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[54] **ELECTROLYTIC STEAM GENERATOR**

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[52] **U.S. Cl.** **219/288**; 219/275; 219/289; 219/293; 338/80

[51] **Int. Cl.** **H05b 3/60**; F22b 1/30

[58] **Field of Search** 338/80–86; 219/271, 275, 284–295

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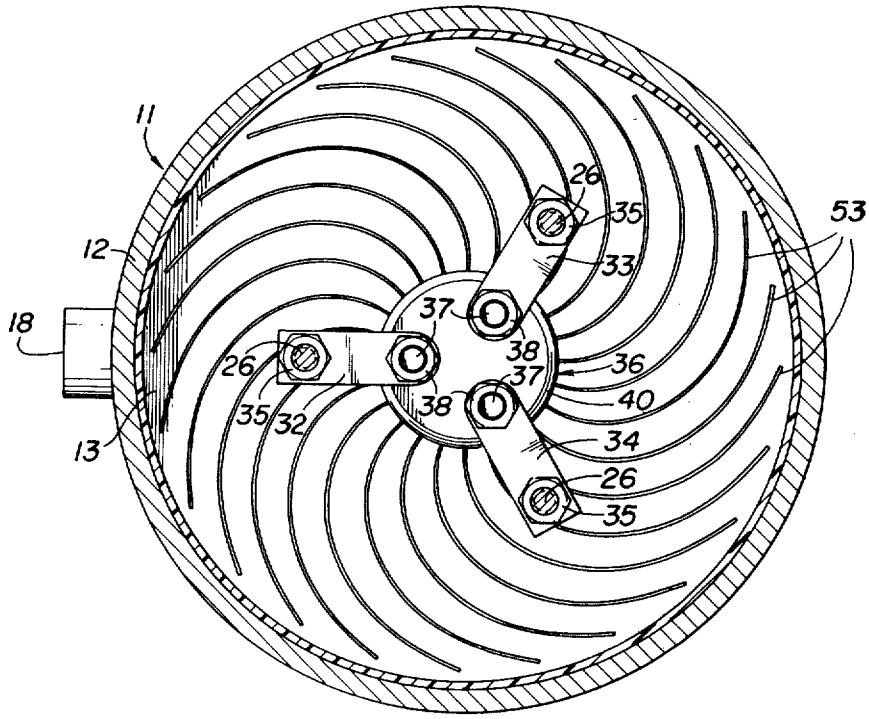
[57] **ABSTRACT**

An electrolytic steam generator includes a tank defining a steam generating chamber having a water inlet and a steam outlet. A plurality of identical electrode plates are mounted at their inner ends only on a centrally disposed vertical post in the chamber with the electrode plates extending radially outwardly from the post. Each electrode plate has a horizontal cross section in the form of the involute of a circle. Means are provided on the post for connecting the electrode plates to a source of power in such manner that a voltage differential is provided between adjacent over of the electrode plates.

7 Claims, 3 Drawing Figures



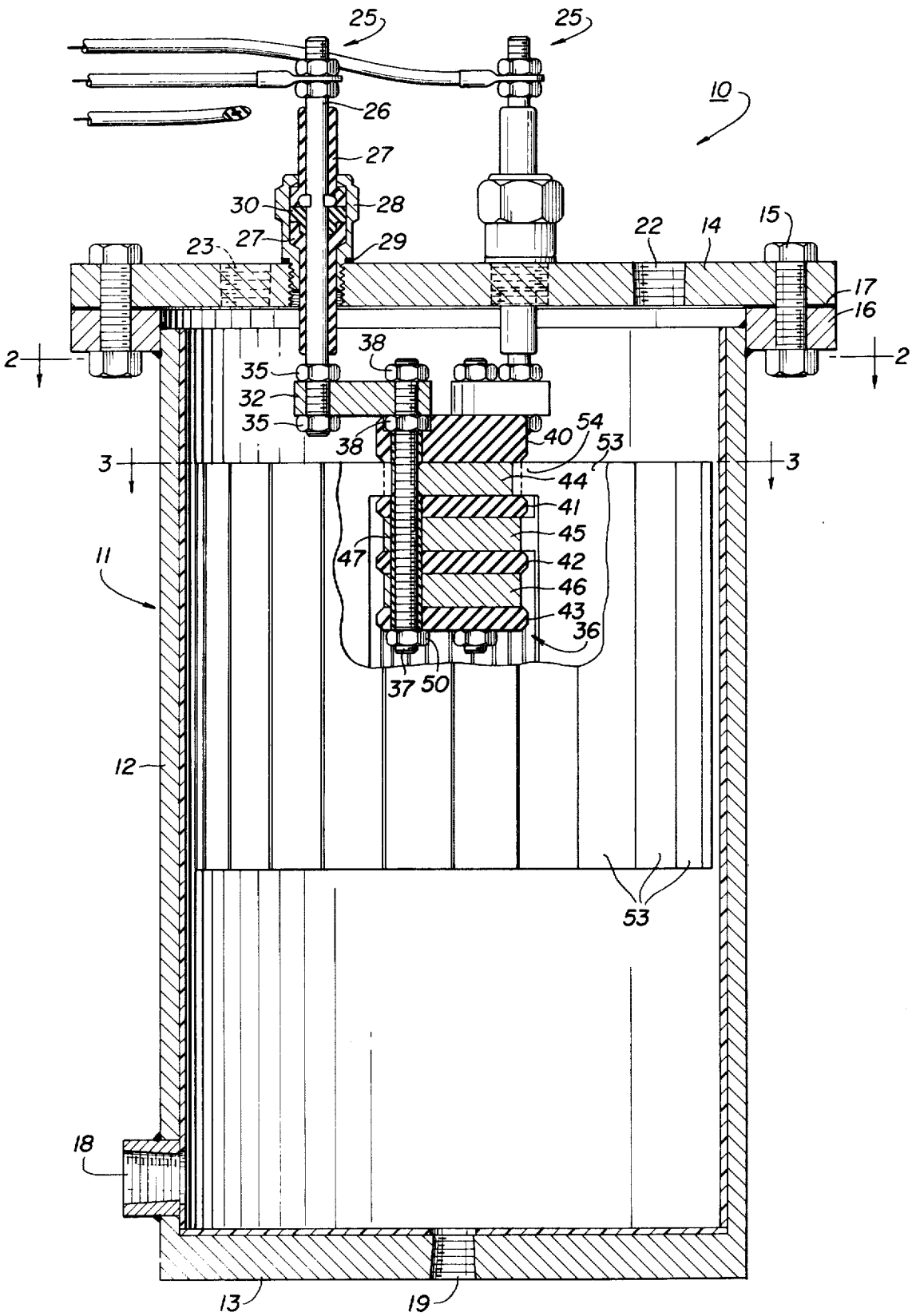

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Fig. 1

FIG. 2

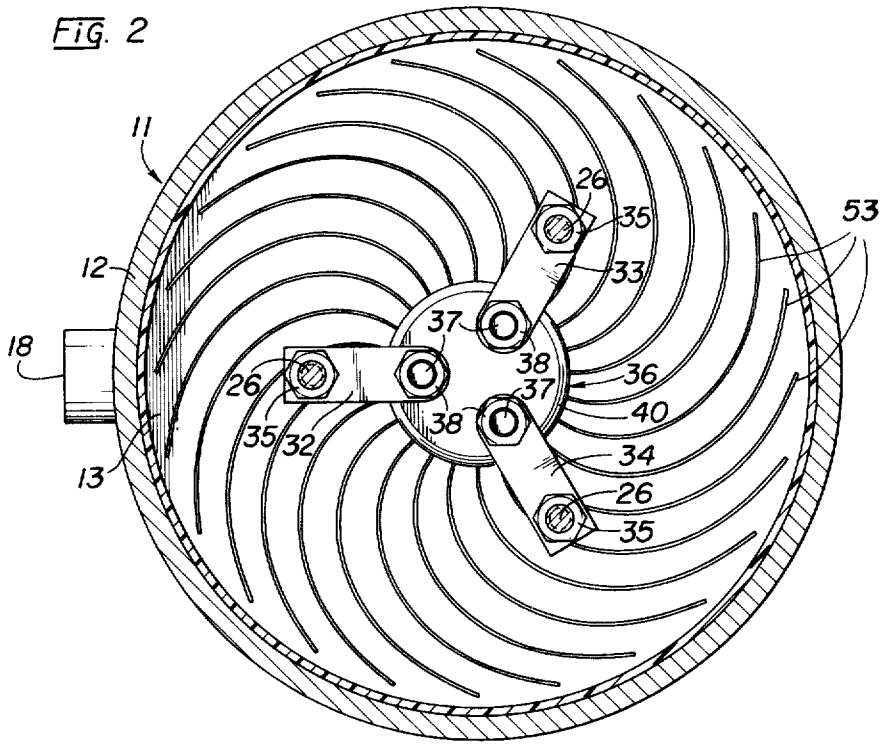
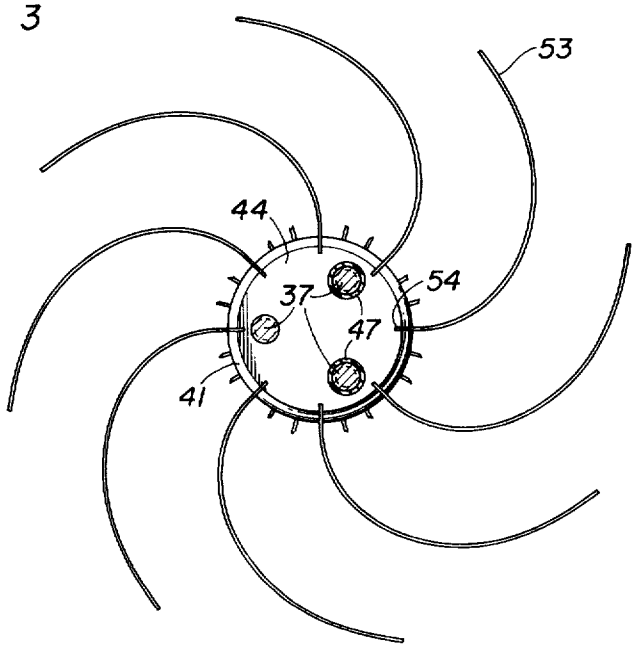


FIG. 3



ELECTROLYTIC STEAM GENERATOR

The present invention relates to electrolytic steam generators, and it relates more particularly to such a generator wherein the electrodes have a cross-section in the shape of the involute of a circle so that the adjacent electrodes are equally spaced throughout their entire facial areas.

BACKGROUND OF THE INVENTION

Electrolytic steam generators find particular application where rapid generation of steam is required for short periods of time, as for example, in pressure cookers and autoclaves. Such generators have generally employed a plurality of spaced apart planar electrodes mounted within a steam generating chamber wherein the electrodes are immersed in water and electrically energized to pass electric current through the water to effect heating and evaporation thereof. Optimum efficiency of such generators requires maximum spacing between the electrodes. Erosion of the electrodes necessarily occurs during use of the generator, and to avoid erratic operation of the generator it is desirable that all of the electrodes be eroded equally and, moreover, that each electrode be eroded equally on both sides. The inherent erosion of the electrodes has, therefore, made it particularly difficult to employ a three phase electric system for energizing the planar electrodes of the prior art since such a system must be balanced both initially and throughout the life of the generator and uneven erosion of the electrodes unbalances the system.

Another problem which has long been associated with electrolytic generators is that of scaling. During use of these generators, the salts in the water tend to deposit on the electrode surfaces thereby to reduce the surface conductivity of the electrodes and thus impair the overall efficiency of the generator. Copending application Ser. No. 253,409 filed May 15, 1972 and assigned to the same assignee as the present invention partially solves this scaling problem by draining the generator at the end of each steam generating cycle. The present invention, in one of its aspects, provides a still further reduction in the amount of scale buildup on the electrodes.

OBJECTS OF THE INVENTION

A principal object of the present invention is therefore to provide an improved electrolytic type generator.

Another object of this invention is to provide a novel electrode design which enables greater overall electrode surface area in a generating chamber of given size.

A further object of this invention is to provide an electrode configuration which may be energized from a three phase electrical power system.

A still further object of this invention is to provide a steam generator wherein the electrodes are self descaling.

SUMMARY OF THE INVENTION

Briefly, the above and further objects may be realized in accordance with the teachings of the present invention by providing a plurality of identical electrode plates which, in cross-section, are each in the shape of the involute of a circle. The electrodes are mounted at their inner ends only by a centrally disposed vertical post from which they radiate outwardly in a cylindrical pressure chamber. Consequently, the electrodes all have the same overall facial area and the facial areas of adjacent electrodes are equally spaced from one another at all points. Accordingly, all of the electrodes erode equally on both sides and relative to one another. The intermittent heating and cooling causes erosion and contraction of the electrodes which results in a small deflection thereof to dislodge scale deposited thereon during the steam generating cycle.

BRIEF DESCRIPTION OF THE DRAWING

Further objects and advantages and a better understanding of the present invention can be had by reference to the following detailed description, wherein:

FIG. 1 is an elevational cross-sectional view of an electrolytic steam generator embodying the present invention;

FIG. 2 is a horizontal cross-sectional view of the generator of FIG. 1 taken along the line 2—2 thereof; and

FIG. 3 is a horizontal cross-sectional view of the electrode assembly taken along the line 3—3 of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

An electrolytic steam generator **10** includes a tank **11** having a cylindrical wall **12** enclosed at the lower end by a fixed, circular bottom wall **13** and provided at the top with a removable cover **14.** The cover **14** is in the form of a flat circular plate secured by a plurality of nut and bolt assemblies **15** to an external annular flange **16** suitably welded to the top of the wall **12.** The cover **14** is hermetically sealed to the flange **16** by means of an annular gasket **17** disposed between the flange and the cover. An internally threaded fitting **18** which provides the water inlet to the generator is secured in an opening near the bottom of the side wall **12,** and an internally threaded drain opening **19** is provided at the center of the bottom wall **13.** A pair of internally threaded openings **22** and **23** are provided in the cover plate **14** for receiving fittings respectively connecting the chamber to a safety valve (not shown) and to the location where the steam is to be used.

While the principals of the present invention may be used with a single phase electric power system, the generator **10** is particularly designed for use with a three phase system wherefore three feed-through electrical connectors **25** are mounted to and extend through the cover plate **14.** The connectors **25** are equally spaced from one another and each includes a central conductive stud **26** which is rigid and threaded at both ends, the central portion being enclosed by porcelein insulating sleeves **27.** A nut **28** having an external thread thereon is screwed into an internally threaded hole in the cover plate **14** and a sealing gasket **29** is interposed between the top surface of the cover plate **14** and an annular shoulder on the nut to hermetically seal the connector to the cover. A sealing ring **30** interposed between the stud **26** and the insulating sleeve **27** prevents steam leakage from the chamber along the walls of the stud. Feed-through connectors such as the connectors **25** are readily available on the market and the particular construction thereof forms no part of the present invention.

As best shown in FIG. **2,** three conductive mounting elements or bars **32, 33** and **34** are secured to the lower ends of the respective studs **26** by a plurality of nuts **35.**

The bars **32, 33** and **34** are radially disposed relative to the central vertical axis of the tank, and a central post assembly **36** is centrally supported in the steam generating chamber from the inner end portions of the bars **32, 33** and **34.** The post assembly **36** comprises three conductive discs **37** which respectively depend from the bars **32, 33** and **34** and are secured thereto by a plurality of nuts **38**; a plurality of flat insulating members or discs **40, 41, 42** and **43**; and a plurality of conductive members or discs **44, 45** and **46.** The conductive discs are alternately interposed with the insulating discs whereby to be insulated from one another. Each of the conductive discs are respectively connected as by welding to one of the posts **37** and insulated from the other two posts **37.** As shown in FIG. **1,** the illustrated post **37** is connected to the uppermost conductive disc **44** and insulated from the other two conductive discs **45** and **46** by an insulating sleeve **47.** The other two posts **37** are similarly connected to respective ones of the other conductive discs **45** and **46** and insulated from the remaining two conductive discs by insulating sleeves. The lower ones of the nuts **38** are received in counterbores in the upper insulating disc **40** and the entire post assembly **36** is held together in a sturdy nonmovable condition by nuts **50** threaded onto the lower ends of the posts **37.**

A plurality of electrodes **53** are mounted to the conductive discs **44, 45** and **46** and radiate outwardly therefrom as shown in FIGS. **2** and **3.** The electrodes are metal plates preferably formed of stainless steel and which, in cross-section, are each in the shape of the involute of a circle. The main body portions of the electrodes are identical. Accordingly, the entire areas of each electrode **53** is equally spaced from the opposing facial areas of the next adjacent electrodes on both sides thereof whereby both sides of the electrodes erode equally. Every third one of the electrodes is connected to the same conductive disc, and the electrodes thus include integral leg portions **54** which are fitted into peripheral slots in the peripheral portion of the associated disc. Therefore, one third of the discs have the leg **54** at the top for mounting to the upper conductive disc **44,** one third have the leg **54** spaced a short distance from the top for mounting to the disc **45,** and one third have the leg **54** positioned for mounting to the disc **46.** In the illustrated embodiment of the invention 24 electrodes **53** are provided with eight of the electrodes being respectively mounted to each of the three conductive discs. It will be understood by those skilled in the art that this number is however, not critical.

As best shown in FIG. **1** the electrodes depend a substantial distance below the post assembly **36** and terminate a substantial distance above the bottom of the steam generating chamber. All of the electrodes have the same height and thus terminate at the bottom in a horizontal plane whereby all of the electrodes are equally immersed in the water contained in the chamber. The particular distance at which the electrodes should terminate above the bottom of the tank will vary depending upon the size of the generator. However, for best results the volume of water below the electrodes should be sufficient to maintain the conductivity of the water within acceptable limits during a normal steam generating cycle when the conductivity of the water within the chamber necessarily increases. An excessive salt concentration would result in foaming and a consequent entrainment of water droplets in the steam exiting the chamber through the steam outlet at the top. Also, the spacing between the electrodes and the water inlet **18** must be sufficient to prevent significant electric current flow to ground.

In normal use only a small portion of the electrodes **53** are immersed in water. However, because of the close electrode spacing which is made possible by the shape of the electrodes, the upper portions of the electrodes provide an electric scrubber which removes any water droplets which bubble up from the surface of the water. consequently, the steam leaving the generator is relatively free of entrained water particles and may be used in pressure cookers and autoclaves without subsequent drying.

In accordance with an important feature of this invention, the electrodes **53** are supported only at the inner ends whereby the curved main portions of the electrodes are free to deflect toward a planar configuration as they heat up during the steam generating cycle. The operating temperature of the electrodes is about 250°F whereby upon cooling the electrodes return to their original shape. While the extent of the deflection is very small so as not to noticeably affect the spacing between the electrodes, it is sufficient to retard salt builup on the facial surfaces of the electrodes.

OPERATION

In use, and as more particularly described in the said copending application Ser. No. 253,409, when steam is required, water is supplied to the steam generating chamber through the inlet **18,** the drain **19** being closed by means of a suitable valve in the drain line connected thereto. Also, the electrodes **53** are energized. When the water level in the chamber reaches the electrodes, electric current passes through the water between the electrodes to heat the water and generate steam. A current relay connected in the power line to the electrodes controls the supply of water to the steam generator whereby the water level is maintained substantially fixed throughout the steam generating cycle. The actual level will, of course, depend on the conductivity of the water and will, therefore, vary from place to place with the actual depth of water in the chamber increasing with the degree of softness of the water. At the end of the steam generating cycle the electrodes are deenergized and the drain line is opened thereby to completely drain the generator. The subsequent cooling of the electrodes causes them to deflect to their original shapes and to dislodge the scale deposited thereon.

While the present invention has been described in connection with a single embodiment, it will be understood by those skilled in the art that many changes and modifications may be made without departing from the true spirit and scope of the present invention. Therefore, it is intended by the appended claims to cover all such changes and modifications which come within the true spirit and scope of this invention.

What we claim is:

1. An electrolytic steam generator, comprising

a tank enclosing a steam generating chamber,

an electrode support in the form of a vertically disposed post,

a plurality of electrodes of substantially the same size and shape mounted in mutually spaced apart relationship within said chamber,

said electrodes radiating outwardly from said post and being equally spaced apart throughout the mutually facing areas thereof,

said electrodes each being in horizontal cross-section in the shape of the involute of a circle,

means connecting said electrodes to a source of electric power to provide a voltage differential between adjacent ones of said electrodes,

a water inlet to said tank,

a drain outlet from said tank, and

a steam outlet from the top of said tank.

2. An electrolytic steam generator according to claim 1 wherein

said post is the sole support for said electrodes,

whereby the expansion and contraction of said electrodes causes scale deposited on said electrodes to be dislodged therefrom.

3. An electrolytic steam generator according to claim 2 wherein said post comprises

a first plurality of conductive discs,

a second plurality of nonconductive discs,

said first and second plurality of discs being alternately interposed whereby said conductive discs are insulated from one another by said nonconductive discs, and

a plurality of conductive studs each respectively connected to one of said conductive discs and insulated from the other conductive discs,

adjacent ones of said electrodes being mounted to different ones of said conductive discs.

4. An electrolytic steam generator according to claim 3 wherein

each of said electrodes is provided with a horizontally extending mounting leg extending into a respective one of a plurality of slots in the associated one of said conductive discs.

5. An electrolytic steam generator according to claim 3 wherein

three conductive studs are provided for connection to a three phase electric power source.

6. An electrolytic steam generator according to claim 1 wherein

said water inlet is disposed at the lower portion of said tank, and

the lower ends of said electrodes are substantially spaced from the bottom of said tank to prevent electric current from passing between said electrodes and said inlet and to provide a water reservoir below said electrodes to maintain the conductivity of the water in the chamber within acceptable limits.

7. An electrolytic steam generator according to claim 1 wherein said support comprises

a plurality of mutually insulated, rigid electric conductors extending through the top of said tank,

a plurality of conductive elements respectively mounted to said conductors and extending therefrom toward the central vertical axis of said tank,

said post being made up of a plurality of alternately disposed conductive and insulating members positioned along the central vertical axis of said tank within said chamber,

each of said conductive elements being connected to one of said conductive members and insulated from the others of said conductive elements, and

a plurality of said electrodes being mounted to each of said conductive elements with adjacent electrodes being connected to different ones of said conductive elements,

said electrodes all extending a substantial distance below said post and terminating in a common horizontal plane.

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