April 9, 1968 J. BURNS 3,377,500

FLAT CATHODE-RAY DISPLAY TUBE

Filed June 20, 1966 2 Sheets-Sheet 1

FIG. 1

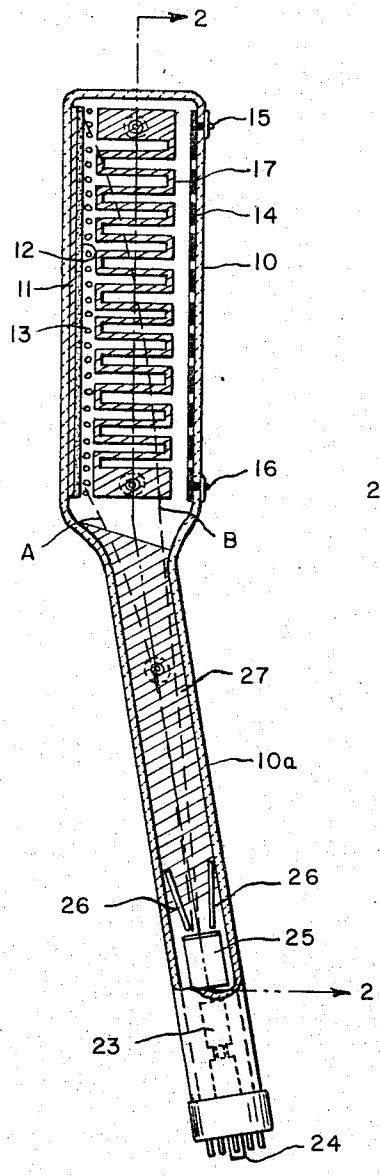
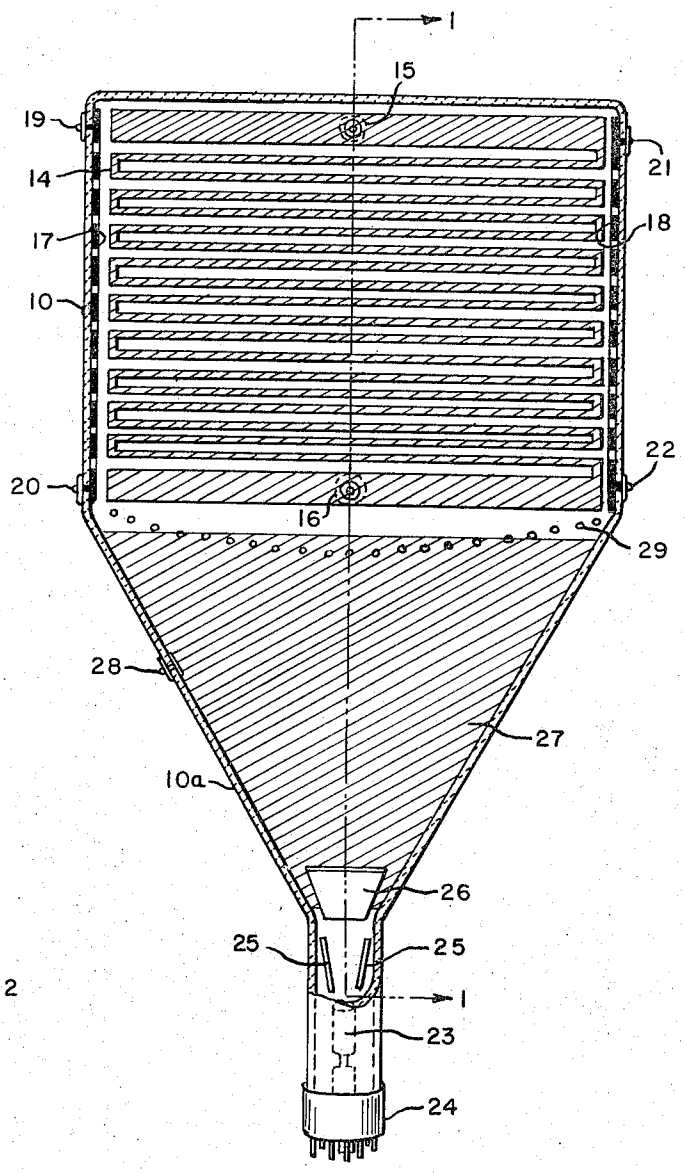


FIG. 2



April 9, 1968 J. BURNS 3,377,500

FLAT CATHODE-RAY DISPLAY TUBE

Filed June 20, 1966 2 Sheets-Sheet 2

FIG. 3

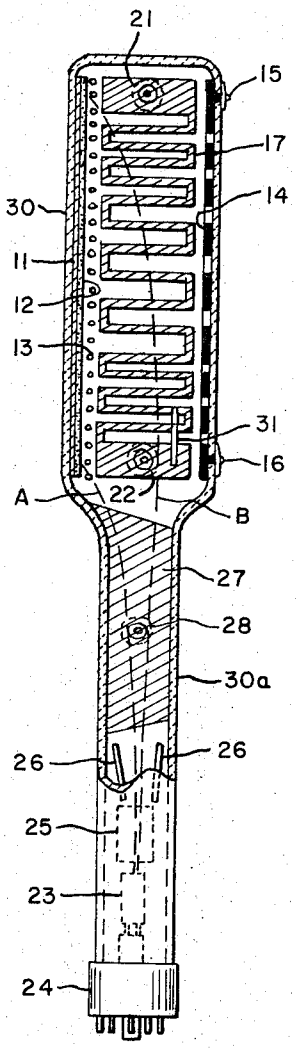
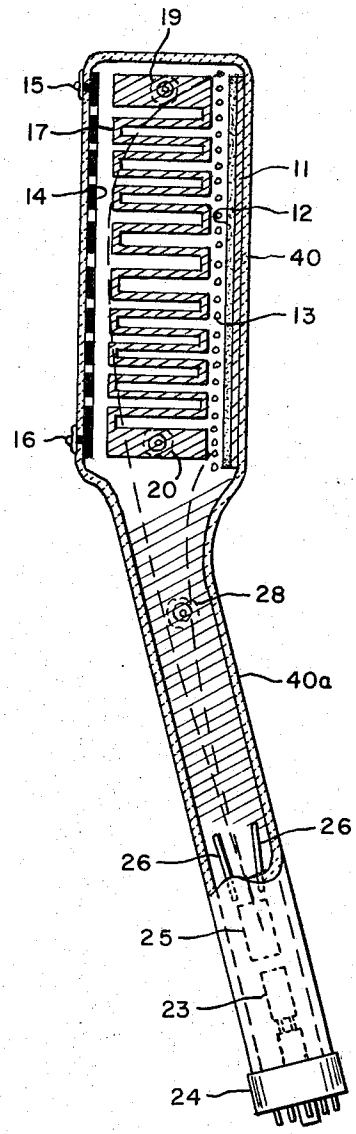


FIG. 4



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FLAT CATHODE-RAY DISPLAY TUBE

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7 Claims. (Cl. 315—14)

This invention relates to flat cathode-ray display tubes and particularly to tubes of such type suitable for use as television display tubes.

There has long been a demand for a flat cathode-ray display tube which has a form factor better suited for inclusion in a cabinet or housing of more conventional moderate depth than that required by the conventional cathode-ray television picture tube.

Heretofore several forms of flat cathode-ray tubes have been proposed with an array of deflectors arranged across a panel opposite the luminescent screen for the purpose of directing the electron beam to the proper horizontal scan position. Such tubes have a number of shortcomings, among which the more important are high power requirements for high switching frequencies and utilization of special deflection tubes and circuits to generate the deflection voltages.

It is an object of the invention, therefore, to provide a new and improved flat cathode-ray display tube which obviates the foregoing disadvantages of prior tubes of the type described.

It is another object of the invention to provide a new and improved flat cathode-ray display tube characterized by high resolution, high deflection sensitivity and accuracy and which can be operated from compact, low-power circuitry using solid-state components.

In accordance with the invention, there is provided a flat cathode-ray display tube comprising an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of the body portion, a transparent conductive film and a phosphorescent screen disposed on one of the major walls of the body portion, a screen electrode adjacent such film, such film being designed and intended to operate at a potential substantially higher than the screen electrode, and means including the screen electrode for establishing an electric field substantially throughout the body portion of the envelope. The display tube further comprises means in the neck portion for developing and injecting a cathode-ray beam into the electric field region and means for deflecting the beam in two orthogonal directions prior to injection into the electric field region to scan a raster on the screen electrode and on the phosphorescent screen.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring now to the drawings:

FIG. 1 is a longitudinal sectional view of a flat cathode-ray display tube embodying the invention;

FIG. 2 is a longitudinal sectional view, along the line 2—2 of FIG. 1, while.

FIGS. 3 and 4 are longitudinal sectional views of flat cathode-ray display tubes embodying the invention in somewhat modified forms.

Referring now more particularly to FIGS. 1 and 2 of the drawings, there is illustrated a flat cathode-ray display tube embodying the invention comprising an envelope **10** including a body portion of substantially parallelepiped configuration and having a thickness which is a minor

fraction of its length and width and a tapered tubular neck portion **10***a* extending from the body portion with its axis lying in, or approximately in, the median plane of the body portion.

The display tube of the invention further comprises a transparent conductive film or coating **11** and a superimposed phosphorescent screen **12**, such as a conventional aluminized phosphor screen, disposed on one of the major flat walls of the body portion of the tube. The film **11** and screen **12** substantially cover the rectangular wall surface to receive the scanning raster of the electron beam, as described hereinafter.

The tube of the invention further comprises a screen electrode **13** in the form of a wire mesh adjacent the film **11** and phosphorescent screen **12**. The conductive film **11** is designed and intended to operate at a potential substantially higher than that of the screen electrode **13**. The conductive film **11** and screen **13** are brought out to external electrical terminals, not shown.

The display tube of the invention further comprises means including the screen electrode **13** for establishing an electric field substantially throughout the body portion of the envelope **10**. This means may be in the form of a conductive coating disposed on the other major wall of the body portion and designed and intended to operate substantially at the potential of the screen electrode and cooperating therewith to establish such electric field. Specifically, the conductive coating may be in the form of a serpentine resistive coating **14** connected at opposite ends to external terminals **15**, **16** adapted for connection to an external supply source so as to provide a small negative potential gradient, for example of the order of 20% of the maximum potential, toward the remote end of the tube. As explained hereinafter, such a potential gradient along the serpentine coating **14** assists in imparting a parabolic trajectory to the electron beam.

The display tube of the invention further comprises serpentine resistive coatings **17** and **18** on the minor side walls of the tube and connected to external terminals **19**, **20** and **21**, **22**, respectively. These coatings **17** and **18** assist the action of the coating **14** to develop a substantially equipotential field through the body portion of the envelope **10**.

The display tube of the invention further comprises means in the neck portion **10***a* of the envelope for developing and injecting a cathode-ray beam into the substantially equipotential field region of the body portion of the envelope. This latter means may comprise a conventional electron gun **23** having suitable connections to external socket pins **24**. Also mounted within the neck portion **10***a* of the tube are means for deflecting the beam from the gun **23** in two orthogonal directions, prior to injection into the equipotential field region, to scan a raster on the screen electrode **13** and on the phosphorescent screen **12**. This deflecting means may be in the form of two pairs of deflection plates **25**, **25** and **26**, **26**.

The display tube of the invention further comprises a conductive coating **27** on the inner wall of the tapered neck portion **10***a* of the envelope. As indicated in FIG. 1, this coating is shaped or proportioned to adjust for trapezoidal pattern distortion of the scanning raster on the phosphorescent screen **12**. Across the body portion of the envelope **10** at its junction with the tapered neck portion there is provided a grid **29** comprising a series of wires normal to the major walls of the tube and between the deflecting plates **25**, **25** and **26**, **26** and the body portion for determining the lower boundary of the substantially equipotential field, as shown in FIGS. 1 and 2; for facilitating scanning into the lower corners of the equipotential region; and for correction of trapezoidal pattern distortion.

It is believed that the operation of the flat cathode-ray display tube of the invention will be apparent from the foregoing description. Briefly, a cathode-ray beam developed by the gun **23** and deflected in two orthogonal directions by the pairs of deflection plates **25**, **25** and **26**, **26** traverses the tapered tubular neck portion **10***a* of the envelope and is injected into the body portion thereof. The screen electrode **13**, the serpentine conductive coating **14**, and the side wall coatings **17** and **18**, all energized at substantially the same potential, create a substantially equipotential electric field substantially throughout the body portion of the envelope. The cathode ray from the electron gun **23**, as it passes through this substantially equipotential field region, is given a substantially parabolic trajectory as it strikes the screen **13**. The potential of these elements is substantially the same as that of the accelerator potential of the electron gun **23**. Doted line paths A and B of FIG. 1 show typical trajectories of the electron beam for extreme deflections in the vertical direction. It is seen that the electrons approach the mesh screen electrode **13** at an acute angle, dependent upon the angle between the axis of the electron gun and the deflection system.

The potential of the phosphorescent screen **12**, under the influence of the conductive film **11**, is substantially higher than that of the screen electrode **13**. However, the high phosphorescent screen potential exerts substantially no influence on the beam electrons until they are in the immediate vicinity of the screen electrode, whereupon the high positive field from the phosphorescent screen penetrating the screen electrode **13** increases the angle of incidence of the electron beam upon it and accelerates the beam as it passes through the screen electrode to the phosphorescent screen **12** for high-voltage phosphor excitation. The depth of the high-voltage penetration into the substantially equipotential region is dependent upon the screen factor of the screen electrode **13**, its thickness and cross-section geometry, the screen electrode-phosphorescent screen potential gradient, and the potential of the substantially equipotential region. Since each aperture in the screen electrode **13** accepts a portion of the electron beam which it intercepts and functions as a focusing electrode, the factors listed above and the phosphorescent screen-screen electrode distance influence the final resolution and brightness of the image developed by the phosphorescent screen **12**.

As stated above, the serpentine conductive coating **14** on the major wall opposite the screen electrode **13** imparts a substantially parabolic trajectory to the cathode-ray beam, thus increasing the angle of incidence of the electron beam on the screen electrode **13** and improving resolution and reducing registration error and pattern distortion resulting from any slight mechanical misalignment. As a potential gradient is established increasing negatively from the terminal **16** of conductive coating **14** toward the far end of the tube and its terminal **15**, it further aids in securing the desired electron trajectory as the beam approaches the screen electrode **13**. While the establishment of a potential gradient along the conductive coating **14** modifies, to a certain extent, the normally equipotential field, this deviation is ordinarily not substantially in excess of 15% of its maximum value.

A potential gradient also may be established on the conductive serpentine coatings **17** and **18** on the narrow side walls of the tube envelope, increasing negatively from the terminals **20** and **22** toward the far end of the tube and the terminals **19** and **21**, to aid in effecting convergence of the electron beam in the plane of FIG. 2, thus reducing trapezoidal pattern distortion without substantially increasing the over-all length of the tube. The side wall conductive coatings **17** and **18** may be used with either static or dynamic potentials applied for the same purpose. The location of the deflection plates near the electron gun and at a considerable distance from the substantially equipotential region substantially enhances the deflection sensitivity of the tube since only a small deflection angle is required to scan completely the phosphorescent screen **12**.

The flat cathode-ray display tube illustrated in FIG. 3 represents a modified form of the invention in which the same reference numerals identify corresponding elements of the tube of FIGS. 1 and 2. The basic difference in the tube of FIG. 3 is that the axis of the tubular neck portion **30***a* of the envelope **30** lies precisely in the median plane of the body portion of the envelope rather than at an angle thereto as shown in FIG. 1. In this arrangement, an auxiliary deflector plate **31** is mounted within the body portion of the envelope adjacent the tubular neck portion thereof to assist in imparting the desired parabolic trajectory to the beam as it approaches the screen electrode **13**. As shown, the auxiliary deflector electrode **31** is parallel to, and adjacent to, the conductive coating **14** and assists in deflecting the electron beam toward the screen electrode **13**.

In FIG. 4 there is represented a flat cathode-ray display tube embodying the present invention in a presently preferred form, elements corresponding to those of FIGS. 1 and 2 being identified by the same reference numerals. In this embodiment of the invention, the axis of the tubular neck portion **40***a* is inclined to the median plane of the body portion of the envelope **40** in a sense opposite to that of the embodiment of FIGS. 1 and 2 so that the electron beam injected into the substantially equipotential region is directed toward the conductive coating **14**. In this case, the conductive coating **14** is maintained at a potential somewhat below that of the cathode of the electron gun **23**, which causes the beam to be reflected back toward the screen electrode **13**, operated slightly above electron-gun accelerator voltage, at a more favorable angle than in the embodiments of FIGS. 1, 2, and 3.

While the various electrodes and conductive coatings of the display tube of the invention may be operated within a wide range of voltages, depending upon their configuration, dimensions, and the desired operation, there follow typical voltages applicable to the tube constructions shown:

FIGS. 1 and 2

	Volts
Accelerator, electron gun **23**	0
Cathode, electron gun **23**	−2,500
Conductive film **11**	10,000
Screen electrode **13**	0
Conductive coating **14**:	
Contact **16**	250
Contact **15**	−250
Conductive coatings **17, 18**:	
Contacts **20, 22**	500
Contacts **19, 21**	−500
Conductive coating **27**	1,000

In FIG. 3, the potentials of the several tube elements may correspond to those of FIGS. 1 and 2 with the addition that the deflector electrode **31** may be operated at a potential varying between 0 and −100 volts.

In FIG. 4, again the various tube elements and conductive coatings may be operated at potentials corresponding to those of FIGS. 1 and 2, with the exception of conductive coating **14** which may be operated at a potential somewhat below that of the cathode of electron gun **23** or about −2,600 volts.

While, in each of the foregoing embodiments of applicant's invention, the screen electrode **13** is shown in the form of a unipotential mesh, it also may be in the form of a series of separate grid wires with an arrangement for switching or commutating the potentials impressed thereon. For example, the electrode **13** may take the form of the switching grid illustrated and described in each of Patents 2,759,993, 2,856,454, and 2,885,465 to B. D. Loughlin, in which the grid is effective to secure registration of the scanning beam with the proper one of a series of different color phosphor stripes. A screen elec-

trode of such a type also serves to enhance the resolution in a cathode-ray tube for monochrome display.

While there have been described what are, at present, considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein, without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A flat cathode-ray display tube comprising

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

means including said screen electrode for establishing an electric field substantially throughout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the electric field region;

and means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen.

2. A flat cathode-ray display tube comprising:

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

a conductive coating disposed on the other major wall of said body portion and designed and intended to operate substantially at the potential of said screen electrode and cooperating therewith for establishing a substantially equipotential electric field substantially throughout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the substantially equipotential field region;

and means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen.

3. A flat cathode-ray display tube comprising:

an envelope including a body portion of subtantially parallelepiped configuration having a thickness whch is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of said body portion;

a transaprent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

a serpentine resistive coating disposed on the other major wall of said body portion and designed and intended to operate substantially at the potential of said screen electrode with a small negative potential gradient toward the remote end of the tube and cooperating with said screen electrode for establishing a substantially equipotential electric field substantially throughout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the substantially equipotential field region;

and means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen.

4. A flat cathode-ray display tube comprising:

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

means including said screen electrode for establishing an electric field substantially throughout said body portion;

serpentine resistive coatings on the minor side walls of said body portion proportioned to correct trapezoidal pattern distortion;

means in said neck portion for developing and injecting a cathode-ray beam into the electric field region;

and means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen.

5. A flat cathode-ray display tube comprising:

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying approximately in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

means including said screen electrode for establishing a substantially equipotential electric field substantially throughout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the substantially equipotential field region;

means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen;

and a grid extending across said body portion normal to the major walls thereof and between said deflecting means and said body portion for defining one boundary of said substantially equipotential field.

6. A flat cathode-ray display tube comprising:

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom with its axis lying in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

a conductive coating disposed on the other major wall of said body portion and designed and intended to operate substantially at the potential of said screen electrode and cooperating therewith for establishing a substantially equipotential electric field substantially throughout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the substantially equipotential field region;

means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen;

and an auxiliary deflecting electrode disposed adjacent said neck portion parallel to and adjacent said conductive coating to deflect said beam toward said screen electrode.

7. A flat cathode-ray display tube comprising:

an envelope including a body portion of substantially parallelepiped configuration having a thickness which is a minor fraction of its length and width and a tapered tubular neck portion extending therefrom

with its axis lying approximately in the median plane of said body portion;

a transparent conductive film and a phosphorescent screen disposed on one of the major walls of said body portion;

a screen electrode adjacent said film, said film being designed and intended to operate at a potential substantially higher than said screen electrode;

a conductive coating disposed on the other major wall of said body portion and designed and intended to operate substantially at the potential of said screen electrode and cooperating therewith for establishing an electric field substantially througout said body portion;

means in said neck portion for developing and injecting a cathode-ray beam into the electric field region directed toward said conductive coating at an angle of the order of 15°;

and means for deflecting said beam in two orthogonal directions prior to injection into said region to scan a raster on said screen electrode and on said phosphorescent screen.

No references cited.

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