates and their purpose is to direct electrons emitted from the cathode toward the grid and other electrodes of the tube so that they approach the second accelerating electrode **29** in paths substantially perpendicular to its surface.

The second accelerating electrode **29** is provided to cooperate with the focusing electrodes and to direct the electrons in the desired direction. This electrode is preferably a stamped metal plate having a large number of small circular apertures therein. These perforated plates may be obtained commercially and are readily adaptable for use. The diameter of the holes may be of the order of .040 inch. When four identical segments are employed this electrode may be formed of a single sheet, bent to form a substantially square enclosure.

Next in order beyond the second accelerating electrode is the horizontal control grid network **31**. This network consists of a plurality of individually insulated strips or conductors lying spaced from and parallel to the second accelerating electrode and positioned between the horizontal-rows of apertures in the latter electrode, as best illustrated in Fig. 2. In the view shown in Fig. 1, one such electrode **33** is visible. Next in order is a shield electrode **35** which consists of a perforated metal plate of approximately the same size as one face of the second accelerating electrode **29**, and mounted parallel thereto with the holes of the two electrodes in register.

Following the shield electrode **35** is the vertical control grid network **37** which consists of a plurality of strip conductors similar to those of the horizontal grid network but positioned at right angles thereto and parallel to the other electrodes. Although not shown herein, the individual wires of the horizontal and vertical control grid networks are to be separately connected for individual excitation in accordance with the teaching of the copending application Serial No. 665,031. Methods for effecting complete control of the electron stream utilizing a number of external leads which is less than the number of individual grid wires have been described and claimed in a copending application of J. A. Rajchman, Serial No. 702,775, filed October 11, 1946, and the application of George W. Brown, Serial No. 694,041 filed August 30, 1946, which is assigned to a common assignee.

It is to be understood that the particular arrangement employed for directing the electrons toward the selected elemental area on a mica sheet **59** of a first target electrode **57** is not, as such, a part of the present invention, and any of the arrangements described in the copending applications referred to above may be employed.

Following the vertical control grid network there is a collector electrode **55** which is also a perforated metal plate similar in size and construction to those employed for the shield and second accelerating electrodes. The holes in the collector electrode are also in register with the holes of the preceding electrodes.

Next in order, is the first target electrode **51.** This electrode has, essentially, two parts and two functions. It includes, in its simplest form, a perforated surface of dielectric secondary-emissive material which may be, for example, a mica sheet **59** having therein small perforations of a diameter less than the diameter of the perforations in the preceding electrodes, but in register therewith. Closely associated with the mica sheet **59** and capacitively coupled to all points, thereon is a metal capacity plate **61.** This plate may again be a perforated metal sheet of the same size as that employed for the collector and the other electrodes.

Finally, the second target electrode **63** is mounted parallel to and adjacent the first target electrode. In its simplest form this electrode may comprise merely a solid metal sheet **62**, although modified forms will be discussed subsequently.

An important feature of the present invention resides in the unique constructional arrangement employed to support the various electrodes. The inner and outer electrodes (excluding the cathode and first accelerating electrode) are preferably supported rigidly by vertical supporting rods embedded in the glass base or supported between two mica sheets in accordance with conventional practice, while all the other electrodes are supported by suitable insulating rods which pass through aligned apertures along the edges of these electrodes. For example, the second accelerating electrode **29** is supported at its outer edges, or at the corners in case four identical sections are employed, by supporting rods such as **30** and **32**, while the target plate **62** is supported at its outer edges by two supporting members **34** and. **38**. Four insulating tubes or rods, **38**, **40**, **24** and **26**, are passed through the apertures in the four corners of the two electrodes. These rods provide the support for all intermediate perforated plate electrodes. The electrodes may be held in spaced parallel relation by means of insulating spacers which are placed around the rods between the electrodes and the rod may be threaded and provided with nuts at each end to hold the whole assembly together. Alternatively an insulated bolt may be passed through the supporting tube for the same purpose, as shown. All the apertures in the perforated plate electrodes will then be held rigidly and permanently in register. Since standard, identical perforated plates may be employed the manufacture of an otherwise complicated structure has been greatly simplified.

The operation of the device including the selection of the individual storage elements, the release of secondary electrons by the dielectric surface of the first target electrode, and the method of conditioning the storage element to one or the other of the two stable conditions is as described in the earlier applications referred to above, and need not be described herein in greater detail. The resulting electron flow under the two possible conditions has been illustrated in Fig. 1. Assume that the aperture or "window" defined by vertical electrodes **39** and **41**, together with the two corresponding adjacent horizontal electrodes, has been opened by the application of suitable opening potentials to the four wires of the two grid networks. This condition is indicated by the "+" sign on the two vertical grid conductors **39** and **41**. Assume further that the storage element, that is, the area of the dielectric **59** in register with the window so defined, has previously been, set at cathode potential. Electrons passing through the open window and the aligned aperture in the positive collector electrode **55** will be turned back toward the collector and will not impinge on the surface of the storage element. This is because the storage element is at cathode potential and the collector electrode is at approximately 300 volts. Of course a few electrons may strike the storage element from time to time if its potential tends to increase. However, as pointed out above, this is merely the stabilizing action which tends to maintain the element at cathode potential. As a result, no electrons pass through the small aperture **56** and no electron current flows in the second target electrode **62**.

The other condition is also illustrated in Fig. 1. Assume that the window defined by, vertical grid wires **45** and **47**, and the cooperating horizontal grid wires, has been opened and that the storage element in register with this window has previously been charged to collector potential. In this case electrons will flow through the window and strike the dielectric surface of the storage element at sufficient velocity to release secondary electrons. These are collected by the collector electrode, which is maintained at a positive potential. In addition, certain electrons of the impinging stream pass through the aperture **58**, centrally located in the storage element and strike the second target electrode **62**, which is maintained at a much higher potential. The resulting electron current can then be measured or used to produce an output indication by a suitable connection to the target electrode **62**.

The purpose of the negatively biased capacity plate is two-fold. First, the capacity plate is used to condition the storage elements in the manner discussed above. Second, due to its negative potential, the capacity plate acts as a shield so as to insure that the electric field produced by the highly positive accelerating electrode does not extend through the small apertures in the dielectric first target electrode **53**. The negative field assists the storage element in turning impinging electrons back towards the collector electrode when the element is at cathode potential, but is not sufficiently negative to prevent the passage of electrons when the element is at collector potential.

The electrical circuit connections for the device illustrated in Figs. 1 and 2 are shown in Fig. 3. The cathode **21** is preferably connected to ground while the focusing electrodes **25** and **27**, the accelerating electrodes **23** and **29**, the shield electrode **38**, the collector electrode **55** and the second target electrode are all connected to a suit-able source of D. C. potential the approximate values of which are indicated in Fig. 1. This source may, for example, be provided by a battery **42** and a resistance voltage divider **44**. The control circuit for applying opening potentials to the horizontal and vertical grid network conductors is indicated by device **44**. The conditioning pulse input is applied to terminal **48** which is capacitively coupled to the capacity plate **61** by means of a condenser **50**. Output is taken from terminals **54** across the load impedance **52**.

The collector electrode **55** may be modified as shown in Fig. 4 by the addition of a fine mesh screen of copper **78**, the purpose of which is to shield the first target **59** from the wires of the vertical control grid **37**, so that the field conditions prevailing at the surface of the first target **59** depend only on the potential of the collector **55** and are independent of the switching potentials applied to electrodes **37.**

An enlarged view of an alternative form of the first target electrode **57** is shown in Fig. 5. The capacity plate **61** and the perforated mica sheet **59** which constitutes the storage elements are employed as before. In addition, an auxiliary shield electrode **64**, consisting of a perforated metal sheet similar to that employed in the other electrodes, is placed against the inner surface of the mica. The purpose of this auxiliary electrode, which may be biased to a potential of +100 volts, is to provide a definite potential between adjacent storage elements in order to minimize leakage If, for example, the dielectric surface of element **66** (Fig. 5) is at collector potential and the surface of the adjacent storage element **68** is at cathode potential, there would be an unduly large potential gradient between them if the intermediary region assumed the potential of one or the other of these elements **66** and **68**, a condition which would be conducive to promote a leakage current. However, by creating points at a potential intermediate between the cathode and collector potentials, which is accomplished by the auxiliary electrode **64**, the potential gradient tending to cause leakage between elements **66** and **68** is minimized. While there may be some ohmic leakage by conduction on the dielectric surface itself, leakage may also be effected by the movement *of* stray secondary electrons or deflected primary electrons from one element to another. The auxiliary electrode **64** is particularly effective in preventing leakage of the latter type.

A further alternative form which may be employed in the construction of the first target electrode **57** is shown in Fig. 6. In this case the capacity plate **61** consists of two perforated metal sheets of the type previously employed between which is clamped a fine mesh **72** of copper wire having from 100 to 400 wires per linear inch. After assembly this electrode is coated with an insulating dielectric material which is secondary-emissive. The coating material then constitutes the storage electrode, the surface of which is impinged by the electrons. The advantage of this arrangement is that very close capacity coupling can be provided between the surface of the dielectric and the capacity plate. As before, the capacity plate will normally be biased to a potential of -50 volts, while the conditioning pulse is superimposed on the fixed bias as in the previous case. When the storage element, that is, the dielectric surface, is at cathode potential, the electrons will not pass through the screen. However, when the surface is at collector potential, those electrons which strike the dielectric surface will release secondary electrons to maintain the potential in a stable condition, while some will pass through the screen to the second target electrode. An additional auxiliary electrode comprising a perforated metal sheet may be placed between the first and second target electrodes in order to neutralize the field from the second target electrode. This will insure that the electric field at the center of the wire mesh will not exceed cathode potential.

In the embodiments illustrated above, in order for the storage element to function as a control grid and to prevent the passage therethrough of electrons when it is at cathode potential, it is desirable that as great an area of the element as possible be brought to cathode potential. When mica is used, the sides of the cylindrical hole **58** (see Figs. 1, 1a or 5) arc parallel to the path of the electrons and will not normally be struck by any electrons. Consequently, cathode potential will exist only at the inner surface of the dielectric and will not extend downwardly into the hole. Control can be improved by providing an arrangement such that the entire surface of the dielectric is exposed to the electron stream. This may be accomplished, for example, as illustrated in Fig. 7. The small aperture in the dielectric surface is made conical in shape with its larger diameter facing the cathode. Since such construction would be difficult to accomplish with mica, and also to illustrate an alternative structure, in Fig. 7 the first target electrode comprises a metal capacity plate **61** having conical perforations which may readily be machined in a metal plate. The electrode is then treated to deposit on its surface a dielectric material of high secondary-emissive characteristics. For example, this may be accomplished by anodizing aluminum in accordance with conventional practices or covering the metal surface with silica or a suitable enamel having the desired characteristics. The entire surface of the aperture will then be exposed to the electron stream and a strong positive field will be created, and in one case, while the entire surface will be maintained at cathode potential in the other case. This design will ensure positive control of the passage of electrons through the holes. The conical shape also ensures that the collector field will leak sufficiently into the aperture for an equipotential to follow the contour of the aperture and to create, consequently, a uniform potential throughout its entire surface. Auxiliary electrodes to properly form the electric field and to minimize the field between adjacent elements may be placed on either or both sides, of the first target electrode.

As pointed out above, it is desirable that the entire surface of the aperture be maintained at collector or cathode potential in order to insure adequate control action of the storage element. The methods outlined above accomplish this by insuring uniform electron bombardment over the entire surface and a uniform potential along the entire surface. Since in the preceding cases the dielectric surface of the aperture is nonconducting, the potential of one point can be different from the potential of an adjacent point if the above precautions are not observed. An alternate method of Ensuring uniform potential over the entire surface of the aperture is illustrated in Fig. 8.

In this ease the first target comprises a metal capacity plate **61** of the type previously utilized, in which a small metallic sleeve **74** is inserted in the metal capacity plate and suitably insulated therefrom by means of glass or ceramic sleeves **76**. These metal sleeves are generally funnel shaped, having their larger diameter toward the electron stream. The sleeves are in register with the corresponding apertures in the adjacent collector electrode and will be bombarded by electrons when the associated windows are open. Since most metals are secondary-emissive these sleeves will function as storage elements in a manner identical to the dielectric surfaces described above. However, since they are conductive, the potential at all points must necessarily be identical. By applying conditioning pulses to the capacity plate as before, and controlling the electron bombardment, the potential of each metal sleeve may be set at either cathode potential or collector potential. In the former case no electrons will pass through the metal sleeve while in the latter case some of the impinging electrons will pass through and strike the second target electrode. A similar result can be obtained also by using the construction of Fig. 7 and evaporating metal into the conical aperture through an appropriate mask.

The second target electrode **63** in Fig. 1 was a. solid metal plate. In certain cases it is desirable to produce a light indication to show visually the condition of the element. An alternative form of second target electrode suitable for this purpose is illustrated in Fig. 9. In this case the electrode structure is composite and comprises a perforated metal plate **67** of the type utilized for the other electrodes. This electrode is placed adjacent and preferably in contact with a fluorescent target which may consist of a transparent base **65**, such as mica, or glass, on the surface of which there is a coating of fluorescent material **78**. Electrons which pass through the first target electrode, as determined by the condition of the storage element, strike the fluorescent coating and produce luminescence for the area. Secondary electrons are also released and these are collected by the metal portion of the target electrode **67** which therefore constitutes a detecting electrode. Electrode **67** is therefore connected to a high potential source of the order of 1000 to 2000 volts, with respect to cathode. The electron current, if any, can be observed by a suitable indicator connected across the output load impedance or used in any manner desired. It will be apparent that this form of construction for the second target electrode may be employed with any of the previously described first target electrodes in the general arrangement illustrated in Fig. 1.

A further important feature of the separation of the storage and indicating functions is now apparent. In the earlier copending application, Serial No. 720,876, filed January 8, 1947, now Patent No. 2,442,985, issued June 8, 1948, describing the use of a light link to determine the condition of the storage element, it was necessary to provide a time delay after the "standby" condition was terminated. This was due to the fact that the fluorescent material was deposited on the electrode corresponding to the present first target electrode and produced luminescence for all elements which were at collector potential and under bombardment. The present system eliminates this time delay since the second target electrode carries the fluorescent material, and the positive potential need be applied to this electrode only when a reading is desired. Thus there need be no general luminescence during "standby" operation and the reading may be made instantly and accurately by energizing the second target electrode only when a reading is desired.

In certain applications of the storage tube, it is desired that it be operated at an extremely high speed. It is thus desirable that those elements which are to be charged to a potential have as low a capacity as possible. The second target electrodes illustrated in Figs. 1 and 9 are quite large and consequently inherently have a relatively large capacity to ground through the adjacent electrodes and other elements of the tube.

In order to reduce the capacity of the second target electrode and thus to increase the speed of response of the device, the arrangement illustrated in Fig. 10 may be employed. Only a portion of the device has been illustrated, that which is not shown being identical to the arrangement illustrated in Fig. 1, or any of its modifications. Thus, the first target electrode **57** is shown in the form illustrated in Fig. 7, including an auxiliary electrode **80** which is biased to a potential of -50 volts. Three focusing electrodes **82**, **84** and **86** are positioned so as to enclose the area beyond the first target electrode and biased so as to permit all electrons passing through the first target to move toward the second target electrode, which in this case is simply a flne wire 88. Focusing electrodes 82 and 88 are biased to a potential of approximately +100 volts, while focusing electrode 86 is biased to a potential of approximately -50 volts. As a result, any electrons which pass through the first target electrode **57** are directed toward and ultimately land on the second target electrode **88** which is maintained at a high positive potential as in the preceding cases. Some electrons may revolve many times around the wire before being collected, but this is of no importance since electron transit times are no limitation in the operation of the device.

While the invention has been described in connection with a device embodying the rectangular structure illustrated in the preceding figures, the principle of operation by means of which the storage element acts as a grid to control the flow of electrons to the second target electrode is applicable to cylindrical types of construction such as are illustrated in the copending application Serial No. 665,031. In such case the first target electrode would' constitute a plurality of interconnected wires positioned either in the center or around the edges of the grid windows so as. to intercept some, electrons and permit others to pass through. The grid wires would then be coated with, a dielectric secondary-emissive material in the manner employed in connection with Fig. 6, for example. Certain electrons would then be directed to and impinge on the dielectric surface while others could pass between the wires onto the second target, depending upon the established potential of the dielectric surface. The second target would be a cylindrical member surrounding the entire electrode structure.

Since the number, of electrons passing through the first target electrode is but a small number of those directed toward the storage element, the output current will necessarily be. rather small. This may readily be amplified within the device by substituting for the second target electrode of Fig. 10, for example, the input of an electron multiplier device which may, if desired, be embodied within the tube structure. Alternatively, one or more electron multipliers may be positioned adjacent the aperture of the first target electrode. Since selection of the element whose condition is to be determined is accomplished by the grid network, a common electron multiplier channel may be employed for more than one element, and the output of all such devices may be connected in parallel.

What I claim is:

1. In an electron storage system, the combination of an electron discharge device comprising a source of electrons; first and second target electrodes; a collector electrode adjacent said first target electrode; electrodal means for directing electrons from said source toward one or more distinct elemental areas of said flrst target electrode; electrode means and an input connection therefor for charging said elemental areas to either one of two predetermined potentials, one of said potentials being cathode potential and the other being the potential of said collector electrode; each of said elemental areas having an aperture therethrough for permitting electrons to pass through a given elemental area of said first target electrode and strike said second target electrode when said elemental area is under electron bombardment and is at collector potential.

2. An electron discharge device including a cathode; one or more accelerating electrodes; first and second control grid networks; a collector electrode; and first and second target electrodes; said electrodes being positioned in the order named; said flrst target electrode including a plurality of separate secondary-emissive storage elements and a capacity plate in capacitive relation thereto, each element having an aperture for the passage therethrough of a portion of the impinging electrons.

3. A device of the character described in claim 2 in which said second target electrode comprises a transparent base supporting a fluorescent material and a perforated conductive detecting electrode.

4. In an electron discharge storage tube including a plurality of perforate secondary-electron emissive storage elements which are charged to either one of two preselected potentials, the method of indicating to which of said potentials a given element is charged which includes the steps of selecting said element, bombarding the selected element with electrons to the exclusion of other elements, establishing an electric field adjacent said selected element to cause the bombarding electrons to pass

through said element when said element is charged to one of said preselected potentials and to prevent said electrons from passing through said element when said element is charged to the other of said preselected potentials, and deriving from the electrons which pass through said element an indication of its condition.

5. The method set forth in claim 4 which includes the additional step of utilizing the electrons passing through said selected element to produce a fluorescent indication of the condition of said element.

6. A device of the character described in claim 2 in which said first target electrode comprises a perforated mica sheet, and a perforated metal plate adjacent thereto.

7. A device of the character described in claim 2 in which said first target electrode comprises a perforated metallic plate having thereon a layer of dielectric secondary-emissive material.

8. A device of the character described in claim 2 in which said first target electrode comprises a perforated conductive capacity plate having located therein and insulated therefrom, a plurality of sleeves of secondary-emissive metal, one of said sleeves lying in each elemental area of said electrode.

9. An electron discharge device comprising a source of electrons and a plurality of electrodes, at least some of said electrodes comprising perforated sheets, means positioning said electrodes in spaced, parallel relation with their perforations in register for the passage of electrons therethrough; a control grid network comprising a plurality of grid wires lying in a plane parallel to the plane of said electrodes, said grid network being spaced between adjacent perforated sheets and a plurality of insulating members supported in ^aligned apertures in said electrodes for supporting said grid wires.

10. In an electron storage system, the combination of an electron discharge device including a cathode; one or more accelerating electrodes; firsthand second

control grid networks; a collector, electrode; first and second target electrodes; said electrodes being positioned in the order named; said first target electrode including a plurality of separate secondary-emissive storage elements and a capacity plate in capacitive relation thereto, each element having an aperture for the passage therethrough of portion of the impinging electrons, a selection circuit connected with said first and second control grid networks, a conditioning pulse input circuit coupled to the capacity plate of said first target electrode, and means providing a bias supply connection for said capacity plate for applying a negative biasing potential thereto with respect to said cathode.

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