Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2460514 C 2011/05/10

(11)(21) **2 460 514**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(86) Date de dépôt PCT/PCT Filing Date: 2002/09/13
(87) Date publication PCT/PCT Publication Date: 2003/03/20
(45) Date de délivrance/Issue Date: 2011/05/10
(85) Entrée phase nationale/National Entry: 2004/03/12
(86) N° demande PCT/PCT Application No.: US 2002/029200
(87) N° publication PCT/PCT Publication No.: 2003/023146
(30) Priorité/Priority: 2001/09/13 (US60/318,838)

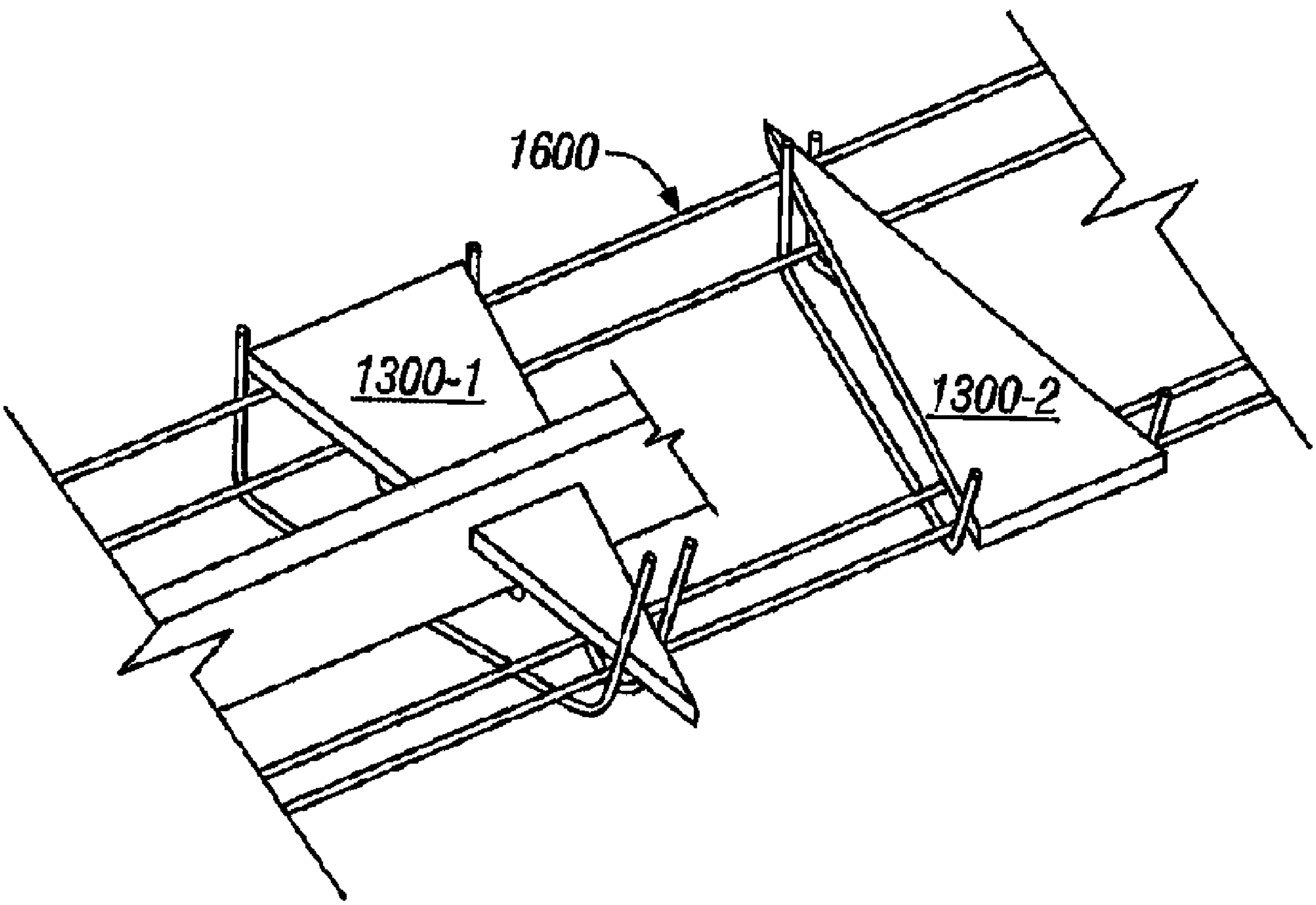
(51) Cl.Int./Int.Cl. *E01C 11/14* (2006.01)

(72) Inventeurs/Inventors:
BOXALL, RUSSELL, US;
PARKES, NIGEL K., US

(73) Propriétaires/Owners:
BOXALL, RUSSELL, US;
PARKES, NIGEL K., US

(74) Agent: SMART & BIGGAR

(54) Titre : PLAQUE DE TRANSFERT DE CHARGES POUR DALLES EN BETON IN SITU
(54) Title: LOAD TRANSFER PLATE FOR IN SITU CONCRETE SLABS



(57) Abrégé/Abstract:
A tapered load plate transfers loads across a joint between adjacent concrete floor slabs. The top and bottom surfaces may taper from approximately 4 inches wide to a narrow substantially pointed end over a length of approximately 12 inches. The tapered load

(11)(21) **2 460 514**

(13) **C**

(57) Abrégé(suite)/Abstract(continued):
plate accommodates differential shrinkage of cast-in-place concrete slabs. When adjacent slabs move away from each other, the narrow end of the tapered load plate moves out of the void that it created in the slab thus allowing the slabs to move relative to one another in a direction parallel to the joint. Tapered load plates may be assembled into a load-plate basket with the direction of the taper alternating from one tapered load plate to the next to account for off-center saw cuts. A tapered load plate and an end cap may be used to provide load transfer across an expansion joint.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

CORRECTED VERSION

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 March 2003 (20.03.2003)

PCT

(10) International Publication Number
WO 03/023146 A1

(51) International Patent Classification[7]: E01C 11/14

(21) International Application Number: PCT/US02/29200

(22) International Filing Date:
13 September 2002 (13.09.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/318,838 13 September 2001 (13.09.2001) US

(71) Applicants and
(72) Inventors: **BOXALL, Russell** [US/US]; 3011 Windsor Chase Drive, Matthews, NC 28105 (US). **PARKES, Nigel, K.** [US/US]; 3473 Palace Court, Tucker, GA 30084 (US).

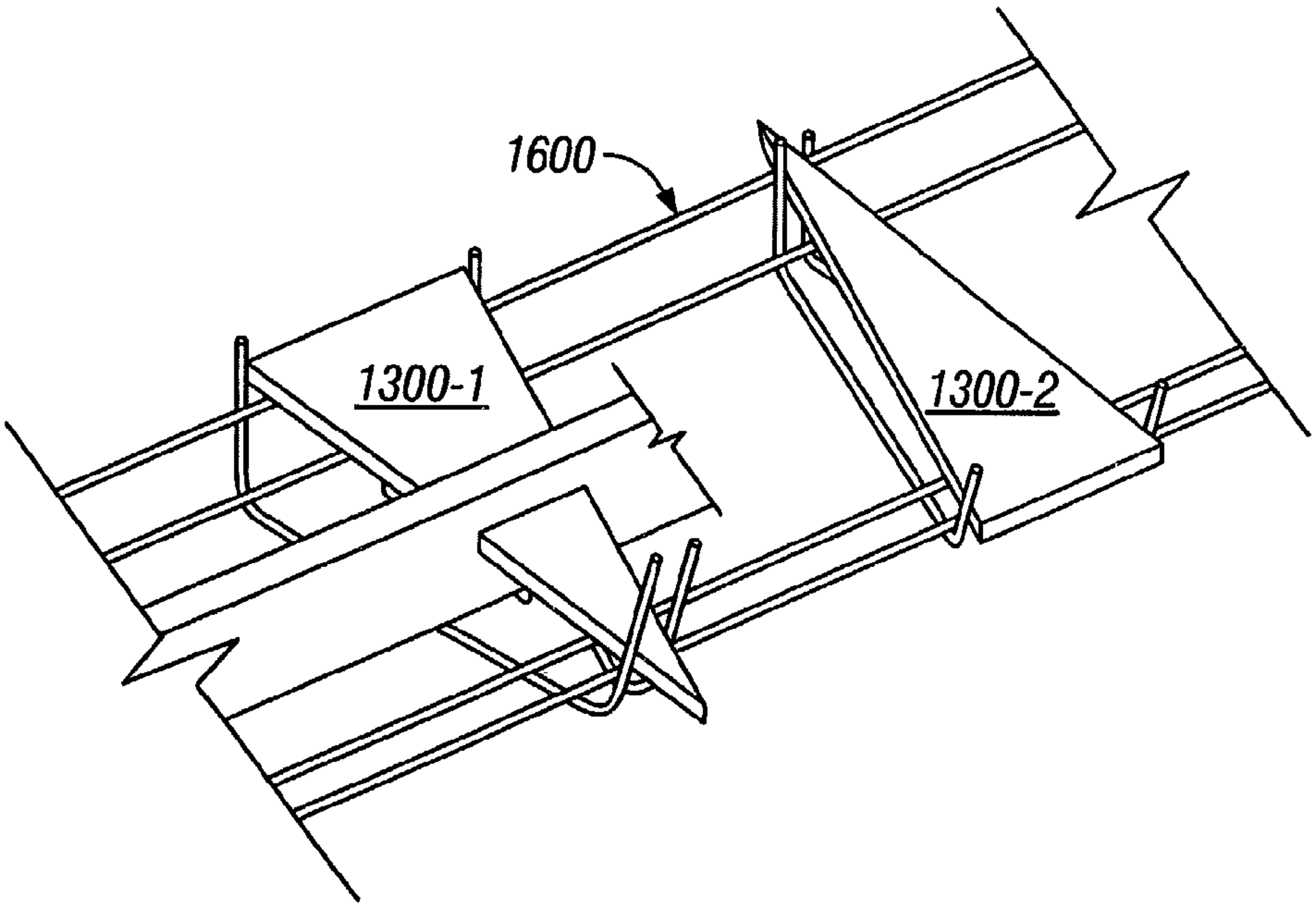
(74) Agents: **KLEIN, William, J.** et al.; Banner & Witcoff, Ltd., Suite 3000, 10 S. Wacker Drive, Chicago, IL 60606-7407 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) **Title:** LOAD TRANSFER PLATE FOR IN SITU CONCRETE SLABS



(57) **Abstract:** A tapered load plate transfers loads across a joint between adjacent concrete floor slabs. The top and bottom surfaces may taper from approximately 4 inches wide to a narrow substantially pointed end over a length of approximately 12 inches. The tapered load plate accommodates differential shrinkage of cast-in-place concrete slabs. When adjacent slabs move away from each other, the narrow end of the tapered load plate moves out of the void that it created in the slab thus allowing the slabs to move relative to one another in a direction parallel to the joint. Tapered load plates may be assembled into a load-plate basket with the direction of the taper alternating from one tapered load plate to the next to account for off-center saw cuts. A tapered load plate and an end cap may be used to provide load transfer across an expansion joint.

WO 03/023146 A1

WO 03/023146 A1

Published:
— *with international search report*

(48) Date of publication of this corrected version:
12 September 2003

(15) Information about Correction:
see PCT Gazette No. 37/2003 of 12 September 2003, Section II

LOAD TRANSFER PLATE FOR IN SITU CONCRETE SLABS

TECHNICAL FIELD

This invention relates generally to transferring loads between adjacent cast-in-place slabs and more particularly to a system for transferring, across a joint between a first slab and a second slab, a load applied to either slab.

BACKGROUND OF THE INVENTION

Referring to Figure 1, when a concrete floor slab 100 is first placed and the concrete starts to cure the volume of the concrete decreases causing the slab to shrink (usually on the order of 1/8 of an inch per 20 feet). Concrete has a relatively low strength when in tension. When the internal stresses due to shrinkage 104 reach a point greater then the tensile strength of the concrete, random stress-relief cracks 102 occur.

These random cracks 102 are undesirable as they detract from the performance of the floor slab 100 and reduce its life span. Referring to Figures 2A and 2B, a typical method of controlling where these cracks 102 occur is to induce a weakened plane by saw cutting the top surface 200 of the concrete slab 100 into small panels, as depicted by saw cut 202.

Referring to Figure 3, an undesirable side effect of having the floor slab 100 made up of numerous small sections is that when the floor is loaded, such as with the wheels of a moving fork lift 300, each section of the floor may be deflected 302 relative to its neighbor causing damage 304 to the joint edge, as depicted in Figure 3.

Referring to Figure 4, a conventional technique for reducing this type of deflection 302 is to span the joint 400 with steel bars 402 each having a round cross-section. These bars 402 are commonly referred to as dowel bars.

Referring to Figures 5A-5C, dowels of this type are typically assembled into a wirework frame 500 that holds the dowels at a desired depth 502 and orientation. This assembly is generally known as a dowel basket.

Using circular-cross-section dowel bars is associated with various drawbacks. For instance, if the dowel bars 402 are misaligned 600 such that they are not oriented totally perpendicular to the joint, the dowel bars 402 can lock the joint 400 thereby undesirably restraining the joint from opening, which in turn may cause random cracks 102.

Referring to Figure 7, if a concrete floor slab, such as slabs 100-1 or 100-2, tries to move along the line of the joint 400 relative to the next panel (for instance due to shrinkage or thermal contraction), the dowel bars 402 will restrain this type of movement 700, thereby causing random cracks 102.

Referring to Figure 8, at an intersection of two joints, movement 800, which is a combination of the two types of movement discussed above in connection with Figures 6 and 7, can cause a situation known as corner cracking 802.

Referring to Figures 9A and 9B, the round-dowel-bar drawbacks discussed above have been addressed in the past by using dowel bars 900 having a square or rectangular cross-section in conjunction with a plastic or steel clip 902 that places a compressible material 904 on the two vertical faces of the dowel bar 900. These clips 902 produce a void in the concrete wider than the dowel bar 900 allowing for sideways movement and a slight degree of misalignment. The clips 902, however, undesirably add to the expense associated with using dowel bars 900 having square and/or rectangular cross-sections. A more cost-effective solution that overcomes the misalignment problem to a greater extent, therefore, would be advantageous.

Under certain conditions, such as outdoor applications, concrete slab placement should be able to withstand concrete expansion, which is typically due to thermal changes, such as colder winter temperatures changing to warmer summer temperatures. Referring to Figure 10, conventionally, a piece of compressible material 1000, such as foam, fiberboard, timber, or the like, is placed in an expansion joint 1002 between concrete slabs 100-1 and 100-2. A round-cross-section dowel bar 402 and an end cap 1004 may be used for transferring a load across the expansion joint 1002. As the slabs 100 expand, they move together, as indicated by arrows 1006, the joint 1002 closes, and the dowel bar 402 goes farther into the end cap 1004. This use of round-cross-section dowel bars, however, is associated with the misalignment drawback discussed above in connection with saw-cut control joints. A cost-effective way of dealing with the misalignment situation while transferring loads between concrete slabs across expansion joints 1002 would therefore be desirable.

Applicants' U.S. Patent 6,354,760 discloses a load plate that overcomes the drawbacks discussed above, namely misalignment and allowing relative movement of slabs parallel to the joint. Referring to Figure 11, the '760 patent discloses using a load plate 1100 rotated such that the load plate has a widest portion (i.e., opposite corners) of the load plate positioned in the joint between slabs 100-1 and 100-2. Using such a load plate 1100 at a construction joint works well because the load plate can be reliably centered at the construction joint between the slabs 100.

A load plate 1100 is not, however, ideally suited for use at saw-cut control joints. As described above, this type of joint results from cracking induced by a saw cut in the upper surface of a concrete slab. The saw cut may be off center with respect to any load plate embedded within the cement, as shown by the dashed line 1200 in Figure 12. If the saw cut and joint are off-center, the load plate will not function as intended because more than half of the load plate will be fixed within one of the slabs and less than half of the load plate will be available for transferring loads to and from the other slab. Another situation for which a load plate 1100 is not ideally suited is when a construction joint, formed by an edge form, for instance, is expected to be relatively wide open. Under such circumstances, an undesirably large area of load plates 1100 may undesirably be removed from slabs on either or both sides of the joint thereby reducing the ability of the load plate 1100 to transfer loads between the slabs. For these reasons, a load transfer device that provides the advantages of the load plate of the '760 patent and that is well suited to use in saw-cut control joints and construction joints, which may become relatively wide open, would be desirable.

SUMMARY OF THE INVENTION

In accordance with an illustrative embodiment of the invention, a tapered load plate may be used to transfer loads across a joint between adjacent concrete floor slabs. The top and bottom surfaces may taper from approximately 4 inches wide to a narrow substantially pointed end 1308 over a length of approximately 12 inches. As will be apparent, other suitable tapered shapes and/or other suitable dimensions may also be used.

A tapered load plate, in accordance with an illustrative embodiment of the invention, advantageously accommodates misalignment of a saw cut for creating a control joint. Misalignment up to an angle substantially equal to the angle of the load plate's taper may be accommodated.

The tapered shape of the tapered load plate advantageously accommodates differential shrinkage of cast-in-place concrete slabs. When adjacent slabs move away from each other, the narrow end of the tapered load plate moves out of the void that it created in the slab. As the tapered load plate retracts, it will occupy less space within the void in the slab thus allowing the slabs to move relative to one another in a direction parallel to the joint.

Tapered load plates may be assembled into a load-plate basket with the direction of the taper alternating from one tapered load plate to the next. If a saw cut, used for creating a control joint, is positioned off-center relative to the tapered load plates, the alternating pattern of tapered load plates in the load-plate basket will ensure that the cross section of tapered load plate material, such as steel, spanning the joint remains substantially constant across any number of pairs of tapered load plates. For use in connection with a construction joint, an edge form may be used to position tapered load plates before the slabs are cast in place.

In accordance with an illustrative embodiment of the invention, a tapered load plate and an end cap, may be used to provide load transfer across an expansion joint. The tapered shape of the load plate will allow for misalignment. As either or both slabs expand and thereby cause the joint to close, the wide end of the tapered load plate moves farther into the end cap. This results in the allowance of an increasing amount of lateral movement between the slabs parallel to the joint 400 to the central and relatively wider portions of the tapered load plate occupying less space in the tapered void.

In accordance with an illustrative embodiment of the invention, a tapered-load-plate basket may be used to position the tapered load plates and compressible material before the concrete slabs are cast in place.

According to one aspect of the present invention, there is provided a system for transferring loads across a joint between concrete on-ground cast-in-place slabs, the system comprising: a first concrete on-ground cast-in-place slab; a second concrete on-ground cast-in-place slab; an expansion joint separating the first and second slabs, wherein the joint is oriented substantially perpendicular to a substantially planar upper surface of the first slab, and a longitudinal axis of the joint is formed by an intersection of the joint and the upper surface of the first slab; a load-plate end cap embedded within the first slab; a tapered load plate that tapers from a relatively wide end to a relatively narrow end, the wide end protruding into a portion of the end cap and the narrow end protruding into the second slab such that the load plate transfers between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; and whereby the load plate restricts relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plate moves farther into the end cap as the joint closes via the first and second slabs moving toward each other in a direction substantially perpendicular to the joint, such that, as the joint closes, the first and second slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, further comprising a tapered-load-plate basket that positions the tapered load plates before the slabs are cast in place.

According to another aspect of the present invention, there is provided a system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising: a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab; a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint; the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, further comprising a tapered-load-plate basket that positions the tapered load plates before the slabs are cast in place.

According to still another aspect of the present invention, there is provided a system for transferring loads across a joint between concrete on-ground cast-in-place slabs, the system comprising: a first concrete on-ground cast-in-place slab; a second concrete on-ground cast-in-place slab; an expansion joint separating the first and second slabs, wherein the joint is oriented substantially perpendicular to a substantially planar upper surface of the first slab, and a longitudinal axis of the joint is formed by an intersection of the joint and the upper surface of the first slab; a load-plate end cap embedded within the first slab; a tapered load plate that tapers from a relatively wide end to a relatively narrow end, the wide end protruding into a portion of the end cap and the narrow end protruding into the second slab such that the load plate transfers between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; and whereby the load plate restricts relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plate moves farther into the end cap as the joint closes via the first and second slabs moving toward each other in a direction substantially perpendicular to the joint, such that, as the joint closes, the first and second slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, the tapered load plate having a width measured in a direction substantially parallel to said longitudinal axis, and having only one relatively wide portion and only one relatively narrow portion, that tapers from said relatively wide portion, said taper from said relatively wide portion being a generally progressive reduction of said width of said load plate as said load plate extends from said wide portion across said expansion joint, said taper including said generally progressive reduction of said width continuing past said expansion joint as said load plate extends to said relatively narrow portion, the wide portion protruding into said first slab and a portion of the end cap.

According to yet another aspect of the present invention, there is provided a system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising: a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab; a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint; the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, wherein the load plates each have their width measured parallel to the longitudinal axis of the joint; and wherein the load plates define a cross section of tapered load plate material spanning the joint, and the cross section remains substantially constant between the joint being positioned on-center relative to the load plates and the joint being, in at least one position of the joint, off-center relative to the load plates.

According to a further aspect of the present invention, there is provided a system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising: a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab; a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint; the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, further being a system for restricting certain movement, accommodating certain other movement and transferring loads between the first concrete on-ground cast-in-place slab and the second concrete on-ground cast-in-place slab, the system further comprising: the joint being subject to opening through a range of joint opening dimensions and beyond; the first tapered load plate and the second tapered load plate each having a taper, and an extent across the joint such that the load plates span the joint, the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; the width of each tapered load plate generally tapering from a relatively wide location in the extent of each plate across the joint to a relatively narrow portion such that, as the joint opens, a tapered gap opens between the load plate and a slab near the narrow portion such that the slabs are allowed increasingly greater relative movement in the direction substantially parallel to the longitudinal axis of the joint; and wherein the first and second tapered load plates are oriented such that for at least the range of joint opening dimensions, reduced width of one load plate at the narrowest width in the joint of the one load plate due to plate taper is compensated for by increased width of the other load plate in the joint due to opposing plate taper, such that for at least the range of joint opening dimensions, the combined widths of the first and second tapered load plates in the joint is consistently adequate for load transfer across the joint; whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint, allow for increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint as the joint opens, and maintain consistently adequate load transfer across the joint.

According to yet a further aspect of the present invention, there is provided a system for restricting certain movement, accommodating certain other movement and transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising the slabs and further comprising: a joint interposing the first and second slabs, at least the first slab having a substantially planar upper surface, at least a portion of the joint being initially defined by at least one of a crack, cut or a form oriented substantially perpendicular to the substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the crack, cut or form and the upper surface of the first slab and wherein the joint is subject to opening through a range of joint opening dimensions and beyond; a first tapered load plate and a second tapered load plate that each have a taper, protrude into the first and second slabs and have an extent across the joint such that the load plates span the joint and transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; the width of each tapered load plate generally tapering from a relatively wide location in the extent of each plate across the joint to a relatively narrow portion such that, as the joint opens, a tapered gap opens between the load plate and the slab near the narrow end portion such that the slabs are allowed increasingly greater relative movement in the direction substantially parallel to the longitudinal axis of the joint; and wherein the first and second tapered load plates are oriented such that for at least the range of joint opening dimensions, reduced width of one load plate at the narrowest width in the joint of the one load plate due to plate taper is compensated for by increased width of the other load plate in the joint due to opposing plate taper, such that for at least the range of joint opening dimensions, the combined widths of the first and second tapered load plates in the joint is consistently adequate for load transfer across the joint; whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint, allow for increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint as the joint opens, and maintain consistently adequate load transfer across the joint.

According to still a further aspect of the present invention, there is provided a system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising: a joint separating the first and second slabs, at least a portion of the joint being initially defined by a partial depth saw cut that results in a crack below the saw cut, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut and the upper surface of the first slab; a first load plate and a second load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; whereby the load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint; the load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each load plate generally tapers from a relatively wide portion near the joint to at least one relatively narrow end in at least one of the slabs such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint; and wherein the tapered load plates define a cross section of tapered load plate material spanning the joint, and the cross section remains substantially constant between the saw cut being positioned on-center relative to the tapered load plates and the saw cut being, in at least one position of the saw cut, off-center relative to the tapered load plates.

According to another aspect of the present invention, there is provided a system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising: a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a partial depth saw cut that results in a crack below the saw cut, the saw cut oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut and the upper surface of the first slab; a first load plate and a second load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; whereby the load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint; the load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each load plate generally tapers from a relatively wide portion near the joint to at least one relatively narrow end in at least one of the slabs such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint.

Additional features and advantages of the invention will be apparent upon reviewing the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a concrete floor slab with random cracks caused by concrete shrinkage.

Figures 2A and 2B are cross-section and plan views of saw-cut control joints.

Figure 3 depicts vertical deflection of a floor slab under a load and damage to an adjacent floor slab.

Figures 4A and 4B are cross section and plan view of dowel bars positioned for transferring loads across joints between adjacent slabs.

Figures 5A-5C are plan and sectional views of a dowel basket for positioning dowel bars before a floor slab is cast in place.

Figure 6 is a plan view of misaligned dowel bars locking a joint and thereby causing a slab to crack.

Figure 7 is a plan view of cracks caused by dowel bars restricting relative movement of slabs parallel to the joint between the slabs.

Figure 8 is a plan view showing corner cracking due to misaligned dowel bars and restricted relative movement of slabs parallel to the joints.

Figures 9A and 9B are isometric and sectional views of a square dowel and square-dowel clip.

Figure 10 is a side view of a typical expansion joint with compressible material in the joint.

Figure 11 is a plan view of a diamond-shaped load plate between two slabs.

Figure 12 is a plan view illustrating an off-center saw cut relative to diamond-shaped load plates.

Figure 13 shows a top and two side views of a tapered load plate in accordance with an illustrative embodiment of the invention.

Figure 14 is a plan view showing a misaligned saw cut relative to a tapered load plate.

Figure 15 is a plan view of a tapered load plate, two slabs, a joint, and a void created by the narrow end of the tapered load plate.

Figure 16 shows tapered load plates in a tapered-load-plate basket, wherein the orientation of the tapered load plates alternates from one tapered load plate to the next.

Figure 17 is a plan view showing an off-center saw cut relative to three alternately oriented tapered load plates.

Figure 18 is a plan view of an open expansion joint, a tapered load plate, and an end cap.

Figure 19 is a plan view similar to Figure 18 with the joint having closed relative to Figure 18.

Figure 20 is a side view of an expansion-type tapered-load-plate basket, compressible material, a tapered load plate, and an end cap.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 13, in accordance with an illustrative embodiment of the invention, a tapered load plate, such as tapered load plate 1300, may be used to transfer loads across a joint between adjacent concrete floor slabs. The tapered load plate 1300 may have top and bottom surfaces that are tapered, substantially planar, and substantially parallel to one another. A triangular-shaped tapered top surface 1302 and two generally rectangular-shaped side surfaces 1304 and 1306 are shown in Figure 13. The top and bottom surfaces may taper from approximately 4 inches wide to a narrow substantially pointed end 1308 over a length of approximately 12 inches. As will be apparent, other suitable tapered shapes and/or other suitable dimensions may also be used.

A tapered load plate 1300, in accordance with an illustrative embodiment of the invention, advantageously accommodates misalignment of a saw cut for creating a control joint. Misalignment up to an angle substantially equal to the angle of the load plate's taper may be accommodated. Referring to Figure 14, a misaligned saw cut 1400 is misaligned by an angle 1402 from correctly aligned saw cut 1404, which is oriented perpendicular to the tapered load plate's longitudinal axis 1406. The load plate's angle of taper is depicted in Figure 14 by angle 1408.

Referring to Figure 15, differential shrinkage of cast-in-place concrete slabs is advantageously accommodated by the tapered shape of the tapered load plate 1300. When adjacent slabs, such as slabs 100-1 and 100-2, move away from each other, as indicated by arrow 1500, the joint 400 is said to open. As this occurs, the narrow end of the tapered load plate 1300 moves out of the void 1502 that it created in the slab 100-2. As the tapered load plate 1300 retracts in this manner, it will occupy less space within the void in the slab 100-2 thus allowing the slabs 100-1 and 100-2 to move relative to one another in a direction parallel to the joint 400. In other words, as the slabs move apart, the narrow end of the tapered load plate occupies less of the width of the tapered void 1502.

Referring to Figure 16, tapered load plates 1300 may be assembled into a load-plate basket 1600 with the direction of the taper alternating from one tapered load plate 1300 to the next. Referring to Figure 17, if a saw cut 1700, used for creating a control joint, is positioned off-center relative to the tapered load plates 1300, the alternating pattern of tapered load plates 1300 in the load-plate basket 1600 will ensure that the cross section of tapered load plate material, such as steel, spanning the joint remains substantially constant across any number of pairs of tapered load plates 1300. For use in connection with a construction joint, an edge form may be used to position tapered load plates before the slabs are cast in place.

Referring to Figure 18, in accordance with an illustrative embodiment of the invention, a tapered load plate 1300 and an end cap 1800 may be used to provide load transfer across an expansion joint of the type discussed above in connection with Figure 10. The tapered shape of the load plate 1300 will allow for misalignment, as discussed above in connection with Figure 14. As either or both slabs 100-1 and 100-2 expand and thereby cause the joint 400 to close, the wide end of the tapered load plate 1300 moves farther into the end cap 1800. This results in the allowance of an increasing amount of lateral movement between the slabs 100-1 and 100-2 parallel to the joint 400 due to the central and relatively wider portions of the tapered load plate occupying less space in the tapered void 1900.

Referring to Figure 20, in accordance with an illustrative embodiment of the invention, a tapered-load-plate basket 2000 may be used to position the tapered load plates 1300 and compressible material 1000 before the concrete slabs 100 are cast in place.

While the invention has been described with respect to specific examples including presently preferred modes of carrying out the invention, the invention is limited only by the following claims.

CLAIMS:

1. A system for transferring loads across a joint between concrete on-ground cast-in-place slabs, the system comprising:

a first concrete on-ground cast-in-place slab;

a second concrete on-ground cast-in-place slab;

an expansion joint separating the first and second slabs, wherein the joint is oriented substantially perpendicular to a substantially planar upper surface of the first slab, and a longitudinal axis of the joint is formed by an intersection of the joint and the upper surface of the first slab;

a load-plate end cap embedded within the first slab;

a tapered load plate that tapers from a relatively wide end to a relatively narrow end, the wide end protruding into a portion of the end cap and the narrow end protruding into the second slab such that the load plate transfers between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; and

whereby the load plate restricts relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plate moves farther into the end cap as the joint closes via the first and second slabs moving toward each other in a direction substantially perpendicular to the joint, such that, as the joint closes, the first and second slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint,

further comprising a tapered-load-plate basket that positions the tapered load plates before the slabs are cast in place.

2. A system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising:

a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab;

a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint;

the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint,

further comprising a tapered-load-plate basket that positions the tapered load plates before the slabs are cast in place.

3. A system for transferring loads across a joint between concrete on-ground cast-in-place slabs, the system comprising:

a first concrete on-ground cast-in-place slab;

a second concrete on-ground cast-in-place slab;

an expansion joint separating the first and second slabs, wherein the joint is oriented substantially perpendicular to a substantially planar upper surface of the first slab, and a longitudinal axis of the joint is formed by an intersection of the joint and the upper surface of the first slab;

a load-plate end cap embedded within the first slab;

a tapered load plate that tapers from a relatively wide end to a relatively narrow end, the wide end protruding into a portion of the end cap and the narrow end protruding into the second slab such that the load plate transfers between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; and whereby the load plate restricts relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plate moves farther into the end cap as the joint closes via the first and second slabs moving toward each other in a direction substantially perpendicular to the joint, such that, as the joint closes, the first and second slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, the tapered load plate having a width measured in a direction substantially parallel to said longitudinal axis, and having only one relatively wide portion and only one relatively narrow portion, that tapers from said relatively wide portion, said taper from said relatively wide portion being a generally progressive reduction of said width of said load plate as said load plate extends from said wide portion across said expansion joint, said taper including said generally progressive reduction of said width continuing past said expansion joint as said load plate extends to said relatively narrow portion, the wide portion protruding into said first slab and a portion of the end cap.

4. The system of Claim 3, further comprising:

a second load-plate end cap embedded within the second slab;

a second tapered load plate having a width measured in a direction substantially parallel to said longitudinal axis, and having only one relatively wide portion and only one relatively narrow portion, that tapers from said relatively wide portion, said taper from said relatively wide portion of said second plate being a generally progressive reduction of said width of said second load plate as said second load plate extends from said second load plate wide portion across said expansion joint, said taper including said generally progressive reduction of said width continuing past said expansion joint as said second load plate extends to said relatively narrow portion, the wide portion protruding into said second slab and a portion of the second end cap, and the narrow portion protruding into the first slab, such that the load plate transfers between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab; and

whereby the second load plate restricts relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the second load plate moves farther into the second end cap as the joint closes via the first and second slabs moving toward each other in a direction substantially perpendicular to the joint.

5. The system of Claim 4, wherein the tapered load plates each have a length measured perpendicular to the joint that is substantially greater than the wide portions.

6. The system of Claim 4, wherein the tapered load plates' wide portions are wide ends.

7. A system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising:

a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab;

a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint;

the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and

wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, wherein the load plates each have their width measured parallel to the longitudinal axis of the joint; and

wherein the load plates define a cross section of tapered load plate material spanning the joint, and the cross section remains substantially constant between the joint being positioned on-center relative to the load plates and the joint being, in at least one position of the joint, off-center relative to the load plates.

8. The system of Claim 7, wherein a portion of the joint is initially defined by either a correctly aligned saw cut or a misaligned saw cut, and the portion of the joint that is initially defined by the saw cut is defined by a partial depth saw cut that results in a crack below the saw cut; and

wherein the load plates define a cross section of tapered load plate material spanning the saw cut, and the cross section remains substantially constant between the saw cut being positioned on-center relative to the load plates and the saw cut being, in at least one position of the joint, off-center relative to the load plates.

9. The system of claim 8, further comprising a load-plate basket that positions the load plates before the slabs are cast in place.

10. The system of Claim 8, wherein the narrow end of the first load plate protrudes into the first slab and the narrow end of the second load plate protrudes into the second slab.

11. A system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising:

a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a saw cut or an edge form oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut or edge form and the upper surface of the first slab;

a first tapered load plate and a second tapered load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the tapered load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint;

the tapered load plates each having a width measured parallel to the longitudinal axis of the joint; and

wherein the width of each tapered load plate generally tapers from a relatively wide end in one of the slabs to a relatively narrow end in the other slab such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint, further being a system for restricting certain movement, accommodating certain other movement and transferring loads between the first concrete on-ground cast-in-place slab and the second concrete on-ground cast-in-place slab, the system further comprising:

the joint being subject to opening through a range of joint opening dimensions and beyond;

the first tapered load plate and the second tapered load plate each having a taper, and an extent across the joint such that the load plates span the joint, the tapered load plates each having a width measured parallel to the longitudinal axis of the joint;

the width of each tapered load plate generally tapering from a relatively wide location in the extent of each plate across the joint to a relatively narrow portion such that, as the joint opens, a tapered gap opens between the load plate and a slab near the narrow portion such that the slabs are allowed increasingly greater relative movement in the direction substantially parallel to the longitudinal axis of the joint; and

wherein the first and second tapered load plates are oriented such that for at least the range of joint opening dimensions, reduced width of one load plate at the narrowest width in the joint of the one load plate due to plate taper is compensated for by increased width of the other load plate in the joint due to opposing plate taper, such that for at least the range of joint opening dimensions, the combined widths of the first and second tapered load plates in the joint is consistently adequate for load transfer across the joint;

whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint, allow for increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint as the joint opens, and maintain consistently adequate load transfer across the joint.

12. A system for restricting certain movement, accommodating certain other movement and transferring loads

between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising the slabs and further comprising:

a joint interposing the first and second slabs, at least the first slab having a substantially planar upper surface, at least a portion of the joint being initially defined by at least one of a crack, cut or a form oriented substantially perpendicular to the substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the crack, cut or form and the upper surface of the first slab and wherein the joint is subject to opening through a range of joint opening dimensions and beyond;

a first tapered load plate and a second tapered load plate that each have a taper, protrude into the first and second slabs and have an extent across the joint such that the load plates span the joint and transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

the tapered load plates each having a width measured parallel to the longitudinal axis of the joint;

the width of each tapered load plate generally tapering from a relatively wide location in the extent of each plate across the joint to a relatively narrow portion such that, as the joint opens, a tapered gap opens between the load plate and the slab near the narrow end portion such that the slabs are allowed increasingly greater relative movement in the direction substantially parallel to the longitudinal axis of the joint; and wherein the first and second tapered load plates are oriented such that for at least the range of joint opening dimensions, reduced width of one load plate at the narrowest width in the joint of the one load plate due to plate taper is compensated for by increased width of the other load plate in the joint due to opposing plate taper, such that for at least the range of joint opening dimensions, the combined widths of the first and second tapered load plates in the joint is consistently adequate for load transfer across the joint;

whereby the tapered load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint, allow for increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint as the joint opens, and maintain consistently adequate load transfer across the joint.

13. The system of Claim 12, wherein the tapered load plates each have a length measured perpendicular to the joint that is substantially greater than the wide portions.

14. The system of Claim 12, wherein:

the tapered load plates' wide portions are wide ends; and

the tapered load plates' narrow portions taper to respective substantially pointed ends.

15. The system of Claim 12, further comprising at least one tapered-load-plate basket that positions the tapered load plates before the slabs are cast in place.

16. The system of Claim 15, further comprising multiple tapered-load-plate baskets that each position multiple tapered load plates before the slabs are cast in place.

17. The system of Claim 12, wherein the joint is a saw-cut control joint.

18. The system of Claim 17, wherein the first tapered load plate's wide portion protrudes into the first slab and the second tapered load plate's wide portion protrudes into the second slab.

19. A system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising:

a joint separating the first and second slabs, at least a portion of the joint being initially defined by a partial depth saw cut that results in a crack below the saw cut, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut and the upper surface of the first slab;

a first load plate and a second load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

whereby the load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint;

the load plates each having a width measured parallel to the longitudinal axis of the joint; and

wherein the width of each load plate generally tapers from a relatively wide portion near the joint to at least one relatively narrow end in at least one of the slabs such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint; and

wherein the tapered load plates define a cross section of tapered load plate material spanning the joint, and the cross section remains substantially constant between the saw cut being positioned on-center relative to the tapered load plates and the saw cut being, in at least one position of the saw cut, off-center relative to the tapered load plates.

20. The system of Claim 19, further comprising a load-plate basket that positions the load plates before the slabs are cast in place.

21. The system of Claim 19, wherein the first load plate's relatively narrow end protrudes into the first slab and the second load plate's relatively narrow end protrudes into the second slab.

22. The system of Claim 19, wherein the width of each load plate generally tapers from a relatively wide end to the relatively narrow end.

23. A system for transferring loads between a first concrete on-ground cast-in-place slab and a second concrete on-ground cast-in-place slab, the system comprising:

a joint separating the first and second slabs, at least a portion of the joint being initially defined by at least one of a partial depth saw cut that results in a crack below the saw cut, the saw cut oriented substantially perpendicular to a substantially planar upper surface of the first slab, wherein a longitudinal axis of the joint is formed by an intersection of the saw cut and the upper surface of the first slab;

a first load plate and a second load plate that each protrude into the first and second slabs such that the load plates transfer between the first and second slabs a load applied to either of the slabs directed substantially perpendicular to the upper surface of the first slab;

whereby the load plates restrict relative movement between the first and second slabs in a direction substantially perpendicular to the upper surface of the first slab, and the load plates allow the joint to open by allowing the first and second slabs to move away from each other in a direction substantially perpendicular to the joint;

the load plates each having a width measured parallel to the longitudinal axis of the joint; and

wherein the width of each load plate generally tapers from a relatively wide portion near the joint to at least one relatively narrow end in at least one of the slabs such that, as the joint opens, the slabs are allowed increasingly greater relative movement in a direction substantially parallel to the longitudinal axis of the joint.

24. The system of Claim 23, further comprising at least one load-plate basket that positions the load plates before the slabs are cast in place.

25. The system of Claim 23, wherein the first load plate's at least one relatively narrow end protrudes into the first slab and the second load plate's at least one relatively narrow end protrudes into the second slab.

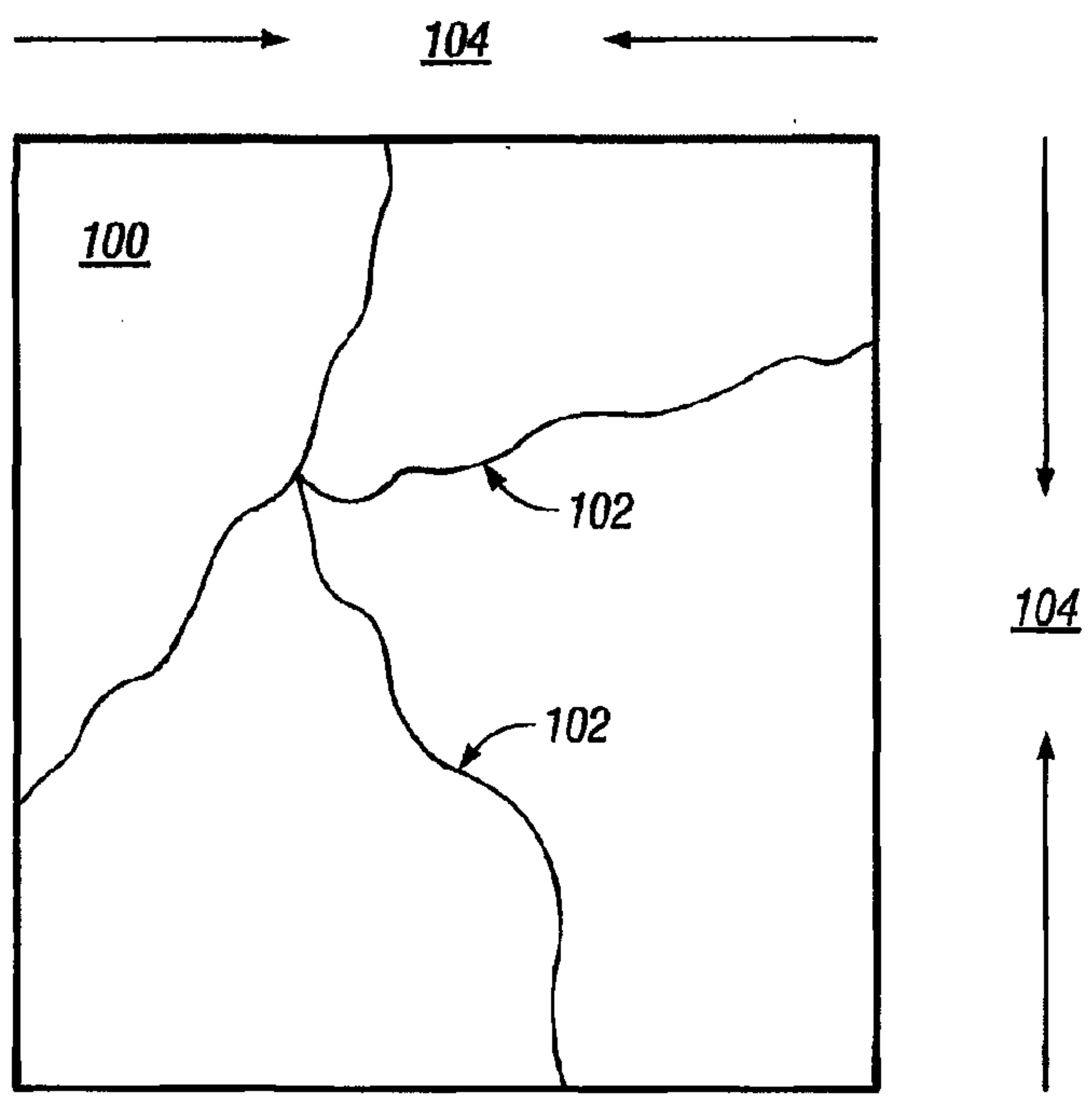


FIG. 1

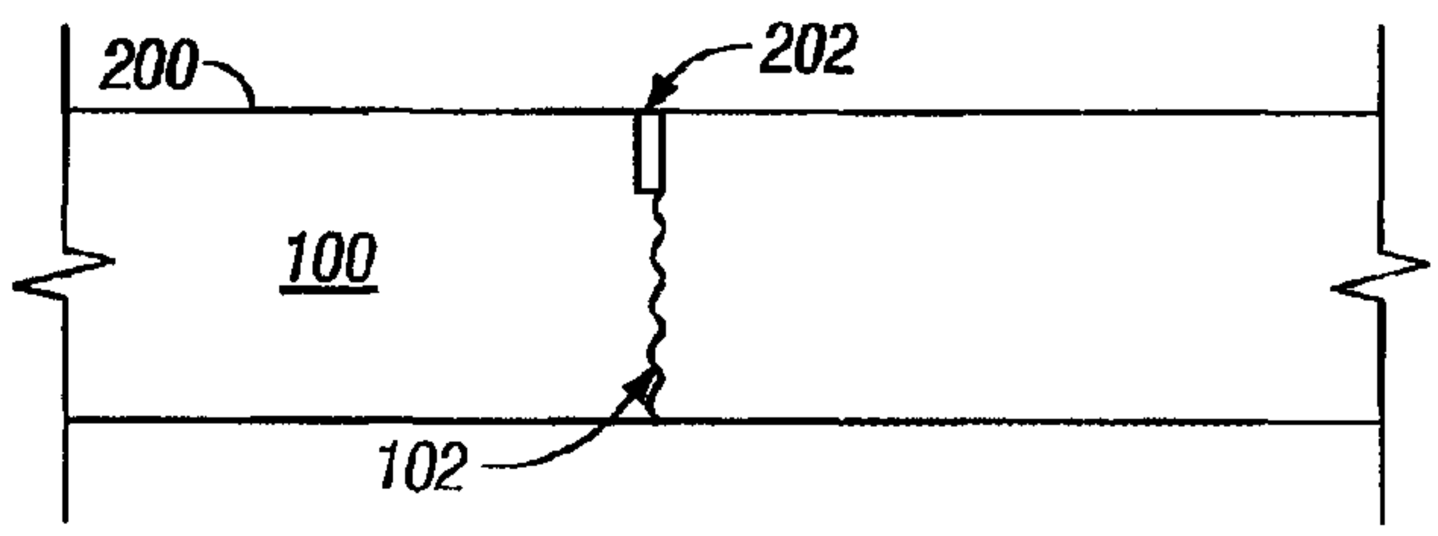


FIG. 2A

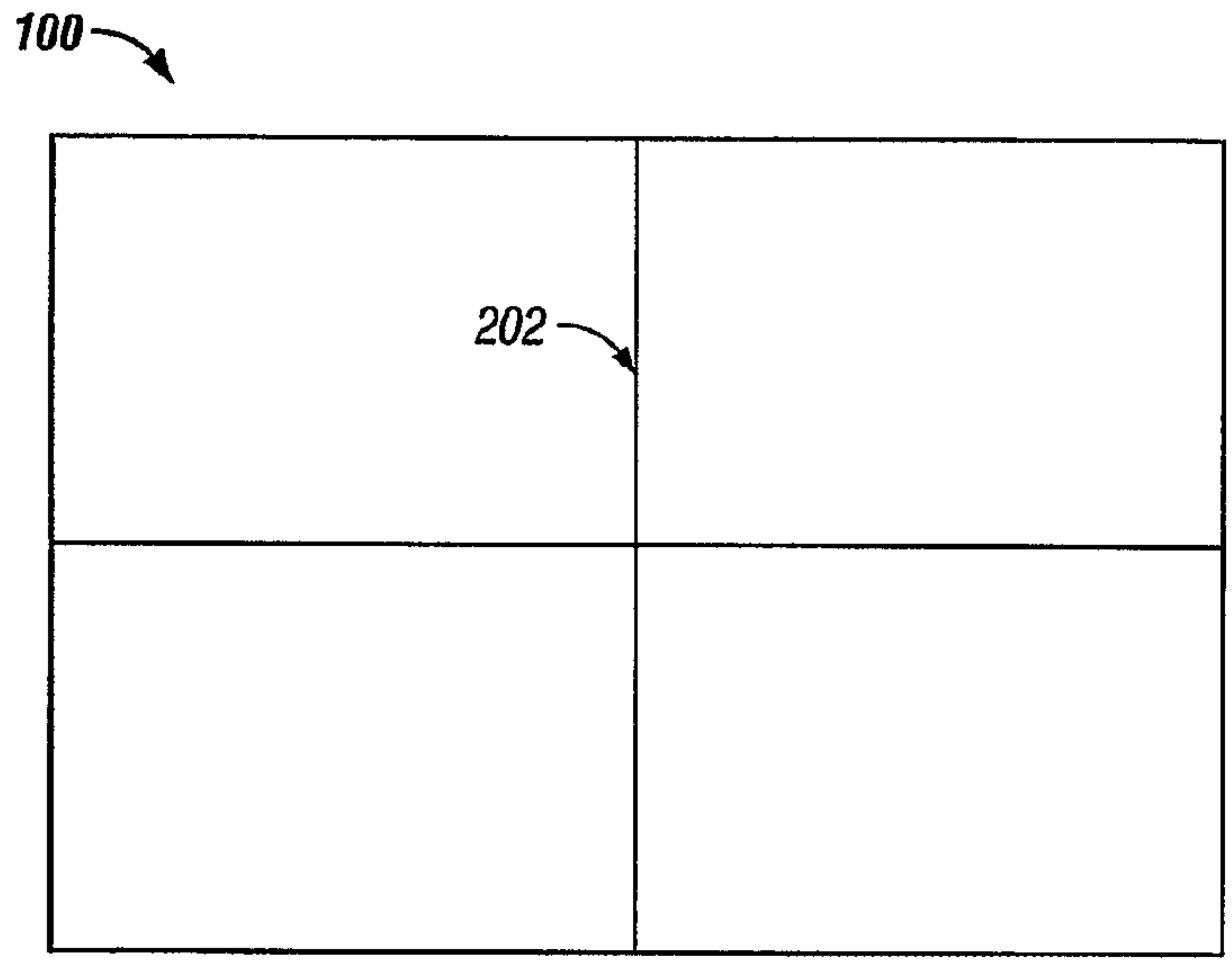


FIG. 2B

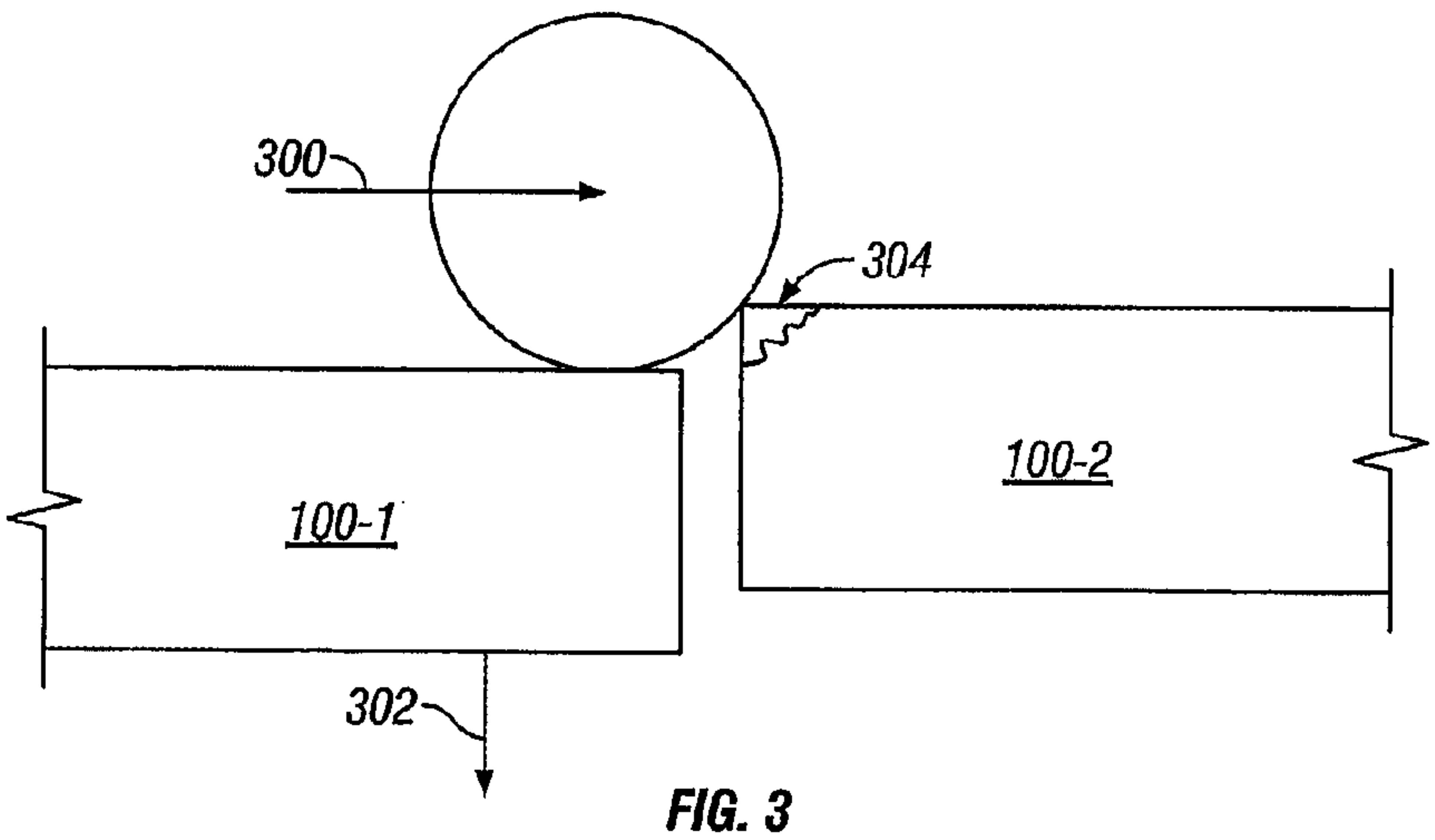


FIG. 3

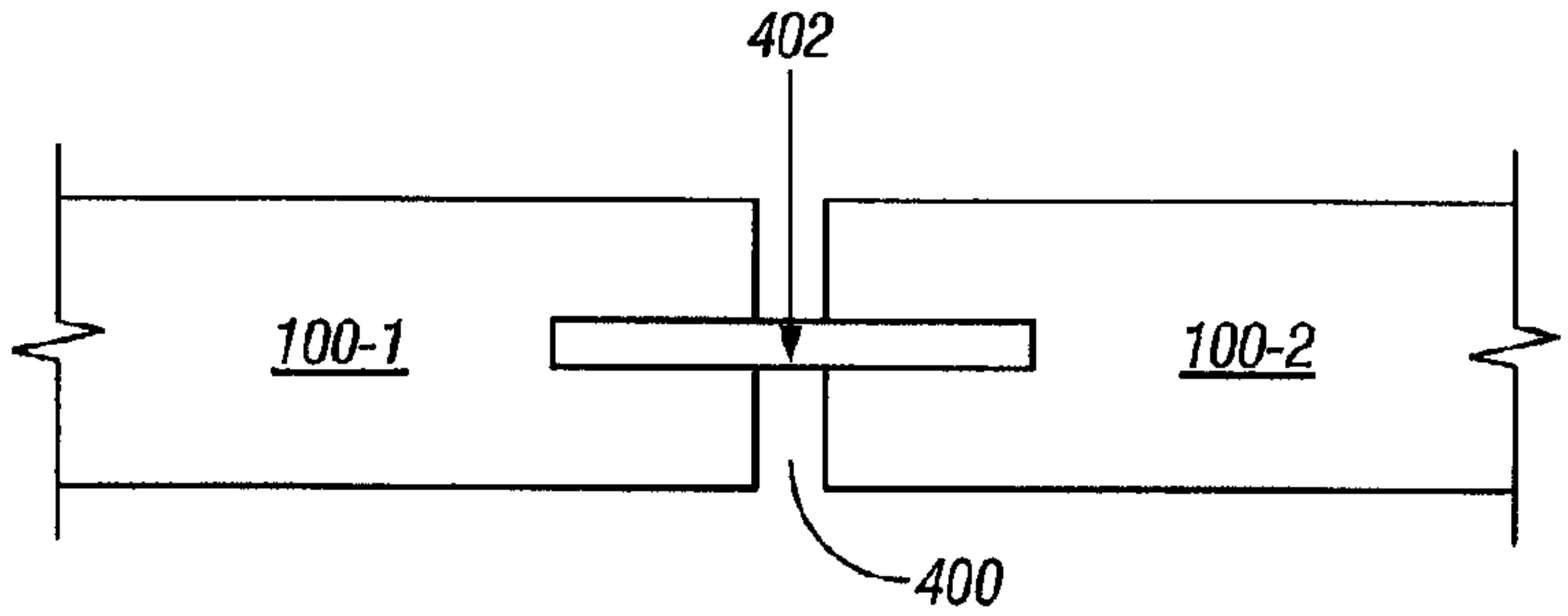

402
100-1
100-2
400

FIG. 4A

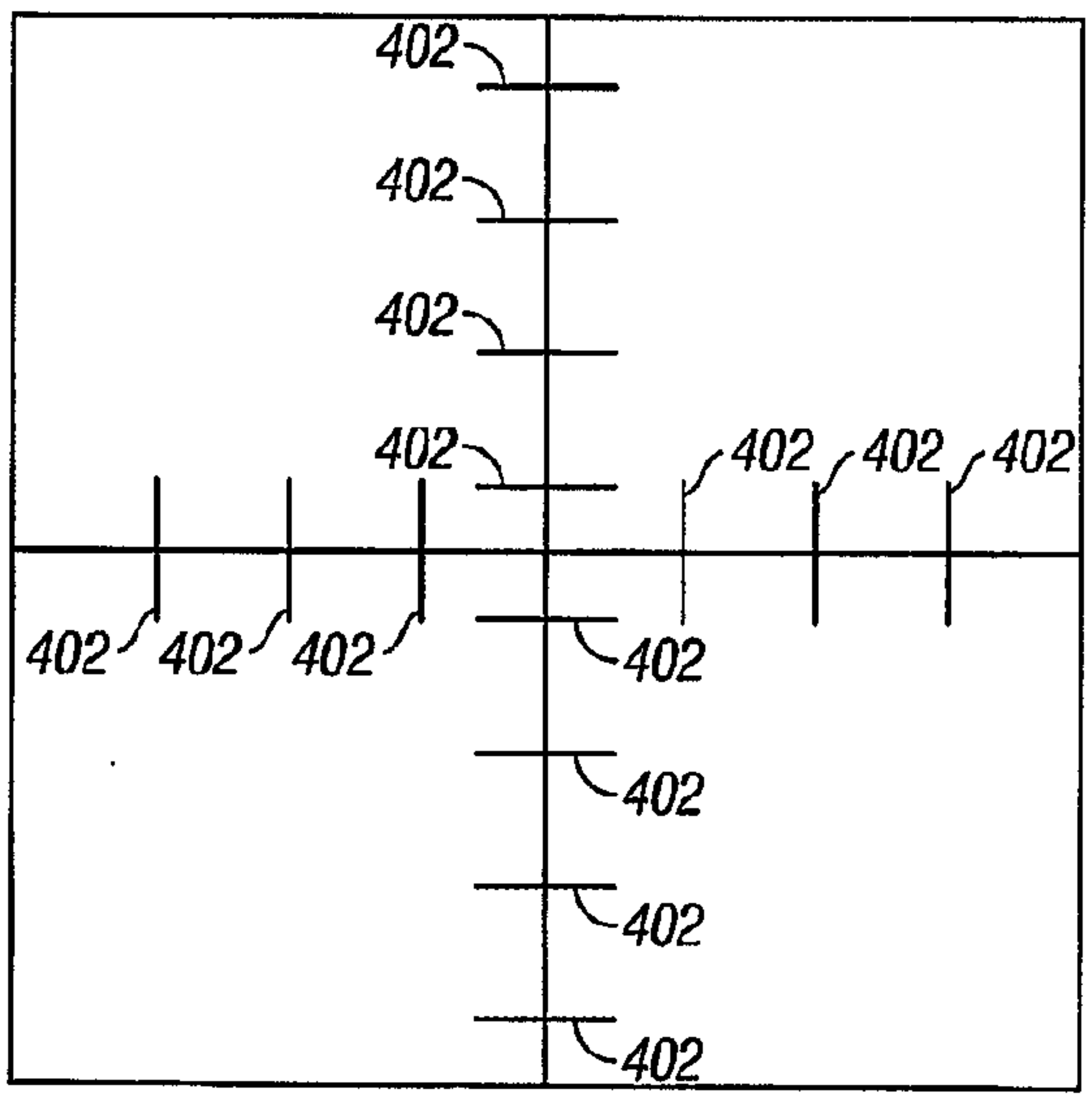

402
402
402
402
402
402
402
402
402
402
402
402
402
402

FIG. 4B

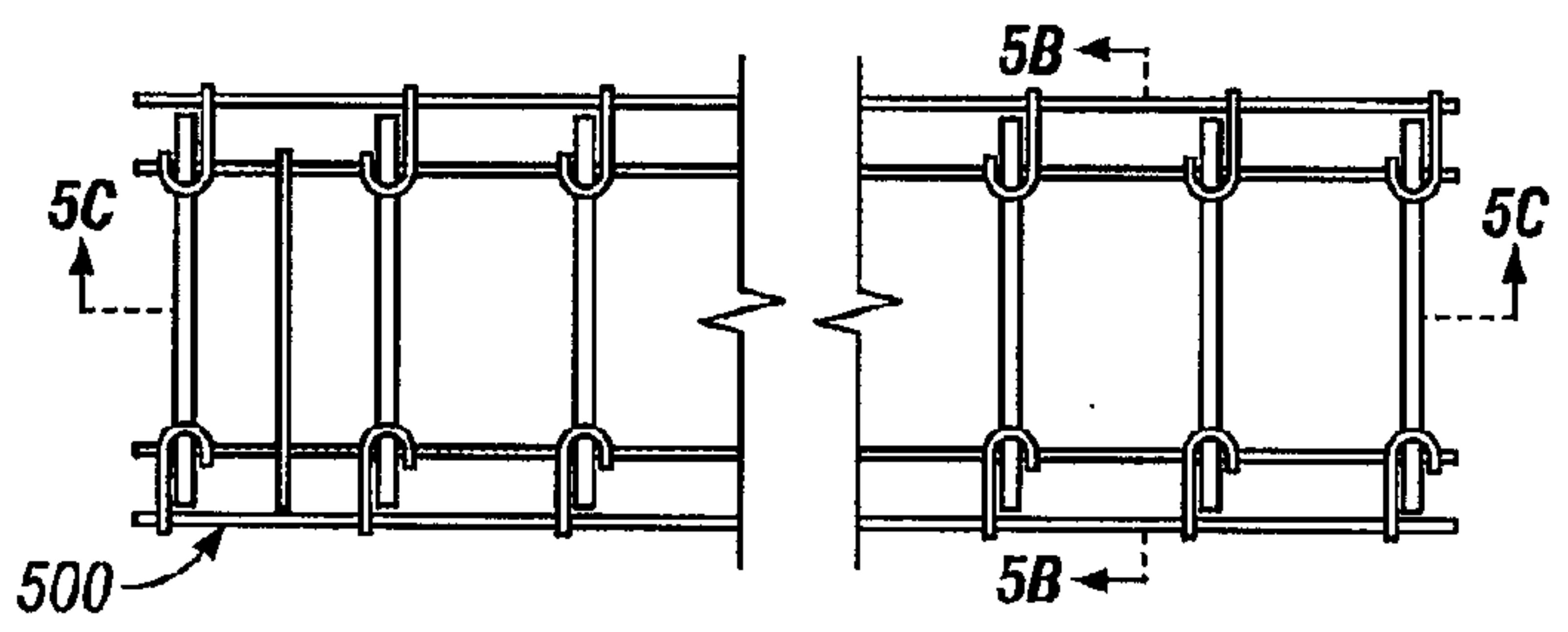


FIG. 5A

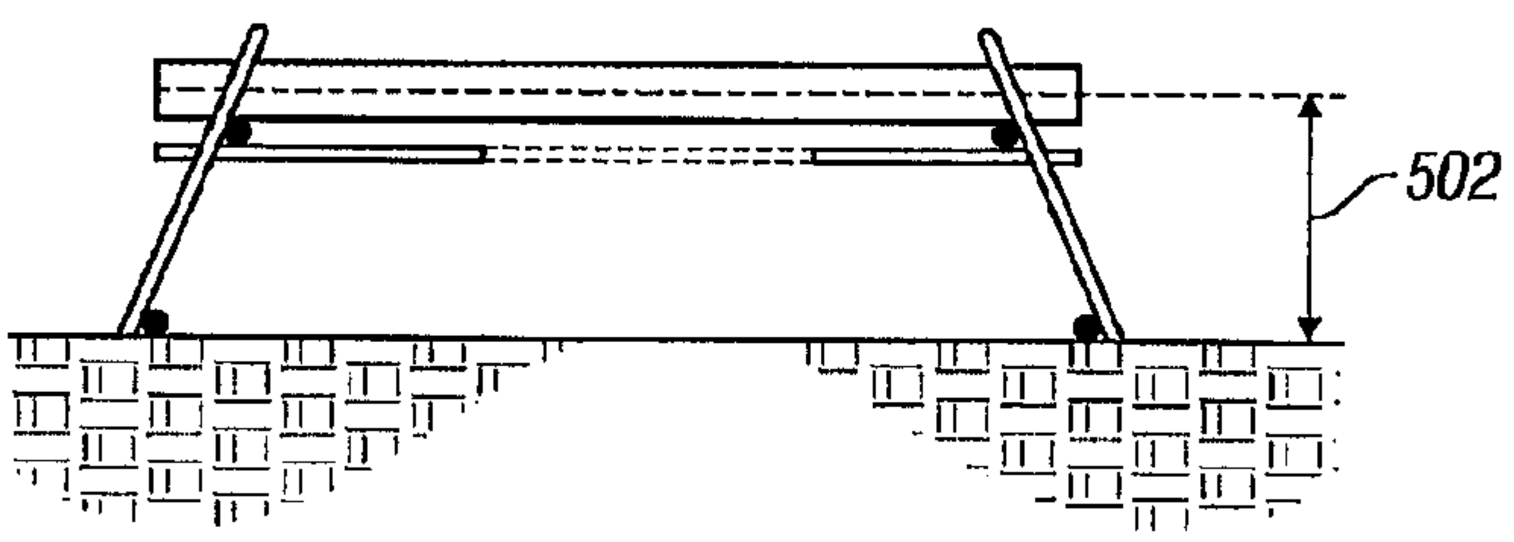


FIG. 5B

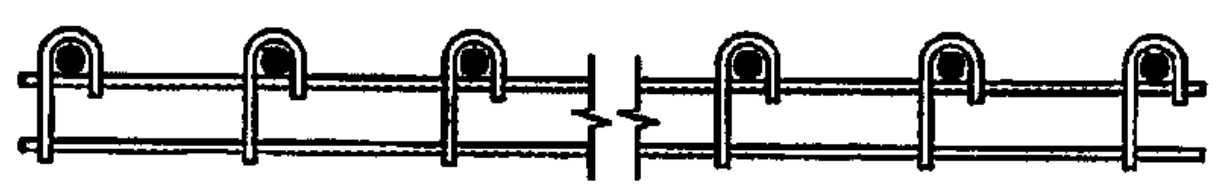


FIG. 5C

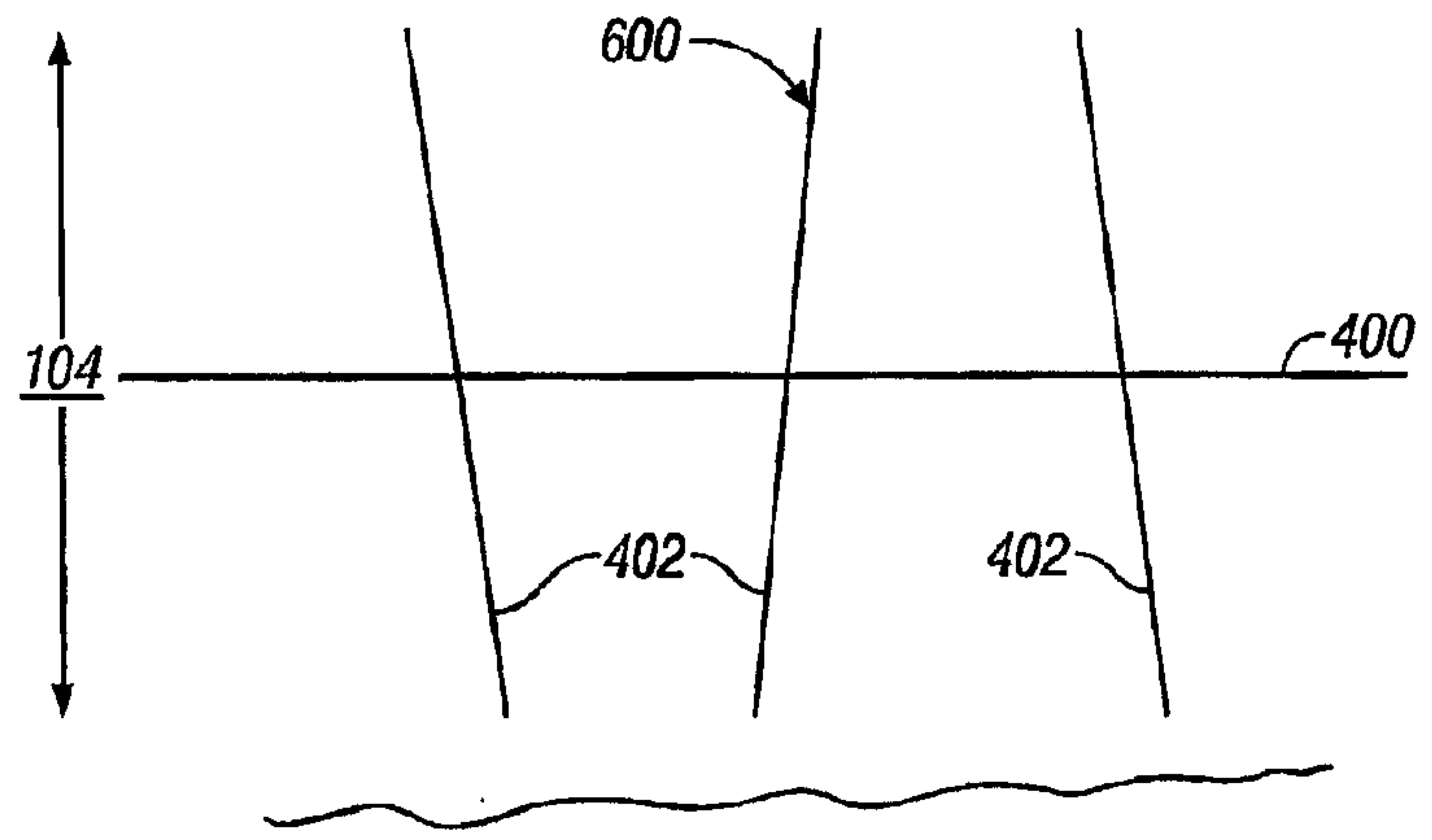


FIG. 6

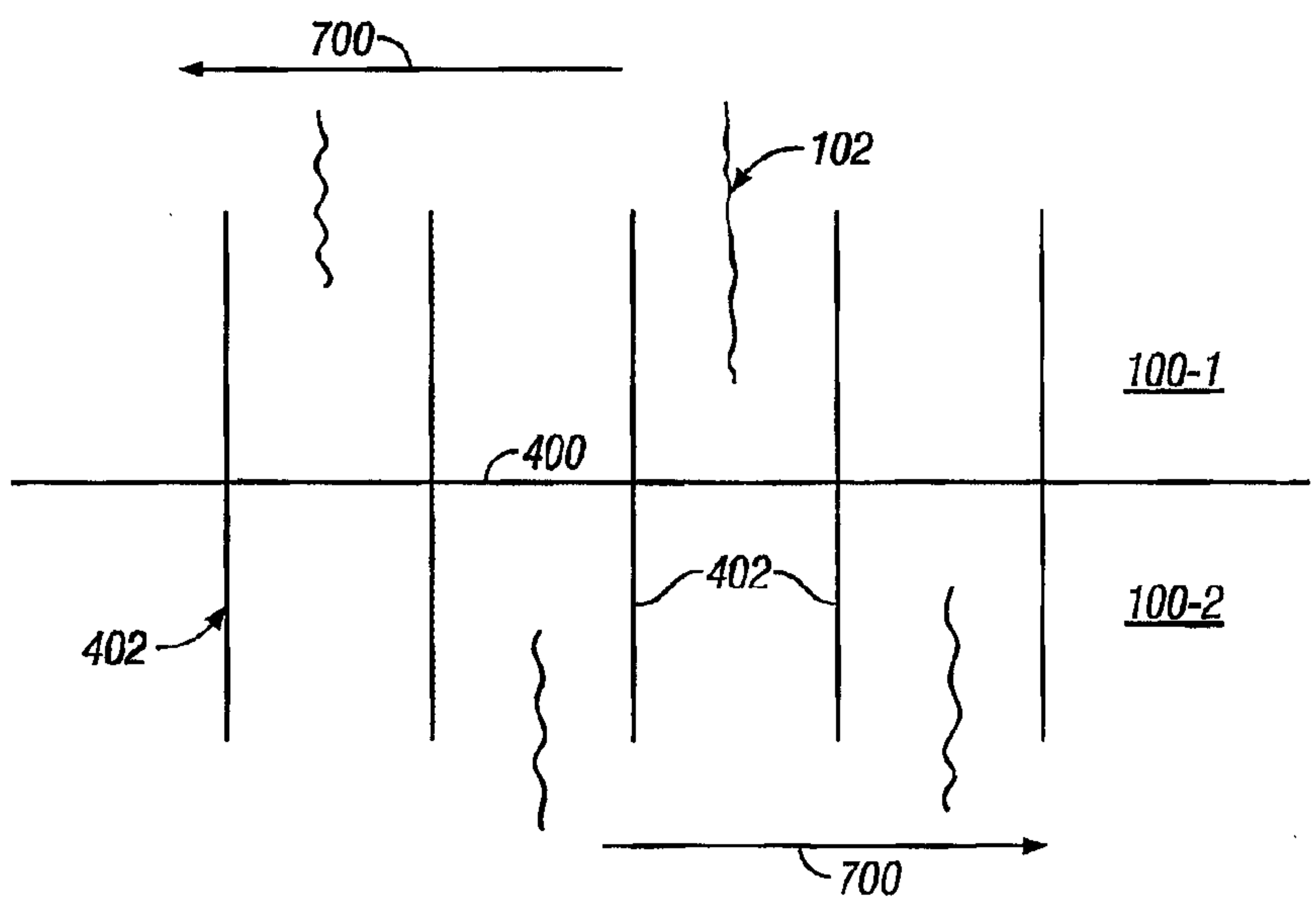


FIG. 7

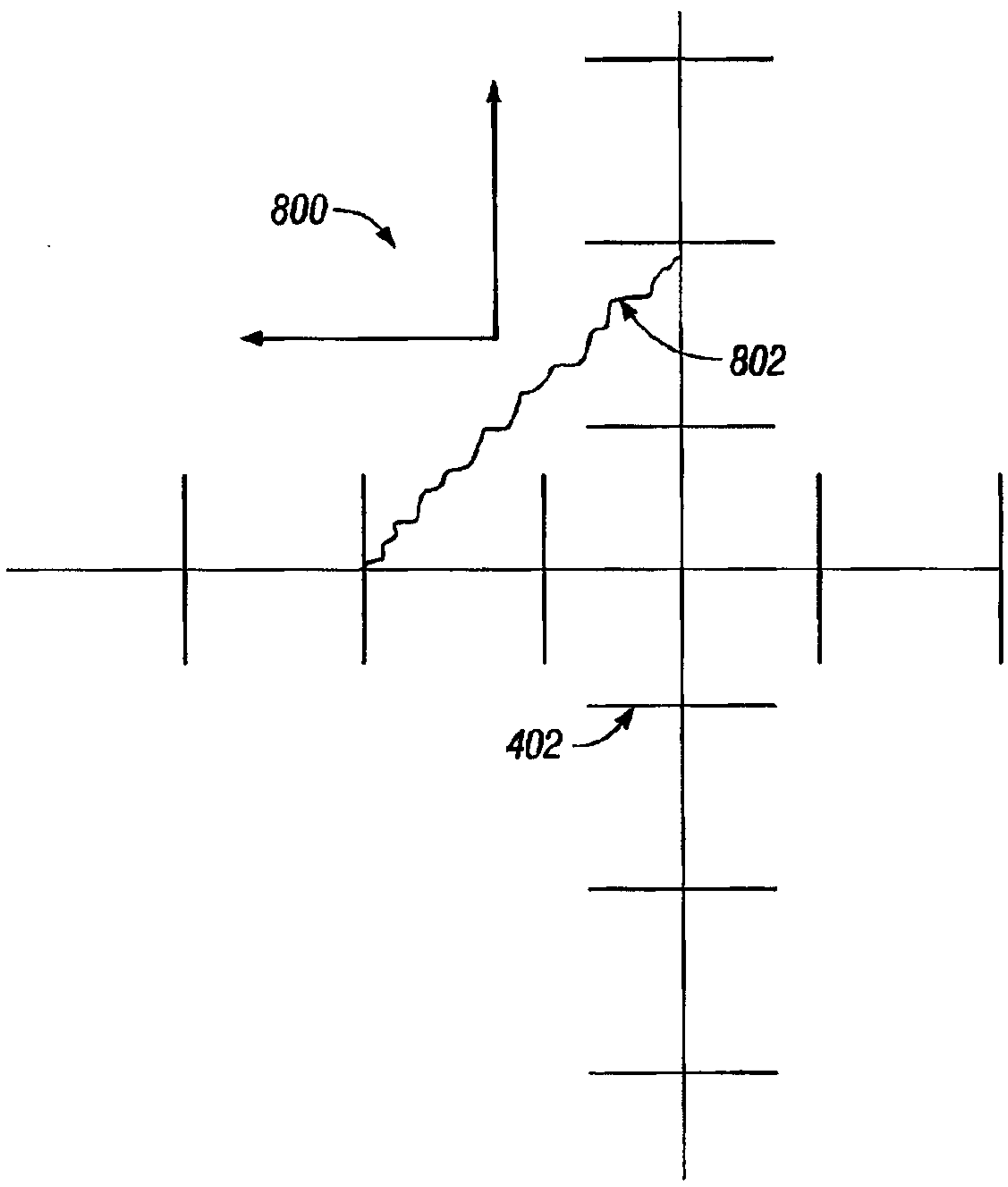


FIG. 8

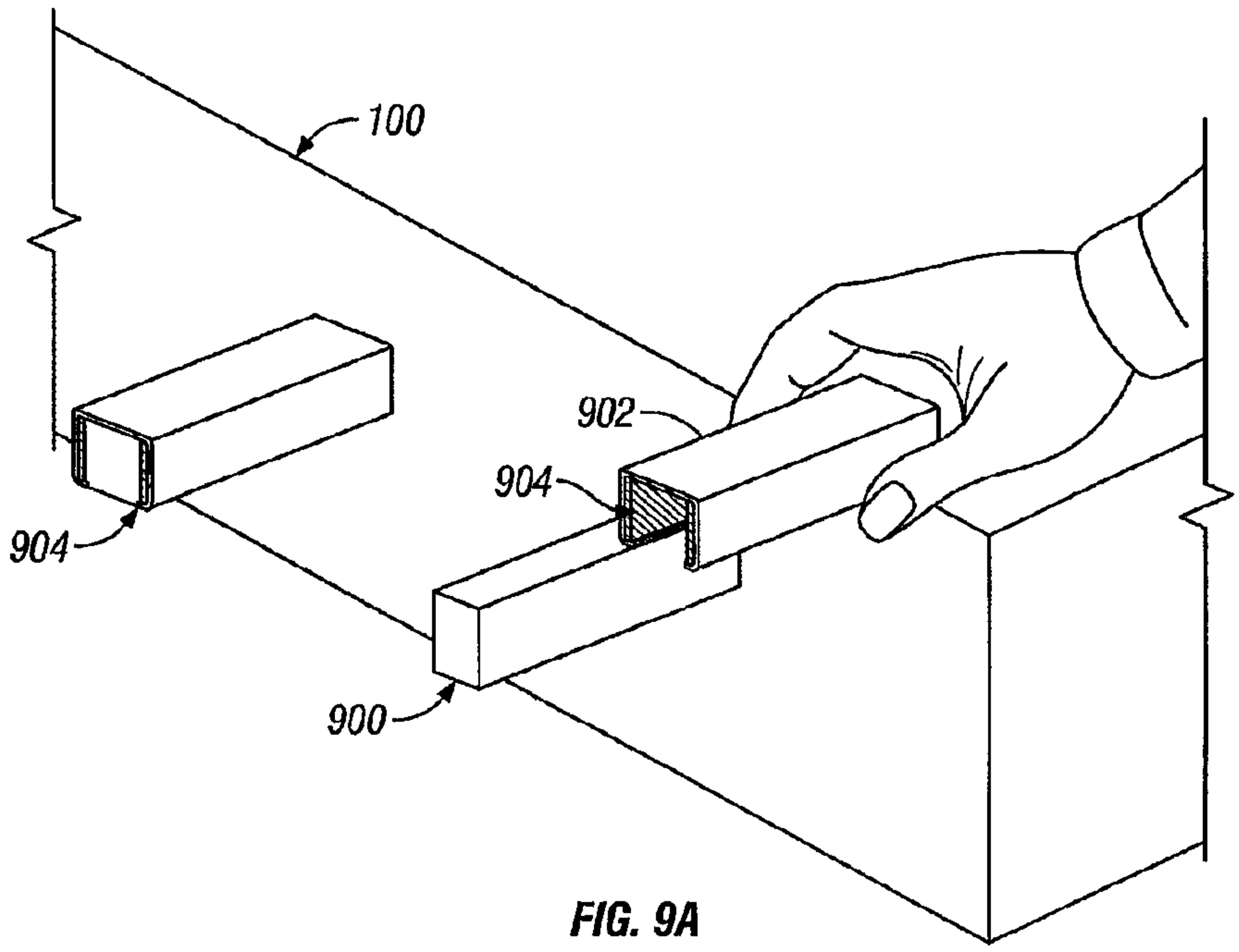


FIG. 9A

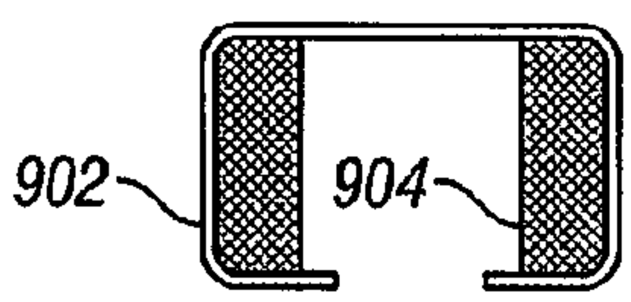


FIG. 9B

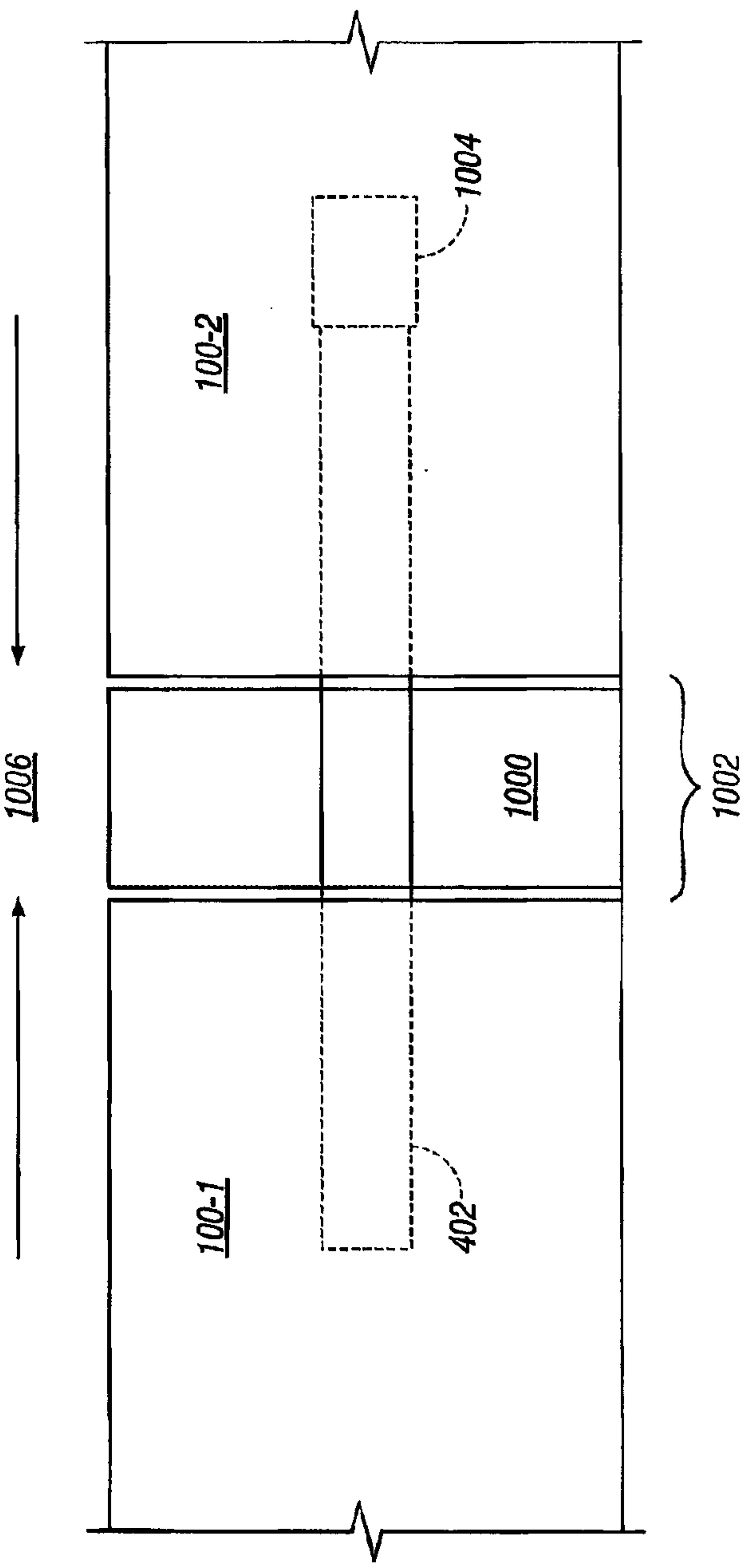


FIG. 10

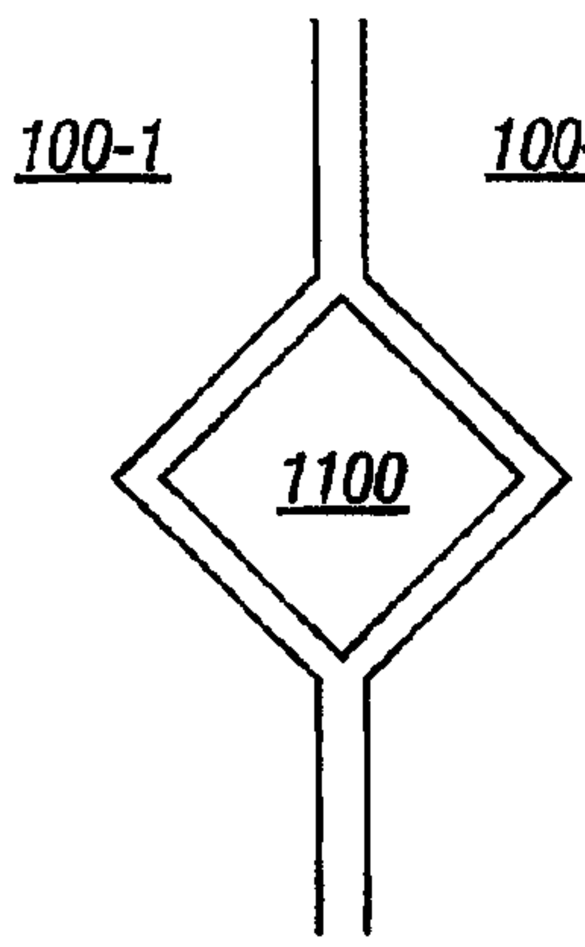


FIG. 11

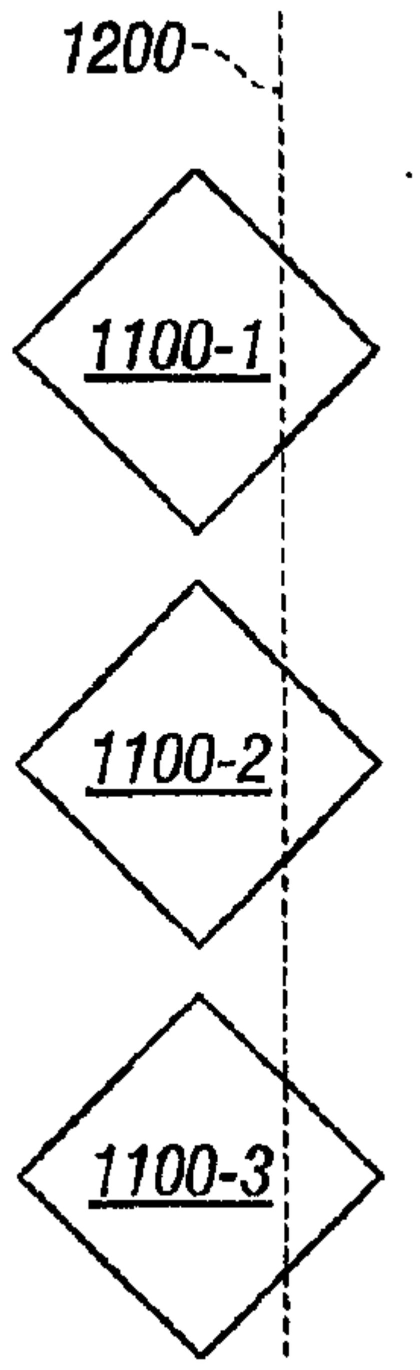


FIG. 12

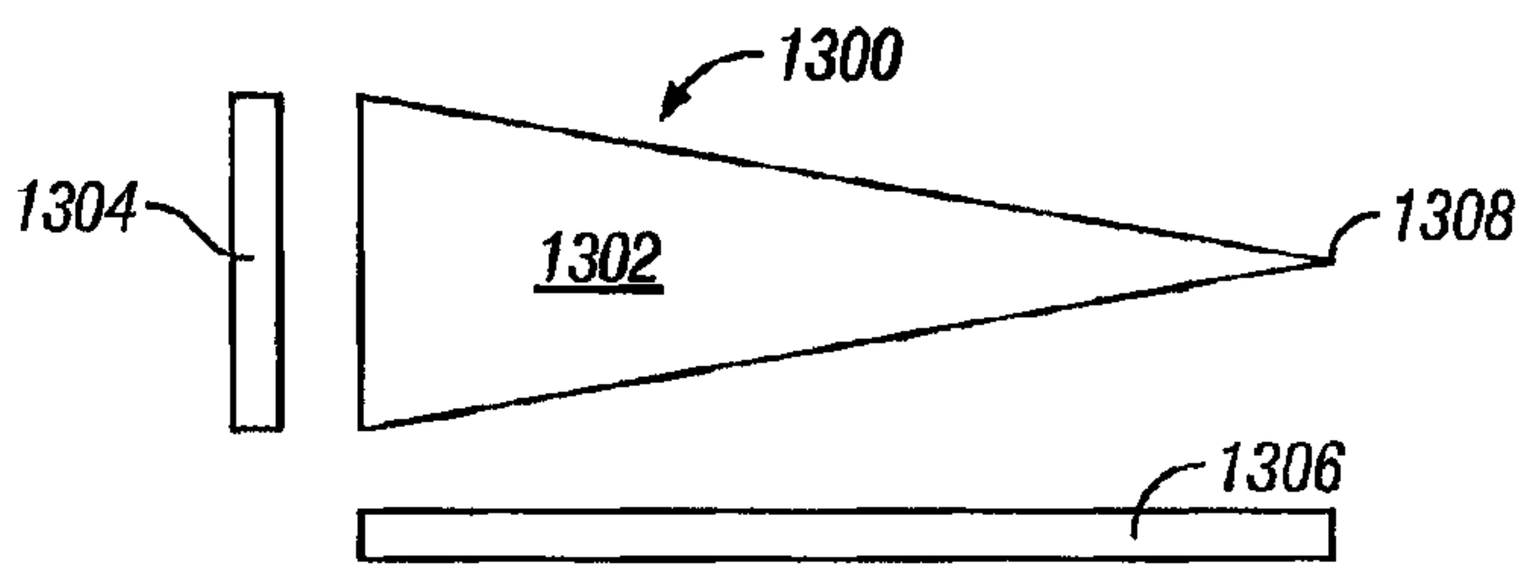


FIG. 13

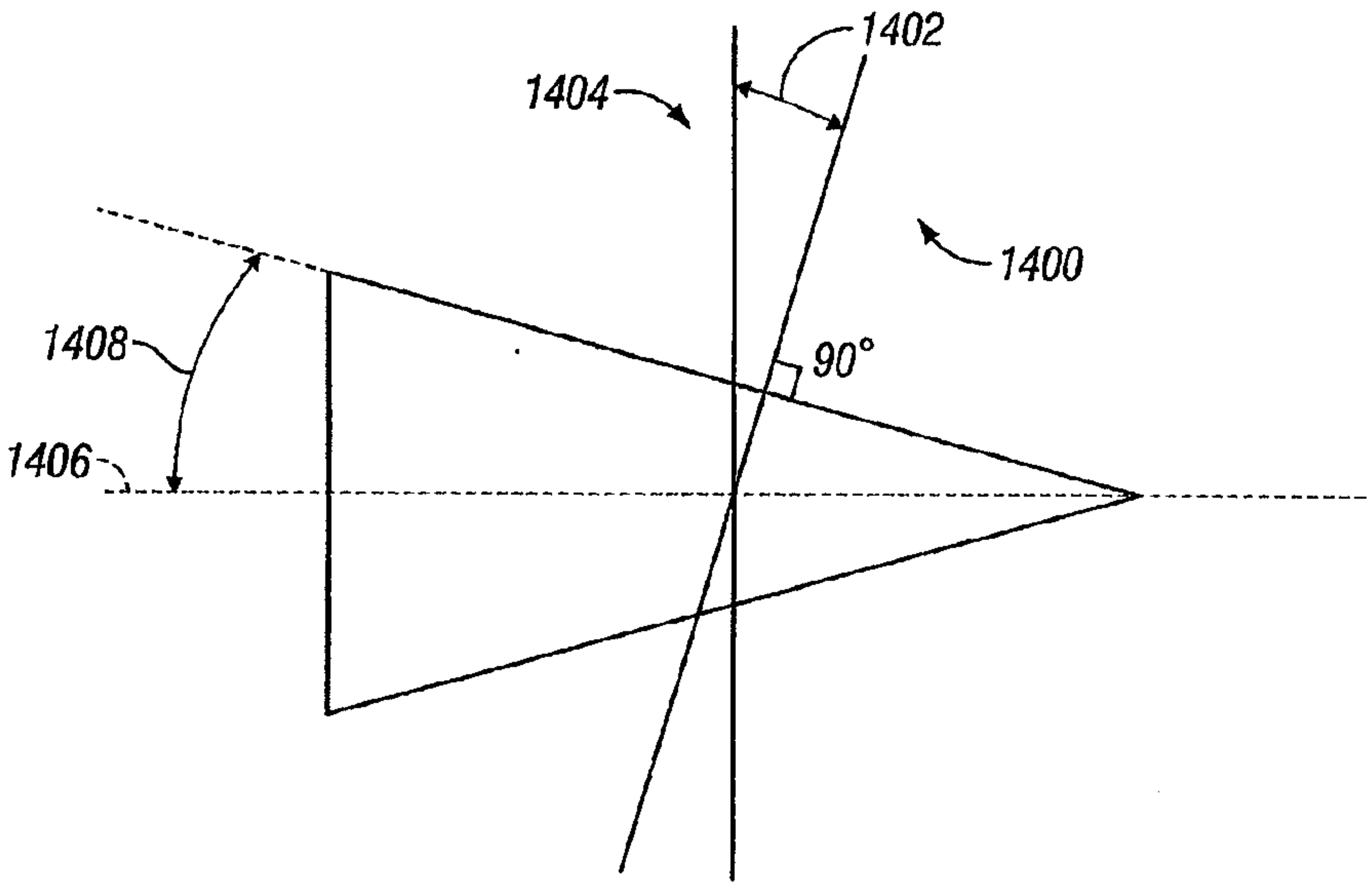


FIG. 14

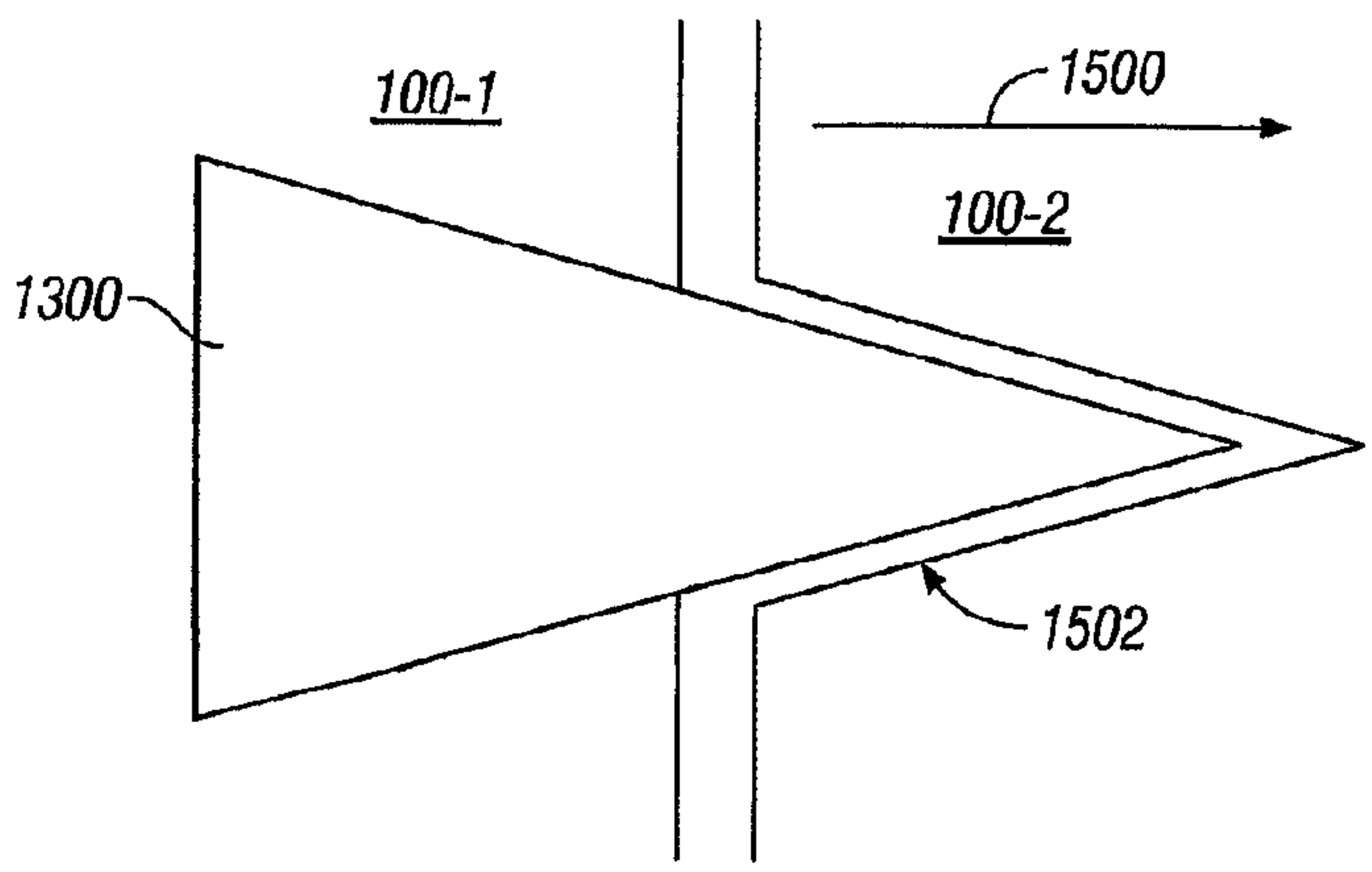


FIG. 15

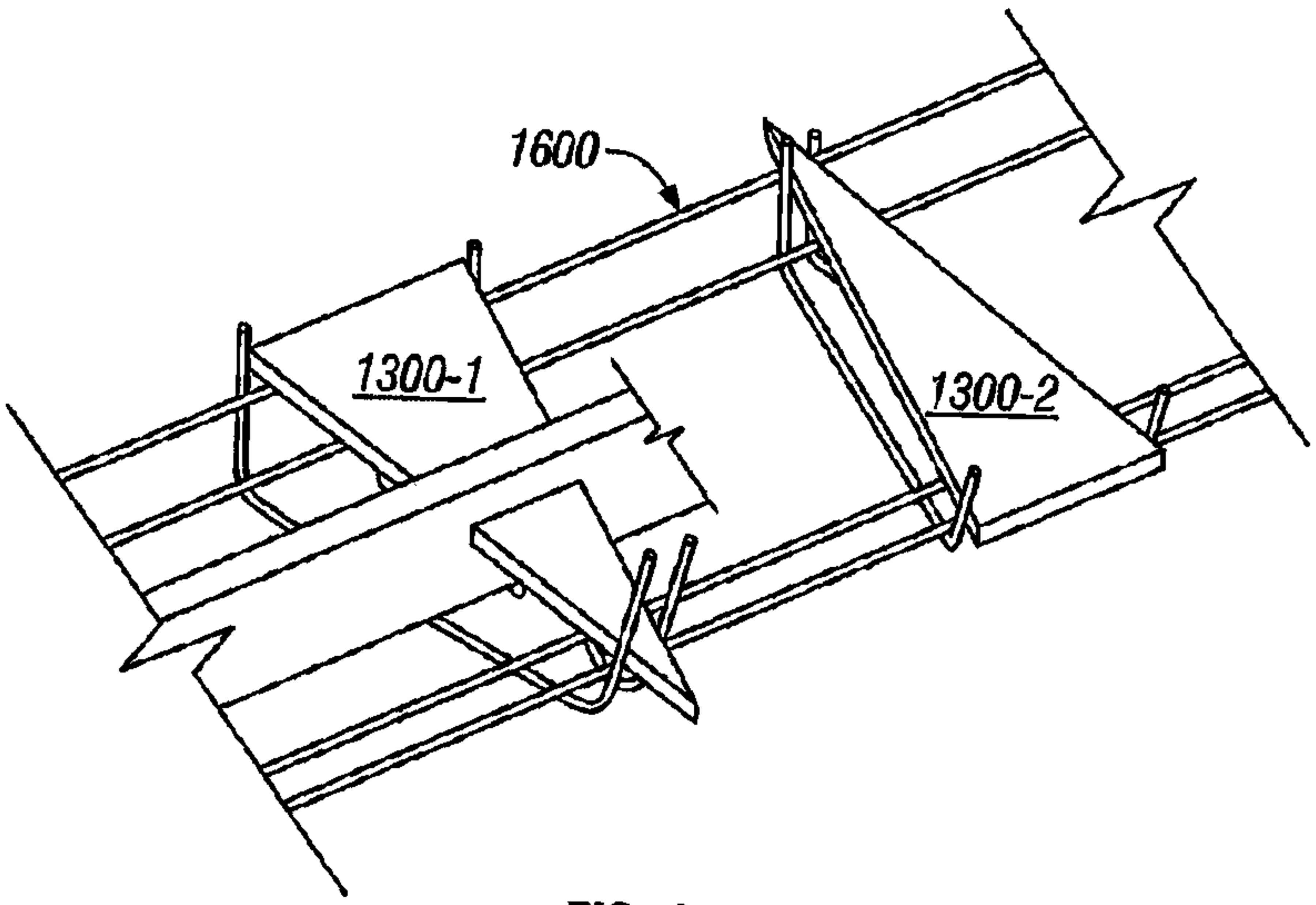


FIG. 16

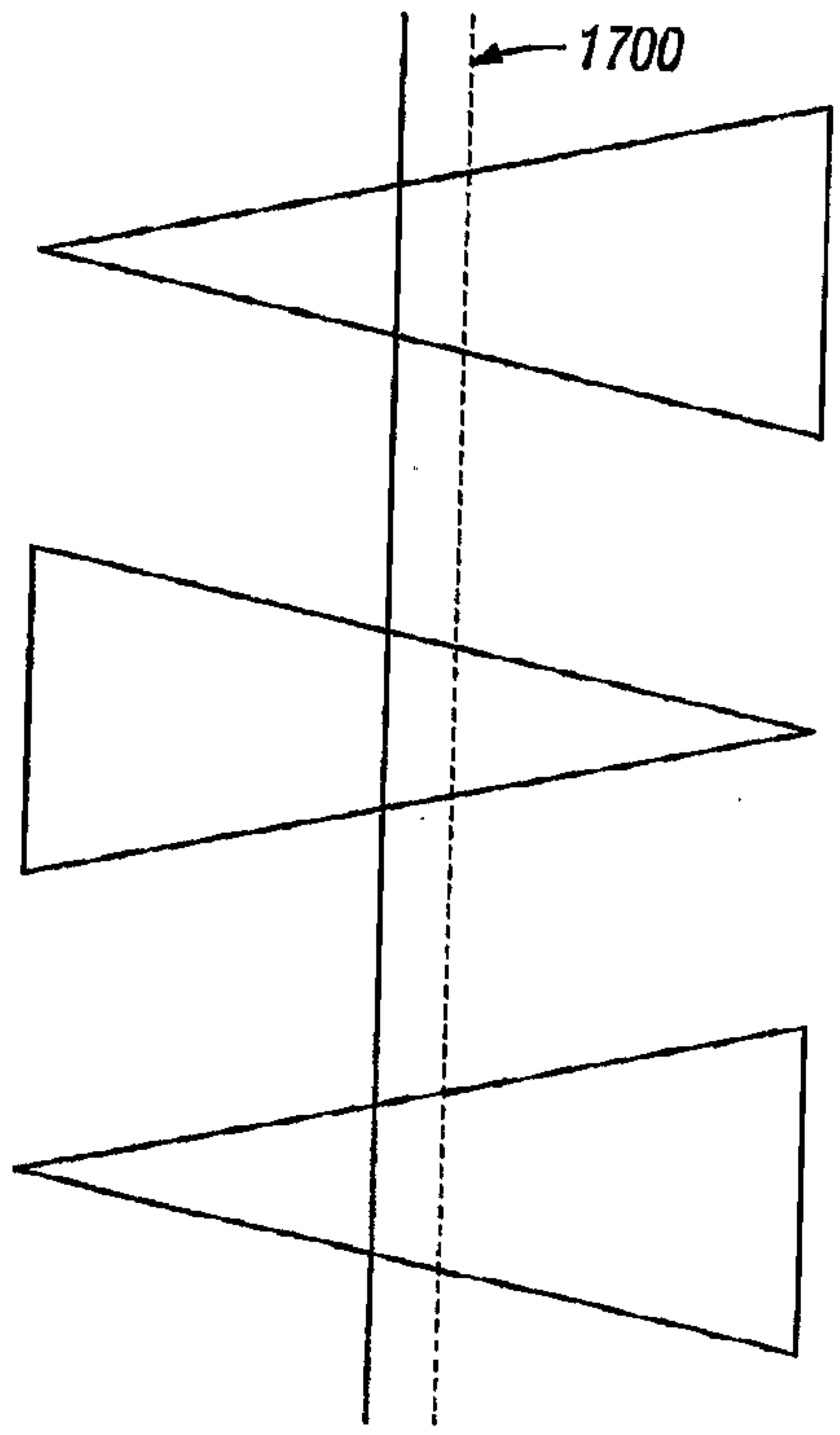


FIG. 17

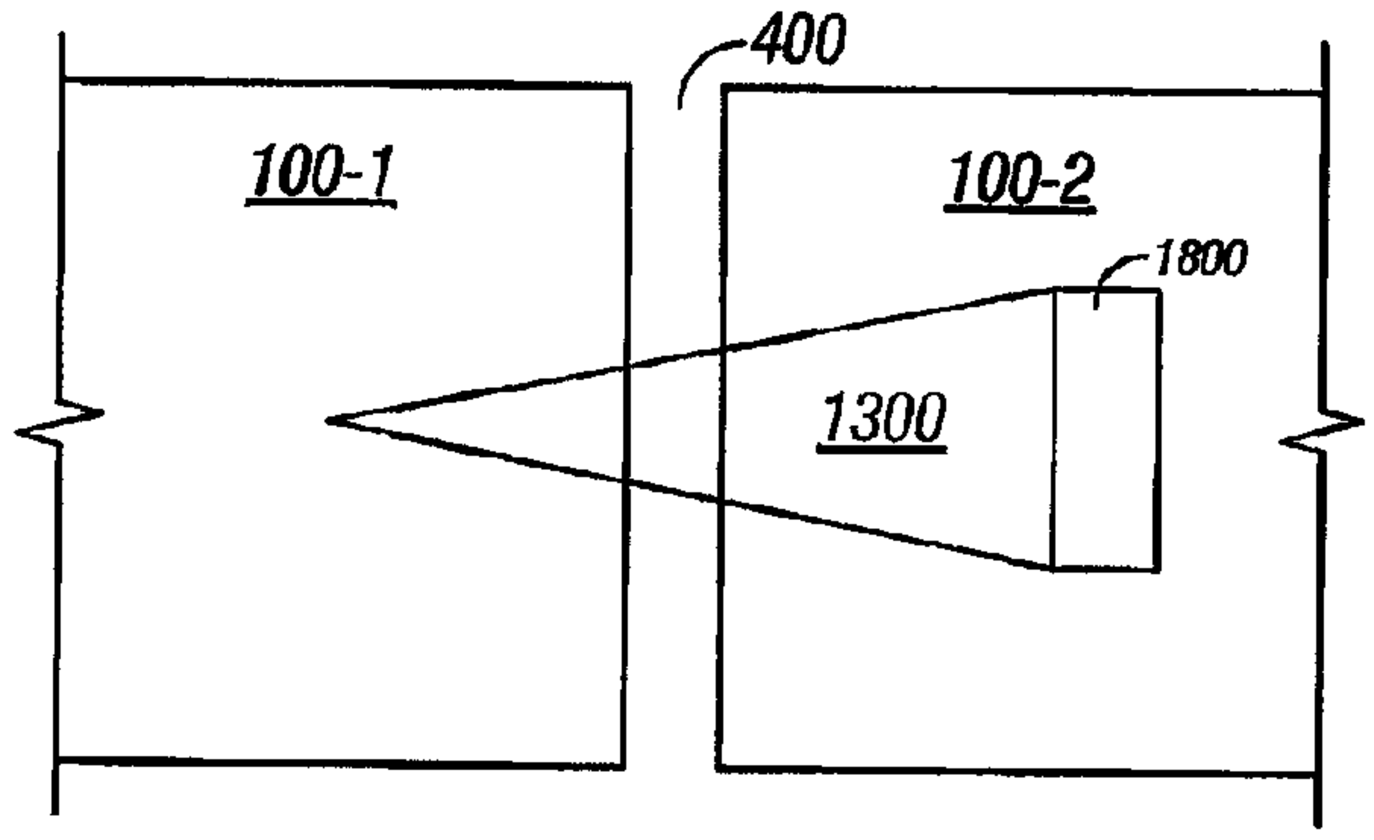


FIG. 18

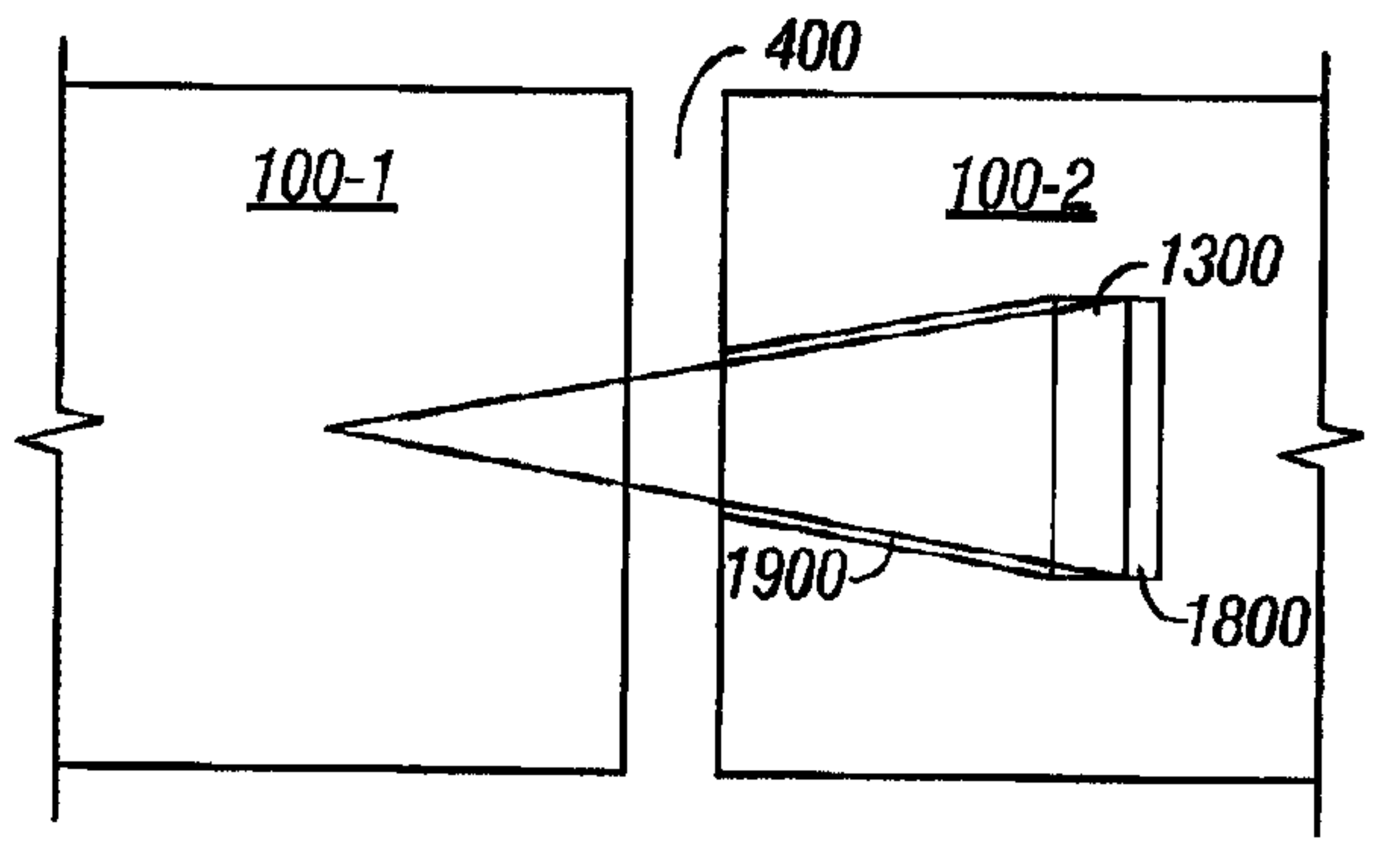


FIG. 19

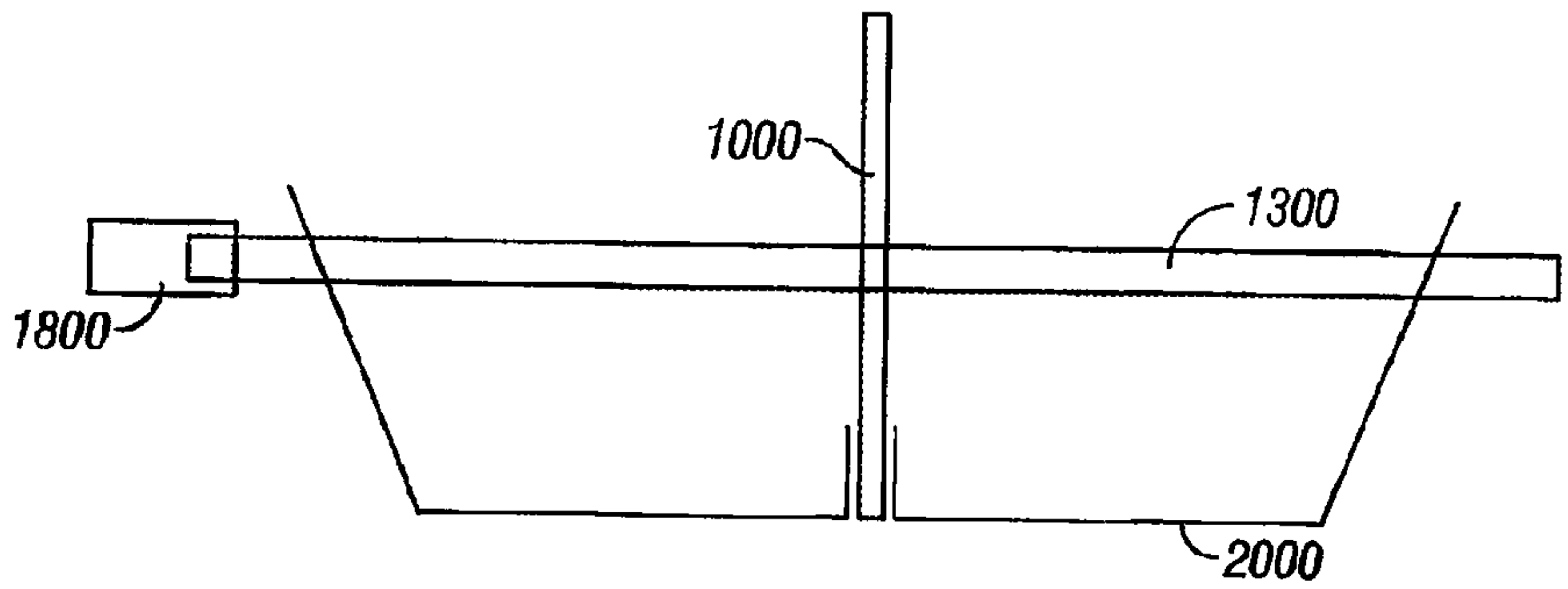
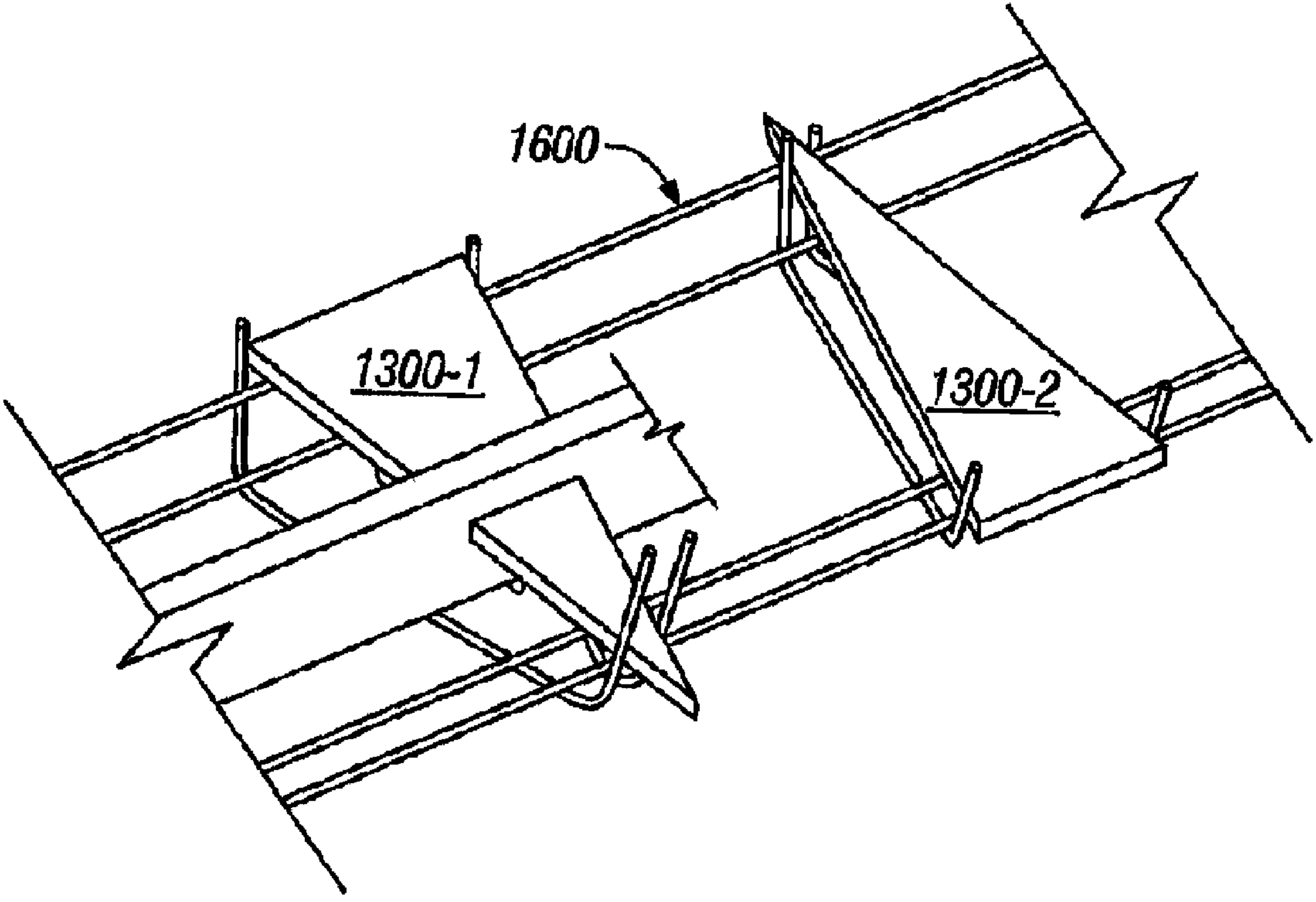


FIG. 20


1600
1300-1
1300-2