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CORRECTED PUBLICATION

(54) **ELECTRONIC ASSEMBLY/SYSTEM WITH REDUCED COST, MASS, AND VOLUME AND INCREASED EFFICIENCY AND POWER DENSITY**

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See Related U.S. Application Data.

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Related U.S. Application Data

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(60) Provisional application No. 60/405,826, filed on Aug. 26, 2002.

Publication Classification

(51) **Int. Cl.**[7] **F21V 7/00**
(52) **U.S. Cl.** **362/247**

(57) **ABSTRACT**

An LED display assembly, comprising a grid of electrical conductors; light emitting diodes in association with the grid and in electrical communication with the conductors that provide power for LED operation, the grid operable to receive heat from the diodes during diode operation, and the array configured for passing coolant fluid for transfer of heat to the fluid. LED packages adjustable relative to a mounting grid, are also provided.

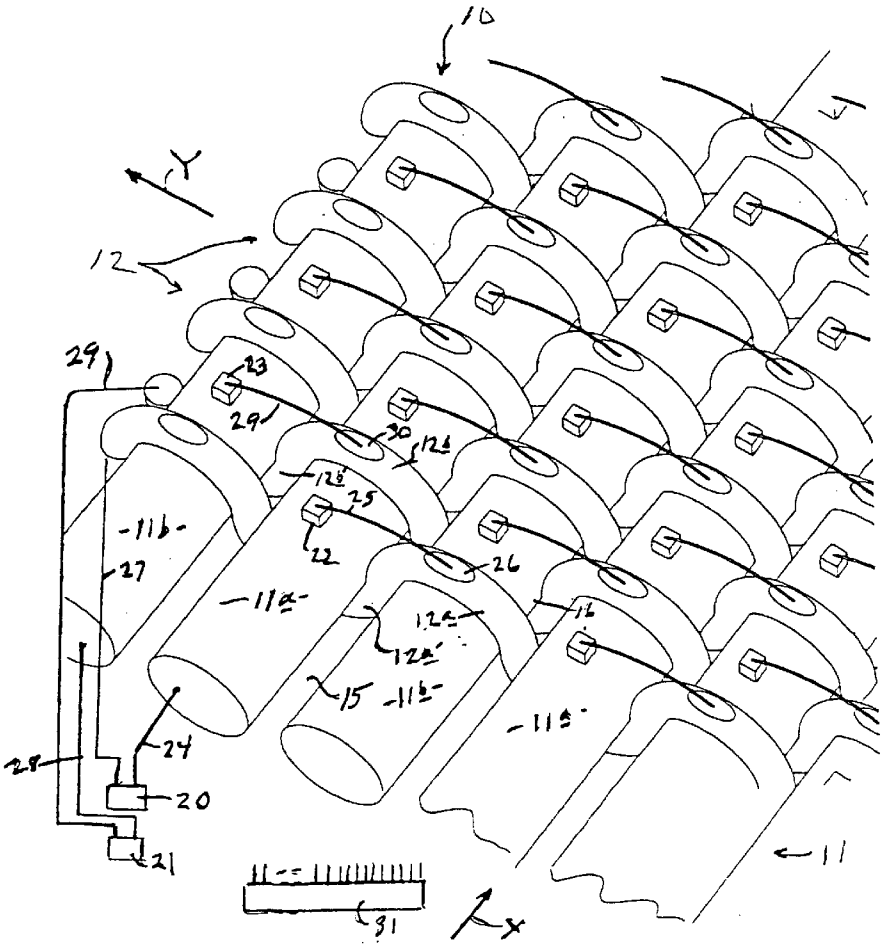


Fig. 1

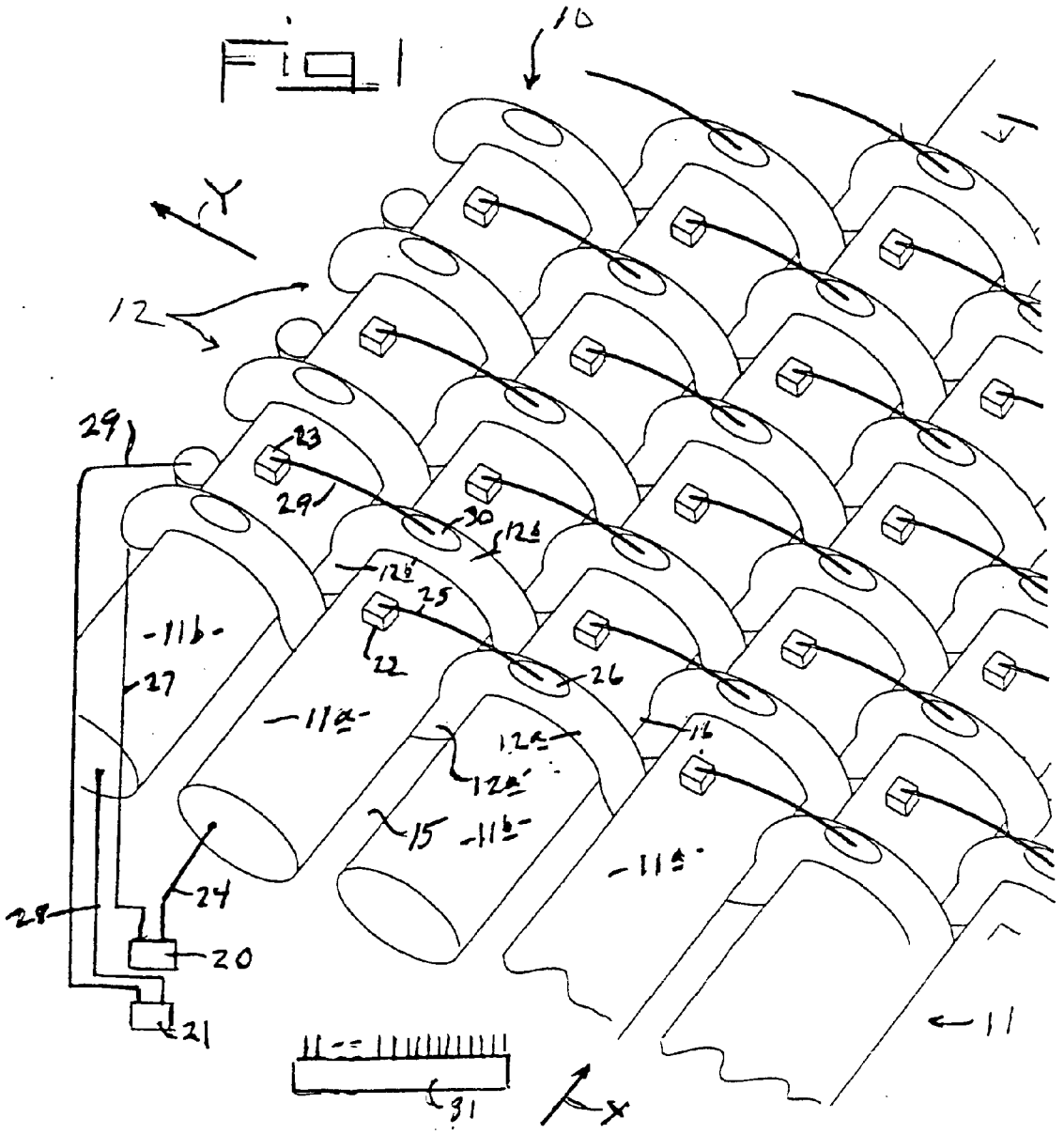

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Y
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12b
12b
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11b
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11a
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12a
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11b
11a
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21
11
31
X

Fig 1a

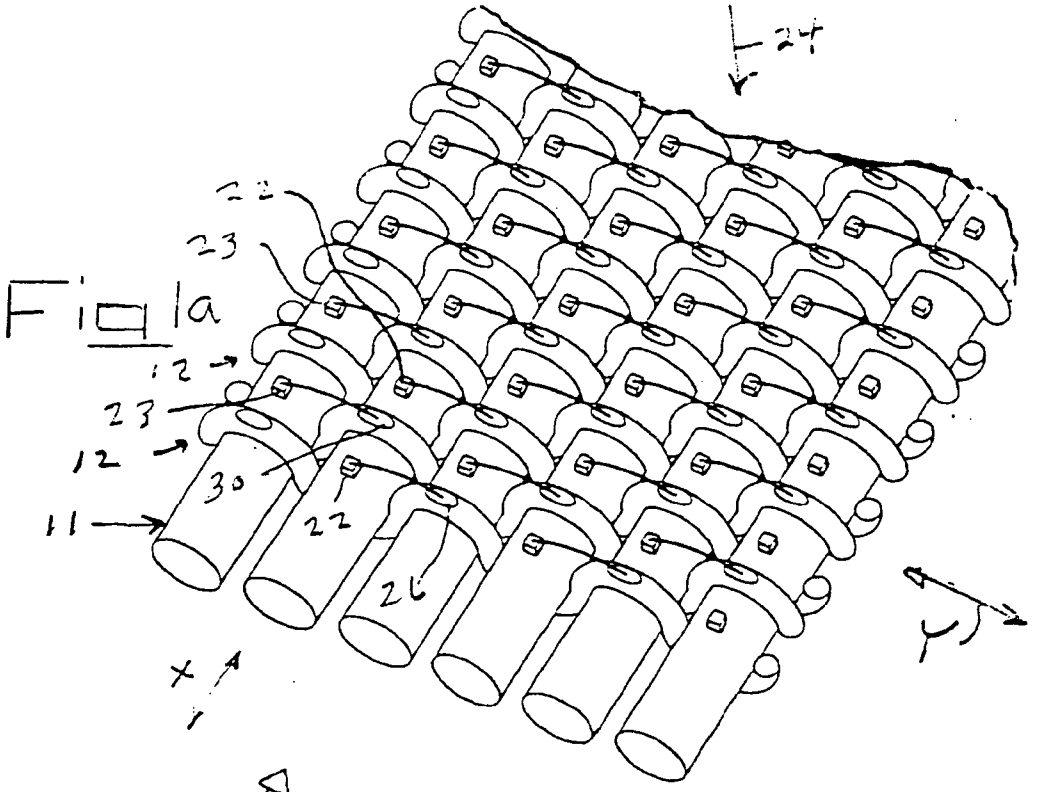


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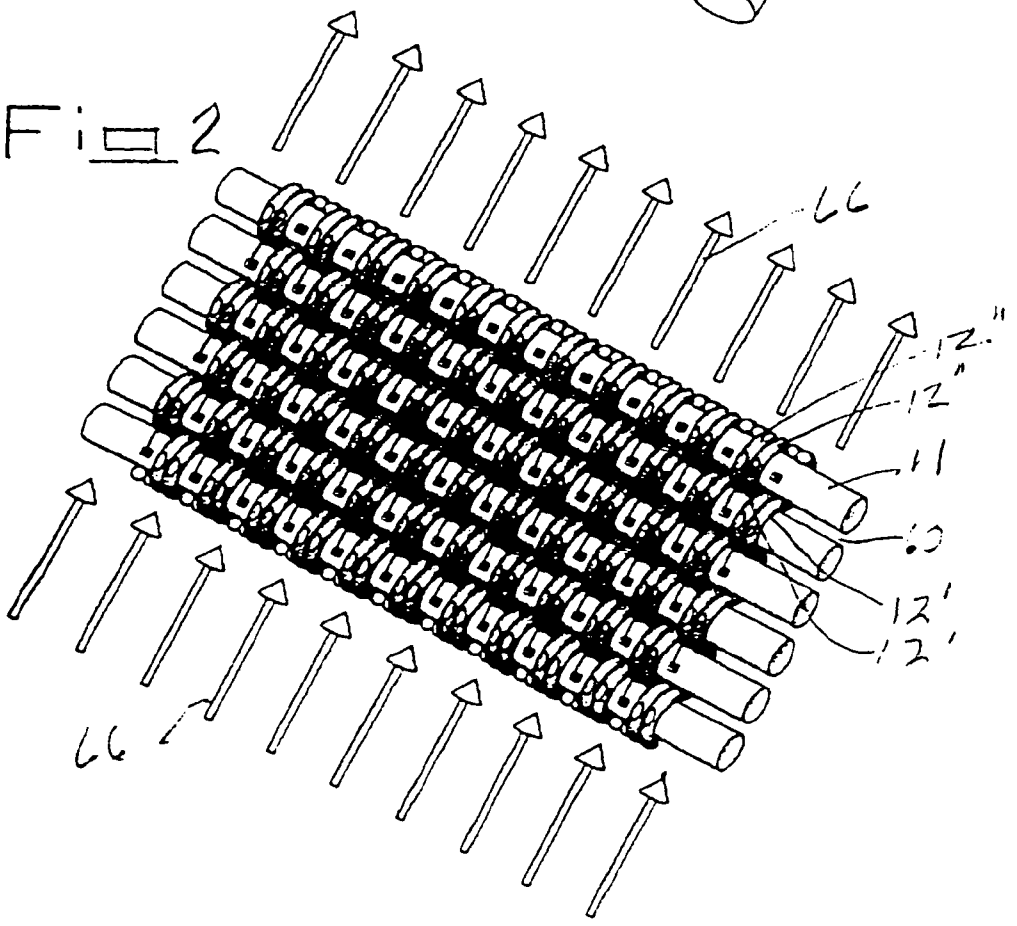
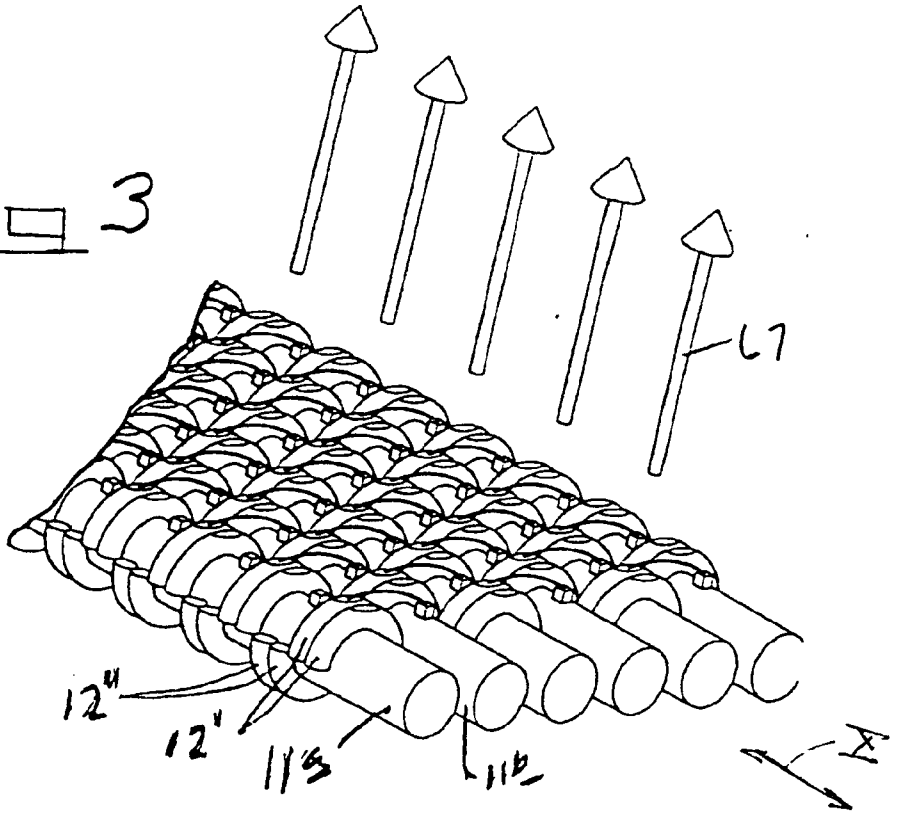


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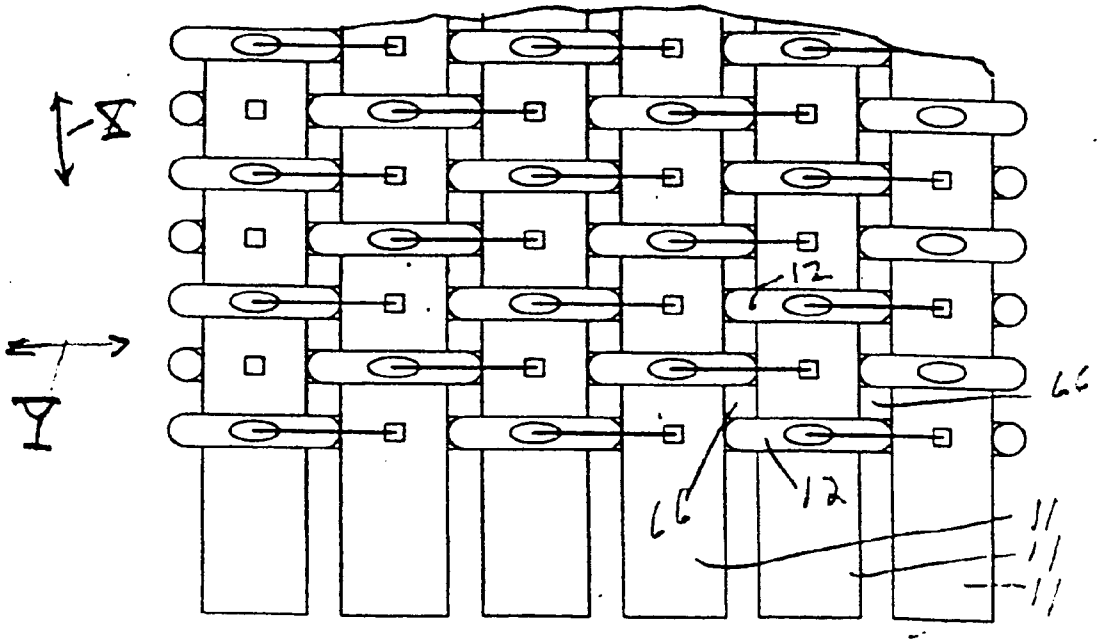
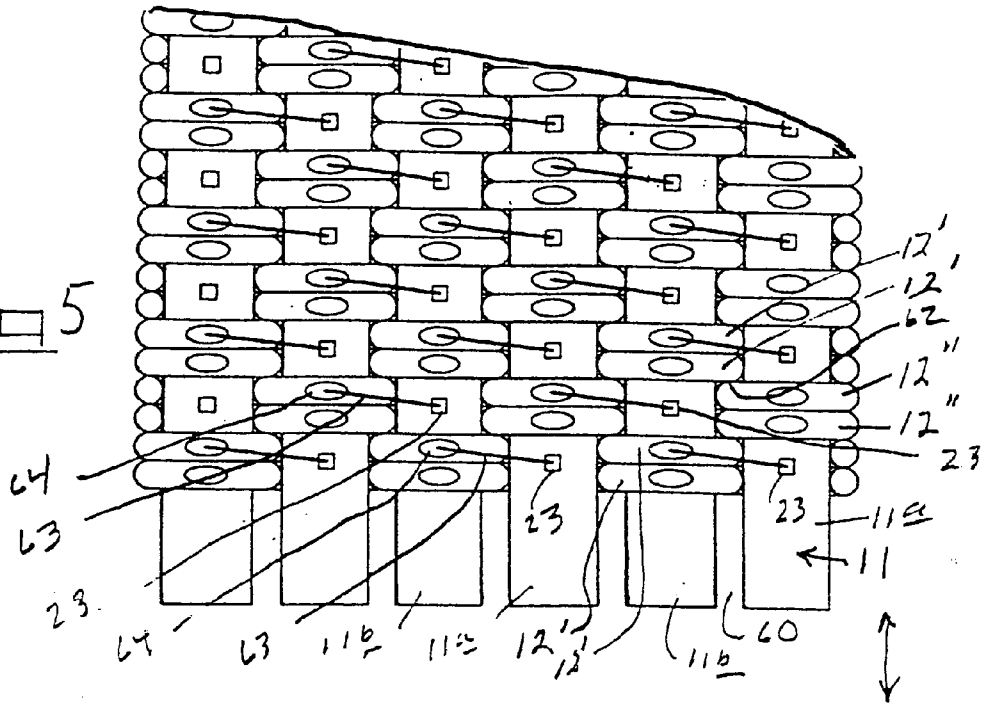


Fig 4

Fig 5


12'
12'
62
12"
12"
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23
23
11a
11
23
64
63
11b
11a
12'
12'
11b
60

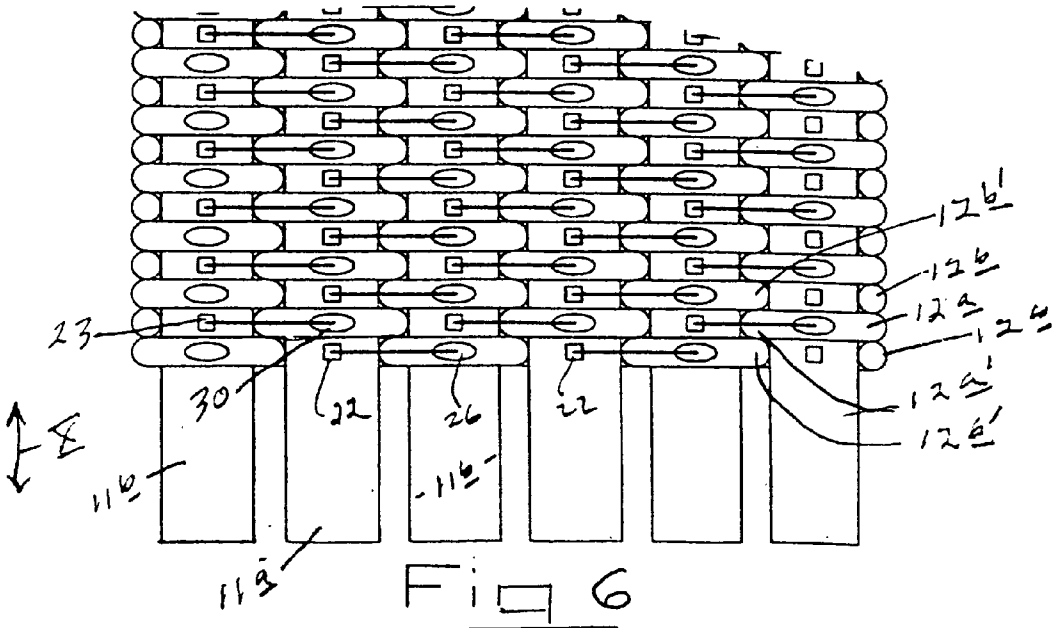

12b'
12b
12a
12a'
12b'
23
30
22
26
22
E
11b
11b
11a

Fig 6

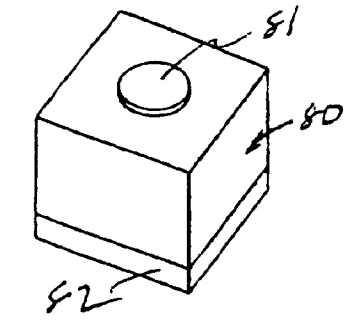


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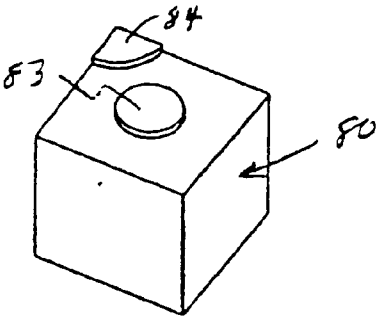


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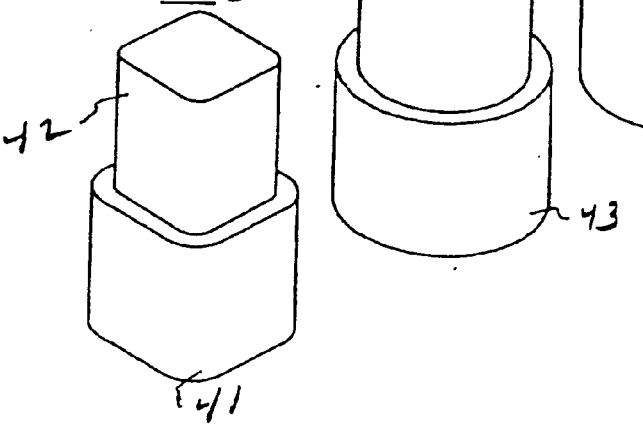


Fig 9

Fig 10

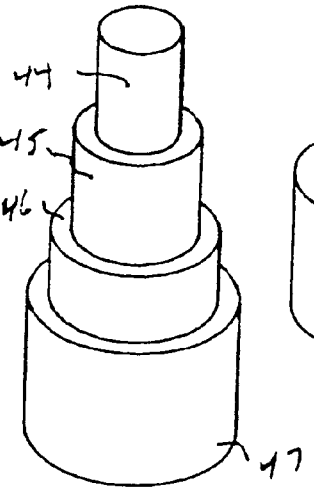


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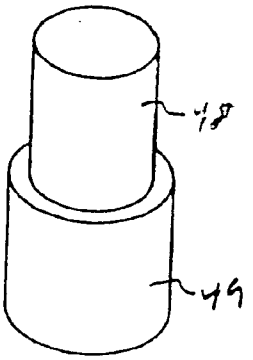


Fig 12

Fig 13

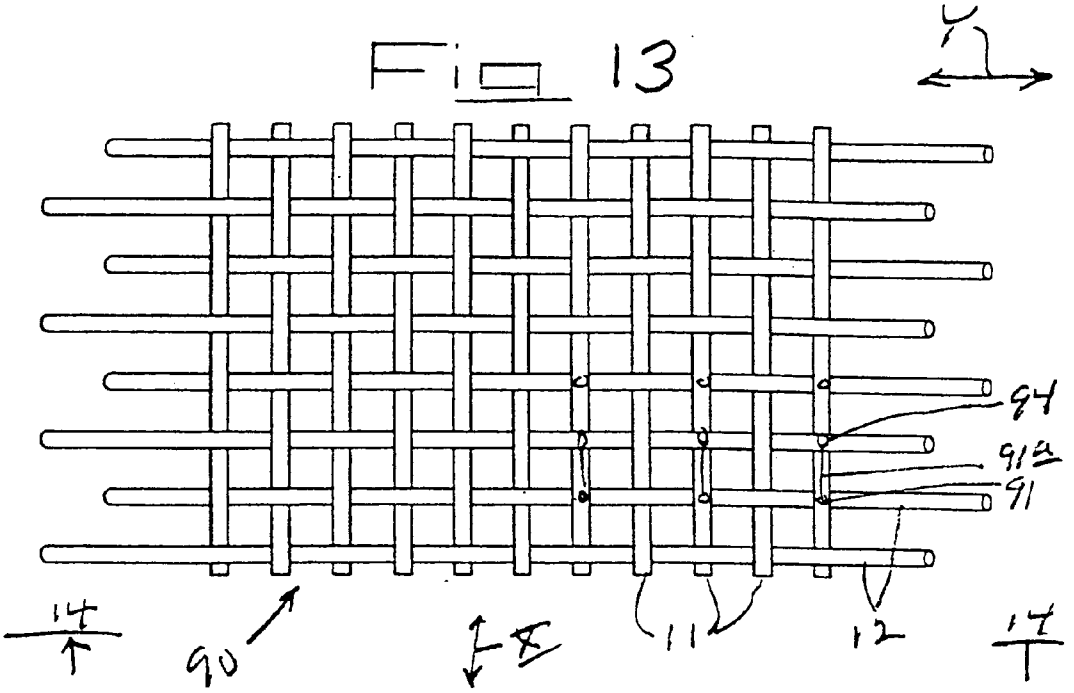


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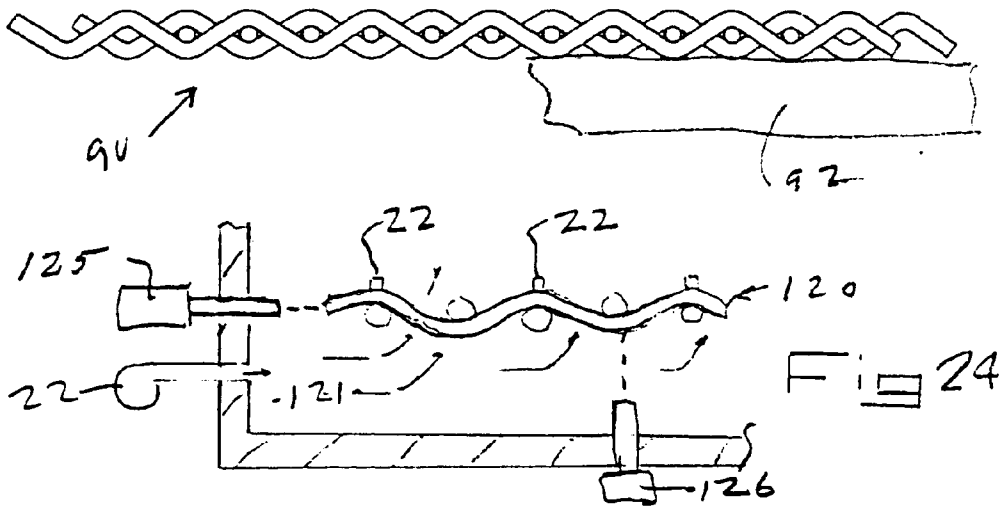


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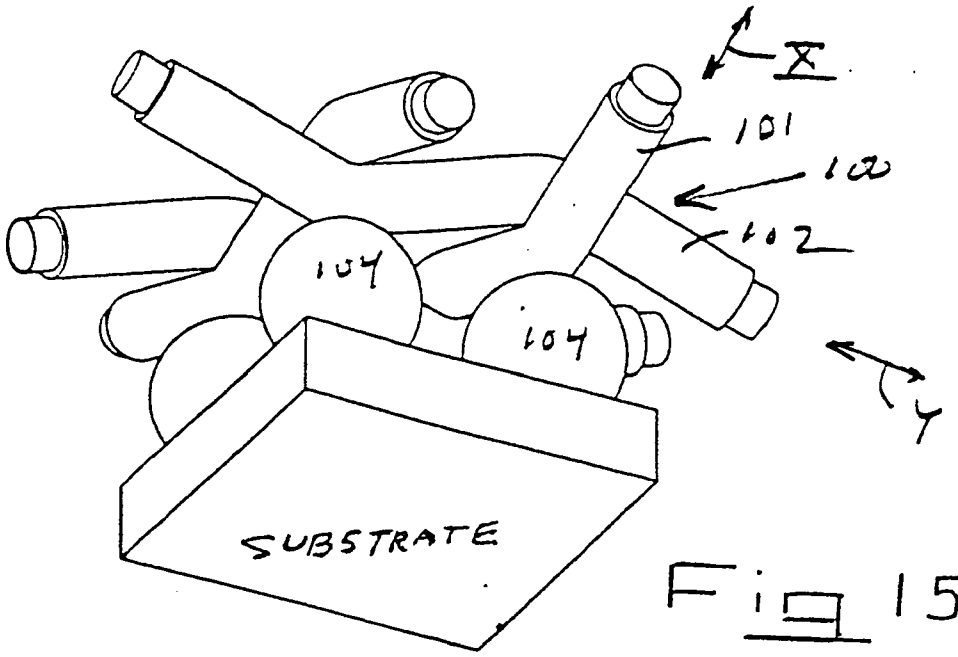


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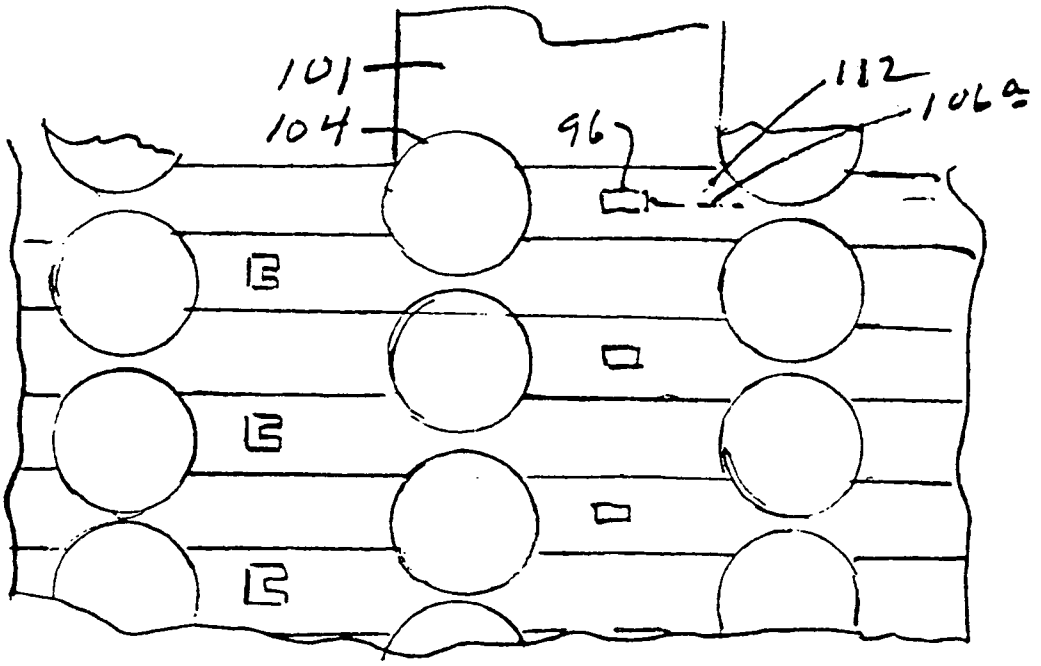


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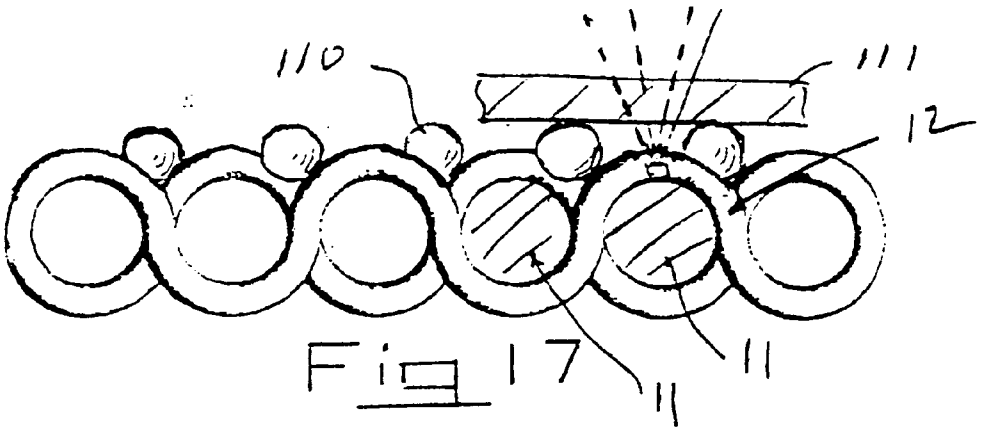


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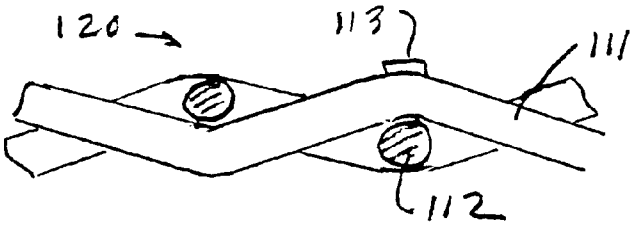


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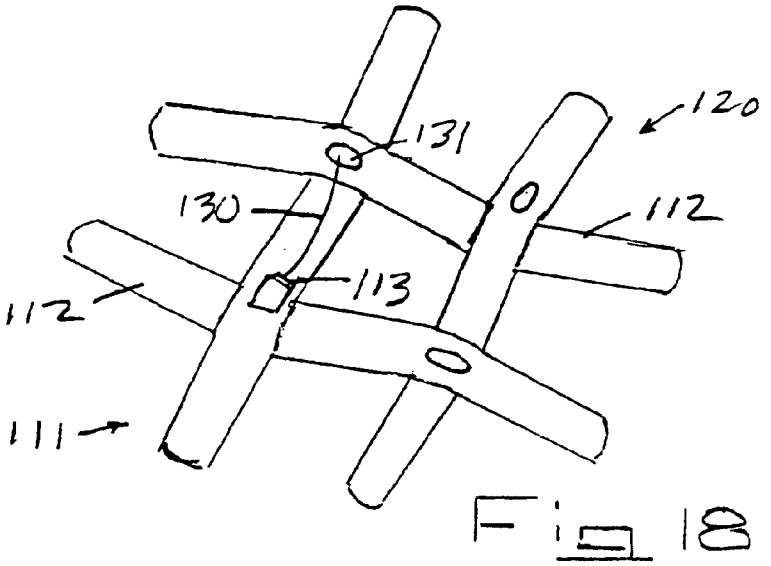
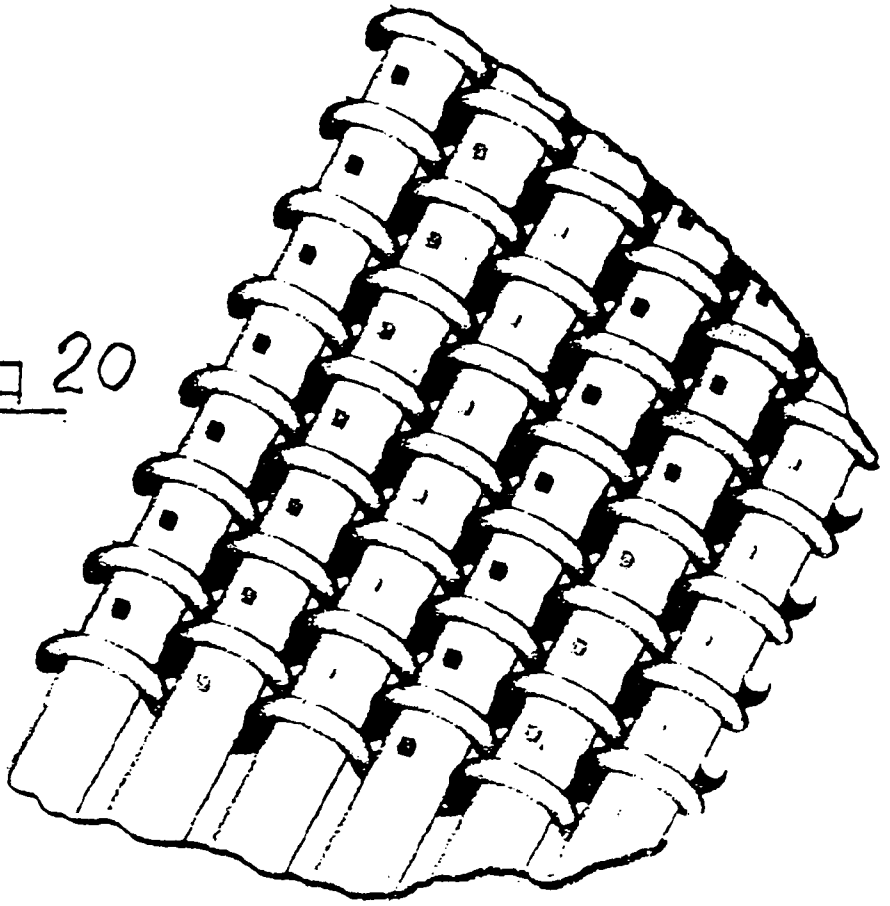


Fig 18

Fig 20



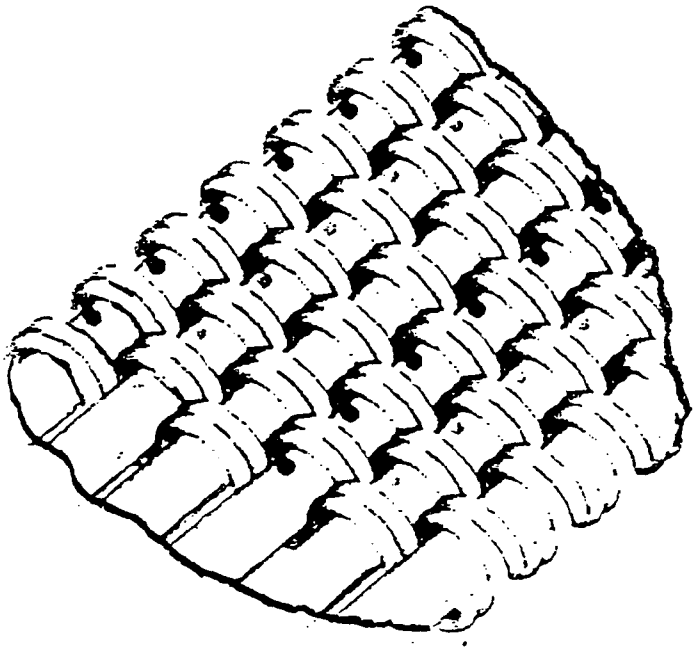


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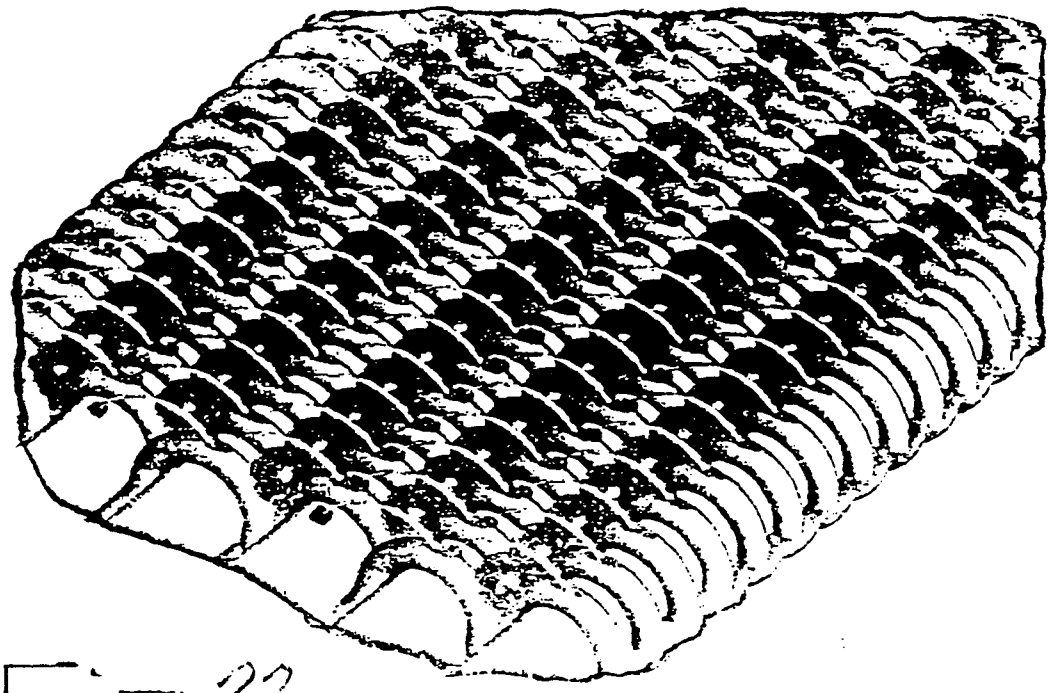


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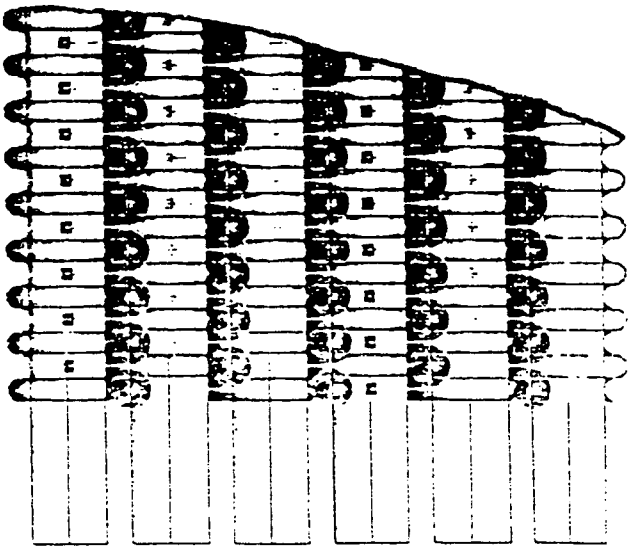


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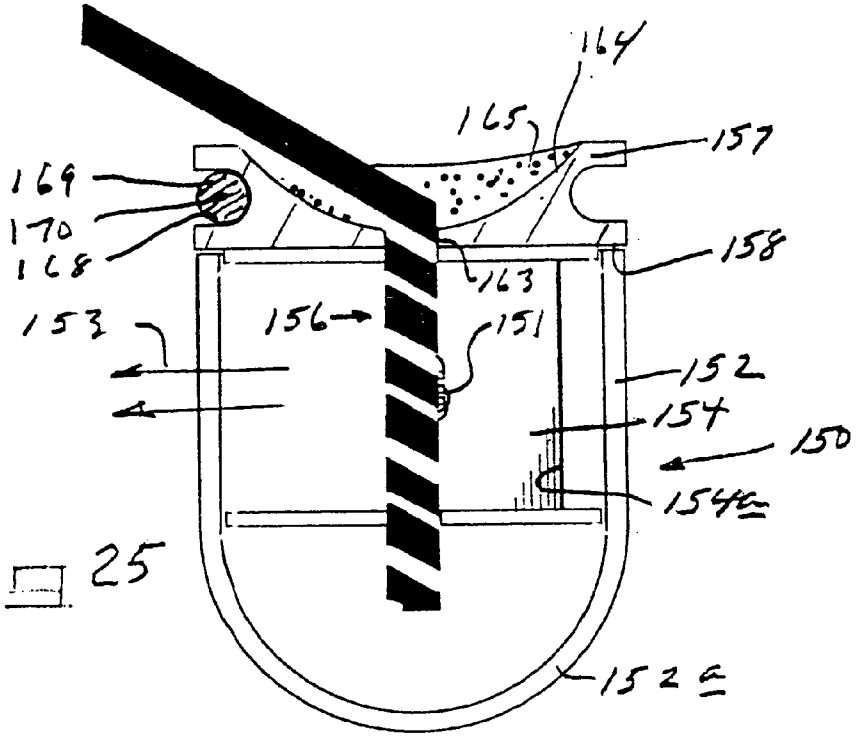


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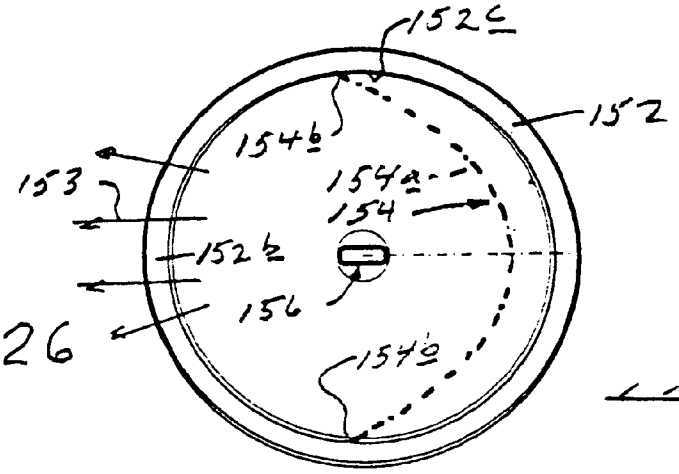
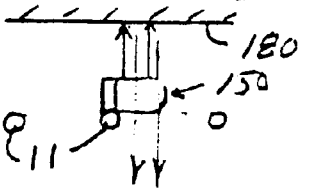


Fig 26

Fig 29



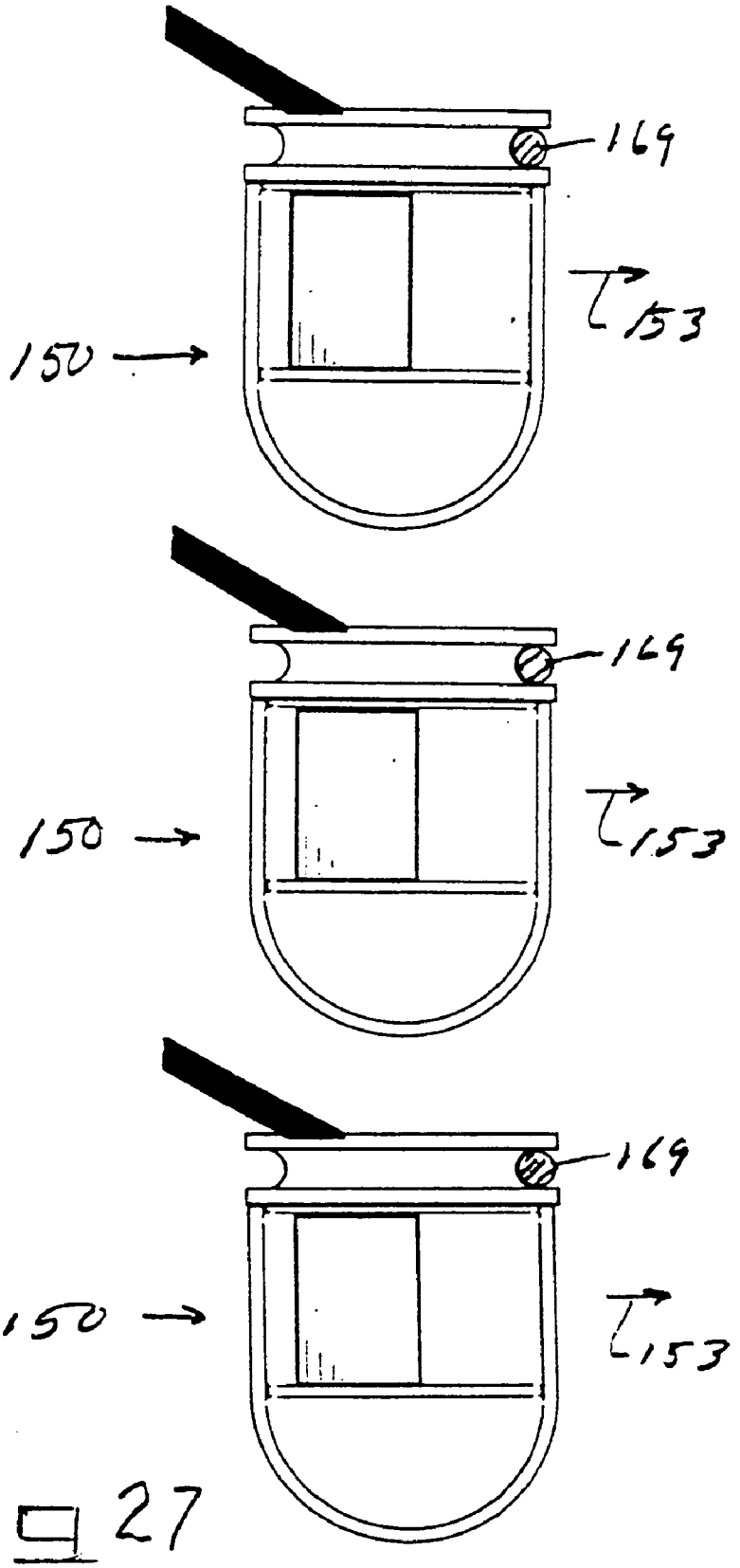


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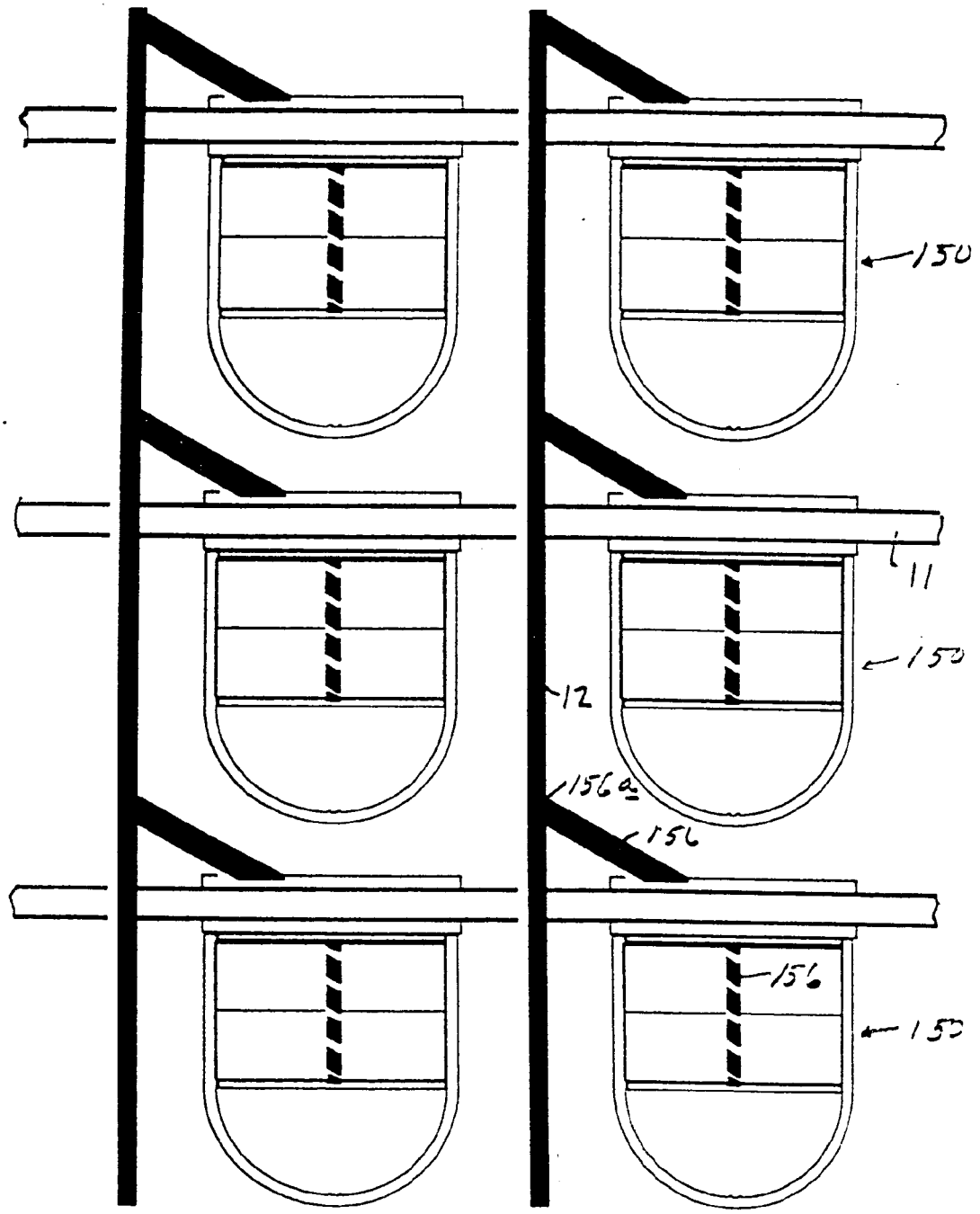


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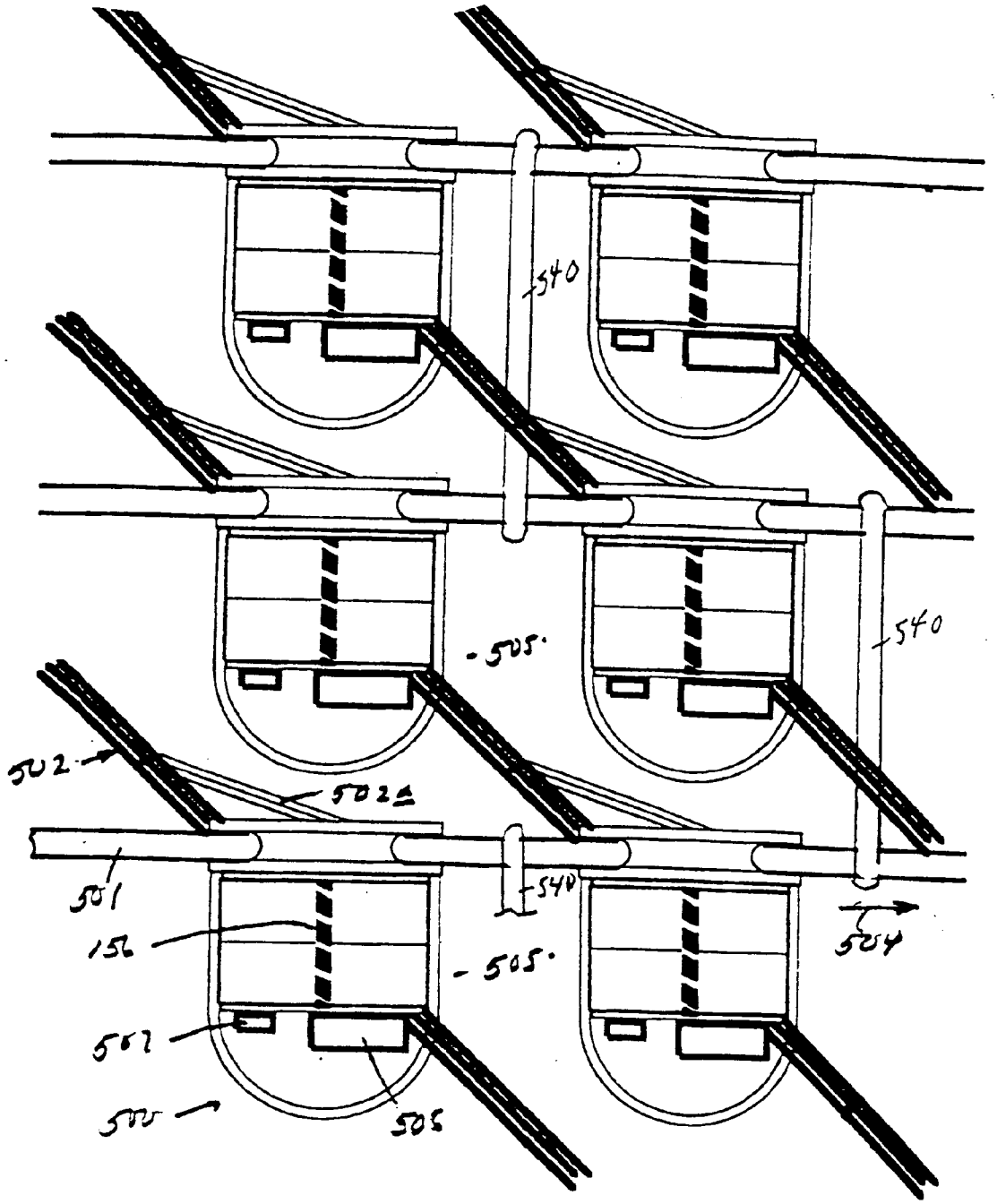


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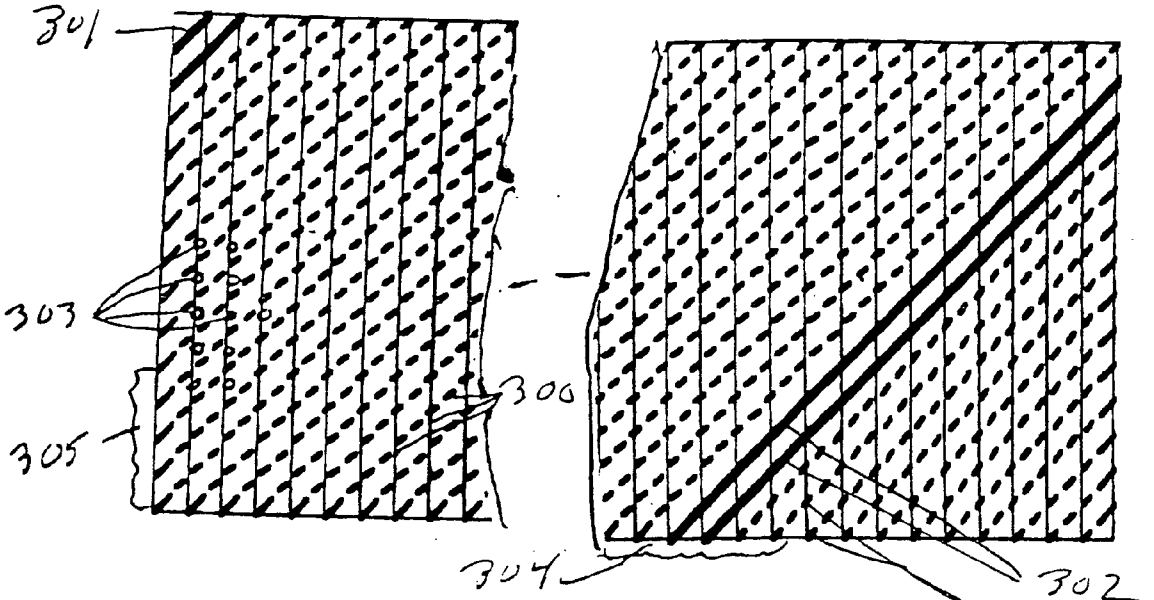

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302a

Fig 30

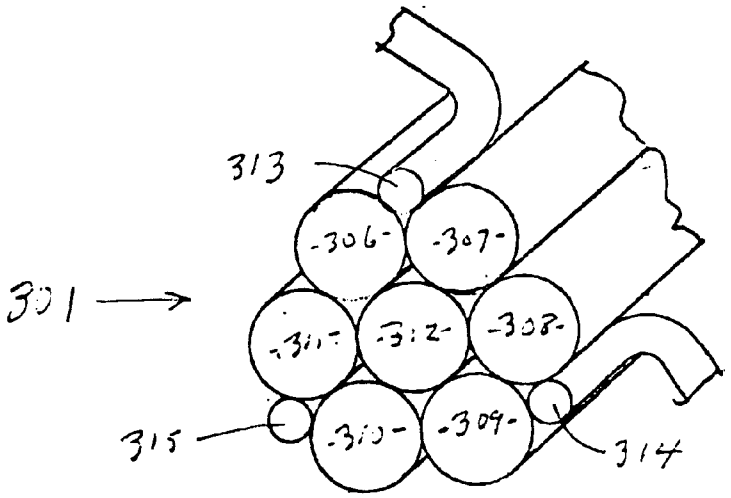

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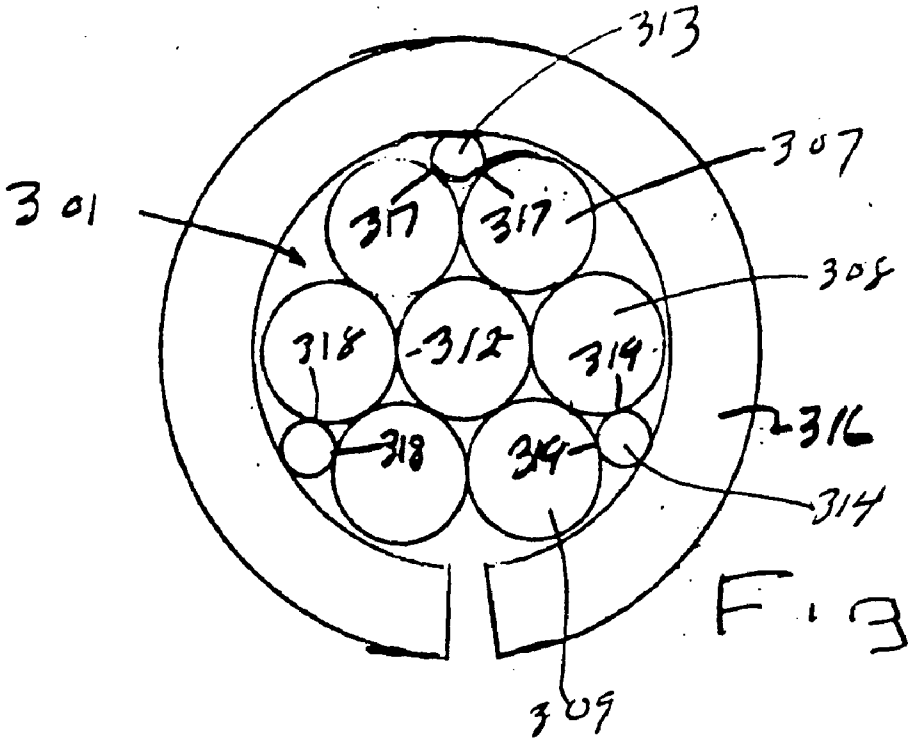

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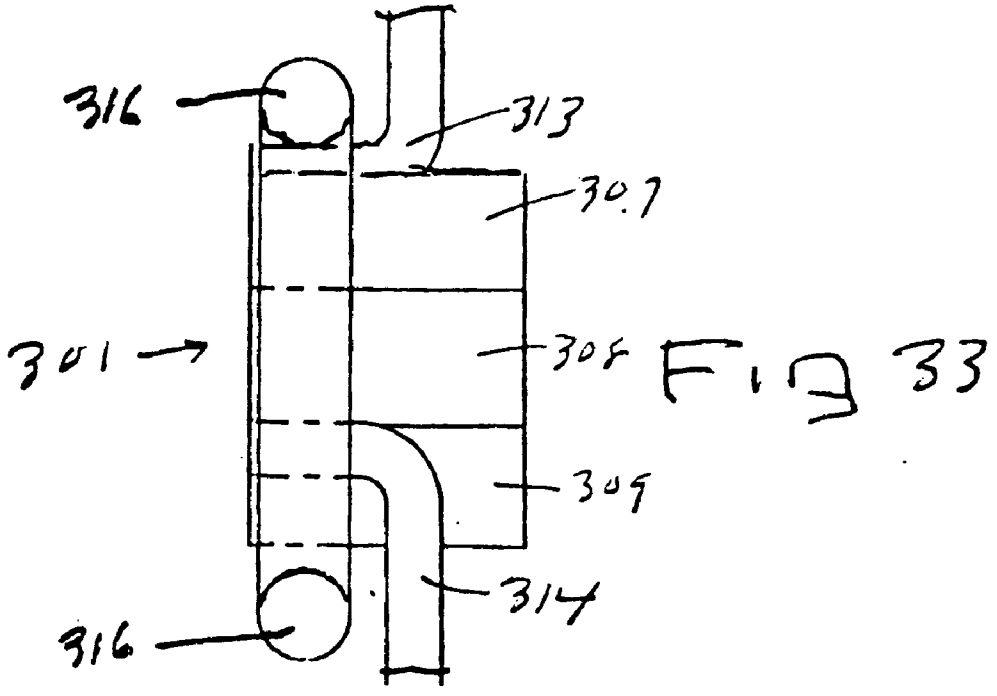

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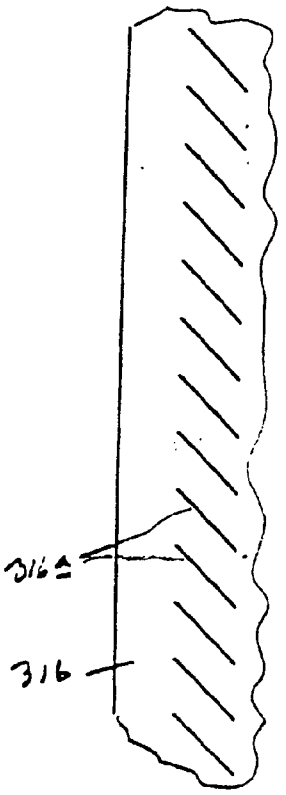


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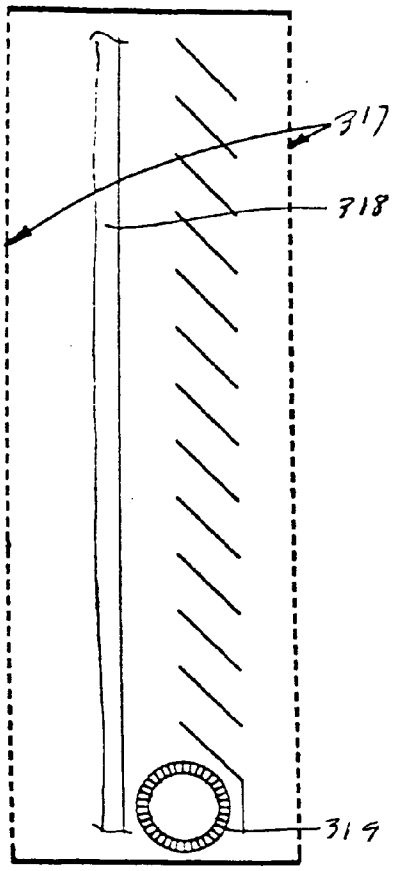
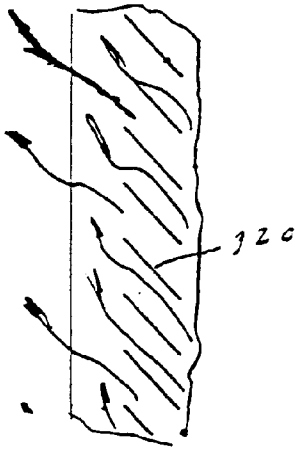


Fig 35

Fig 36



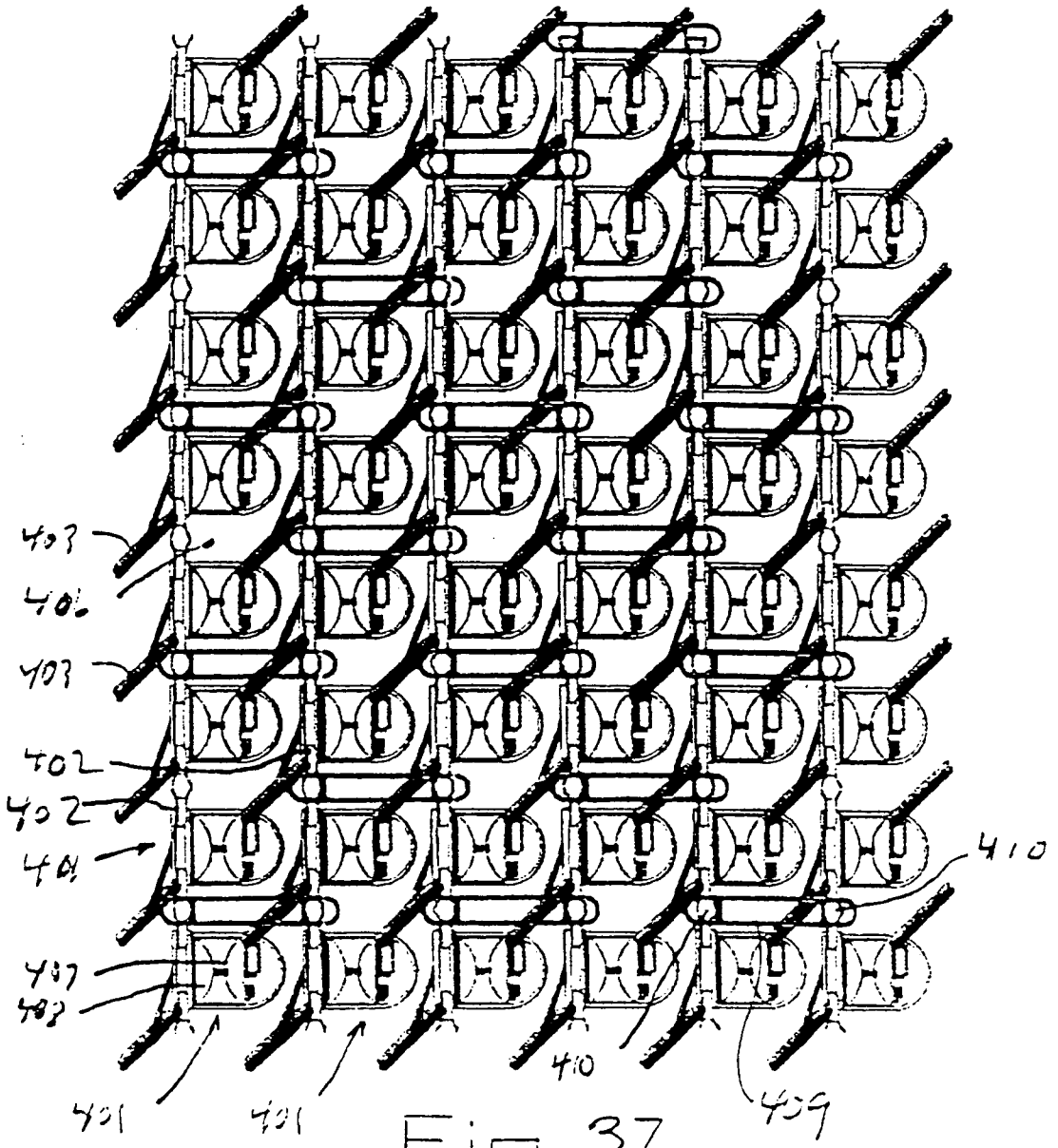


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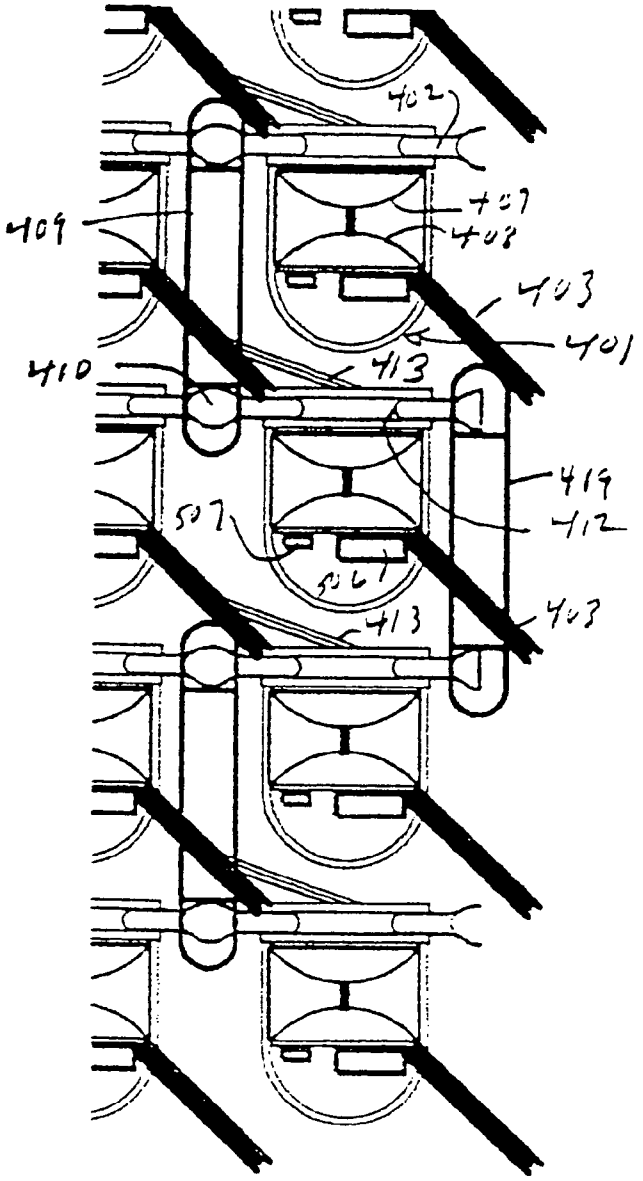


Fig 38

Fig 39

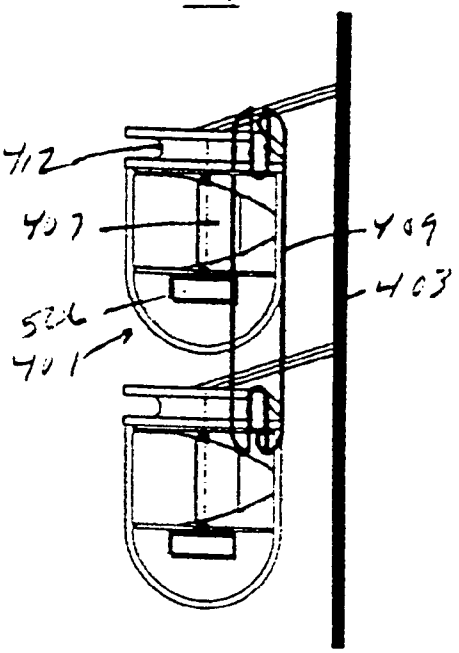
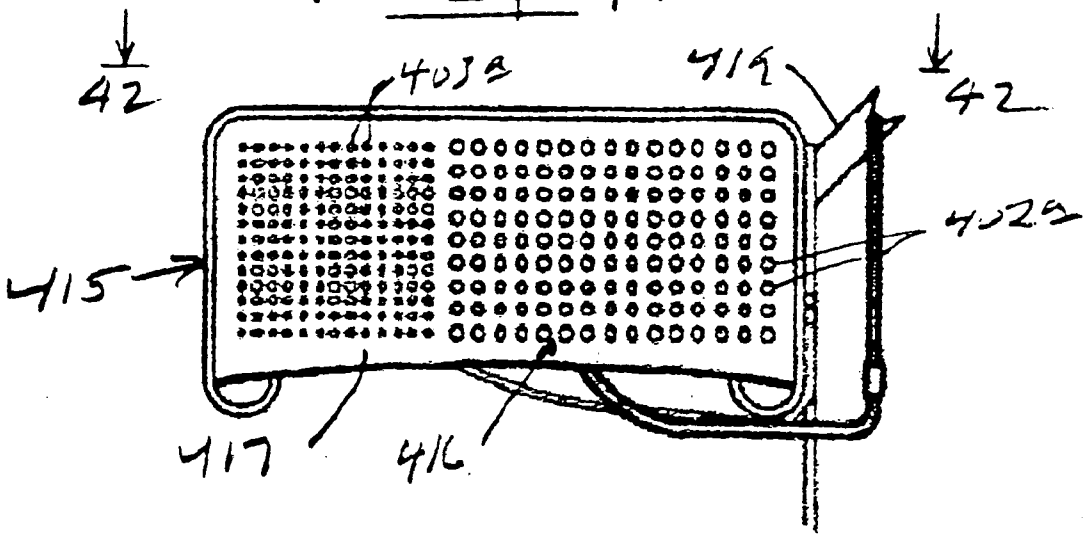


Fig 40



Fig 41



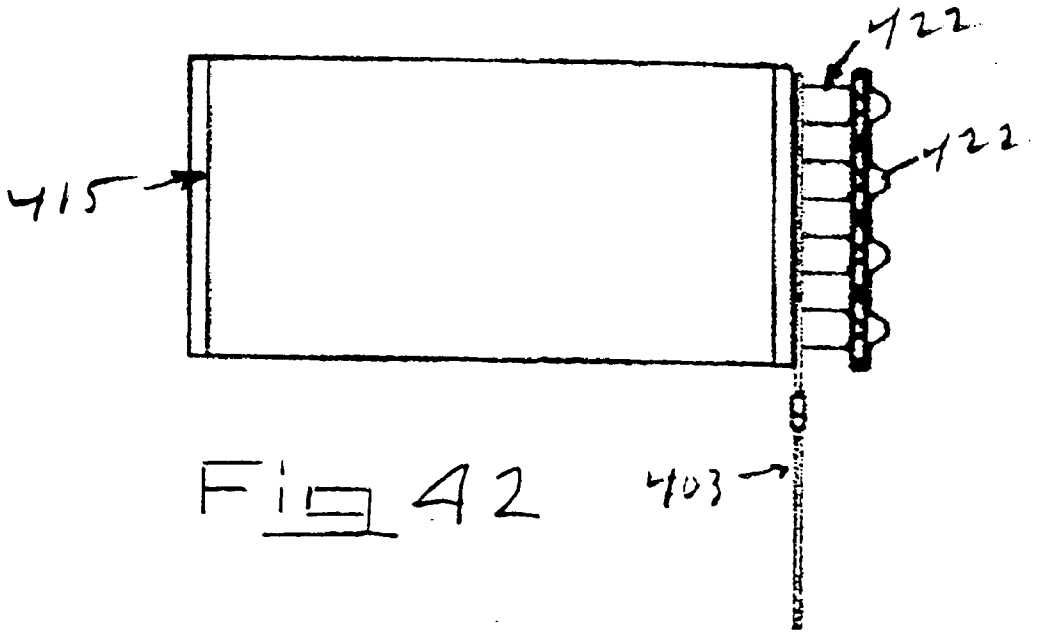


Fig 42

Fig 43

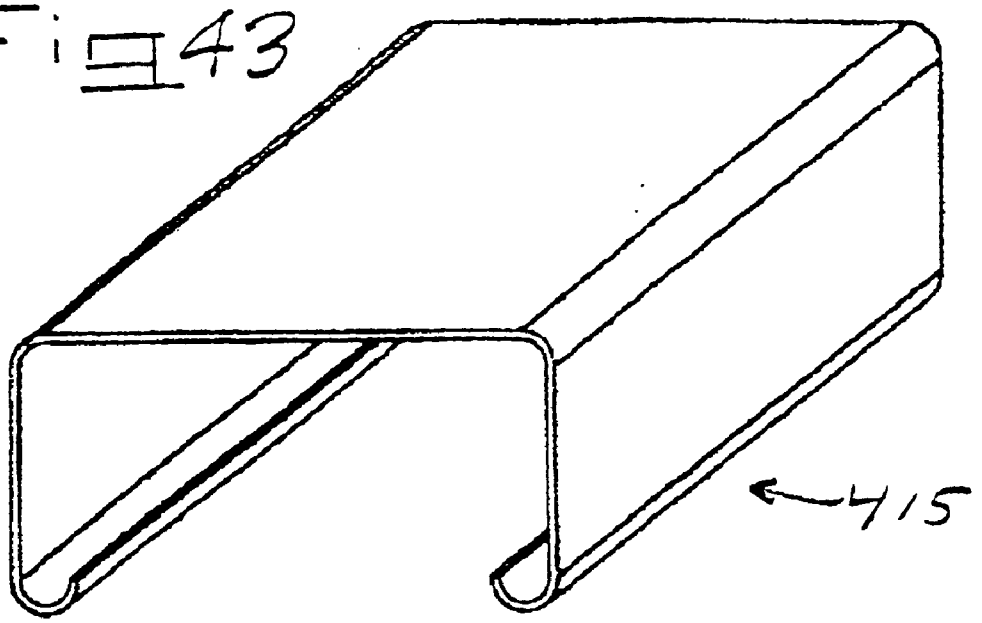
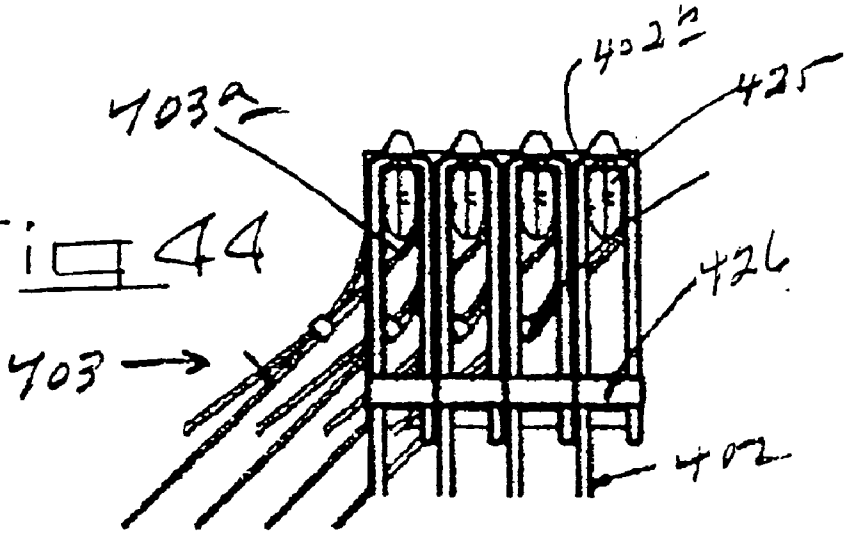


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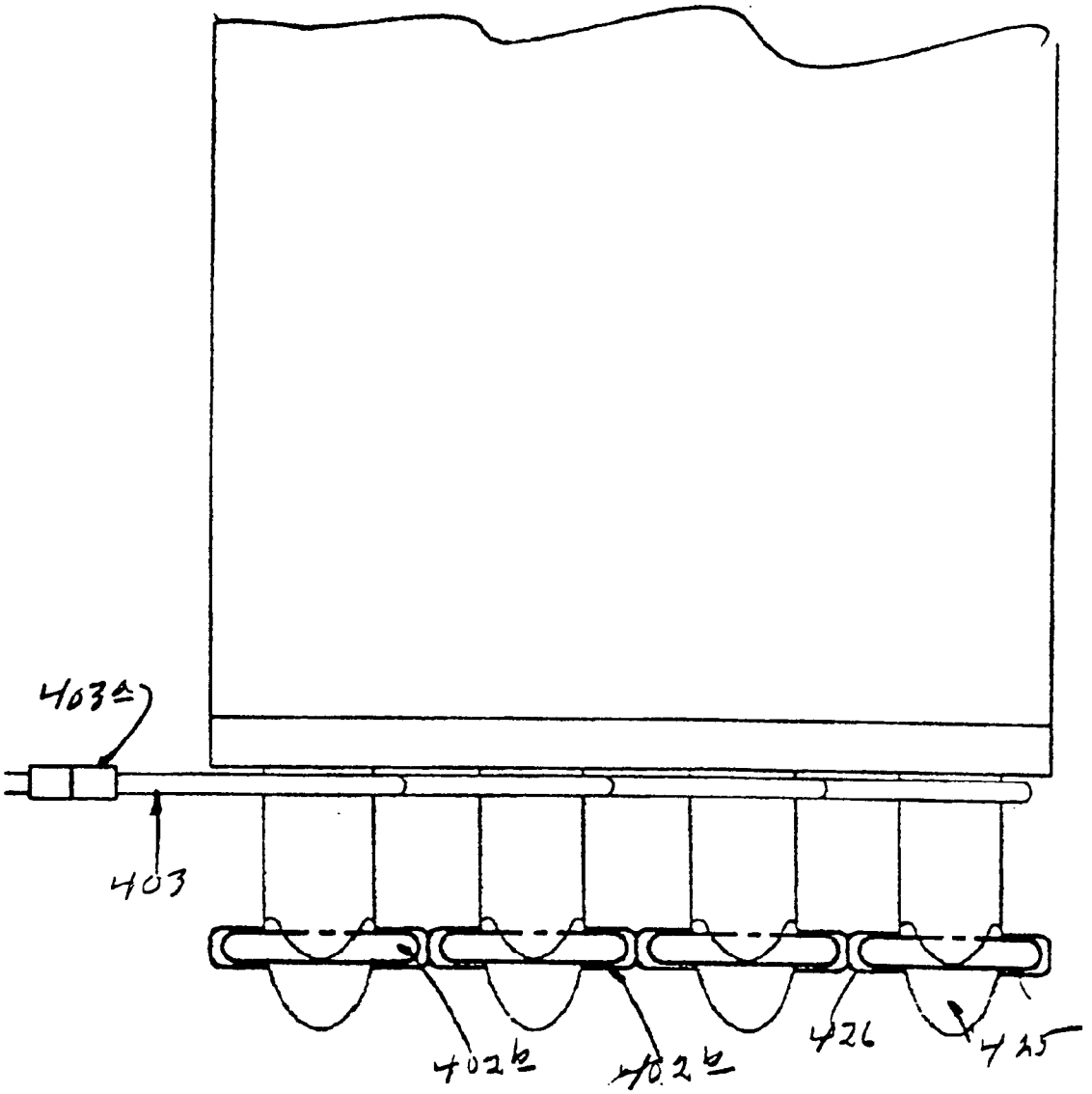


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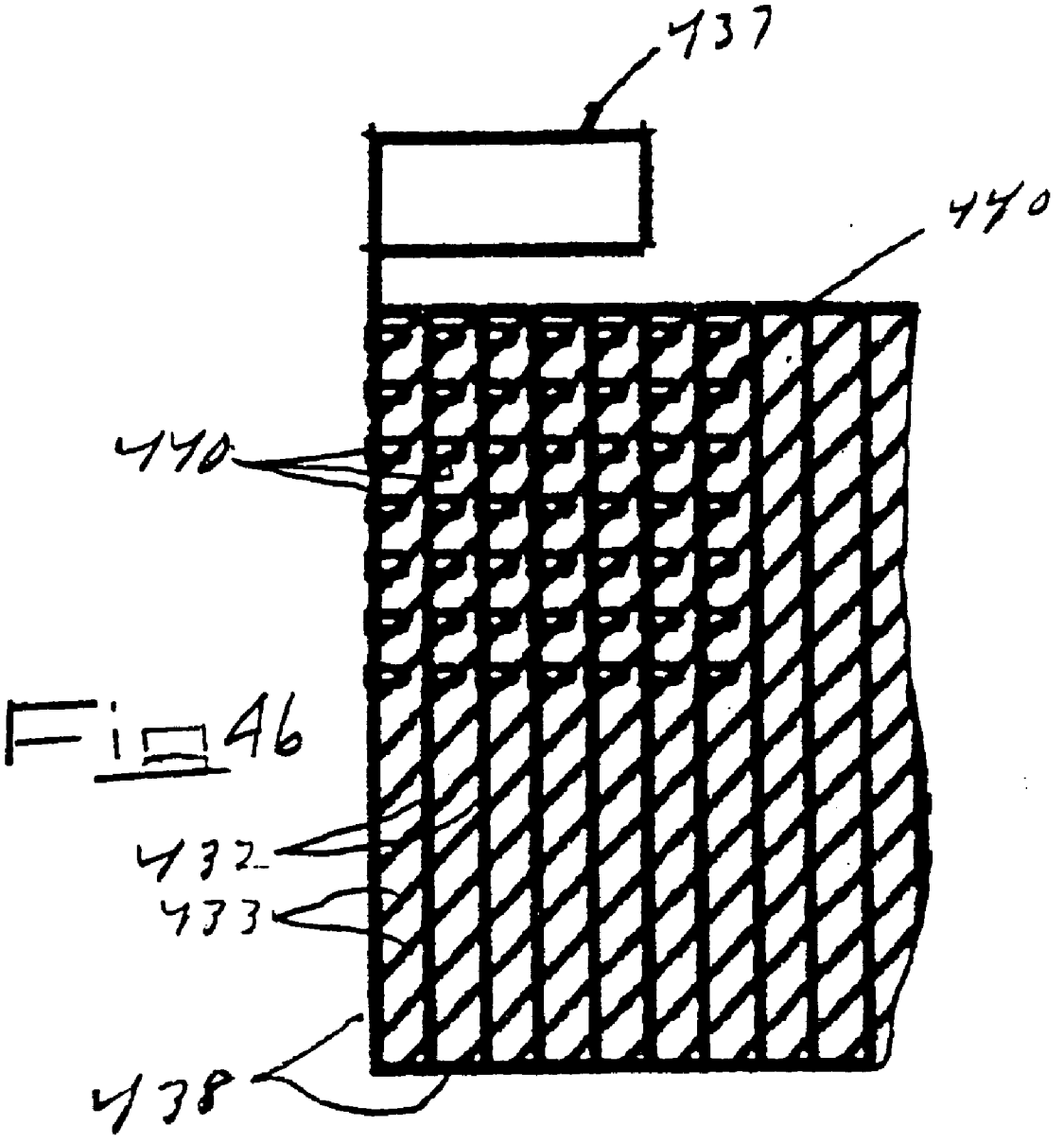


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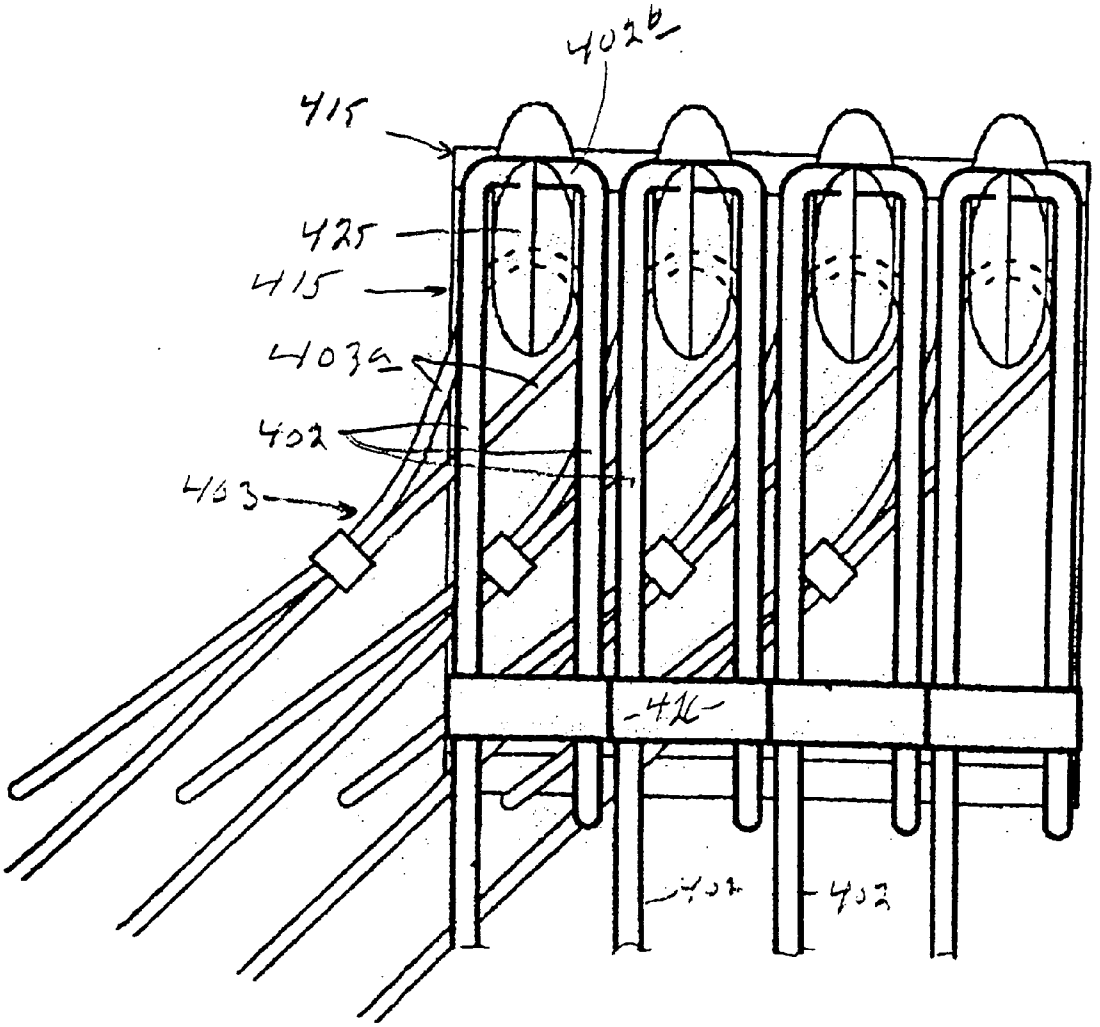


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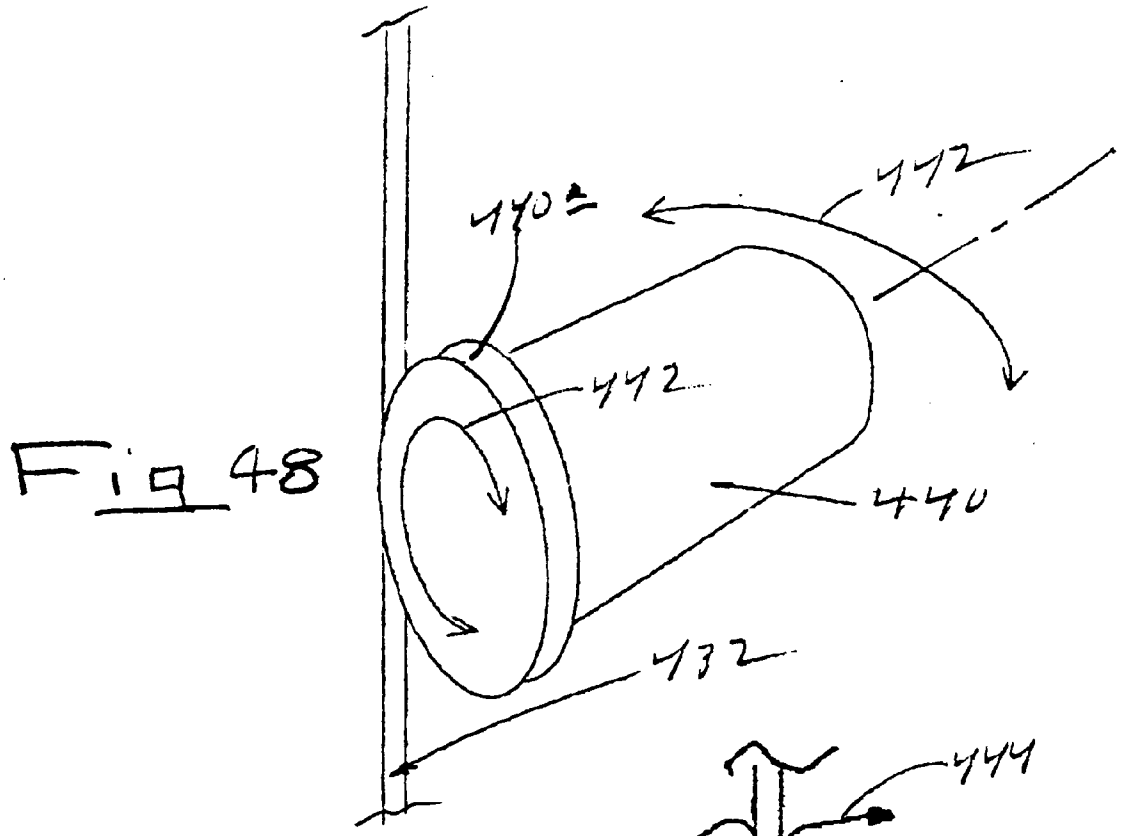


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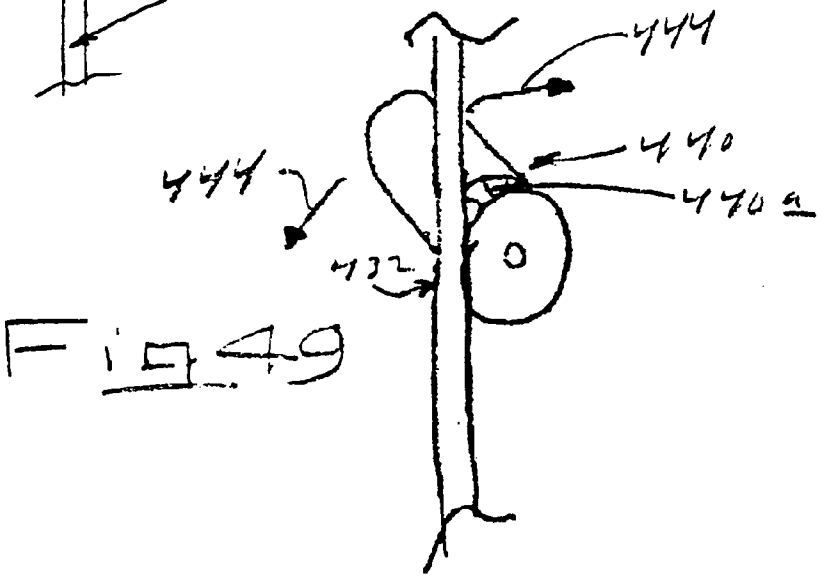


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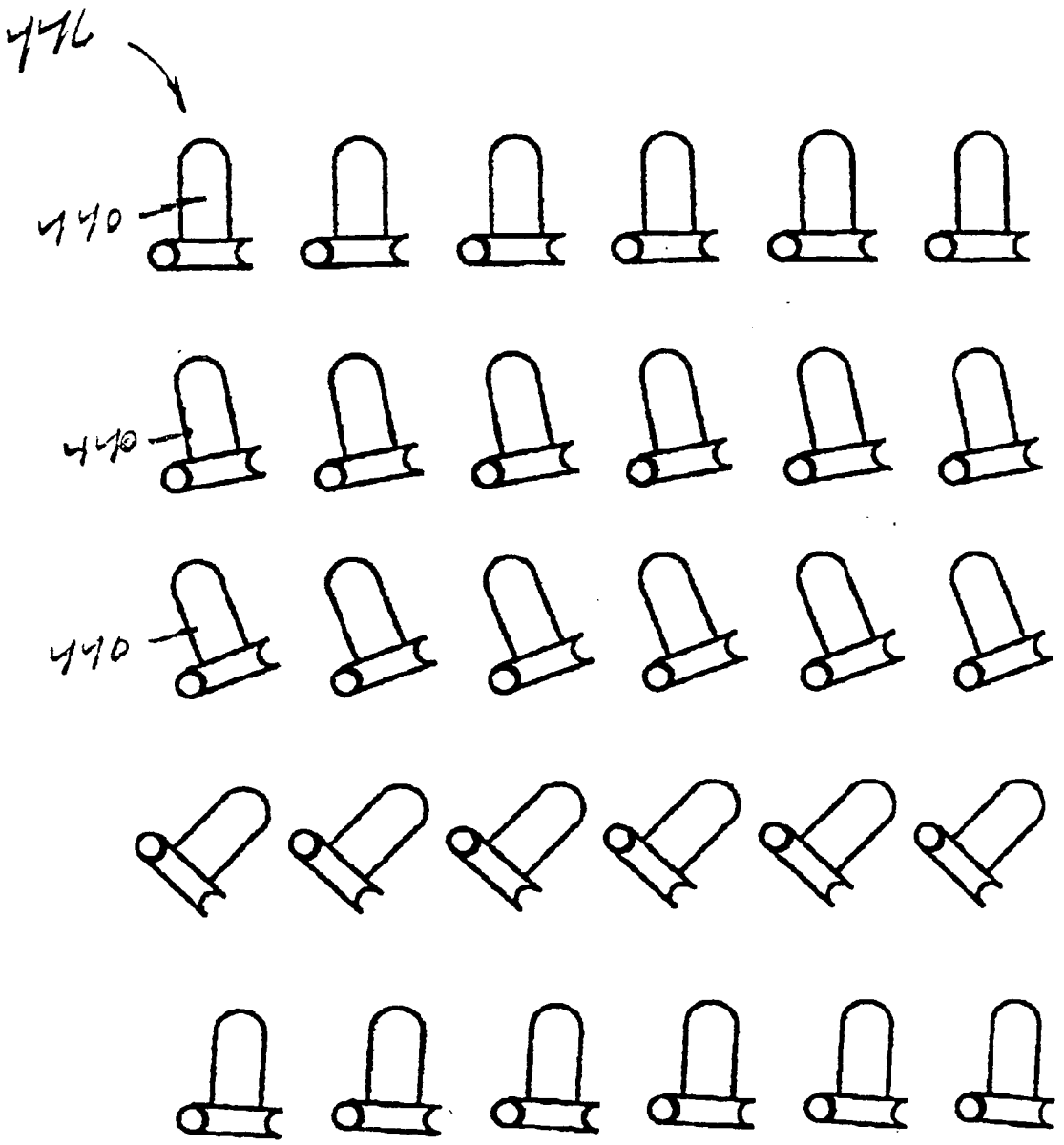


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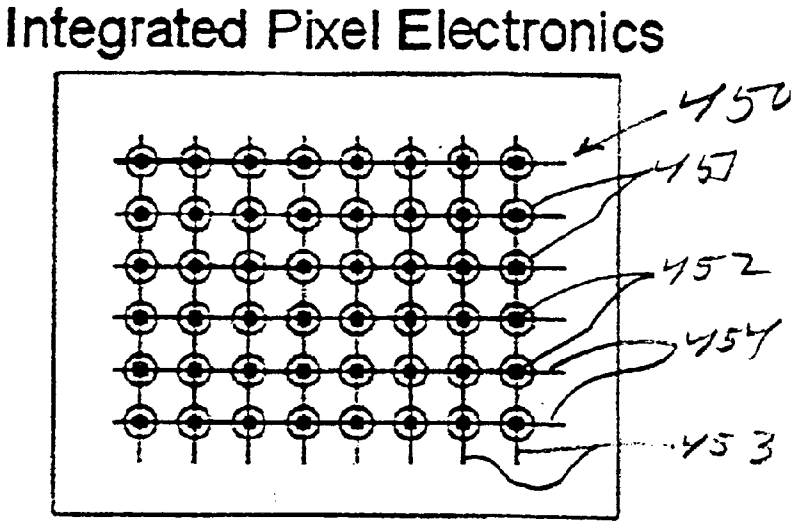

Integrated Pixel Electronics
452
457
452
454
453

Fig 51

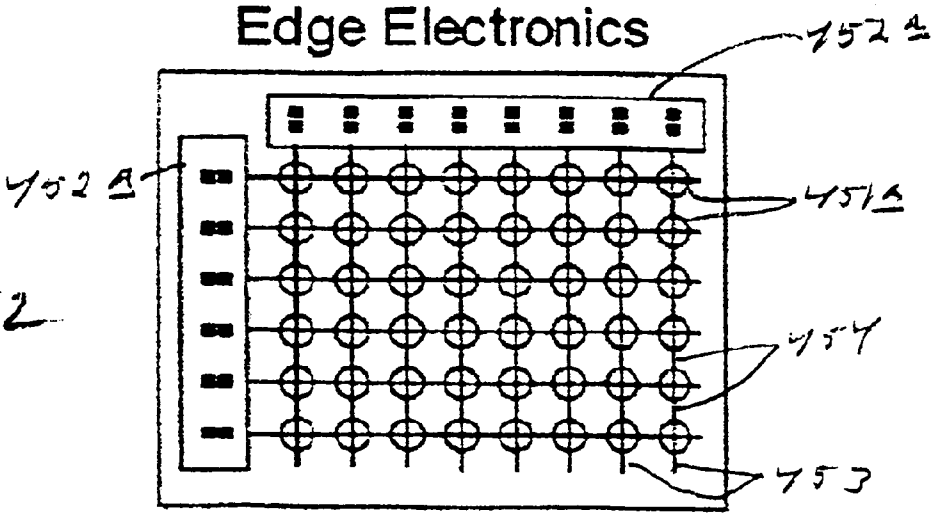

Edge Electronics
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451A
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Fig 52

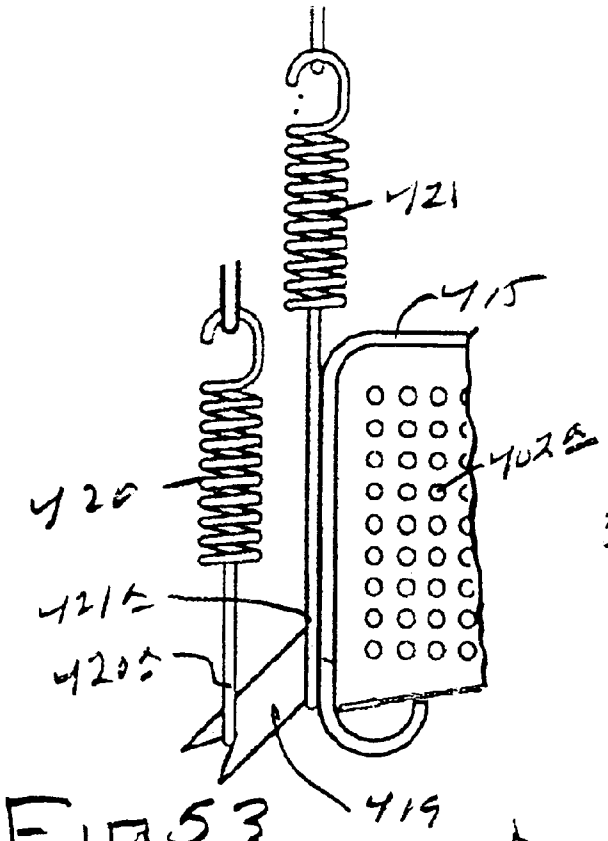


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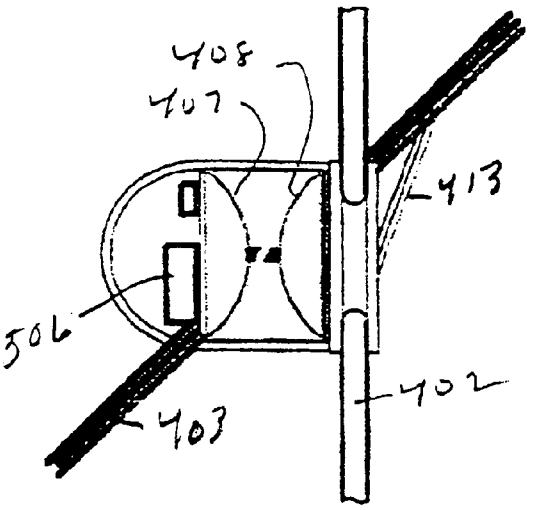


Fig 54

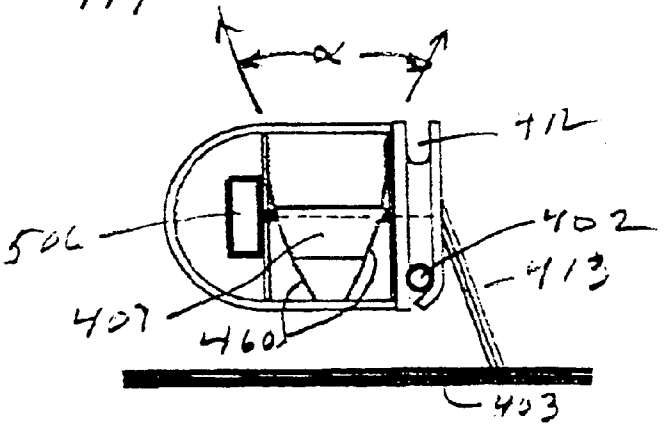


Fig 55

ELECTRONIC ASSEMBLY/SYSTEM WITH REDUCED COST, MASS, AND VOLUME AND INCREASED EFFICIENCY AND POWER DENSITY

BACKGROUND OF THE INVENTION

[0001] This application is a continuation-in-part of prior pending U.S. application Ser. No. 10/625,185 filed Jul. 23, 2003.

[0002] The methods described and claimed herein relate generally to provision of electronic-optical packages, and more particularly to provision of grids or arrays of such packages supported in such manner as to facilitate their installation and use as in closely assembled or packed configurations.

[0003] Large-scale LED displays are typified by the use of T 1¾ (5 mm) packaged LEDs soldered to rigid printed circuit boards. Such circuit board/modules typically contain a large number of LEDs and must be replaced to correct for the failure of even a single LED. In addition to cost, weight and volume issues or problems, these displays are limited in resolution as a result of the LED package size (typically 0.2 inches in diameter), or about 300 times the plan form area of a bare LED (8000 times the volume), and they are limited in brightness by the small number of LEDs that can be placed in a given area, and also by the thermal resistance of the package and module design. The resolution limit is a function of spacing that is further restricted by package (LED) size. The brightness limit is a function of the number of LEDs per unit area and their individual light output, which is further dependent on the thermal resistance between the LED junction and the local environment. Also, existing LED signage and displays have limited ability to tailor the radiation emission pattern to the needs of the target/audience and thereby increase efficiency. Increased efficiency allows for reduced system and operating cost and/or more radiation delivered to the target.

[0004] There is need for improvements in the provision and operation of LED display assemblies that overcome problems of heating and inability to adequately transfer or dispose of heat generated by LED operation; problems of inadequate LED support on substrates or circuit boards; problems resulting from lack of flexibility of the LED support means; difficulties in manufacturing close packed LED displays; and other problems and difficulties as will appear.

SUMMARY OF THE INVENTION

[0005] It is a major object of the methods disclosed herein to provide ways for overcoming the above identified problems. Basically, the improved method includes:

[0006] a) forming an array, or grid of electrical conductors,

[0007] b) providing light emitting diodes located in association with the array and in electrical communication with the conductors that provide power for LED operation,

[0008] c) the array operable or operated to receive heat from the diodes during diode operation, and the array or grid configured for passing coolant fluid for transfer of heat to the fluid.

[0009] As will appear, the electrical conductors typically and advantageously may be provided in the form of insulated metallic wires which may be interwoven or configured to act as electrical and thermal conductors, and that also may serve as structural supports for arrays of LEDs. The LEDs may be selectively removed or replaced on such supports.

[0010] Another aspect of the improved method includes provision of an LED supporting means, such as a grid characterized by ease of conformance to selected shape, curvature, or complex configuration after the LED array is attached to the grid, the grid having flexibility to enable such compliance to desired shaping.

[0011] Another object is to effect and/or guide flow of coolant fluid through or along a shape compliant screen incorporating such LEDs. In this regard, the screen is amenable to fitting to

[0012] i) a substrate on which LED bases are placed, and/or

[0013] ii) a superstrate provided in association with the screen and LEDs, to provide structural strength to the assembly.

[0014] Yet another aspect of the improved is to provide a first protective sheet facing the diodes to pass light emitted by the diode array; and to provide a second sheet at the opposite side of the screen and diodes, the first and second sheets forming an enclosure within which coolant fluid is flowable. The screen itself may be dark or darkened to increase viewing contrast with the LED array, during its operation.

[0015] A further feature is provision of the electrical conductors to include primary conductors extending generally in one direction, and secondary conductors extending generally in another direction, the LEDs mounted on the primary conductors, and having terminals extending to the secondary conductors for electrical association thereto. In this regard, secondary conductors are typically provided to have one of the following:

[0016] i) substantial spacing therebetween to pass coolant fluid through the screen,

[0017] ii) reduced spacing therebetween, to pass coolant fluid primarily parallel to the screen,

[0018] iii) cross sections which are substantially less than the cross sections of primary conductors which support diodes,

[0019] iv) junctions with diode wires.

[0020] Yet another feature is provision of a screen display incorporating diodes or diode devices, wherein each diode is provided to include a light emitter or emitters, a transparent container having a window area, the emitter supported within the container, and a reflector within the container to reflect emitted light toward said window. As will appear, an electrical lead or leads may be provided to extend with helical configuration within the container, such as a glass tube, to the emitter or emitters. The lead or leads may be formed to have flattened, or generally rectangular cross sections for stable support of the emitter or emitters.

[0021] The improved may include provision of a metallic base carrying the container, and through which said lead or

leads extend. The base typically is formed to have an edge portion defining a recess for reception of a support for the diode, allowing diode rotation about the support. Multiple of the diodes may be supported by a conductor or conductors in a screen, and to have their windows oriented to face in the same or selected directions. The diodes may be rotated, or be rotatable, about axes defined by their supporting conductors.

[0022] Additional features include provision of certain power providing conductors that comprise first, second, and third pairs of wires to transmit electrical energization to red, green and blue LED pixels, respectively; provision of LED primary, secondary and tertiary wires electrically connected to the red, green and blue pixels, respectively, said primary wires clamp connected to said first pair of wires, said secondary wires clamp connected to said second pair of wires, and said tertiary wires clamp connected to said third pair of wires; provision for clamped nesting of such primary, secondary and tertiary wires; provision of certain conductors that extend at an acute angle or angles relative to others of said conductors; provision of protector means such as a plate or plate, or a screen or screens at the front or rear of the grid, and with air passing openings, as will appear.

[0023] The method as disclosed also includes:

[0024] a) providing multiple LEDs in a display array, and

[0025] b) selectively electrically energizing the LEDs in the array to adjust the display,

[0026] c) cooling the display array.

[0027] A further aspect of the includes selectively adjusting the positioning of the LEDs in the array to controllably vary the overall display.

[0028] These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following specification and drawings, in which:

DRAWING DESCRIPTION

[0029] **FIG. 1** is a perspective view showing provision of one form of grid or screen incorporating LEDs, and **FIG. 1*a*** is similar but shows coolant flow through the screen;

[0030] **FIG. 2** is a perspective view showing provision of another form of grid or screen incorporating LEDs, and showing coolant flow primarily adjacent and across the screen and diodes;

[0031] **FIG. 3** is a view like **FIG. 2** but showing coolant flow primarily through the screen and past diodes;

[0032] **FIG. 4** is a top plan view of an array of diodes on a screen similar to that of **FIG. 1**, and showing open spaces between conductors to pass coolant fluids;

[0033] **FIG. 5** is a top plan view of an array of diodes on a screen, similar to that of **FIG. 2**, the conductors provided in closely packed relation;

[0034] **FIG. 6** is a view like that of **FIG. 5**, but showing a different configuring of electrical conductors;

[0035] **FIGS. 7 and 8** are perspective views of two different forms of LEDs as provided;

[0036] **FIGS. 9-12** are perspective views of sections of electrical conductors as provided;

[0037] **FIG. 13** shows weaving of electrical conductors;

[0038] **FIG. 14** is an edge view taken on lines **14-14** of **FIG. 13**;

[0039] **FIG. 15** is a perspective view of a ball grid connection to a screen;

[0040] **FIG. 16** is a plan view of a ball grid connection to a screen;

[0041] **FIG. 17** is an elevation showing a ball grid connection to a screen;

[0042] **FIG. 18** is a perspective view showing yet another screen configuration;

[0043] **FIG. 19** is an edge view of the screen of **FIG. 18**; and

[0044] **FIGS. 20-23** show arrangements of electrical conductors forming screens, and arrays of LEDs mounted thereon;

[0045] **FIG. 24** is a view showing screen cooling;

[0046] **FIG. 25** is a section taken through an LED package as provided;

[0047] **FIG. 26** is a section taken on lines **26-26** of **FIG. 25**;

[0048] **FIG. 27** is a view showing a display provided to embody multiple LED packages of the type shown in **FIGS. 25 and 26**;

[0049] **FIG. 28** is a view showing a display provided to embody multiple LED packages as shown in **FIGS. 25 and 26**, the packages mounted on a conductor screen of the type shown in **FIG. 1**; and **FIG. 28*a*** is a modification;

[0050] **FIG. 29** shows an LED package mounted on a screen conductor and transmitting light to a reflector;

[0051] **FIG. 30** is a schematic diagram of a sign that incorporates the LED supporting grid, and with address wires provided to extend at acute angles;

[0052] **FIG. 31** is a perspective view of a wire bundle as provided;

[0053] **FIG. 32** is a cross section taken through the **FIG. 31** wire bundle;

[0054] **FIG. 33** is a section taken on lines **33-33** of **FIG. 32**;

[0055] **FIG. 34** is a view of protective metallic plate, with air passing openings;

[0056] **FIG. 35** is a section taken through a grid as described, with protective mesh at front and rear sides thereof;

[0057] **FIG. 36** is a view like **FIG. 35**, showing use of air passing louvers;

[0058] **FIG. 37** is a plan view showing multiple light emitter packages supported by wires, in an array;

[0059] **FIG. 38** is an enlarged view of a portion of the **FIG. 37** array;

[0060] **FIG. 39** is a view of two light emitter packages in **FIG. 38**, but in rotated positions;

[0061] **FIG. 40** is an end view of a connector as shown in **FIGS. 38 and 39**;

[0062] **FIG. 41** is an end view of a conductor conduit supporting conductor wire terminal holders;

[0063] **FIG. 42** is a top plan view taken on lines **42-42** of **FIG. 41**;

[0064] **FIG. 43** is a perspective view of a conductor wire channel, as also seen in **FIG. 41**;

[0065] **FIG. 44** is a view showing retraction of conductor wires;

[0066] **FIG. 45** is an enlarged and rotated view of **FIG. 42**;

[0067] **FIG. 46** is a front elevation showing locations of pixel packages on a fragmentary grid of addressing wires arrayed at 45° relative to conductor wires;

[0068] **FIG. 47** is an enlarged view, like **FIG. 44**, but taken at the opposite end of the grid;

[0069] **FIG. 48** is a schematic perspective view showing pixel package adjustment rotation about the package axes;

[0070] **FIG. 49** is a schematic perspective view showing pixel package with adjustment rotation capacity about the axis of the package supporting conductor;

[0071] **FIG. 50** shows in schematic form a representative grid having supporting wires or conductors, and pixel packages adjusted at different angles, as for use in a billboard;

[0072] **FIG. 51** is a schematic view showing pixel packages on a grid, and with control electronic circuitry integrated into the packages;

[0073] **FIG. 52** is a schematic view like **FIG. 51**, with control circuitry in zones or modules at edges of the grid;

[0074] **FIG. 53** is a fragmentary view showing wire conduit wire conduit tensioning;

[0075] **FIG. 54** is a schematic view showing use of bowed end wall mirrors in a pixel package;

[0076] **FIG. 55** is a view like **FIG. 54**, but rotated 90° about the package axis.

DETAILED DESCRIPTION

[0077] **FIG. 1** shows a screen **10** forming a grid of electrical conductors. As illustrated, the conductors include like primary conductors **11** extending generally in one direction, and designated as an X-direction; and secondary conductors **12** extending generally in another direction, designated as a Y-direction. As shown, the primary conductors preferably have overall diameters d_1 or cross sections greater than the overall diameters d_2 or cross sections of the secondary conductors, and the latter extend over and under the conductor **11** in a weaving or mesh relationship as at **12***a* and **12***a*'. There is space as at **15** between successive parallel conductors **11**; and there is space as at **16** between successive undulating conductors **12**, whereby coolant can flow downwardly through the screen via spaces **15** and **16** and near or adjacent diodes, to remove heat generated by diode operation.

[0078] Light emitting diodes are located or mounted in an array on various conductors, as shown on crests of conductor **12**, and in such manner that each diode is in electrical communication with two conductors, establishing a circuit path from a conductor **11** to a conductor **12**, via the diode internal circuit. See conductor energization controls **20** and **21** for two representation diodes **22** and **23**, with circuit paths (for diode **22**) at **24**, **11***a*, **22**, **25**, junction **26**, **12***a*, **12***b* and **27**; and circuit paths (for diode **23**) at **28**, **11***b*, **23**, **29**, junction **30**, **12***a*, **12***b*, and **29**. Controls **20** and **29** are interconnected so that diodes **22** and **23** can be selectively energized in timed relation. Diode **22** is mounted on the top side or crest of conductor **11***a*, and diode **23** is mounted on the top side of conductor **1***b*. Other diodes as shown are similarly mounted and selectively controlled by controls indicated in bank **31**, controls **20** and **21** considered as part of that bank. Electrical connections to metallic wires in the conductors are made by removal of or penetration through conductor insulation. Wires **25** and **29** extend in the Y-direction, and may be insulated. Junctions as at **26** and **30** are provided on all crests of secondary conductors **12**, and all LEDs are mounted on conductors **11**, and protectively between sequential crests of conductors **12**.

[0079] The electrical conductors may comprise insulated metal wires that act as electrical and thermal conductors and that also serve as structural load conductors, for arrays of such diodes. See for example **FIG. 9** showing metallic conductor **40** having a square cross section, and a layer **41** of dielectric insulation thereon; **FIG. 10** showing metallic conductor **42** having tubular cross section with bore **42***a*, and a cylindrical layer **43** of insulation thereon; **FIG. 11** showing circular cross section metallic wire at **44**, tubular insulation layer **45**, tubular cross section metallic wire **46**, and tubular layer of insulation **47**; and **FIG. 12** showing solid metallic wire **48** and insulation **49** thereon, **48** being circular and **49** being tubular. **FIG. 7** shows a six-sided LED body **80** with electrical terminal areas **81** and **82**; and **FIG. 8** shows a similar LED body with terminal areas **83** and **84**.

[0080] **FIG. 1***a* is like **FIG. 1**, showing an array of LEDs **23** and **24** staggered in the Y-direction at one side of the screen defined by the interwoven conductors **11** and **12**. Coolant such as air flows at **54**, downwardly toward and over the diodes and through the screen defined by spaced conductors **11** and **12**. Air may also be caused to flow generally parallel to the screen, as in the X or Y direction, to cool the screen and diodes. Heat generated by the diodes is carried away by coolant flow. Note diode wire junctions **60** with and at the tops of the supporting conductors **12**, maximally exposed to coolant flow for heat transfer to coolant. The conductors **11** are large enough in diameter to support the mounted and exposed diodes **22** and **23** and other similar diodes, arrayed as shown.

[0081] In **FIGS. 2 and 5**, the conductors **11** are generally the same as the conductors **11** in **FIG. 1**, and are spaced apart as seen at **60**. The conductors **12** are arranged in side by side pairs, as seen for example at **12'** and **12'**, and **12"** and **12"**. Successive pairs of such conductors pass over and under conductors **11**, as shown. Like pairs **12'** pass together over a conductor **11**, along its length, and like successive pairs **12"** pass together over the next conductor **11**, along its length in staggered relation in the X-direction in relation to closest pairs **12'**; and portions of the pairs **12"** nest between portions of the pairs **12'**, at locations **62** between conductors **11**, as is

clear from **FIG. 5**. A close packed assembly is thereby achieved. As before, LEDs **23** are mounted on exposed tops of sequentially alternate conductors **11***b*; and LEDs **22** are likewise mounted on exposed tops of sequentially alternate conductors **11***a*. Each LED has a wire **63** connecting it to the top of a conductor **12** in a pair of such conductors, as at a junction as seen at **64**. Insulation is removed or penetrated to enable electrical communication between LED wire **63** and the metal wire within a conductor.

[**0082**] In **FIG. 2**, coolant is shown flowing at **66** parallel to the plane of the conductor formed screen; and in **FIG. 3**, coolant is shown flowing at **67** generally normal to the plane of the conductor formed screen, and through the screen, for removing heat from the LEDs and screen, such heat produced by LED operation. **FIG. 3** is generally like **FIG. 5**, except that the pairs of conductors **12'** and **12'** are spaced from the pairs **12"** and **12"** to form air passing openings.

[**0083**] **FIG. 4**, which is an assembly similar to that shown in **FIG. 1**, illustrates provision of spaces **66** formed between successive straight conductors **11** in the Y-direction, and between undulant over and under extending conductors **12** in the X-direction. Those spaces facilitate flow of coolant fluid through the screen or grid of conductors. The X and Y directions are substantially normal to one another.

[**0084**] It will be understood that the screen as shown facilitates its bending or warping, particularly about an axis or axes parallel to the X-direction extents of conductors **11** to conform the screen to desired shape or shapes. This may alter the perceived LED illumination emanating from different portions of the screen, as may be desired.

[**0085**] In **FIG. 6**, the conductors **11** are arranged to extend in spaced parallel relation in the X-direction, as in **FIG. 1**. Successive conductors **12** are closely packed, so that portions **12***a*' of conductors **12***a* closely nest between portions **12***b*' of conductors **12***b*, conductors **12***a* alternating between conductors **12***b*. LEDs **23** are located on the exposed tops of conductors **11***b*, whereas LEDs **22** are located on the tops of conductors **11***a* which alternate between conductors **11***b*. Wires from LEDs **22** extend to junctions **26** at the tops of conductors **12***b* overlying conductors **11***b*, whereas wires from the LEDs **23** extend to junctions **30** at the tops of conductors overlying conductors **11***a*.

[**0086**] **FIGS. 13 and 14** show a mesh **90** of interwoven conductors **11** and **12**, with LEDs **91** at the crests of conductors **11**, which have wave-like configuration, as do conductors **12**. This facilitates bending or warping of the screen or mesh about axes extending in both the X and Y direction, to accommodate to desired curved shaping as on object **92**. LED wires **91***a* extend to junctions **94** on conductors **12**.

[**0087**] **FIGS. 15 and 16** show a screen or mesh **100**, similar to mesh **90** in **FIGS. 13 and 14**, with X direction conductors **101** interwoven with Y direction conductors **102**. A substrate **103** extends beneath the mesh, and dielectric spacers such as spheres or balls **104** are located between **100** and **103** to engage and position them relative to one another. In **FIG. 16**, LEDs **106** mounted on crests of conductors **101**, have wires **106***a* extending to junctions **107** on crests of conductors **102**.

[**0088**] **FIG. 17** shows positioning balls **110** between the tops of conductors **12** woven above and below conductors **11**. Balls **110** also serve as protection and spacing means. LEDs are mounted on conductors **11** between conductors **12**. A superstrate **111** may be located at the tops of the balls **110**. Superstrate **111** may be a transparent plate, to pass light emitted by the LEDs.

[**0089**] **FIGS. 18 and 19** show a mesh **120** similar to that seen at **90** in **FIGS. 13 and 14**. The "open-weave" conductors are seen at **111** and **112**; and LEDs **113** are mounted on crests of certain conductors such as **111**. LED wires **130** extend to junctions **131** on conductors **112**. The latter may have concentric configuration.

[**0090**] **FIGS. 20-23** show alternative screen and LED configurations.

[**0091**] **FIG. 24** shows a screen **120** like any of the described screens, with cooling air **121** blown at **122** into a space **123** below the screen, to flow adjacent the screen and upwardly through the screen. A housing is seen at **124**. Actuators **125** and **126** may be provided to actively and repeatedly displace, deform or warp the screen, as for an active sign display.

[**0092**] Referring now to **FIGS. 25 and 26**, the illustrated LED or LED "pixel" package, or diode package **150** includes a light emitter or emitters **151** within a transparent container, one example being a glass tube **152** having a hemispherical end **152***a*. A window area **152***b* is defined by tube **152**, or container, for transmission of emitted light in a direction or directions **153**. A reflector **154** is located within the tube, and has a reflecting surface **154***a* for reflecting emitted light in a forward direction **153**, through the window and to the exterior. The reflector may have edges **154***b* engaging or supported by the tube interior wall **152***c*.

[**0093**] An electrical lead or leads indicated at **156** extends with helical configuration into the tube and within the tube, to the emitter or emitters, that configuration providing support. The lead or leads preferably has or have a flattened or generally rectangular configuration seen in **FIG. 26**. Wires contained in the lead or leads may include "red", "green" and "blue" (relating to emitted light color) and an additional wire, such as an electrical neutral or return wire, to the emitter or emitters. The wires may consist of AWC32 copper multifilar and or AWC26 copper wire or AWG26 4 conductor insulated copper multifilar wire helically wound around a rectangular cross-section AWG18 insulated copper wire. A metallic, as for example aluminum base **157**, has an edge recess **158** receiving the end of the tube **152**, and supporting the tube. Specularly reflecting aluminum walls **159** and **160** are provided in the tube, and support the reflector **154**, as at endwise locations **161** and **162**.

[**0094**] The base **157** defines a through opening **163** passing the lead or leads; the base also defines an end recess **164** filled with potting compound **165** as for example epoxy resin. The lead or leads pass through that compound. The base also has an edge portion defining an annular recess **168**, for reception of a package support or support portion **169**, as for example a portion of the conductor **11***a* as seen in **FIG. 1**. The recess **168** preferably has cylindrical wall configuration, allowing rotation of the diode about an axis **170** defined by the recess or conductor. Diode or pixel replacement is also facilitated. Lead wires may be connected to conductors **11** and **12** of the screen, as referred to above.

[**0095**] **FIG. 27** shows the LED packages **150** of **FIGS. 25 and 26** arranged in a display sequence or configuration.

FIG. 28 shows the **FIGS. 25 and 26** LED packages mounted to mesh defining conductors **11** and **12**, so that the LED packages are carried by the mesh conductors **11** and are rotatable about axes **170**, as referred to. Integrated pixel electronics is thereby provided. Note leads **156** connected at **156***a* to conductors **12**. **FIG. 29** shows LED package **150** mounted on a conductor **11**, and transmitting light to a reflector **180**.

[**0096**] **FIG. 30** shows a sign or array employing LED packages as disclosed. The display incorporates vertical conductors **300**, with representative addressing wires **301** and **302** extending at acute angles, for example 45° across and relative to wires **300**. Wires **301** are extensive of wires **302** in a geometric sense. Other addressing wires are indicated in broken lines, as at **302***a*. LED packages are shown at **303** carried by wires **300**. This configuration, shown schematically, achieves reduced lengths of addressing wires, as compared with horizontal wires. Connections **304** and **305** to wires **300**, **301**, and **302***a* are made at the screen, i.e. array perimeter.

[**0097**] **FIGS. 31-33** are sections showing details of construction of the LED addressing wires which may be of multifilar construction. Referring to **FIG. 31**, wire **301**, numerals **306** and **307** refer to LED red light emitting pair; **308** and **309** refer to green emitting pair; and **310** and **311** refer to blue light emitting pair. A pair of red AWG **18** insulated copper wires is used to activate the red LEDs for a row of pixels. This wire pair and its neighboring wire pairs may be helically wound around an insulated central core that may serve as a tensile element. AWG **26** insulated copper wires from the pixel may be nested between wire pairs of like color. An insulated metal retainer may be used to compress the pixel wires against the power supply wires.

[**0098**] Numerals **313-315** designate three insulated copper wires from the three pixels, respectively, nested between the referenced wire pairs. A small amount of insulation is removed at wire regions to establish electrical connection between **313** and **306** and **307**; between **314** and **308** and **309**; and between **315** and **310** and **311**. A stainless steel retainer **316** extends about the wire assembly, and holds the wires in compression at the central regions, for example as seen at **317**, **318**, and **319** in **FIGS. 32 and 33**. The retainer may take the form of a split ring fastener that engages the wires **313-315** and may yieldably deform them at their contact points **317-319**.

[**0099**] **FIG. 34** schematically shows a metal plate **316** that may be used and positioned as an absorber of sunlight that passes through a display sign array incorporating devices as described above. It also blocks light transmitted toward the rear of the sign array. As such, the plate **316** may be regarded as overlapping the array at the rear thereof. The angled slits **316***a* that extend through the plate pass cooler air (possibly blower induced) flowing in the space between the plate and the array. Plate **316** also provides mechanical protection at the back of the display. **FIG. 34** also represents a side view of an array of overlapping elements that absorb sunlight and extraneous radiation while allowing the passage of cooling air. The array creates a thermal chimney effect to further increase cooling air flow and this effect may be further enhanced by the use of array surfaces with high absorptivity for sunlight and low emisstivity in the longwave infrared region. In addition the array provides mechanical protection for signage and display elements.

[**0100**] **FIG. 35** is a section showing protective metallic screens **317** at the back and front sides of the display array schematically indicated at **318**. Such screens may pass cooling air, blower driven at **319**. **FIG. 36** is like **FIG. 35**, but shows louvers or slots **320** in place of screens **317**.

[**0101**] Screens may be used in place of circuit boards and conductors on or as film circuitry. Screens can provide power and signal conduits as at **300** or **302** in **FIG. 30**, with reduced cost, mass, and volume, while providing paths between the conduits for flow of cooling fluids to allow systems/products with greatly reduced thermal resistance and/or increased power density operation. Screens may also allow optical communication between circuit elements via open regions between the wires. Screens greatly simplify the manufacture of 3D electronics, allow mechanical compliance, and may behave somewhat elastically to provide pressure type electrical contacts. Screens may have diodes electrically connected to the junctions between crossing wires and/or be in contact with electronic circuitry on chip or chips that provides diodes and/or electrically switchable elements to control the flow of electrons through the screen array. Connection schemes such as solder and including ball grid arrays are also a possible means of connection. Screen and chip arrangements include "Z Fold" serpentine/sinuous screen with chips between each layer and spiral/helical screens with chips between each layer/rotation. Screens are also good candidates for neural net architectures. Connection with input/output elements may be via ends/edges of screens and employ contact means such as solder, conductive adhesive, and/or mechanical/pressure contact. See **304** and **305** in **FIG. 30**.

[**0102**] **FIG. 28***a* shows modifications in the manner of supporting LEDs and their electrical connections, in an array. The LEDs appear at **500** and are adjustably, and/or removably supported on conductors **501**, which may be power conductors, as described in **FIG. 25**. Addressing wires or conductors, are shown at **502**, and may take the multi-filer form as shown in **FIGS. 31-33**. Wires **502** extend at acute angles (for example 45°) relative to conductors **501**, extending in direction or directions **504**. Coolant gas passing spaces between structure appear at **505**. Local electronic circuitry, in the LED packages are seen at **506**. Pixel package circuitry is indicated at **507** in the packages. Local addressing wire branches **502***a* extend (i.e. branch) from the wires **502** to **156**, as described above. Wires **502** and conductors **501** form the grid or screen. Linking connectors **540** may be provided as sown to connect successive conductors **501**, so as to allow or restrict flexing of the screen or array.

[**0103**] **FIGS. 37-39** show rows and columns of light emitting packages (LEDs) **401** generally of the type referred to above, and supported by conductor wires **402** running vertically, in the drawing. Addressing (control) wires appear at **403**, and run at acute angles, as for example 45°, relative to wires **402**. Wires **402** and **403** form a grid, with coolant fluid passing passages **406** through the structure. The packages **401** contain internal mirrors **407** and **408** convex toward one another to reflect LED emitted light. Clips **409** are connected to bulges **410** on wires **402**, to retain the wires in spaced relation as shown, and to block wire **402** rotation about their axes. **FIG. 40** is an end view of a clip. The LED packages are electrically connected to wire **402** (that extend

through grooves **412** in the bases of the LEDs), and to wires **403**, via leads **413**. See also circuitry **506** and **507**, as described above.

[**0104**] **FIGS. 41-43** show a wire conduit **415**, in the form of a metallic channel, for example. It supports or contains closely spaced conductor wires **402***a* in zone **416**, and closely spaced addressing wires **403***a*, in zone **417**, outside the display or grid, or at the edges of the grid. The items **402***a* and **403***a* sown in **FIG. 41** represent wire cross sections, or wire passing openings in a plastic sheet, or plate, or support **417**, carried by the conduit. Numeral **419** may represent a conduit support. See also **FIG. 53** showing stabilizing tension springs **420** and **421** connected at **420***a* and **421***a* to support **419**.

[**0105**] **FIG. 42**, a top plan view, also shows studs **422** forming wire terminals carried by conduit **415**.

[**0106**] **FIGS. 44 and 47** show conductor wires **402** having bends **402***b* and receiving bosses or retainers **425**. See also address wires **403** that loop at **403***a* about retainers **425**. A holder **426** extends crosswise of **402** to hold them in position. **FIG. 45**, like **FIG. 42**, also shows wire bends **402***b* looping about retainers **425**. Retainers **422** also anchor the addressing wires **403**, having connections **403***a*.

[**0107**] **FIG. 46** schematically shows parallel conductor wires **432** extending vertically, and addressing wires **433** extending at 45° angles relative to wires **432**, thereby forming a grid. LEDs i.e. pixel packages **440** are carried by the grid, as described above, and electrically connected to the wires **432** and **433**. Electronic controls to control the LEDs are indicated at **437**. A frame for the grid is shown at **438**.

[**0108**] **FIG. 48** schematically shows a pixel package **440** peripherally attached to a conductor wire **432**, as via an annular groove **440***a* in **440**, allowing adjustable rotation of **440** (see arrows **442**) about the package axis **443**. **FIG. 49** shows adjustable rotation of the package **440** about the lengthwise axis of conductor **432**. See arrows **444**. **FIG. 50** schematically shows an array **446** of LED packages **440**, with the packages in different rows having different adjusted angularities, for variably directing emitted light in selected directions.

[**0109**] **FIG. 51** schematically shows an array **450** of pixel packages **451**, which have electronic control circuitry **452** within the pixel envelopes. In **FIG. 52**, the modified array **450***a* of LED pixel packages **451***a* has control circuitry **452***a* at edges of the array. Array wires **453** and **454** form grids.

[**0110**] **FIGS. 54 and 55** show LED pixel package elements the same as in **FIGS. 38 and 39**. Emitted radiation is within included angle α, in **FIG. 55**. Azimuth or radiation is reduced by vertical axis parabolic mirror trough, indicated at **460**.

[**0111**] A preferred form of the invention appears in **FIGS. 25-33** and **FIGS. 37-39**.

[**0112**] As disclosed herein large-screen modular displays and signs are enabled, along with various curvatures and complex geometric forms. Also, large scale video displays, and projection displays as for billboards are made possible. Low volume, low mass, low cost, high brightness, high resolution and high efficiency are enabled. Double sided displays can be provided. LEDs can be placed on opposite sides of the screen, and the screen can serve as a pattern for LED placement.

[**0113**] LED bases can be placed on a transparent substrate, or the screen can be provided as a polymer film or sheet.

[**0114**] Screen and superstrate may collectively provide mechanical, structural strength. Superstrate may be thin or layered to allow second or third flexure modes. Superstrates may be thin to reduce sideways transmission of radiation from LEDs. Some LED sideways light transmission can be provided for integrating between pixels.

[**0115**] Provision is made for use of means to use conductive/red LEDs. Screen elements can be connected to side faces of LEDs via conductive adhesives, solder, amalgams, indium, stabilite **22**, and conductive grease. A metallic superstrate can be used.

[**0116**] Red LEDs can be provided with two conductors on same side (UEC red on sapphire) Superstrates may have high refractive indices to increase usable radiation (polycarbonate 1.59)

[**0117**] Superstrates may have transparent adhesive layer, thermoplastic, thermoset, pressure sensitive features.

[**0118**] The screen can be deformed after weaving, during manufacture, or deform screen before and/or during weaving. Screen warp and woof wires of different metals can be used to reduce the possibility of electrical shorting.

[**0119**] Another modification comprises an array of light emitting diodes periodically placed on the weft wires of a woven aluminum and/or copper screen (wire cloth) with the weft wires acting as one conductor, and the warp wires acting as the opposite conductor. The wires may be electrically isolated at their crossing points by such means as anodic coatings and/or by the addition of inorganic or organic over-coatings. The LEDs can be activated by pulsed and/or continuous current and may be addressed as a whole or in groups or individually as in an active video display by control of conductor energization. Woven wire screen provides a very low cost substrate.

[**0120**] Additional benefits include efficient heat transport, low mass, low volume, reel to reel manufacturing with screen travel between reels and roll-up on a reel with LEDs placed in position. This allows freedom of display shape, transportable in a roll, ability to be held in tension, in a wide range of materials and sizes.

[**0121**] A video display may include an X-Y grid of light emitting diodes placed on an aluminum woven screen suspended or placed between a transparent polycarbonate sheet and another enclosing sheet on the opposite side. An aluminum sheet with gaps between the screen and the enclosing sheet become sufficient to allow forced air to enter and flow upward between the polycarbonate sheet and the screen, through the screen and exiting at the top rearmost part of the screen.

[**0122**] Conductor wires act as structural conductors, electrical conductors, and thermal conductors, and may also be provided with a black region made especially effective because of "cavity effect". Wires may vary in size, materials, coatings etc. with axis, e.g. stainless steel wire may be used

in tension in one axis direction and copper or aluminum wire of smaller diameter may be used in opposite axis direction (i.e. X-Y axes).

[0123] Manufacture may include placement of a screen on PTFE coated needle/cone array/drum to allow coating of die/wire bond/adhesive attach/screen without clogging holes; then forcing fluid through the screen to prevent clogging. Screens can be spaced apart by use of beads or spheres.

[0124] Electrostatic or electromagnetic powering of LEDs is possible, and particularly pulsed operation, as with LED video displays. High applied voltage allows smaller conductor cross sections.

[0125] LEDs with junction faces on metal, or with good junction heat transfer/thermal capacitance, can withstand very high voltage spikes.

[0126] Patterned superstrate and/or substrate may act as one conductor and screen or substrate as another conductor.

[0127] Anisotropic screens may be provided with wires along one axis of a different material than wires extending along another axis (thickness, form, alloy. Tensile strength and flexibility may be more important in one axis e.g. opposite roll axis or row axis; dissimilar metals are more apt to form dielectric regions at points of contact and this may be encouraged via processing and/or choice of material properties and coatings; a current flow in one LED row may be several times greater than current flow in another LED row.

[0128] Advantages and benefits of the **FIG. 25** to **28** described LED device construction include:

[0129] SPATIAL TUNING: Benefits accruing from the ability to aim the radiation from the emitters to the target include a reduction in emitter cost and/or electrical system cost and/or operating cost and/or increased radiation delivered to the target. The herein described pixel package can be rotated as for example 360 degrees around it's axis and 360 degrees around an axis perpendicular to its' axis, and as a consequence has complete freedom of movement in both elevation and azimuth.

[0130] HORIZONTAL AXIS OPTICS: The target audience for signage and billboards typically moves horizontally as in vehicles. Horizontal axis optics provide for optimum control as the horizontal angular aperture is typically much greater than the vertical angular aperture.

[0131] ANGULAR APERTURE CONTROL: Minimizing the radiation beyond the angular extent needed for the task is an important element in minimizing cost. Maximizing the aperture to emitter size ratio allows a minimization of the angular extent of the output radiation. The herein described pixel design allows for a minimization of the output radiation by minimizing the emitter array size via close emitter spacing and a narrow gauge substrate and by maximizing the aperture size for a given pixel spacing.

[0132] BIFACIAL DISPLAY: Bifacial displays are possible with a single array of bifacial pixels or via a forward and rearward spaced pixel arrays, which may provide or allow differing energizing content to the displays. The pixel package allows mounting in front of or in back of the display "plane". This allows one face to use pixel packages mounted on the front of the vertical wires and facing forward, and the opposite face to use pixel packages mounted on the opposite side of the wires and facing rearward. The packages may be displaced vertically to allow clearance.

[0133] TRANSPARENT DISPLAY: Displays can be made with a wide range of transparency to suit a variety of end uses.

[0134] OPTICAL EFFICIENCY: The pixel design allows for use of a linear emitter array coupled with a visible mirror film parabolic trough, to control radiation in the vertical axis. Horizontal axis radiation may be controlled by end reflectors of similar material and these may be curved to aid in the control of the angular extent of the radiation in the horizontal axis. This design minimizes the average number of reflections and provides for high efficiency for each reflection. The pixel optical system may be contained within a cylindrical glass envelope for environmental protection. Additional benefits of such an envelope include:

[0135] 1) functioning as a circular compressive element to constrain the elastically deformed **3M** VMF and thereby cause it to form a parabolic curve; (The film is typically specularly reflecting film such as 3M visible mirror film. The reflecting film may be paired with/attached to additional film/s to provide the desired mechanical and other properties. The film/s may also be adhered to the container walls and/or constrained by lands/ridges/bumps along the container walls.)

[0136] 2) functioning as a container for a wide range of liquids, gels, solids, and/or smaller containers;

[0137] 3) functioning as a refractive optical element.

[0138] CONTRAST RATIO: Increasing the contrast ratio allows an improvement in visibility and/or a reduction in radiative power for a given visibility. The herein described configuration allows high contrast ratio viewing by:

[0139] 1) Minimizing the angular extent of the output radiation and increasing the aperture area of the output radiation reduces the probability of sunlight or other extraneous radiation being reflected from the 'display" to the target/viewer,

[0140] 2) Optical porosity (low solidity), which allows a portion of the radiation that would impinge on and possibly be reflected into the target on a high solidity display pass through and be absorbed on a subsidiary surface/s,

[0141] 3) Insuring all surfaces within the targets field of view have very low reflectivity by means such as coating and texturing.

[0142] DETECTOR/DETECTOR ARRAY: The described pixel may also operate as detectors, alone or in conjunction with emitters.

[0143] The lifetime and efficiency of semiconductor devices (LEDs) degrades strongly with increasing temperature. Provision is made for reducing the thermal resistance between the emitters and the local environment, and thereby increasing lifetime, reliability, durability, and efficiency and reduce operating cost, pursuant to provision of the following:

[0144] 1) A low solidity array which allows a portion of the solar load to be diverted to subsidiary surfaces and thereby make a smaller contribution to array heating. In addition, the open design allows airflow in and around the array and in very close thermal communication with the emitters.

[0145] 2) Wind enhanced cooling. A porous array allows the passage of and the ability to transfer heat to the local air stream. Wind speed increases strongly with increasing height and high mounted signage and displays may benefit greatly from this cooling.

[0146] 3) Thermally induced convection cooling caused by the wire array, the pixel packages, and by proper design of subsidiary surfaces behind the array (horizontal axis overlapping slats/louvers).

[0147] 4) Solar assisted cooling may be promoted by proper design of subsidiary louvered absorber array behind the screen. Louver surfaces with a high absorptivity for sunlight and a low infrared emissivity may be used to further increase airflow.

[0148] 5) The pixel package enables use of a rectangular copper substrate for LED mounting. This substrate acts as a thermal, electrical, and structural conduit and its cross section may be easily sized to provide sufficiently low thermal resistance. The pixel package is thermally coupled to the row and column wires to aid in the transport of heat to the local environment. In addition, the pixel package may be liquid filled to allow reduced LED operating temperature.

[0149] 6) Active cooling may be used if necessary, but its need and its cost may be greatly reduced by the aforementioned features.

[0150] Provision is made for use of active and/or passively addressed pixels. Local (pixel based) electronics may be included in the pixel package and placed on the emitter substrate, behind the reflector, in the aluminum bushing and/or in the hemispherical cap. Local electronics may vary with application and include capacitors, resistors, inductors, diodes, transistors, standard integrated circuits such as 555 timers or application specific integrated circuits. Multiplexing may be used to reduce the cost of the electrical system, and the ability to multiplex is greatly increased by minimizing the pixel output radiation required by means discussed in the above optics section.

[0151] Provision is made for use of in-field replaceable pixels that may be made to be replaceable from either side of the screen.

[0152] Use of vertically oriented column/common wires and 45 degree oriented row/addressing wires to allows large scale seamless signage and displays with all pixels/electronics addressable/accessible from the top or the bottom of the screen.

[0153] Control electronics may be integrated into pixel packages; and/or control electronics may be concentrated in modules or zones at edge or edges of the arrays.

[0154] Provision is made for use of robust signage/displays created by arranging a parallel array of large diameter vertically oriented common/column wires in tension between horizontal upper and lower rigid members. The upper end of each vertical wire may be formed into a loop and affixed to and electrically isolated from the upper rigid horizontal member. The lower end of each vertical wire may be formed into a loop and elastically attached to and electrically isolated from the lower rigid member by a stainless steel extension spring. Both upper and lower mounts may serve to prevent rotation of the vertical wires around their own axes. A parallel array of 45 degree row wires may be connected in tension between the upper and lower rigid horizontal members by means analogous to those described for the vertical wire array. The 45 degree row wires may be constructed of a large diameter electrically insulated central wire helically wound with a 6 strand small diameter multifilar insulated wire array. The multifilar wire array includes paired red, green, and blue wires. The 45 degree wire array may be placed behind the vertical wire array and the pixel packages may be mounted in front of the vertical wires. The pixel packages may be mechanically connected to the vertical wires by plastic deformation of the pixel package aluminum bushing and/or the wire and/or by adhesives. The pixel common wire may be electrically connected to the large diameter vertical common wire through the aluminum bushing via wirebonding or pressure welding or directly to the larger diameter wire by soldering or pressure type connection. Red, green, and blue wires emanating from the pixel may be connected to the 45 degree row wires by soldering or by pressure type contacts.

[0155] The row and column wires may be constructed of aluminum to reduce cost and weight for a given strength, electrical and thermal conduction. In addition, electrically insulative coatings adhere better and have longer life on aluminum than copper.

[0156] Signage and displays of simple or complex face or form (circular or hyperbolic cylinders, cones and conoids, hyperbolic paraboloids) may be assembled on site or shop fabricated by simple techniques that lend themselves to manual or automated fabrication.

[0157] Other important advantages are listed as follows:

[0158] 1. Organic Light Emitting Diodes: (OLEDS) may be used as light emitters alone or in conjunction with inorganic LEDs. OLEDs may be easier to apply to screen type substrates and may allow reduced product cost.

[0159] 2. Multiplexing: The ability to tailor the angular extent of the radiation output and the increased contrast provided by the OnScreen design allows a greater degree of multiplexing and a concurrent reduction in system cost.

[0160] 3. 45° Scanning: 45° scanning reduces line artifacts compared to vertical or horizontal scanning and thereby allows higher apparent resolution for a given number of pixels and/or a reduced number of pixels for a given apparent resolution.

[0161] 4. In Field Pixel Replaceability: The ability to replace individual pixels in the field allows reduced maintenance cost.

[0162] 5. Freedom of Form: Array construction allows a wide variety of signage/display forms. One example is a vertical axis cylindrical display viewed

from the inside and/or the outside and with varying degree of array transparency determined by design.

[0163] 6. Shop Or Site Fabrication: The light weight and flexible nature of the OnScreen array coupled with the mechanism of flexible local linkage allows for shop fabrication of large area arrays.

[0164] 7. Pixel Level Voltage Reduction: Pixel "on-board" reduction allows higher array supply voltages and thereby lower current levels and reduced self-heating of array wiring and/or reduced wire cross-sectional area.

I claim:

1. The method of providing an LED array assembly, that includes:

a) providing a grid of electrical conductors,

b) providing light emitting diodes and locating the diodes in association with the grid and in electrical communication with the conductors that provide power for LED operation,

c) the grid operable to receive heat from the diodes during diode operation, and the grid configured for passing coolant fluid for transfer of heat to the fluid.

2. The method of claim 1 wherein the electrical conductors are provided in the form of insulated metal wires that act as electrical and thermal conductors and that also serve as structural load conductors, for arrays of such diodes.

3. The method of claim 1 wherein the wires are dielectrically coated.

4. The method of claim 1 wherein the conductors are provided in the form of woven wires.

5. The method of claim 1 wherein the array has at least one of the following characteristics:

i) curvature

ii) complex shape

iii) compliant configuration

iv) flexibility.

6. The method of claim 1 including effecting and/or guiding flow of coolant fluid through or along the array.

7. The method of claim 1 wherein the grid is provided as a dark grid to increase viewing contrast with LEDs during their operation.

8. The method of claim 1 including providing one of the following:

i) a substrate above which LEDs are placed

ii) a superstrate associated with the array and LEDs to provide structural strength to the assembly.

9. The method of claim 1 including providing a first sheet facing the diodes, to pass light emitted by the diodes.

10. The method of claim 9 including providing a second sheet at an opposite side of the diodes, the first and second sheets forming an enclosure within which coolant fluid is flowable.

11. The method of claim 1 wherein the grid of electrical conductors is provided to include primary conductors extending generally in one direction, and secondary conductors extending generally in another direction, the LEDs being mounted on the primary conductors, and having terminals extending to the secondary conductors for electrical association thereto.

12. The method of claim 11 wherein the secondary conductors are configured to extend above and/or below the primary conductors.

13. The method of claim 12 wherein the secondary conductors are provided to have one of the following:

i) substantial spacing therebetween to pass coolant fluid through the grid,

ii) lack of substantial spacing therebetween, to pass coolant fluid parallel to the grid,

iii) cross sections which are substantially less than the cross sections of primary conductors which support diodes,

iv) junctions with diode wires.

14. The method of claim 1 wherein certain of the conductors include multiple wire strands.

15. The method of claim 1 including providing balls or beads and seating the balls or beads on the conductors to act as spacers.

16. The method of claim 1 including providing means displacing and conducting coolant to one side of the screen, to flow through or adjacent to the array assembly.

17. The method of claim 1 including providing a transparent panel extending in the path of light from the LEDs.

18. The method of claim 1 wherein each diode is provided to include a light emitter or emitters, a transparent container having a window area, the emitter supported within the container, and a reflector within the container to reflect emitted light toward said window.

19. The method of claim 18 including providing an electrical lead or leads extending with helical configuration within the container to said emitter or emitters.

20. The method of claim 19 wherein the lead or leads is or are formed to has or have a generally rectangular cross section, for stable support of the emitter or emitters.

21. The method of claim 18 including providing a metallic base carrying the container, and through which said lead or leads extend.

22. The method of claim 20 including providing said lead or leads include wires associated with a red and/or green and/or blue emitter.

23. The method of claim 18 wherein multiple of said diodes have their container windows facing in the same or selected directions.

24. The method of claim 23 wherein the diodes and array assembly define a display.

25. The method of claim 21 wherein said base is provided to have an edge portion defining a recess for reception of a support for the diode, allowing diode rotation about the support, and including effecting said rotation.

26. The method of claim 25 wherein said electrical conductors are provided to define a mesh, and multiple of said LED devices are carried by the mesh, with said recesses receiving portions of said conductors allowing rotation of the devices relative to the mesh.

27. The method of providing a light emitting diode device, that includes

i) providing an electrically energizable light emitter, or emitters;

ii) providing a transparent container having a window;

iii) supporting the emitter or emitters within the container;

iv) and providing a reflector structure within the container to reflect emitted light toward said window.

28. The method of claim 27 including providing an electrical lead or leads extending with helical configuration within the container to said emitter or emitters.

29. The method of claim 27 wherein the lead or leads is or are provided to has or have a generally rectangular cross section, and to support the emitter or emitters.

30. The method of claim 27 including providing a metallic base carrying the container, and through which said lead or leads extend.

31. The method of claim 27 wherein said reflector structure is provided to include spaced reflecting walls, and a curved reflector supported between said walls.

32. The method of claim 28 including providing said lead or leads to include wires associated with a red and/or green and/or blue emitter.

33. The method of claim 27 including providing multiple of said devices having their windows facing in a display direction or directions.

34. The method of claim 33 including providing display structure supporting said diode devices in a multiple diode display configuration.

35. The method of claim 30 wherein said base has is provided to have an edge portion defining a recess for reception of a support for the diode, allowing diode rotation about the support, and including effecting said rotation to a selected diode display configuration.

36. The method of claim 1 wherein certain of said conductors that provide power for diode operation are configured as first, second and third pairs of wires to transmit electrical energization to red, green and blue LED pixels, respectively.

37. The method of claim 36 wherein each LED has primary, secondary and tertiary wires electrically connected to the red, green and blue pixels, respectively, said primary wire configured to be clamp connected to said first pair of wires, said secondary wire configured to be clamp connected to said second pair of wires, and said tertiary wire configured to be clamp connected to said third pair of wires.

38. The method of claim 37 including locating said three pairs of wires about a central region, and said LED primary, secondary and tertiary wires are respectively nested between said three pairs of wires, there being a retainer acting to clamp said primary, secondary and tertiary wires in nested position.

39. The method of claim 38 wherein said certain conductors are located to extend at an acute angle or angles relative to others of said conductors, said certain conductors defining LED addressing conductors to selectively address LEDs on said others of the conductors.

40. The method of claim 39 wherein said acute angle or angles are approximately 450.

41. The method of claim 1 including providing protective means at one of the following:

i) at the front of the grid;

ii) at the rear of the grid;

iii) at both the front and rear of the grid.

42. The method of claim 1 wherein said protective means is provided to include at least one metallic plate.

43. The method of claim 42 wherein said metallic plate is characterized by one of the following:

$X_{1)}$ forming air passing openings;

$X_{2)}$ forming air passing louvers;

$X_{3)}$ forming air passing through slits.

44. The method of claim 42 wherein said protective means is provided in the form of a metallic screen or screens.

45. The method of claim 1 wherein the diodes are removably supported by the grid.

46. The method of claim 1 characterized by at least one of the following:

i) diode emission control electronics provided within diode packages

ii) diode emission control electronics provided at or proximate an edge or edges of the grid.

47. The method of claim 1 including providing a light reflecting mirror or mirrors in association with a diode or diodes.

48. The method of claim 47 wherein said mirror or mirrors is or are provided in the form of one or more of the following:

i) a parabolic mirror

ii) dual mirrors within a package

iii) a parabolic trough forming mirror or mirrors.

49. The method of claim 1 including providing a conduit for extensions of the conductors, outside the grid.

50. The method of claim 49 including providing spring tension exerting means acting on the conduit.

51. The method of claim 49 including providing holders about which end portions of the conductors in the grid are looped, the holders provided in association with the conduit.

52. The method of claim 1 wherein the diodes are provided in the form of packages having adjustable operative connection to the conductors characterized by one of the following:

i) rotatable adjustability about one axis

ii) rotatable adjustability about two axes.

53. The method of claim 52 wherein the diodes packages in the array are provided to have different positions of adjusted angularity.

54. The method of providing and LED array assembly that includes:

a) providing a grid of electrical conductors,

b) providing light emitting diodes and locating the diodes in association with the grid and in electrical communication with the conductors that provide power for LED operation,

c) and providing LED structure allowing rotary adjustment of at least some LEDs relative to conductors on which those LEDs are supported.

55. The method of claim 54 wherein said rotary adjustment is characterized by one of the following:

i) rotation about an axis or axes defined by the LED or LEDs

ii) rotation about a conductor axis or axes

iii) rotation about both i) and ii) above.

56. The method of claim 54 including providing clip means positioning the conductors relative to which the LEDs are rotatably adjustable.

57. The method that includes:

a) providing multiple LEDs in a display array, and

b) selectively electrically energizing the LEDs in the array to adjust the display,

c) cooling the display array.

58. The of claim 57 including selectively adjusting the positioning of the LEDs in the array.

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