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2,597,677

QUANTIZING APPARATUS

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Fig. 1a.

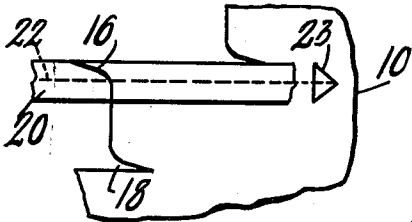


Fig. 1.

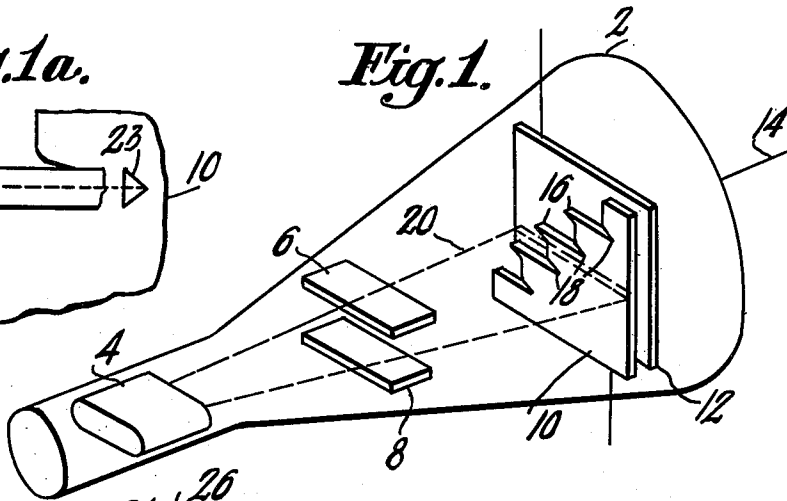


Fig. 2.

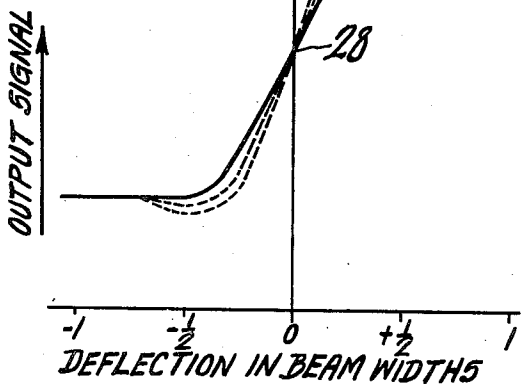


Fig. 2a.

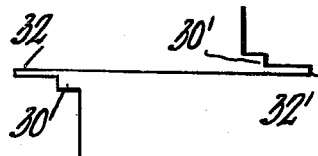
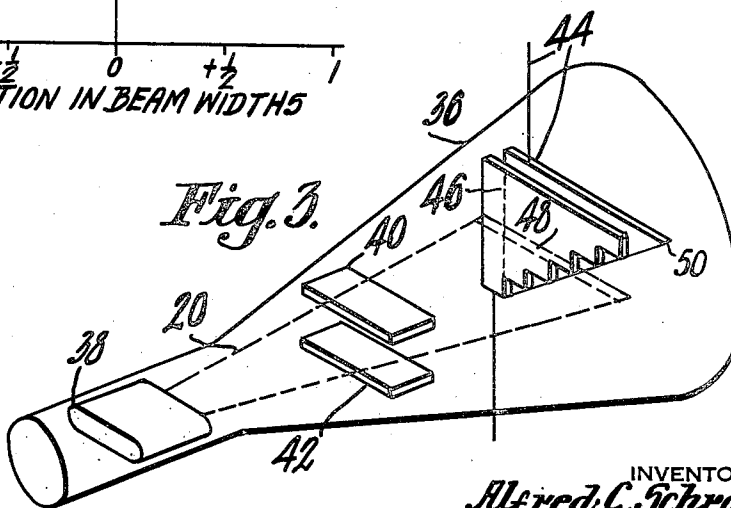


Fig. 3.



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QUANTIZING APPARATUS

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3 Claims. (Cl. 313—89)

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This invention relates to improvements in cathode ray tubes adapted to quantize signals applied to them. In particular, it relates to arrangements wherein signals that lie between the quanta levels may be separated out from the quantized signal and also to cathode ray tube structures wherein the flat to rise ratio of the quantizing tube is increased.

In the art of quantizing the signal is transmitted at one or another discrete amplitude level. For example, assume that it is desired to transmit a positive going sawtooth wave. If the number of equal quantized steps is 10 then the quantized signal has zero value until the sawtooth reaches 10 per cent of the amplitude. At this point, the quantized signal suddenly increases in value to 10 per cent of its maximum. The quantized signal remains at this 10% level until the sawtooth wave reaches 20 per cent of its height at which point the output signal abruptly increases in amplitude to 20 per cent of its maximum, etc.

It has previously been suggested that quantizing operations be performed in the special type cathode ray tube employing a line beam of electrons. The line beam of electrons is deflected by the signal to be quantized up and down a stepped shaped target. However, the line beam has some thickness along the line of its deflection and, therefore, it takes a finite amount of signal amplitude to deflect the beam from a position where it is entirely on one step to a position where it is entirely on the adjacent step. The ratio of the finite amplitude necessary to go from one step to the other to the maximum signal amplitude to be handled by the device is called the flat to rise ratio. The smaller the flat to rise ratio the less amount of amplitude is required to change from one quanta level to another.

It is therefore an object of this invention to provide an improved quantized cathode ray tube wherein the relative amplitude change required to cause the output signal to go from one quantized level to another is reduced.

A further object of this invention is to provide an improved cathode ray tube wherein the flat to rise ratio is reduced.

Briefly, the above mentioned objectives may be obtained in the following manner. Just before the beam reaches the end of one quanta level, means are provided for changing the current reaching the output circuit in a direction that is opposite to the change in the beam current reaching the output circuit when the beam is deflected to an adjacent quanta level. For example,

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if the target and the electron tube is of the stepped type, the top of each step can be extended along the line of the beam and the bottom of each step can be notched.

In quantizing systems a second signal is often reduced in amplitude and transmitted between the quanta levels of the primary or first signal. At the receiver, the combined signal is quantized so as to provide the primary signal and this signal is subtracted from the combined signal so as to obtain the secondary signal that lies between the quanta levels. Generally speaking, this subtraction process has been achieved by the use of circuits having an extremely wide pass band.

It is, therefore, another object of this invention to provide a cathode ray tube wherein one signal may be subtracted from another and in particular where a quantized signal is subtracted from a combined signal.

Briefly, this can be accomplished by employing a cathode ray tube wherein means are provided for projecting a horizontal line beam of electrons. A step-shaped target having one side of the steps parallel to the length of the line beam is mounted near the end of the cathode ray tube opposite the gun. Another target is mounted on the side remote from the gun of the first target and is so shaped that it fills in the steps. In other words, one edge of it is parallel to the tangent to the outside corners of the steps. Means are necessarily so provided for vertically deflecting the line beam up and down the step shaped target. Those signals provided by the step target are quantized inasmuch as the signal must change abruptly as it goes from one step to the next. While the beam is being deflected up or down a step it traverses the right triangular section of the second target that has filled in the step. Therefore, at one end of the step the amount of the beam striking the remote or second target is zero whereas at the other end of the step, the amount of beam striking the target reaches a maximum. In between these two, the amount of the beam striking the second target changes linearly with vertical deflection. Each of the steps of the target area are provided with especially designed steps to improve the accuracy of the transition from one step to the next.

The advantages to be derived from the use of this invention in a manner in which they are obtained will become clearer from consideration of the drawings in which:

Figure 1 shows a cathode ray tube constructed in accordance with the principles of this inven-

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tion such that the flat to rise ratio of the quantized output signal has been decreased.

Figure 1a illustrates for purposes of explanation a portion of the mask employed in the cathode ray tube of Figure 1.

Figure 2 is comprised of a graphical illustration indicating the change in the output signal produced by beam deflection in a standard quantized cathode ray tube and also in the cathode ray tube which is the subject of this invention.

Figure 2a illustrates another form of target construction that may be employed in a cathode ray tube of this invention.

Figure 3 illustrates a type of cathode ray tube constructed in accordance with one of the features of this invention so as to provide means for quantizing a received signal and subtracting the quantized signal from the received signal so as to derive the information aligning between quanta levels.

Turning now to Figure 1 there is shown a cathode ray tube comprised of an evacuated envelope 2 having electron gun 4 mounted in one end thereof. The electron gun may be constructed in accordance with the text of U. S. Patent 2,434,713 to Mueller so as to project an astigmatic or line beam of electrons. Assume for purposes of explanation that the line beam of electrons lies in a horizontal plane. Deflection plates 6 and 8 are mounted on either side of the extreme positions of the line beam projected by the gun 4. If the signal to be quantized is applied to one or both of the deflection plates 6 and 8, the vertical position of the astigmatic beam will be proportional to the signal amplitude. In this particular arrangement a stepped shaped mask 10 of beam obstructing material is inserted between the deflection plates 6, 8 and a target 12 that is connected to an output circuit 14. The dotted lines represent a fan shaped line beam of electrons that is projected by the electronic gun 4. The tops of the steps in the mask 10 are parallel to the longer axis of the electron beam. It will be appreciated from the drawings that the amount of beam current reaching the target 12 and hence the output circuit 14 depends upon the vertical position of the beam on the stepped mask 10.

If the steps in the mask 10 are precisely rectangular the beam must be deflected by an amount equal to its own thickness in order to pass from the top of one step in the mask 10 to the bottom of another. Therefore, the beam must be deflected by an amount equal to its own thickness before the output signal can pass from one quanta level to another.

In accordance with this invention the steps in the mask 10 are so shaped that the signal in the output lead 14 can pass from one quanta level to another as a result of a beam deflection which is less than the beam thickness. This is accomplished by extending the tops of the steps in a horizontal direction so as to form lips indicated by the number 16. At the same time the bottoms of the steps are notched as indicated by the numeral 18. The details of these lips and notches will be better understood from a consideration of Figure 1a. For purposes of explanation, a cross section of the beam 20 is shown in the drawing and indicated by numeral 20 in Figure 1a. The position of the beam is such that its top coincides with the horizontal side of a step in the mask 10. A center line of the beam is indicated by the numeral 22 and the distribution of electrons across the thickness of the beam is

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indicated by a triangular 23. Other types of electron distribution may be employed but this electron distribution shape will be used in connection with the discussion of Figure 2.

Turning now to Figure 2 for an explanation of the operation of this invention there is shown a plot of the output signal appearing in the supply to the output lead 14 by the target 12 as a function of the vertical deflection of the beam. The deflection is measured by beam widths and zero deflection indicates a vertical position of the beam wherein its center line 22 coincides with the top or horizontal edge of one of the steps in the mask 10. A solid line 24 illustrates the type of output signal produced when the conventional rectangle stepped mask is employed. It will be noted that it requires a deflection of one beam width to pass from a position that is completely on one step to a position that is completely on an adjacent step. A dotted curve 26 indicates what happens when the lips 16 and notches 18 are employed. As the top of each of the beams 20 passes the bottom of the lip 16, the amount of electrons in the beam reaching the target 12 is gradually decreased. The relative amount of this decrease depends upon the area of the lip 16 with respect to the area of the quantized step as a whole. The maximum decrease in the signal occurs when the beam is in the position shown in Figure 1a, that is, when the top of the beam coincides with the top of one of the steps in the mask 10. If the beam is deflected upward from this illustrated position, the amount of beam current reaching the target 12 is increased due to the fact that electrons can now flow through the notch 18 and strike the target 12. When the beam is in the zero position, that is, when the center line 22 coincides with the top of one of the steps, the beam current added by the notch 18 exactly offsets the beam current subtracted by the lip 16; and, therefore the amount of beam current reaching the target 12 is precisely the same as it would be had the lips and notches of this invention not been employed. Therefore, the dotted curve 26 crosses the solid line 24 at a point 28. As the beam is deflected further, the notch 18 contributes more heavily to the beam current and the lip 16 subtracts less and less so that the upper portion of the dotted curve 26 is produced. The horizontal portions of the solid curve represents adjacent quanta levels.

It will be noted that the dotted curve 26 extends below the solid curve 24 for negative deflections and above the solid curve 24 for position deflections. Therefore, the signals produced by the apparatus of this invention passes below one quanta level and above the next. However, this has been found to produce desirable results in certain applications. The amounts of overswing of the dotted curve 26, although producing desirable results in some applications, is extremely small and, therefore, produces no harmful results in other applications. The important thing to notice, however, is that the slope of the change from one quanta level to the next is increased.

It will be understood that the exact shape of these dotted curves 26 will depend upon the shape and size of the lips 16 and the notches 18 as well as on the distribution of electrons across the thickness of the beam. For example, the curve 26 is the type of curve obtained from employing a lip such as that indicated by the numerals 30 and 32 in Figure 2a, and the dotted curve 34 indicates the type of signal produced when only lip

30 is employed. The notches 30' and 32' are also included as they contribute to the shape of the upper portion of the curves.

Referring now to Figure 3, there is shown a cathode ray tube wherein a received signal may be quantized and the quantized signal immediately subtracted from the received signal. The cathode ray tube illustrated therein is comprised of an evacuated envelope 36, an electron gun 38 and a pair of deflection plates 40 and 42 that are arranged in a manner similar to that shown in Figure 1. On the remote side of the deflection plates is a target structure comprised of a first target 44. As shown, this is triangular in shape. Between the target 44 and the deflection plates 40 and 42 there is a step shaped target 46. It will be noted that the lower edge of the target 44 is tangent to the outer corners of the steps in target 46. Therefore, when the beam is in the position shown, the signal generated in the target 46 is proportional to the section of the beam that intersects this target, namely, the portion 48. On the other hand the target 44 intersects the cross hatched portion of the beam indicated by the numeral 50. It is apparent then that the output signal supplied by the target 46 increases rather abruptly as the beam is deflected up and down over the various steps by the application of the signal to the deflection plates 40 and 42. In the position shown, the beam lies in the middle of one of the steps in the target 46. It can be seen that as the beam is deflected upward from this position that the cross sectional area 50 increases and hence the signal output provided by the target 44 increases in a linear fashion. If the beam is deflected downward, the cross sectional area 50 may decrease linearly to zero. This change in the cross sectional area 50 between zero and a maximum value is linear if the edge of the target 44 is a straight line. Therefore, the signals provided by the target 44 are always proportional to the signal amplitude within one step of the target 46.

Having thus described my invention, what is claimed is:

1. A quantizing tube adapted to produce a

quantized signal that has a minimum flat to rise ratio comprising in combination and evacuated envelope, an electron gun mounted in said envelope, said electron gun being adapted to project a ribbon like beam of electrons, deflection plates positioned on either side of the small dimension of said beam, a target having substantially rectangular steps mounted within said envelope in such a manner that one side of said steps is positioned 90° from the other side of the step, the side of each step parallel to the greater dimension of said beam being extended beyond the dimension of the body of the step.

2. A quantizing tube as described in claim 1, in which a mask having the shape of said target is positioned in front of a target that is rectangular in shape.

3. Quantizing apparatus comprising in combination an evacuated envelope, an electron gun adapted to project a line beam of electrons in a horizontal plane, an output electrode, means for permitting different discrete levels of the beam current to reach said output electrode depending on the vertical position of the beam, said latter means being adapted to change the beam current just before a discrete level in an opposite direction from the change in beam current produced in the output electrode when the beam passes that discrete level.

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