DEPARTMENT OF THE NAVY
OFFICE OF COUNSEL
NAVAL UNDERSEA WARFARE CENTER DIVISION
1176 HOWELL STREET NEWPORT RI 02841-1708

IN REPLY REFER TO

Attorney Docket No. 300164
10 October 2019

The below identified patent application is available for licensing. Requests for information should be addressed to:

TECHNOLOGY PARTNERSHIP OFFICE
NAVAL UNDERSEA WARFARE CENTER
1176 HOWELL ST.
CODE 00T2, BLDG. 102T
NEWPORT, RI 02841

Serial Number 16/527,369
Filing Date 31 July 2019
Inventor David F. Rivera

Address any questions concerning this matter to the Technology Partnership Office at (401) 832-3339.

DISTRIBUTION STATEMENT
Approved for Public Release
Distribution is unlimited

PARALLEL PLATE ANTENNA WITH VERTICAL POLARIZATION

STATEMENT OF GOVERNMENT INTEREST

[0001] The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

CROSS REFERENCE TO OTHER PATENT APPLICATIONS

[0002] None.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

[0003] The present invention relates generally to antennas, and more particularly to a parallel plate antenna.

(2) Description of the Prior Art

[0004] Presently, electrically short antennas are used in receive-only applications. As such, there is a continuing need for a compact antenna with practical transmitting and receiving capabilities. Such a compact antenna could be used on platforms including unmanned aerial or undersea vehicles.

SUMMARY OF THE INVENTION

[0005] It is therefore a primary object and a general purpose of the present invention to provide a compact antenna.

[0006] It is a further purpose of the present invention to provide a compact antenna capable of radiating a vertically polarized wave.

[0007] To attain the objects of the present invention, an antenna is provided in which size compaction of the antenna is facilitated by an arrangement of three conducting plates vertically spaced apart and in alignment with each other on a vertical axis. The antenna includes a rectangular base to support the conducting plates.

[0008] In the invention, a cross-shaped support is affixed to a front planar section of the base and extending perpendicular therefrom. The cross-shaped support secures the conducting plates at multiple points of each plate. The support has an indentation in an arm of the cross in which the indentation is sized to accommodate a section of one of the conducting plates.

[0009] A J-shaped second support is fastened to a rear planar section of the base at a bend of the J-shape with adjacent portions of the support extending perpendicular therefrom to allow the conducting plates to be secured to the support. The cross-shaped support and the J-shaped support are spaced apart between the lengths of the base in regard to their attachment to the base. The conducting plates are secured to the supports in order to position planar sections of each plate to be perpendicular to the base as well as properly spaced apart from each other.

[0010] A first conducting plate is J-shaped with a planar bend of the J-shape facing a width edge of the base. A long extension of the J-shape of the plate is secured to the long extension of the J-shaped second support. Remaining sections of the conducting plate are secured to the arms of the cross-shaped support. The conducting plate is spaced apart from and perpendicular to the base.

[0011] A second conducting plate is also J-shaped. The long extension of the J-shape of the plate is secured to a short extension of the J-shaped second support. The long extension as well as the remaining sections of the second conducting plate are secured at the arms of the cross-shaped support. The plane of the second conducting plate is perpendicular to the base and is spaced apart from the first conducting plate.

[0012] A third conducting plate is U-shaped and integral with a L-shaped section with a bend of the U-shape facing the base width. The short leg of the L-shape is integral to a first end of the U-shape of the conducting plate. The long leg of the L-shape is attached in the slot of the cross-shaped support. A second end of the U-shape is fastened to the long extension of the J-shaped second support. The remaining sections of the third conducting plate are secured to the cross-shaped support.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Other objects, features and advantages of the present invention will become apparent upon reference to the following description of the preferred embodiments and to the drawings, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

[0014] **FIG. 1** is a perspective view of a parallel plate antenna in accordance with an embodiment of the present invention;

[0015] **FIG. 2** is a perspective view of an elongated cross-shaped support and a J-shaped support positioned on the base of the antenna of the present invention;

[0016] **FIG. 3** is a perspective view of the J-shaped support positioned on the base;

[0017] **FIG. 4** is a perspective view of a first conducting plate positioned on the J-shaped support;

[0018] **FIG. 5** is a perspective view of a second conducting plate positioned on the J-shaped support;

[0019] **FIG. 6** is a perspective view of a third conducting plate positioned on the J-shaped support;

[0020] **FIG. 7** depicts a resonance established by a first frequency with current flow shown in conductive paths formed by the conducting plates of the antenna of the present invention;

[0021] **FIG. 8** depicts a resonance established by a second frequency with current flow shown in conductive paths formed by the conducting plates; and

[0022] **FIG. 9** depicts a resonance established by a third frequency with current flow shown in conductive paths formed by the conducting plates.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Referring now to the drawings, **FIG. 1** depicts a parallel plate antenna in accordance with an embodiment of the present invention shown and referenced by numeral **10**. In the illustrated embodiment, three parallel conducting plates of the antenna are shown. However, it is to be understood that an antenna in accordance with the present invention could be constructed with additional conducting plates without departing from the scope of the present invention.

[0024] Generally, the various parts of antenna **10** are electrically conductive. Electrical conductivity can be achieved by using solid metals and metal-coated non-conductive substrates for the various parts without departing from the scope of the present invention.

[0025] As shown in **FIG. 1**, the antenna **10** includes a conductive rectangular base **20** having a length, a thickness and a width. As shown in **FIG. 2**, a non-conductive elongated cross-shaped support **30** is mechanically fastened to a front planar section of the base **20** and extending perpendicular therefrom. As also shown in the figure and in **FIG. 3**, a condcutive J-shaped second support **40** is mechanically fastened to a rear planar section of the base **20** and extending perpendicular therefrom.

[0026] By the use of numerous fastener indentations **32** with appropriately sized fasteners (not shown), the cross-shaped support **30** is capable of securing a first conducting plate **50**, a second conducting plate **60** and a third conducting plate **70** at multiple points of each plate. The cross-shaped support **30** also has a first arm **33** with an elongated indentation **34** or slot in which the indentation can accommodate a section of the third conducting plate **70** by being oversized compared to a vertical thickness of the plate.

[0027] The J-shaped second support **40** is mechanically fastened to a rear planar section of the base **20** at a bend of the J-shape with adjacent portions of the second support extending perpendicular therefrom to mechanically secure the first conducting plate **50**, the second conducting plate **60** and the third conducting plate **70**. The first support **30** and the second support **40** are spaced apart from one another along the length of the base **20** in regard to their attachment to the base.

[0028] The first conducting plate **50,** the second conducting plate **60** and the third conducting plate **70** are secured to the first support **30** and the second support **40** in order to position planar sections of each plate to be perpendicular to the base **20** as well as properly spaced apart from each other. The base **20,** the second support **40,** and the plates are electrically conductive. The first support **30** is non-conductive.

[0029] The size compaction of the antenna **10** is achieved by the arrangement of the first conducting plate **50,** the second conducting plate **60** and the third conducting plate **70** spaced apart vertically and in alignment with each other.

[0030] As shown in **FIG. 4,** the first conducting plate **50** of the three conducting plates is J-shaped with a planar bend of the J-shape facing a first edge **22** of the base at the width. A first end **52** at a long extension of the J-shape of the first conducting plate **50** is secured to a portion of the long extension of the J-shaped second support **40** in proximity to the bend of the J-shape. The remaining sections of the J-shape of the first conducting plate **50** are mechanically secured to an end of a second arm **35,** a third arm **36** and a fourth arm **38** of the cross-shaped support **30.** The plane of the first conducting plate **50** is spaced apart from and perpendicular to the base **20.**

[0031] As shown in **FIG. 5**, the second conducting plate **60** of the three conducting plates is J-shaped. The plane of the long extension of the J-shape of the second conducting plate **60** angularly faces and is in parallel with a plane of the long extension of the J-shape of the first conducting plate **50.** The long extension of the J-shape of the second conducting plate **60** is secured in proximity to an end of a short extension of the J-shaped second support **40.** The long extension as well as the remaining sections of the second conducting plate **60** are secured at the end of the second arm **35,** the third arm **36** and the fourth arm **38** of the cross-shaped support **30.** The plane of the second conducting plate **60** is perpendicular to the base **20** and is spaced apart from the first conducting plate **50.**

[0032] As shown in **FIG. 6**, the third conducting plate **70** of the three conducting plates is U-shaped and integral with an L-shaped section facing the first width edge **22.** A short leg **72** of the L-shape is integral to an edge **74** of the U-shape of the third conducting plate **70.** A long leg **76** of the L-shape is positioned inward and mechanically attached in the slot **34** of the cross-shaped support **30.** A second end **78** of the U-shape of the third conducting plate **70** is mechanically fastened in proximity to an end of the long extension of the J-shaped second support **40.** The remaining sections of the third conducting plate **70** are secured at the end of the second arm **35**, the third arm **36** and the fourth arm **38** of the cross-shaped support **30**.

[0033] The antenna **10** can be cast as a single structural element or can be assembled from individual elements by welding without departing from the scope of the present invention. The base **20** also serves as an attachment point at a feed point connection **80** for an electrical ground plane **82** for the antenna **10**. The feed point connection **80** must be adjusted accordingly to obtain a good impedance match at a fundamental frequency.

[0034] Dimensions of the antenna **10** are expressed as a fraction of a fundamental operating wavelength λ, calculated in Equation **(1)** as:

$$\lambda = \frac{v_o}{f} \qquad \textbf{(1)}$$

where v_o is the speed of light and f is the operating frequency, Hz.

[0035] Starting with **FIG. 3**, the U-shaped channel of the second support **40** is dimensioned with a height **(H1)** of $\lambda/16$ for a first or long extension **42** (vertical support) with a U-channel width **(W)** of $\lambda/48$. A second or short extension **44** (vertical support) is dimensioned with a height **(H2)** of $\lambda/24$ spaced apart at a distance **(G)** of $\lambda/44$ from the first extension **42**.

[0036] In **FIG. 4,** the first conducting plate **50** is positioned for attachment to the second support **40.** The first conducting plate **50** is positioned at a distance **(S)** of $\lambda/175$ from the base **20.** This distance **(S)** is also the distance from an end **54** of the short extension of the first conducting plate **50** to a forward edge **46** of the second support **40.** The feed point location **80** is located at a distance **(F)** of $\lambda/66$ from a forward edge **48** of the long extension **42** of the second support **40.**

[0037] The length **(L2)** of the bend of the first conducting plate **50** is $\lambda/33$. The height **(H)** of the conducting plate **50** is $\lambda/69$ with **(L1)** being the distance of $\lambda/21$ from a bend edge **56** to the forward edge **48** of the long extension **42** of the second support **40. (L3)** is the length $\lambda/24$ from a bend edge **58** to the end **54** of the first conducting plate **50.**

[0038] In **FIG. 5,** the second conducting plate **60** is positioned for attachment to the second support **40.** The second conducting plate **60** is dimensioned with a height **(H)** of $\lambda/69$. The second conducting plate **60** has a distance **(S)** of $\lambda/175$ from the first conducting plate **50.** The distance **(S)** is also a distance from the forward edge **48** of the second support **40** to an end **62** of the second conducting plate **60. (L1)** is a distance $\lambda/21$ from an edge **64** of the second conducting plate **60** to the forward edge **46** of the second support **40. (L2)** is a width $\lambda/33$ of the bend of the second conducting plate **60. (L3)** is a length $\lambda/24$ of a short extension of the second conducting plate **60.**

[0039] In **FIG. 6,** the third conducting plate **70** is positioned for attachment to the second support **40.** The third conducting plate **60** is dimensioned with a height **(H)** of $\lambda/69$. The third conducting plate **70** has a distance **(S)** of $\lambda/175$ from the second conducting plate **60. (L1)** is a distance $\lambda/21$ from an edge of a bend **64** of the third conducting plate **70** to the forward edge **48** of the second support **40. (L4)** is a distance $\lambda/15$ from another edge **66** to the edge **74** of the third conducting plate **70. (L5)** is a distance $\lambda/66$ from the edge **74** to the edge **77** of the third conducting plate **70. (L6)** is a distance $\lambda/23$ from the edge **77** to the end opposite to the end **78** of the third conducting plate **70.**

[0040] The antenna **10** has vertical polarization due to a net direction of electric current flow on the surface of the conducting plates. This is best depicted as an unfurling of the antenna **10** into a flat antenna as shown in **FIG. 7, FIG. 8** and **FIG. 9** where dotted lines are the locations of where the antenna **10** is bent. When a feed is energized, current flow is established through the conductive paths formed by the plates. The direction of current on the surface of the conducting plates changes with frequency.

[0041] In **FIG. 7**, a current path at a first resonance is shown. In **FIG. 8**, a current path at a second resonance is shown in which the resonance is 1.6 times the first resonance. In **FIG. 9**, a current path at a third resonance is shown in which the resonance is 2.1 times the first resonance.

[0042] Despite the changes in current distribution, the radiation patterns maintain a similar shape (up to the third resonance at least). This likely occurs because currents traveling in opposite directions in the adjacent plates cancel the local radiated fields; thereby producing a net radiated field with vertical polarization.

[0043] It will be understood that many additional changes in the details, materials, steps and arrangement of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the expressed in the appended claims.

PARALLEL PLATE ANTENNA WITH VERTICAL POLARIZATION

ABSTRACT OF DISCLOSURE

An antenna is provided with conducting plates spaced apart from each other and the base to be in vertical alignment. A cross-shaped support extends perpendicular from a front section of the base to secure the conducting plates. An arm of the support indents to accommodate a conducting plate. A J-shaped support is fastened to a rear planar section of the base with extensions extending perpendicular to secure the conducting plates. A first conducting plate is J-shaped with a bend facing a width edge. A second conducting plate is also J-shaped with the plane of the plate perpendicular to the base and spaced apart from the first conducting plate. A third conducting plate is U-shaped and integral with an L-shaped section with a bend of the U-shape facing the width edge. The short leg of the L-shape section attached in the indentation of the cross-shaped support.

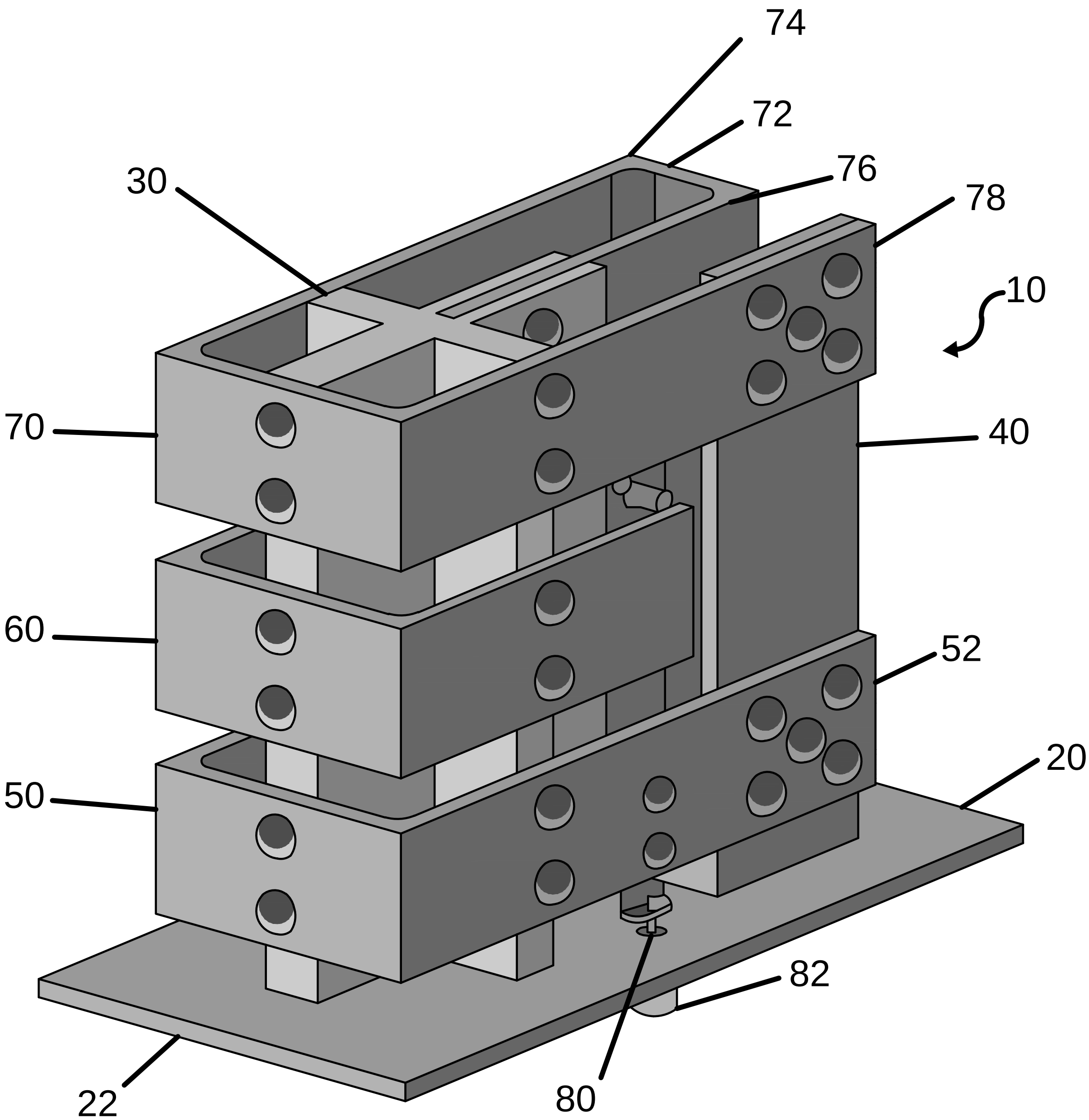

FIG .1

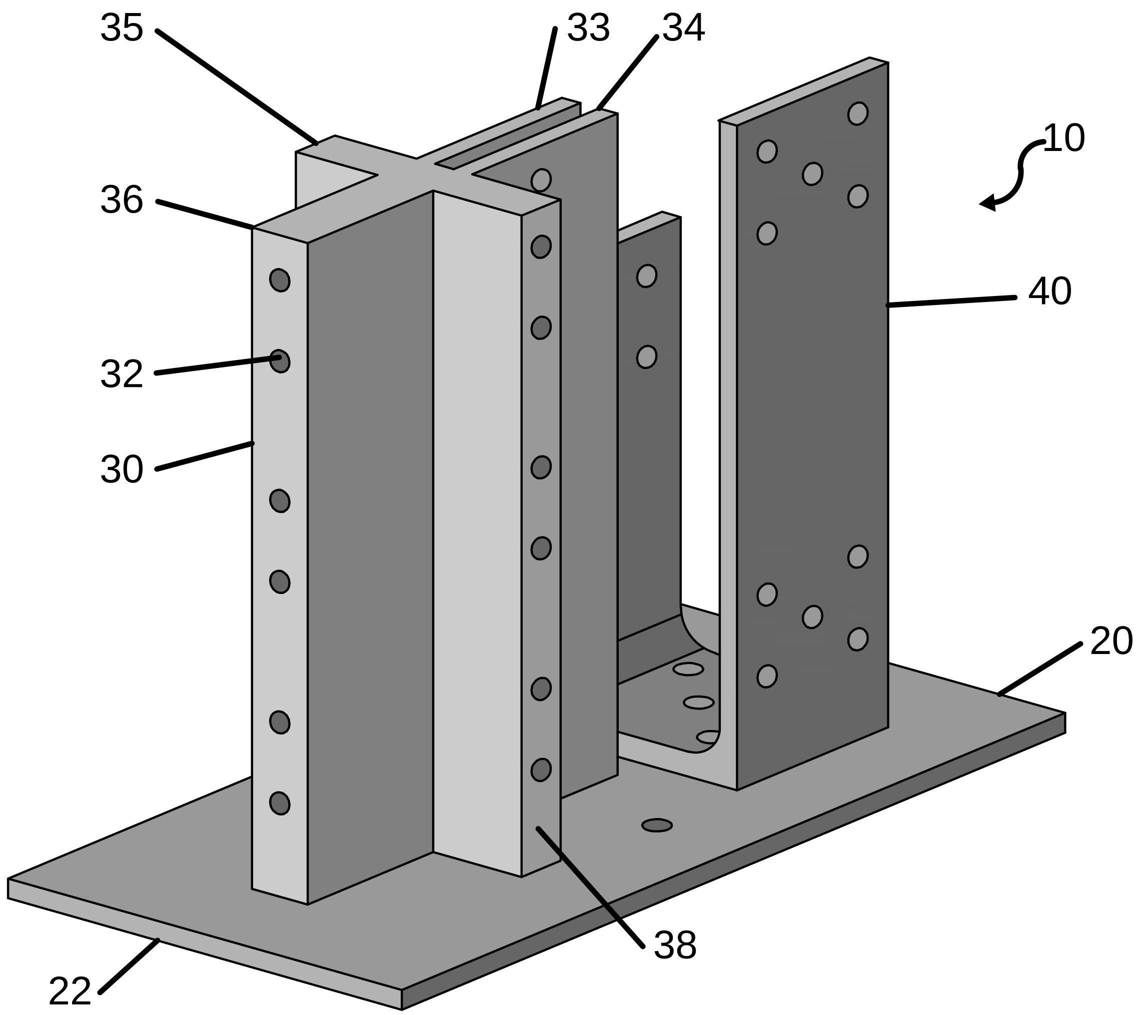

FIG .2

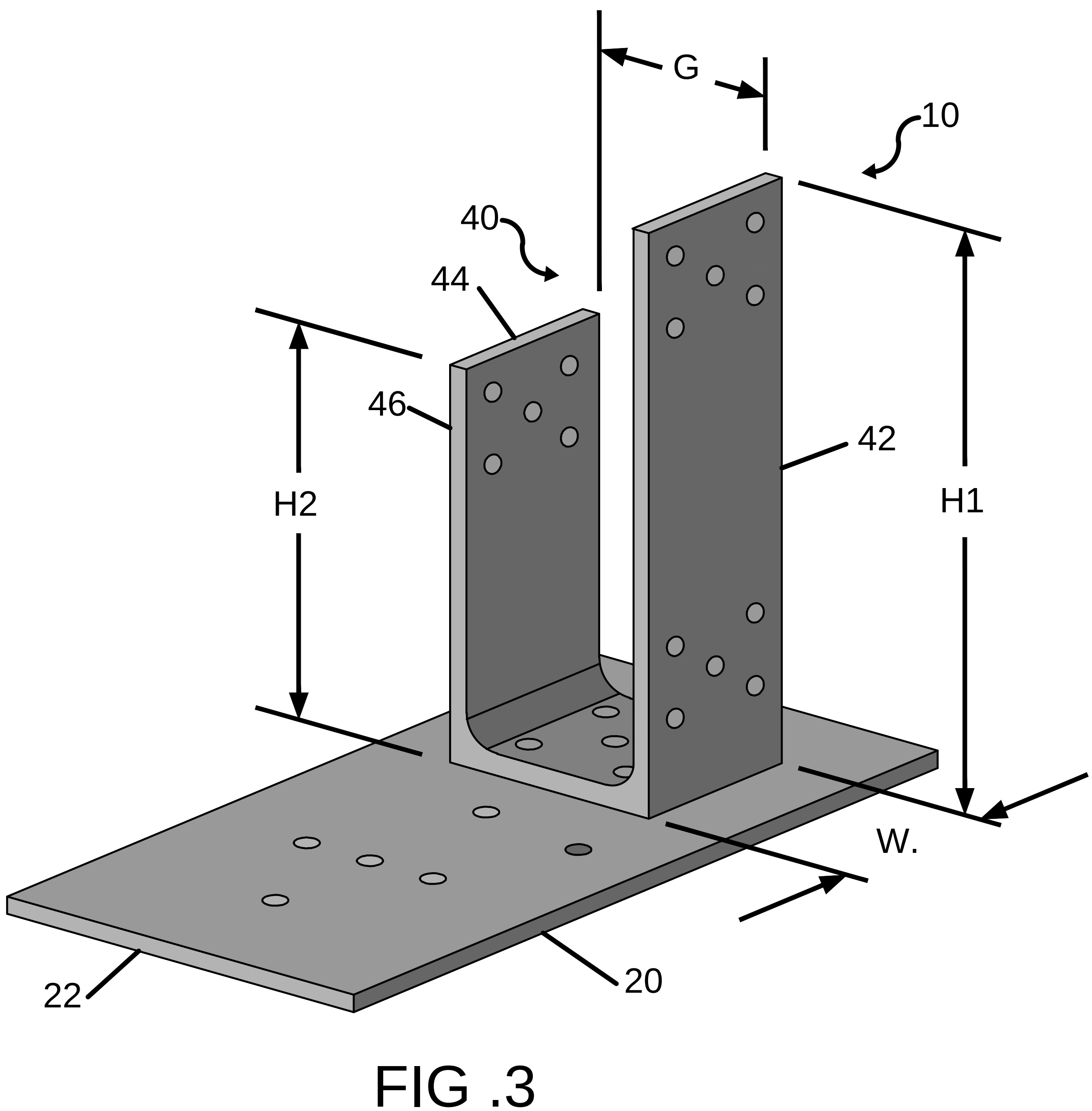

FIG .3

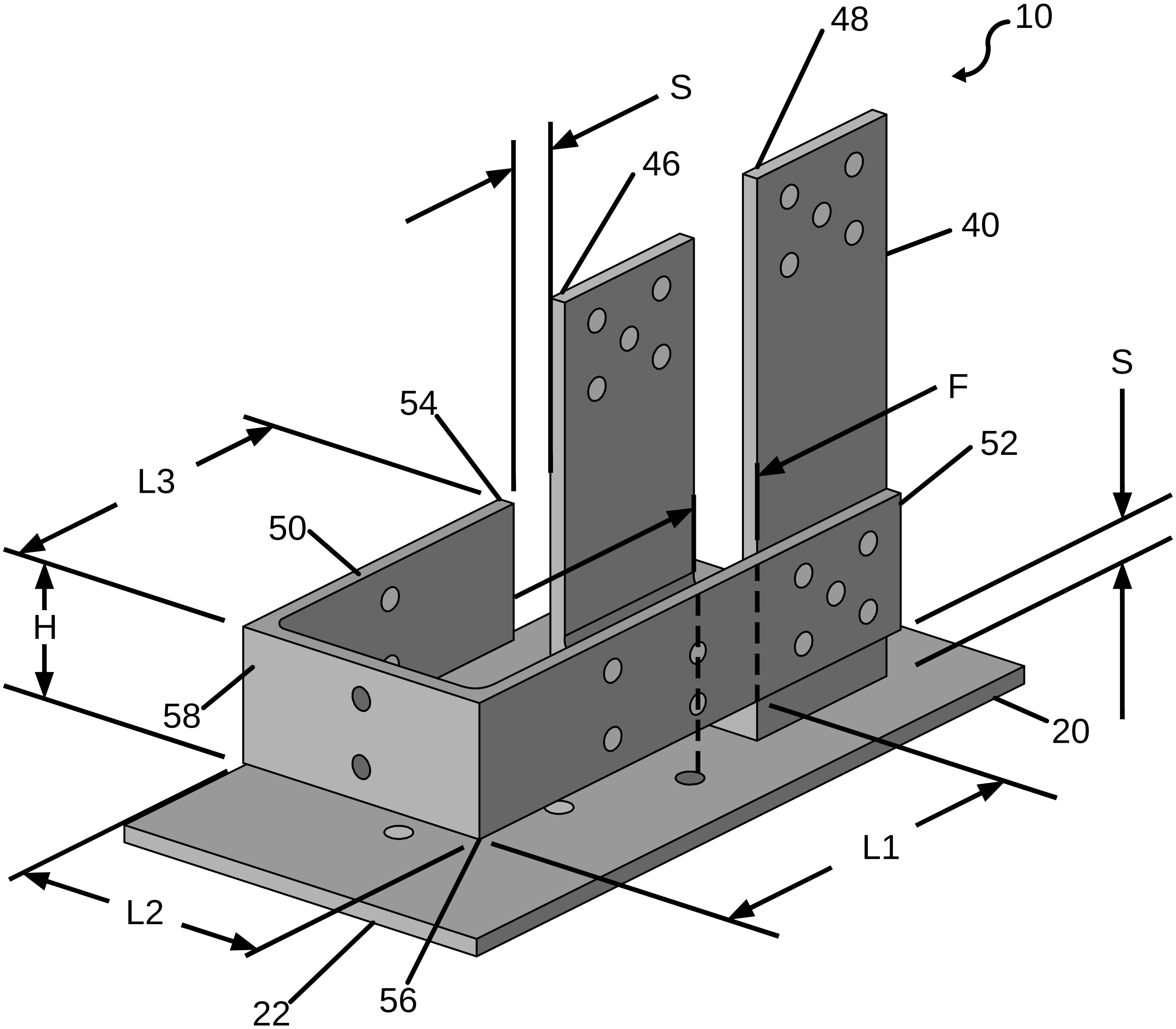

FIG .4

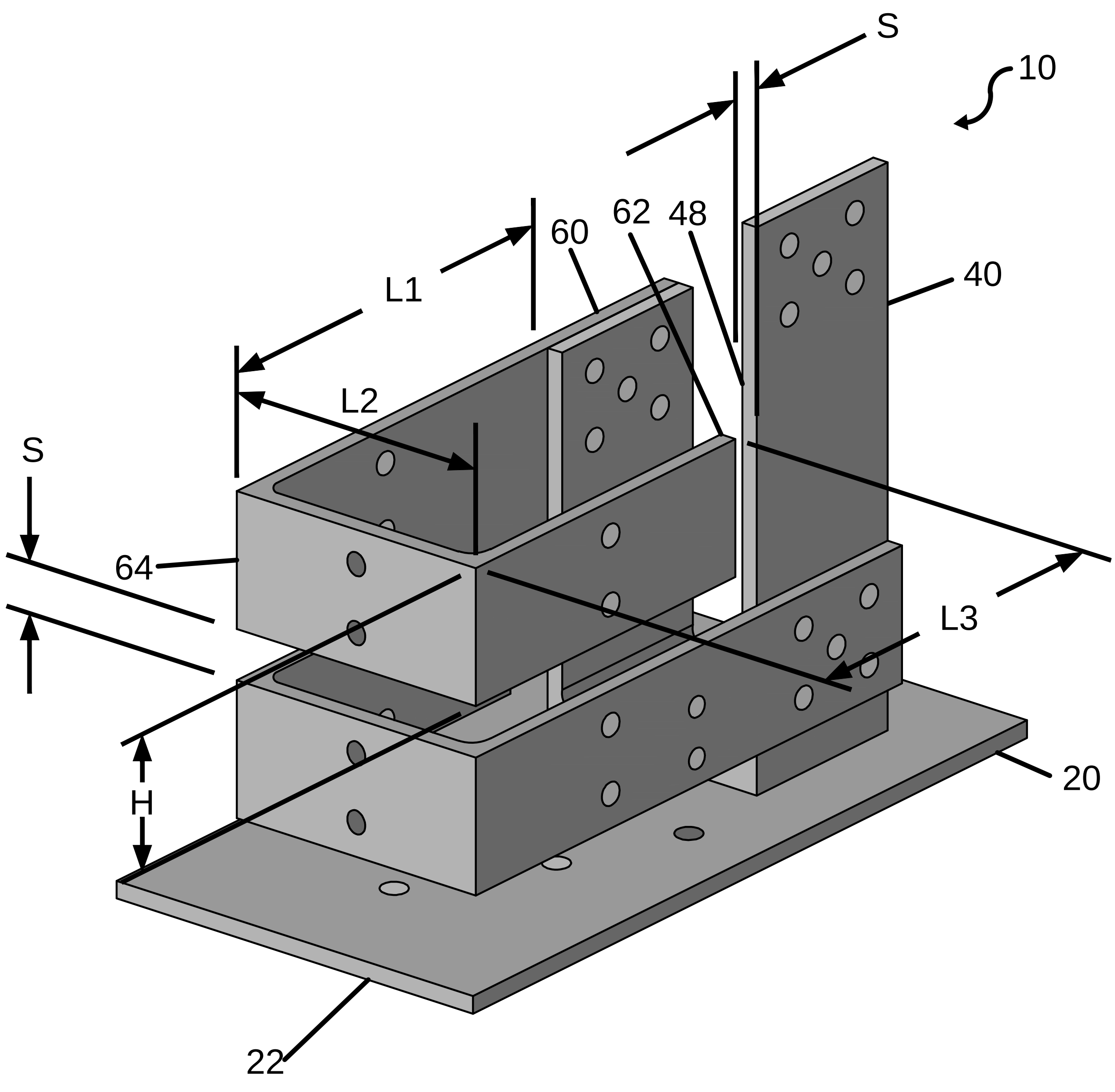

FIG .5

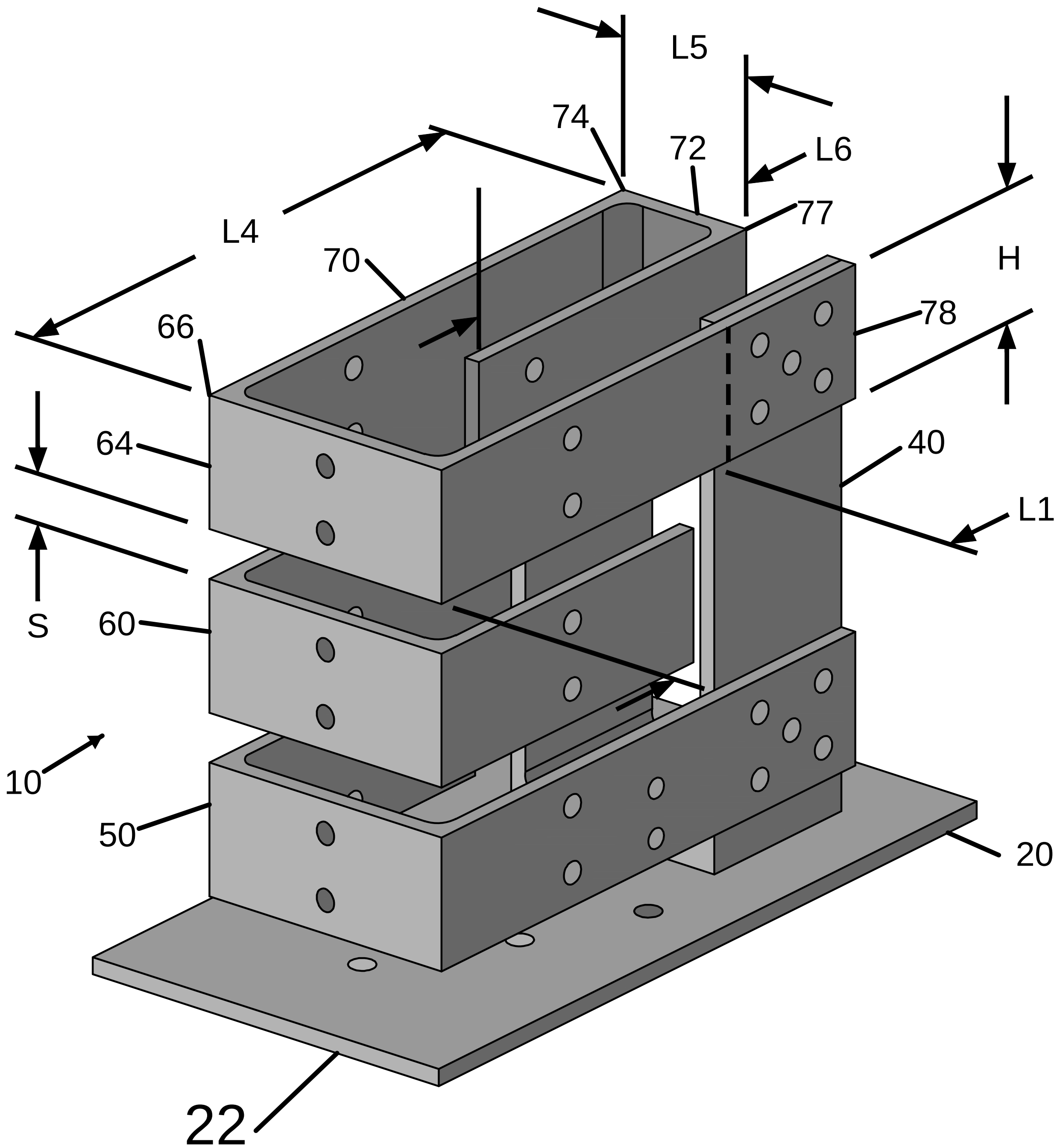

FIG .6

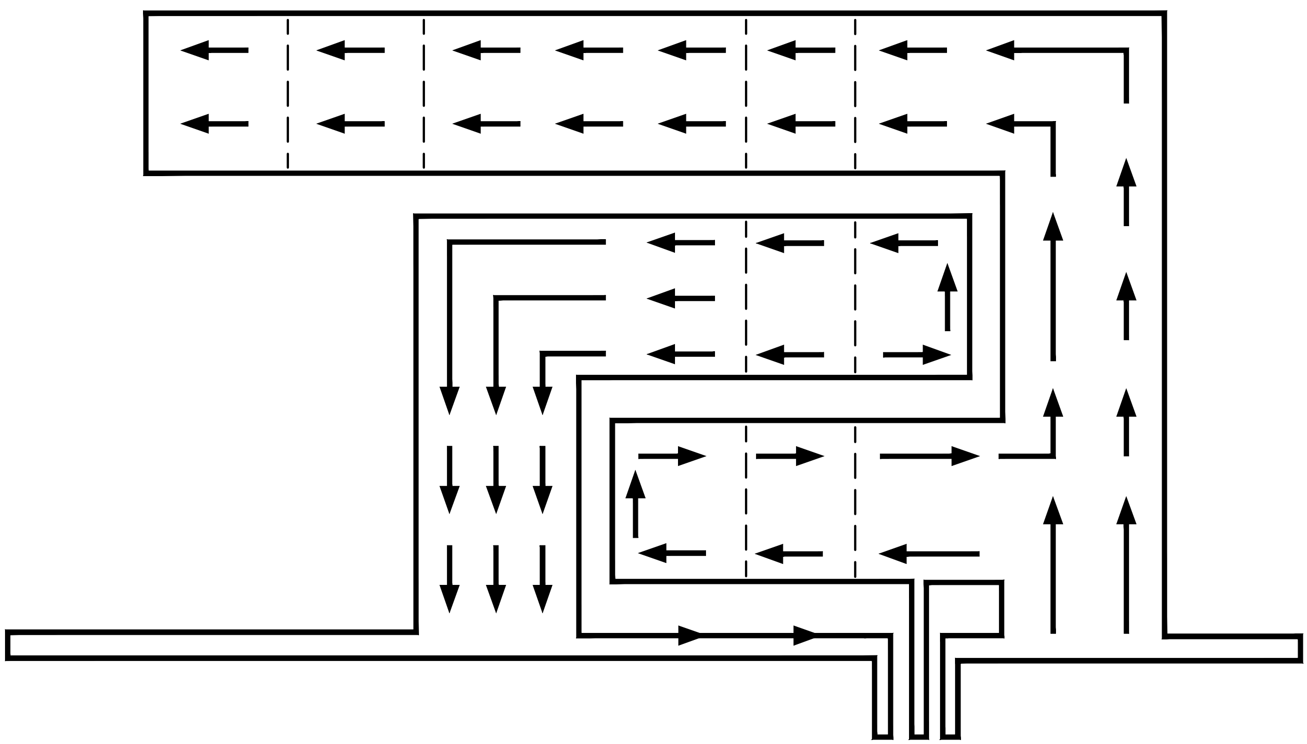

FIG .7

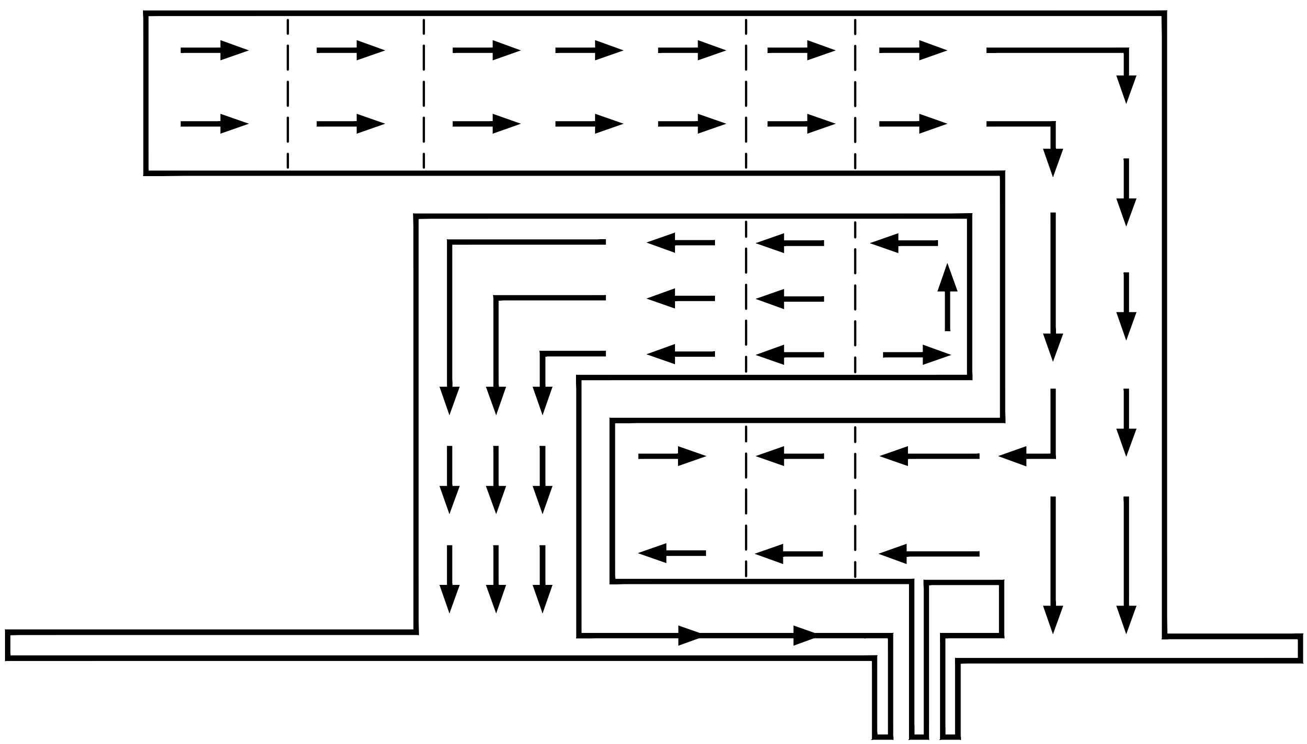

FIG .8

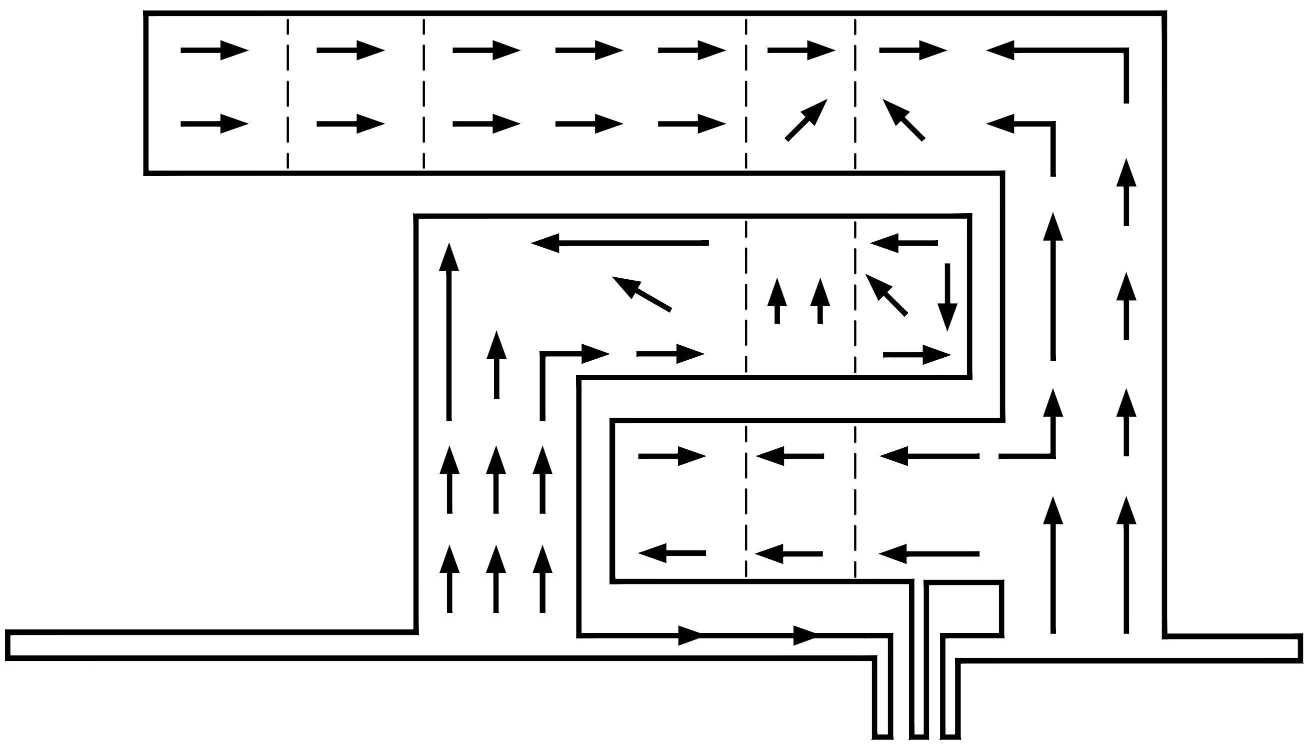

FIG .9