Jan. 23, 1951

A. S. JENSEN

2,538,836

BARRIER GRID STORAGE TUBE

Filed Oct. 15, 1948

Fig.1

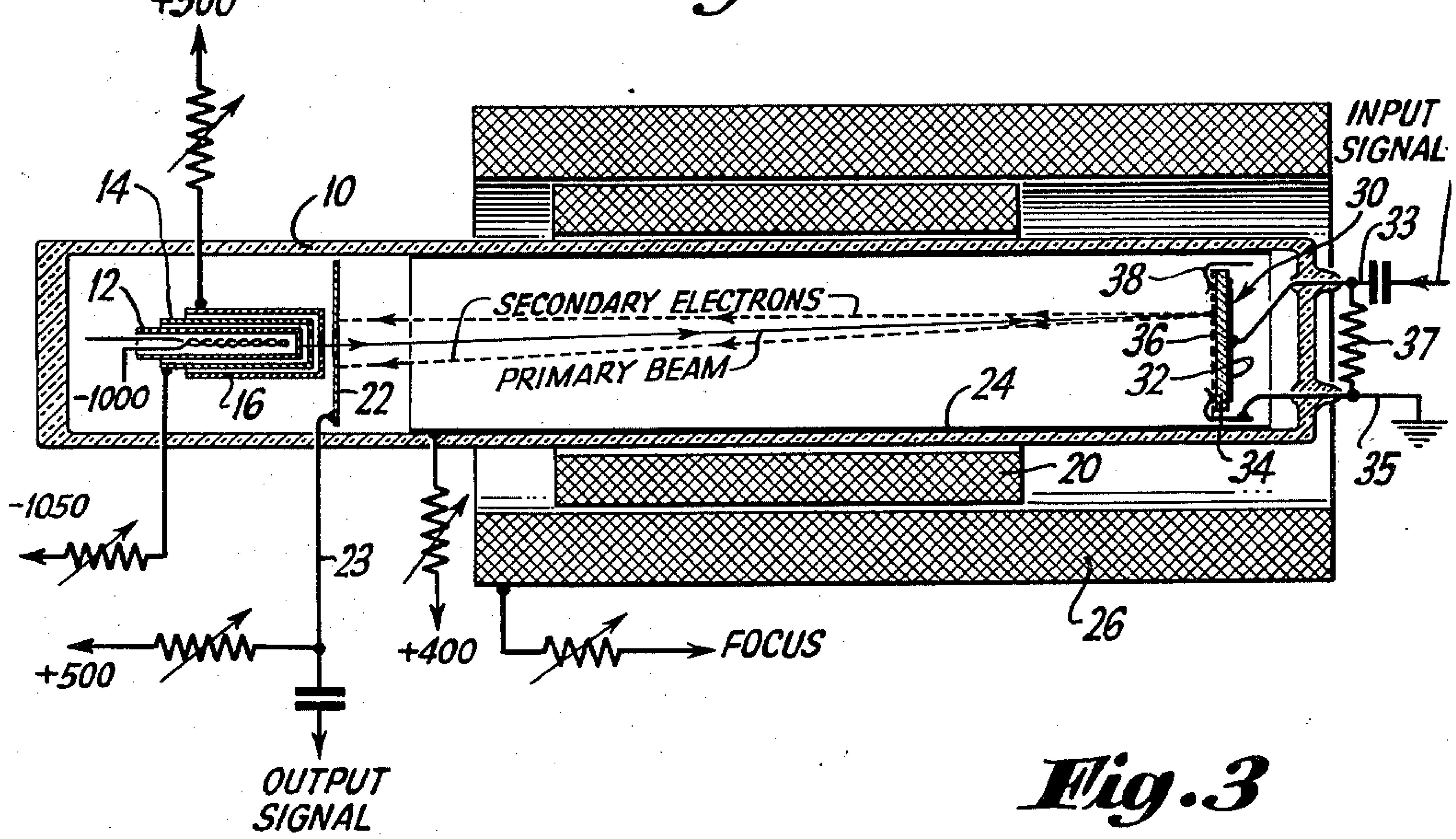


Fig.2

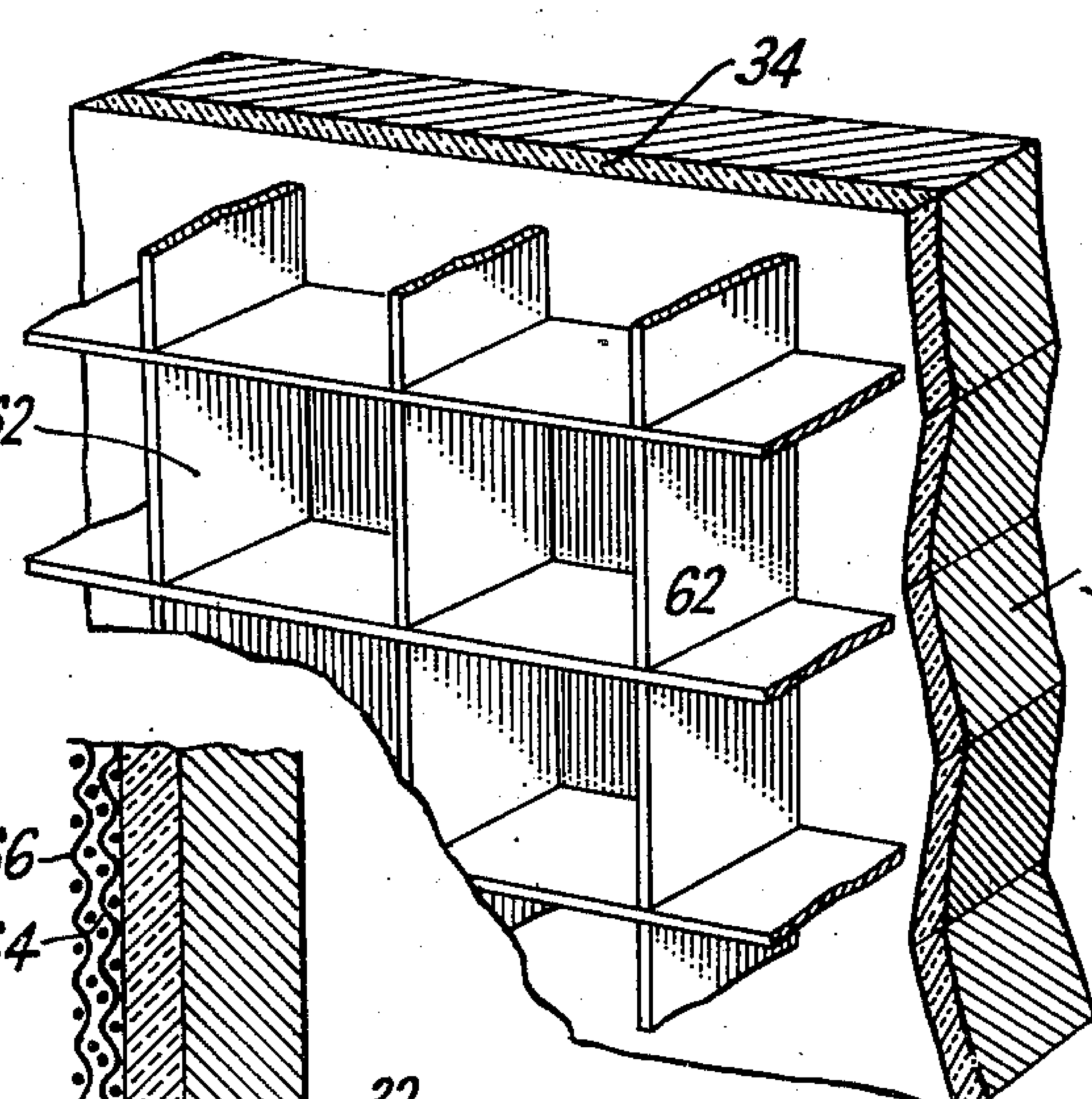
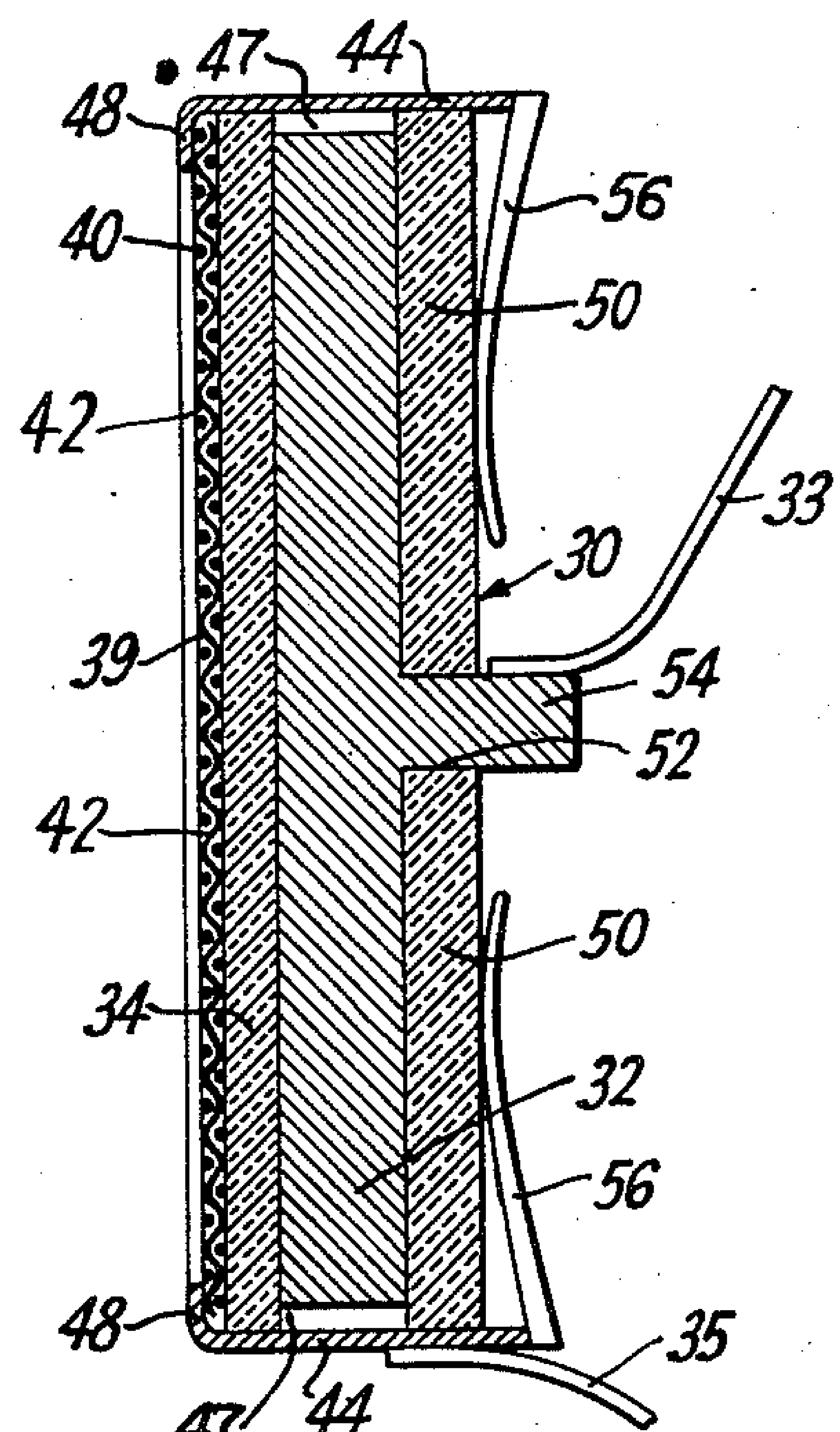


Fig.3



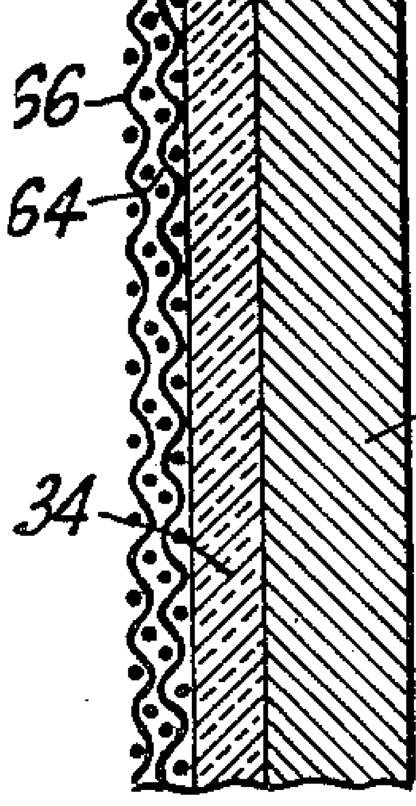


Fig.4

INVENTOR
ARTHUR S. JENSEN
BY
William A. Zalesak
ATTORNEY

UNITED STATES PATENT OFFICE

2,538,836

BARRIER GRID STORAGE TUBE

Arthur S. Jensen, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application October 15, 1948, Serial No. 54,701

12 Claims. (Cl. 250—164)

1

This invention relates to cathode ray tubes, and in particular to storage tubes of the cathode ray type.

A storage tube is one, in which a signal may be stored for a period of time and subsequently reproduced. In one type of storage tube, there is utilized a target structure comprising a thin dielectric sheet having on one side thereof a metal signal plate. The target sheet is mounted within the tube and is scanned by an electron beam focussed upon the exposed surface of the dielectric sheet. A pattern of electrostatic charges may be established on the insulating surface of the dielectric sheet when signals are applied to the metal signal plate of the target during the scanning of the dielectric surface by the electron beam. The established charge pattern on the dielectric surface is used to vary or modulate the secondary emission from the dielectric surface due to the scanning of the surface by the electron beam. An output signal of the tube is that obtained by the collection of the modulated secondary emission from the insulating target surface by a collector electrode. A tube of this type is disclosed in the application of R. L. Snyder, Jr., filed July 24, 1945, Serial 606,812.

One type of storage tube as described above is that having a fine mesh barrier screen closely spaced from the exposed dielectric surface of the target. This fine mesh screen is maintained during tube operation at a common D. C. potential with the metal signal plate in contact with the opposite side of the dielectric sheet. When the insulating target surface is scanned by the electron beam, the dielectric surface will change in potential until an equilibrium potential is reached, at which the number of secondary electrons leaving the dielectric surface and passing through the barrier screen is exactly equal to the number of primary electrons striking the surface. When the dielectric surface has reached equilibrium potential, the secondary electrons in excess of the number of secondaries leaving the target will collect in the form of a space charge between the barrier screen and target surface and rain back onto the dielectric target surface in a manner to be redistributed on the target surface and change the potential of the unbombarded parts of the dielectric surface. These redistributed electrons tend to neutralize charges already on the target surface and make impossible any accurate comparison of signals from scan to scan.

To minimize this redistribution effect, the barrier screen is closely spaced from the target surface. The spacing of the barrier screen from the dielectric surface is a compromise. If the spacing is too great, redistribution effects will shade the signals, introducing more interline crosstalk, and reduce the resolution. If the spacing is too small, whenever negative signals are applied to the plate, very negative portions of the target surface surrounding the beam spot may, by a "coplanar grid effect" erect a potential barrier outside the screen, over which many of the secondaries cannot go. As a result they will be collected by the barrier grid screen, and their absence from the secondary beam each scan will cause a positive signal to appear on the collector.

2

Accordingly, it is an object of this invention to provide an improved storage tube of the cathode ray type.

It is also an object of this invention to provide a storage tube having uniform collection of signal from the target surface.

It is also an object of this invention to provide a storage tube in which shading of the signal by redistribution of secondary electrons on the target surface is eliminated.

It is a further object of my invention to provide a storage tube in which there is eliminated the potential barrier against signal electrons provided by negatively charged areas on the target surface.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a cross sectional view of a storage tube according to my invention.

Figure 2 is a partial, sectional view of a modification of the target structure of the tube of Figure 1 according to my invention.

Figures 3 and 4 show cross sectional views of other modifications of target structures according to my invention.

The drawing discloses a storage delay tube of the cathode ray type comprising an envelope **10** of glass or any other suitable material. Within the envelope is positioned an electron gun for the purpose of forming and focussing an electron beam upon a target electrode **30**. The gun structure consists of a thermionic cathode **12**, surrounded by an apertured control grid **14** and an anode electrode **16**, for accelerating the electron emission from the cathode **12** and focussing the electrons of the beam onto the surface of a target **30**. Two pairs of deflecting coils represented by a yoke structure 20, are positioned along the beam path between the anode electrode 16 and target 30. As is well known in the art, these pairs of deflecting coils each produce electromagnetic fields at right angles to each other and to the path of the electron beam. It is understood that these coils respectively will have varying currents applied, say by a saw-tooth generator, to produce line and frame scansion; or appropriate currents may also be applied to the deflection coils for producing spiral scansion of the target, or line scansion only, as may be desired. The means for producing different types of scansion of the target surface 30 are also well known in the art and need not be further described.

The operation of the tube of Figure 1 depends upon a signal being generated by the emission of secondary electrons from the target 30, when bombarded by the electron beam. A collector electrode in the type of tube shown, comprises an apertured plate 22 mounted in the enevelope 10 coaxial with the electron beam path. A conductive coating 24, applied to the inner surface of the envelope 10, extends from a point adjacent the collector electrode 22 to beyond the target electrode 30. The conductive coating 24 is connected to a sourec of D. C. potential (not shown) and during tube operation maintains a uniform electrostatic field between the collector 22 and target 30. Outside of yoke 20 there is placed a solenoid 26, which, during tube operation, produces a strong magnetic focussing field parallel to the axis of the tube 10.

The target electrode 30 (Figure 1) comprises essentially a metal support plate 32 mounted transverse to the path of the electron beam and which may function as the signal plate of the target electrode. On the surface of the signal plate 32, facing the electron gun, is fixed a dielectric layer 34, such as mica. Target 30 may also be formed, using an aluminum signal plate, having a dielectric surface of aluminum oxide, facing the electron beam, formed, for example, by anodizing the aluminum. However, the construction of the target 30 need not be confined to either of these described forms, but may also comprise any other appropriate insulating materials such as titanium dioxide, or silicon dioxide, for example, deposited in any manner such as evaporation or thermal decomposition upon a conductive signal plate. As shown in Figure 1, closely spaced from the exposed surface of the mica layer 34, there is a fine mesh screen 36, or a barrier grid, which may be mounted a few mils from the surface of the dielectric layer 34 by a supporting ring 38, mounted on the target 30. The screen 36 is maintained during tube operation at the same D. C. potential as signal plate 32. As shown in Figure 1, screen 36 and plate 32 are connected to the same ground terminal with, however, an impedance 37 separating plate 32 from screen 36.

As the surface of dielectric 34 is scanned by the electron beam, secondaries are emitted and drawn away toward collector electrode 22, which is maintained during tube operation, at a high positive potential relative to the potential of surface 34.

The principle of electrostatic storage on an insulating surface has long been known and used in television pickup tubes, such as the iconoscope. If an insulating surface is bombarded by an electron beam, the secondary emission ratio will vary with the energy of the bombarding electrons. If the energy is such that the secondary emission ratio is greater than unity, then the potential of the insulator target surface will become more and more positive and will change with respect to the electrode which collects the secondaries until the number of secondaries leaving the target surface is exactly equal to the number of primary electrons striking the target plus the secondary electrons falling back on the target surface. The target surface potential at which this action takes place, is known as the equilibrium potential. The secondary electrons which return to the target surface, first collect in the form of a space charge and then rain back on the insulating target surface, charging the unbombarded parts of the surface to a negative potential. Thus, a charge pattern is built up on the surface between the bombarded and unbombarded target portions and in the absence of any applied signal. The returning secondary electrons, redistribute themselves and partially neutralize any positive charges already formed on the surface, thus making any comparison of signals from scan to scan impossible.

In the operation of the tube of Figure 1, the electron beam strikes the dielectric surface 34 with sufficient velocity to produce a secondary emission ratio greater than unity and drives the surface of the dielectric 34 to an equilibrium potential as described above. To obtain this condition, the screen 36 and signal plate 32 in the specific tube described of Figure 1, are maintained at a potential about one thousand volts positive relative to the cathode 12 of the electron gun.

Since surface 34 of the target is an insulator, the only source of current to it is the primary beam, and the only drain of current from it is the secondary electron emission. At the equilibrium potential of the target surface, these two must be equal. The barrier grid or screen 36 functions as a virtual collector, so that the equilibrium potential for the target surface 34 is established with respect to screen 36 and not to the actual collector electrode 22. Wherever the beam strikes the dielectric 34 with a velocity sufficient to initiate a secondary emission ratio greater than one, the potential of the elemental area under bombardment of the surface of dielectric 34 is brought to this equilibrium potential, which exists at a few volts positive with respect to the screen 36, because the initial velocity of most of the secondary electrons is sufficient to lift them over a field of several volts. The exact potential is not very definite, because it is affected by space charge conditions and the geometry of screen 36 and nearby electrodes. However, at this equilibrium potential, a number of secondary electrons just equal to the number of arriving primaries are sufficiently energetic to penetrate the negative screen 36. These secondaries do not return to the target, as appropriate fields outside screen 36 urge them away and toward the collector 22 as the secondary beam. Meanwhile, the excess secondary electrons are not sufficiently energetic to penetrate the negative barrier screen 36 and fall back onto the target surface 34. These excess secondary electrons are restricted in their motion by the close proximity of the screen 36 to the dielectric surface, so that their redistribution to portions of the target not directly under the beam is considerably reduced.

In normal operation, the screen 36 over the target surface 34 is maintained at constant D. C. potential and the signal plate 32 is connected through a conductor 33 to a source (not shown) of the A. C. signal to be recorded. The exposed insulator surface of the dielectric 34 is capacitively coupled to the signal plate 32 and also to the screen 36. When a signal voltage is impressed on a signal plate 32 it also appears, somewhat diminished in amplitude, on the recording surface 34 of the target.

If an A. C. signal is applied to plate 32, so that it is driven negatively relative to the equilibrium potential, any elemental area under bombardment of the surface of dielectric 34 at the time by the electron beam, will also be driven negatively relative to the screen. Under these conditions, a positive field between screen 36 and the negative target plate 30 will be presented to the surface of dielectric 34 and, therefore, the secondary electrons, released by the impact of the beam electron, are drawn away from the surface of dielectric 34. Since the number of secondary electrons from the surface of dielectric 34 is greater than the number of primary electrons from the electron gun, there is a net loss of negative charge and the elemental target surface area under the striking beam will become more positive until it attains equilibrium potential. If, however, the elemental area of surface 34 is driven positive with respect to the screen 36 at the time of bombardment, due to an incoming signal driving plate 32 in a positive direction, a more negative field between screen 36 and target 30 is presented to the surface 34 and the secondary emission is suppressed. Since no secondary electrons leave the target surface element, there is a net gain of negative charge and the potential of the target surface under the striking primary beam will drop in potential until the elemental area attains equilibrium potential.

Thus, as the beam is deflected across the surface 34, while a signal is impressed on the signal plate 32, it will cause each element of surface area it strikes to come to equilibrium potential, regardless of the potential the surface would otherwise have due to the influence of the signal plate. This action, then establishes a potential difference between the signal plate 32 and the dielectric surface element under the beam, which will cause the element to have a potential different from that of the equilibrium potential, when the beam moves off of the surface element and the signal plate 32 returns to the potential of screen 36. If the beam scans a long path over the target surface 34, while a fluctuating voltage is impressed on the signal plate 32, a band of charges, as wide as the beam, will remain on the path when the beam is cut off. If the signal plate 32 returns to the potential of screen 36, the potential along the path will vary in proportion to the signal voltage impressed during the beam transit. The secondary emission from the dielectric surface, however, fluctuates according to the charging demand. If no change of charge is required by an elemental surface of the dielectric, the secondary electrons released therefrom are equal in number to the impinging beam electrons. If a negative charge is supplied to the dielectric surface 34 to bring the elemental target area to equilibrium potential, secondary emission is suppressed until the demand has been satisfied. If a positive charge is needed to bring the target area to equilibrium the secondary emission is a maximum until full charge is achieved.

One adaptation of the tube disclosed may be in signal comparison, where both signals are not available simultaneously, or where it is desirable to make the comparison at some arbitrary phase relation. The tube may be used in various other ways where storage of information is desired. Signals may be impressed on the signal plate while the beam scans a predetermined pattern over the target. The signal and beam may then be shut off, leaving the information stored on the target. At any desired later time, the beam may be turned on and, with no new signals impressed on the signal plate, scanned over the pattern so that the signal impressed during the first operation will be reproduced. The signals need not be recorded in one scansion and utilized in the next scansion. Signals can be stored at one time and reproduced at any later time merely by shutting off and turning on the beam at the desired time. In some tubes of the type described, signals have been stored on the target surface up to one hundred hours with little loss of definition. As will be evident from the described method of operation, recorded signals may be combined with new signals, enabling one to use the tube for carrying out complex operations by suitable combination of signals.

In tubes of the type described in Figure 1, there are essentially three related problems involved in the design of the tube, particularly with regard to the target structure of the tube.

One problem, for example, is that of screen disturbance caused by the successive intersection of the beam by the wires of screen 36 which generates a disturbing signal. However, it can be shown, and it is true in practice, that if the ratio of the screen wire diameter to the beam spot size is small, that the screen disturbance is not troublesome. In tubes of the type shown in Figure 1, where the beam diameter is between 10 and 15 mils, it has been found that a wire diameter of one mil is sufficiently fine to give a satisfactory screen disturbance ratio and yet provide sufficient mechanical strength for a self-supporting screen.

Another problem, involved in tubes of this type, is that of the so called "co-planar" grid effect. Whenever negative signals are applied to the signal plate 32 of the tube of the type shown in Figure 1, very negatively charged areas will be built up on the dielectric target surface by the scanning beam. These negative portions of the target will create a negative field in front of the target surface, which will act as a potential barrier suppressing the secondary emission from the target surface and forcing back to the screen 36, the secondary signal electrons passing through screen 36. As a result of this coplanar grid effect, portions of the secondary emission forming the signal current is collected by the screen 36, and their absence from the secondary beam on successive scans will cause positive signals to appear in the collector circuit.

A third problem involved in tubes of the type described in Figure 1, is that secondary emission, which falls back onto the target surface, will tend to go to other more positive areas of the target surface. This redistribution of electrons will tend to discharge areas of the target other than that which the beam is striking. This redistribution effect produces a shading of the signals and reduces the resolution of the output signal of the tube.

To effectively solve the problems of a co-planar grid effect and a redistribution effect in tubes of this type, several types of target structures may be utilized. The screen 36 may be modified in several different ways to eliminate these effects.

For example, in Figure 2, there is disclosed a type of target structure in which the metal backing plate 32 has one surface covered by the dielectric layer 34. Plate 32 and dielectric layer 34 correspond with the identical structures of Figure 1. However, in place of the negative grid screen 36 in Figure 1, there is substituted a thick screen 62, which may be made up of a cellular structure formed by intersecting walls or strips of conductive material.

A thick screen of a type similar to 62 shown in Figure 2 has a somewhat critical relationship between the thickness and the width of an aperture opening of the screen. The shielding effect of such a screen 62 must not only neutralize the co-planar negative fields extending from the target surface but also such a screen 62 must not prevent the collection of the secondary electron emission from the surface of dielectric 34. A screen having a ratio of screen thickness to aperture width equal to 1:1 would almost completely shield the surface of dielectric 34 from the positive fields of electrodes 24 and 22 so as to prevent the collection of secondary emission from the surface of dielectric 34. Thus, little or none of the secondary emission from the dielectric surface 34 would leave the target. A tube, similar to that described above and shown in Figure 1, and in which the maximum signals impressed upon the signal plate 32 may range up to 100 volts peak voltage, could be operated with a thick screen having a ratio of screen thickness to aperture width equal to less than 1:1 and more than 1:2. If the screen used, had a ratio of thickness to aperture width less than 1:2, the tube would not operate successfully within the above range of maximum input signals, but would have to be confined in operation to a lower input signal voltage range. That is, a screen having a ratio of screen thickness to aperture width equal to less than 1:2 would not effectively eliminate the co-planar grid effects or redistribution effects of a tube operated with the above maximum input signals.

The edges of the strips forming the cellular screen 62 are of approximately one mil thickness so as to provide a satisfactory screen disturbance ratio as described above. For a tube, similar to that described for Figure 1, the signals impressed upon the signal plate 32 are less than 100 volts peak voltage. In such cases, the dielectric layer 34 of the target of Figure 2 is preferably one mil in thickness while the thickness of screen 62 may vary from 2 mils to 10 mils, with the ratio of screen thickness to aperture width being between 1:1 and 1:2.

The screen 62, of the target structure shown in Figure 2, will effectively eliminate the co-planar grid effect described above as well as prevent redistribution of secondary electrons on the target surface. The size of the openings of screen 62 must be as small as, or preferably smaller than, the size of a picture element, or spot size of a primary beam. A picture element can be defined as the smallest element that can be resolved by the tube. The picture element may also be defined as the spot size of the primary electron beam when it strikes the target surface. In a tube, similar to that shown in Figures 1 and 2, the spot size is between 10–15 mils in diameter.

If the openings in screen 62 were larger, the portions of screen 62 would not extend between each picture element to effectively screen one element from another and thus prevent the charges on adjacent picture elements from adversely affecting both the redistribution of secondary electrons on the target surface and the emission of secondaries from the elemental areas. If the width of the openings of screen 62 are approximately 4 mils, then the spot size of the primary beam of the tube will simultaneously cover several of the mesh openings.

A highly successful type of screen corresponding to screen 36 in Figure 1 which has been found to give excellent results in tubes of the type of Figure 1, is a woven stainless steel screen having approximately 230 openings per inch and woven from wire of one mil diameter. Such a screen is shown in Figure 3 in which the screen 39 is woven from warp wires 42 running vertically in the figure, and woof wires 40 running into the plane of the paper of Figure 2. The wires are one mil in diameter, so that the effective thickness of the screen is approximately 2 mils. I have found that when this woven screen 39 is placed in contact with the dielectric surface 34 as shown in the figure, that portions of the screen are sufficiently spaced from the dielectric surface to eliminate the co-planar effects and redistribution effects described above. Since there are approximately 230 wires per inch, the distance between successive wires or width of aperture is around 3 mils. The spot size of the primary electron beam of the tube will cover between ten and twenty-five openings of this screen at one time. This number of openings in the mesh 39 would represent a picture element. Since portions of the mesh screen 39 are spaced at least 2 mils from the dielectric surface 34, this woven mesh screen provides an effective screen for eliminating the co-planar grid effects and redistribution effects, described above, for a tube in which the amplitude of the signals applied to the signal plate 32 are less than 100 volts.

The woven mesh 39, of Figure 3, formed from the one mil stainless steel wire, provides sufficient stiffness and rigidity to prevent any disturbance due to vibration of the screen 39 caused by large charges on the elemental areas of the target surface 34 which tend to attract or repel the negatively charged screens during tube operation. Screen 39 of Figure 3 may be of a finer mesh with a smaller thickness and still provide the same screening effect for the signals applied to the plate 32. Screen 39 of Figure 3, has a ratio of the thickness of the screen to the width of aperture in the screen of approximately 2:3. The size of the mesh of the screen 39 may be varied as long as this ratio is approximately maintained, to provide the optimum screening the dielectric surfaces. However, the maximum size of the mesh is limited by the picture element as described above.

Figure 3 also shows a means for assembling the component parts of target 30 together. The invention is not limited to this specific structure of Figure 3 but the mounting structure is shown only by way of example. The target parts 30 are mounted within a supporting ring 44 having at one end a flanged lip 48. The woven wire mesh 9 is first welded to the flanged ring portion 48. The thin mica or dielectric disc 34 is then dropped into the supporting ring 44 so as to rest in contact against the wire mesh 39. The metal signal plate 32 is of an annular shape and is also inserted into the support ring 44 and held tightly in contact against the dielectric disc 34. Since incoming signals are applied to the signal plate 32 the signal plate is insulatedly spaced at 47 from the support ring 44. To maintain the signal plate 32 in this spaced relationship relative to support ring 44, a second ceramic or insulating disc 50 is inserted into the open end of support ring 44. The insulator 50 tightly fits the inner circumference of the support ring 44 and is apertured at 52 to permit the passage therethrough of a stud 54 integral with the signal plate 32. In this manner the stud 54 of the signal plate maintains the signal plate insulatingly spaced from the support ring 44. To tightly maintain the several parts of the target structure in close contact, spring fingers 56 are welded to the edge of the support ring 44 and extend into spring-pressed contact with the exposed surface of the insulator disc 50. The support ring 44 with the component parts of the target 30 held therein as shown in Figure 3 may be mounted within the tube envelope 10 in any desired manner and in the position shown in Figure 1. As shown in Figure 3, lead 33 may be connected to the signal plate 32 by welding or other means to the projecting stud 54. Also the barrier grid 39 is connected into its circuit by fastening conductor 35 to the support ring 44 as shown.

Another type of target structure which will tend to eliminate the co-planar grid effect and the redistribution effect in tubes of the type shown in Figure 1, is that indicated in Figure 4, in which there is utilized a pair of screens 64 and 66 superimposed, one upon the other, upon the surface of the dielectric layer 34. The apertures of screen 64 need not match the apertures of screen 66. These two screens 64 and 66 are an approximation to the thick cellular screen shown in Figure 2. The use of two screens doubles the barrier thickness and thus permits the use of a wider mesh than can be effectively used with the single woven screen shown in Figure 3. Thus, if both woven screens 64 and 66 had 100 mesh per inch and were made from one mil diameter wire, the transmission ratio of each screen would be 81 percent and of the two would be approximately 65 percent, which is a higher transmission ratio than that provided by the 230 per inch mesh woven screen of the target of Figure 3. However, the effective screen thickness is now 4 wire diameters or about 4 mils in thickness.

The effective aperture width of the double screen grid of Figure 4 would vary from 9 mils in the case where the apertures of one screen are matched with the apertures of the other screen to approximately 4½ mils depending in what position one screen was placed upon the other. Thus the ratio of screen thickness to aperture width for the double mesh screen, shown in Figure 4, would be within the range of 1:1 to 1:2, given above as that necessary for successful tube operation. The two screens 64 and 66 are mounted in contact with each other and may be held in a supporting structure against the dielectric layer 34 in a manner similar to that shown in Figure 3.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What I claim is:

1. A target electrode comprising a metal support plate, an insulating layer covering one face of said support plate, a mesh screen mounted in contact with said insulating layer, the ratio of the thickness of said screen to the width of an opening of said screen being between 1:2 and 1:1.

2. A target electrode comprising a metal support plate, an insulating layer covering one face of said support plate, a mesh screen mounted in contact with said insulating layer, the ratio of the thickness of said screen to the width of an opening of said screen being approximately 2:3.

3. A target electrode comprising a metal support plate, a thin dielectric layer covering one face of said support plate, an apertured screen mounted in contact with said dielectric layer, said screen having a cellular structure in which the width of the apertures are approximately equal to the thickness of said screen.

4. A target electrode comprising a conductive plate, means forming a dielectric surface on one face of said conductive plate, a first fine mesh screen in contact with said dielectric surface and second fine mesh screen superimposed on and in contact with said first screen.

5. A cathode ray tube comprising an envelope, means within said envelope for forming an electron beam along a path, a target electrode within said envelope mounted transverse to said beam path, said target electrode including a sheet of dielectric material intercepting said electron beam path, a wire screen in contact with the surface of said dielectric sheet intercepting said electron beam path, a metal signal plate in contact with the opposite surface of said dielectric sheet, the ratio of the thickness of said screen to width of mesh opening of said screen being between 1:2 and 1:1.

6. A cathode ray tube comprising an envelope, means within said envelope for forming an electron beam along a path, a target electrode within said envelope mounted transverse to said beam path, said target electrode including a sheet of dielectric material intercepting said electron beam path, a wire screen in contact with the surface of said dielectric sheet intercepting said electron beam path, a metal signal plate in contact with the opposite surface of said dielectric sheet, the ratio of the thickness of said screen to width of mesh opening of said screen being approximately 2:3.

7. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a support plate having a dielectric surface on one side of said support plate, electron gun means spaced within said envelope from said target electrode for forming a beam of electrons and focussing said electron beam on said dielectric surface, an apertured screen fixed to said dielectric surface, the apertures through said screen being less than the spot size formed on said dielectric surface by said focussed electron beam.

8. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a conductive signal plate and means forming a dielectric surface on one face of said signal plate, electron gun means spaced within said envelope from said target electrode for forming a beam of electrons, means for focussing said electron beam on said dielectric surface, a woven mesh screen mounted in contact with said dielectric surface, the mesh openings through said screen being less than the spot size formed on said dielectric surface by said focussed electron beam.

9. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a conductive signal plate and means forming a dielectric surface on one face of said signal plate, electron gun means spaced within said envelope from said target electrode

for forming a beam of electrons, means for focussing said electron beam on said dielectric surface, a woven mesh screen mounted in contact with said dielectric surface, the mesh openings through said screen being less than the spot size formed on said dielectric surface by said focussed electron beam, the ratio of the thickness of said screen to the width of a mesh opening through said screen being less than 1:1.

10. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a conductive signal plate and means forming a dielectric surface on one face of said signal plate, electron gun means spaced within said envelope from said target electrode for forming a beam of electrons, means for focussing said electron beam on said dielectric surface, a woven mesh screen mounted in contact with said dielectric surface, the mesh openings through said screen being less than the spot size formed on said dielectric surface by said focussed electron beam, the ratio of the thickness of said screen to the width of a mesh opening through said screen being approximately 2:3.

11. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a conductive signal plate and means forming a dielectric surface on one face of said signal plate, electron gun means spaced within said envelope from said target electrode for forming a beam of electrons, means for focussing said electron beam on said dielectric surface, an apertured screen mounted in contact

with said dielectric surface, said screen having a cellular structure in which the width of the apertures in the screen and the thickness of the screen are respectively less than the spot size formed on said dielectric surface by said focussed electron beam.

12. A storage tube comprising an envelope, a target electrode mounted within said envelope and including a conductive signal plate and means forming a dielectric surface on one face of said signal plate, electron gun means spaced within said envelope from said target electrode for forming a beam of electrons, means for focussing said electron beam on said dielectric surface, a first fine mesh screen mounted in contact with said dielectric surface, a second fine mesh screen mounted in contact with said first screen, the apertures of said first and second screens being less than the spot size formed on said dielectric surface.

ARTHUR S. JENSEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,280,191	Hergenrother	Apr. 21, 1942
2,281,280	Gabor	Apr. 28, 1942
2,403,239	Rose	July 2, 1946
2,454,410	Snyder	Nov. 23, 1948