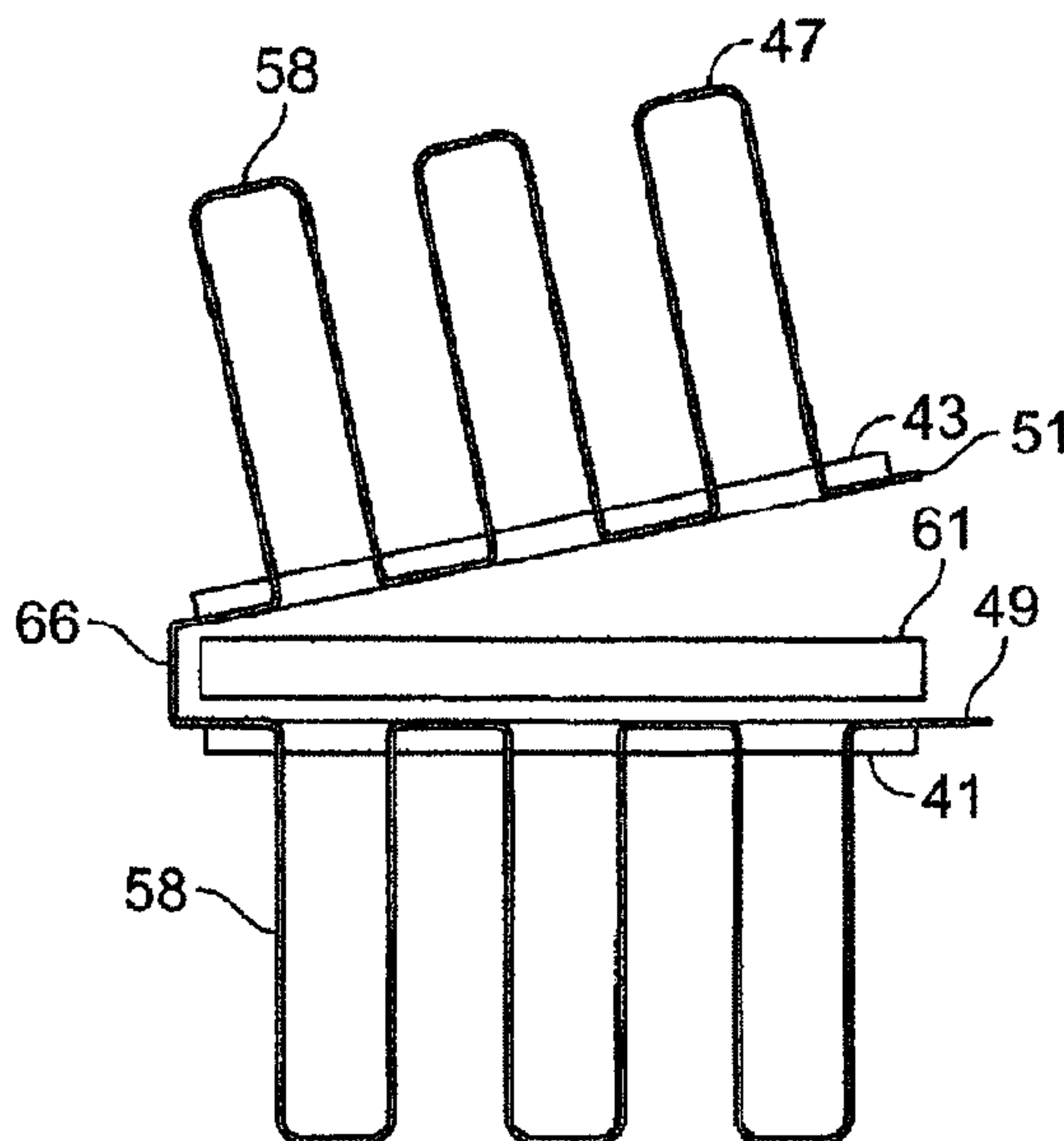




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(54) Titre : APPAREIL DE CHAUFFAGE PAR RESISTANCE ELECTRIQUE PLIANT ET SA METHODE D'UTILISATION
 (54) Title: FOLDABLE ELECTRIC RESISTANCE HEATER AND METHOD OF USE



(57) Abrégé/Abstract:

A foldable electric resistance heater comprises at least a pair of insulator plates with a resistance wire threaded through openings in the insulator plates. In one mode, the insulator plates are folded with respect to each other and fastened together using one or more fasteners. In another mode, the plates can have other angled configurations with respect to each other. One or more insulators is positioned between the folded plates or adjacent the plates to isolate the resistance wire. The folded plate configuration and resistance wire provide significant advantages in manufacturing costs while forming a more robust heater configuration.

ABSTRACT

A foldable electric resistance heater comprises at least a pair of insulator plates with a resistance wire threaded through openings in the insulator plates. In one mode, the insulator
5 plates are folded with respect to each other and fastened together using one or more fasteners. In another mode, the plates can have other angled configurations with respect to each other. One or more insulators is positioned between the folded plates or adjacent the plates to isolate the resistance wire.
10 The folded plate configuration and resistance wire provide significant advantages in manufacturing costs while forming a more robust heater configuration.

FOLDABLE ELECTRIC RESISTANCE HEATER AND METHOD OF USE

5 FIELD OF THE INVENTION

The present invention is directed to an electric resistance heater with an improved insulator configuration and, particularly to a heater that allows the insulator plates supporting the resistance wires to fold to form a more robust or flexible heater configuration.

BACKGROUND ART

In the prior art, electrical resistance wire heaters are well known. These heaters are used in a variety of applications to heat a fluid, which is generally a moving stream of air. One typical application is for clothes dryers, wherein a stream of air is heated for drying clothes.

One type of these heaters is illustrated in Figures 1-3. The heater is designated by the reference numeral 10 and employs a ribbon resistance wire 1, which has a square or rectangular cross section, as opposed to other heaters that employ resistance wires that would have a circular cross section. The heater 10 comprises a pair of insulator plates 3 and 5, each of which having a number of openings therethrough. The openings

located in the insulators plates 3 and 5 are positioned so that the ribbon follows a path along the insulators from a first terminal end 9 of the wire to a second terminal end 11. The terminal ends 9 and 11 then link to a power source via terminals 5 and lead wires or some other connection to bring power to the heater. The plates 3 and 5 are typically supported by the ends of the plates engaging slots in a heater frame; the plates are not fastened to the frame so that they can move. However, since the frame receiving the ends of the plates are spaced apart, the resistance wire extending between the plates still maintains the spacing between the plates as they extend between the frame.

Figure 1 shows one configuration wherein the ribbon 1 follows a convoluted path 4 between the two plates 3 and 5. The ribbon 1 passes through a first opening 13 in plate 3, travels a certain distance, then passes through opening 15, forms a loop, and passes back through opening 15 in the second plate 5. The ribbon 1 then travels to plate 3, entering opening 17, forming another loop, and passing back through the same opening 17 and towards the plate 5. This looping continues until the terminal end 11 of the ribbon ends at the opposite end of plate 3.

In a preferred configuration, the ribbon is shaped with expanded and spaced apart portions 21 and 22. The portions are formed along the length of the ribbon at locations such that a

part of the insulator plate is positioned between the spaced
apart portions 21 and 22. This arrangement holds the two
insulator plates 3 and 5 in place so as to assist in maintaining
the spacing of the plates when the ribbon passes through the
5 openings in the plates 3 and 5.

The spacing of the two insulator plates can vary as the
heater requirements would dictate. Typically, the spacing
distance "A", see Figure 1, is on the order of about 1 inch.
This spacing is often dictated by the particular heater
10 application.

The path of travel of the wire is dictated by the number
and spacing of the openings in the plates 3 and 5. Figure 2
shows a typical arrangement of openings, wherein the ribbon
would travel down a first row 24, crossover at opening 23, and
15 travel down second row 25, so that the first end 27 of the wire
and second end 29 of the wire terminate at the same side of the
heater so that connection to a power source is facilitated.

Figure 3 shows another prior art heater configuration
wherein only one row 30 and 31 exists for each of the plates 33
20 and 35, respectively. Starting at one end 32 of plate 33 and at
end 36 of wire 1, the wire loops through plates 33 and 35,
terminating at a second end 38 on the opposite end of the plates
33 and 35. It can be seen here that to move the wire along the

plates, plate 33 has five opening whereas plate 35 has only four
openings, and that the openings in the plates are offset with
respect to each other so that the looping of the ribbon can
occur. This means that two different plate configurations are
5 needed to make this heater, which increases manufacturing costs.

The heater application usually controls the length of
resistance wire needed to get the correct number of ohms to
produce the wattage required based on the voltage source used.
This results in defining the size of the insulator plate and
10 number of openings therein for the wire travel. Generally, the
length of resistance wire is such that the wire must follow
along two rows, as shown in Figure 2. Also, in order to have
the ends 27 and 29 of the wire terminate at the same location,
an even number of row with the same number of openings is
15 required. In Figure 2, this is shown by a pair of rows having
four openings.

The heater design of Figure 1 is not without its problems
though. First, it requires that the ribbon be specially shaped
with the portions 21 and 22 to maintain the spacing of the
20 plates 3 and 5. Second, because of the need to match the rows
in the plates so that the ends of the wire terminate on the same
end, there is less flexibility in designing the heater with the
necessary length of wire to meet the heating requirements.

Third, manufacturing is complicated by having to thread the wires through two insulator plates and employ the portions 21 and 22 to maintain the spacing of the plates 3 and 5. Yet another problem is the length of the travel of the wire between the two plates. The longer the distance between the plates, the more opportunity for the wires to move and possibly contact each other and burn out the heater.

In light of the problems with the present day heaters, there is a need to provide improved heater designs, which simplify the manufacturing and offer more flexibility in meeting the heating load requirements via the configuration of the resistance wire with respect to the insulator plates.

In response to this need, the present invention provides an improved heater design, which eliminates many of the problems present in the prior art heaters.

SUMMARY OF THE INVENTION

It is a first object of the invention to provide an improved electrical resistance heater.

It is another object of the invention to provide an electrical heater that employs a resistance wire element and insulator plates that are folded together to create a more

robust configuration than that found in prior art heaters employing similar kinds of insulator plates.

Other objects and advantages will become apparent as a description of the invention proceeds.

5 The invention is an improvement in electrical resistance heater that employs resistance wires, e.g., ribbons, which are woven through openings in an insulator plate such as mica board. In one embodiment, the invention comprises an electrical resistance wire heater that has at least first and second
10 insulator plates, wherein each of the insulator plates have a plurality of openings therein to receive the resistance wire. The resistance wire passes through the plurality of openings in the first and second insulator plates in a looped configuration. At least one insulator is arranged adjacent to the looped
15 resistance wire where the resistance wire contacts the openings for short circuit protection. The first and second insulator plates are folded with respect to each other in an angled configuration. The number of insulating plates and angles can vary depending on the heating requirements of the heater.
20 Acute, right, or obtuse angles can be employed.

While the heater could employ just two insulator plates, a third insulator plate can be provided, which would be linked to the second insulator plate. The third insulator plate would

also be folded with respect to the second insulator plate in an angled configuration.

The insulators can be made of any insulating material, with a preferred material being a mica material. The insulator
5 adjacent to the resistance wire contacting the openings in the insulators plates can have any form; it can be a single component such as a plate or multiple components as so desired.

The resistance wire can have any configuration, e.g., circular, oval, or polygonal cross section, e.g., square or
10 rectangular. A preferred configuration is a ribbon.

In another embodiment, the first and second insulator plates are folded over with respect to each other, with at least one insulator positioned between the folded over plates. One or more fasteners are employed to secure the three plates together,
15 thus providing a more robust design of a heater.

The resistance wire and/or insulator plates can be configured so that ends of the resistance wire terminate on either the same side of the insulator plates or opposite sides of the insulator plates when the plates are in the folded over
20 configuration or angled configuration.

In yet another embodiment, first and second insulator plates can be symmetrical in their opening configuration so that

only one plate configuration is needed for manufacturing the heater.

Unlike prior art designs, angling the first and second insulator plates means that rows of openings in the insulator plates can be an odd number and still terminate on the same side of the heater.

Folding the insulator plates over each other allows for the manufacture of a heater wherein the looped configurations of the resistance wires can have different heights. The loops on one side of the heater can be shorter or longer than the other side to provide different heating if needed.

In the folded over heater configuration, the resistance wire will bend about 180 degrees when traveling from the first insulator plate to the second plate. To accommodate the fold or bend and when using an insulator shaped as a plate between the two plates securing the looped resistance wire, the insulator plate can include a notch to receive the resistance wire when bent.

The invention also includes a heater assembly that includes a heater and a heater frame. The inventive heater can be used in this heater assembly, with the inventive heater mounted to the heater frame in a fixed manner or a manner that permits the heater to move while mounted to the frame. For example, the

heater could be configured so that one or more plate portions thereof engage a slot(s) in the heater, with the plate portion being able to move in the slot as a result of heater operation. Alternatively, the heater could be fixed at one portion and
5 movably mounted at another portion to allow the heater to still move during operation. If desired, the heater could be rigidly secured to the frame as well.

The invention also is an improvement in the heating of a desired space or material using electrical resistance wires.
10 The inventive heater can be used anywhere an electrical resistance wire heater would normally be used, e.g., clothes dryer, testing equipment, industrial applications of space heating, etc.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Reference is now made to the drawings of the invention wherein:

Figure 1 is a side view of a prior art heater configuration.

20 Figure 2 shows a top view of a prior art insulator plate for use in the heater of Figure 1.

Figure 3 shows an exploded view of a prior art heater, showing the resistance wire and opposing insulator plates.

Figure 4 shows a side view of a first embodiment of the inventive heater.

Figure 5 shows the heater of Figure 4 in a partially folded configuration.

5 Figure 6A shows the heater of Figure 4 in a fully folded configuration.

Figure 6B shows an exemplary insulator for the heater of Figure 4.

10 Figure 7 shows a top view of the insulator plates of the heater of Figure 4.

Figure 8 shows another embodiment of the heater of Figure 4 with a different plate configuration.

Figure 9 shows another embodiment of the heater of Figure 4 with an alternative resistance wire configuration.

15 Figure 10 shows an alternative embodiment to the heater of Figure 4, showing a different folded configuration.

Figure 11 shows yet another embodiment of the heater of Figure 4 with a still different folded configuration.

20 Figure 12 shows a pair of symmetric insulator plates for use as part of the inventive heater.

Figure 13 is a schematic representation of a mounting of the inventive heater to a heater frame.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

One embodiment of the heater of the invention is shown in Figures 4-7. With reference to Figures 4 and 5, the inventive heater is designated by the reference numeral 40 and includes a pair of insulator plates 41 and 43.

Each of the plates 41 and 43 has a number of openings 45, which are sized to receive a resistance wire 47. The resistance wire passes through the openings 45, starting at a first end 49 and terminating at a second end 51.

As seen in Figures 4 and 7, the wire 47, starting at end 49 loops between adjacent openings 45 along row 53, crosses over via opening 55 to a second row 57, and then travels along second row 57, terminating at end 51. Comparing the prior art design of Figure 1 with the embodiment of Figure 4, it is apparent that it is much easier to loop the wire 47 through the side-by-side plates 41 and 43, since loop 58 can have a free end 59 as opposed to the requirement that the loops extend through each plate of the prior art design. In Figure 1, the loop requires an additional step of threading of the wire through the openings in the second plate 5, which is not required when making the inventive heater. While one resistance wire is illustrated for the inventive heater, it should be understood that the heater

could have the required number of openings and row to accommodate more than one resistance wire, if needed.

Figure 4 also shows an additional insulator in the form of a plate 61, which is designed to provide additional insulating protection against wire-to-wire contact when the plates 41 and 43 are folded together. While a plate is shown, other shapes or configurations could be employed to maintain spacing between the plates 41 and 43. For example, a number of discrete insulators could be positioned in spaced-apart locations between the plates 41 and 43 to maintain a spacing between the wires when looped through the plates 41 and 43.

The insulator plates and insulator can be made of any insulating material, with a preferred material being mica. The resistance wire is preferably a ribbon, but virtually any configuration wire can be used that would be able to be looped through the openings in the plates 41 and 43 as shown.

Figures 5-6B show the heater 40 in the partially folded and folded positions, with the additional insulator plate 61 in position. Figure 6A also illustrates a fastener 63, which extends through an opening (not shown) in each of the plates 41, 43, and 61. The fastener can be any type that would hold the three plates together, thereby providing a more robust connection between the plates as compared to the embodiment of

Figure 1, which must rely on the ribbon 1 to connect the plates together and maintain spacing. Figure 6B shows just the plate 61 and its opening 62 to receive the fastener 63. A corresponding opening is located in each of the plates 41 and 43 to permit fastening. While one opening 62 is shown, more than one opening could be employed to better secure the plates 41 and 43 together. The plate 61 also includes a notch 64. The notch is designed to provide a space for the portion 66 of the wire extending between the two plates 41 and 43, see Figure 5. The notch facilitates the travel of the wire from one loop 58 on plate 41 to the beginning of a second loop 58 on plate 43.

Referring again to Figure 7, it can be seen that the number of openings between the plates 41 and 43 do not have to match to have the wire 47 terminate on the same end of the plates. Plate 41 has two rows of three openings, with plate 43 having two rows of only two openings.

Figure 8 shows another embodiment of the invention. In the embodiment of Figures 1 and 2, an even number of rows is required to ensure that the terminal ends of the resistance wire end up on the same side of the plate. The inventive heater has the ability to employ odd numbers of rows, which provide more flexibility in defining the length of the wire for the heater and the heating load. That is, Figure 8 shows that the plates

41' and 43' can have three rows 65, 67, and 69 for the wire to travel and still have termination of the wire on the same side of the heater.

One significant advantage of the invention is that the heater 40 can match the height "A" used in the prior art heaters, but with loops of wire that are only roughly half the length, see Figure 6A. This eliminates or reduces the problems noted above when the wire between the plates of the prior art heater is of a certain length. With the inventive heater, the wire length for a loop is significantly decreased. As seen in Figure 6A, the heater 40 can still match dimension "A" of the prior art heater, but without the complicated looping and wire configuration. Since the dimension "A" of the prior art heater is one that is dictated by, at least, the particular heater application and installation, it is a significant advantage of the invention to be able to make a heater with such a dimension but in a significantly simpler and more cost effective way.

Figure 9 illustrates the aspect of the invention, wherein the loop length of the wire can vary for each side of the heater. Whereas the prior art design is limited to a set distance between the insulator plates, the inventive heater can provide one set of loops that are a different height than the other set of loops. Thus, for a heater design of 1 inch in

width, the heater of Figure 9 can have loops 73 that are shorter in height than loops 75. In this embodiment, the loops 75 are approximately twice as larger, 0.67 inches versus 0.33 inches. This provides more flexibility in heater design since a zone may
5 need more heat than another zone and loops 75 would be used to heat the zone requiring more heat.

Figures 10 and 11 show other embodiments of the invention. Figure 10 shows a heater 80 having an L-shaped configuration. In this configuration, the heater has plates 81 and 83 that can
10 be positioned so that they form a right angle so that heat is supplied to zones B and C. Little or no heat is applied to zone D as a result of the placement of the insulator plate 84. Unlike the embodiment of Figures 4-7, the insulator plates are not fastened together. Instead, the plates would be attached to
15 a frame or other structure of the heater for support as detailed below.

Figure 11 shows a heater 90 with a u-shaped configuration. This heater employs three plates 91, 93, and 95 so that heat is supplied to three zones E, F, and G. Little or no heat is
20 applied in zone H as a result of insulator plate 94.

The embodiments depicted in Figures 10 and 11 are only exemplary and other configurations could be employed to provide heat in certain zones only. For example, five plates could be

used to form an S-like configuration. More, the angle between two plates could be more or less than the 90 degrees shown in Figure 10 as the configuration would dictate, e.g., acute or obtuse.

5 In each of the embodiments of Figures 10 and 11, insulator plates 84 and 94, respectively are arranged with each insulator plate receiving the resistance wire. The plates 84 and 94 provide further protection against shorting of the wire threaded in openings in the insulator plates 81 and 83 and insulator
10 plates 91, 93, and 95 as well as isolating zones where heat is not needed. Although not shown, the insulator plate 84 and 94 can be attached to the plates holding the resistance wire in any known fashion, e.g., fasteners or the like. The arrangements can be mounted in a similar fashion as described below for the
15 other embodiments of the invention so that specific illustrations of the plate mounting are not necessary for understanding of these embodiments.

The invention provides significant advantages over the prior art designs. One improvement relates to the ease of
20 manufacture of the heater. In the prior art design of Figures 1 and 2, the expansion or forming of the protruded portions 21 and 22 of the wire needed to maintain the separation of the plates must be done as the wire is threaded through the openings or

after the heater is assembled. In contrast, in the invention, the two plates of the embodiment of Figures 4-8 are connected using a fastener or the like and this rigid connection eliminates the requirement for expanding the resistance wire to
5 maintain the spacing between the plates. In addition, the heater, when using the fastened-together three plate design of Figures 4-8, is much more robust since the three plates being held together impart an improved rigidity to the heater. In the prior art, the resistance wire itself provides a rigidity to the
10 heater for a substantial part of it, but this is far less than what is provided by the inventive heater.

Because of the use of two opposing plates in the prior art design of Figures 1-3 and the requirement that the resistance wire being threaded through the openings in the plates, the
15 plates of the prior art design are not symmetrical. This is because the location of the openings in the top plate does not align with the location of the openings in the bottom plate and two plates of different opening configuration must be used for the heater, see Figure 3. Because the inventive heater only
20 threads the resistance wire through the openings in one plate at a time, the plates making up the heater can be symmetric, thus reducing manufacturing costs. This is shown in Figure 12, wherein each of plates 111 and 113 has the same opening pattern.

While one opening 114 does not receive the resistance wire, the cost of making this additional opening is inconsequential when considering that two different plates do not have to be made to form the heater.

5 The heater of the invention can be mounted in the same manner as the prior art heater, i.e., ends of the insulator plates could engage slots in a heater frame without a fixed attachment. Alternatively, one or both ends of the folded over plates could be rigidly attached to a heater support structure.

10 For the embodiments of Figures 11 and 12, the plates could also have a loose engagement with a heater structure, wherein the plates merely engage slots or have rigid attachments for the plates or a combination thereof. Figure 13 shows a schematic of an exemplary mounting of the heater to a heater frame. The

15 folded over heater is schematically identified by reference numeral 120, but without showing the looped resistance wire, which would run across the page when viewing the drawing, wire ends, one or more fasteners holding the plates together, etc.

20 One end 121 of the heater 120 has the terminations of the resistance wire with the other end 123 having the fold of the resistance wire. The end 123 has a plate 125, with one end of the plate 125 attached to the heater 120 at 126. The other end of the plate 125 engages a slot 127 in a heater frame 129. The

attachment can be any type, a fastener or the like. The other end of the heater 121 can be rigidly attached to the frame 129 using a bracket 131. It should be understood that the manner in which the heater 120 would be supported by a heater frame is
5 exemplary in Figure 13 and other configurations can be used that would encompass loose or sliding attachment for both ends of the heater or fixed attachment at one end. While not often employed, certain heater applications could even permit a fixed attachment at both ends of the heater. While the short ends of
10 the heater are shown as connecting to a heater frame, the long ends of the heater could also be supported, either alone or in combination with the short ends. Additional supports along the length of the heater could also be employed if necessary.

The heater can be used in virtually any application that
15 requires heating of a space or a material. These applications include heating equipment for testing or analyzing, clothes dryers, wherein a moving stream of air is heated, industrial heating of air or other gases, and the like. The heater can be used in virtually any mounted arrangement that would permit the
20 desired heating to take place.

As such, an invention has been disclosed in terms of preferred embodiments thereof which fulfills each and every one of the objects of the present invention as set forth above and

provides a new and improved electric resistance heater and its method of use.

The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be
5 given the broadest interpretation consistent with the description as a whole.

CLAIMS

1. An electrical resistance wire heater comprising:

at least first and second rigid insulator plates, wherein
5 each of the insulator plates has a plurality of openings
therethrough to receive resistance wire;

at least one resistance wire passing through the plurality
of openings in the first and second rigid insulator plates;

wherein said resistance wire forms a plurality of loops,
10 each loop comprising a loop bend joined by adjacent loop
segments, the first rigid insulator plate having a first set of
loops and the second rigid insulator plate having a second set
of loops different from the first set of loops;

wherein loop bends of a plurality of said loops pass
15 through a plurality of openings in said first or second rigid
insulator plates, the plurality of loops passing through the
plurality of openings in the first or second rigid insulator
plates extending from a surface of each of said first or said
second rigid insulator plates; and

20 at least one insulator arranged adjacent to an opposing
surface of said first or said second rigid insulator plates for
short circuit protection,

wherein the at least first and second rigid insulator plates are linked by said resistance wire and positioned in an angled configuration with respect to said surfaces of said first and second rigid insulator plates.

5 2. The heater of claim 1, wherein said surfaces of at least first and second rigid insulator plates form angles of about 90 degrees.

3. The heater of claim 1 or 2, further comprising a third rigid insulator plate linked to the second rigid insulator plate by
10 said resistance wire, the second and third rigid insulator plates positioned in an angled configuration with respect to surfaces of said second and third rigid insulator plates.

4. The heater of claim 1, 2, or 3, wherein the at least first and second rigid insulator plates and insulator are made from
15 mica.

5. The heater of any one of claims 1 to 4, wherein the at least one insulator is a plate.

6. The heater of any one of claims 1 to 5, wherein the resistance wire is a ribbon.

20 7. The heater of any one of claims 1 to 6, wherein said at least one insulator is positioned between said opposing surfaces of

said first and second rigid insulator plates and at least one fastener holds the at least first and second rigid insulator plates together.

8. The heater of claim 7, wherein first and second ends of the
5 resistance wire terminate on either a same side of the at least first and second rigid insulator plates or opposite sides of the at least first and second rigid insulator plates.

9. The heater of claim 7 or 8, wherein the first and second rigid insulator plates are symmetrical in opening configuration.

10 10. The heater of claim 7, 8, or 9, wherein the plurality of openings in each of the first and second rigid insulator plates further comprises an odd number of rows of openings.

11. The heater of any one of claims 7 to 10, wherein a first set of loops extends from the first rigid insulator plate and a
15 second set of loops extends from the second rigid insulator plate, wherein a height of the first set of loops is different from a height of the second set of loops.

12. The heater of any one of claims 7 to 11, wherein the resistance wire is bent in about a 180 degree angle when
20 traveling from the first rigid insulator plate to the second rigid insulator plate.

13. The heater of claim 12, wherein the insulator is a plate and the plate has a notch to accommodate the bend of the resistance wire.

14. A heater assembly comprising a heater frame and the heater
5 of any one of claims 1 to 13.

15. The heater assembly of claim 14, wherein the heater is supported by the heater frame so that it can move with respect to the heater frame.

16. A method of heating a space or material comprising:

10 providing an electric resistance heater wire comprising at least first and second rigid insulator plates, wherein each of the first and second rigid insulator plates has a plurality of openings therethrough to receive resistance wire;

at least one resistance wire passing through the plurality
15 of openings in the first and second rigid insulator plates;

wherein said resistance wire forms a plurality of loops, each loop comprising a loop bend joined by adjacent loop segments, the first rigid insulator plate having a first set of loops and the second rigid insulator plate having a second set
20 of loops different from the first set of loops;

wherein loop bends of a plurality of said loops pass through a plurality of openings in said first or second rigid insulator plates, the plurality of loops passing through the plurality of openings in the first or second rigid insulator plates extending from a surface of each of said first or said second rigid insulator plates; and

at least one insulator arranged adjacent to an opposing surface of said first or said second rigid insulator plates for short circuit protection,

wherein the at least first and second rigid insulator plates are linked by said resistance wire and positioned in an angled configuration with respect to said surfaces of said first and second rigid insulator plates; and

heating said space or material with the electrical resistance wire heater.

17. The method of claim 16, further comprising folding over the at least first and second rigid insulator plates with respect to each other, wherein at least one insulator is positioned between the first and second rigid insulator plates when in the folded over position; and at least one fastener holds the at least first and second rigid insulator plates together.

18. The heater of any one of claims 1 to 13 wherein a plurality of loops consecutively pass through a plurality of openings in either the first or second plates.

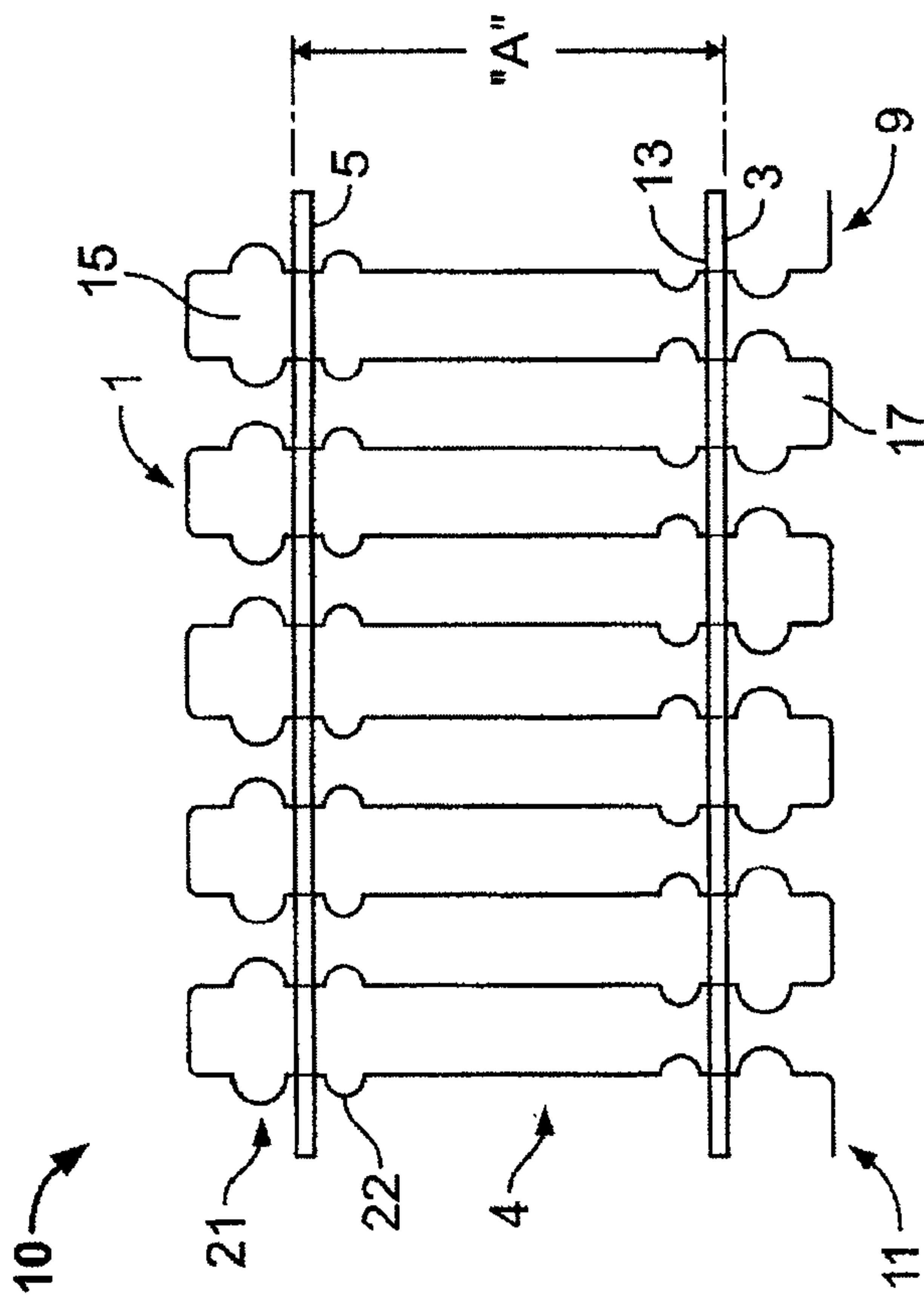


FIG. 1
(Prior Art)

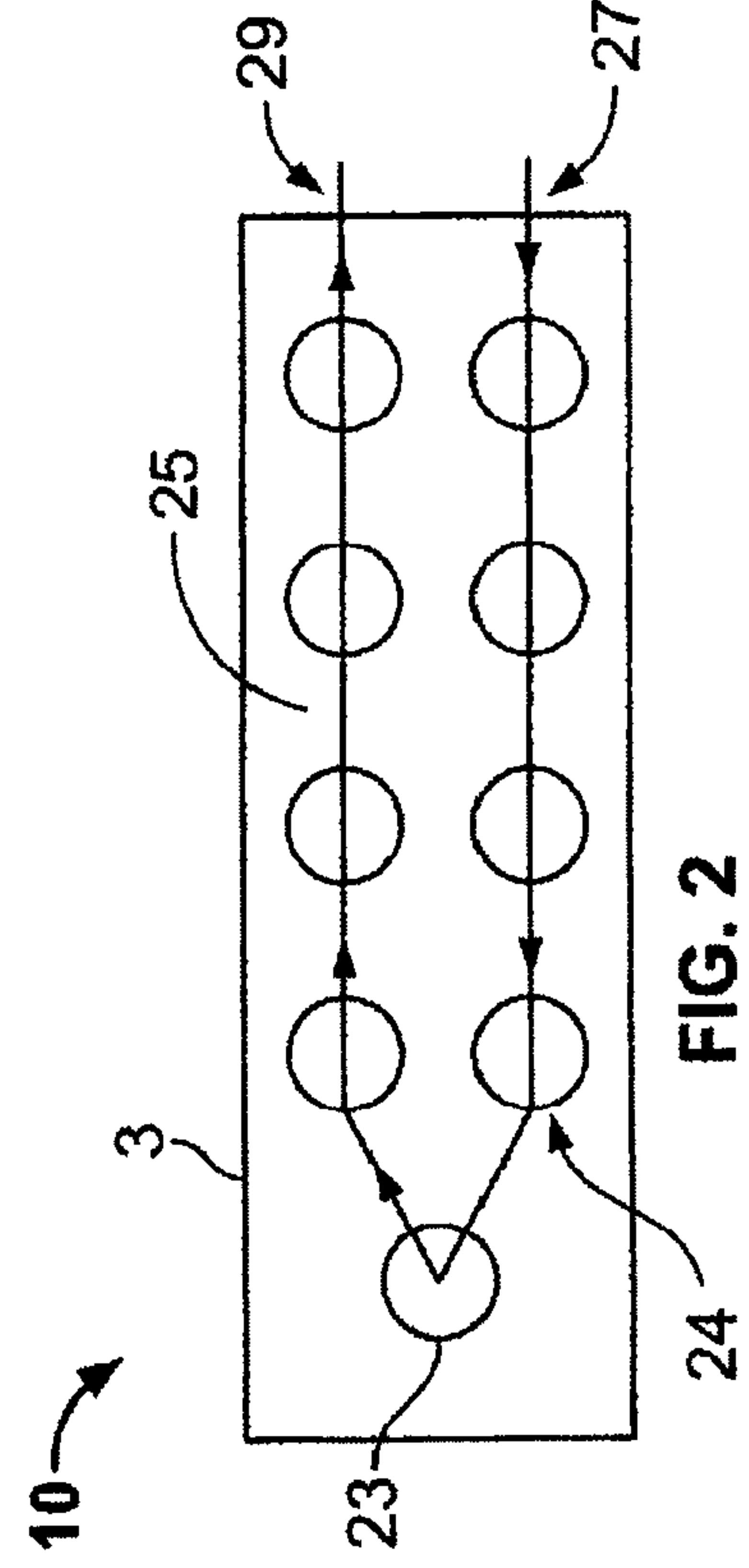


FIG. 2
(Prior Art)

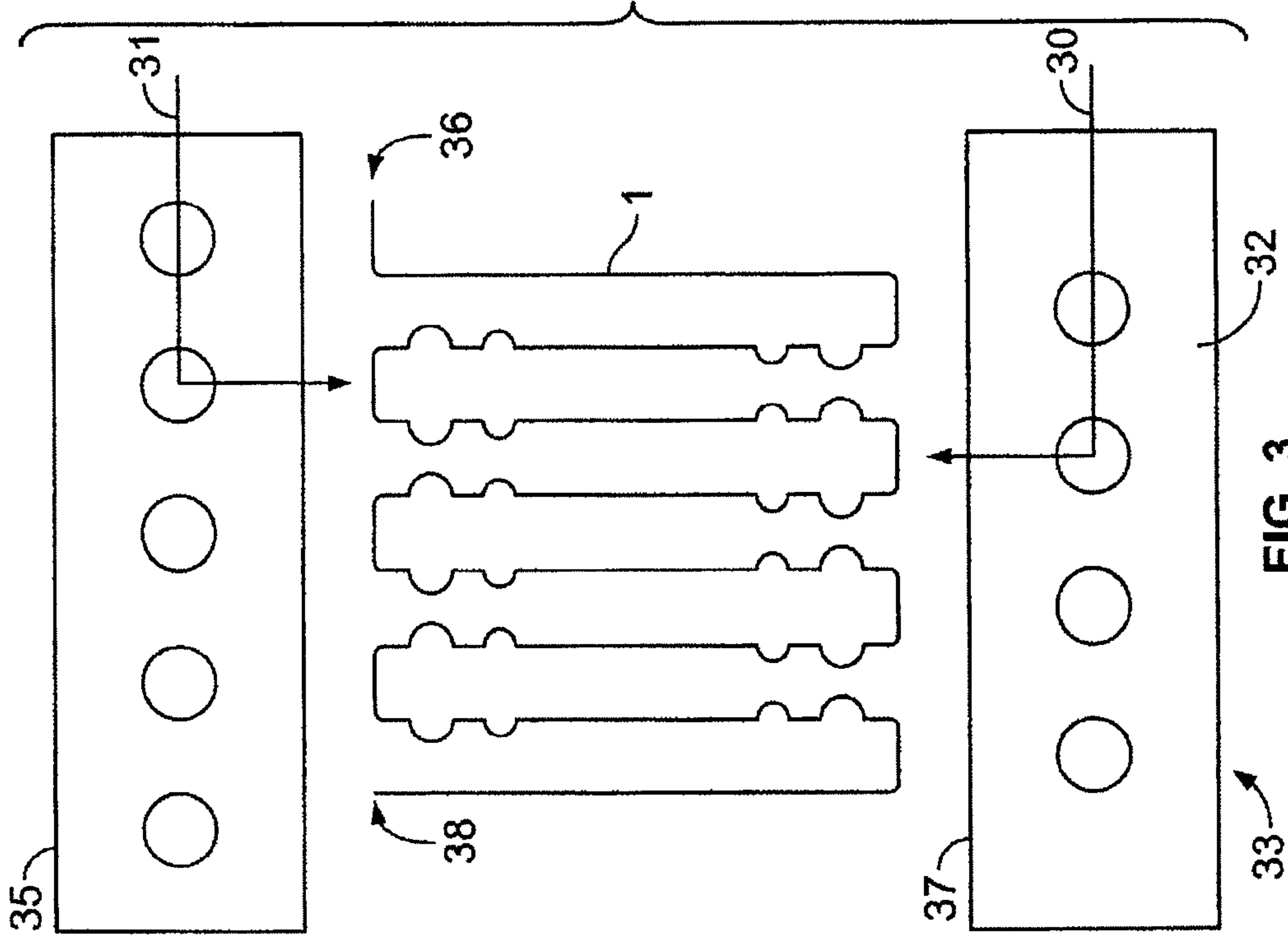


FIG. 3
(Prior Art)

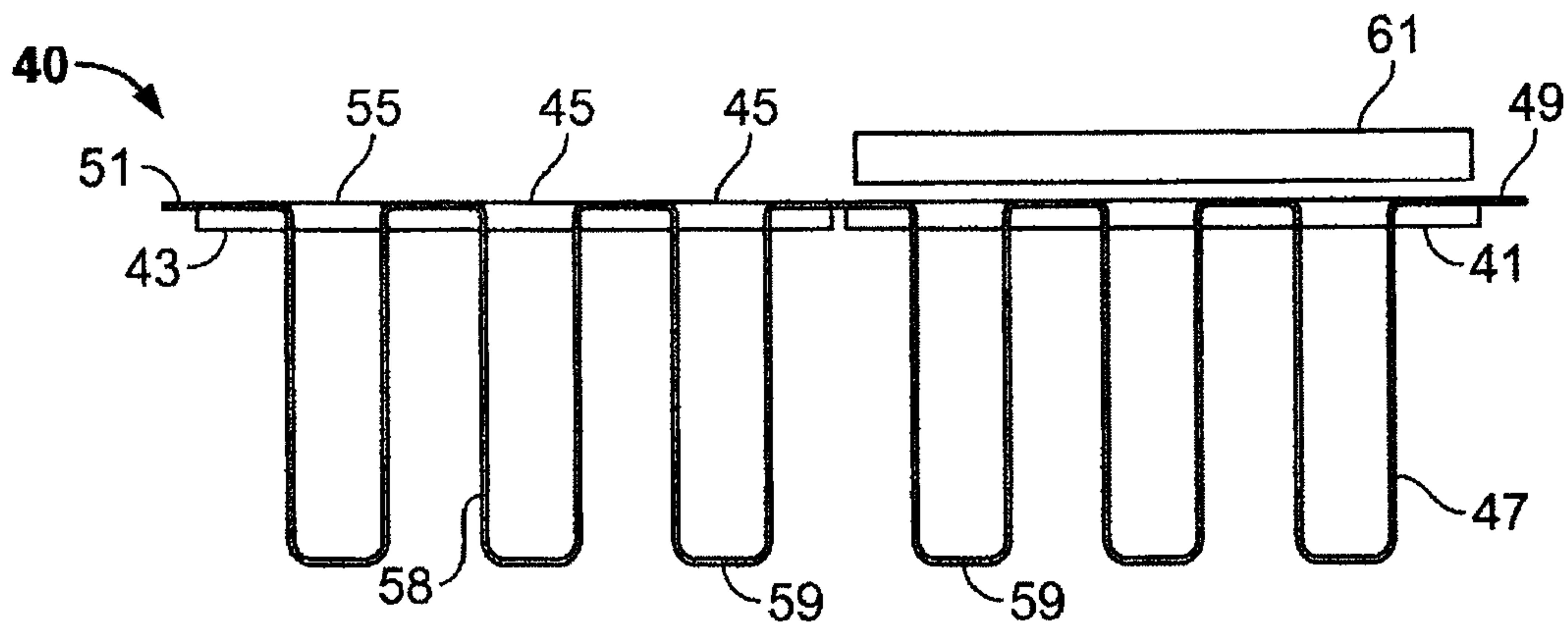


FIG. 4

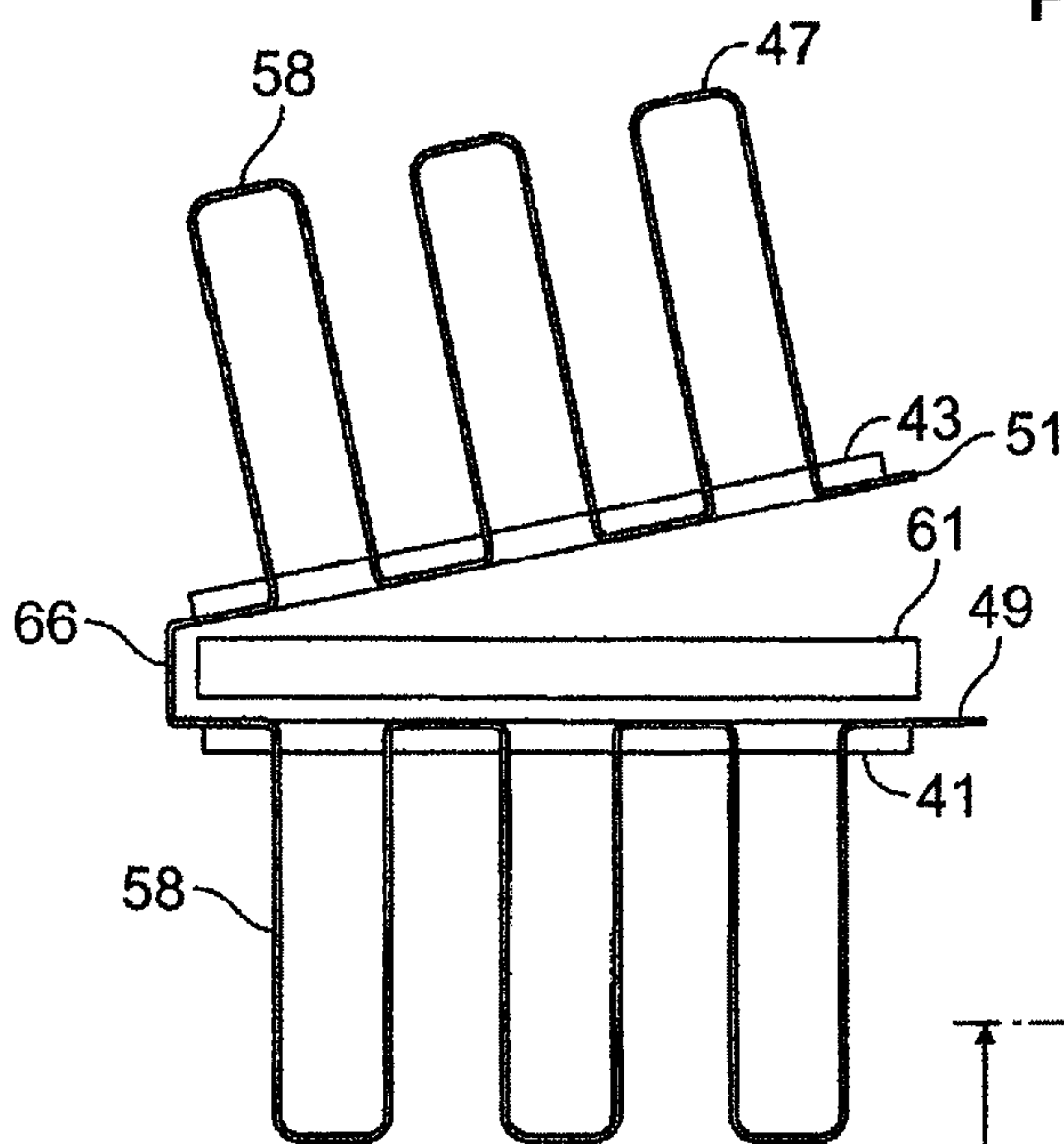


FIG. 5

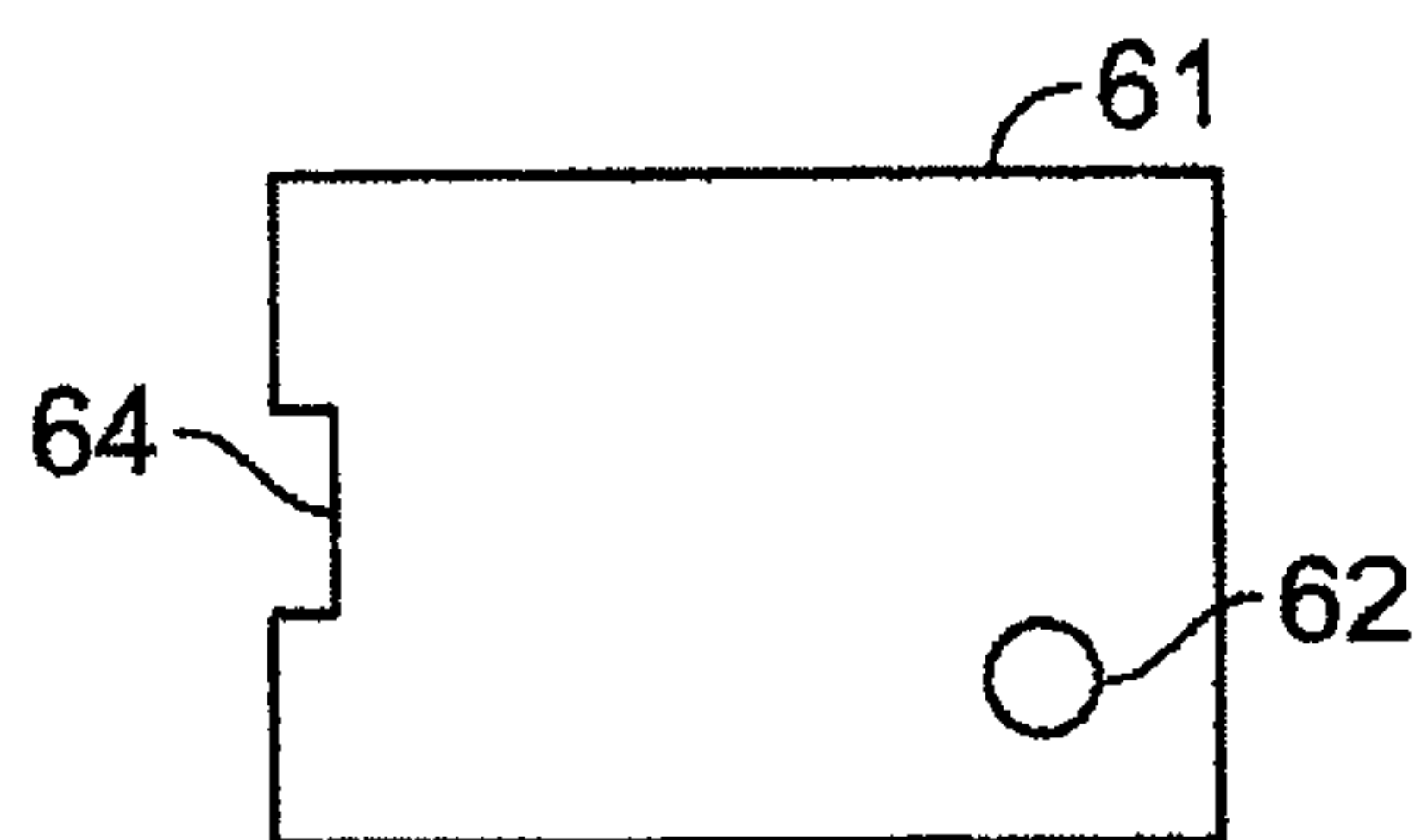


FIG. 6B

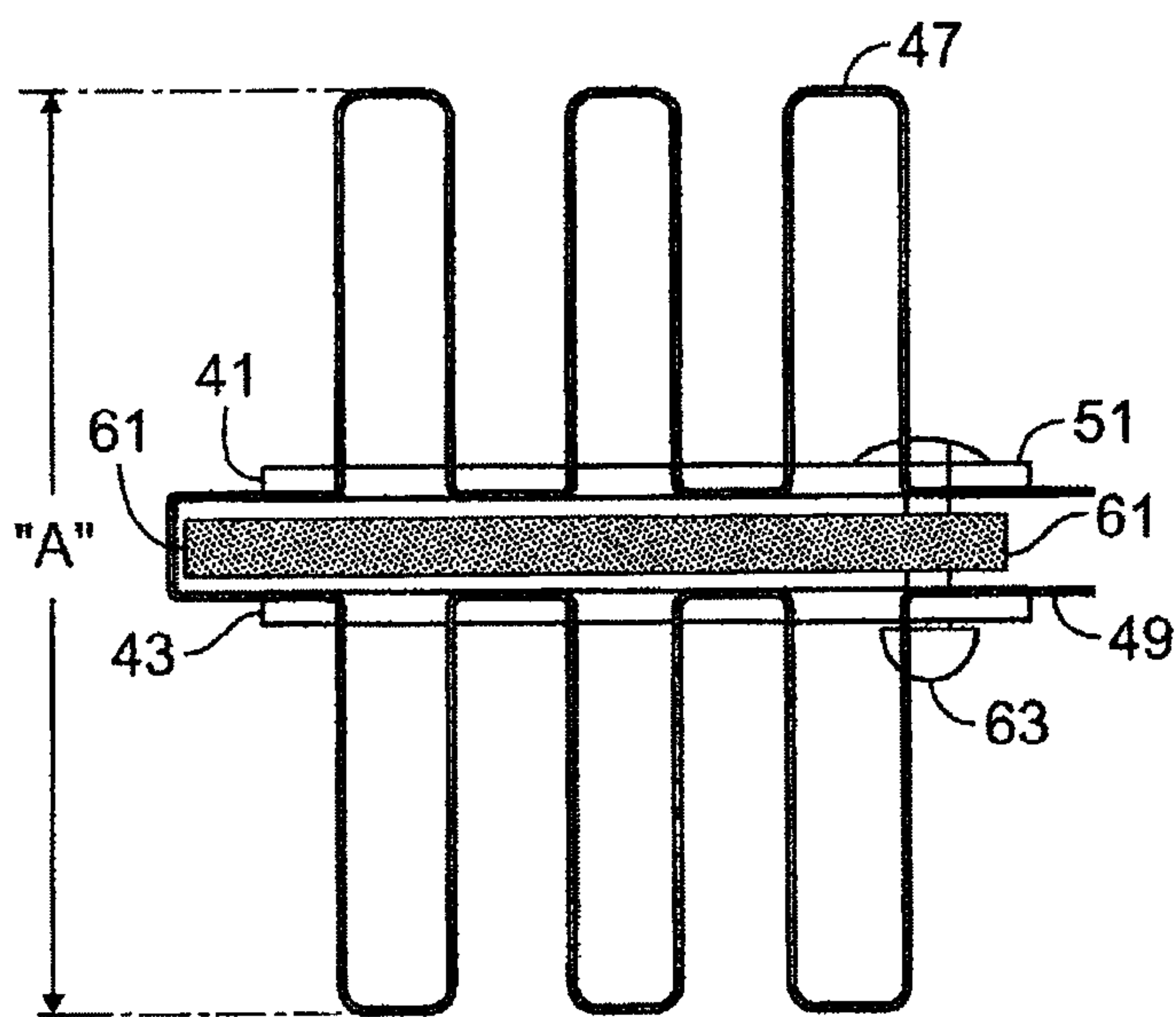


FIG. 6A

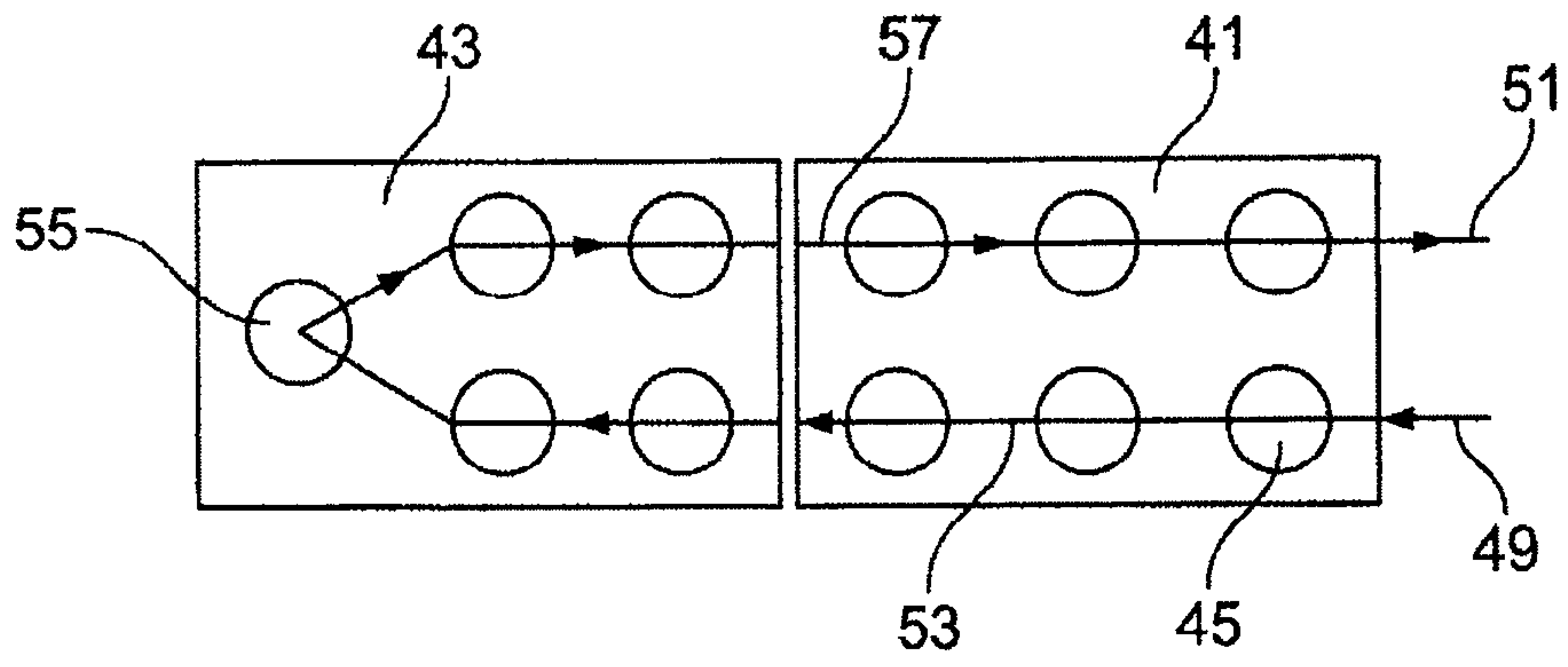


FIG. 7

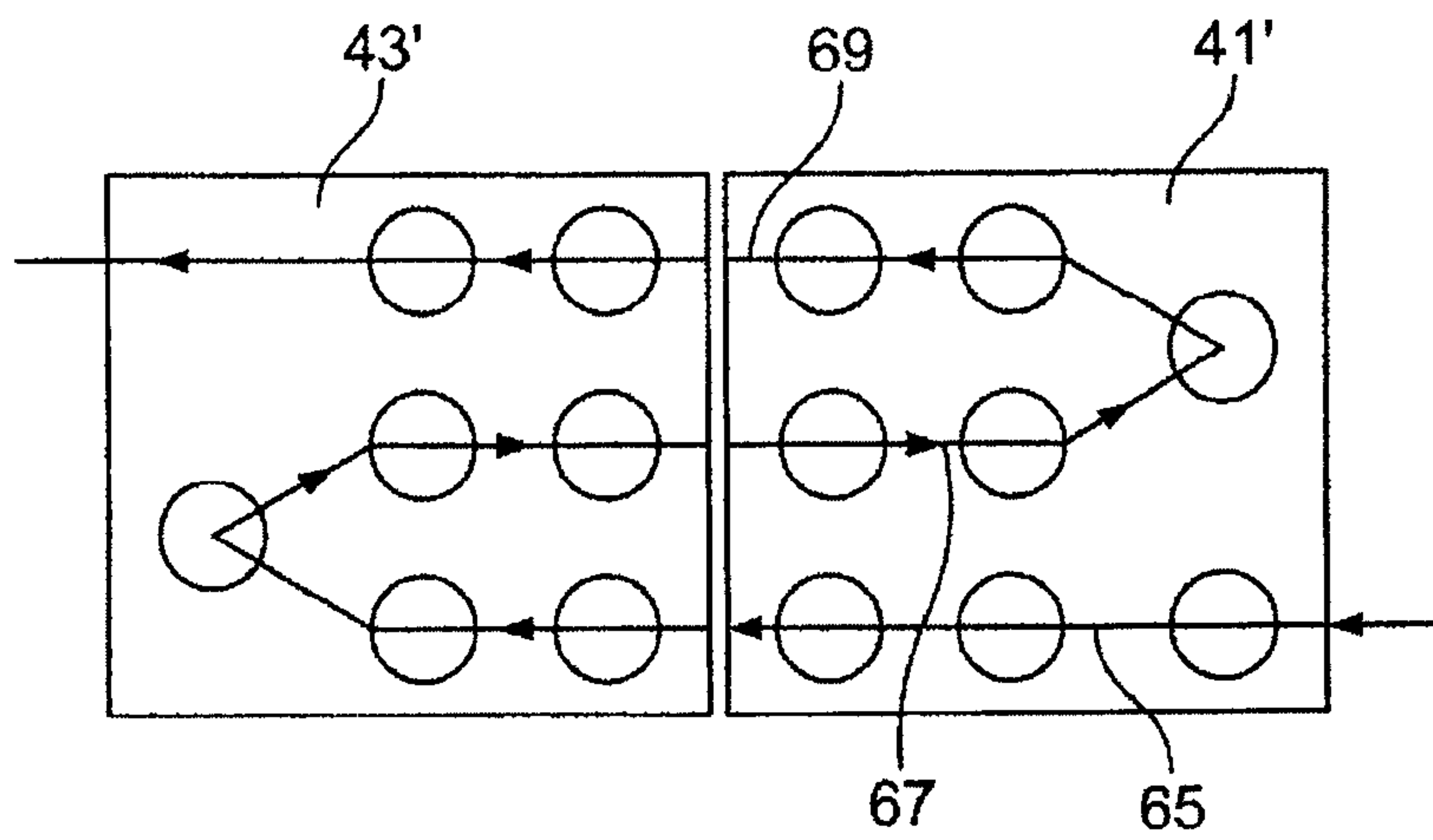


FIG. 8

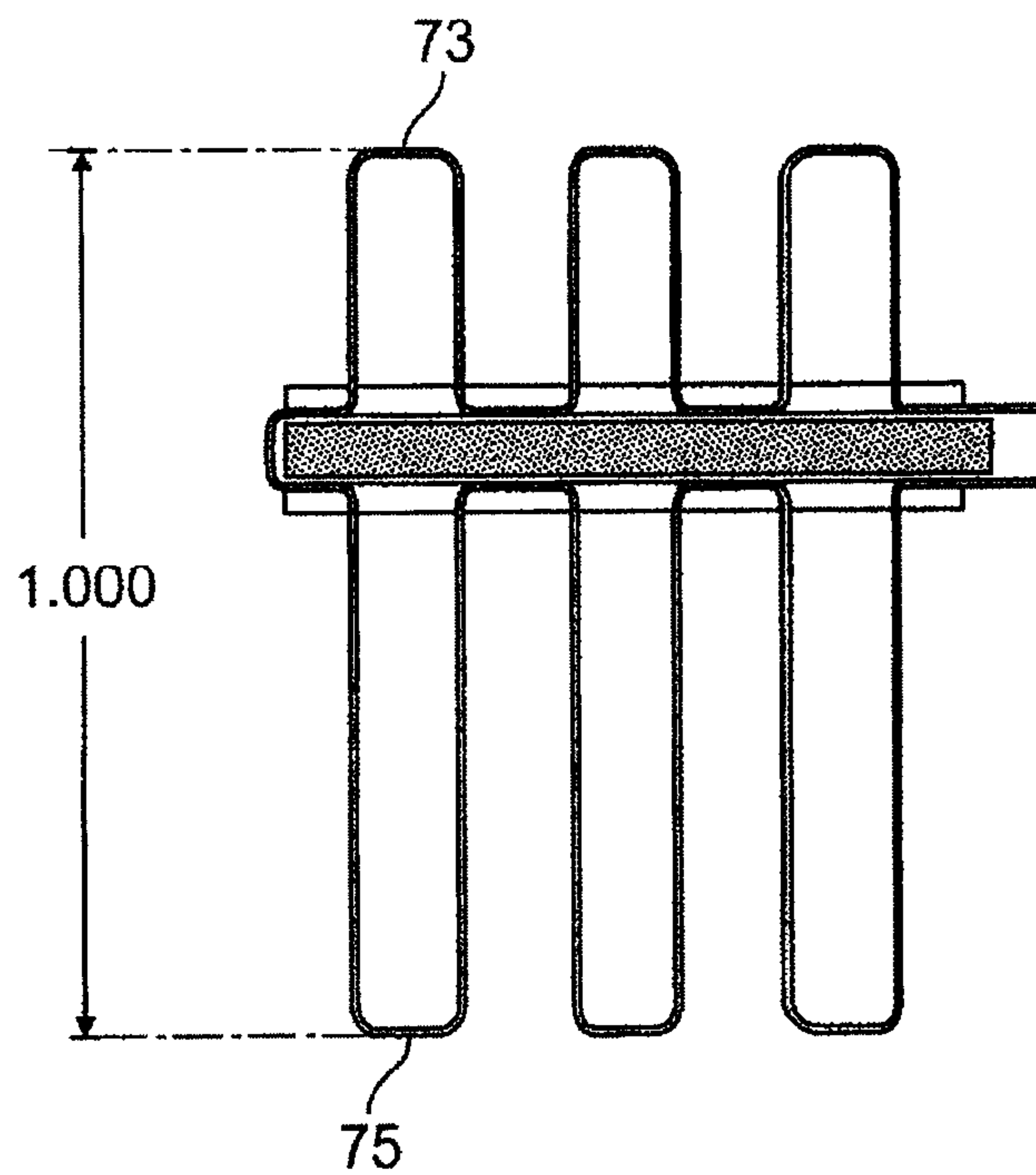


FIG. 9

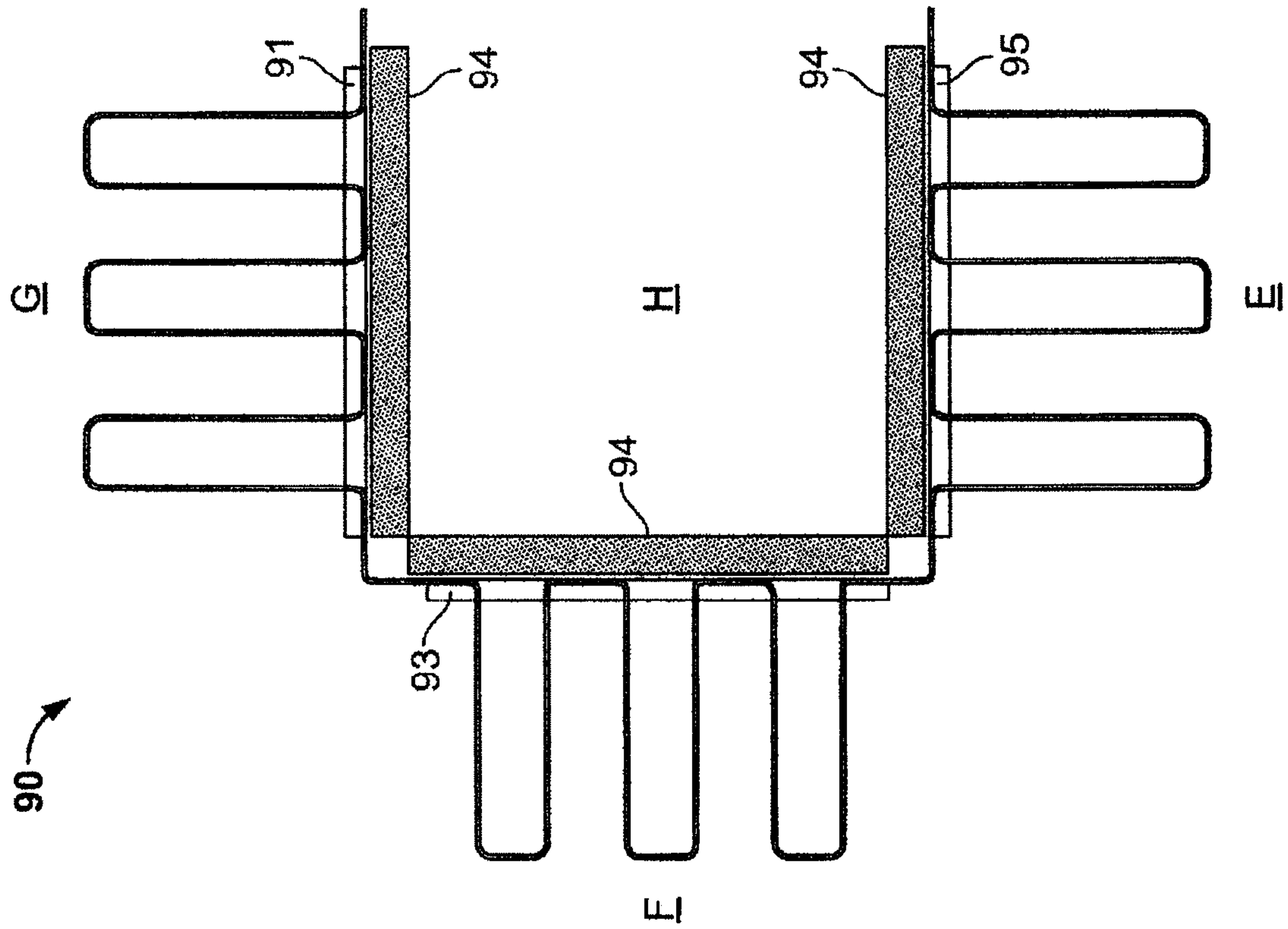


FIG. 10

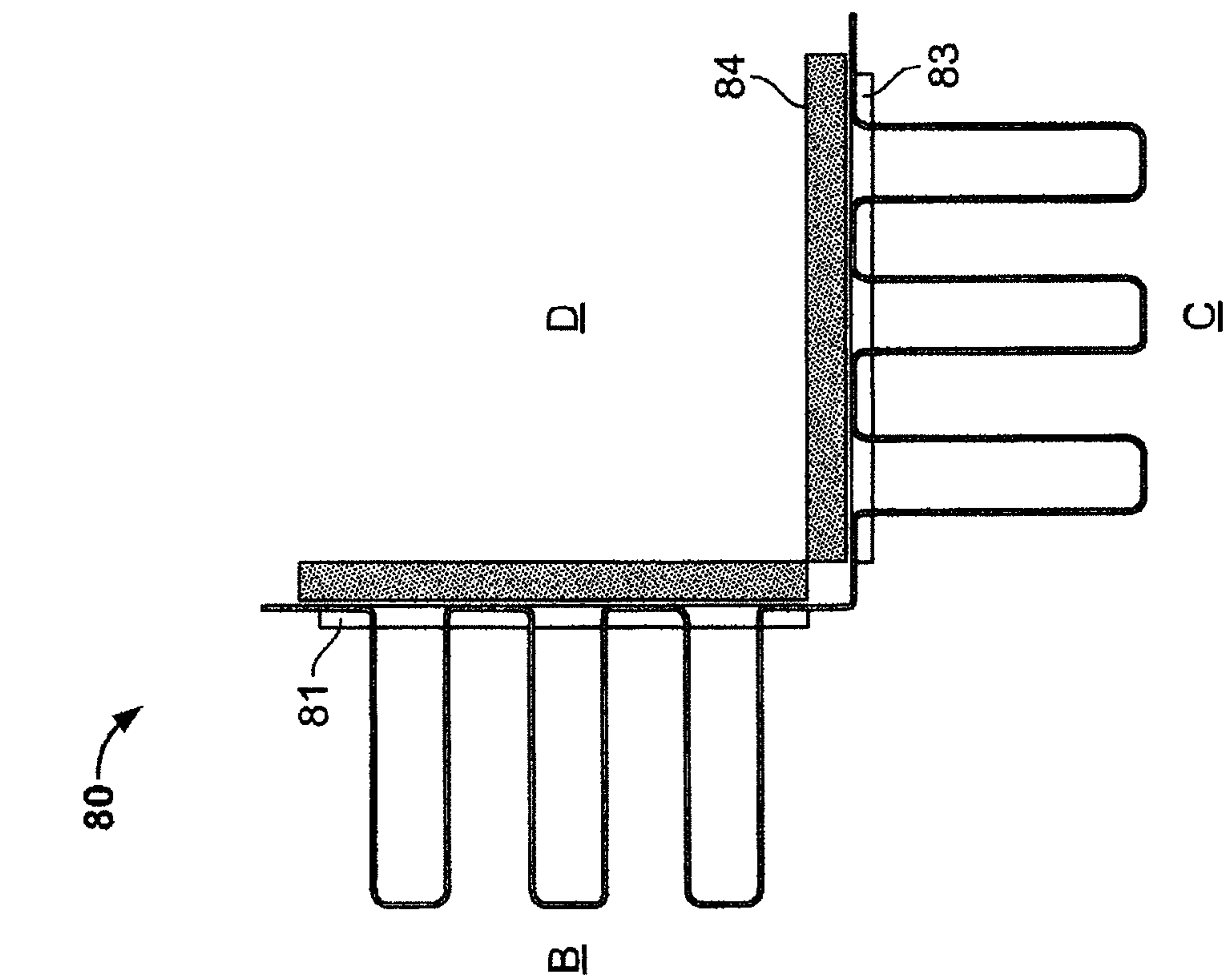


FIG. 11

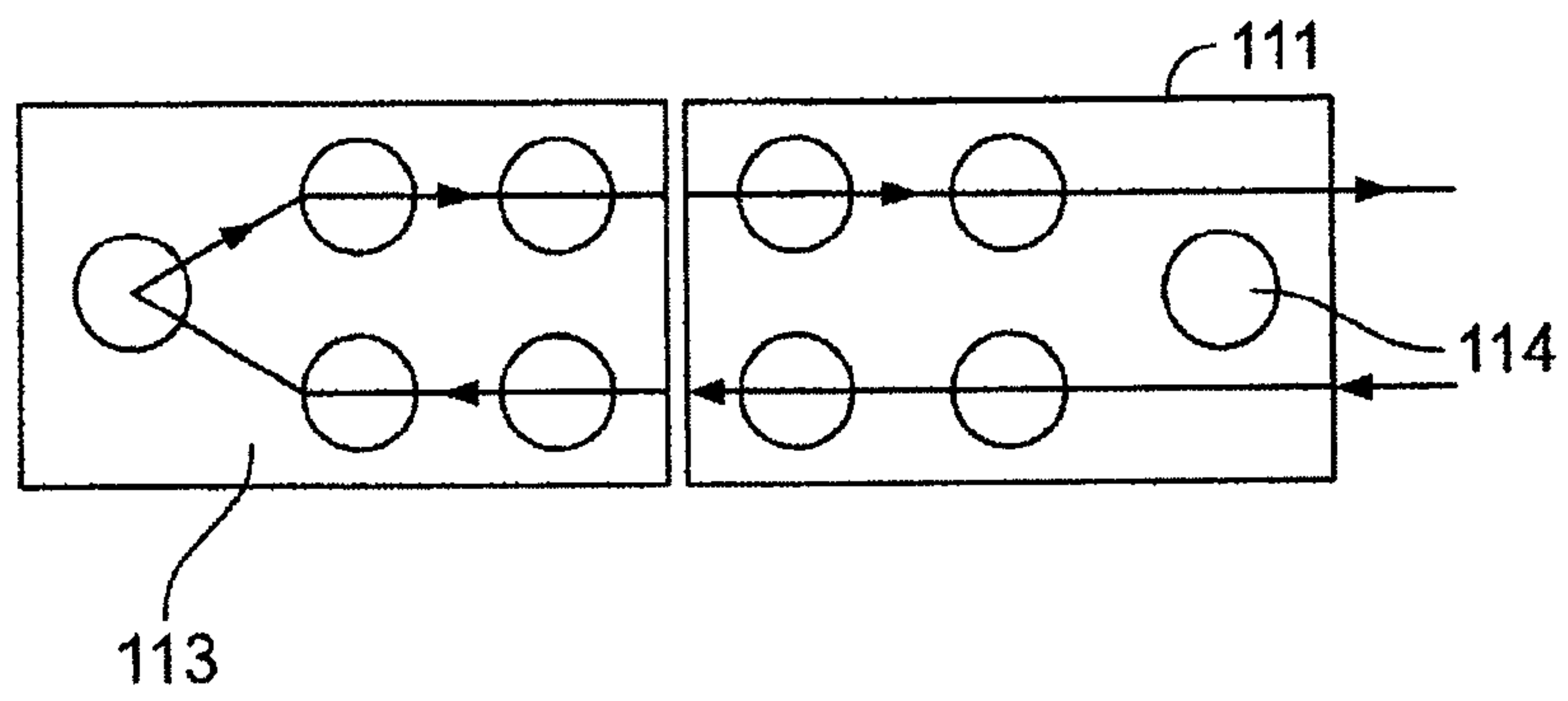


FIG. 12

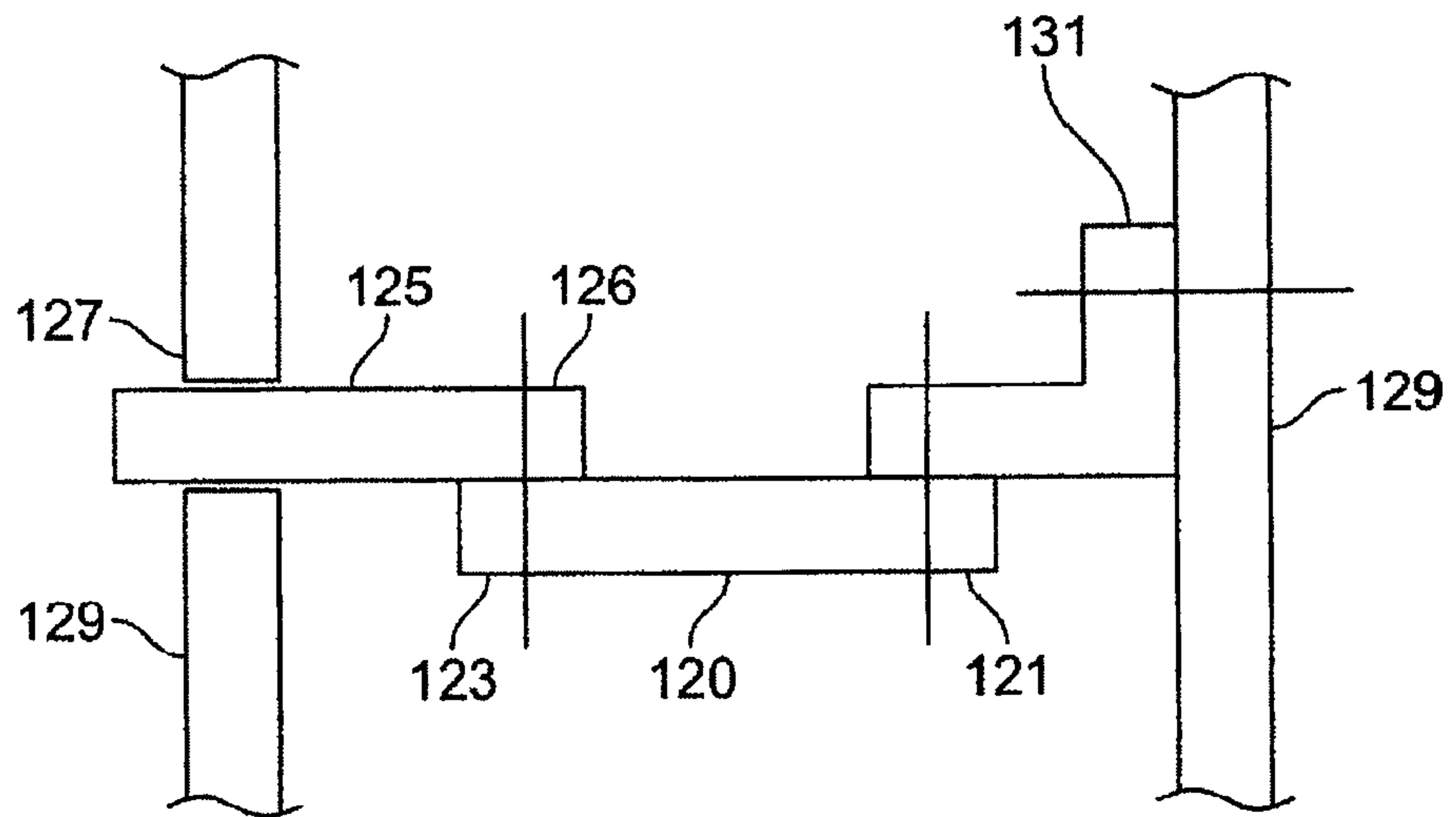


FIG. 13

