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GRID STRUCTURE FOR CATHODE-RAY TUBES

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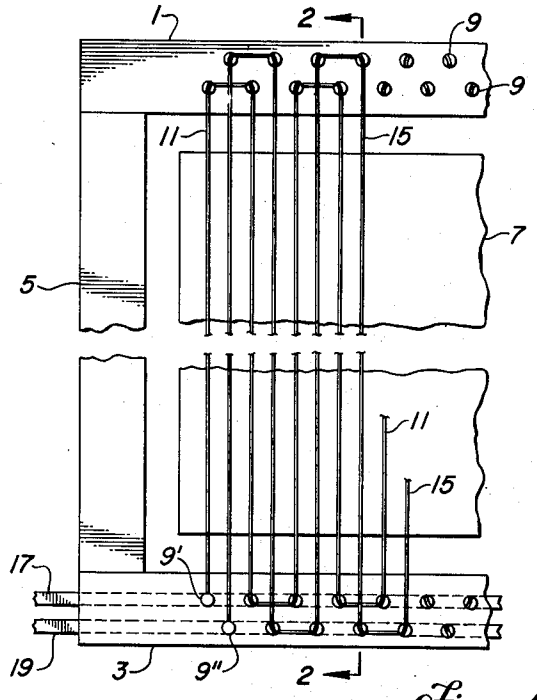


Fig. 1.

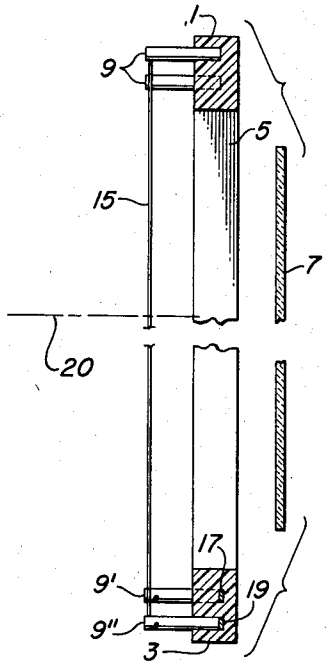


Fig. 2.

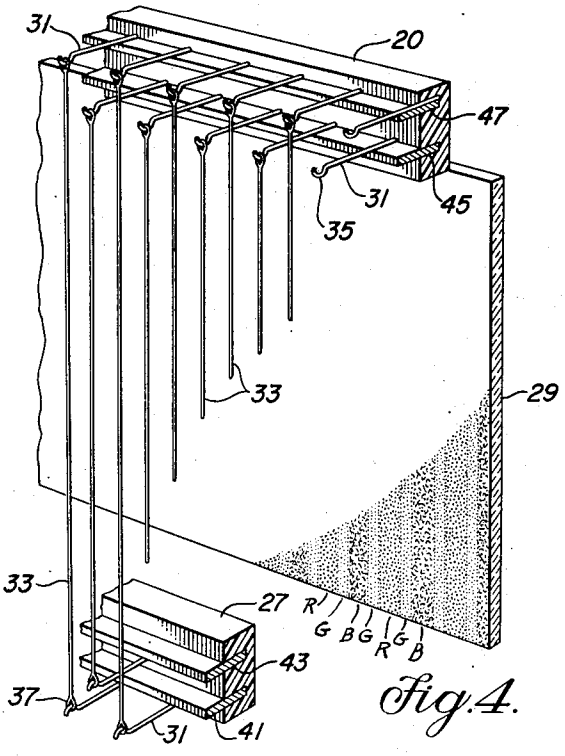


Fig. 4.

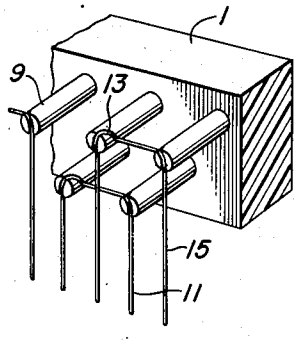


Fig. 3.

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GRID STRUCTURE FOR CATHODE-RAY TUBES

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The present invention relates to an improvement in grid structures of cathode-ray tubes. Grids of the nature of those to be described are particularly useful in the acceleration of the electron beam (cathode-ray) in the region adjacent the phosphor coated target. They also function to focus the scanning cathode-ray beam to an extremely fine spot on the target. This invention is particularly, although not exclusively, suitable for use in connection with the "Direct View Color Tube" as described in copending U. S. patent application, Serial No. 234,190, filed June 29, 1951, and the tube described in copending U. S. patent application, Serial No. 219,213, filed April 4, 1951, for an invention entitled "Cathode Ray Focusing Apparatus."

The grid structure of the instant invention is suitable for application in a cathode-ray tube wherein the luminescent target or screen area is divided into areas which are smaller, in at least one dimension, than picture element size. Phosphors capable of producing light representative of the primary or component colors, considered as red, green and blue, for an additive tricolor system, are preferably evenly distributed upon the tube target area. The developed cathode-ray scanning beam is directed through the grid structure of the present invention to impact the target to produce luminous effects thereon.

The electron beam usually employed in such a tube is focused to a diameter substantially equal to the width of a picture element. It is one of the purposes of the grid structure of the present invention to focus the beam to a further extent so that as it impinges upon the target its impact area at any one instant is of sub-elemental area size. With such focusing the sub-elemental area phosphor coatings of the target will be excited to luminese in the particular color light which is developed at the area of impact.

Although it is realized that in the prior art proposals have been made for improving the operation of the cathode-ray devices for polychrome operation, as far as is known, they have failed to provide the many advantages of the apparatus herein to be described. For example, many such tubes employ masks apertured in such fashion as to permit electrons to strike a single sub-elemental area of the target. In one form of such prior art tube the direction of the beam is changed when it is desired to impact different phosphors to produce different colors of light. In other prior art tubes a plurality of electron guns develop separate cathode-ray scanning beams so that each color of light may be separately modulated.

The grid structure of the present invention is of a type adapted to be employed with a cathode-ray tube having a luminescent target comprised of areas having one dimension at least which is less than picture element size. The target when impacted by the scanning cathode-ray beam is adapted to luminesce to produce light in different colors determined by the characteristics of the particular phosphor excited at any moment. The angle of incidence of the cathode-ray beam upon the target determines which type phosphor is subject to electron beam excitation.

Preferably the phosphors corresponding to the primary colors to be employed are deposited upon the target in parallel strips with a cyclic order of arrangement of the different phosphors. For example, the target may be coated with strips of phosphors capable of producing red, blue and green light respectively with repetitious deployment of such respective phosphors constituting the entire target area. At times it is desirable to locate the green light producing phosphor between strips of red and blue light producing phosphors, in which case the phosphor strips producing green light may assume a width one-half that of the phosphors producing red or blue light because twice as many strips to produce green light are present in the target area.

Accordingly, this invention is not concerned with the precise arrangement of phosphors but rather the grid structure to control tube operation. The grid of the present invention comprises a frame having spaced support beams which define the limiting boundaries of a window area in which an electro-optical image is to be made observable. Each of the beams supports a plurality of cantilever arms. An electrical conducting means, preferably in the form of fine wire, is strung between the support beams and carried by the cantilever arms. The wires are so disposed as to be parallel to the edges of the phosphor strips and the spacing between adjacent wires is made equal to one picture element. This provides at least one conductor for each target width corresponding to the different phosphor strips forming each color cycle. The cantilever arms are of sufficient resilience to tend to maintain the wire conductor taut so that it will maintain its position parallel to the phosphor strips. The conductive wires are of such diameter that only a minor portion of the target area is obscured by the fine wire, in contrast to the substantial target area covered by the apertured mask arrangements of the prior art. Electrical conducting means are provided for interlinking the wires of the grid so that a substantially uniform potential, relative to the tube cathode, may be applied to these wires. Usually it is desirable to connect the strung conductors so that the odd and even numbered (alternate) wires are connected in sets and thus appropriate potentials relative to the electron beam source may be applied thereto to control the impact point on the target, as will later be set forth in more detail. In some instances all conductors may operate at the same potential relative to the beam source, as will also hereinafter be pointed out.

The grid structure with which this invention is concerned is positioned adjacent the target and a potential of about one-quarter the magnitude of that applied to the target, relative to the electron beam source, is maintained on the grid. This is also approximately the potential relative to the source that is maintained upon the anode of the electron gun. Under these conditions the electrons comprising the cathode-ray beam travel at relatively low velocity through the major portion of the tube, that is, between the electron gun and the focusing and control grid of the present invention. They are accelerated to a higher velocity upon passing through the focusing and control grid when they become subjected to the relatively intense electrical field between the said grid and the target. Maintaining the grid at the relative potential mentioned serves to focus into a narrow trace (relative to the beam dimensions) the electrons which strike the target. With such potential and focusing arrangements greater color realization and definition is attainable when a grid of this type is employed in a polychrome television tube.

In operation a color oscillator or color control apparatus may apply a potential difference between the even and odd numbered wires of the grid such that the angle of incidence of the beam is controlled by this difference of potential. For example, the application of equal magnitude and like polarity potentials (relative to the beam source) to the even and odd numbered wires of the grid will cause the beam to be focused in a narrow trace substantially parallel to the wires and equi-distant therefrom to excite that light producing phosphor which is located intermediate the adjacent grid wires. This is usually the phosphor to produce green light. If the odd numbered wires are made slightly positive with respect to the even numbered wires of the grid then the electron beam will be deflected in the direction of the odd numbered wires to excite, for example, the blue light producing phosphor. When the even numbered grid wires are given a higher positive potential than the odd numbered wires, and following the suggested phosphor arrangement, the red light producing phosphors are excited.

The particular target structure suitable for use in connection with a grid of the present invention may assume any of various forms. It is merely necessary that the phosphors be deposited in linear relation one to the other and the grid wires placed parallel to the edges of the phosphor strips. By way of example the target may be formed of any transparent vitreous element having the described form of phosphor coatings thereover. An aluminum coating of a tenuous nature relative to the phosphor is coated on the phosphor surface adapted to be impacted by the high velocity electrons as scanning occurs. The purpose of such aluminum coating is threefold in that (1) a conducting surface is established on the target, (2) the relatively heavy ions are prevented from producing an undesirable ion burn or spot on the target and (3) halation effects are decreased and the useful illumination is about two-fold improved due to the mirror effect of the aluminum foil serving to prevent light developed being directed inwardly to the tube and away from the viewer.

Objects of the present invention, therefore, are to provide a grid structure suitable for use in the cathode-ray tubes to recreate color images produced from received signals transmitted under the standards of all presently proposed color television systems; to provide a grid structure wherein the cathode-ray beam can be brought to a finer and shaper focus than can be readily accomplished by conventional means; to provide a grid structure of a type suitable for accelerating the electrons to a high velocity in the vicinity of the target area so that a brilliant image may be obtained upon the target of the tube; to provide a grid wherein the color display on the target of a cathode-ray tube may be varied in any sequence desired with a minimum of energy being expended in the focusing process; and to provide a grid structure wherein the time of transition of the beam between the different colors on the cathode ray tube target is a minimum thus resulting in a maximum duty cycle being attained.

Other and further objects of the present invention will become apparent to those skilled in the art from a reading of the following detailed description thereof when taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a front elevational view, looking in the direction of the cathode-ray tube target, of one form of grid structure made in accordance with the present invention;

Fig. 2 is a view in cross section of the structure of Fig. 1 looking in the directions of the arrows defining the plane 2—2;

Fig. 3 is a view in perspective of a portion of the grid structure of Fig. 1, and

Fig. 4 shows a perspective view of another form of grid structure suitable for utilization in accordance with the present invention.

Referring now to the drawings and particularly to the embodiment shown in Figs. 1–3, a pair of spaced support beams **1** and **3** is shown being maintained in substantially parallel relation by a spacer **5** which has a similarly situated mate (not shown) at the other extremity of the beams. The beams **1** and **3** and the spacers **5** form a window area which has dimensions usually slightly larger than the target **7** upon which the images are to be created. A plurality of cantilever arms **9** is supported to extend outwardly from each of the beams **1** and **3**. In the preferred modification, these arms are respectively disposed in inner and outer rows on the beams **1** and **3** in such manner that the positions of the arms **9** extending from beam **1** respectively correspond to the positions of the arms extending from beam **3**. An electrical conducting strand or wire **11** is strung back and forth between the arms **9** of the inner rows of the beams. The wire size is generally of the order of only a few mils. Stainless steel or nickel wire of a diameter of about 0.002" is quite satisfactory where the tube is of at least the so-called **17"** variety.

The strand **11** is securely affixed to arm **9'** and then stretched across the space between the beams and inserted in the slot **13** located in the correspondingly positioned arm of beam **1**. This slot **13** is arcuate in the direction of the next adjacent arm of the inner row so that the strand is directed to this arm. Since all of the cantilever arms are appropriately slotted, the strand is continuously and progressively strung back and forth between the inner rows of the beams. In similar manner an electrical strand **15** is secured to arm **9"** located in the outer row on beam **3** and then strung tightly between the arms in the outer rows of the beams. A pair of electrical conductors **17** and **19** is positioned in beam **3** in contact respectively with the arms **9** of the inner row and the arms **9** of the outer row. These conductors are then extended outwardly from the frame to appropriate terminal connecting points (not shown) so that the wires may connect to an electric circuit from which separate potentials relative to the cathode, may be applied to the even numbered wires collectively and to the odd numbered wires in like manner.

In Fig. 2 there is shown a cross sectional view of the structure of Fig. 1 wherein the relative location of the grid wires, frame and target is apparent. The dash-dot line **20** indicates a path followed by the cathode ray scanning beam. The beams **1** and **3** are comprised of an insulating material such as, plastic or Bakelite and the pins **9** are of a conducting material such as steel. It is apparent from Fig. 2 that the conducting strands **11** and **15** are substantially coplanar. This is due to the fact that the cross reaches of the individual strands between adjacent arms of the inner rows are sufficiently set back by the arcuate slots **13** so that the strands **11** and **13** are never in contact.

It will be seen from Fig. 1 that the adjacent wires spanning the space between the beams **1** and **3** are connected respectively to the conductors **17** and **19**. Thus when a moderate difference in potential between the conductors **17** and **19** is provided (relative to the 4000 or more volts at which the grid is always maintained above the electron source) the cathode-ray beam will be deflected in a direction toward the positive wires. On the other hand when the moderate difference in potential causes the opposite wires to become more positive the cathode-ray beam will be deflected in the other direction. Accordingly when equal potential is applied to the conductors **17** and **19** the beam will strike the target and form a focused trace equi-distant from adjacent wires. As has been previously mentioned, the spacing between adjacent wires is substantially equal to the width of a picture element which corresponds to the width of the minimum number of strips of phosphor capable of producing red, green and blue light. As should immediately be apparent more than merely the inner and outer rows of arms (as herein represented) may be employed in the grid structure of the present invention. Accordingly, the spacing of the arms one from another in any individual row should substantially correspond to the width of a picture element multiplied by the number of rows of arms. The second dimension of the beam striking the target at any given instant is dependent upon the number of horizontal scanning lines to be traced to provide each image. It thus is unaffected by the grid electrode of this invention. Thus, the grid of the instant invention confines a beam having a transverse dimension of substantially picture element size to a focused (somewhat elliptical) trace of a width less than that of a single phosphor strip.

The basic difference between the structure of Fig. 4 and that previously described is the use of individual conducting strands in place of the continuous conducting strands as is shown in the structure of Figs. 1–3. In similar manner however, a pair of beams **20** and **27** is positioned adjacent a target or screen **29**. Cross members or spacers such as those designated by the numeral **5** in Fig. 1 may be employed to complete a frame structure for the beams of Fig. 4, or the beams **20** and **27** may be mounted upon the target **29** if desired, thus eliminating any necessity for cross members. In this embodiment, as in the former described, a plurality of cantilever arms **31** is supported to extend outwardly from the beams **20** and **27** respectively and further the arms **31** are shown positioned in inner and outer rows on each of the beams. The individual conducting strands **33** are adapted to extend between correspondingly positioned arms of the beams with, for example, the hooks **35** being provided on the ends of the arms **31** to engage the loops **37** formed on the extremities of the individual conductors. If desired spot welding or other means of attachment may be substituted for the hooks **35** and loops **37**. With the herein presented arrangements the conductors **33** are purposely formed of a length slightly less than the space between the fixed ends of the arms to which they are to be attached. Hence, the conductors

are maintained taut and parallel by the resiliency of the arms 31. The arms 31 may suitably be formed of piano wire and the conductors 33 may comprise stainless steel or nickel wire as desired.

With the latter arrangement there is provided a pair of conductors 41 and 43 positioned in the beam 27 such that the conductor 41 provides contact with each of the arms 31 located in the outer row of this beam. Likewise, the conductor 43 interlinks the arms located on the inner row of this beam. In this embodiment it is also desirable to employ a pair of conductors 45 and 47 positioned in the beam 20 in similar fashion to the manner in which the conductors 41 and 43 are disposed in the beam 27. With this arrangement, potentials of different magnitudes (relative to the electron source) may be applied to each of the conductors 41 and 43.

The structure of Fig. 4 is capable of performing identical functions to that of the structure of Figs. 1–3, that is, the electron beam may be successively focused and deflected to the right or left of its axis as desired to thereby produce, for example, light of the red and blue colors respectively. When the adjacent strands are supplied with the same potential (relative to the cathode) the beam is directed onto the target 29 at a position equi-distant from the adjacent strands and accordingly green light is produced. However, in order to show the versatility of the structures of the present invention the target or screen 29 is herein represented as being comprised of equal width strips of blue and red light producing phosphors with half width strips of green light producing phosphors being interposed therebetween. In this manner an equal area of the target is covered by each of the selected color producing phosphors but with such an arrangement more desirable qualities of reproduction are attainable. When such a target is employed the conductors 33 are positioned so that adjacent conductors, if projected onto the target, would divide the red and blue strips into equal areas. Thus if the potential applied to the wires in front of the red light producing phosphors is positive relative to the potential on the wires located in front of the blue light producing phosphors the electron beam is caused to converge in the red light producing area. However, if the positive potential is applied to the conductors in front of the blue light producing areas the beam converges upon the blue and when adjacent conductors are maintained at equal potentials the beam strikes the intermediate green light producing phosphors.

Obviously the embodiments shown in the figures are merely schematic, in that there is a limit to the number of arms and conductors which may be shown in a drawing. With present day television standards some 500–1000 or so wires (depending upon the target construction) would normally appear between the support beams. Further it will be apparent that the structures herein disclosed may be modified without departing from the scope of this invention; for example, cantilever beams having a width equal to the spacing between adjacent arms in any row could be used to replace the cantilever arms as shown. The beams could then be appropriately notched and the conducting strands strung back and forth in the manner herein described.

The grid structures of the instant invention may readily be employed with the tube of the first identified copending application, in which case, all of the wires comprising the grid would be maintained at substantially the same potential relative to the cathode and the angle of beam incidence on the target area would be under the control of an additional deflecting means, such as a second set of plates capable of deflecting the scanning beam in the horizontal direction. It is then the primary function of the grid to confine the cathode ray scanning beam to a focused trace upon the target area. Likewise when the grid is employed as an element of a multi-gun tube it may present uniform potential, relative to the potential of the guns, to the scanning ray with deflection thereof being provided solely by other elements of the tube. In the alternative the grid may serve as the beam focusing and color deflecting means for tubes of the multi-gun type.

In the foregoing considerations it has been set forth that the parallelly strung color control grid wires are spaced to correspond to the width of any group of phosphor strips corresponding to one color cycle or corresponding to one dimension of a picture point or elemental area. This reference was particularly for ease of description. In the finally-produced type it will be appreciated that the

color control grid wires spacing is actually normally slightly less than the set-forth width of phosphor strips, due to the fact that the color control grid is positioned closer to the electron beam source and gun than the final phosphor target. The color control grid is actually so close to the target that the spacing is almost equal to the described width of phosphor strips, but, in practice, the wire spacing may be regarded as being generally equal to that fraction of the width of the phosphor strips for each color cycle which is represented by the ratio of the distance of the color control grid from the virtual electron source to the distance of the target from the same virtual electron source.

Thus, within the meaning of what has herein been set forth and as the invention will be defined in the claims, any reference to identity of grid wire spacing and phosphor strip width for one color cycle or even the substantial equality thereof shall be understood to include at least that degree of tolerance herein stated.

Having now described the invention, what is claimed is:

1. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported from each of the spaced beams and located in staggered array to form a plurality of rows of aligned arms, and electrical conducting means connecting the arms of the separate rows.

2. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported from each of the spaced beams and located in staggered arrays to form a plurality of rows of aligned arms and electrical strand conductors connecting the arms of corresponding rows of the spaced support beams.

3. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported from each of the spaced beams and located in arrays to form a plurality of rows of aligned arms and electrical strand conductors connecting the arms of corresponding rows of the spaced support beams.

4. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported from each of the spaced beams and located in staggered array to form a plurality of rows of aligned arms, and electrical strand conductors spanning the space between the beams and connecting the arms of the separate rows.

5. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported from each of the spaced beams and located in staggered array to form a plurality of rows of aligned arms, and electrical strand conductors spanning the space between the beams in parallel reaches.

6. The grid structure as claimed in claim 5 wherein the electrical strand conductors comprise at least a pair of continuous wires electrically isolated from each other and disposed transversely of the support beams in alternate reaches.

7. The grid structure as claimed in claim 6 including electrical conductors respectively connecting the reaches of the pairs of continuous wires.

8. A grid structure for use in a cathode-ray tube capable of developing images in polychrome by progressively causing an electron beam to impinge upon less than picture element areas of the target area comprising a frame having spaced support beams, a plurality of cantilever arms extending substantially parallel respectively from each of the spaced beams, said arms being disposed to form an equal number of aligned spaced rows on each of the beams, electrical strand conductors spanning the spacing between the beams and connecting the correspondingly positioned arms of the beams and a plurality of electrical conductors respectively connecting the arms of at least some of the rows.

9. The grid structure of claim 8 wherein the spaced beams are substantially coplanar and the strand conductors define a plane spaced from and substantially parallel to the plane of the beams.

10. The grid structure of claim 9 wherein the individual strand conductors are substantially parallel and the normal dimension between adjacent strand conductors substantially corresponds to the width of a picture element multiplied by the number of rows of arms.

11. A grid structure comprising a frame having at least a pair of spaced support beams, a plurality of cantilever arms supported from each of the beams and located in staggered rows, a plurality of electrical strand

conductors respectively spanning the spacing between the beams and means connecting the individual strand conductors to the correspondingly positioned arms of the beams and further electrical connections linking the arms of at least some of the rows in electrical connection.

12. A grid structure comprising a frame having at least a pair of spaced support beams, a plurality of cantilever arms supported from each of the beams and located in staggered rows, an electrical conducting strand strung back-and-forth between the beams and over adjacent pairs of arms in each row the corresponding rows in the beams being strung in pairs in electrical series relation and electrical conductors connecting the arms of at least some of the rows in series relations.

13. The grid structure of claim 12 including means on each cantilever arm for securing the electrical conducting strand thereto.

14. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported by the beams and extending outwardly therefrom and generally normal to the plane of the frame, a pair of continuous strand conductors electrically isolated from each other supported by the arms and strung between said beams to occupy adjacent parallel positions transversely of the beams respectively and means for connecting electrical potential to the conductor.

15. The grid structure of claim 14 wherein said means

for connecting electrical potential to the electrical conducting means comprise a pair of electrical conductors respectively in contact with each of said continuous strand conductors at positions along the lengths thereof corresponding to substantially twice the spacing of the support beams.

16. A grid structure comprising a frame having spaced support beams, a plurality of cantilever arms supported by the beams and extending outwardly therefrom and generally normal to the plane of the frame, a plurality of individual continuous strand conductors and means for connecting electrical potential to the electrical conducting means comprising a plurality of electrical conductors respectively interlinking the arms said conductors connecting to alternate arms to form, when strung back and forth, two sets of electrically isolated conductors occupying adjacent parallel interleaved positions.

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