US00RE35108E

United States Patent [19]

[11] E **Patent Number: Re. 35,108**

[45] **Reissued Date of Patent: Dec. 5, 1995**

Hagen et al.

[54] **METHOD FOR SPINNING MULTIPLE COLORED YARN**

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[73] Assignee: **BASF Corporation**, Parsippany, N.J.

[21] Appl. No.: **224,900**

[22] Filed: **Apr. 8, 1994**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **5,234,650**
Issued: **Aug. 10, 1993**
Appl. No.: **860,665**
Filed: **Mar. 30, 1992**

[51] **Int. Cl.**[6] **D01D 4/06**

[52] **U.S. Cl.** **264/176.1**; 264/103; 264/210.8; 264/211.14; 264/245; 425/131.5; 425/198; 425/463; 425/464

[58] **Field of Search** 264/176.1, 103, 264/75, 210.8, 78, 211.14, 245; 425/131.5, 198–199, 464, 463, 462, 382.2

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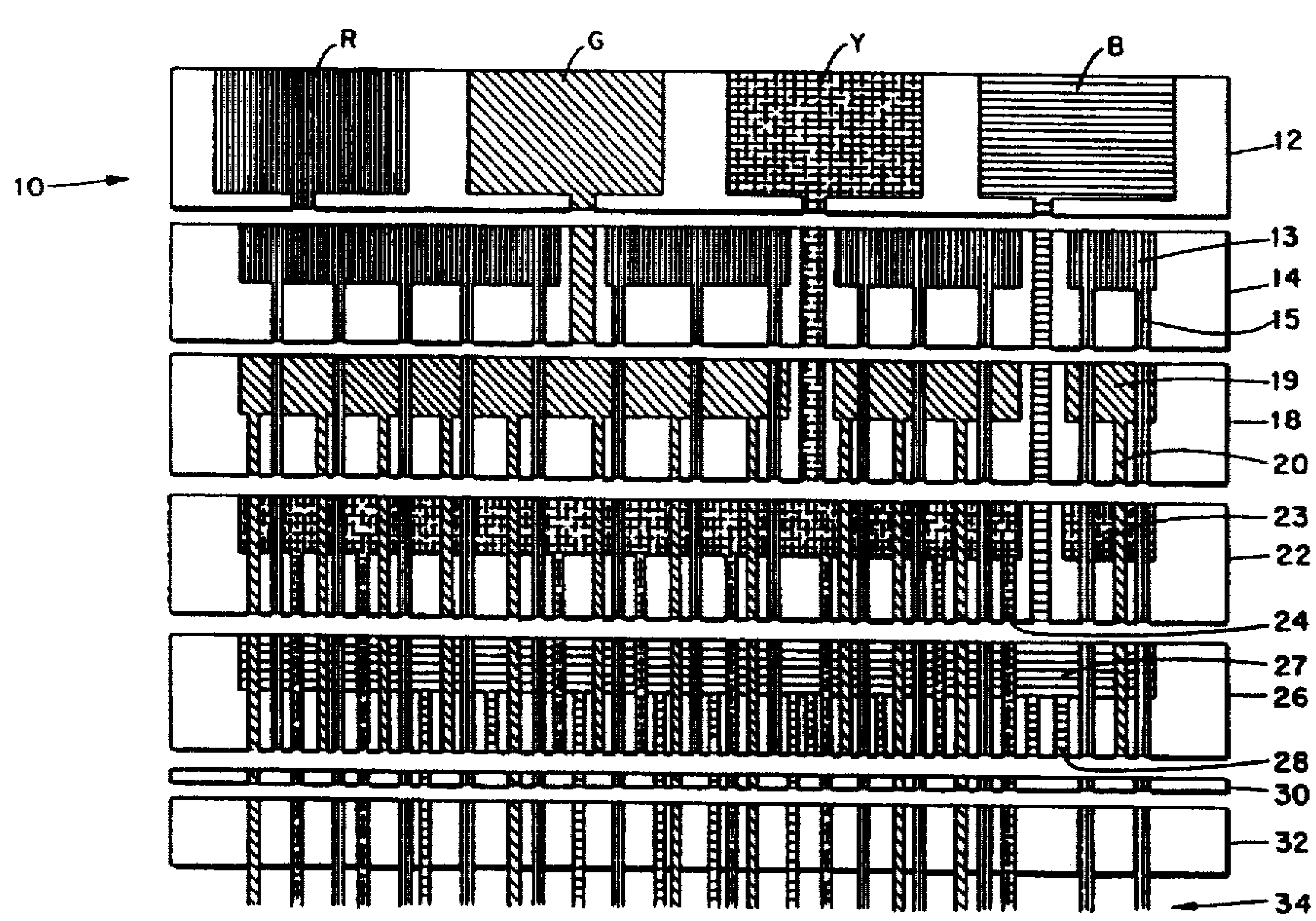
Primary Examiner—Jeffery R. Thurlow
Attorney, Agent, or Firm—Karen M. Dellerman

[57] **ABSTRACT**

A spin pack for spinning multiple components includes a distribution device which distributes mutually separated molten polymer streams to a spinneret so that each mutually separated molten polymer stream is accessible at each active spinneret backhole. Intermediate the spinneret and the distribution device, a selection assembly selects which, if any, mutually separated molten polymer stream flows into which backhole.

3 Claims, 20 Drawing Sheets



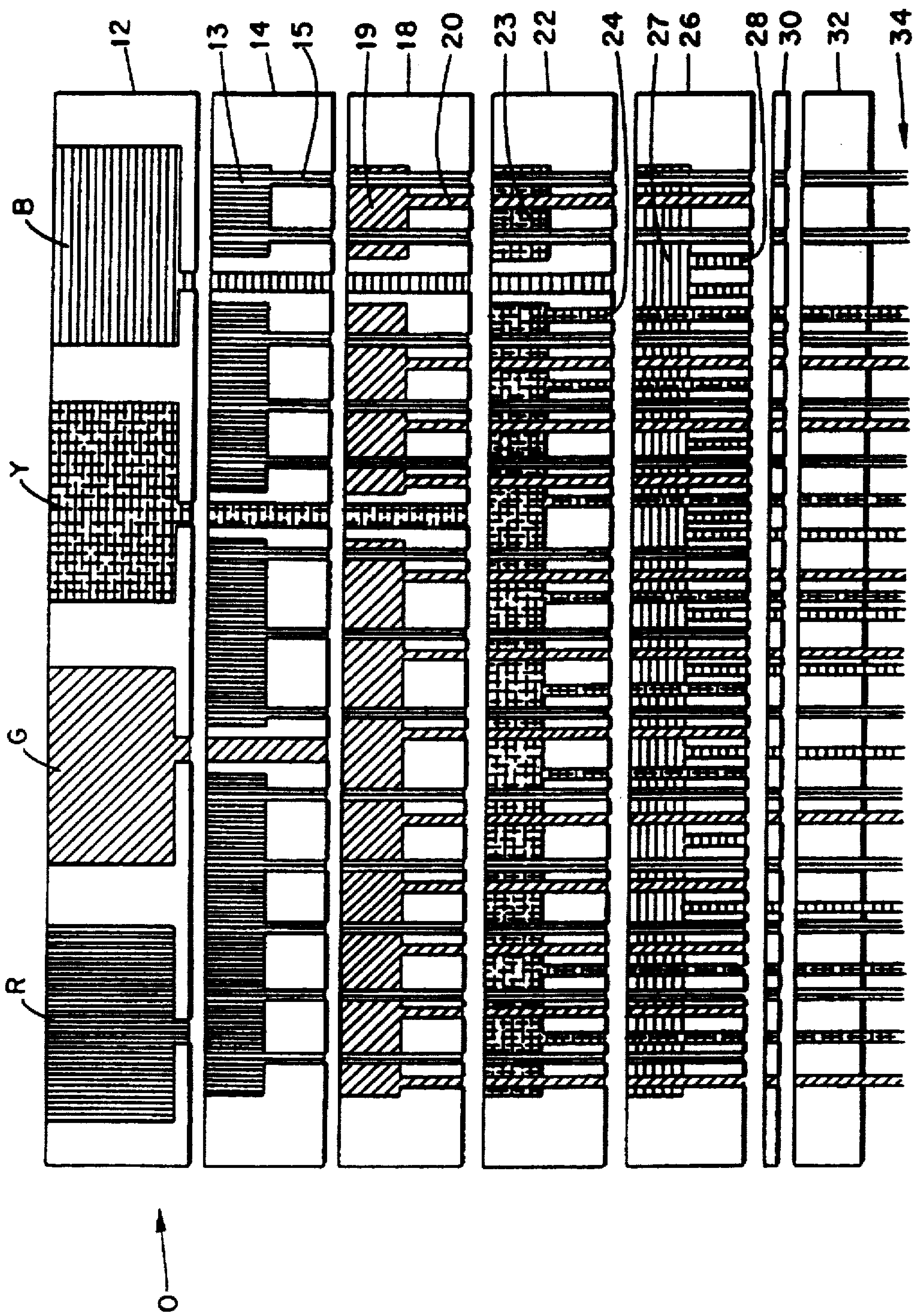


FIGURE 1

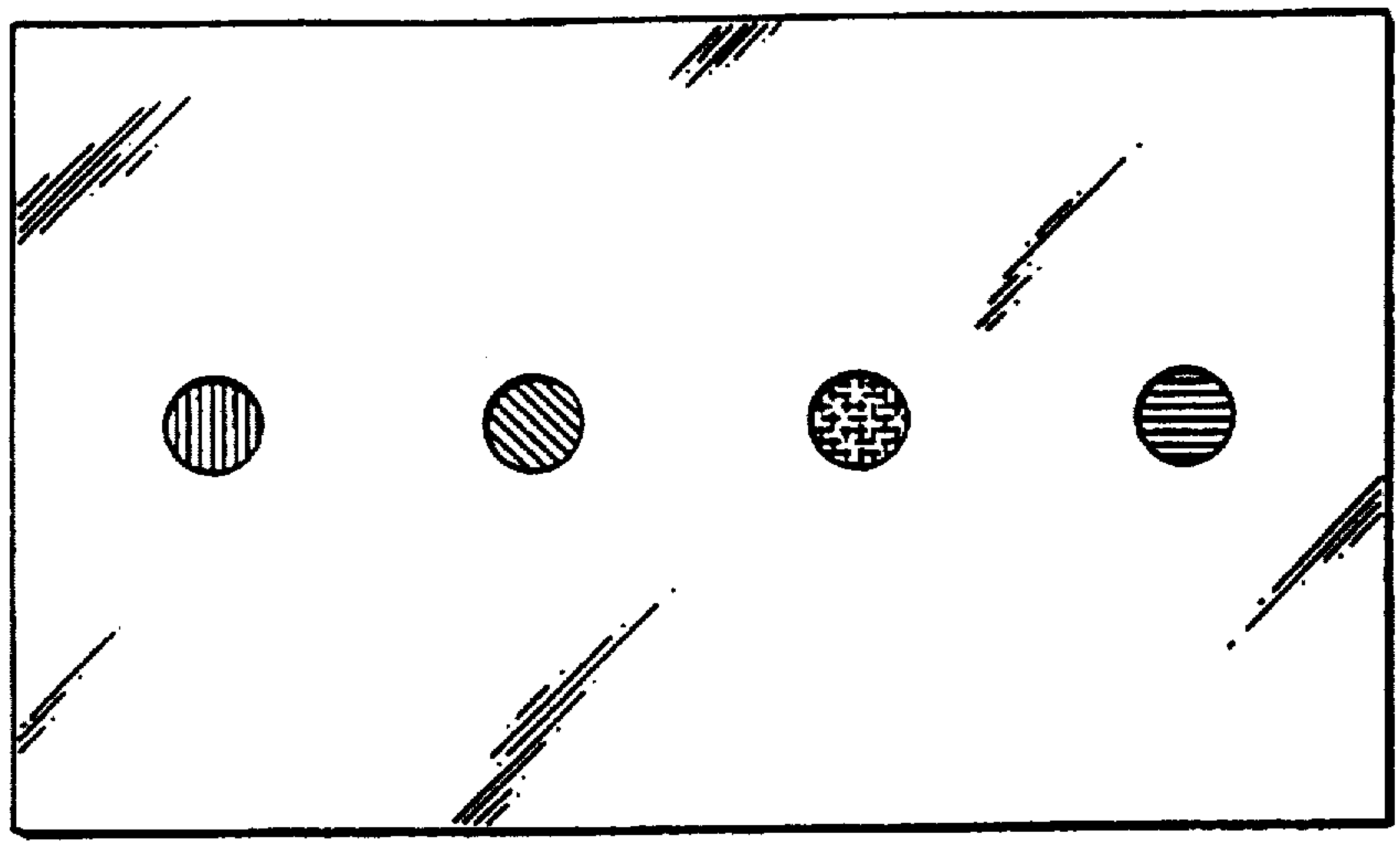


FIGURE 2

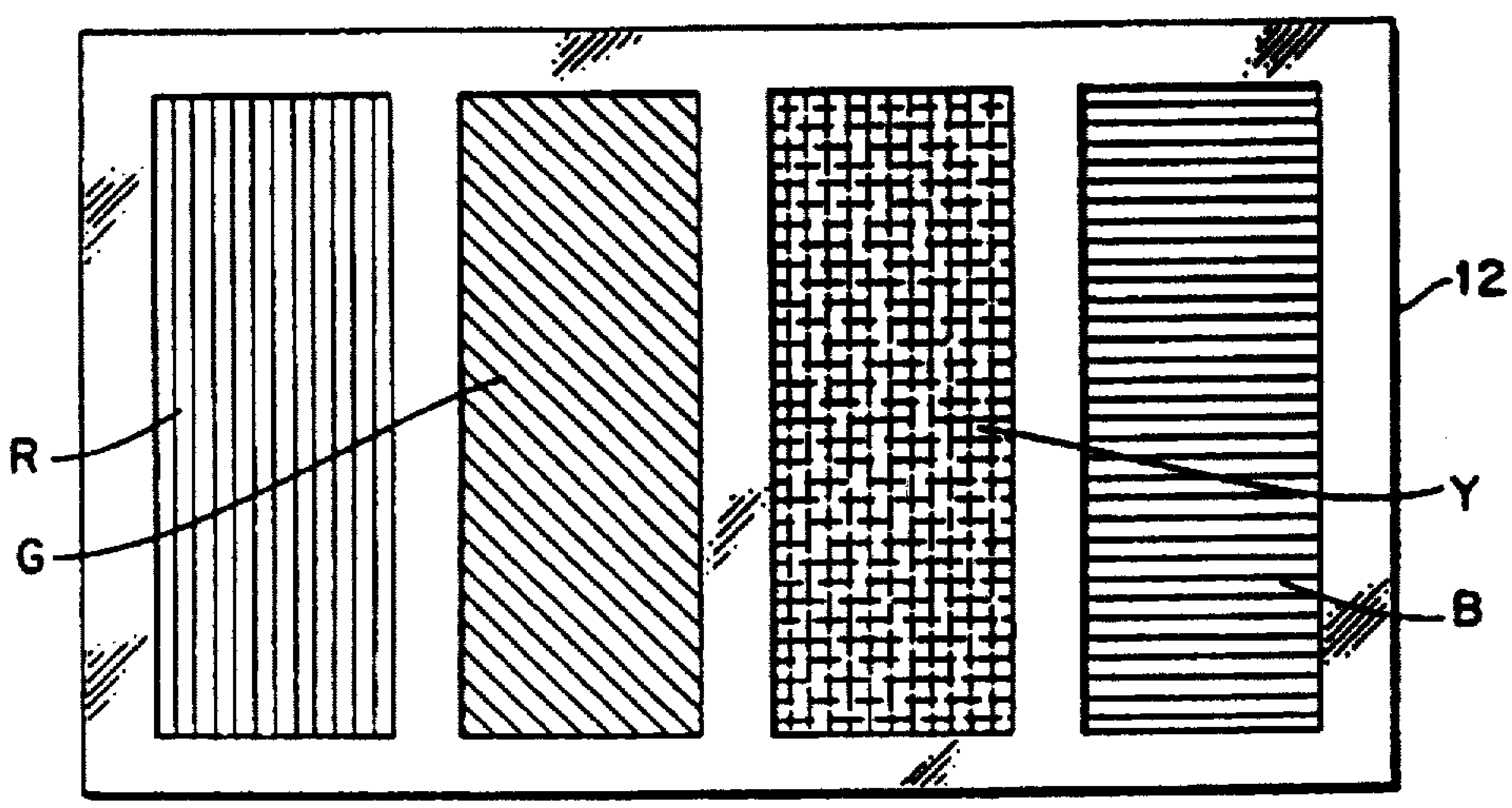


FIGURE 3

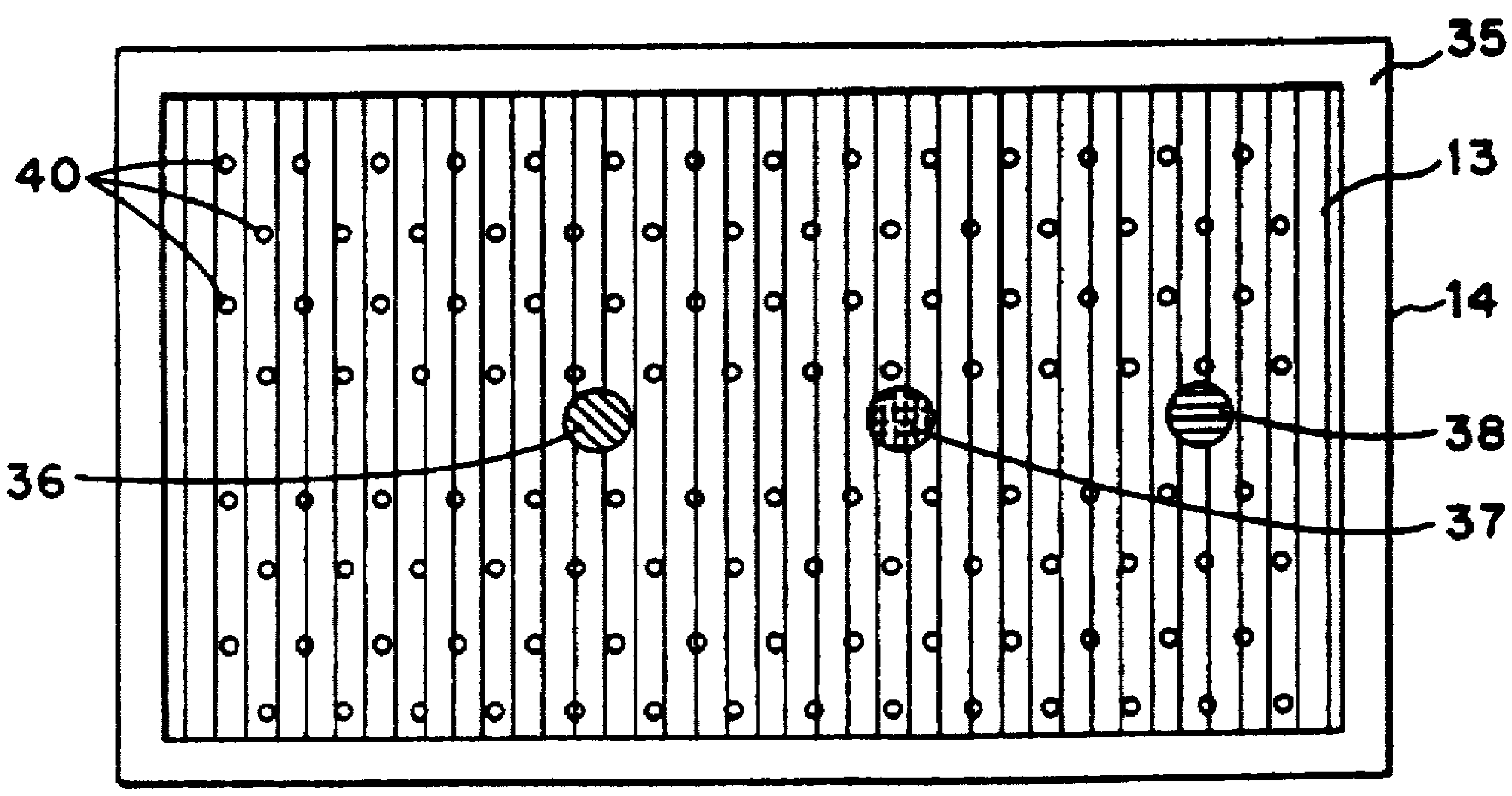


FIGURE 4

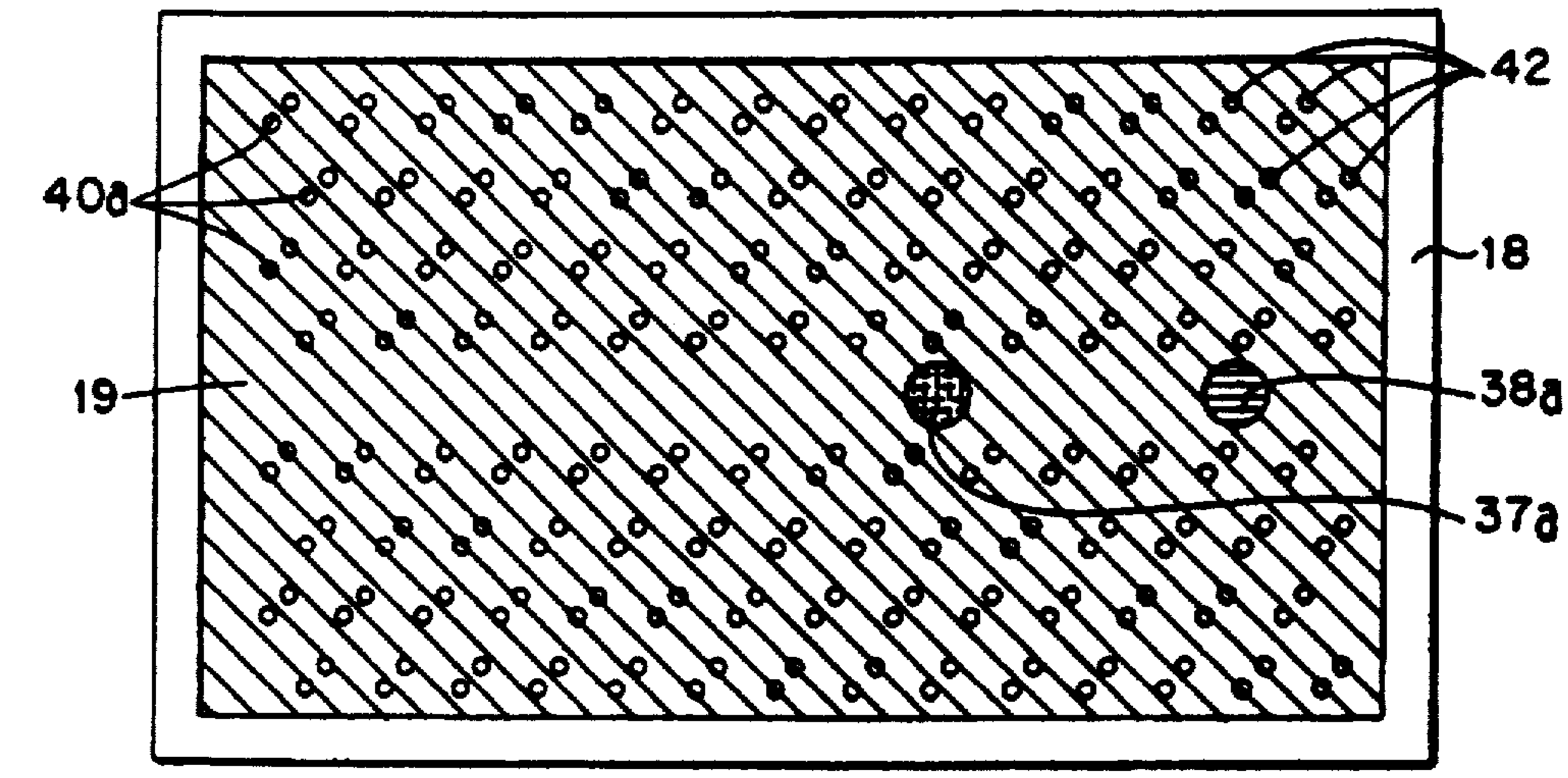


FIGURE 5

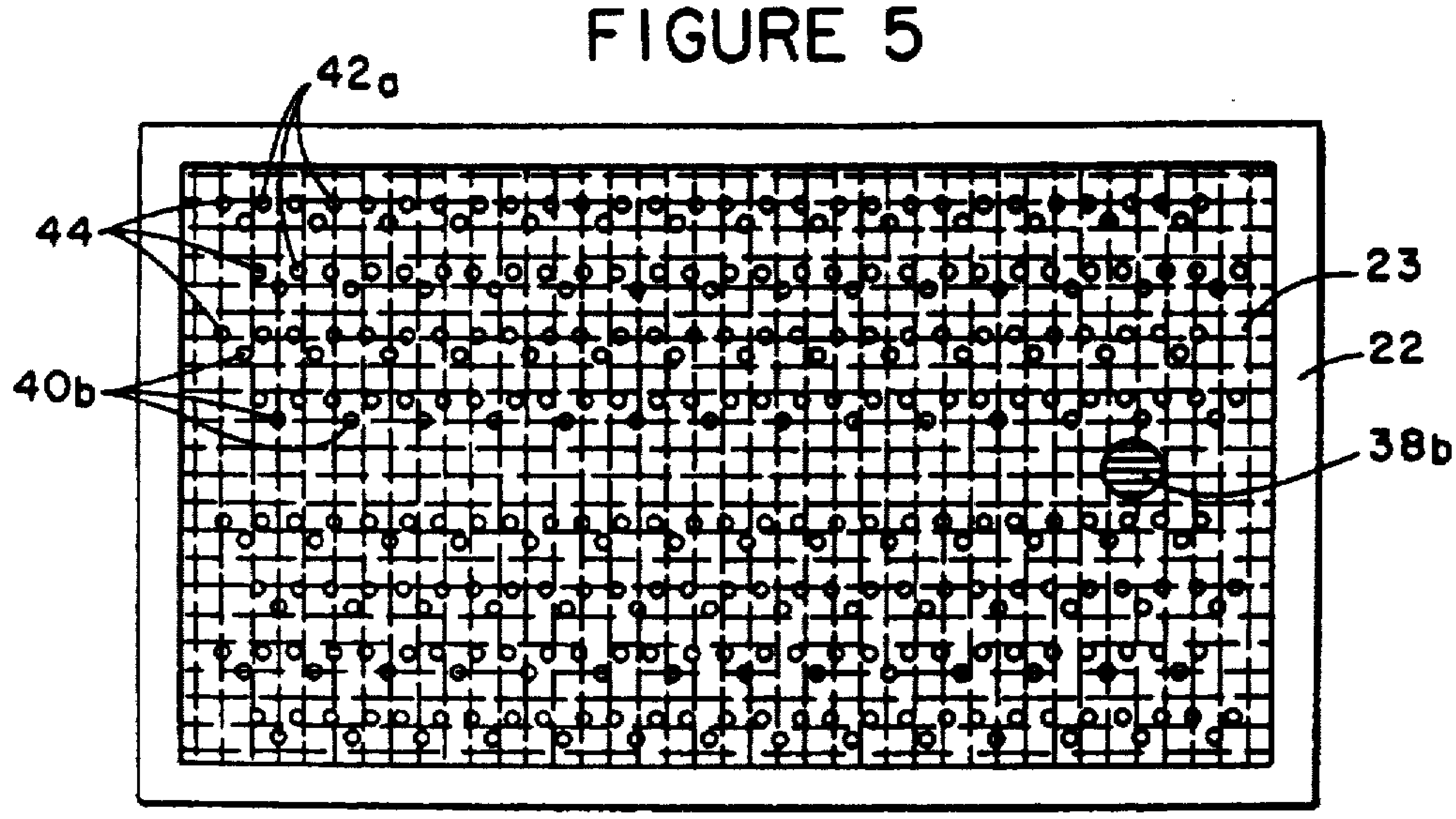


FIGURE 6

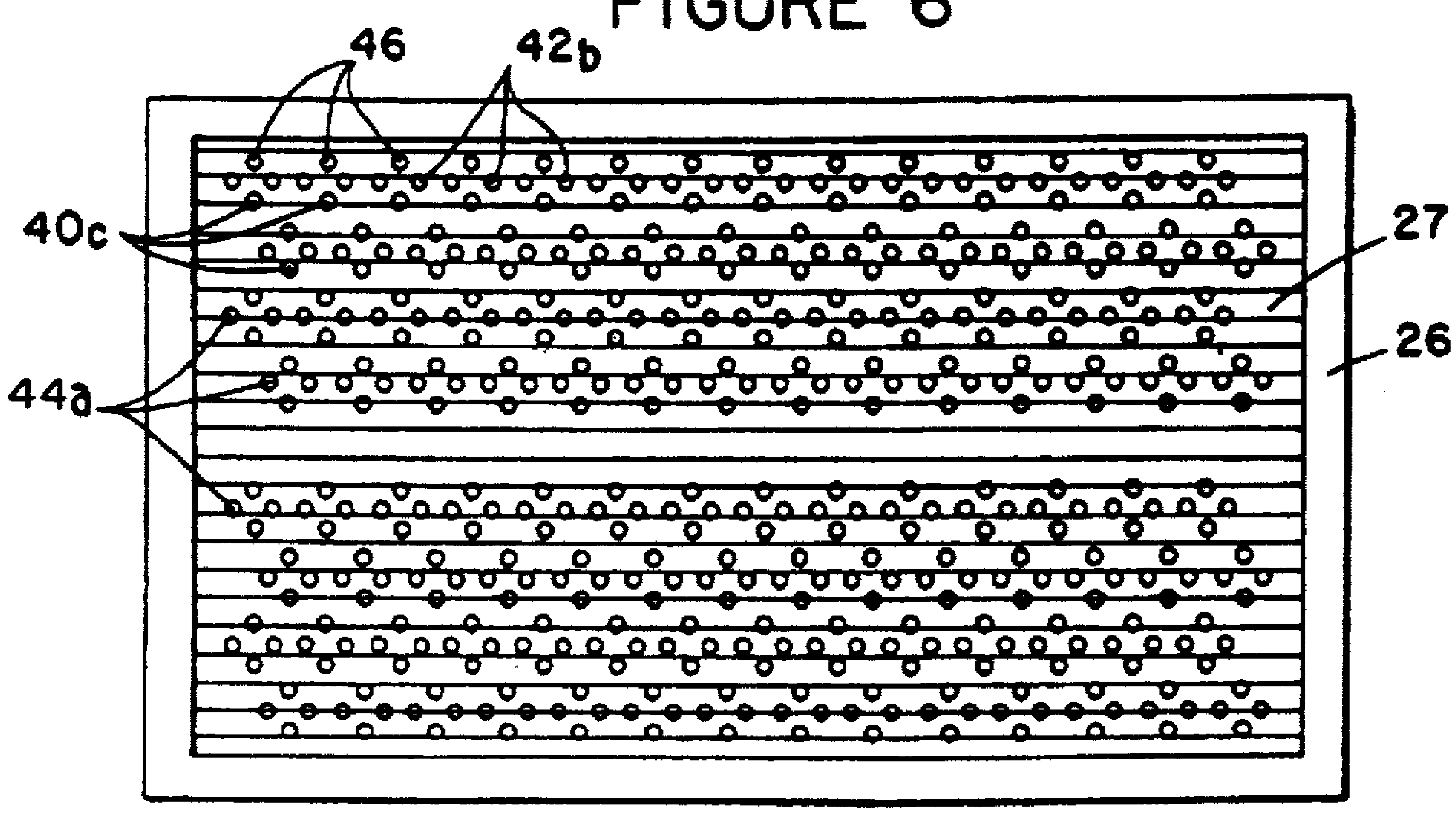
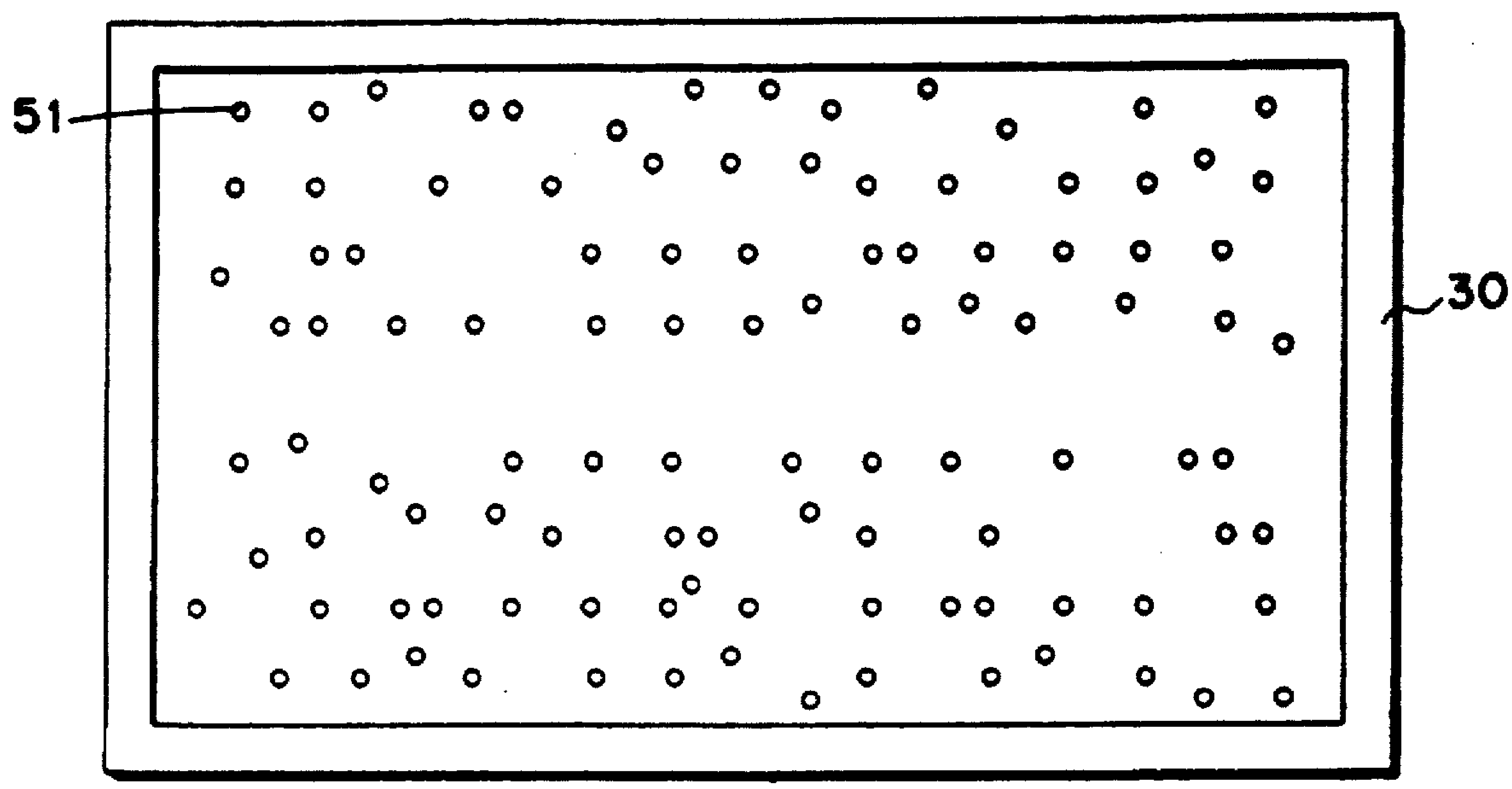


FIGURE 7



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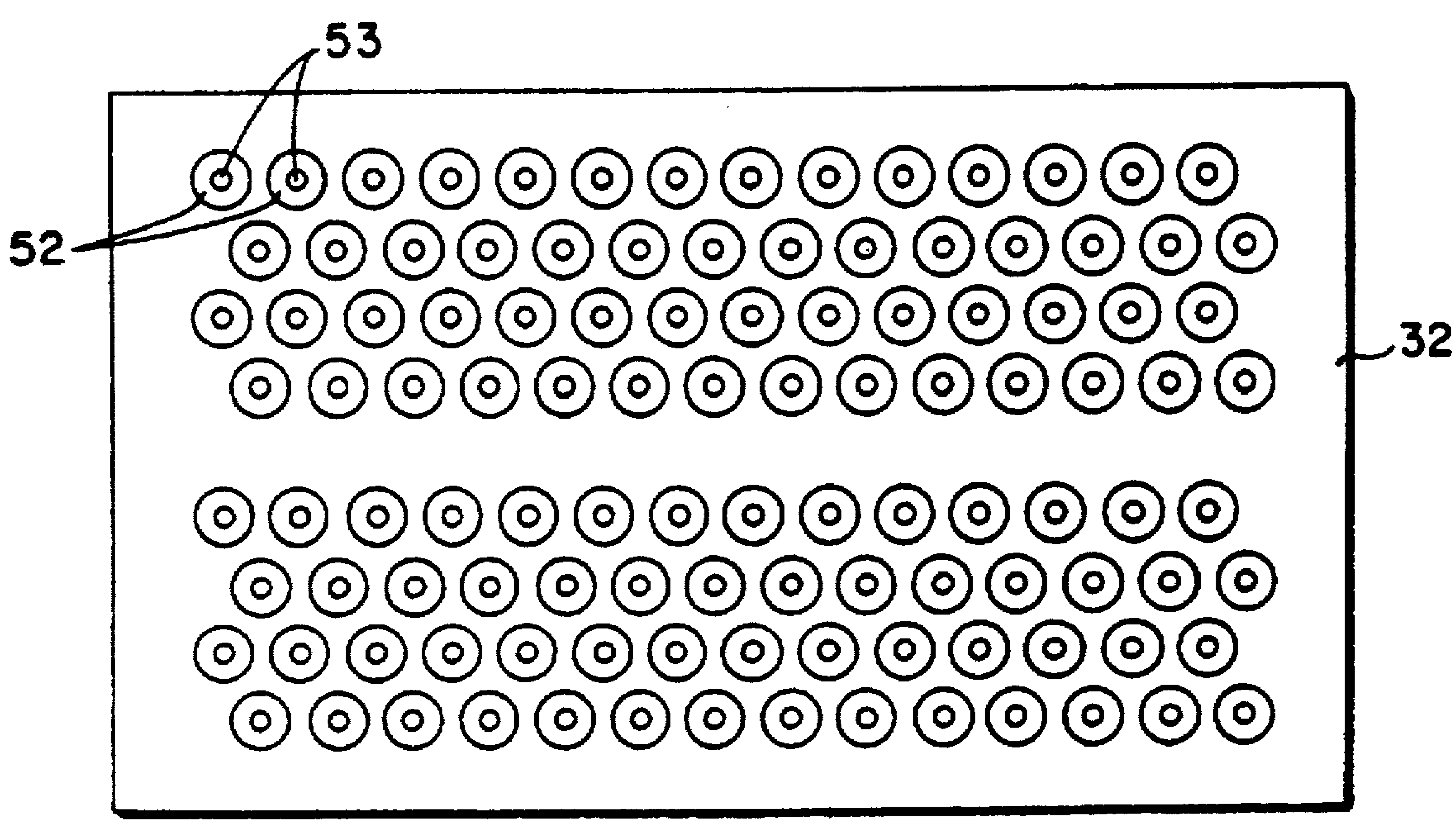


FIGURE 9

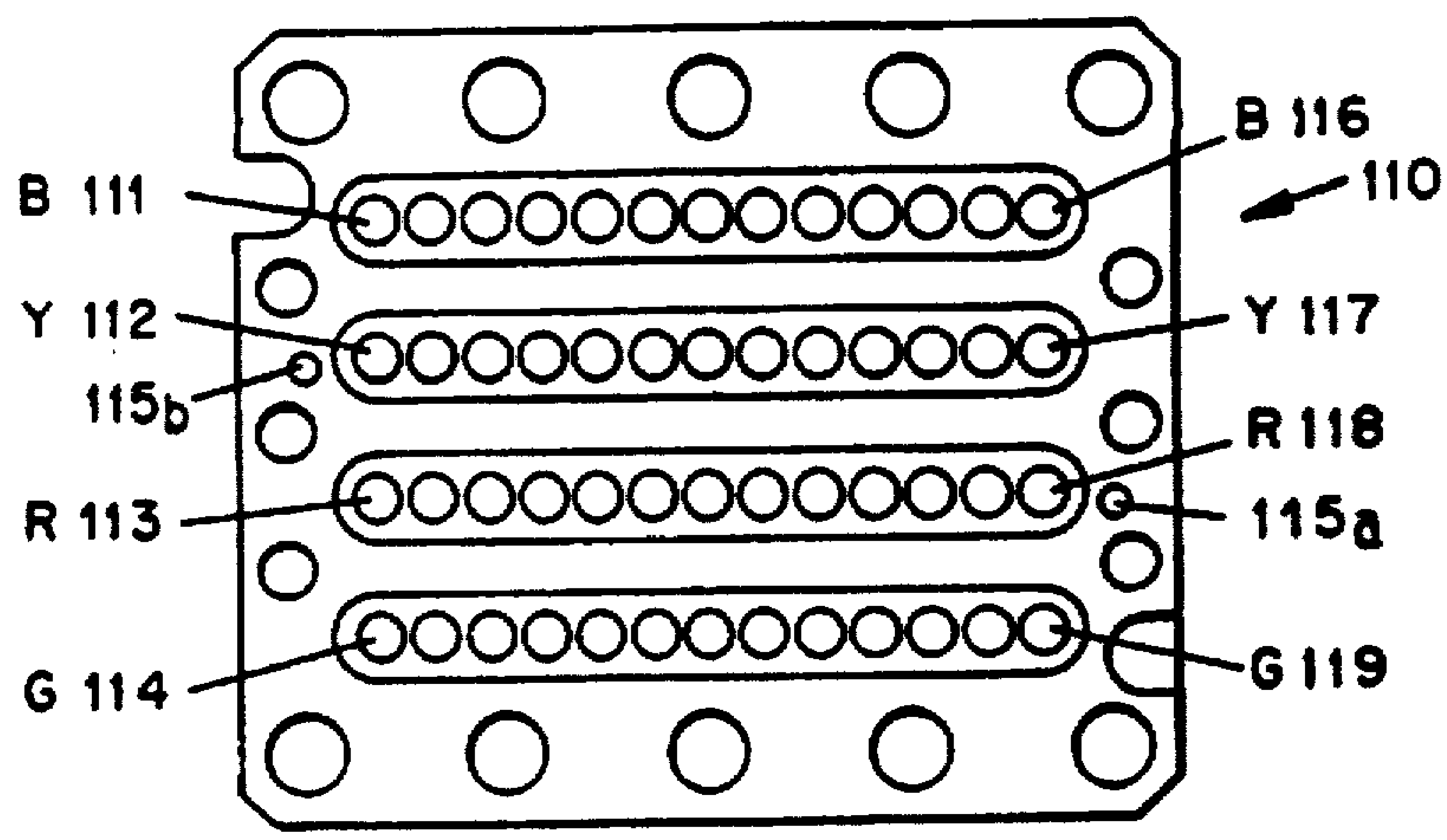


FIGURE 10

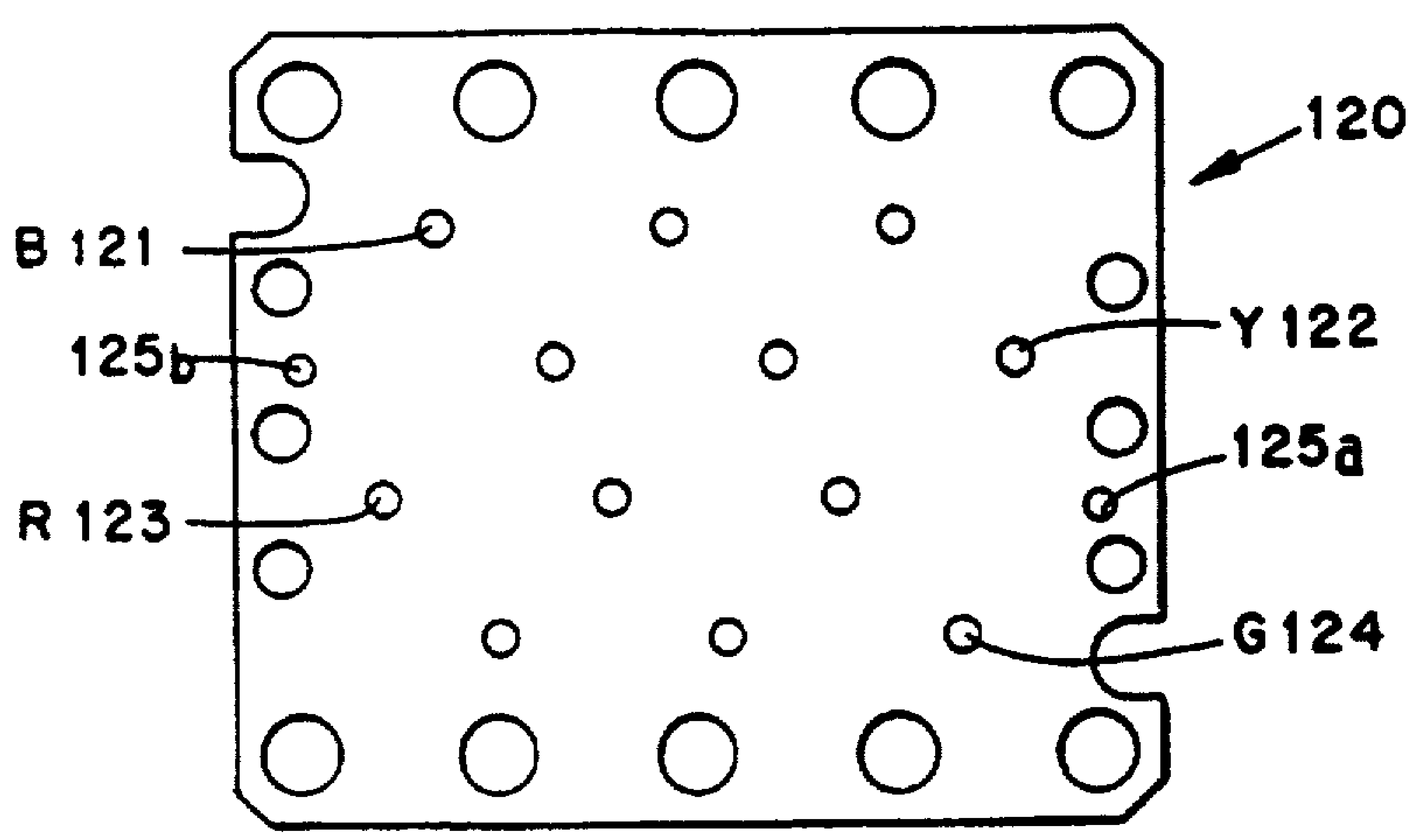
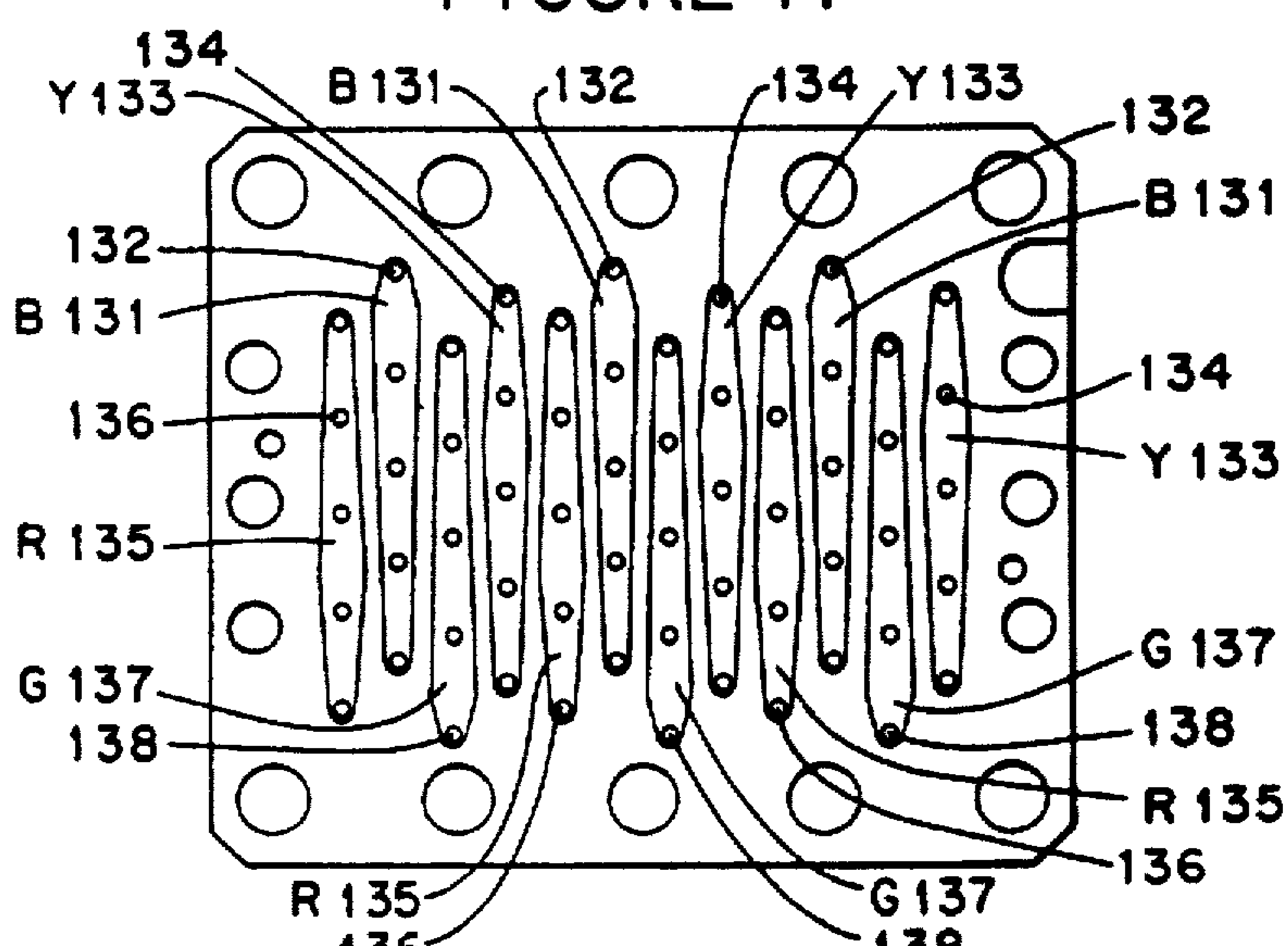


FIGURE 11



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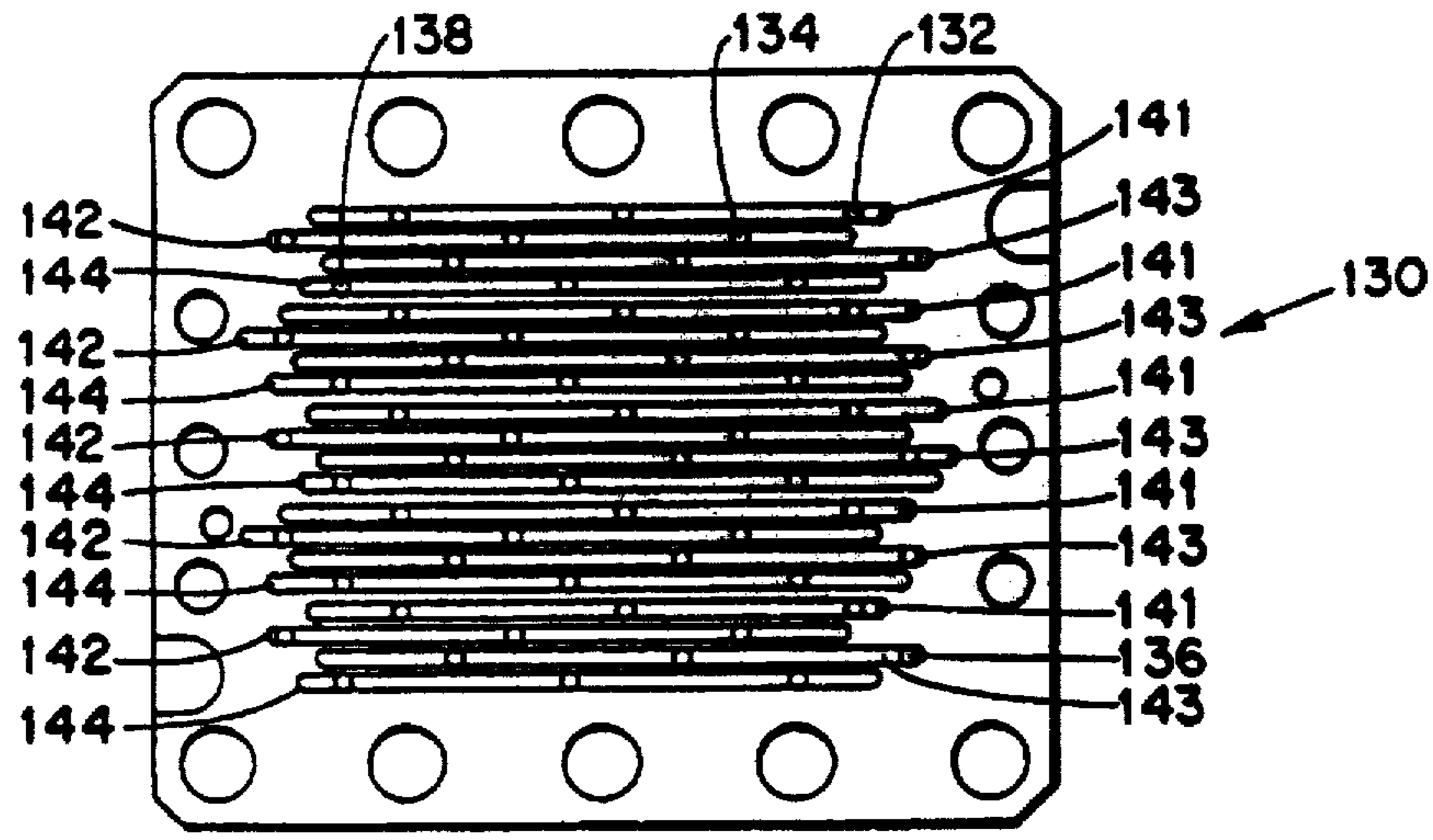
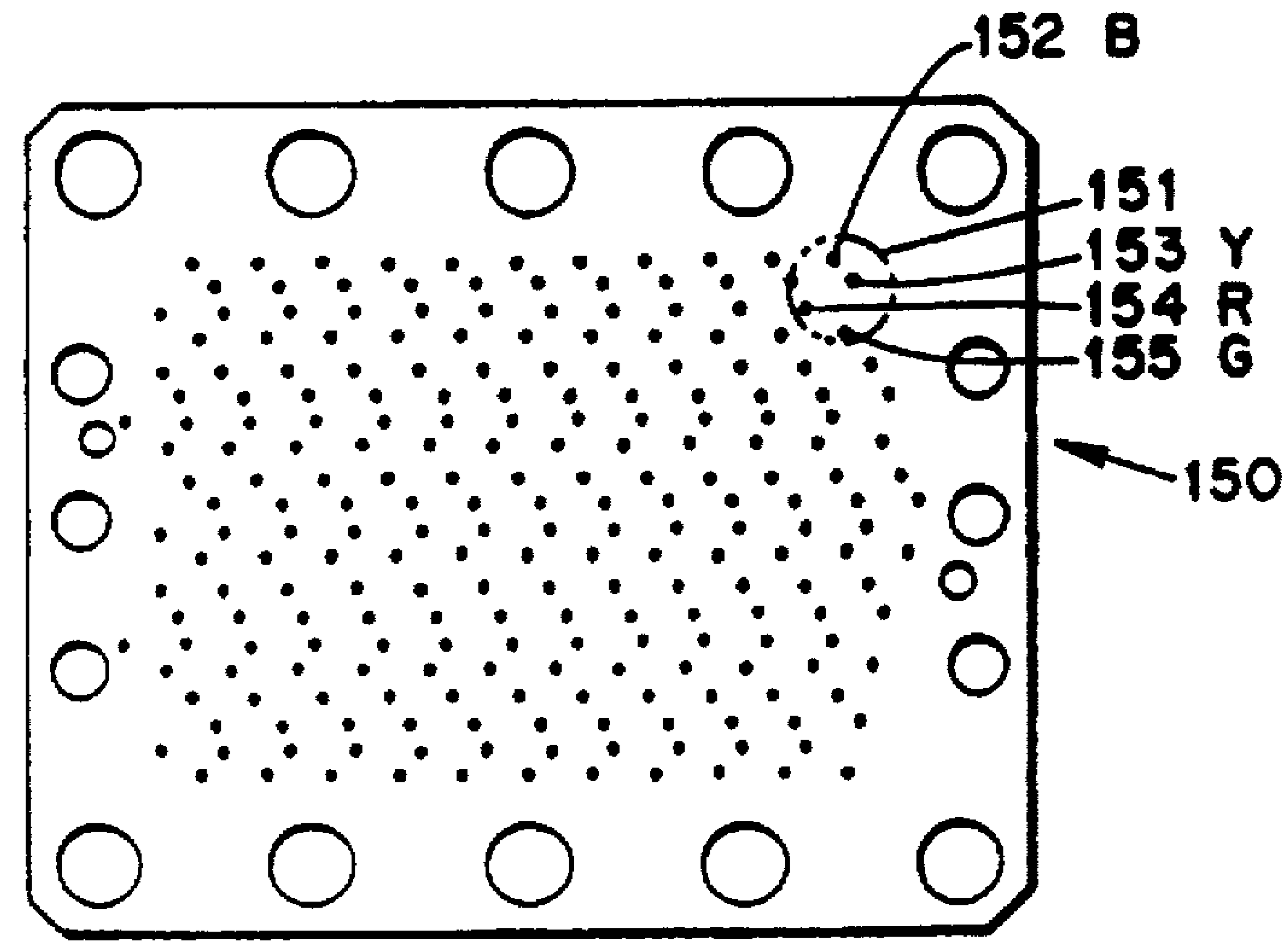


FIGURE 13



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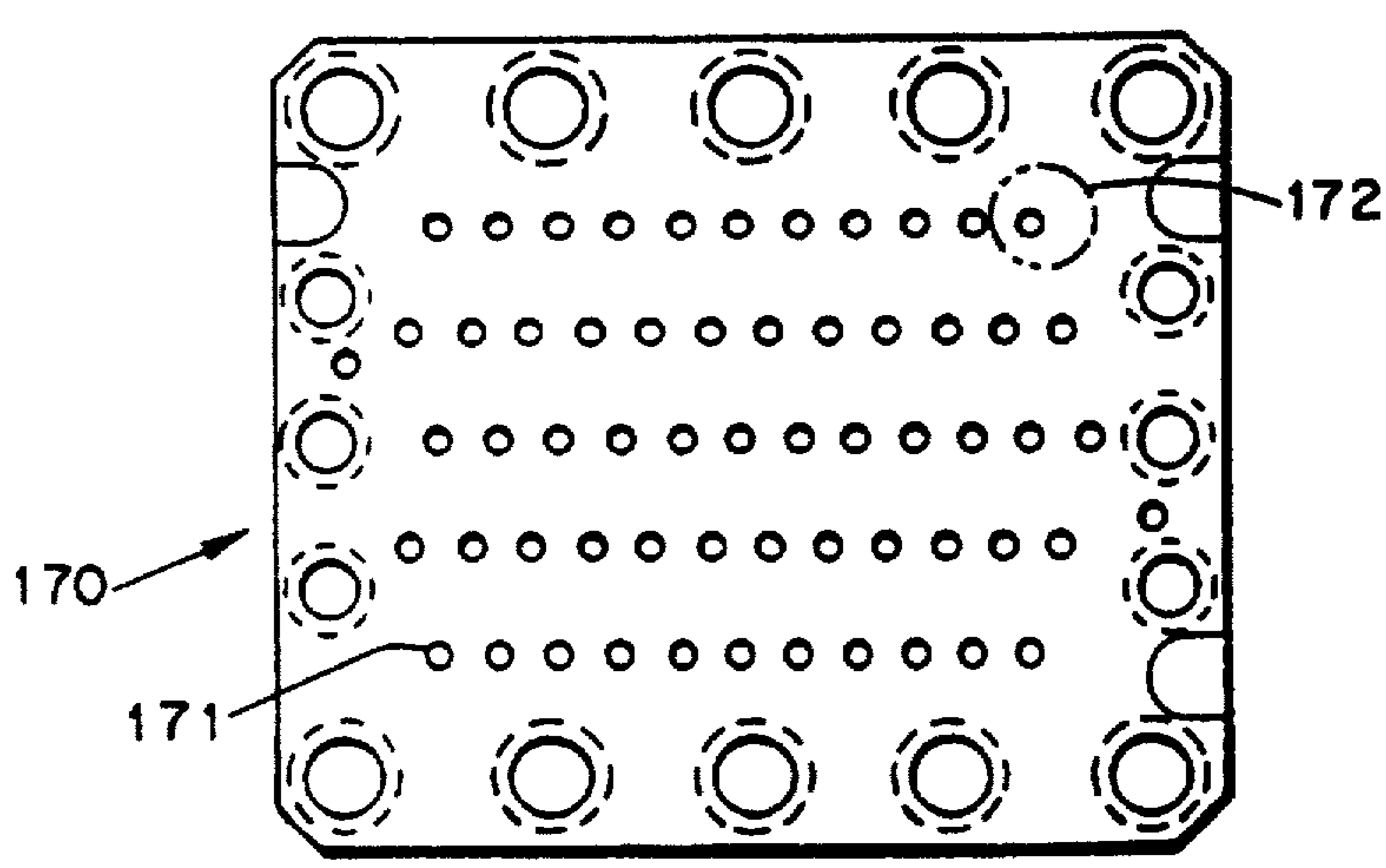

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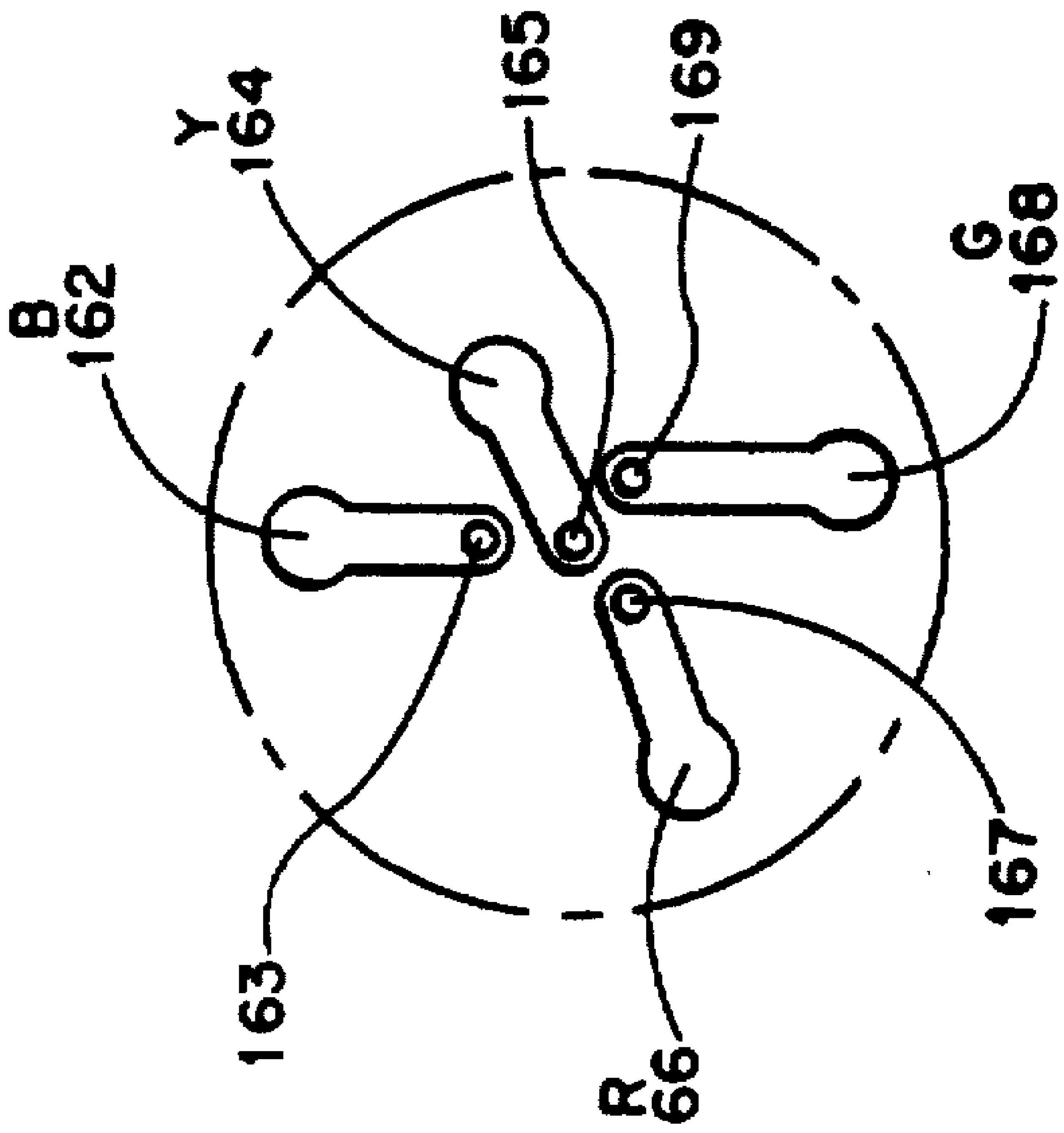
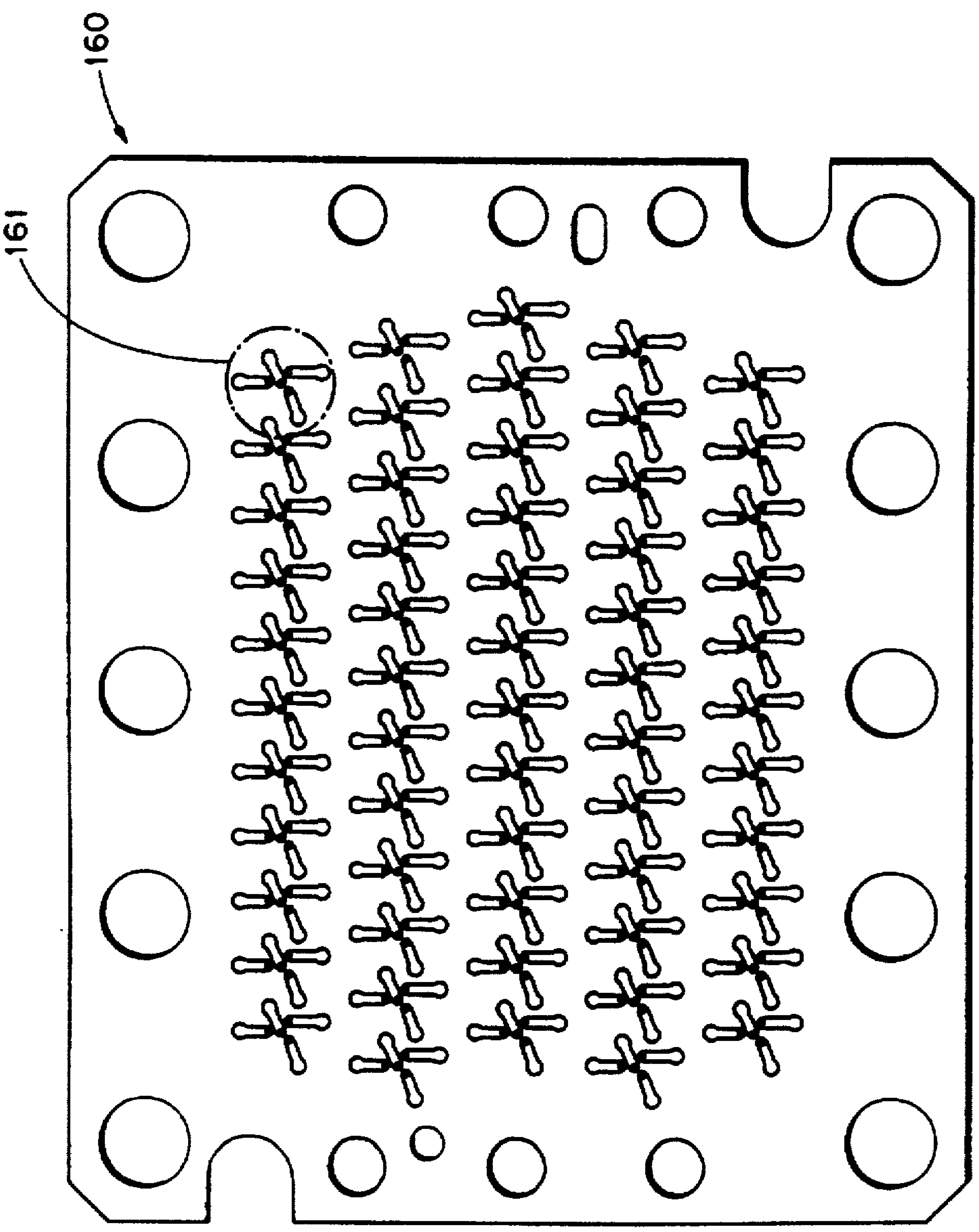


FIGURE 15A



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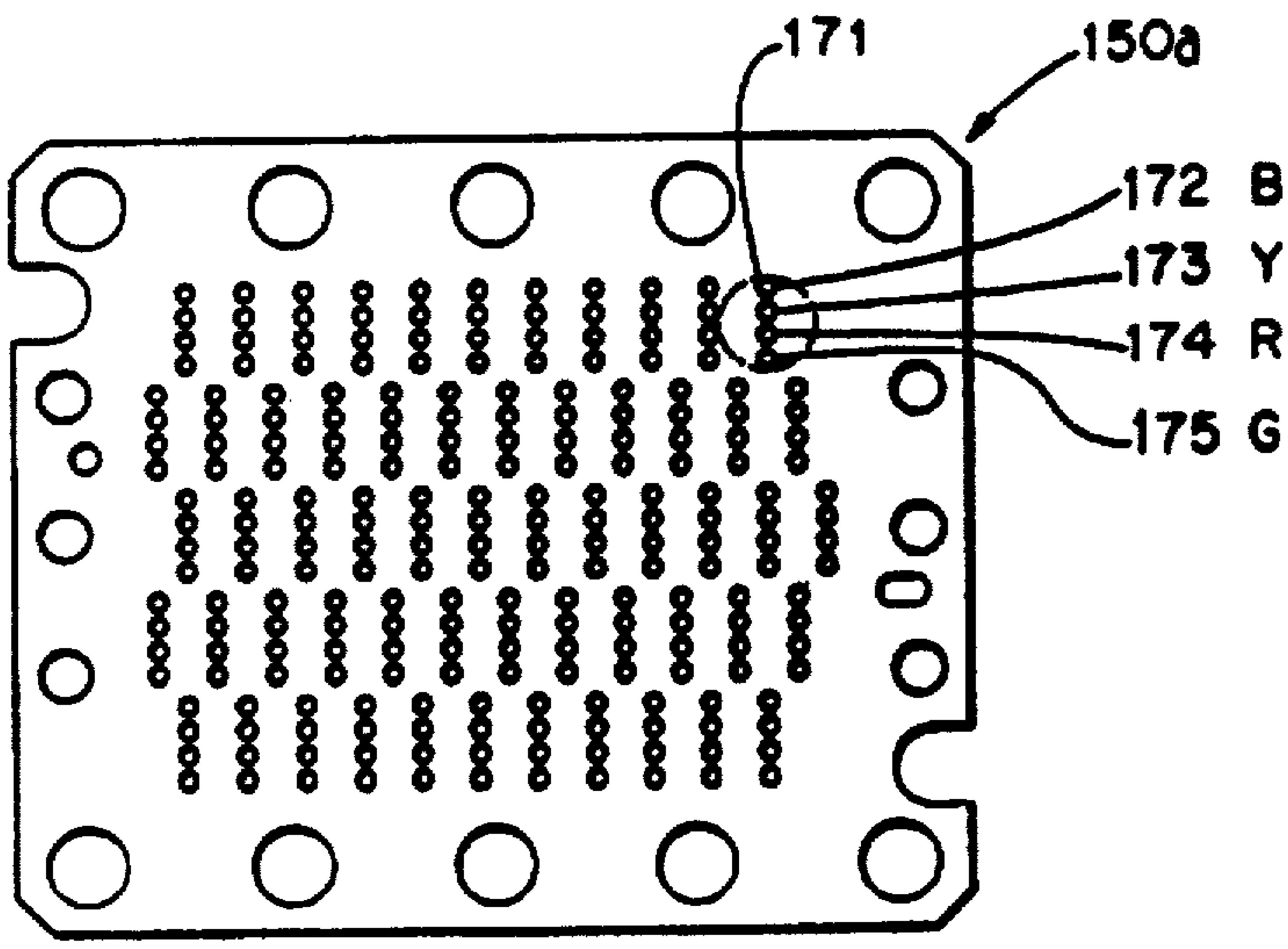

FIGURE 17

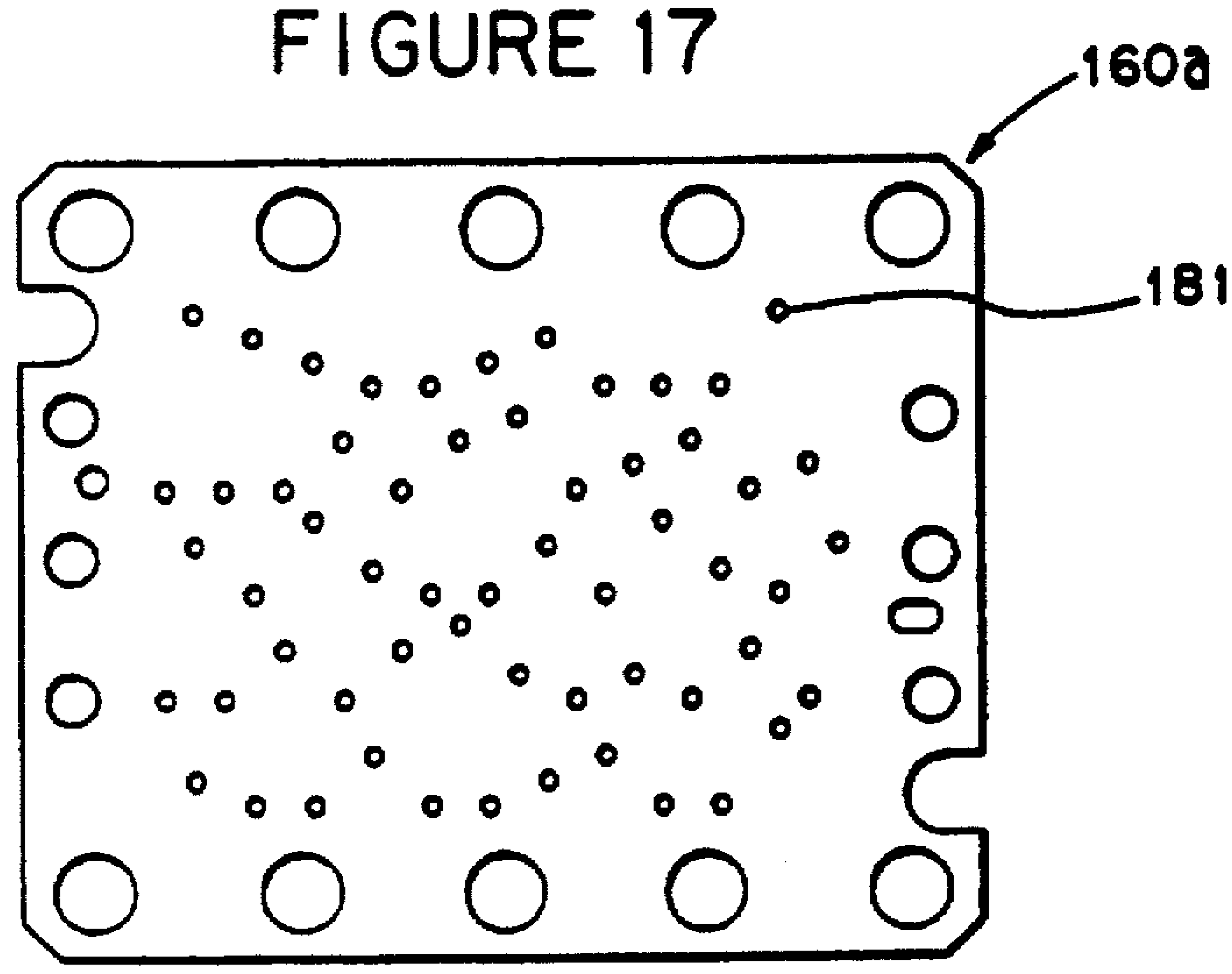

FIGURE 18

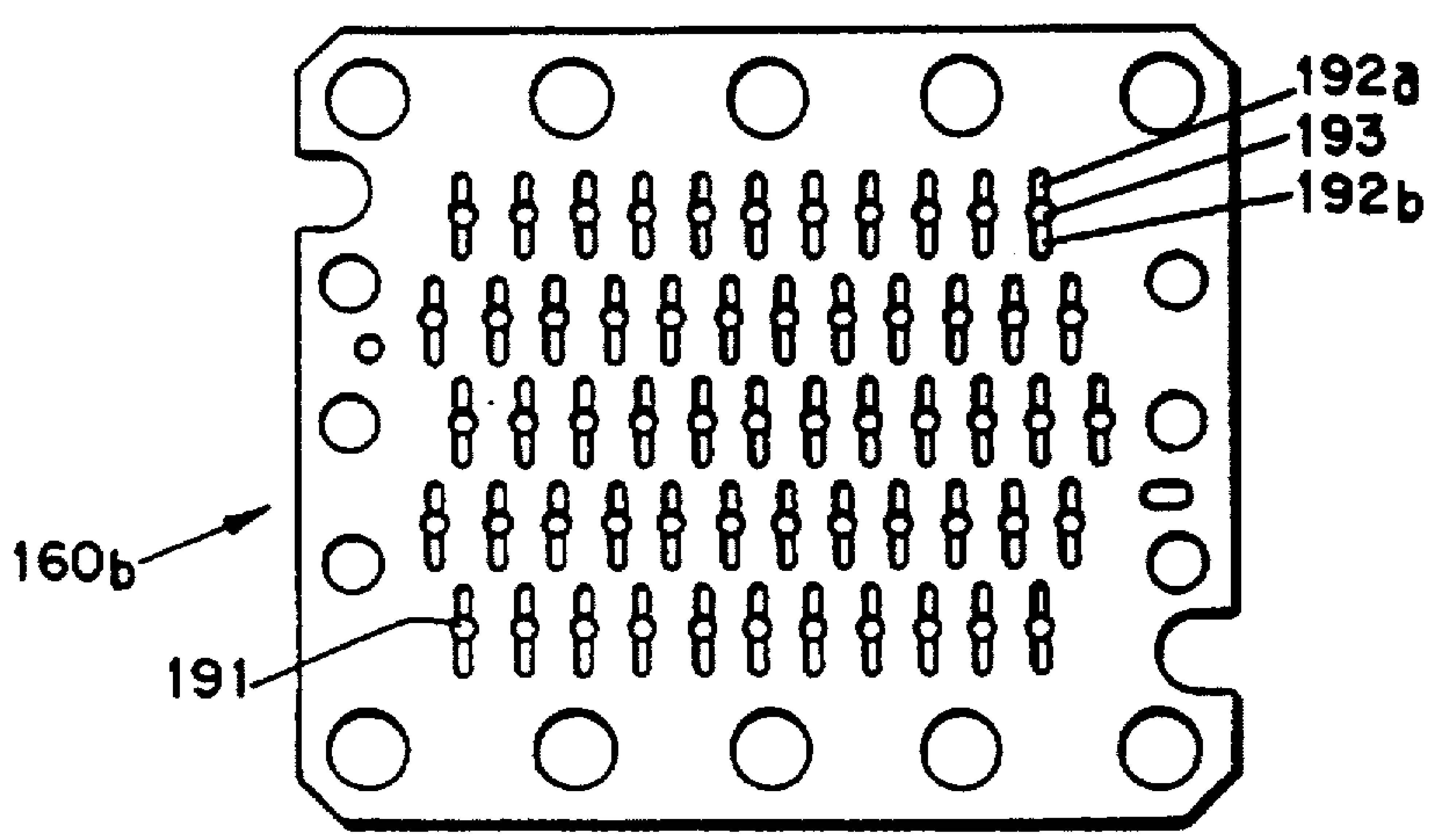

FIGURE 19

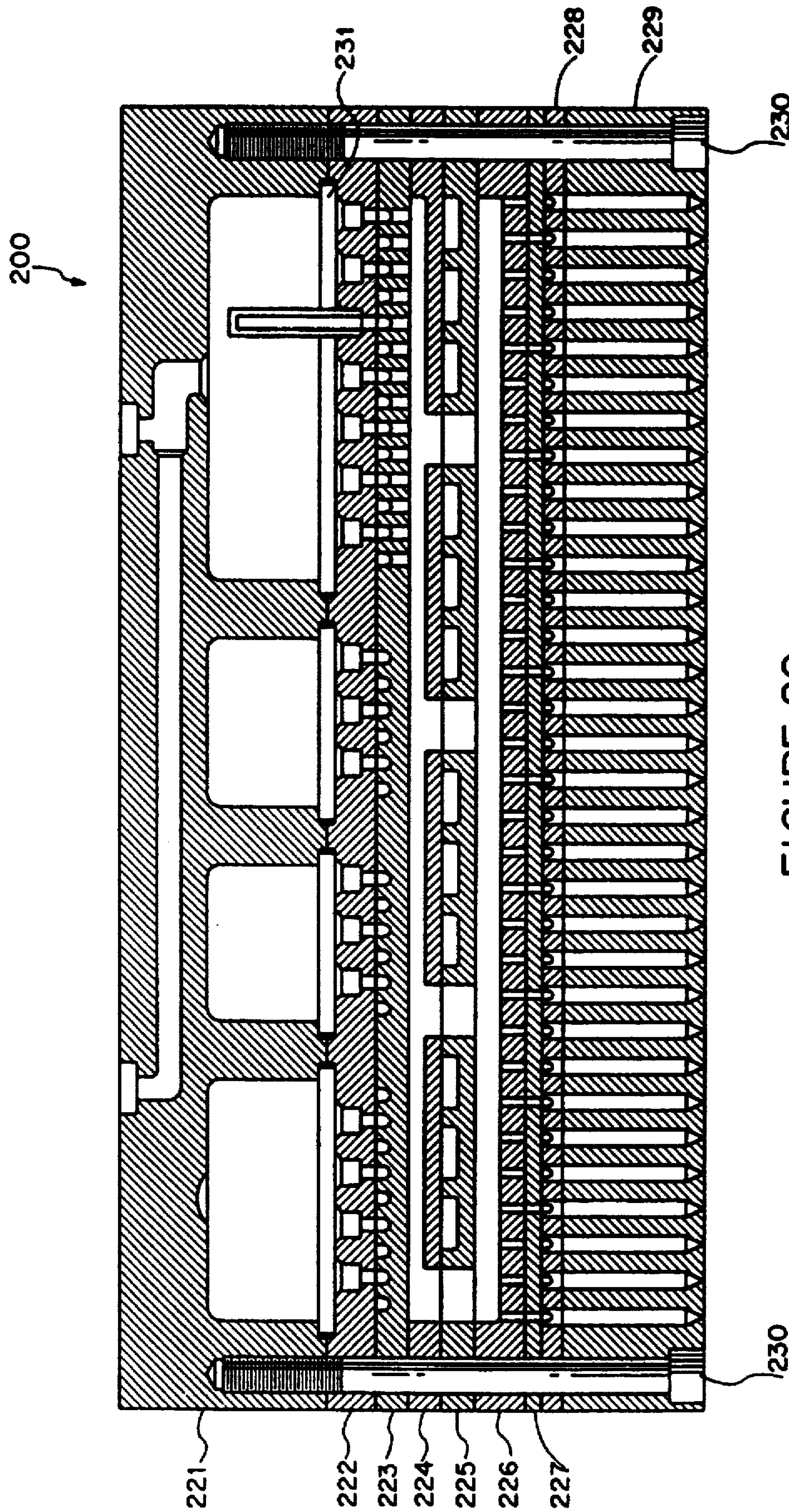

FIGURE 20

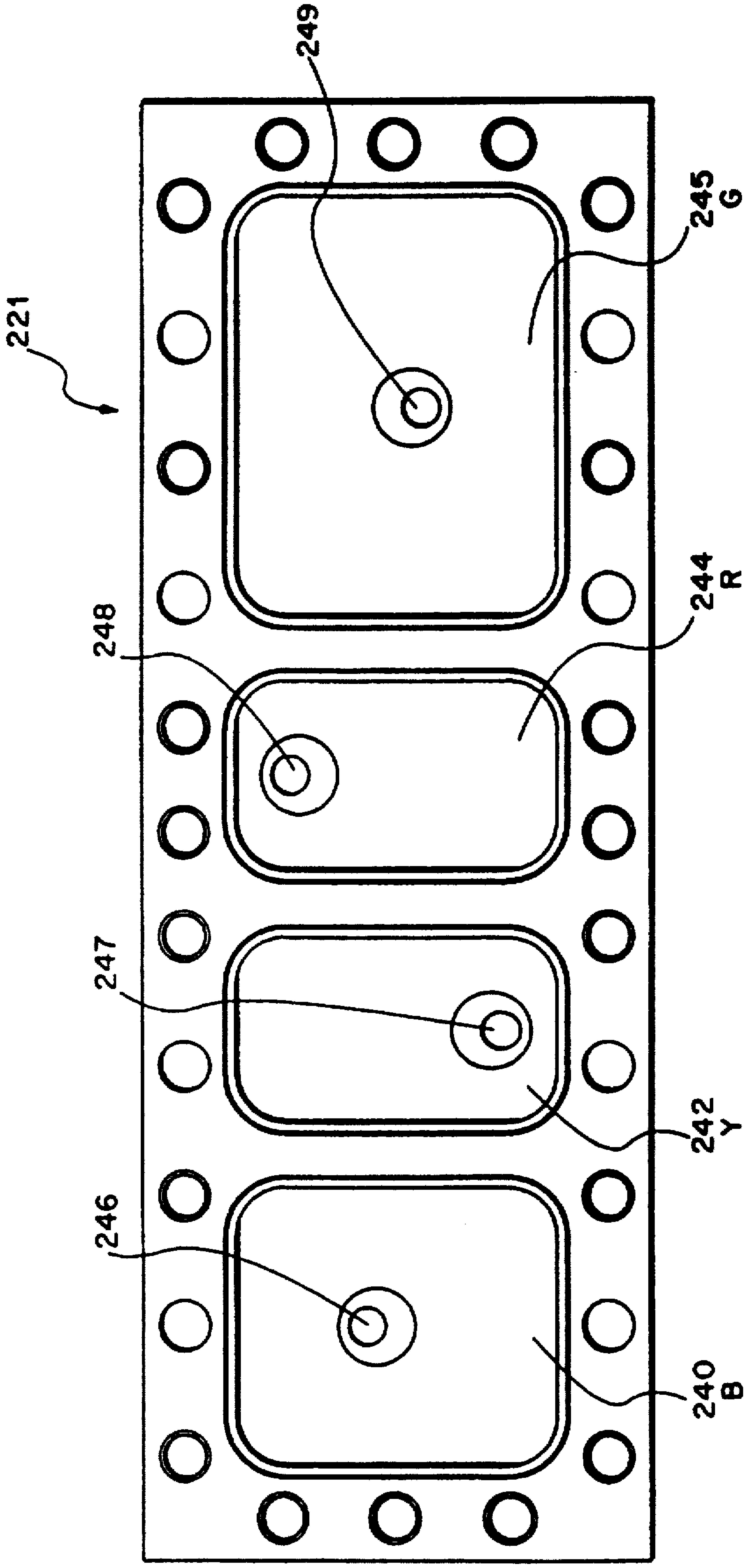

FIGURE 21

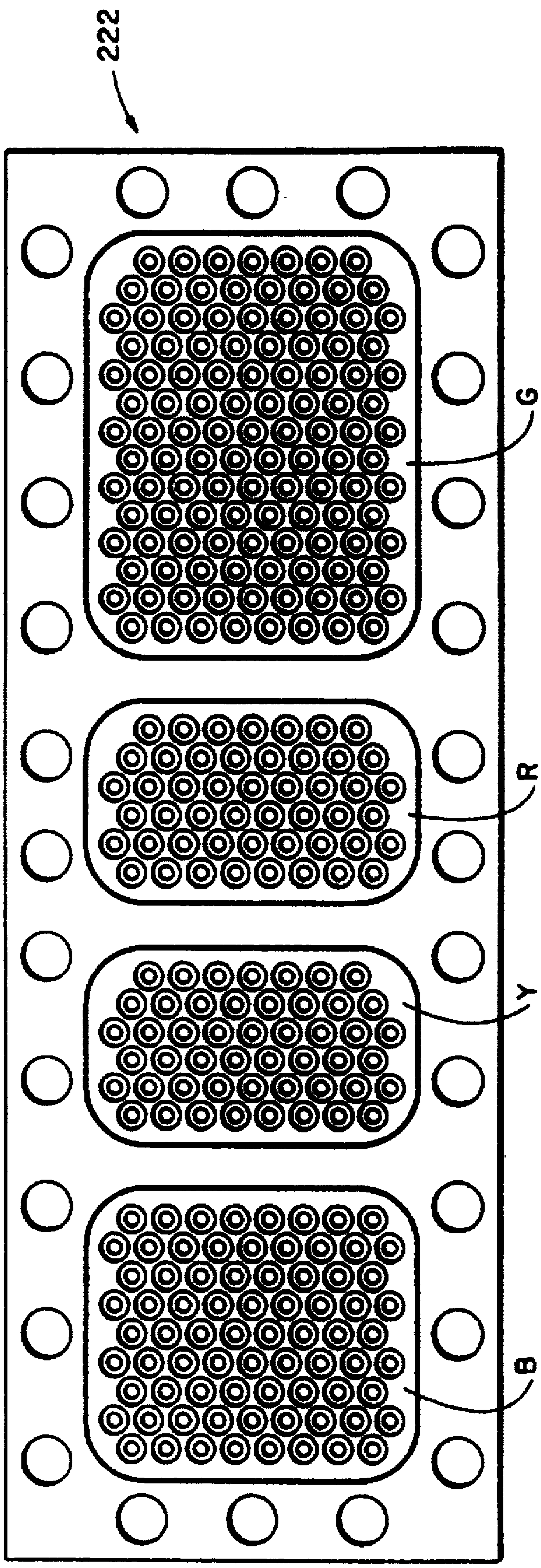

FIGURE 22

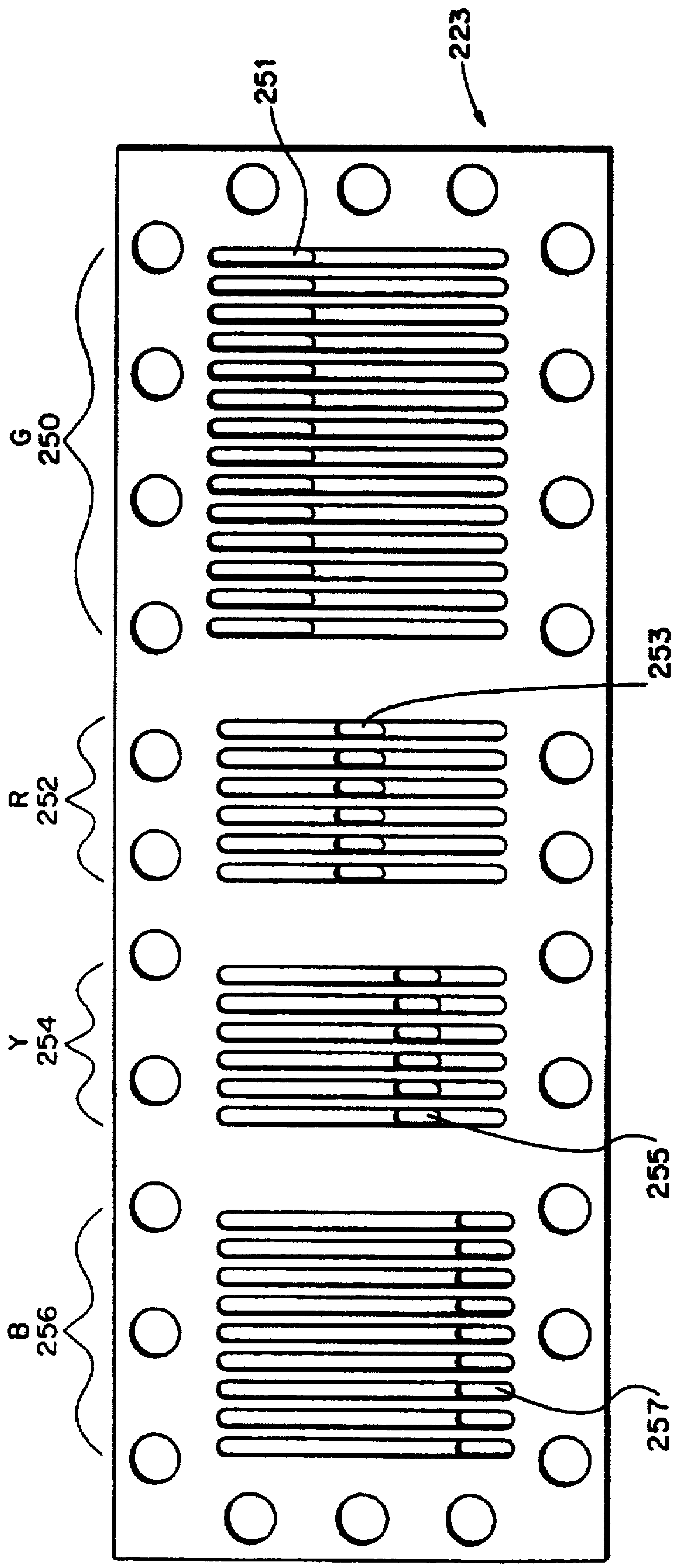

FIGURE 23

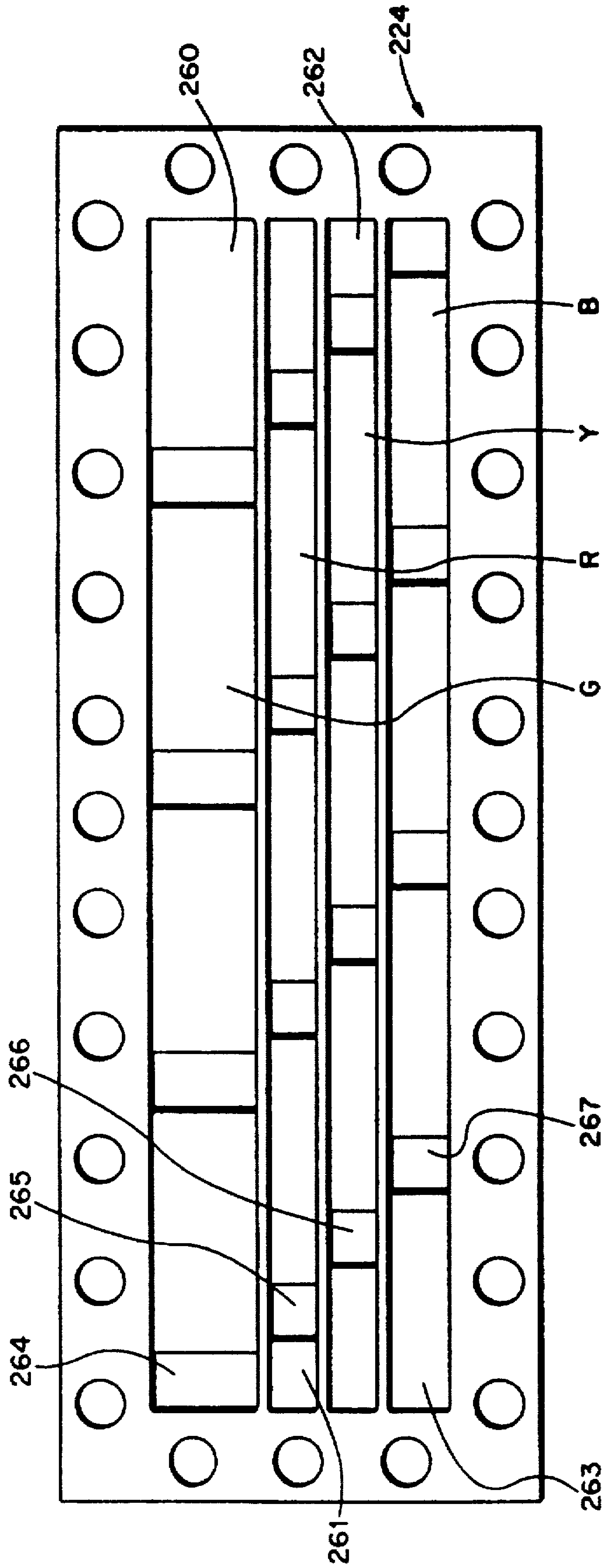

FIGURE 24

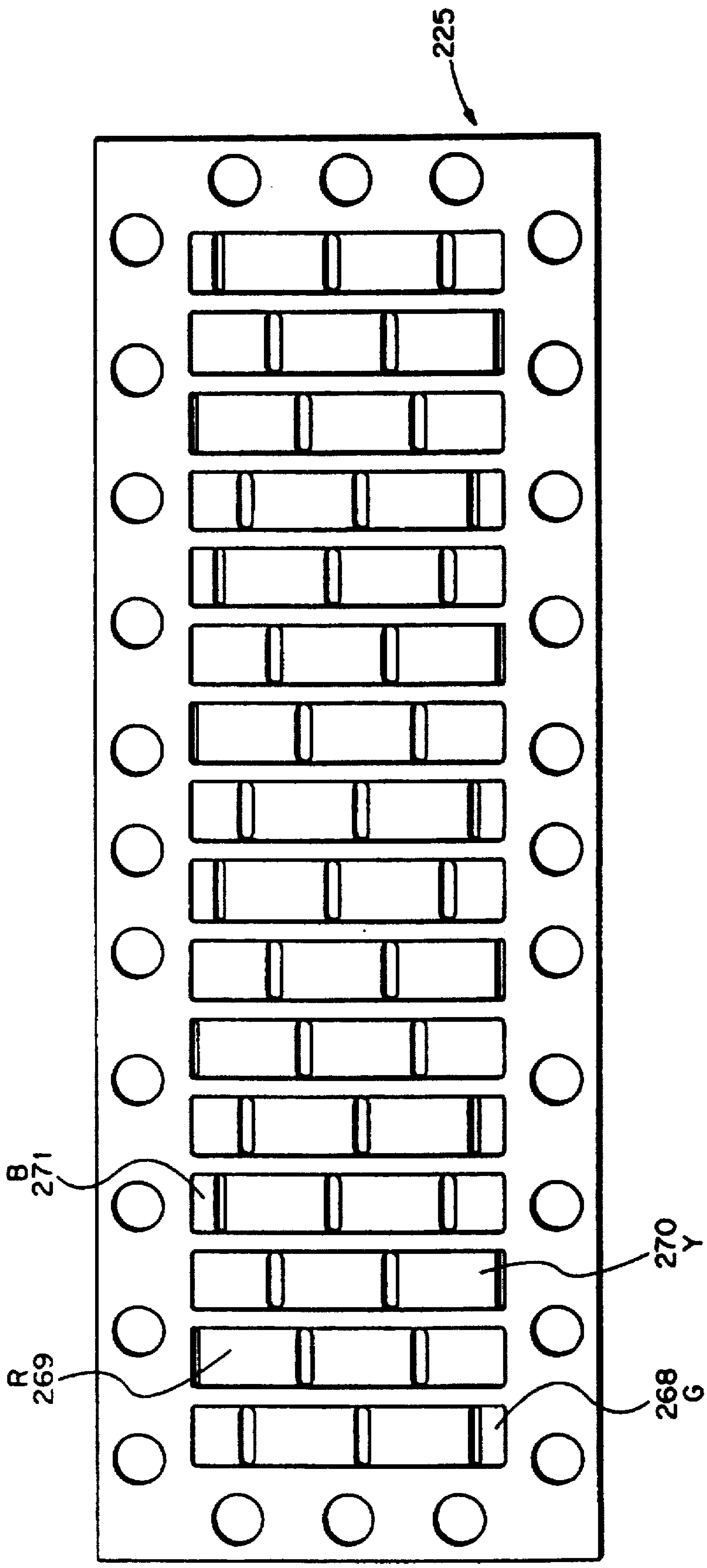

FIGURE 25

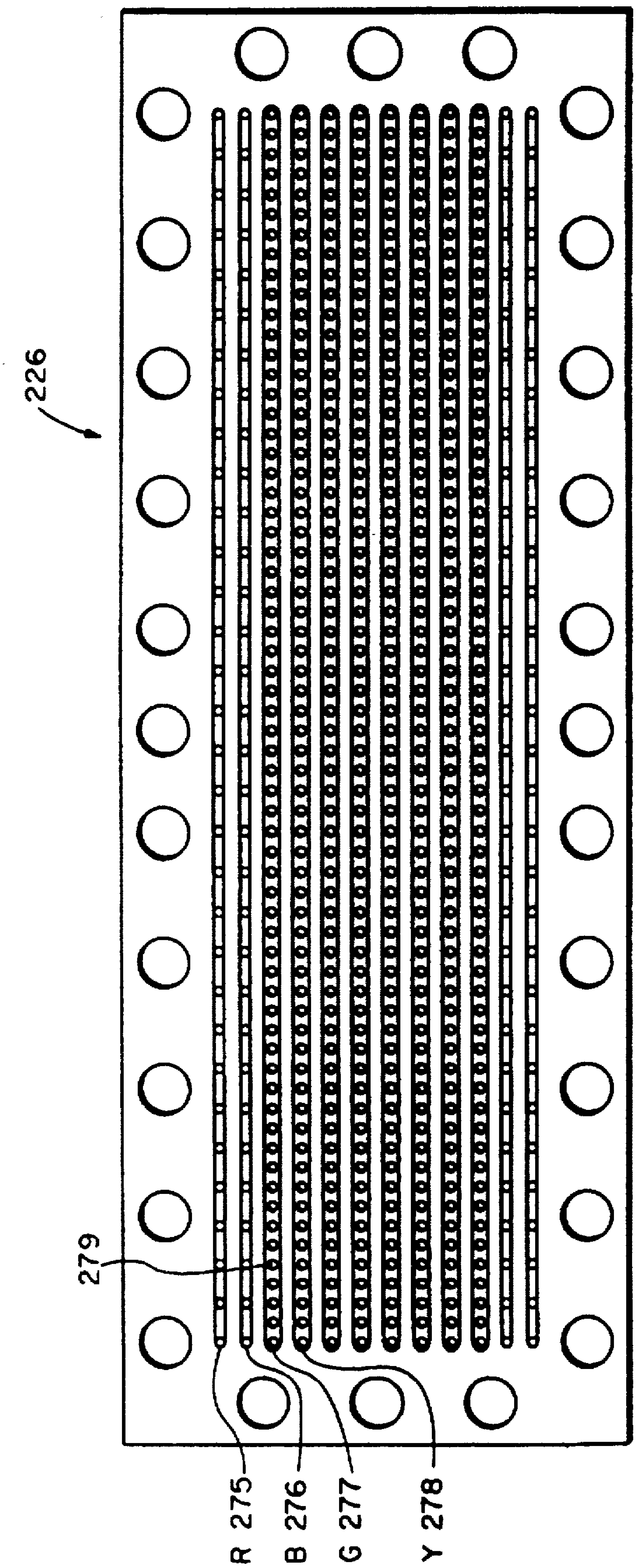

FIGURE 26

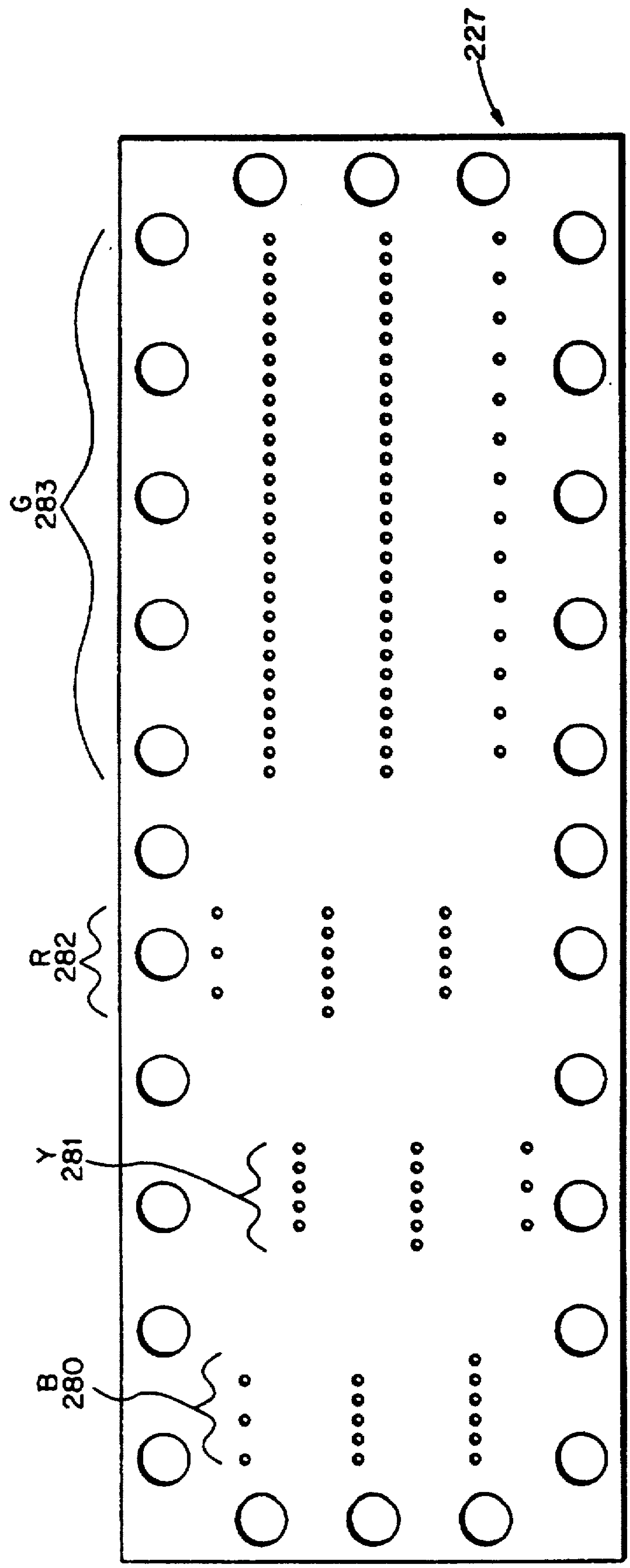

FIGURE 27

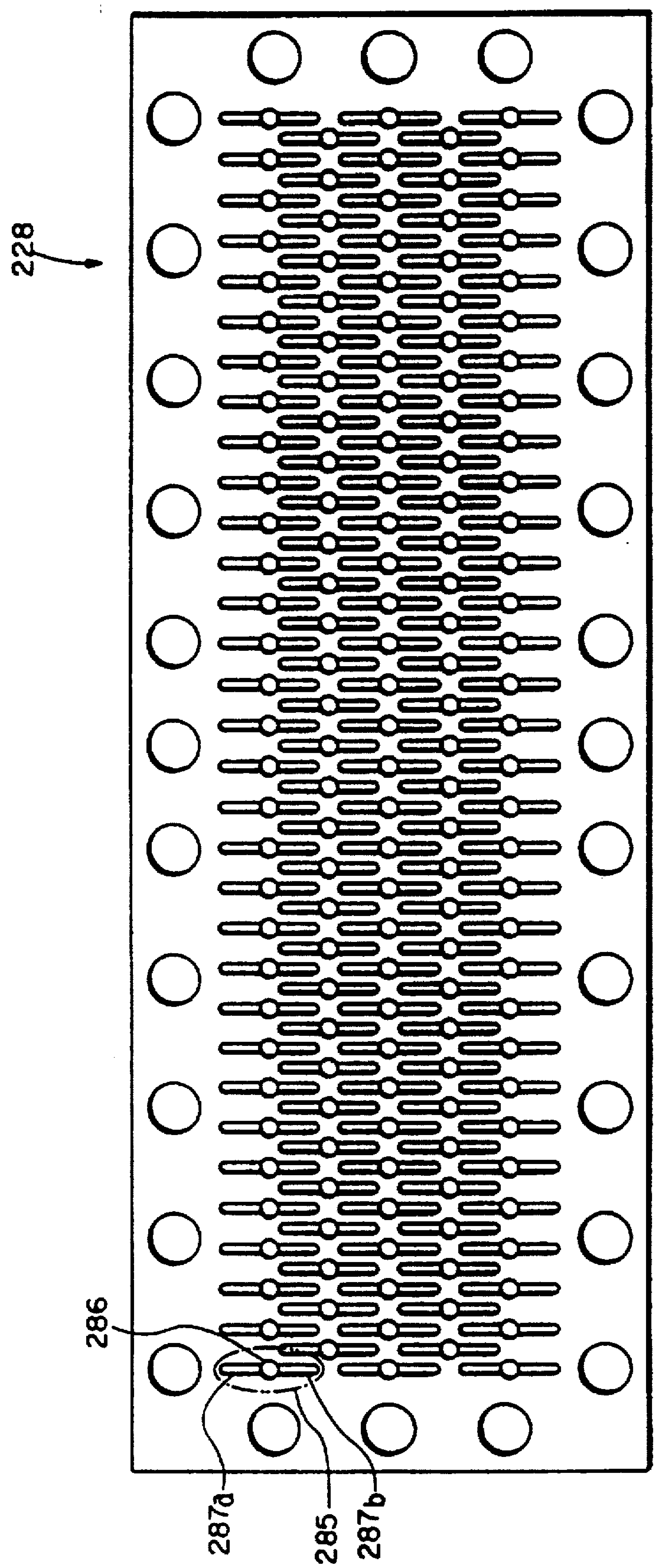

FIGURE 28

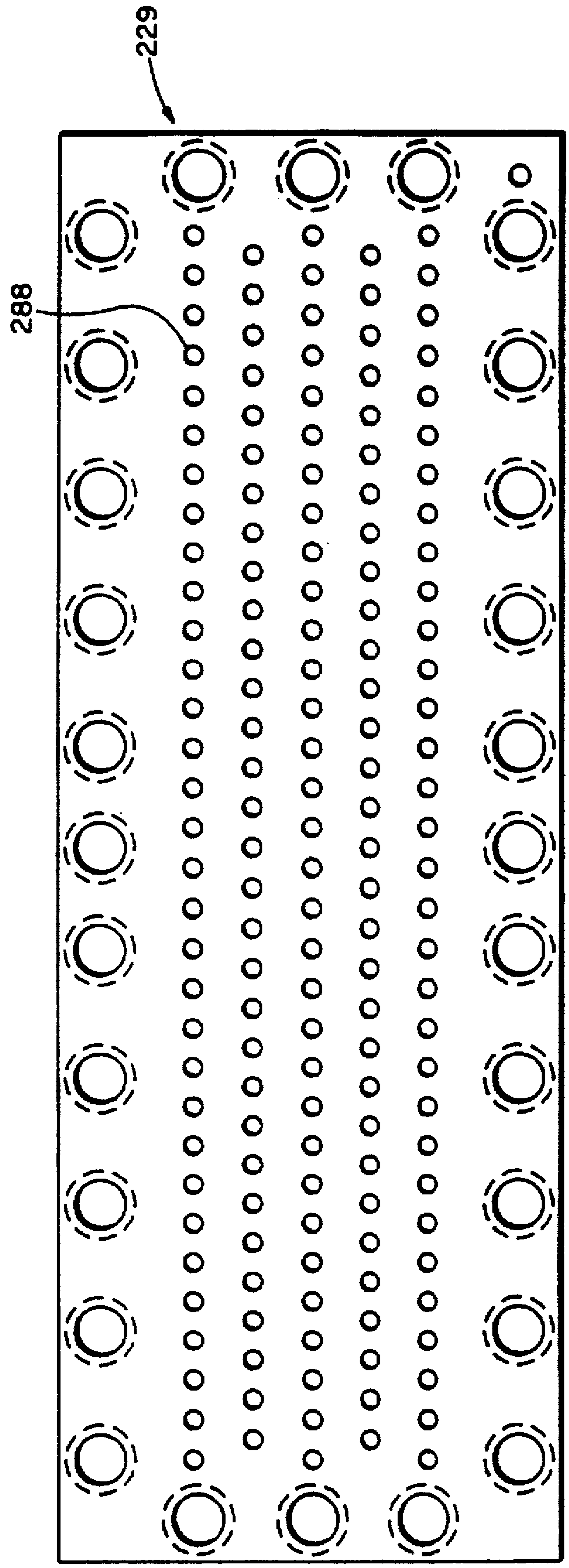

FIGURE 29

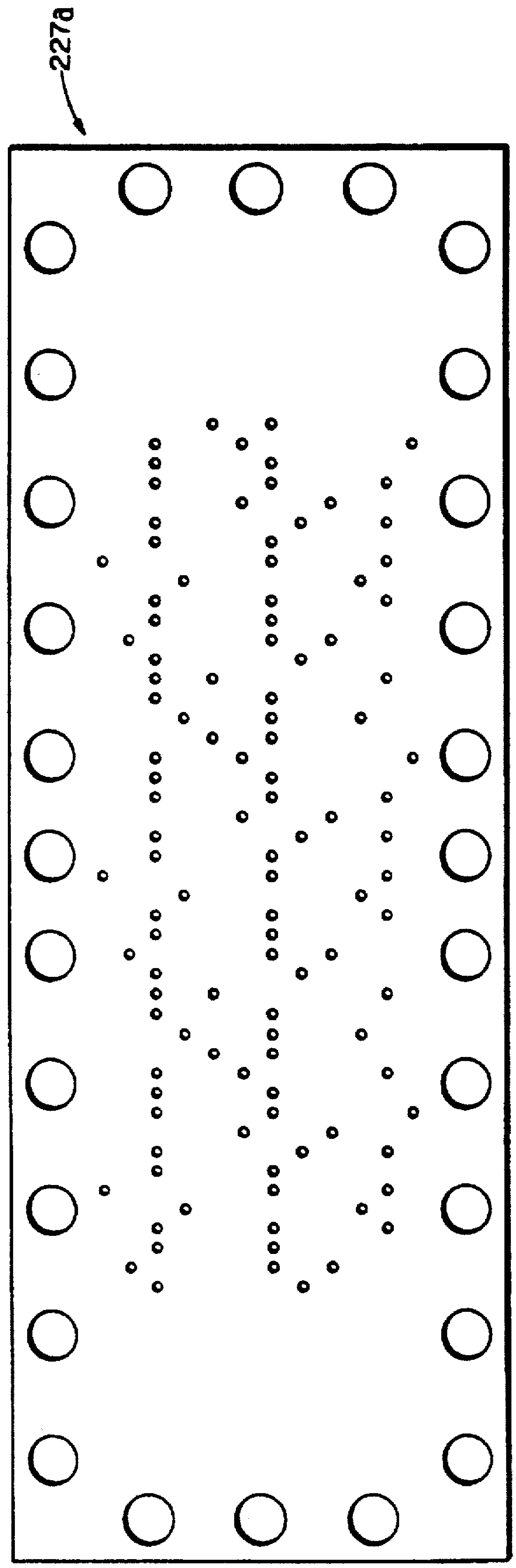

FIGURE 30

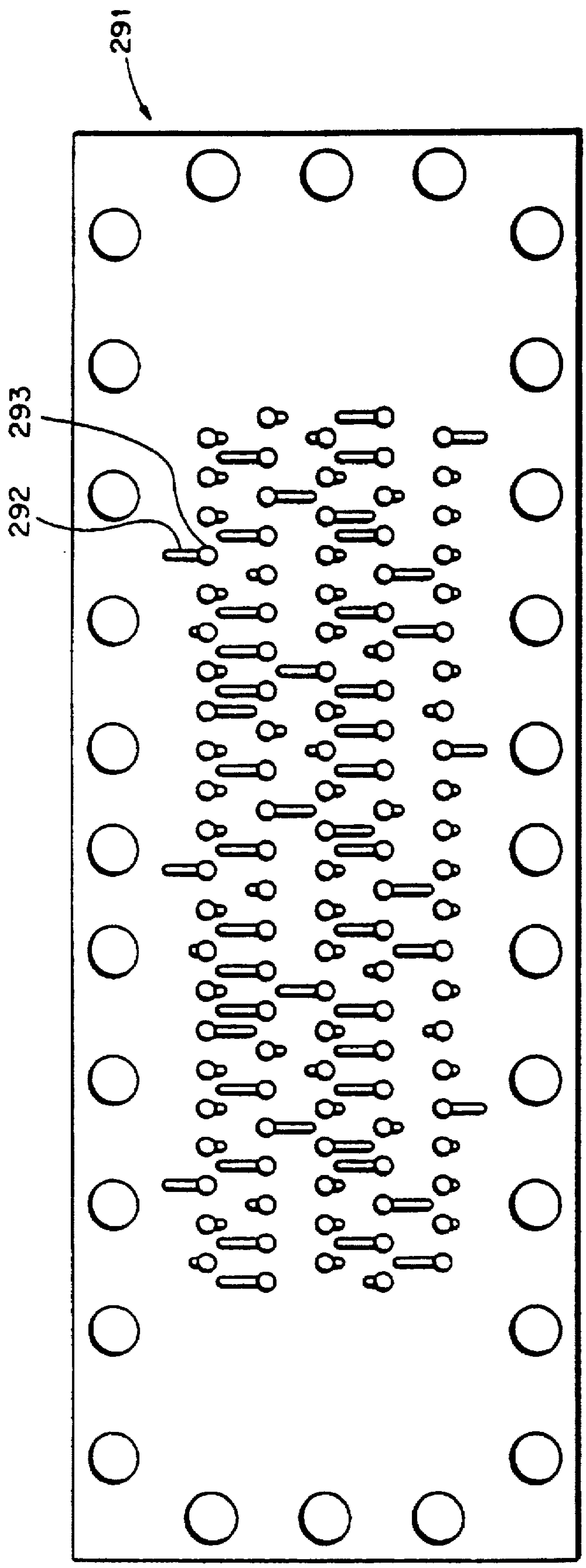

FIGURE 31

METHOD FOR SPINNING MULTIPLE COLORED YARN

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

FIELD OF THE INVENTION

This invention relates generally to melt extrusion of fiber-forming polymers. More specifically, this invention relates to melt extrusion to form multicomponent yarn.

BACKGROUND OF THE INVENTION

Spin packs for extruding component fibers are known. Such spin packs are of two general types: those which spin multicomponent filaments (more than one component within a single filament); and those which spin mixed filament yarn (more than one type of filament within a yarn). In this application, the term "multicomponent yarn" refers to both of these general types as well as combinations of the two. The term "active backhole" denotes backholes for spinneret orifices that are, or will be, actively extruding filameters.

Exemplary of spin packs for mixed filament yarn in U.S. Pat. No. 3,457,341 to Duncan et al., which discloses spinning mixed filament yarn by extruding two different polymer components through two different sized orifices of the same spinneret. This is done to control differential spinning characteristics of the individual polymers within established levels of operability.

Exemplary of spin packs for multicomponent filaments is U.S. Pat. No. 3,730,662 to Nunning. Nunning discloses a spin pack for spinning side-by-side or sheath/core filaments by distributing mutually separated polymer streams to each spinneret backhole. Each discrete stream enters each active backhole.

Known are spinnerets useful for spinning both multicomponent and "ordinary" (single-component) filaments by simple rotation of a distribution plate. Such a device is disclosed in U.S. Pat. No. 3,584,339 to Kamachi et al.

Also, known is an apparatus for preparing profiled multicomponent fibers from mutually separated polymer streams. Such an apparatus is described in commonly assigned PCT Application No. WO 89/02938. In that apparatus, mutually separated polymer streams are routed in a predetermined fashion to the backhole of each spinneret orifice.

Yet, all of the known spin packs are designed for spinning one or two predetermined and fixed multicomponent or mixed filaments. Especially valuable would be a spin pack which routes multiple mutually separated polymer streams to the proximity of the spinneret backhole and allows variable selection at the backhole of the polymer stream which issues through the spinneret orifice.

Such a spin pack would be useful in preparing uniformly spread components in mixed filament yarn, inter alia. U.S. Pat. No. 3,681,910 to Reese teaches a composite yarn of two discrete classes having a high degree of filament mixing. Yet, high filament mixing (or distribution) in yarns composed of more than two discrete classes is unknown in the art.

Also useful would be a yarn in which a high degree of filament mixing is present in one area of the yarn and components in other areas of the yarn, one or more filament

types are concentrated. Such an arrangement of mixed and non-mixed areas result in a heather yarn with a pleasing color highlight effect. Such a yarn is also not known.

SUMMARY OF THE INVENTION

To meet the needs described above, a first embodiment of the present invention provides a spin pack for spinning multiple components. The spin pack includes means for receiving at least two mutually separated molten polymer streams; a spinneret having a backhole and least one active fiber extrusion orifice; upstream of the spinneret, a distribution device in fluid flow communication with the receiving means and having means for distributing the mutually separated molten polymer streams to the spinneret wherein each mutually separated molten polymer stream is accessible at each backhole; and intermediate the spinneret and the distribution device, a selection assembly having means for selecting which, if any, mutually separated molten polymer stream flows into which backhole.

Another embodiment of the present invention concerns a process for spinning multiple components by (a) feeding mutually separated molten polymer components to a spin pack having a spinneret with extrusion orifices for issuing filaments, each extrusion orifice having a backhole for receiving molten polymer; (b) distributing each mutually separated component so that each component is accessible as a distinct component at every active spinneret backhole; (c) selecting which component accessible at each backhole, if any, is issued as a filament from the extrusion orifice; and (d) extruding multiple component filaments.

A further embodiment of the present invention concerns a mixed filament yarn having the appearance of high color homogeneity and characterized by filaments of at least three different colors dispersed approximately uniformly through said yarn.

A still further embodiment of the present invention is a multi-component yarn having two or more differentiated zones of filament mixing.

It is an object of the present invention to provide an improved spin pack design.

It is another object of the present invention to provide an improved process for melt spinning multicomponent filaments or mixed filament yarns.

A further object of the present invention is to provide an improved mixed filament yarn.

After reading the following description, related objects and advantages of the present invention will be apparent to those ordinarily skilled in the art to which the invention pertains.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1–9** schematically represent a first embodiment of a spin pack according to the present invention.

FIGS. **10–16** illustrate a first alternate configuration of the second embodiment of a spin pack according to the present invention.

FIGS. **17–19** illustrate a second alternate configuration of the second embodiment of the spin pack of the present invention.

FIGS. **20–29** illustrate a third alternate configuration of the second embodiment of the spin pack of the present invention.

FIGS. **30–31** illustrates a fourth alternate configuration of the second embodiment of the spin pack of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

To promote an understanding of the principles of the present invention, descriptions of specific embodiments of the invention follow and specific language describes the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, and that such alterations and further modifications, and such further applications of the principles of the invention as discussed are contemplated as would normally occur to one ordinarily skilled in the art to which the invention pertains.

As used in the following description of the drawings, unless noted otherwise, the terms "vertical" and "horizontal" refer to the orientation of the drawing on the page and not to the orientation of the apparatus in three dimensional space.

In general, the present invention relates to an apparatus and method for routing mutually separated polymer streams to each backhole of a spinneret such that each polymer stream is accessible to each backhole. At the backhole, the streams permitted to enter the backhole are versatilely programmed. This principle of the present invention applies to at least two, preferably four, and possibly more different polymer streams.

As a result of the accessibility of each component at each backhole, this invention provides economic and process advantages. The invention is economically advantageous since product changes are facilitated by simply exchanging a single plate in a spin pack. Process advantages are facilitated from the reduced part inventory permitted by the flexibility of this invention.

The first embodiment of the present invention is a spin pack for spinning multicomponent yarn where at least two, preferably four, and possibly more, different polymer component streams are each fed mutually separated to the backhole of a spinneret orifice to form at each backhole, a cluster of feedstreams. Members from each cluster are then selected for extrusion. This embodiment is based on a "pool and down" method of distribution. Individual feed streams form pools which separate into a plurality of streams of that polymer, which then pass down, mutually separated from the other types of polymer, to be accessible at the spinneret backhole.

FIGS. **1–9** schematically represent a spin pack according to the first embodiment. This embodiment is relatively uncomplicated and is presented first to assist in understanding this invention.

FIG. **1** is a schematic cross-section illustrating polymer flow through spin pack **10**. To illustrate the invention, four polymer feeds of four different colors are shown. Each color is fed to filter plate **12**. Colors illustrated are blue (B), yellow (Y), green (G), and red (R). Each color is kept mutually separate from filter plate **12** to spinneret **32**.

Polymer (R) flows from filter plate **12** to pool plate **14**, where it forms pool **13** for making a larger number of smaller red polymer streams. Thirteen red streams **15** are shown. Pool **13** does not intersect the other polymer feed flows, which pass completely through to pool plate **18**. In pool plate **18**, polymer (G) forms pool **19** to form twelve smaller green polymer streams **21**. Each polymer stream (R) passes through pool plate **18** intact and feed streams (Y) and

(B) pass through to pool plate **22**, where polymer (Y) forms pool **23** and eight smaller yellow polymer streams **24**. All streams remain mutually separated at this plate and pass through, without mixing, to pool plate **26**. At pool plate **26**, the final feed stream—polymer (B)—forms pool **27** and ten smaller blue polymer streams **28**. Now each color has been distributed to form numerous separated polymer feed steams. Each feed stream is now accessible to each backhole of spinneret **32**. The manner in which each steam is accessible will be more readily understood from FIGS. **2–8** which show, in plan view, the component parts of spin pack **10**.

Program plate **30**, however, allows only pre-selected polymer streams to pass through to spinneret **32**. In this manner, a pre-selected number and arrangement of fibers **34** are extruded to form yarn. As shown, a mixed filament yarn is prepared having six green filaments, five yellow filaments, ten red filaments, and five blue filaments.

FIGS. **2–9** are top plan views of spin pack components of a first alternate configuration of the first embodiment of the present invention. The spin pack comprises a series of stacked plates, each plate specialized for a particular function. There are four primary functions—filtering, pooling, programming, and extruding. The plates are shown such that FIG. **3** is the uppermost (or first) plate and FIG. **9** is the lowest (or last) plate.

FIG. **2** shows beam porting of red, green, yellow, and blue polymer to filter plate **12** shown in FIG. **3**.

FIG. **3** is a top plan view of filter plate **12** showing the orientation of polymer streams (R), (G), (Y), and (B).

FIG. **4** is a top plan view of pool plate **14** showing red polymer pool **13**. The pool is formed by feeding red polymer from filter plate **12** into a reservoir formed by raised edge **35**. All of the pool plates are formed as reservoirs defined by a raised edge. Ports for green, yellow, and blue polymers are shown as **36**, **37**, and **38**, respectively. Holes **40** split red polymer into multiple mutually separated red polymer streams.

FIG. **5** is a top plan view of pool plate **18** showing green polymer pool **19**, and ports for yellow and blue polymers are shown as **37**a and **38**a, respectively. Ports **37**a and **38**a communicate with ports **37** and **38** in pool plate **14** to pass yellow and blue polymer down through pool plate **18** intact. Holes **40**a sealingly communicate with holes **40** in pool plate **14** to pass red polymer through intact as multiple red polymer streams. Holes **42** separate green polymer into many individual green polymer streams.

Pool plate **22** is shown in top plan view in FIG. **6** illustrating yellow polymer pool **23**. Holes **44** form multiple yellow polymer streams. Port **38**b communicates with port **38**a to pass blue polymer feed streams (B) intact through this plate. Holes **40**b sealingly communicate with holes **40**a in pool plate **18** to pass red polymer (R) through intact. Holes **42**a sealingly communicate with holes **42** in pool plate **18** to pass green polymer streams through intact.

FIG. **7** illustrates pool plate **26** which receives blue polymer from port **38**b and forms blue polymer pool **27**. Holes **46** form multiple blue polymer streams. Holes **40**c pass red polymer as multiple individual red polymer streams; holes **42**b pass green polymer as multiple individual green polymer streams; and holes **44**a pass yellow polymer as multiple yellow polymer streams. On plate **26**, holes **46**, **44**a, **42**b and **40**c form clusters **50** of four holes. One cluster **50** is indicated with a broken lined square. Each cluster **50** has one hole corresponding to each separate polymer component fed to the spin pack. There is at least one cluster **50** for each active extrusion orifice. Clusters **50** function to make each polymer feed accessible to each spinneret backhole.

FIG. **8** is a top plan view of program plate **30**. Program plate **30** panes only pre-selected polymer streams from each cluster to spinneret **32** (top plan view in FIG. **9**) to prepare a mixed filament yarn. Program holes **51** sealingly align with only a single mutually separated polymer stream of clusters **50**. Therefore, only a single polymer stream goes to the backhole. It should be readily recognized that, by providing more than one program hole per cluster, more than one polymer stream will enter the backhole. The color chosen for extrusion may be varied by exchanging program plate **30** for another program plate having a different arrangement of holes. In addition, program plate **30** may act as a metering plate.

FIG. **9** is a top plan view of spinneret **32** showing backholes **52** and extrusion orifices **53**. Any known spinneret may be used.

FIGS. **10–16** illustrate a first alternate configuration of the second embodiment of the spin pack of the present invention. This configuration operates on a linear distribution principle. The spin pack shown in these figures is designed to spin four-component trilobal fibers. Other fiber configurations are possible by simply substituting the program plate as discussed further below. The figures show plates which, when assembled, stack sealingly to form a spin pack according to the present invention. Most of the plates are shown in top plan view. The following discussion starts with the first plate in the pack and proceeds to the final plate, the spinneret.

FIG. **10** shows filter plate **110** designed to receive four different polymer components into horizontal filter grooves **111**, **112**, **113**, and **114**. In each horizontal filter groove, there are multiple filter holes **116**, **117**, **118**, and **119**, respectively, which horizontally distribute the flow of polymer (B, Y, R, G, respectively) directed to the filter groove. Also, there are alignment holes used to align each plate with its nearest neighbors. For example, alignment holes **115** and **115**b of filter plate **110** align with alignment holes **125**a and **125**b of first distribution plate **120** (FIG. **11**).

FIG. **11** is a top plan view of the top surface of first distribution plate **120**, the next descending plate in the pack. This surface sealingly contacts the lower surface (not shown) of filter plate **110** (FIG. **10**). Through holes corresponding to each mutually separated polymer feed form rows. The holes in the rows are staggered so that there is only one hole per column. Polymer B from filter groove **111** flows from filter hole **116** to through holes **121**. Polymer Y from filter groove **112** flows from filter hole **117** to through holes **122**. Polymer from filter groove **113** flows from filter hole **118** to through holes **123**. Polymer from filter groove **114** flows from filter hole **119** to through holes **124**.

FIG. **12** is a top plan view of second distribution plate **130**, the next descending plate in the pack. Second distribution plate **130** is provided with twelve vertical distribution grooves for receiving polymer from upper plate **120** as separate polymer streams. In the example used, blue polymer (b) is received from holes **121** into vertical distribution grooves **131**. As shown, three vertical distribution grooves **131** are provided for blue polymer. Each groove **131** is provided with through holes **132** to further distribute blue polymer (B) below. Vertical distribution grooves **133** receive yellow polymer (Y) from through holes **122** in upper plate **120**. Three vertical distribution grooves **133** are so provided for yellow polymer. In vertical distribution grooves **133**, through holes **134** are present to distribute yellow polymer (Y) below. Vertical distribution grooves **135** receive red (R) polymer from through holes **123** in upper plate **120**. Three vertical distribution grooves **138** contain through holes **136** to receive red polymer. Finally, vertical distribution grooves **137** receive green (G) polymer from through holes **124** in upper plate **120**. Three vertical distribution grooves **137** are provided with through holes **138** which distribute green polymer to the remaining plates below.

FIG. **13** is a bottom plan view of plate **130** showing twenty horizontal distribution grooves representing five rows of each color polymer. Since the bottom face of plate **130** sealingly contacts the top face of the next adjacent plate, the horizontal distribution grooves form closed flow paths bounded by the next adjacent plate. Polymer may only flow where downstream holes are provided. This is true of all the stacked plates of the invention. Blue (B) polymer passes from through holes **132** (FIG. **12**) into horizontal distribution grooves **141**. Yellow (Y) polymer passes from through holes **134** (FIG. **12**) into horizontal distribution grooves **142**. Horizontal distribution grooves **143** receive red polymer from through holes **136** (FIG. **12**). Finally, green polymer is received from through holes **138** (FIG. **12**) into horizontal grooves **144**.

FIG. **14** shows top plan view of metering plate **150** showing a representative hole cluster **151** encircled with a dotted line. As shown, hole cluster **151** includes one metering hole for each color polymer. Metering hole **152** in the cluster meters blue polymer from horizontal distribution groove **141** in distribution plate **130** (FIG. **13**). Metering hole **153** meters yellow polymer from horizontal distribution groove **142** in distribution plate **130** (FIG. **13**). Metering hole **154** meters red polymer from horizontal distribution groove **143** in plate **130** (FIG. **13**). Metering hole **155** meters green polymer from horizontal distribution groove **144** in distribution plate **130** (FIG. **13**). Each color is, therefore, accessible to each spinneret backhole.

FIG. **15** is a top plan view of program plate **160** showing slot and program hole clusters **161**. An enlarged view of a representative cluster **16** is shown in FIG. **15A**. It should be recognized that program plate **160** can have various other arrangements to provide or close off access to the spinneret for one or more colors (discrete polymer streams) presented by each metering hole cluster **151**. By simply replacing program plate **160**, various different multicomponent yarns may be selectively extruded from the spin pack.

FIGS. **15** and **15A**, however, depict an exemplary program plate which shows one program hole for every color so that every color enters the spinneret backhole. The program holes in any one cluster each communicate with the same spinneret backhole. Slot **162** receives blue polymer from metering hole **152** and directs it transversely to program hole **163** which provides flow to the backhole of the spinneret (FIG. **16**). Similarly, slot **164** picks up yellow polymer from metering hole **153** and directs it transversely to program hole **165** which provides flow to the backhole of the spinneret. Likewise, slot **166** receives red polymer from metering hole **154** and directs it transversely to program hole **167** which provides flow to the backhole of the spinneret. Finally, slot **168** picks up green polymer from metering hole **155** and directs it transversely to program hole **169** which provides flow to the backhole of the spinneret.

FIG. **16** is the final plate in the pack and sealingly adjoins the bottom surface (not shown) of final plate **160**. FIG. **16** is a top plan view of spinneret plate **170** showing backholes **171** to the spinning orifices. The backhole corresponding to the illustrated cluster **161** in FIG. **15** is shown with dotted line circle **172**. In the design described by FIGS. **10-16**, each color will enter each backhole. Four color (or four component) multicomponent filaments are formed. The spinneret orifice may be of any design (shape) known or developed in the art.

FIGS. **17–19** illustrate an optional configuration in the spin pack of FIGS. **10–16**. More particularly, the three plates illustrated by FIGS. **17–19** may be substituted for plates **160** and **160** shown in FIGS. **14** and **15**, respectively. The use of plates shown in FIGS. **17–19** results in a mixed filament yarn, although multicomponent filaments are also possible. For ease in understanding, plates are numbered **150**a, **160**a, and **160**b to emphasize their corresponding functions to the plates numbered **150** and **160**.

FIG. **17** is a top plan view of metering plate

Metering plate **150**a has clusters **171** shown encircled by **150**a. a dotted line. These clusters are composed of four metering holes **172**, **173**, **174**, and **175**, respectively. These metering holes are aligned to meter polymer from horizontal distribution grooves **141**, **142**, **143**, and **144**, respectively, corresponding to polymers blue, yellow, red, and green, also respectively.

FIG. **18** is a top plan view of program plate **160**a, which is provided with program holes, one program hole for each cluster **171** (FIG. **17**). Therefore, while each polymer color is available at program plate **160**a, the presence of only one program hole per cluster **171** makes three of the metering holes blind at the top surface of program plate **160**a. For example, the sample cluster **171** corresponds to program hole **181** and allows only yellow polymer to pass through.

FIG. **19** is a top plan view of capillary plate **160**b. Capillary plate **160**b includes capillary holes **191**, one capillary hole **191** corresponds to each cluster **171**. Capillary holes **191** are designed to receive polymer flow from program plate **181**, regardless of which color has been selected by the program plate. The keyhole shaped configuration capillary hole **191** with wings **192**a and **192**b and central capillary **193** permits this function. The wings of capillary hole **191** fits a wing **192**a will receive blue or yellow polymer streams and direct the streams to capillary hole **193**. Wing **192**b is designed to receive red or green polymer flow.

The plates shown in FIGS. **17–19** allow for easy interchangeability of plates for various colors (or components) to be versatilely spun from a single spinneret. Simple replacement of program plate **160**a allows the number of filaments of a single color to be quickly and easily altered. In addition, the plates shown in FIGS. **17–19** provide improved fluid dynamics over the plates shown in FIGS. **14** and **15**.

As noted, versatility is an advantage of the present invention. Versatility is important for doing experimentation and product development for color matching, color mixing, and color effects (like heather yarns). The present invention also lends itself to use with existing product lines that are prepared regularly on a production basis. Thus, different products from the same polymer feed streams are possible, which differ only in filament to filament ratios. For example, a **112** filament product having 56 red and 56 green filaments may be spun from a feed stream used previously to make a **112** filament product having 28 red, 28 yellow, and 56 green filaments.

FIGS. **20–31** represent a third alternate configuration of the second embodiment of a spin pack assembly according to the present invention. This spin pack is designed to prepare 112 filament yarns having 14 filaments each of two colors, 28 filaments of a third color, and 56 filaments of a fourth color. Accordingly, the colored polymers are fed to

the spin pack in proportion to their presence in the final product. FIGS. **20–29** show a spin pack for producing a product wherein the different colored fibers are grouped. The plate of FIG. **30** may be substituted for the plate of FIG. **27** to produce a product wherein the different colored fibers are distributed (ungrouped). The single plate of FIG. **31** may be substituted for the plate of FIG. **28** to produce an identical product (ungrouped) but with improved fluid dynamic properties.

FIG. **20** is a cross-sectional elevational view of spin pack assembly **200**. Spin pack assembly **200** includes spin pack housing **221**, filter plate **222**, first distribution plate **223**, second distribution plate **224**, third distribution plate **225**, fourth distribution plate **226**, program plate **227**, metering plate **228**, and spinneret **229**. The assembly is held together with screws **230**. Gasket **231** provides a seal between housing **221** and filter plate **222**.

FIG. **21** is a bottom plan view of spin pack housing **221**, showing polymer feed chambers **240**, **242**, **244**, and **245**, each with respective feed stream inlets **246**, **247**, **248**, and **249** for respective polymer pools (B), (Y), (R), and (G).

FIG. **22** is a top plan view of filter plate **222**. The top face of filter plate **222** sealingly adjoins bottom face of spin pack housing **221** (FIG. **21**). FIG. **22** shows the filtering orifices corresponding to each feed polymer pool of FIG. **21**.

FIG. **23** is a top plan view of first distribution plate **223** showing vertical grooves **250**. In each vertical groove **250**, there is formed a through hole or slot **251**. Vertical grooves **250** receive green polymer (G) from filtering orifices immediately above. Vertical grooves **252** receive red polymer (R) from filtering orifices immediately above. Vertical grooves **254** receive yellow polymer (Y) from filtering orifices immediately above. Vertical grooves **256** receive blue polymer (B) from filtering orifices immediately above. Each set of vertical grooves **250**, **252**, **254**, and **256** are provided with through holes **251**, **253**, **255**, and **257**, respectively, which are aligned with horizontal channels (FIG. **24**) and distribute polymer to plates below.

A top plan view of second distribution plate **224** is shown in FIG. **24**. Here, horizontal channels receive polymer from first distribution plate **23** and, as shown, separate received flow into four smaller flows. Horizontal channel **260** receives green polymer from through holes **251**. Horizontal channel **261** receives red polymer from through holes **253**. Horizontal channel **262** receives yellow polymer from through holes **255**. Horizontal channel **263** receives blue polymer from through holes **257**. Four through holes are present in each channel to split the polymer feed into four individual streams. These streams are passed to the next distribution plate in a staggered fashion as is shown by the staggered arrangement of the through holes. Horizontal channel **260** is provided with through holes **264**. Horizontal channel **261** is provided with through holes **265**, which are horizontally offset to the right from through holes **264**. Channel **262** is provided with through holes **266**, which are offset to the right from through holes **265**. Horizontal channel **263** is provided with through holes **267**, which are offset to the right from through holes **266**.

The purpose of the staggering or offsetting of the through holes in FIG. **24** is apparent from FIG. **25**, which is a top plan view of third distribution plate **225**. Third distribution plate 225 is provided with 16 vertical channels corresponding to the 16 through holes in second distribution plate **224**. The vertical channels of distribution plate **225** alternatingly receive feed from distribution plate **224**. Vertical channel **26** receives green polymer flow from through hole **264**. Vertical channel **269** receives red polymer from through hole **265**. Vertical channel **270** receives yellow polymer from through hole **266**. Vertical hole **271** receives blue polymer from through hole **267**. Each vertical channel is provided with three through holes to further split polymer flow.

FIG. **26** shows the next plate, fourth distribution plate **226**, in top plan view. Fourth distribution plate **226** is provided with horizontal grooves for receiving polymer flow from third distribution plate **225**. As shown, horizontal groove **275** receives red polymer from vertical channel **226**. Horizontal groove **276** receives blue polymer from vertical channel **271**. Horizontal groove **277** receives green polymer from vertical channel **268**, and horizontal groove **278** receives yellow polymer from vertical channel **270**. Each horizontal groove is provided with through holes **279** for presenting numerous flow streams to the next plate.

The next plate is program plate **227**, shown in top plan view in FIG. **27**. Program plate **227** selects the polymer colors which are passed through to metering plate **228** (FIG. **28**). Program plate **227** is provided with through holes corresponding to the preselected polymer flow passing to the metering plate. As shown, program holes **280** permit blue polymer from horizontal grooves **276** to flow to the metering plate. Program holes **281** allow yellow polymer from horizontal groove **278** to flow to the metering plate. Program holes **282** allow red polymer from horizontal groove **275** to flow to the metering plate. Program holes **283** allow green polymer from horizontal groove **277** to flow to the metering plate. While distribution plate **226** makes each color of polymer available in the vicinity of the backhole of the spinneret (shown in FIG. **29**), program plate **227** selects those streams which pass through to the metering plate, and thus, on to the backhole of the spinneret for extrusion into fiber. Various configurations of the program plate are conceivable. For example, if through holes were provided along the entire face of the program plate, and these holes corresponded to the horizontal rows of metering plate **226**, then every polymer would be presented to every backhole.

This versatility is facilitated by metering plate **228** shown in top plan view in FIG. **28**. Metering plate **228** is provided with one keyhole configuration **285** corresponding to each spinneret backhole or active extrusion orifice. Keyhole **285** is configured to receive flow from any one or up to all of the four separate polymer types. Each keyhole **285** includes metering hole **286** and wings **287**a and **287**b, which are elongated parts on either side of the keyhole. The wings are sufficiently long to align with all of the four polymer feeds presented by distribution plate **226** to program plate **227**.

Turning to FIG. **29**, there is shown in top plan view a spinneret which may be any known or developed spinneret, There is no known limit to the spinneret types useful in the present invention. Spinneret backholes **288** are shown.

FIGS. **30** and **31** show alternative program and metering plates for use in the third alternate configuration of the second embodiment of the present invention,

FIG. **30** is a top plan view of program plate **227**a which may be substituted for program plate **227** to provide a more distributed (ungrouped) arrangement of the four polymer colors in the final yarn.

FIG. **31** is a top plan view of metering plate **291**, which may be substituted for metering plate **228** (FIG. **28**). Metering plate **291** is useful for products produced in high volume where versatility is not necessary. In addition, metering plate **291** has improved fluid dynamic characteristics. Each polymer color is accessible at the top surface of program plate **227**a. Only certain colors pass through. The wings **292** on each metering hole **293** are just long enough to pick up the polymer fed through program plate **227**a.

The present invention includes a process for spinning multiple components from a single spinneret. The process includes feeding mutually separated molten polymer components to a spin pack having a spinneret with extrusion orifices for extruding filaments. The typical extrusion orifices have a backhole for receiving molten polymer. Each mutually separated component is distributed so that each component is accessible as a distinct component at every spinneret backhole. Spin packs suitable for practicing the process of the present invention are described above.

[Another aspect of the present invention is a mixed filament yarn containing at least three different colored filaments, By using the process of the invention, the filaments can be arranged in the yarn with a uniformity never before possible, so that when made into carpet, the carpet gives a one-color appearance. This is accomplished by co-spinning the colors in a preselected uniform distribution across the spinneret face. The following example illustrates the uniqueness of the mixed filament yarn of the present invention. The example is presented for illustration purposes only, and is not intended to in any way limit the present invention.

EXAMPLE

Comparative Mixed Filament Yarns

Two different yarns of 112 filaments each are prepared. One yarn is prepared by spinning 28 blue, 42 gray, and 42 black filaments separately and then combining these yarns via a drawtexuring step to produce a heather yarn having a mottled or chunky appearance. The other yarn is prepared by spinning 28 red, 42 gray, and 42 black filaments and then combining them in the same manner.

Mixed Filament Yarns According to the Invention

A second set of two 112 filament yarns is prepared using a pack according to the design of the first configuration of the second embodiment of the present invention (FIGS. **10–16**). The first yarn is made of 28 blue, 42 gray, and 42 black filaments. The second yarn is made of 28 red, 42 gray, and 42 black. The yarns from the spin pack of the present invention possess a high degree of filament mixing.

In all four cases, the yarns are prepared from BS700F polymer (available from BASF Corporation) in a melt spinning apparatus. The polymers are discharged at a temperature of 265° C. Finish oil is applied to the yarn and it is drawn to 3.1X. After texturizing, the yarn is wound onto a package at a speed in excess of 1500 mpm and a tension greater than 100 gms. The yarn has a denier of 2200.

Identical ends of the yarn are combined and then tufted into a 1/10 inch gauge level loop carpet having a face fiber weight of between 24 and 30 ounces per square yard. The four samples produced are judged for solid color appearance by a panel of observers using a paired comparison method. The results are given in Table 1. A higher number on a scale of 0 to 5 indicates a greater degree of filament mixing.

TABLE 1

SUBJECTIVE APPEARANCE RATINGS FILAMENT MIXING			
Conventional Yarns	(Blue, White, Black)	Carpet 1	1.0

TABLE 1-continued

SUBJECTIVE APPEARANCE RATINGS FILAMENT MIXING			
	(Red, White, Black)	Carpet 2	0.8
Yarns of the Invention	(Blue, White, Black)	Carpet 1	4.6
	(Red, White, Black)	Carpet 2	3.7

A still further aspect of the present invention is a yarn in which there is a high degree of filament mixing in one zone of the yarn and one or more zones of no mixing. For example, a yarn is composed of three components which are highly mixed in one zone of the yarn and the remainder of the yarn is composed of a concentration of a single component. It is contemplated that there are two or more such zones of component concentration.]

What is claimed is:

1. A process for spinning mixed filament yarn comprising:

(a) feeding three or more differentially colored mutually separated molten polymer components to spin pack having a spinneret with extrusion orifices for issuing filaments, each extrusion orifice having a backhole for receiving molten polymer;

(b) distributing each mutually separated component so that every component is accessible as a distinct component at every active spinneret backhole;

(c) selectively preventing, via a plate having through holes, all but one component from entering a backhole; and

(d) extruding [multiple component] *mixed filament* yarn.

2. The process of claim **1** wherein said distributing comprises b.1) pooling each component; b.2) after said pooling, splitting the pool into multiple distinct streams; and b.3) routing the multiple distinct streams to the vicinity of each spinneret backhole.

3. The process of claim **1** wherein said distributing comprises:

b.1) routing each mutually separated component to a series of distribution plates having grooves with through holes therein;

b.2) splitting the streams in each groove; and

b.3) passing the split streams to the vicinity of each spinneret backhole.

* * * * *