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Calvanico et al.

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(54) **BOTTOM-MOUNTED WHOLE HOUSE FAN ASSEMBLY**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 16/145,970, filed on Sep. 28, 2018, now abandoned.

(51) **Int. Cl.**
F24F 7/02 (2006.01)
F04D 29/64 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***F24F 7/025*** (2013.01); ***F04D 29/646*** (2013.01); ***F24F 7/065*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,626,742 A * 1/1953 Turner F04D 29/646 416/500
2,830,779 A * 4/1958 Wentling F04D 29/601 280/47.24

(Continued)

FOREIGN PATENT DOCUMENTS

DE 202008012984 U1 1/2009
EP 0277497 B1 5/1991

(Continued)

OTHER PUBLICATIONS

"QC" (QC Manufacturing, "How to Install QuietCool Whole House Fans", Posted Feb. 2, 2018, Youtube, URL: https://www.youtube.com/watch?v=PqNR4m0lHaw) (Year: 2018).*

(Continued)

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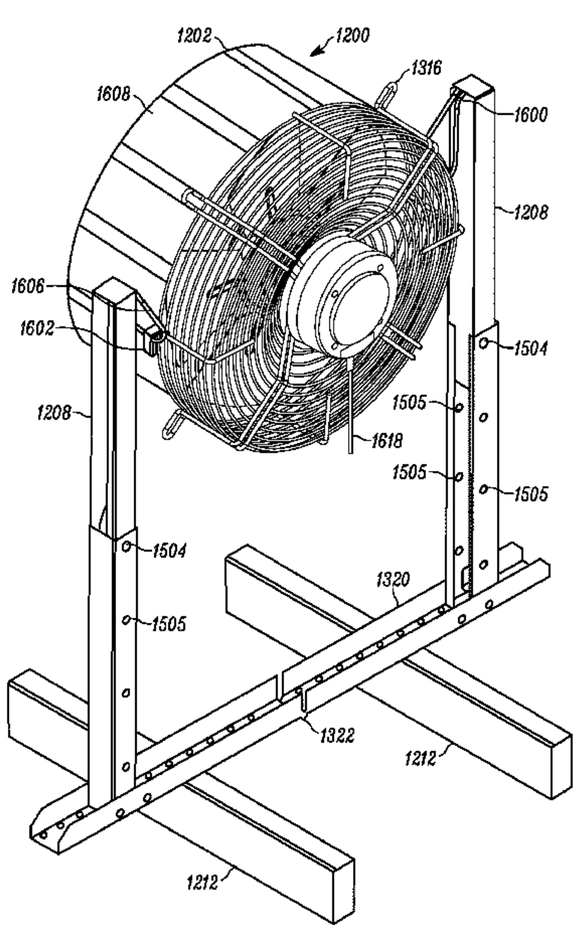
(57) **ABSTRACT**

A bottom-mounted whole house fan assembly includes an intake plenum mounted over an opening in a ceiling of a building. The intake plenum is supported on the ceiling in the attic of the building. One end of a flexible duct is connected to the intake plenum and the other end of the duct is connected to a fan so that the fan draws air in the building through the intake plenum and duct and exhausts the air in the attic from whence the air is vented to atmosphere. The fan is supported by at least one vertical strut that is connected to the ceiling at the lower end of the strut and to a housing of the fan at the upper end of the strut. A sound dampener is interposed between the strut and the fan housing and/or the ceiling beam to which the strut is attached.

18 Claims, 20 Drawing Sheets



(51) **Int. Cl.**

F24F 13/24	(2006.01)
F24F 13/02	(2006.01)
F24F 7/06	(2006.01)

(52) **U.S. Cl.**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

2,868,558	A *	1/1959	Krauss	F04D 29/646 280/47.131
3,096,933	A *	7/1963	Bora	F04D 29/646 417/247
3,405,894	A *	10/1968	Jordan	F04D 29/646 416/246
4,388,784	A	6/1983	Jentoft et al.	
4,685,256	A	8/1987	Alkjaer	
4,715,502	A *	12/1987	Salmon	H04Q 1/09 211/175
4,750,302	A	6/1988	Bechtold	
4,788,804	A	12/1988	Haas	
4,823,525	A	4/1989	Roberts et al.	
4,833,838	A	5/1989	Van Dame	
4,966,819	A	10/1990	Schatz et al.	
5,502,935	A	4/1996	Demmer	
5,522,189	A	6/1996	Mortensen et al.	
5,561,952	A	10/1996	Damron	
5,913,779	A	6/1999	Edvardsen	
6,164,025	A	12/2000	Lindgren	
6,212,834	B1	4/2001	Lindgren	
6,219,977	B1	4/2001	Chao et al.	
6,263,624	B1	7/2001	Hoy et al.	
6,503,601	B1	1/2003	Edvardsen	
6,695,692	B1	2/2004	York	
6,877,282	B2	4/2005	Melsen et al.	
6,918,216	B2	7/2005	Hoy et al.	
7,185,464	B2	3/2007	Bracale	
7,296,388	B2	11/2007	Valentz et al.	
7,351,296	B2	4/2008	Waggoner et al.	
7,497,774	B2	3/2009	Stevenson et al.	
7,607,266	B2	10/2009	D'Hagin	
8,292,706	B2	10/2012	Møller et al.	
8,555,571	B2	10/2013	Darmer et al.	
8,720,135	B2	5/2014	Sønderkaer et al.	
8,896,924	B2	11/2014	Weaver	
8,998,691	B1	4/2015	Stevenson	
9,903,603	B2	2/2018	Stevenson	
10,024,061	B2	7/2018	Ainger	
10,371,397	B1	8/2019	Stevenson	
10,739,025	B1	8/2020	Stevenson	
10,753,627	B1	8/2020	Stevenson	
10,830,464	B1	11/2020	Stevenson	
2004/0074156	A1	4/2004	Haynes	
2005/0000173	A1	1/2005	Lindgren et al.	
2005/0081462	A1	4/2005	Mulford et al.	
2005/0086878	A1	4/2005	Feucht et al.	
2009/0272047	A1	11/2009	Gottler	
2010/0269426	A1	10/2010	Richter et al.	
2012/0174506	A1	7/2012	Buckley et al.	
2014/0206278	A1	7/2014	Stevenson	
2015/0128516	A1	5/2015	Valencia et al.	
2017/0275876	A1	9/2017	Mucha et al.	
2021/0156582	A1	5/2021	Stevenson et al.	

FOREIGN PATENT DOCUMENTS

EP	0389058	B1	6/1992
EP	0756659	B1	11/1999
EP	0760043	B1	1/2000
EP	0792977	B1	5/2003
EP	1203129	B1	11/2005
EP	1424455	B1	7/2006
EP	1756481	B1	7/2008
EP	1756482	B1	7/2008
EP	1311732	B1	5/2009
EP	1281821	B1	6/2010
EP	2208834	A2	7/2010
EP	2242889	A1	10/2010
EP	2305915	A2	4/2011
EP	1485547	B1	10/2011
EP	2508690	A1	10/2012
EP	2626482	A1	8/2013
EP	2749706	A1	7/2014
EP	2749707	A1	7/2014
EP	2231956	B1	8/2015
EP	2927387	A1	10/2015
EP	2947226	A1	11/2015
EP	1896673	B1	4/2016
EP	3015617	A1	5/2016
EP	2077302	B1	8/2016
EP	3133222	A1	2/2017
EP	3181777	A1	6/2017
EP	2481864	B1	7/2017
EP	2947227	B1	4/2018
EP	3199718	B1	5/2018
EP	3323957	A1	5/2018
FR	2735047	B1	8/1997
GB	2400885	B	8/2006
NL	2006780		11/2012
PL	382913	B	7/2014
PL	403358	A1	10/2014
PL	392795	B	10/2016
PL	400174	B	6/2017

OTHER PUBLICATIONS

"Patterson" (Patterson Fan Company, Inc, "Industrial Fans Mounting Options", From Mar. 14, 2015, URL: https://www.pattersonfan.com/mounting-options.html) (Year: 2015).*

"Patterson" (Patterson Fan Company, Inc, "Pedestal Base Assembly", provided as supporting documentation, URL: https://www.pattersonfan.com/uploads/2/9/7/4/29747215/pb_assembly.pdf) (Year: 2021).*

QC Manufacturing, Inc. v. *Solatube International, Inc. et al.,* Case No. 8:18-cv-00540-DOC(JDEx) (C.D. Cal. filed Mar. 29, 2018).

* cited by examiner

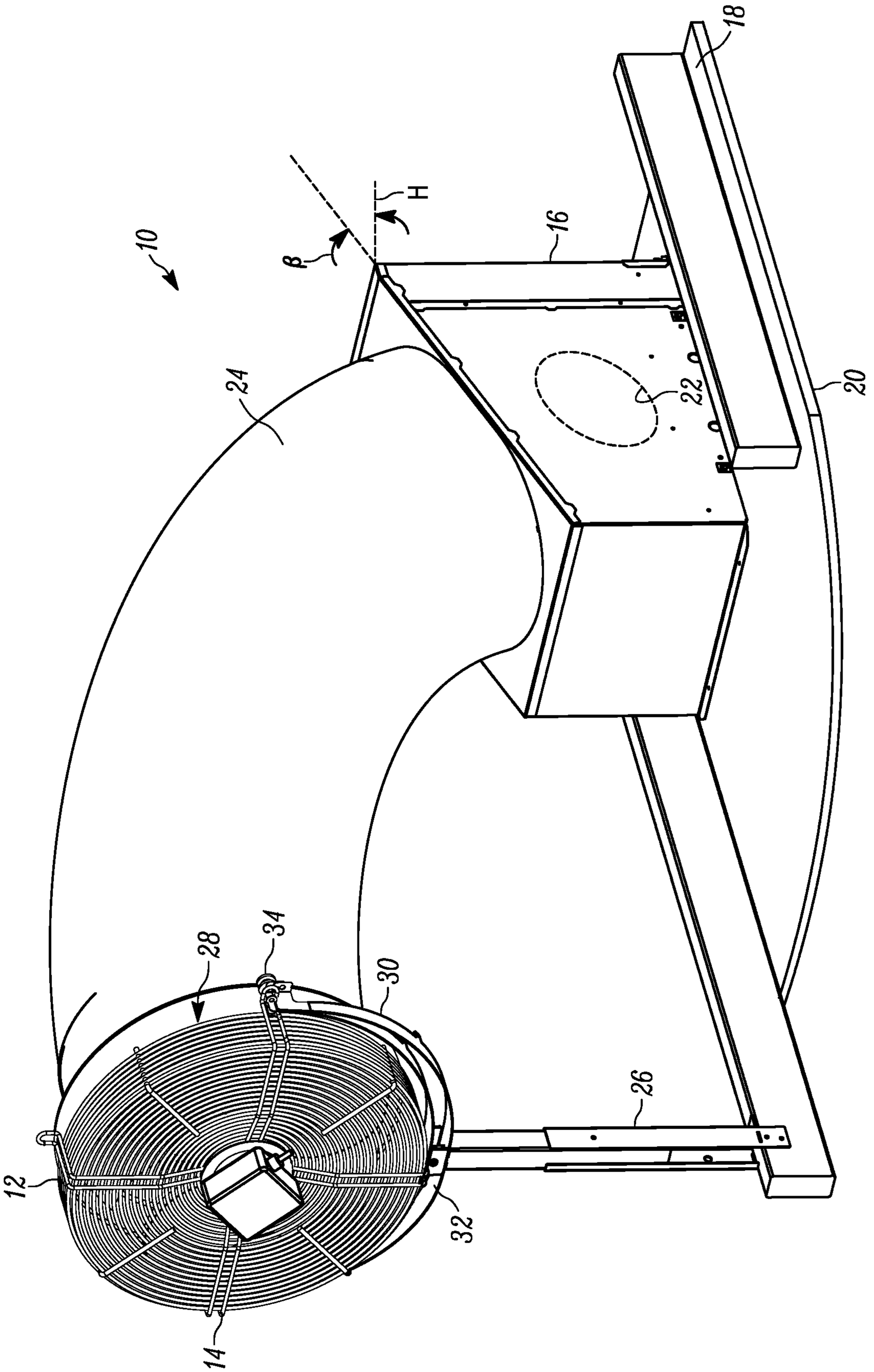


FIG. 1

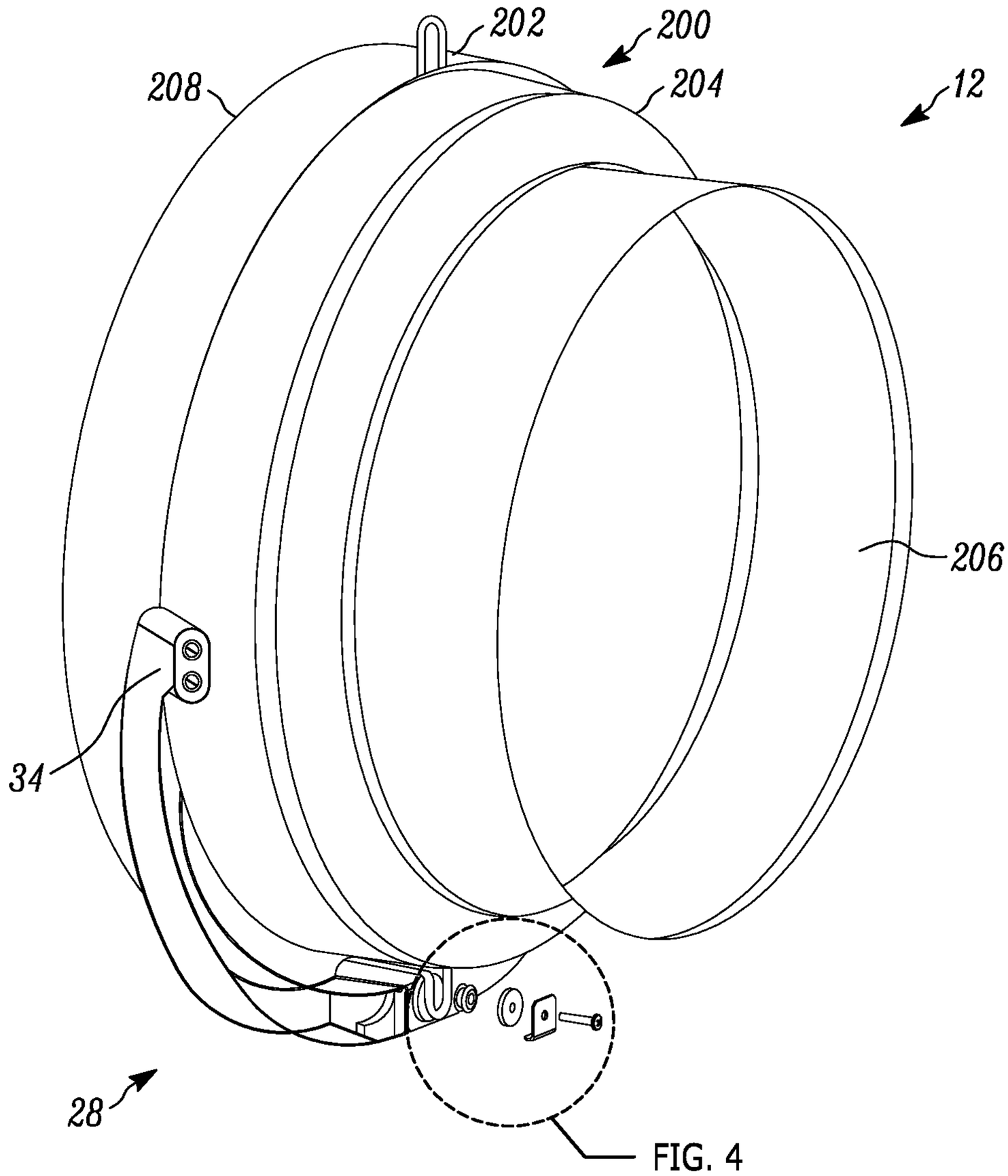
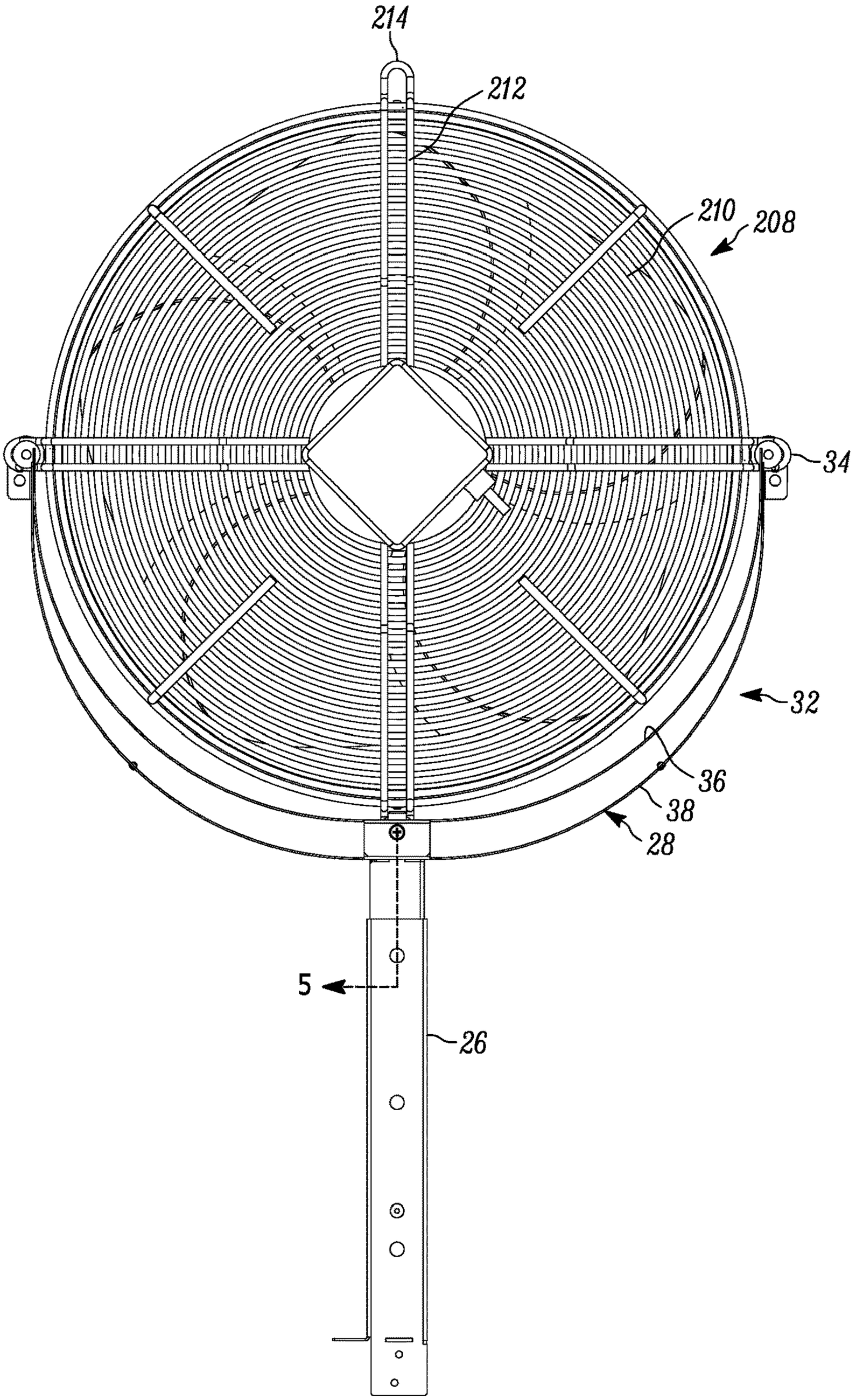


FIG. 2



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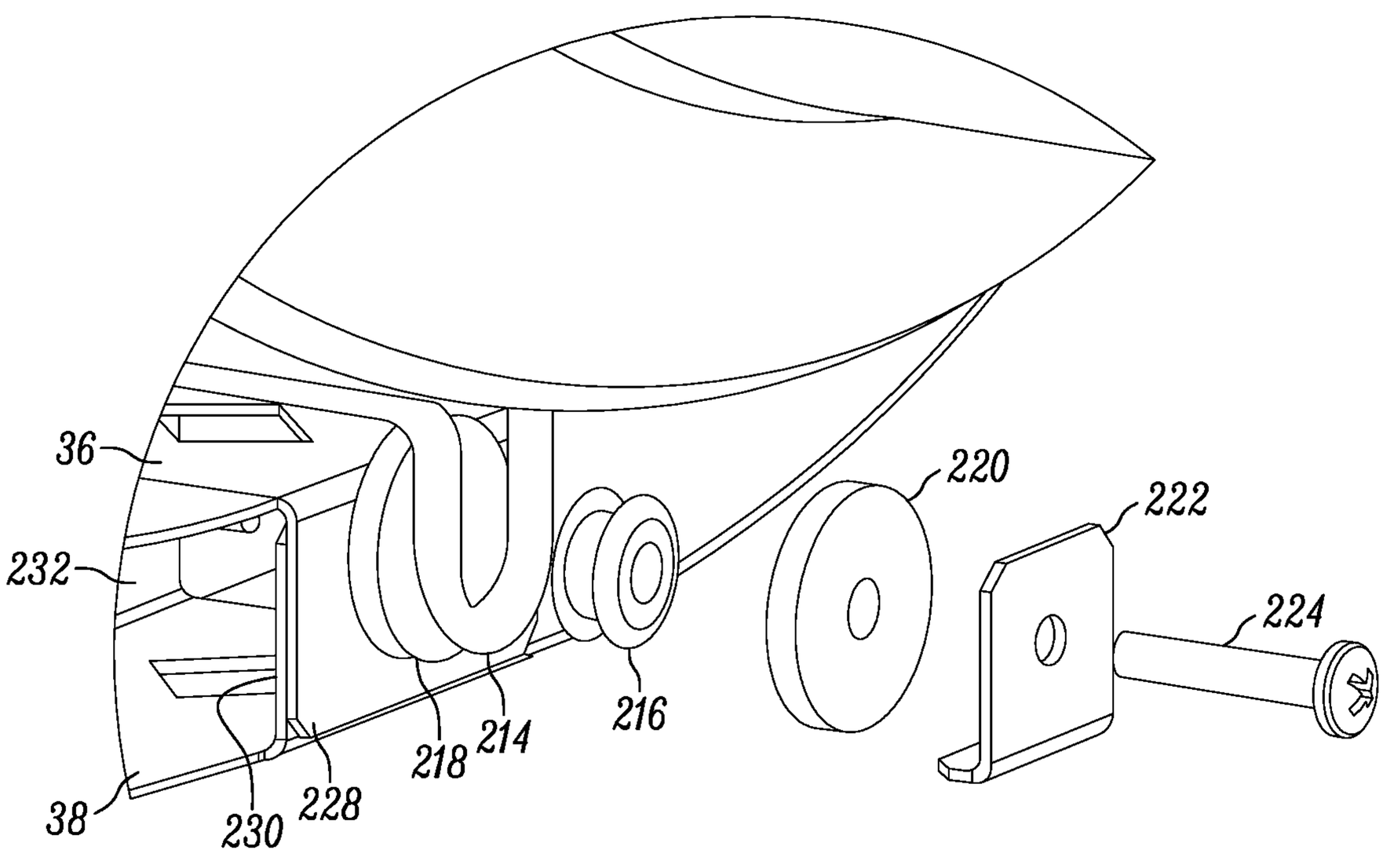

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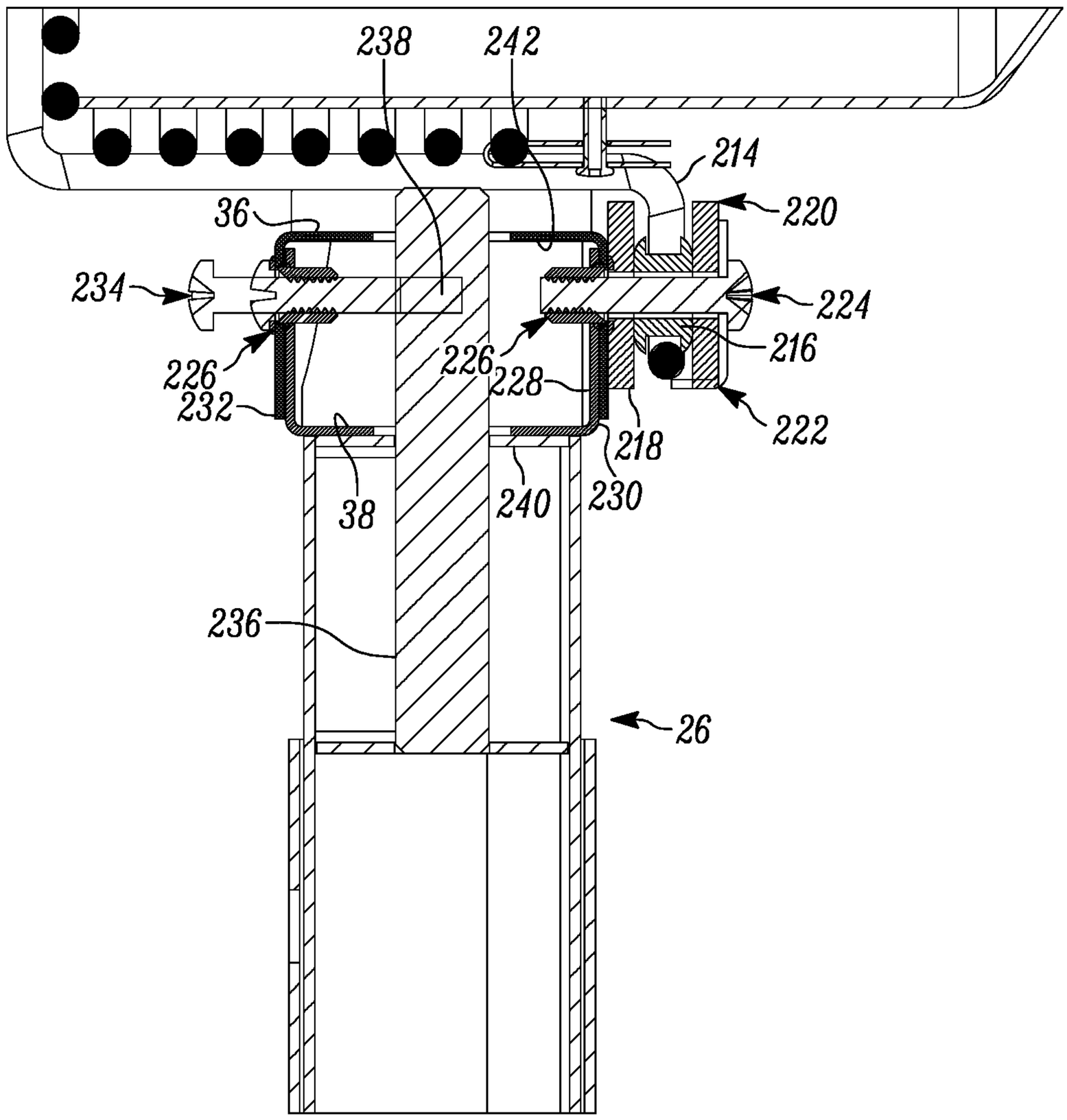
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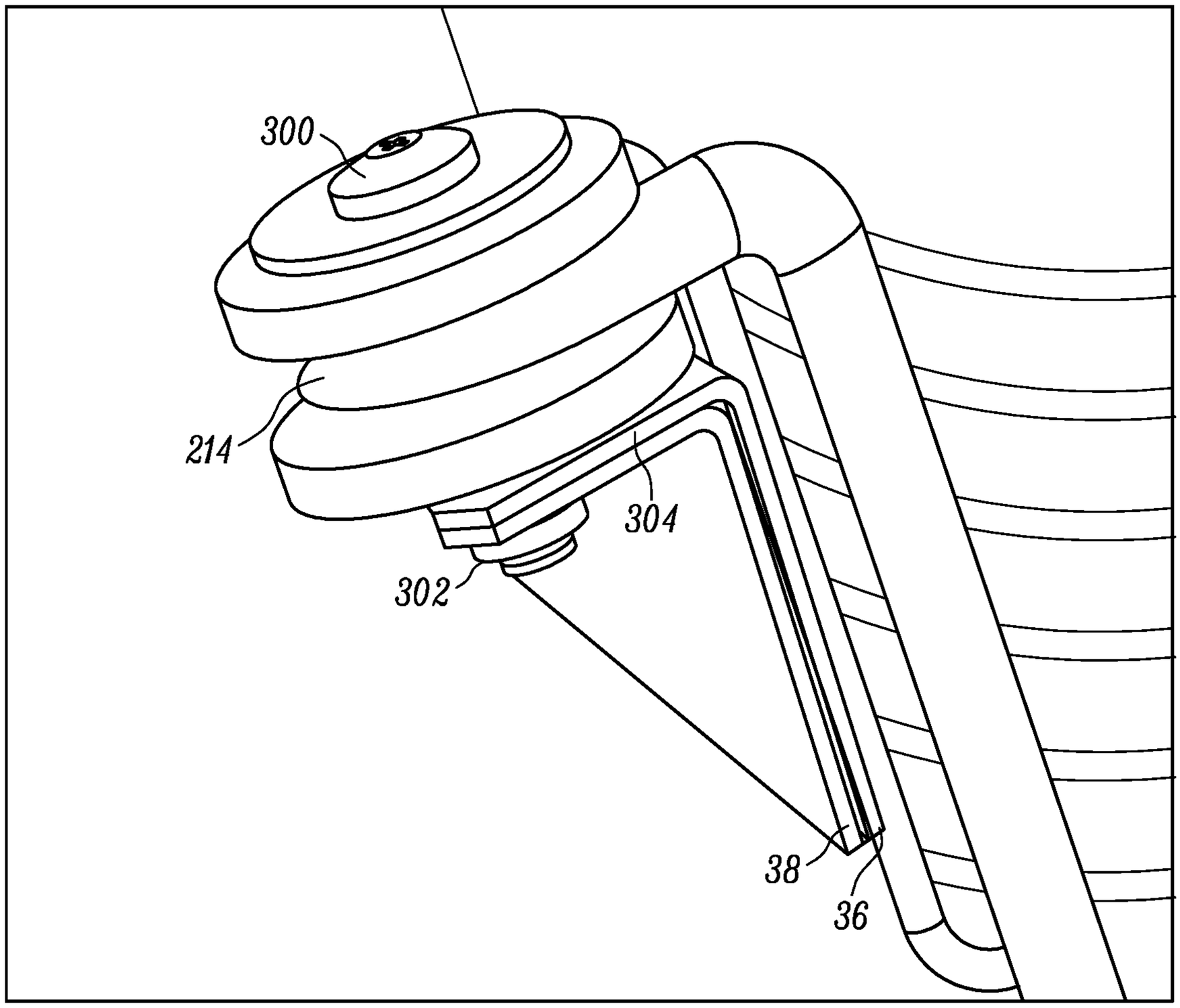
FIG. 5



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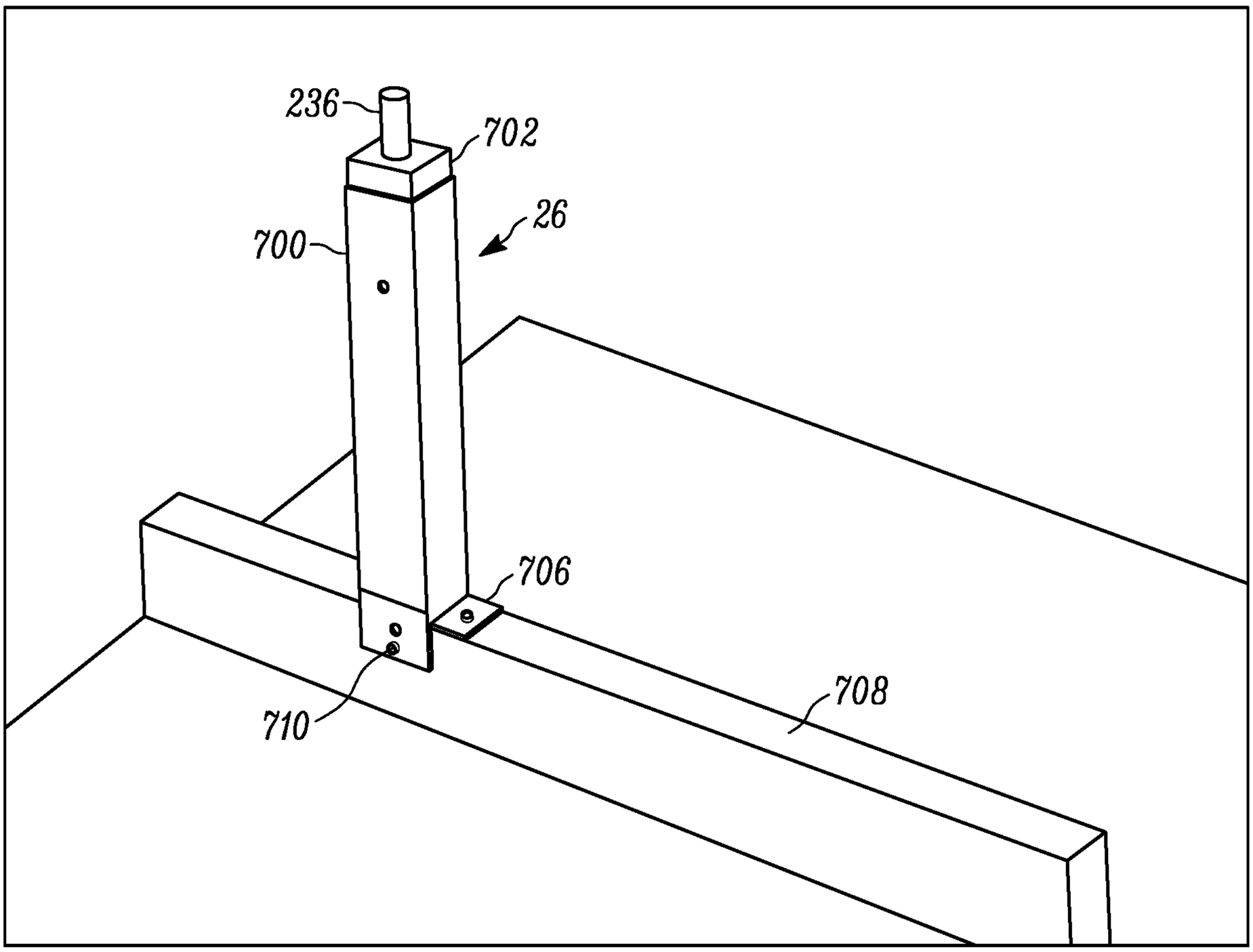

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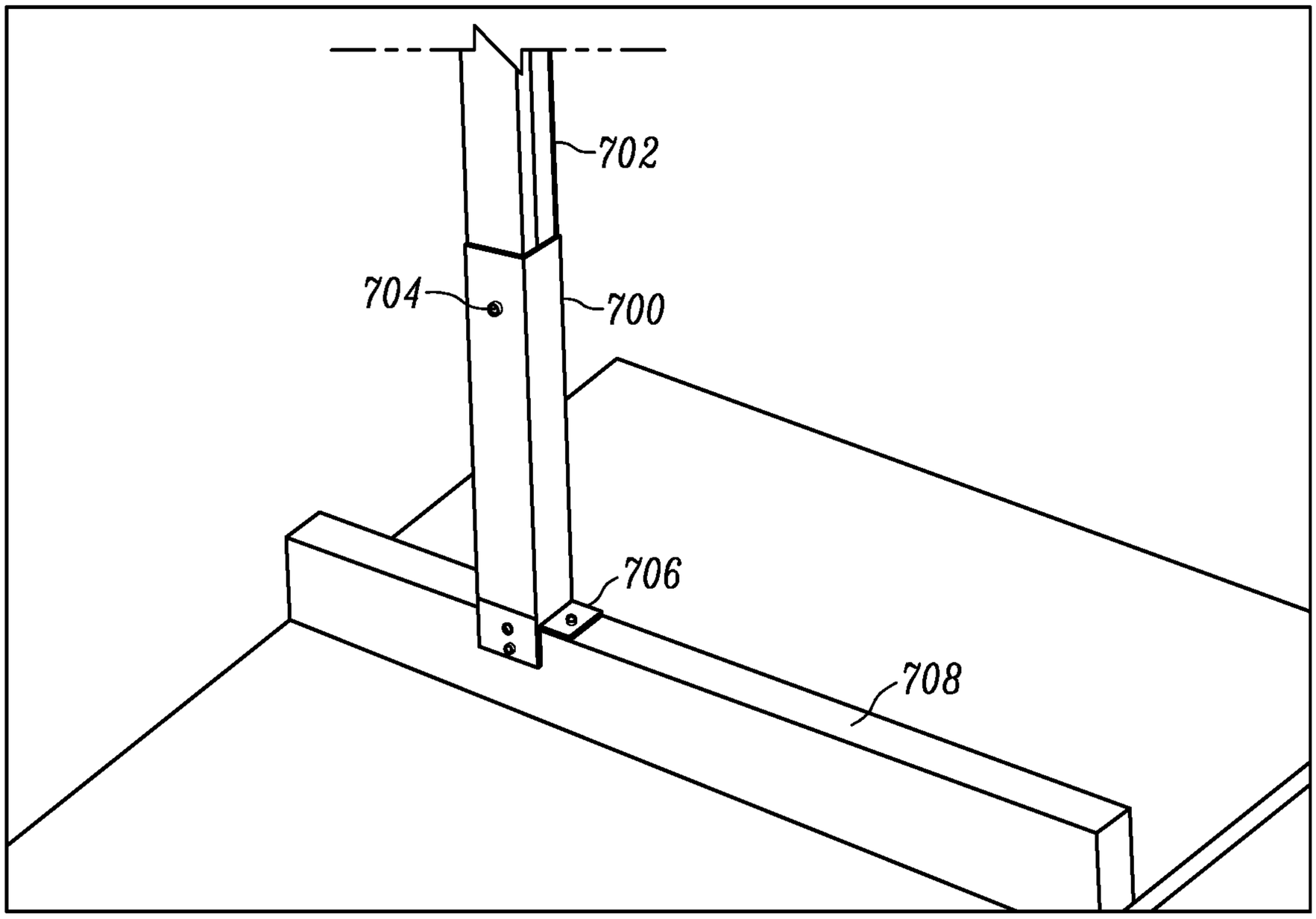

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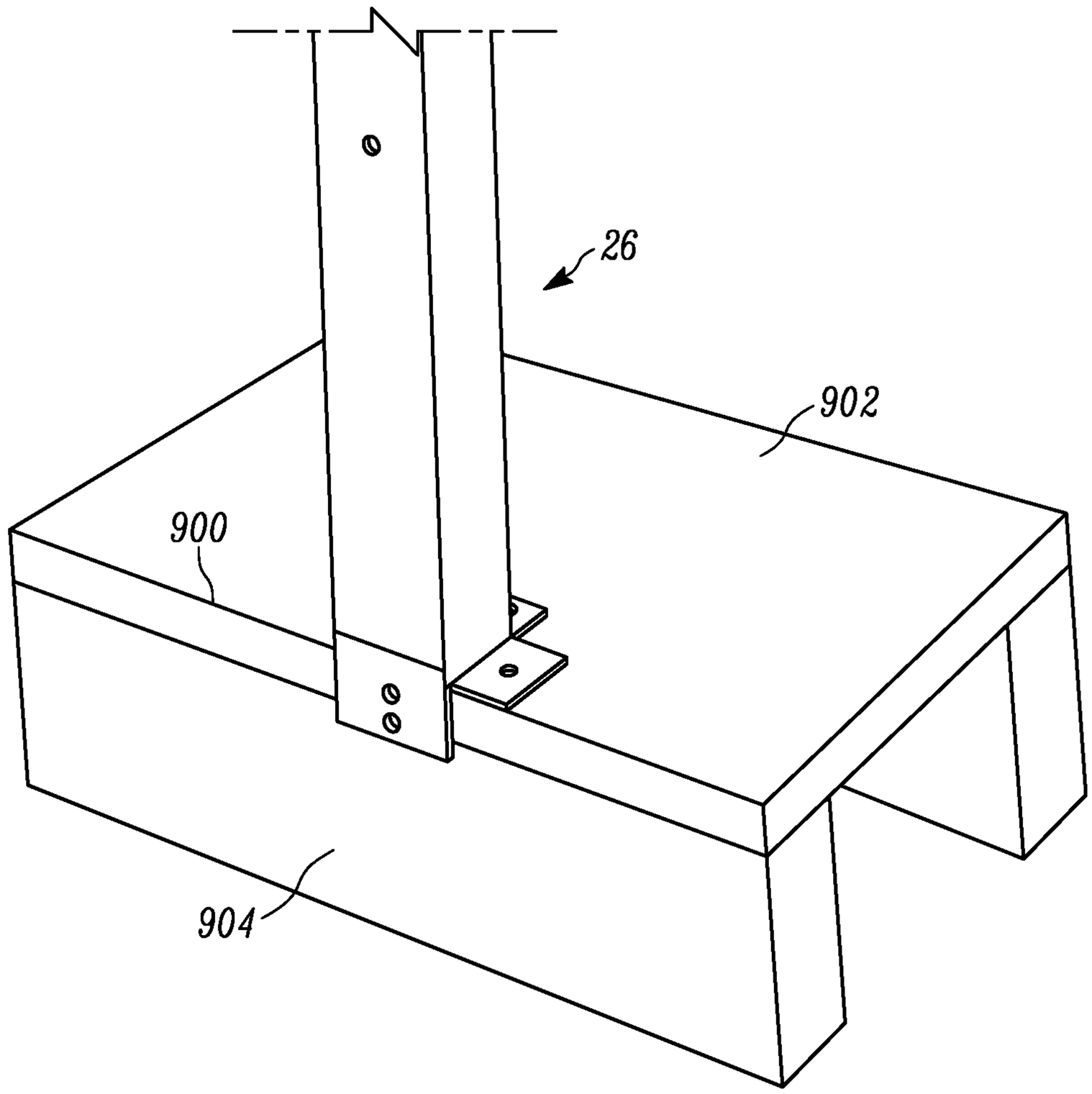

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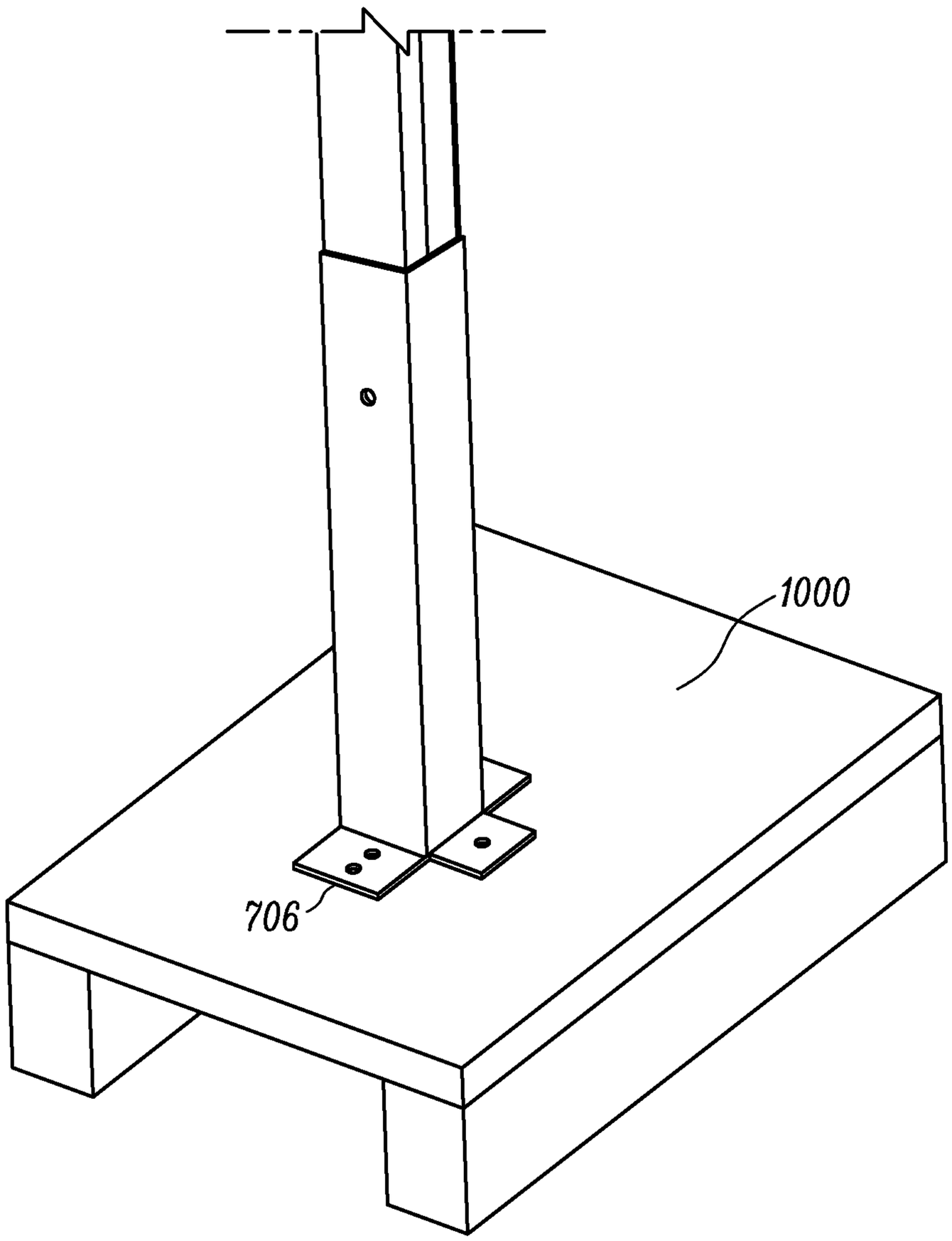

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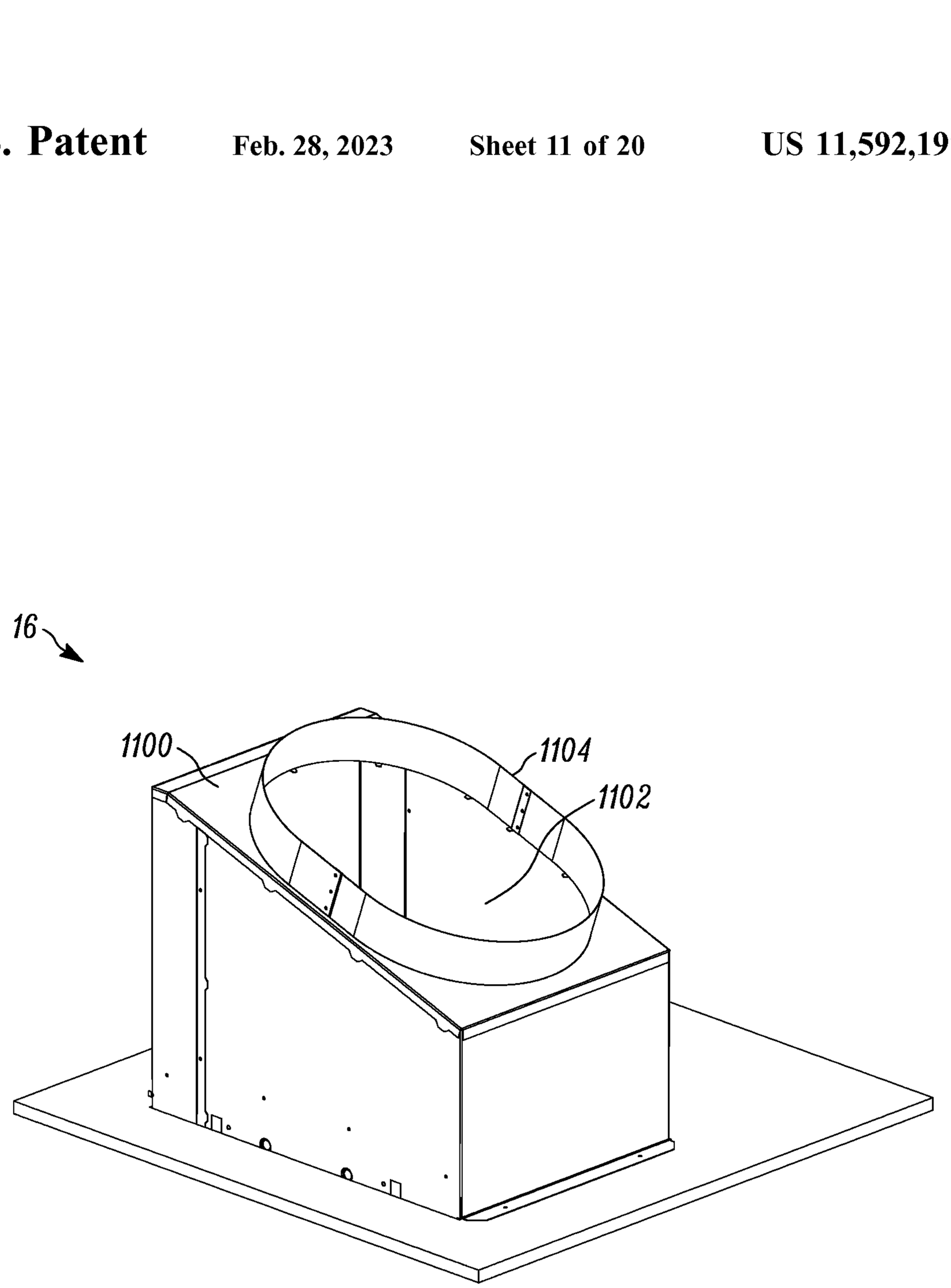

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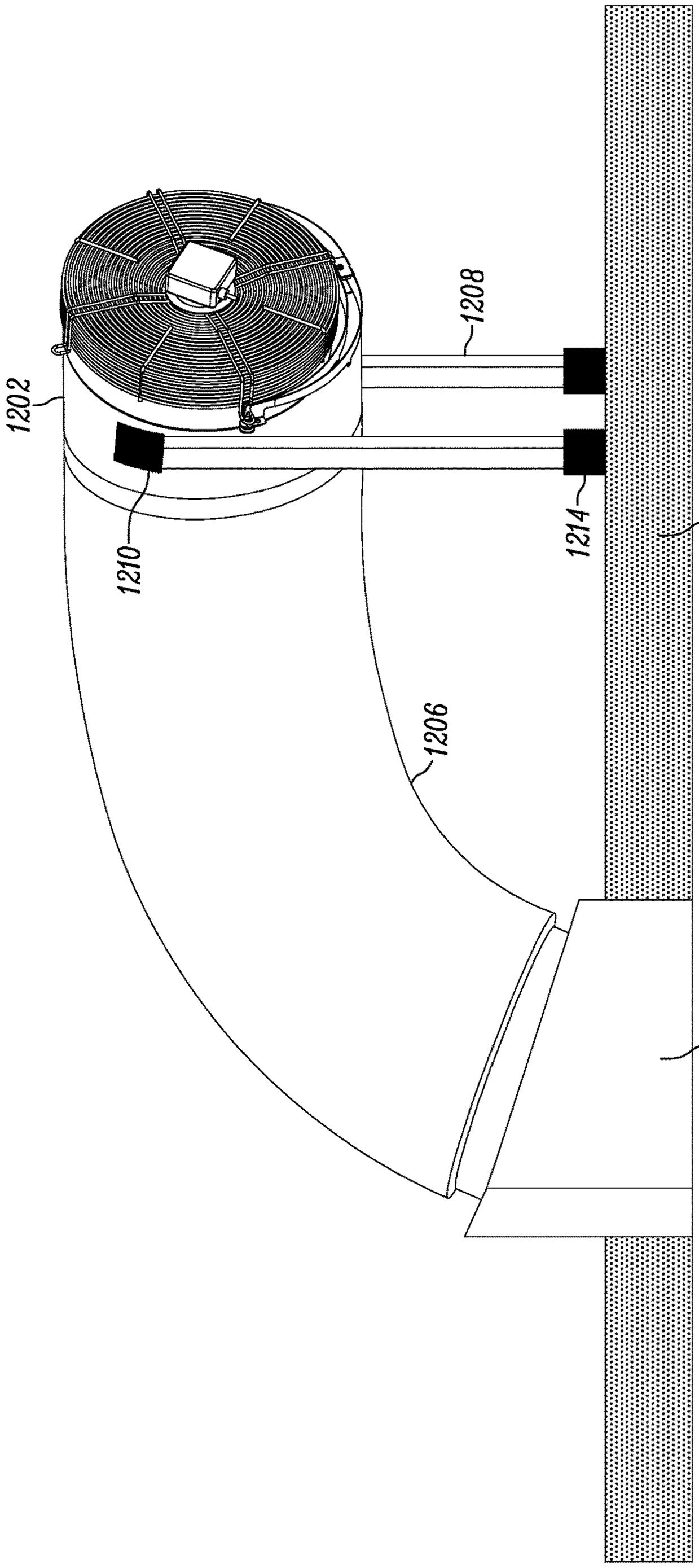
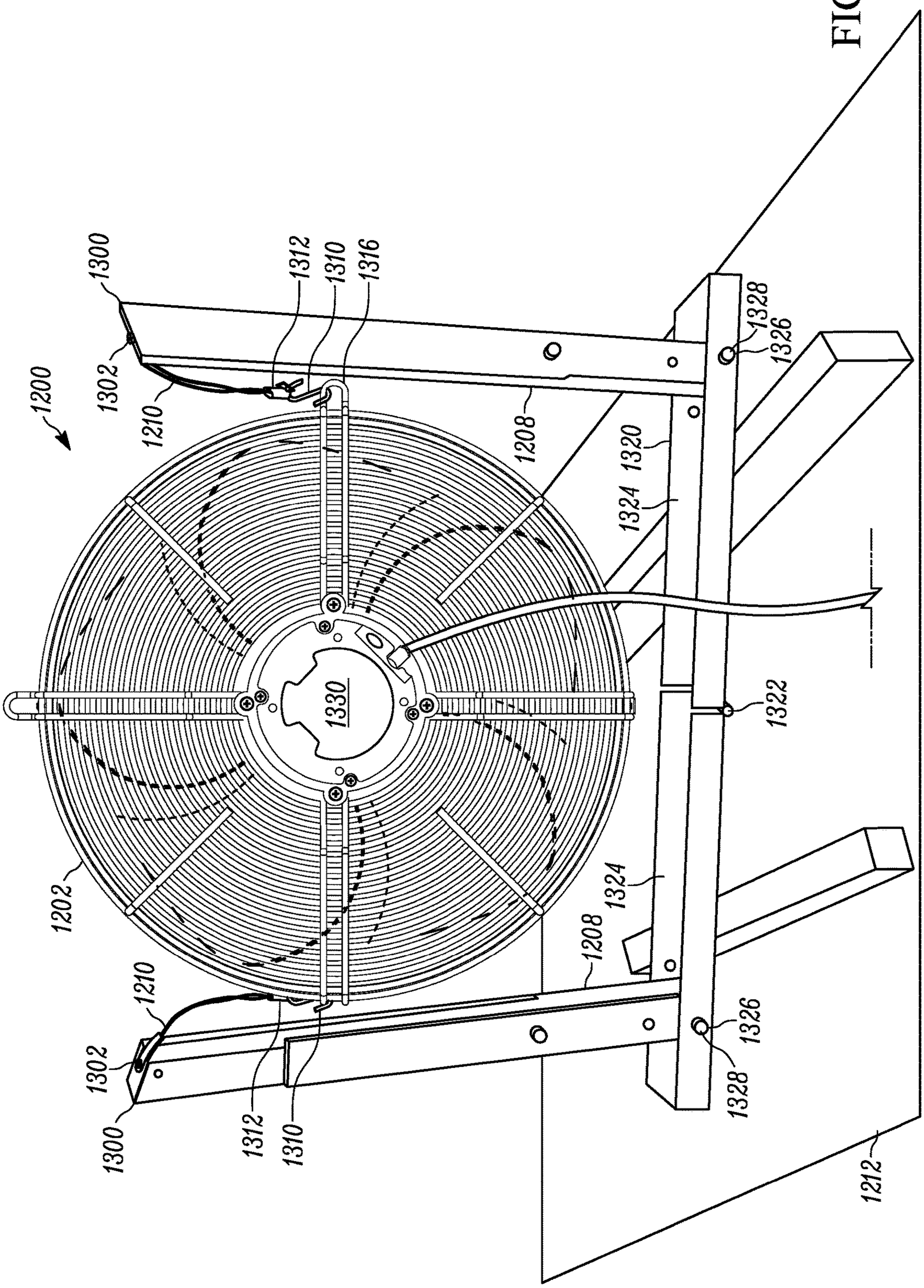


FIG. 12

FIG. 13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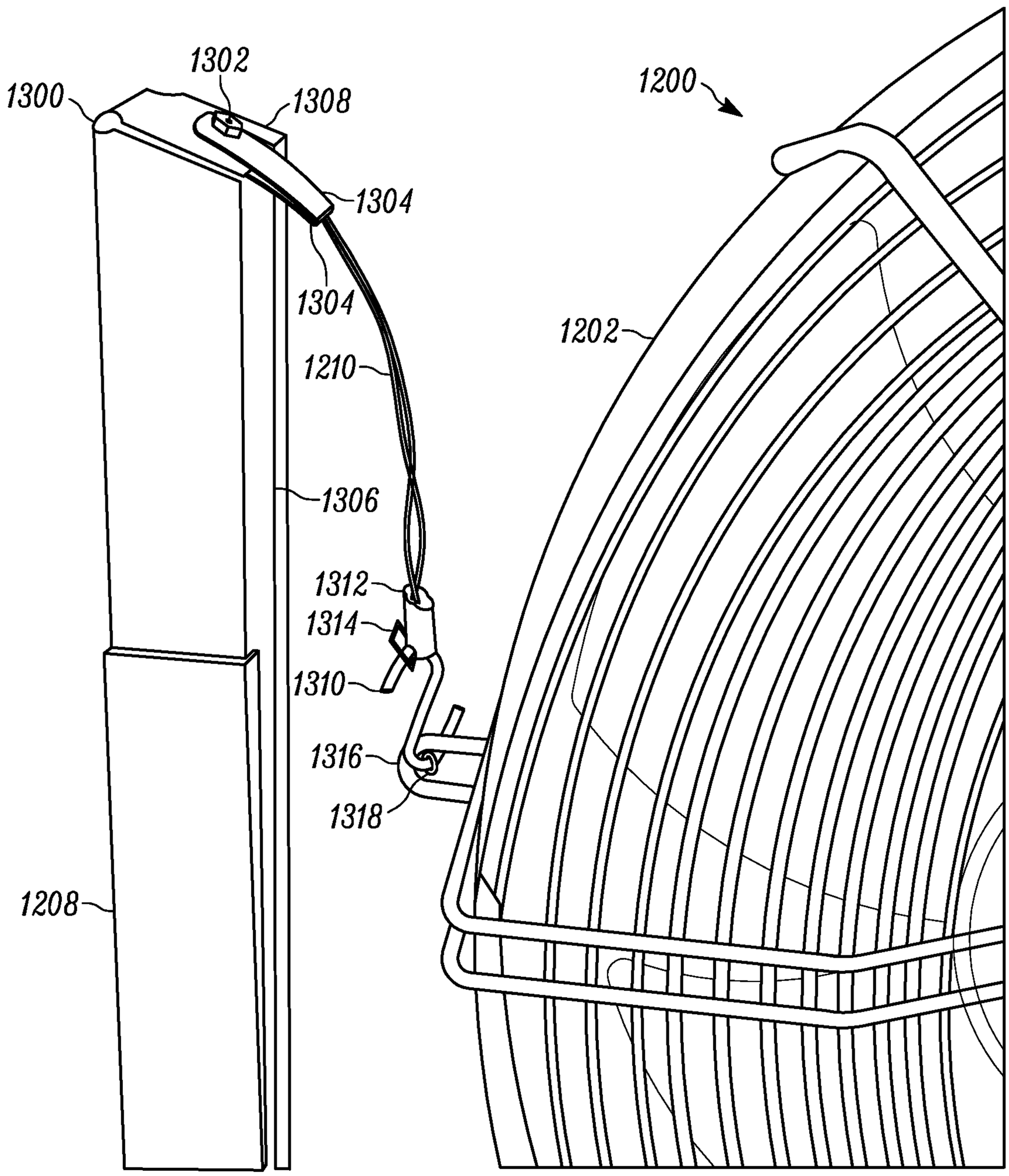
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FIG. 14

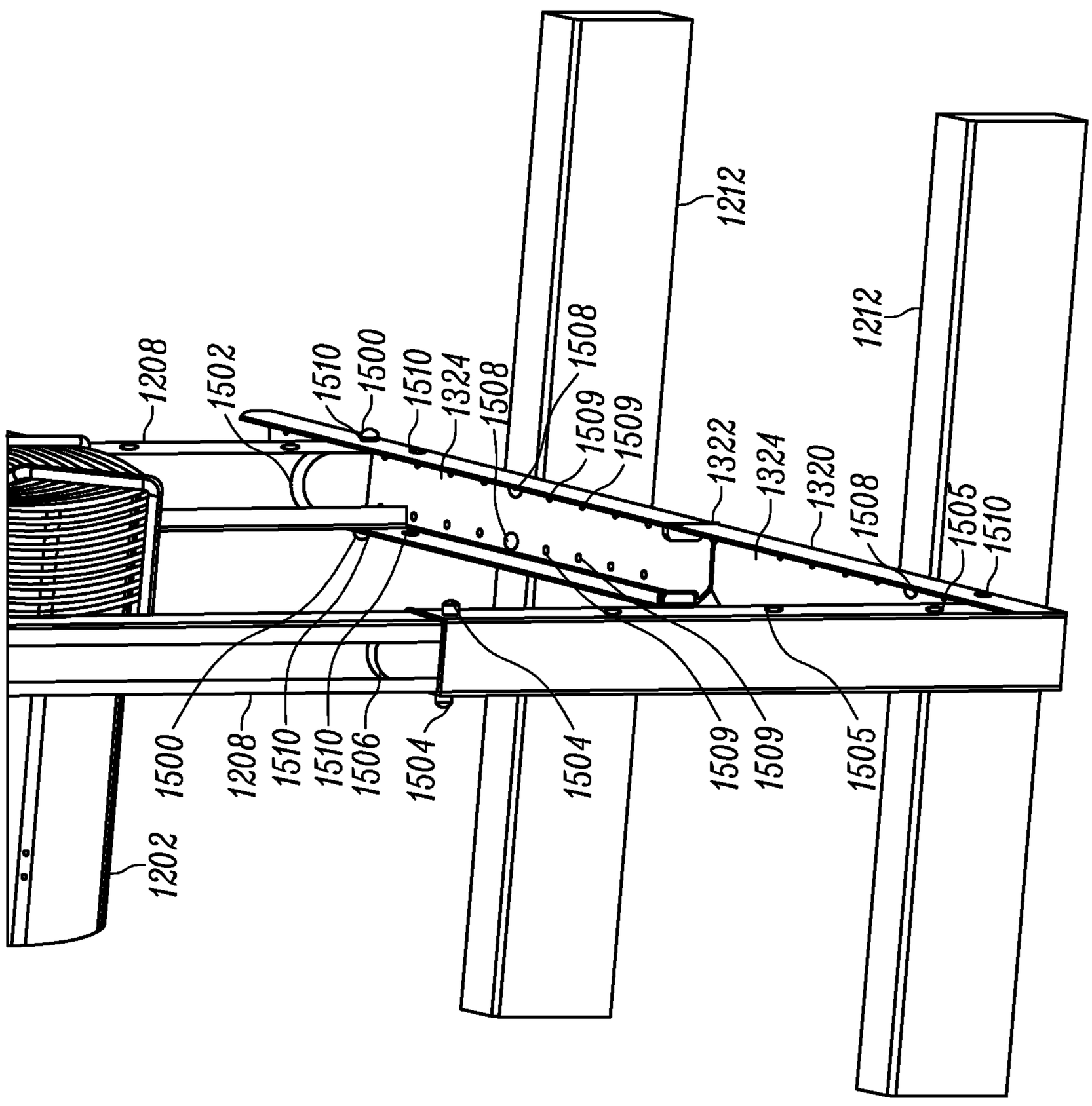
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FIG. 15

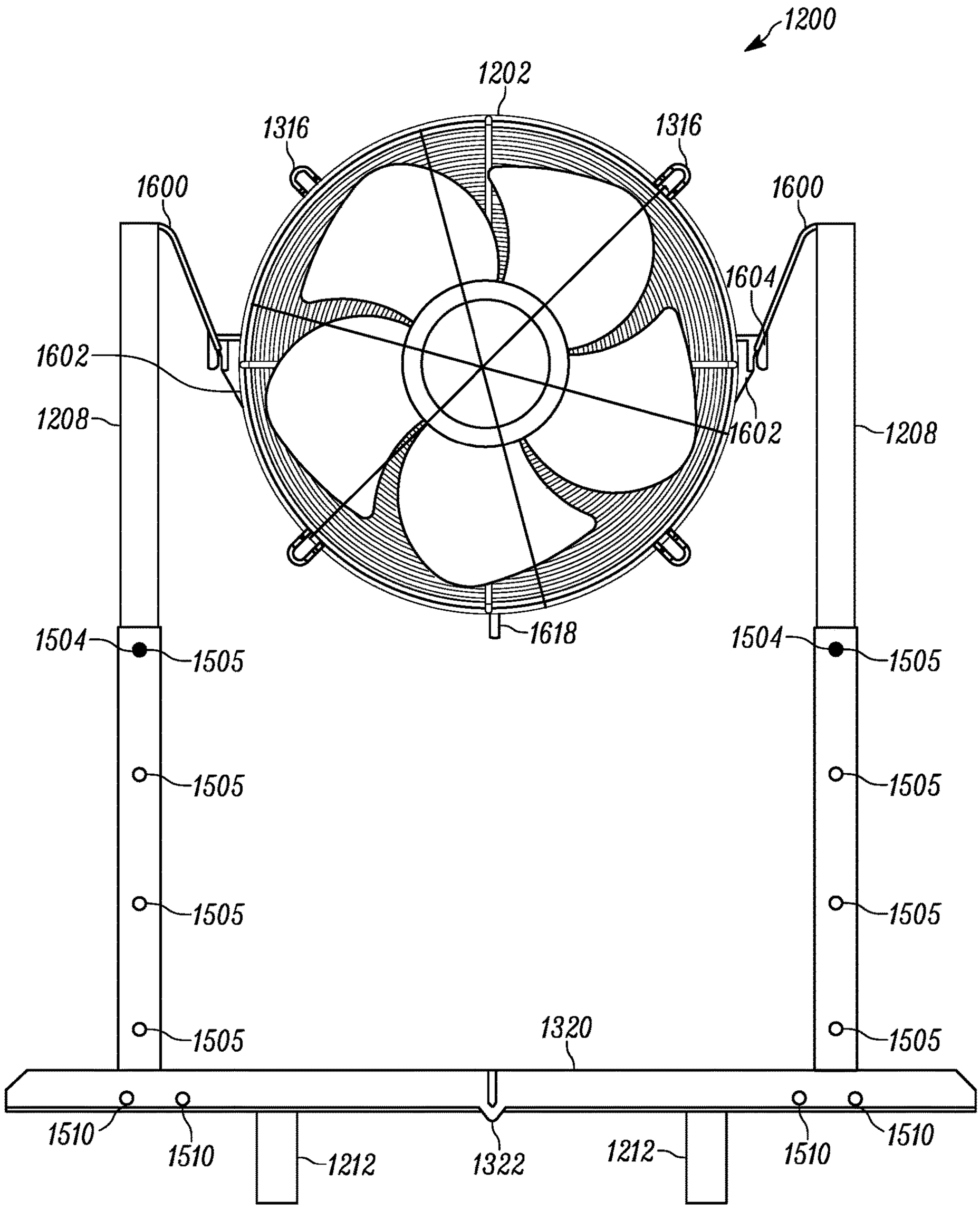
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FIG. 16

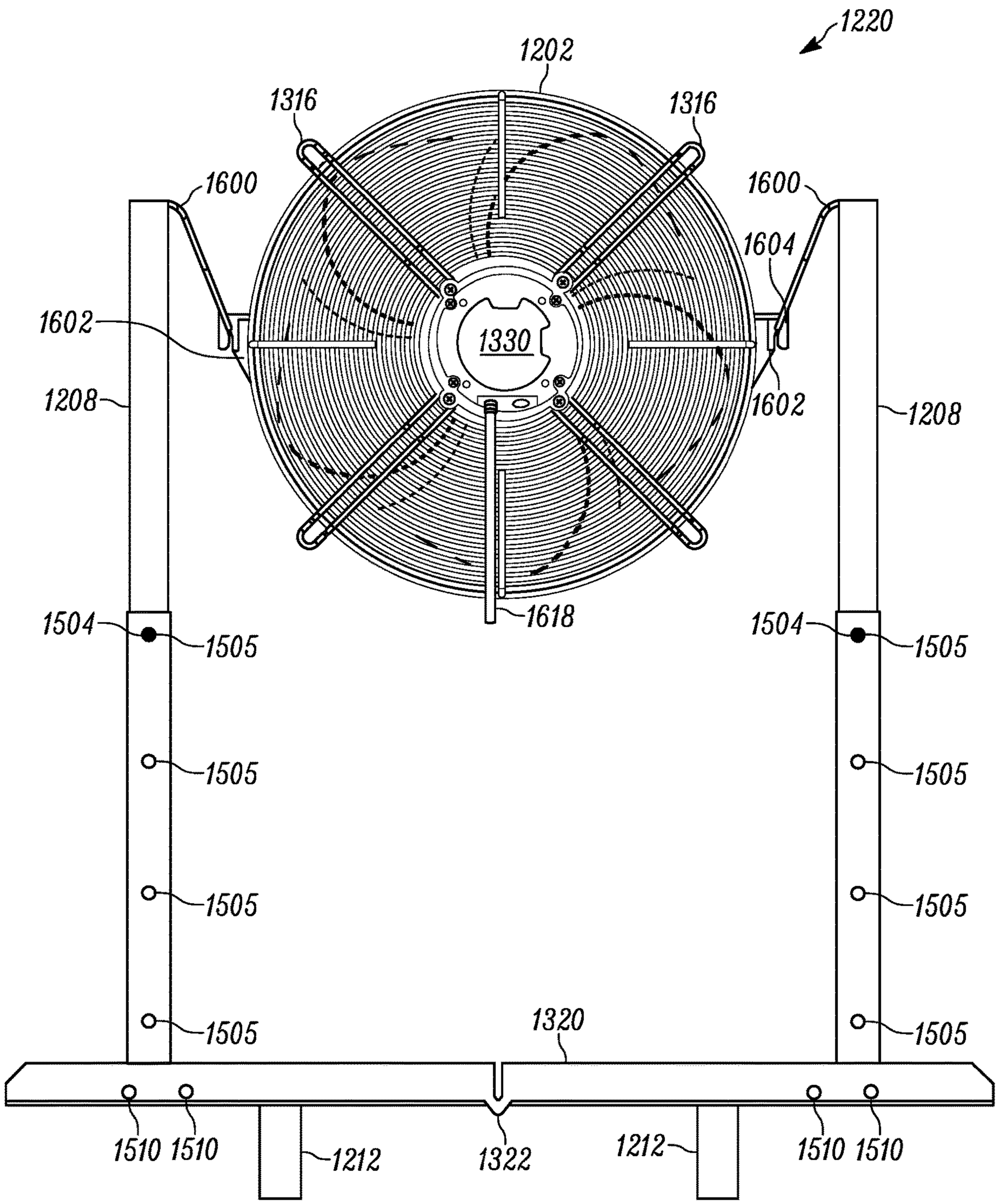
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FIG. 17

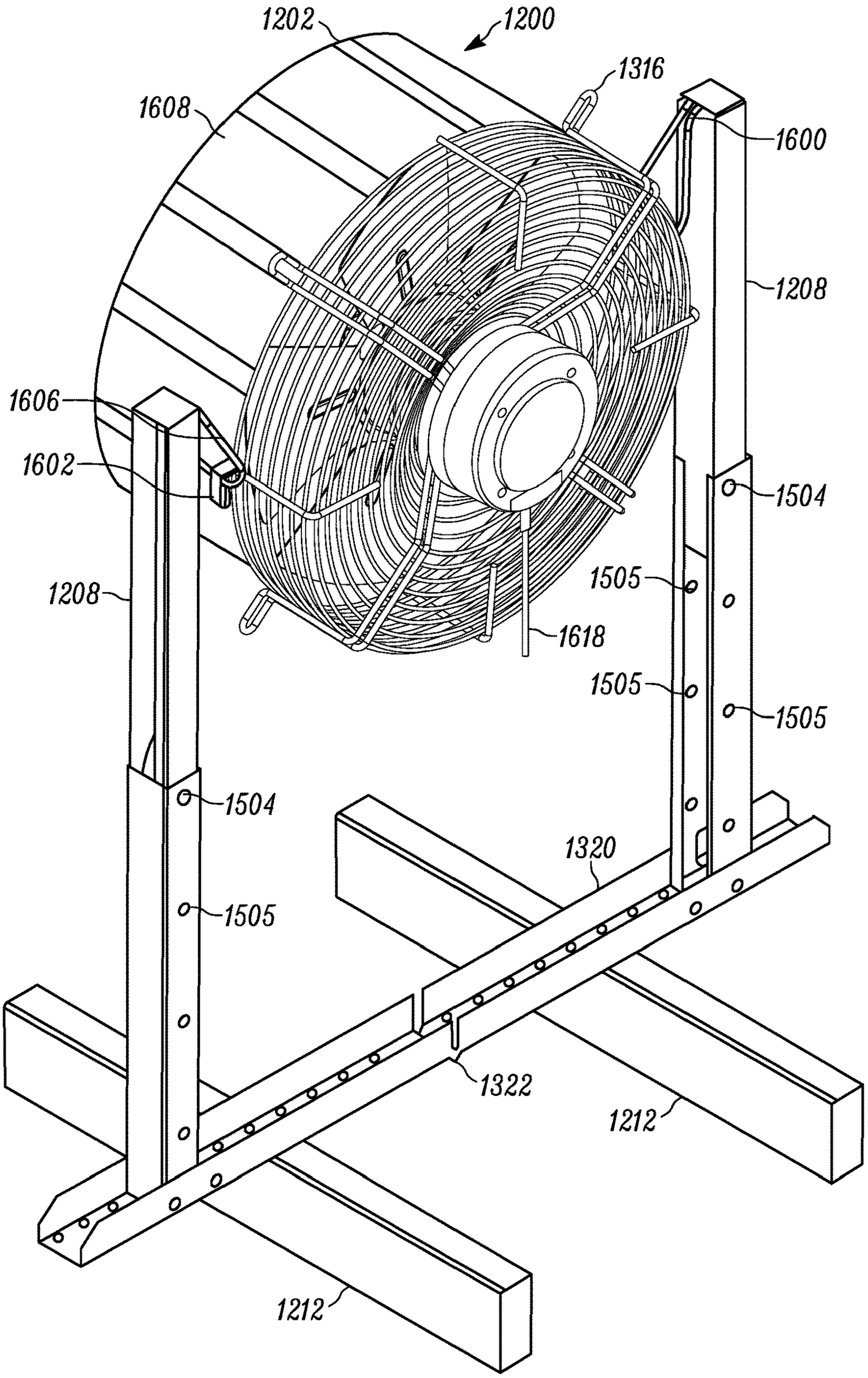
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FIG. 18

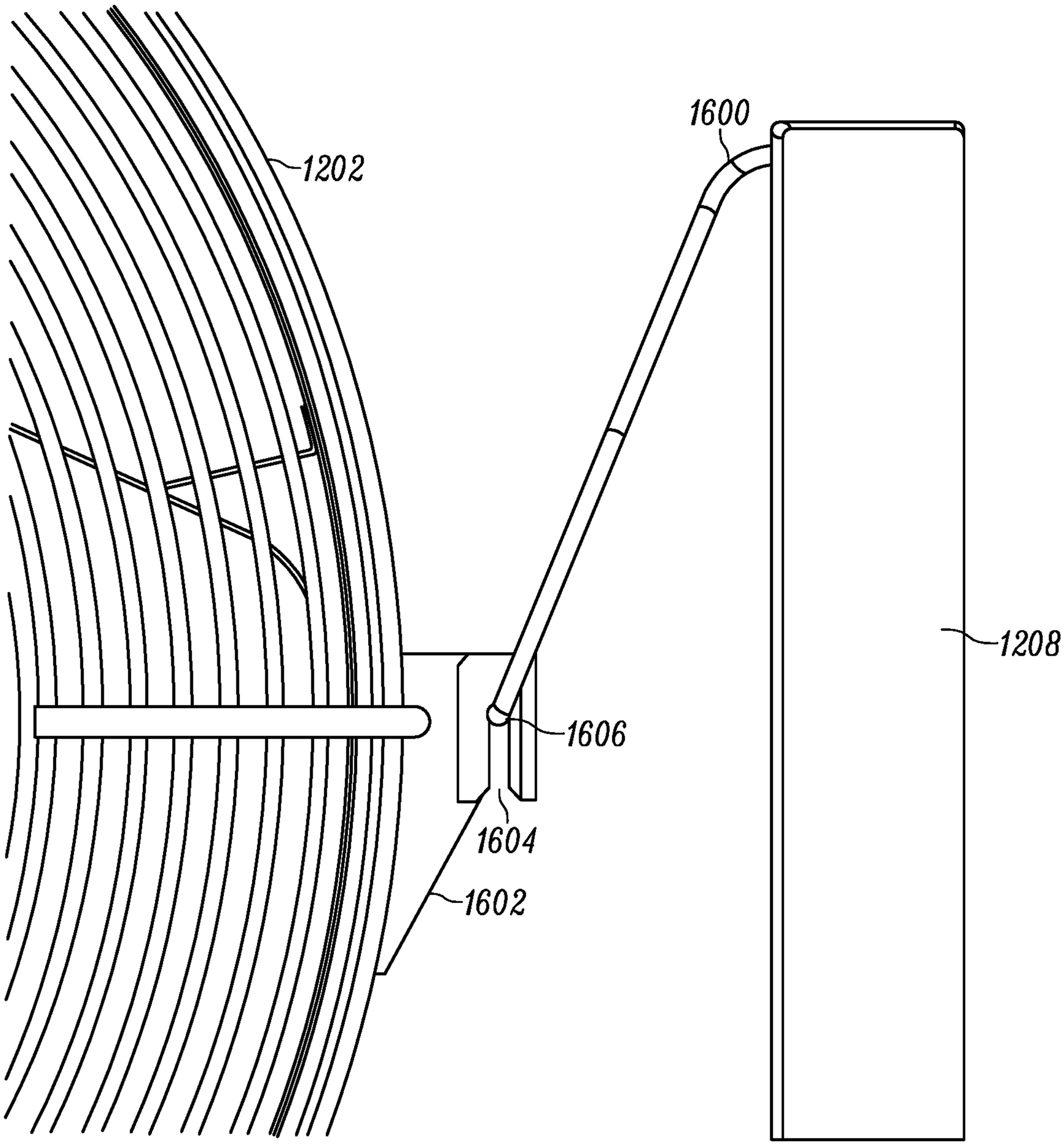

FIG. 19

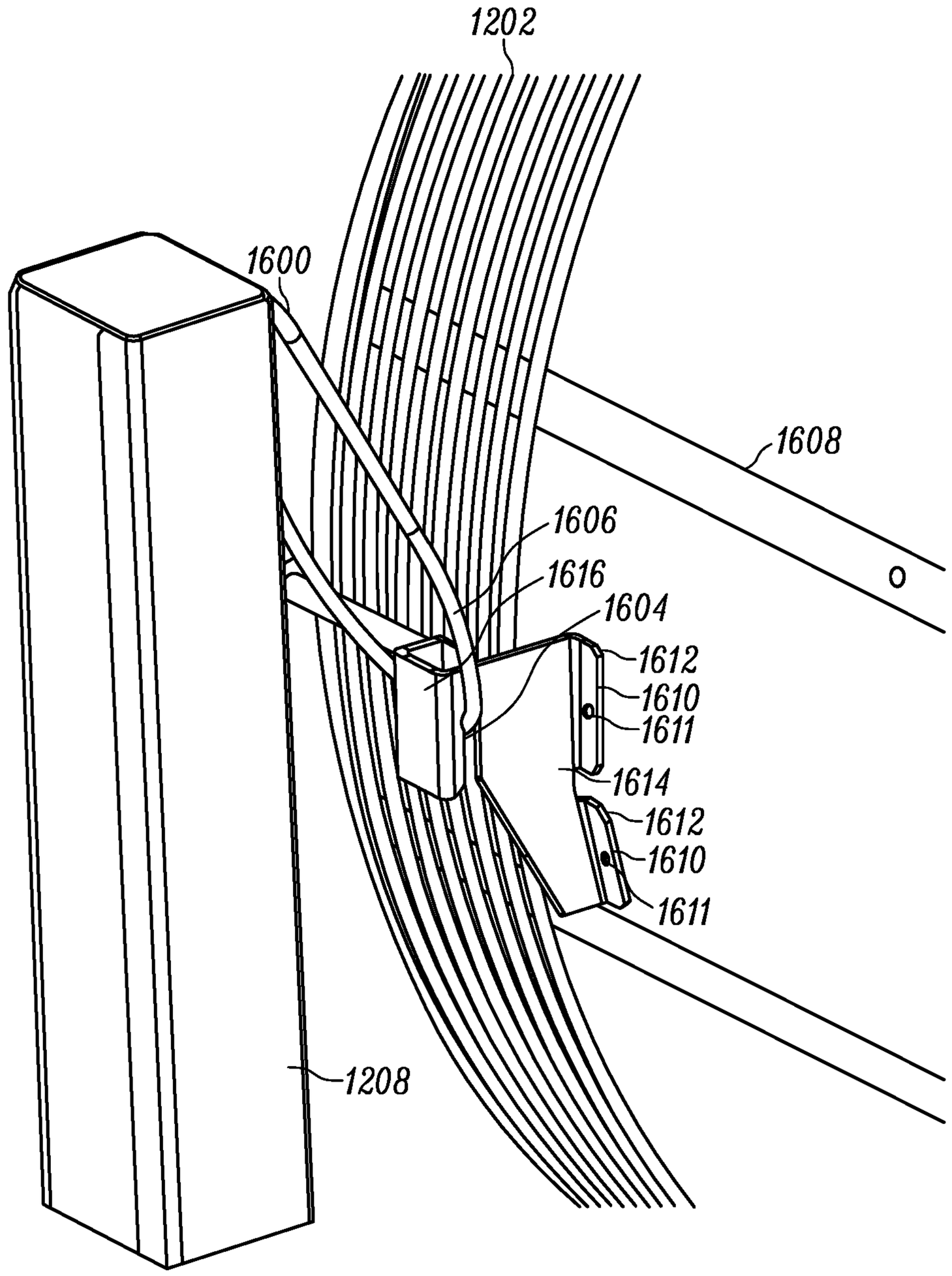
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FIG. 20

BOTTOM-MOUNTED WHOLE HOUSE FAN ASSEMBLY

FIELD

The application relates generally to whole house fan (WHF) assemblies, and more particularly to bottom mounted WHF assemblies.

BACKGROUND

Whole house fans (WHF) are used to draw hot air from a house into the attic by means of a fan, with the hot air being exhausted out of the attic grates. Cooler air from outside is drawn into the house through an open door or window to provide for natural ventilation without the expense of an air conditioning compressor.

WHFs have been provided that are suspended from roof rafters. As understood herein, this design, in attempt to dampen vibration from the fan for sound quieting, poses several technical problems and drawbacks.

SUMMARY

Accordingly, in one aspect an assembly includes at least one fan housing, at least one fan mounted in the fan housing, and at least one intake plenum configured to be mounted on at least one structure of a ceiling in a building above an opening of the ceiling. At least one air duct is configured for connecting the fan housing to the intake plenum such that the fan when energized can draw air in through the opening of the ceiling, the intake plenum, and the duct and exhaust air into an attic of the building. The assembly also includes at least one strut configured for vertical mounting on structure of the ceiling at a lower end of the at least one strut and to the fan housing at an upper end of the at least one strut.

In some implementations, the air duct may be flexible. The air duct may also have a first end connectable to the intake plenum and a second end connectable to the fan housing so that the fan when connected to the air duct may draw air in the building through the intake plenum and duct and exhaust the air in the attic. Also, in some implementations, the assembly may include a sound dampener interposed between the at least one strut and the fan housing, and/or interposed between the at least one strut and structure of the ceiling to which the at least one strut is mounted.

Furthermore, in some examples the assembly may include at least one arcuate collar that may be configured to be engaged with a top portion of the at least one strut. In these examples, the arcuate collar may be spaced from the fan housing along at least a segment of the collar and may be coupled to the fan housing by respective first and second couplings at opposed ends of the collar.

Also, in some examples, the assembly may include at least first and second struts, where each of the first and second struts may be configured for vertical mounting to structure of the ceiling. In these examples, the assembly may also include a first non-rigid connector configured for attachment to the first strut and to the fan housing to suspend the fan housing from the first strut, as well as a second non-rigid connector configured for attachment to the second strut and to the fan housing to suspend the fan housing from the second strut. Thus, if desired in these examples the assembly may further include a first ear hook configured for attachment to the fan housing and configured for connection to the first strut via the first non-rigid connector, as well as a second ear hook configured for attachment to the fan housing and configured for connection to the second strut via the second non-rigid connector. The first non-rigid connector may include a first strap, cable, and/or wire that is configured for attachment to an upper surface of the first strut, while the second non-rigid connector may include a second strap, cable, and/or wire that is configured for attachment to an upper surface of the second strut. Still further, if desired the assembly may include at least one crossbar configured for horizontal mounting on structure of the ceiling and configured to vertically mount the first and second struts on structure of the ceiling.

In another aspect, an assembly includes an intake plenum mountable over an opening in a ceiling of a building to be supported on one or more ceiling beams in an attic of the building. The assembly also includes a flexible duct having a first end connectable to the intake plenum and a second end connectable to housing of a fan so that the fan when connected to the duct draws air in the building through the intake plenum and duct and exhausts the air into the attic. The assembly further includes at least one strut configured for vertical connection to a ceiling beam or support surface at a lower end of the strut and to the housing of the fan at an upper end of the strut. The assembly also includes a sound dampener interposed between the strut and the fan housing, and/or between the strut and the ceiling beam or support surface to which the strut is attached.

If desired, in some examples the sound dampener may include at least one collar engageable with the upper end of the strut, with the collar being engageable with the housing at opposing ends of the collar and being spaced from the housing while engaged with the housing. Also, in some examples, the collar may include an inner band and an outer band generally parallel to the inner band and spaced from the inner band along at least a segment of the collar.

In some implementations, the sound dampener may include at least one resilient grommet. Also, in some implementations, the strut may include a first segment and a second segment slidably engaged with the first segment in a first configuration and not slidably engaged with the second segment in a second configuration. The second segment may include a U-shaped channel configured for receiving the first segment and may include plural bendable tabs on a bottom end of the second segment for flush engagement with the structure of the ceiling.

In still another aspect, an assembly includes at least one fan housing, at least one fan mounted in the fan housing, at least one intake plenum configured to be mounted on at least one structure of a ceiling in a building above an opening of the ceiling, and at least one air duct configured for connecting the fan housing to the intake plenum such that the fan when energized can draw air in through the opening of the ceiling, the intake plenum, and the duct and exhaust air into an attic of the building. The assembly also includes at least a first strut configured for vertical mounting on structure of the ceiling, at least a first non-rigid connector configured for attachment to the first strut and to the fan housing to suspend the fan housing from the first strut, at least a second strut configured for vertical mounting on structure of the ceiling, and at least a second non-rigid connector configured for attachment to the second strut and to the fan housing to suspend the fan housing from the second strut.

In some examples, the first and second non-rigid connectors may respectively include one or more straps, cables, and/or wires that may be configured for respective attachment to the first and second struts. The first and second non-rigid connectors may even be configured for attachment to the fan housing via respective ear hooks coupled to the fan

housing, and each of the first and second non-rigid connectors may be configured to establish a loop that engages a respective ear hook coupled to the fan housing.

Still further, in some implementations the assembly may include a crossbar. The crossbar may be configured for mounting on structure of the ceiling and configured to vertically mount the first and second struts on structure of the ceiling.

In still another aspect, a method includes vertically mounting at least one post on a ceiling structure in an attic, engaging the at least one post with a housing of a fan, and dampening at least some vibration from the fan from propagating to the post.

The details of the present application, both as to structure and operation, can best be understood in reference to the accompanying drawings, in which like reference numerals refer to like parts, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective of a whole house fan (WHF) assembly consistent with present principles, with the ceiling opening shown in phantom;

FIG. **2** is a perspective view of the fan housing shown in FIG. **1**;

FIG. **3** is a front elevational view of the fan housing shown in FIG. **1** mounted on the strut.

FIG. **4** is an exploded perspective detail view of the dampening coupling at the strut as indicated by the numeral "**4**" in FIG. **2**;

FIG. **5** is a cross-sectional view as taken along the line "**5**" in FIG. **3**;

FIG. **6** is a detail perspective view of one of the side couplings;

FIGS. **7-10** are perspective views of the strut showing example ways to mount the strut on ceiling structure in the attic;

FIG. **11** is a perspective view of the damper;

FIG. **12** is a diagram of an alternate embodiment;

FIG. **13** is a perspective view showing non-rigid connectors in accordance with the alternate embodiment;

FIG. **14** is a detail perspective view of one of the non-rigid connectors;

FIG. **15** shows a detailed perspective view of example struts and a crossbar that mounts the struts to structure of a ceiling;

FIG. **16** shows a front elevational view of struts suspending a fan assembly via ear hooks;

FIG. **17** shows a rear elevational view of struts suspending a fan assembly via ear hooks;

FIG. **18** shows a perspective view of struts suspending a fan assembly via ear hooks;

FIG. **19** shows a detailed rear elevational view of an example ear hook; and

FIG. **20** shows a detailed perspective view of an example ear hook.

DETAILED DESCRIPTION

FIG. **1** illustrates an assembly **10** that includes a fan housing **12** and a fan **14** mounted in the fan housing **12** for rotation of the fan blades therein. The assembly also includes an intake plenum **16** such as a damper that is mounted in an attic **18** on structure (such as a ceiling joist or support) of a ceiling **20** in a building above an opening **22** of the ceiling. In some embodiments the plenum **16** may rest on the top of the ceiling drywall or other portions of the attic floor between the beams and can be mechanically secured to at least one beam or other portion of the attic floor.

An air duct **24**, which may be flexible, which may be thermally insulated, and which may be acoustically insulated, connects the fan housing **12** to the intake plenum **16** such that the fan **14** when energized draws air in through the opening **22** of the ceiling, the intake plenum **16**, and the duct **24**, exhausting the air into the attic **18** from whence the air may be vented through roof vents to atmosphere.

The assembly **10** also includes at least one start **26** configured for vertical mounting on structure of the ceiling/attic floor. Consistent with present principles, at least one arcuate collar **28** is configured to be engaged with a top portion **30** of the strut **26**, with the arcuate collar **28** being spaced from the fan housing **12** as shown along at least a segment **32** of the collar and coupled to the fan housing **12** by respective dampening couplings **34** at opposed ends of the collar and by a third dampening coupling at the strut-housing interface, it being understood that the resilient members of the dampening couplings are substantially identical in configuration and operation.

Referring briefly to FIG. **3**, the collar **28** includes an arcuate inner band **36** and an arcuate outer band **38** that is generally parallel to the inner band **36** and that is spaced from the inner band **36** along the segment **32** of the collar. Essentially, the bands **36**, **38** are spaced from each other and are not coupled to each except at the side and bottom couplings **34** as more fully described below, to provide for additional vibration dampening.

Because the side couplings **34** are located slightly rearward (relative to the direction of fan exhaust) relative to the bottom coupling **34** on the fan housing **12**, the front of the fan housing **12** tilts slightly downward relative to the horizontal axis "H" at an angle α of, e.g., one to fifteen degrees, meaning the rear of the fan housing tilts slightly up. An oblique angle β is established with respect to the horizontal by the top surface of the damper **16** and the damper **16** oriented with its top surface tilted slightly toward the fan as shown. With the slight upward tilt of the rear of the fan housing that connects to the duct **24** and the described tilt of the top surface of the damper **16** which also connects to the duct **24**, bends of the duct **24** are lessened.

FIGS. **2-6** illustrate details on a dampening coupling consistent with present principles. In the example shown, the strut through the collar **28**, is coupled to the fan housing **12** using three dampening couplings **34**, two at the opposed ends of the generally semi-circular collar **28** and one at the strut **26**. The dampening couplings **34** include respective resilient members and are configured such that no metal-to-metal contact exists between the collar **28** and the fan housing **12**.

As shown in FIG. **2**, the example fan housing **12** includes an annular continuous shroud **200** in which the fan (not shown in FIG. **2**) is disposed. The shroud **200** may include a cylindrical exhaust segment **202** at the end of the housing **12** through which the fan exhausts air, and a frustum-shaped segment **204** tapering radially inward from the cylindrical exhaust segment **202** to merge with a cylindrical intake segment **206** which is coupled to the duct **24** shown in FIG. **1**.

The fan housing **12** may also include a grill **208** that covers the exhaust end defined by the cylindrical exhaust segment **202**. As shown in FIG. **3**, the grill **208** includes a grid **210** of concentric circular bars supported by four straight radial bar pairs **212**, with each radial bar pair **212** terminating in a respective hollow ear **214** that extends

radially beyond the grid **210**, with the left, right, and bottom ears establishing a portion of the respective three collar-to-fan housing couplings **34**.

Each coupling **34** includes a resilient member made of one or more pieces of deformable, resilient rubber or plastic. In the example shown and now referring to FIGS. **4** and **5**, each coupling **34** includes a rubber grommet **216** that is received within the respective ear **214** of the grill **208**. The example grommet **216** is configured with a relatively smaller narrow middle portion as shown and larger end disks that are larger than the ear **214**, so that one of the end disks can be deformed by pushing the end disk through the opening of the ear **214** until it clears the opening and returns to its materially biased larger disk-like shape, with the narrow middle portion disposed in the ear **214** and the opposed larger end disks of the grommet disposed on either side of the ear **214**.

In addition to the grommet **216**, inboard and outboard resilient, preferably rubber cushioning washers **218**, **220** straddle the end disks of the grommet **216**. One or both washers **218**, **220** may have a respective metal support washer or clip **222** on the side of the washer that is opposed to the grommet **216**, so that a fastener such as a screw can pass through the support clips **222**, washers **218**, **220**, and grommet **216** and engage, e.g., a nut **226** (FIG. **5**). If desired, the grommet **216** and rubber washers **218**, **220** may be made of a single piece of unitary molded material.

Note that the outer clip **222** as best shown in FIG. **4** is L-shaped with the bight formed by the "L" facing the washer **220**. This L-shaped clip **222** serves to interlock with the coupling structure on the grill to prevent slippage at the lower coupling owing to the weight of the fan above the coupling.

FIGS. **4** and **5** show the bottom coupling **34** while FIG. **6**, discussed further below, shows an example side coupling. As perhaps best shown in FIG. **4**, at the bottom coupling **34**, the inner band **36** includes a rear tab **228** that is bent approximately ninety degrees from the plane defined by the inner band at that point. The outer band **38** similarly comprises a rear tab **230** that is bent approximately ninety degrees from the plane defined by the outer band at that point, with the rear tabs **228**, **230** being flush together and held between the inboard washer **218** and nut **226** (FIG. **5**), clamping the collar **28** to the grill **208** at the lower coupling **34**.

At least the outer band **38** may also include a front tab **232** parallel to the rear tab **230**, and if desired the inner band **36** likewise may include a front tab parallel to its rear tab and flush against the front tab **232** of the outer band **38**. As best shown in FIG. **5**, a set screw **234** may extend through the front tabs into a lateral channel **238** of a post **236** of the strut **26**. The post **236** extends through lower and upper openings **240**, **242** of the respective outer and inner bands **38**, **36** and is held in place by the set screw **234** to couple the strut **26** to the collar **28** with the end of the post **236** being slightly spaced from the grill **208** and thus not touching structure on the fan housing. Alternatively, the post **236** may extend through at least one opening being formed in a connector band that is itself coupled to the inner and outer bands **36**, **38**, where the connector band may be coupled to the fan housing **12**.

The shroud **200**, grill **208**, strut **26**, and collar **28** typically are made of metal, although other materials such as hard plastic or composite materials may be used.

FIG. **6** illustrates a coupling **34** at the side of the fan assembly (one coupling **34** at each side as shown in **3**). A grommet (not shown in FIG. **6**) is received in an ear **214** of the grill **208** and is straddled by resilient washers that in turn may be supported by metal washers through which a bolt **600** extends to engage a nut **302**, with tabs **304** of the inner and outer band **36**, **38** being flush with other, sandwiched between the nut **302** and lower washer. The grommet and washers in FIG. **6** are substantially identical in configuration and operation to those shown and described above in FIGS. **2-5**.

Now referring to FIGS. **7** and **8**, in some implementations the strut may include an outer segment **700** that may be U-shaped in transverse cross-section and an inner segment **702** slidably engaged with the outer segment in a first configuration (FIG. **7**) slidably engaged with the outer segment in a second configuration (FIG. **8**). A set pin **704** may extend through holes in the segment **700**, **702** that register with each other to hold the strut **26** in the extended configuration shown in FIG. **8**.

In examples, plural bendable tabs **706** may be provided on a bottom end of the outer segment **700** for flush engagement with the structure of the ceiling/attic floor, in the example shown, with a ceiling joist **708**. Each tab **706** may be formed with two screw holes **710**, with the proximal screw hole being engaged with a screw to fasten the strut to the joist **708** in FIGS. **7** and **8** and with the distal screw hole being used for other mount types. For example, referring briefly to FIG. **9**, the strut **26** may be mounted on an edge **900** with two tabs **706** bent to rest on a horizontal surface **902** and one tab **706** left unbent to be flush a vertical side **904** of the mount, with the distal screw holes being used for fasteners that engage the horizontal surface **902**. In FIG. **10**, all three tabs **706** are bent to be flush with a horizontal mount **1000**.

In some examples and referring back to FIG. **7**, the inner segment **702** of the strut can include a lower cross-sectional size and an upper cross-sectional size established by the post **236**, with the upper cross-sectional size being smaller than the lower cross-sectional size. If desired, the post **236** and top portion of the inner segment **702** may be established by a plastic plug, with plastic plates (not shown) being engaged with the portion of the collar **26** that receives the post, to further provide for vibration dampening.

FIG. **11** shows the damper **16** with top surface **1100** that is angled obliquely as described above with respect to the horizontal. The damper **16** is hollow except for the oblique top surface is generally parallelepiped-shaped. Preferably the damper **16** is oriented toward the fan housing such that the top surface **1100** is tilted toward the fan housing for reasons described previously. An opening **1102** bordered by a cylindrical curb **1104** may be centrally formed in the top surface with the curb **1104** extending above to the surface **1100** to join the duct **24**.

FIG. **12** shows a bottom-mounted attic whale house fan assembly **1200** with a fan and housing **1202** that are substantially identical in configuration and operation to those described above drawing air in through a damper **1204** and ducting **1206**, also substantially identical in configuration and operation to those described above. However, in the embodiment shown in FIG. **12** left and right struts **1208** support opposed sides of the fan housing at respective left and right upper couplings **1210** (only one upper coupling shown in the perspective of FIG. **12**). The couplings **1210** may be substantially identical in configuration and operation to those described above or may be configured according to the description of FIGS. **13** and **14** below.

Also, FIG. **12** shows that if desired, the struts **1208** may be supported on structure **1212** of the ceiling/attic floor by respective lower couplings **1214** which may be resilient or otherwise vibration-dampening. For example, the lower couplings **1214** may be rubber bushings with cavities that

receive the respective struts **1208** therein with the bottom of each cavity being interposed between the bottom of the strut and the structure **1212** on which the strut is supported.

Now in cross-reference to FIGS. **13** and **14**, they show additional details according to the example embodiment described above in reference to FIG. **12**, but with the damper **1204** and ducting **1206** being omitted for simplicity. As shown in FIGS. **13** and **14**, in some examples the couplings **1210** may be established at least in part by non-rigid, vibration dampening connectors. The connectors may themselves be established at least in part by cylindrical cables or dual generally parallel cables, cylindrical wires or dual generally parallel wires, or straps or dual generally parallel straps that are each flat on opposing sides. Regardless, the couplings **1210** may be composed in whole or in part of metal, plastic, composite, etc., may have a powder coating, and may be used to suspend the fan housing **1202** to each strut **1208**.

In the example shown in FIGS. **13** and **14**, the couplings **1210** may be configured for attachment to respective top surfaces **1300** of the of the struts **1208**, although the couplings may also be configured to attach to other surfaces of the struts **1208** such as upper side surfaces or upper inner surfaces. In any case, it may be appreciated from FIGS. **13** and **14** that the respective top surfaces **1300** of the struts **1208** may he oriented oblique with respect to the vertical when the struts **1208** are vertically mounted in accordance with present principles. Also, the top surfaces **1300** may include one or more bolts or other engagement members **1302** that may engage end portions of the cable, wire, or strap connectors **1210** (referred to as "straps" below for simplicity).

As may be appreciated from FIG. **14**, the respective end portions of the straps **1210** that connect to the struts **1208** may each include two tabs **1304** generally converging into a "U"-shaped apex at proximal ends and generally extending distally along the longitudinal dimension of the straps **1210** in parallel to lay flush with opposing sides of the top surface **1304**, e.g., a top side and a bottom side of the top surface **1304**. The bottom side of the top surface **1300** may be accessible through a hollow opening **1306** in the strut **1208**. The bolt **1302** and a nut (not shown) may then be used to engage the tabs **1304** with the top surface **1300** by pinching opposing outer sides of the tabs **1304** together with the bolt head and nut at the opposing sides of the top surface **1300**

Furthermore, if desired resilient members such as rubber washers **1308** may be disposed on each flat side of each tab **1304** to avoid direct contact between the tabs **1304** and the top surface **1300** (on inner sides of the tabs) and between the tabs **1304** and either of the bolt head or nut (on outer sides of the tabs). Additionally, or alternatively, rubber grommets may be used where the hole in each tab **1304** may wrap around the outside of the relatively smaller narrow middle portion of the grommet and the bolt may extend through the center of the grommet itself to engage the tab **1304** with the strut **1208**. In either case, in embodiments where the tabs **1304** are composed of metal for example, direct metal-to-metal contact between the tabs **1304** and top surface **1300** may be avoided, as well as direct metal-to-metal contact between the tabs **1304** and either the bolt head or nut.

However, note that in other embodiments, only a single tab may be used rather than tabs extending distally in parallel. The single tab may attach to either of the top side or bottom side of the top surface **1300** or to another upper portion of the strut, with a resilient member **1308** such as a rubber washer or grommet interposed therebetween similar to as described above.

Still in reference to FIGS. **13** and **14**, respective opposite ends of the straps **1210** than the ends connecting to the struts **1208** may engage the fan housing **1202** via respective metallic S-clips **1310** to suspend the fan housing **1202** from the struts **1208** (with the fan housing **1202** also supporting the motor **1330** of the fan as also shown in FIG. **13**). Thus, each of these opposite ends of the straps **1210** may include an attachment member **1312** best shown in FIG. **14**. The attachment member **1312** may have a hole in it through which one end of the S-clip **1310** may be fed until a bend in the S-clip **1310** is located in the hole. The other end of the S-clip **1310** may be fed through a respective side ear **1316** on the housing **1202** that may be substantially identical in configuration and operation to the ears **214** described above.

Furthermore, in some examples a resilient member **1314** such as a rubber grommet may be used as a contact buffer between a respective S-clip **1310** and respective strap **1210**. Thus, the resilient member **1314** may be incorporated into or positionable into the hole of the respective attachment member **1312** as a grommet or other vibration-dampening structure (e.g., rubber ring) so that the respective S-clip **1310** is fed through the grommet or other resilient structure **1314** to thus engage the S-clip **1310** with the strap **1210**.

As indicated above, the other bend or hook of the S-clip **1310** may be positioned to engage the ear **1316** and, in so doing, an additional resilient member **1318** may be positioned between the contact point for the bend or hook of the respective S-clip and the reciprocal contact point for the respective ear **1316** itself. For example, a rubber grommet may be placed in the ear **1316** similar to the rubber grommet **216** being received within the respective ear **214** as described above, and/or the ear **1316** may be lined or coated with rubber to establish the resilient member **1318**. Additionally, or alternatively, a rubber ring or liner to establish one of the resilient members **1318** may be positioned on the S-clip itself and circumscribe a segment of the S-clip **1310** establishing its contact point with the ear **1316**.

Now specifically in reference to FIG. **13**, in some examples the struts **1208** may be vertically mounted to a crossbar **1320** as shown. The crossbar **1320** may then be supported on structure **1212** of the ceiling/attic floor, e.g., with screws and with a flat rubber sheet or other sound-dampening structure interposed between the bottom of the crossbar **1320** that would otherwise contact portions of the ceiling/attic floor and the ceiling/attic floor itself. The struts **1208** may thus be vertically mounted to the ceiling/attic floor via the crossbar **1320** in some examples, rather than via the lower couplings **1214** as described above.

In some examples, the crossbar **1320** may even include a centrally located joint **1322** at which opposing portions of the crossbar **1320** may be folded, e.g., for packaging and transportation. The joint **1322** may be a male/female mechanical hinge with reciprocal components on each side of the joint **1322**. The joint also be established by a revolute or pin joint or another type of joint such as a living hinge. In any case, in extended form as shown when mounted to a ceiling or attic floor, the crossbar **1320** may span, e.g., sixteen or twenty-four inches on center beams of the ceiling/attic floor perpendicular to the beams, or at another angle to achieve desired fan direction.

If desired, the crossbar **1320** may even include one or more openings **1324** into which the struts **1208** may be folded from respective pivot points. As best shown in FIG. **13**, each pivot point may be established by a screw **1328** that extends through screw holes **1326** on each side wall of the crossbar **1320** and that extends through respective holes on each side wall of an end portion of the strut **1208** (not shown

in the perspective of FIG. **13**) when aligned with the holes **1326** inside the opening **1324** of the crossbar **1320**.

Additionally, or alternatively, opposing spring-biased push buttons **1500** may be used instead of the screws **1328**, as shown in the alternate example of FIG. **15**. As also shown in FIG. **15**, each push button **1500** may be mounted on a respective strut **1208** and may be pushed outward from inside the opening **1324** under bias of a respective arc spring **1502** (or other type of spring) and out of a respective hole **1510** in a side wall of the crossbar **1320** to engage the strut **1208** with the crossbar **1320**. Thus, in this example a person may push each button **1500** inward against spring bias and through a side wall hole **1510** of the crossbar **1320** to move each strut **1208** to a different crossbar location also with holes **1510**, as will be described further below.

In any case, note in terms of the example shown in FIGS. **13** and **14** that the struts **1208** may be adjusted to appropriate length to be folded into the opening **1324**. The length of the struts **1208** may be adjusted similar to as set forth above with respect to the first and second configurations and set pin of FIGS. **7** and **8**.

However, also note that opposing spring-biased push buttons **1504** as shown in FIG. **15** may also be used to adjust the length of each strut **1208**, e.g., to appropriate length for folding into the opening **1324**. In such examples, the length may be adjusted by pushing each button **1504** as mounted on an inner segment of the strut **1208** against bias of an arc spring **1506** (or other type of spring) toward the inner segment of the strut **1208** and through a respective hole **1505** of an outer segment of the strut **1208** from which the button **1504** might already protrude. The length of the strut **1208** may then be adjusted and the spring bias of each button **1504** may be allowed to push each button **1504** back out through another hole **1505** formed in the strut's outer segment to hold the strut at a desired length.

In either case, once folded into the openings **1324** shown in both of FIGS. **13** and **15**, the struts **1208** may lay flush with the profile of the crossbar **1320**.

Now further describing FIG. **15** in particular and for completeness, as shown the crossbar **1320** may be mounted to the structure **1212** of the ceiling via screws **1508** extending through one or more holes **1509** of a bottom surface of the crossbar **1320**.

Also note that multiple sets of holes **1510** may be disposed on side walls of the crossbar **1320** at various transverse sections of the crossbar **1320**. Each set of holes **1510** may be used to adjust where the struts **1208** engage the crossbar **1320** for mounting to the structure **1212**. Thus, different sets of the holes **1510** that are located along same transverse segments of the crossbar **1320** at a same height but on opposing side walls may be used for mounting the struts **1208** via the buttons **1500** to the crossbar **1320**, depending on the particular width or diameter of the fan housing **1202**. This may facilitate use of a single crossbar **1320** for use with fans and housings of different sizes so that the struts **1208** may remain mounted vertical or at least substantially vertical when the housing is suspended, rather than at an oblique angle with respect to vertical.

Now in cross-reference to FIGS. **16-20**, they show an alternate way in which non-rigid connectors (connectors **1600** in these figures) may be attached to the vertically mounted struts **1208** to suspend the whole house fan assembly **1200** from the struts **1208**. In this example, suspension is done in part through use of one or more ear hooks **1602** on the housing **1202**. FIG. **16** shows a front elevational view of this example implementation, while FIG. **17** shows a rear elevational view and FIG. **18** shows a perspective view. FIG. **19** then shows a detailed rear elevational view of one of the ear hooks **1602**, and FIG. **20** shows a detailed perspective view of one of the ear hooks **1602**. Most if not all of the components of the whole house fan assembly **1200** and related structure as shown in these figures may be the same as described above save for differences noted in this paragraph and below.

As may be appreciated from FIGS. **16-20**, each ear hook **1602** may be distinct from the ears **1316** located elsewhere on the housing **1202**. Each ear hook **1602** may also have an opening **1604** facing or opening downward toward the crossbar **1320** so that a loop **1606** of a respective non-rigid connector **1600** may engage the ear hook **1602** via the opening **1604** to dampen sound from the fan. Gravity may hold the loop **1606** engaged with the ear hook **1602** owing to the weight of the assembly **1200** and shape of the hook **1602**.

Each non-rigid connector **1600** may be established by one or more wires, cables, and/or straps made in whole or in part of metal (e.g., steel), plastic, composite, etc. Each connector **1600** may also have a powder coating and may be used to suspend the fan housing **1202** to a respective strut **1208**. Moreover, as shown best in FIGS. **18** and **20**, each ear hook **1602** may be disposed on a fan shroud **1608** that establishes part of the fan housing **1202** and that may be substantially similar in function and configuration to the shroud **200** described above.

As best shown in FIG. **20**, each ear hook **1602** may be secured to the shroud **1608** via one or more screws **1610** that extend through holes **1611** on respective tabs **1612** of each ear hook **1602** and also that extend into screw holes in the shroud **1608** itself. The tabs **1612** may lie flush or substantially flush with the exterior surface of the shroud **1608**. As also shown best in FIG. **20**, each ear hook **1602** may have a segment **1614** extending perpendicularly away from the tabs **1612** and/or shroud **1608** to form part of the opening **1604** along with a distal knob **1616** that may be box-shaped (save for, e.g., a side opening facing the shroud **1608** and/or top and bottom openings) and that may also form part of the opening **1604**. The distal knob **1616** may thus help establish multiple contact points of the hook **1602** at which a respective connector **1600** may engage the hook **1602**.

Furthermore, as shown best in FIGS. **18** and **20**, in some examples each connector **1600** may form a respective loop **1606** as one end, which may be engaged with the hook **1602**, and then each connector **1600** may form another loop at its other end which may be used connect the connector **1600** to a respective strut **1208** via one or more of the ways described above (e.g., via a screw, via wrap around a grommet which itself is engaged with a screw, etc.).Alternatively, the connector **1600** may split into separate generally parallel segments as it extends from the loop **1606** to form separate terminating ends which may each engage one or more upper surfaces of the respective strut **1208** via a screw, clamp, coupling, etc. in accordance with present principles.

For completeness, also note that a portion of a power cord **1618** that connects to an electrical outlet at one end to provide power the motor **1330** at its other end is shown in FIGS. **16-18**. Also, for completeness, note that in some embodiments as resilient member which may be made of rubber may be disposed between the loop **1606** and contact points of the ear hook **1604**, if desired. For example, a rubber sleeve may circumscribe the loop **1606** at its contact points, and/or rubber may be molded to the ear hook **1604** itself at points that contact the loop **1606**. Further still, resilient members may also be used for where the connectors **1600**

engage the struts **1208** similar to as set forth in other examples above (e.g., using a rubber grommet).

Present principles discussed above allow for isolation or dampening of vibration while improving ease of installation, solving installation problems in high attics. Furthermore, present principles facilitate creating a pitch angle on the fan to improve air flow through the duct that cannot be created with a hanging fan, while achieving the same or lower quietness as a hanging fan.

While the particular device is herein shown and described in detail, it is to be understood that the subject matter which is encompassed by the present invention is limited only by the claims.

Components included in one embodiment can be used in other embodiments in any appropriate combination. For example, any of the various components described herein and/or depicted in the Figures may be combined, interchanged or excluded from other embodiments.

"A system having at least one of A, B, and C" (likewise "a system having at least one of A, B, or C" and "a system having at least one of A, B, C") includes systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.

What is claimed is:

1. An assembly, comprising:

at least one fan housing;

at least one fan mounted in the fan housing;

at least one intake plenum configured to be mounted on at least one structure of a ceiling in a building above an opening of the ceiling;

at least one air duct configured for connecting the fan housing to the intake plenum such that the fan when energized can draw air in through the opening of the ceiling, the intake plenum, and the duct and exhaust air into an attic of the building; and

at least one strut configured for vertical mounting on structure of the ceiling at a lower end of the strut and to the fan housing at an upper end of the strut such that the fan housing is not suspended from a rafter and is mounted, when installed in a building, to the ceiling by the at least one strut.

2. The assembly of claim **1**, wherein the air duct is flexible, and wherein the air duct has a first end connectable to the intake plenum and a second end connectable to the fan housing so that the fan when connected to the air duct draws air in the building through the intake plenum and duct and exhausts the air in the attic.

3. The assembly of claim **1**, comprising:

a sound dampener interposed between the at least one strut and the fan housing, and/or interposed between the at least one strut and structure of the ceiling to which the at least one strut is mounted.

4. The assembly of claim **1**, comprising:

at least first and second struts, each of the first and second struts being configured for vertical mounting to structure of the ceiling

at least a first non-rigid connector configured for attachment to the first strut and to the fan housing to suspend the fan housing from the first strut; and

at least a second non-rigid connector configured for attachment to the second strut and to the fan housing to suspend the fan housing from the second strut.

5. The assembly of claim **4**, comprising:

a first ear hook configured for attachment to the fan housing and configured for connection, via the first non-rigid connector, to the first strut; and

a second ear hook configured for attachment to the fan housing and configured for connection, via the second non-rigid connector, to the second strut.

6. The assembly of claim **4**, comprising:

at least one crossbar configured for horizontal mounting on structure of the ceiling and configured to vertically mount the first and second struts on structure of the ceiling.

7. An assembly comprising:

an intake plenum mountable over an opening in a ceiling of a building to be supported on one or more ceiling beams in an attic of the building;

a flexible duct having a first end connectable to the intake plenum and a second end connectable to a housing of a fan, so that the fan when connected to the duct draws air in the building through the intake plenum and duct and exhausts the air into the attic;

at least one strut configured for vertical connection to a ceiling beam or support surface at a lower end of the strut and to the housing of the fan at an upper end of the strut; and

a sound dampener interposed between the strut and the fan housing, and/or between the strut and the ceiling beam or support surface to which the strut is attached.

8. The assembly of claim **7**, wherein the strut comprises a first segment and a second segment slidably engaged with the first segment in a first configuration and not slidably engaged with the second segment in a second configuration.

9. The assembly of claim **8**, wherein the second segment comprises a U-shaped channel configured for receiving the first segment.

10. An assembly, comprising:

at least one fan coupled to a fan housing;

at least one intake plenum configured to be mounted on at least one structure of a ceiling in a building above an opening of the ceiling;

at least one air duct configured for connecting the fan housing to the intake plenum such that the fan when energized can draw air in through the opening of the ceiling, the intake plenum, and the duct and exhaust air into an attic of the building;

at least a first strut configured for vertical mounting on structure of the ceiling;

at least a first non-rigid connector configured for attachment to the first strut and to the fan housing to suspend the fan housing from the first strut;

at least a second strut configured for vertical mounting on structure of the ceiling; and

at least a second non-rigid connector configured for attachment to the second strut and to the fan housing to suspend the fan housing from the second strut.

11. The assembly of claim **10**, wherein the first and second non-rigid connectors are configured for attachment to the fan housing via respective ear hooks coupled to the fan housing.

12. The assembly of claim **11**, wherein each of the first and second non-rigid connectors are configured to establish a loop that engages a respective ear hook coupled to the fan housing.

13. The assembly of claim **10**, comprising:

a crossbar configured for mounting on structure of the ceiling and configured to vertically mount the first and second struts on structure of the ceiling.

14. The assembly of claim **5**, wherein the ear hooks are secured to a fan shroud that establishes a part of the fan housing.

15. The assembly of claim **14**, wherein each ear hook comprises a respective tab, and each ear hook is secured to

the shroud by at least one respective fastener extending through the respective tab and into the shroud.

16. The assembly of claim **15**, wherein the tabs are substantially flush with an exterior surface of the shroud.

17. The assembly of claim **15**, wherein each ear hook comprises:

a respective segment extending from the respective tab and/or shroud and a respective box-shaped structure to establish multiple contact points of the respective ear hook at which a respective connector may engage the respective ear hook.

18. An assembly comprising:

a fan housing supporting a fan;

first and second struts;

first and second non-rigid connectors each comprising a first end connectable to the fan housing and a second end connectable to the respective first or second strut, whereby the fan housing is suspended between the struts by the connectors when installed in an attic with the struts vertically oriented and resting on respective bottom ends with the second ends of the connectors elevated above the first ends of the connectors.

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