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(54) Title: IMPROVEMENTS RELATING TO SOLAR WATER HEATERS

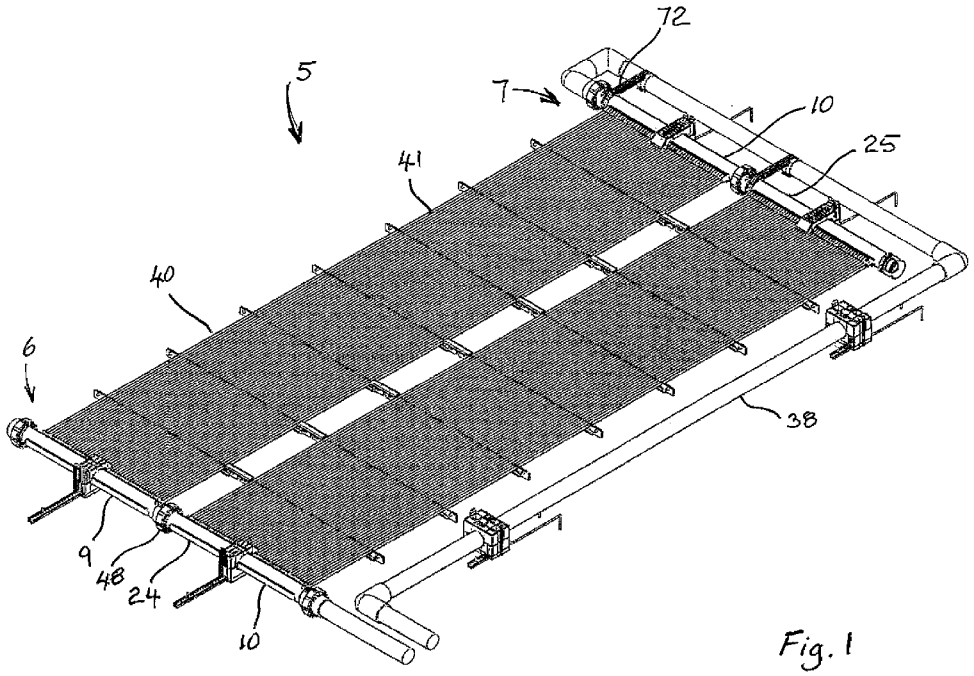

Fig. 1

(57) **Abstract:** A solar heat exchanger in which the manifolds are connected together using a threadless connection arrangement in which the end of one manifold tube carries at least two annular seals and the internal bore of the end of the adjacent manifold tube is cammed and when locked, the connection of the two manifolds is resistant to loosening when exposed to repeated thermal expansion and contraction cycles.

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IMPROVEMENTS RELATING TO SOLAR WATER HEATERS

Technical Field

[0001] This invention relates to improvements in solar water heating systems which include a solar collector panel, which is usually disposed on a roof, and which includes an array of plastic tubes connected to a plastic water manifold. Typically one end of each array of tubes is connected to a water supply manifold and t6he other end is connected to a water return manifold.

Background to the Invention

[0002] It is important to provide a watertight connection between the tubes and manifolds of such solar panels. It is also important to provide sufficient strength to the attachment of the tubes to the manifold.

[0003] A method of forming such manifold and tube panels by over-moulding the supply and return manifolds to make water tight connections to the small bore solar collection tubes, was first proposed in US patent 4,352,772 which over moulds the manifold onto the tubes. This approach has also been followed in US patents 6,787,116, 7,112,297 and 9,227,353.

[0004] However these previous systems suffer from several problems:

(a) Weakening of the solar collection tubes at the overmould due to a thinning of the wall section caused by the overmolding process. Exposure to side impact can then fracture the overmould, resulting in leaks.

(b) The exposed threads on the manifold joining couplings are prone to damage during transport and installation. This creates difficulties for the installers.

(c) The threads can undo with expansion and contraction. To overcome this, some manufacturers recommend that silicone sealant be applied to the threads during installation to act as a thread locker and seal the thread, but this is not always successful.

(d) During installation, large collectors can be difficult to align for manifold connection, so that single face-to-face seals often leak due to bending stress at the coupling.

[0005] USA patent 6948687 discloses a sealing ring for joining two manifolds. A problem encountered with this type of joint is exposure to repeated thermal expansion and contraction cycles.

[0006] USA patent 6948687 also discloses a clamp for holding the manifold in position while allowing the manifold to expand and contract. Another proposal using a plastic spring mechanism to take up thermal expansion, is disclosed in US 20110073105. These proposals for clamping the system to the roof do not adequately address avoidance of damaging the roof tiles.

[0007] It is an object of this invention ameliorate the prior art problems mentioned.

Brief Description of the Invention

[0008] In a first aspect this invention provides a solar heat exchanger for heating water which includes an array of tubes, an injection moulded manifold there being connections between each tube in the array and the manifold which are over moulded to seal the tubes to the manifold.

[0009] In another aspect this invention provides a solar heat exchanger for heating water, said heater comprising:

- an array of tubes, and
- an injection moulded manifold,

there being a respective connection between the manifold and each tube in the array, wherein each said connection is overmoulded with a plastics compound that adheres to both the manifold and the tubes and thereby seals the tubes to the manifold.

[0010] Said manifold may have an array of spigots onto which each tube is pushed and each spigot is provided with a recess at its base adjacent the manifold so that during

said overmoulding, said plastic compound flows into the recess to mechanically anchor the tubes, the overmoulding and the manifold together.

[0011] Said manifold is preferably a rigid moulding of a polypropylene and the tubes are formed of a flexible polypropylene material.

[0012] Said flowable plastics compound preferably chemically adheres to the spigots, the manifold body and the tubes.

[0013] In a further aspect this invention provides a method of joining adjacent manifolds together using a cam locking system with a triple seal, to provide improved leak resistance and prevent loosening when exposed to repeated thermal expansion and contraction cycles.

[0014] In a further aspect the invention provides a method of joining adjacent manifolds together using a cam locking system with a triple seal, to provide improved leak resistance and prevent loosening when exposed to repeated thermal expansion and contraction cycles.

[0015] In a further aspect the invention provides a solar heat exchanger in which the manifolds are connected together using a threadless connection arrangement in which the end of one manifold tube carries at least two annular seals and the internal bore of the end of the adjacent manifold tube is cammed and when locked, the connection of the two manifolds is resistant to loosening when exposed to repeated thermal expansion and contraction cycles.

[0016] In a further aspect the invention provides a system for securing a solar heat exchanger to a tiled roof which includes: a wire hook for attachment to a roof batten under the tiles, an adjustable connection strip connected to said wire hook, and a manifold clamp attached to said adjustable connection strip.

[0017] The method of connecting the manifolds together is by cam locking a seal with a proprietary 1/8 turn hand tool. There are 2 other O rings per connection which prevent

distortion at the union and make for a triple seal against leakage. The triple seal design ensues correct self alignment and a seal without bending stress. There are no external threads prone to impact or damage.

[0018] In one aspect, adjacent manifolds are joined together using a cam locking system with a triple seal, to provide improved leak resistance and prevent loosening when exposed to repeated thermal expansion and contraction cycles. The method of connecting the manifolds together is by cam locking a seal There are no external threads prone to impact or damage. The solar heat exchanger is secured to a tiled roof using a system consisting of clamps and an adjustable location strip for the batten wire hook. The clamp can also connect the return pipes to the manifold. This arrangement avoids drilling and damaging tiles. This arrangement also accommodates large thermal expansion of the solar tube mat. The cam lock is designed to prevent loosening of the connection over time.

[0019] The solar tubes are first pushed onto an injection moulded manifold which has an array of spigots and then this assembly is overmoulded with a plastic compound that adheres to both manifold and tube. The overmoulding also flows into a recess at the base of each spigot that mechanically anchors the 3 pieces together.

[0020] In a further aspect this invention provides a system for clamping the solar heat exchanger to a tiled roof which consists of clamps and an adjustable location strip for the batten wire hook. Using a clamp that is held to a batten by a wire hook and an adjustable connection. The clamp can also connect the return pipes to the manifold.

[0021] This arrangement avoids drilling and damaging tiles. The saving in installation time may enable the system to be priced lower than competitors.

[0022] The holding clamp is easy to install without disturbing a tiled roof and has an adjustable length to ensure that the manifolds are installed straight and true without stress on the couplings.

[0023] Allowing for thermal expansion while holding the collectors securely to the roof is important. For example a polypropylene tubular mat expands 2.0mm/m/10°C. The collectors will experience temperature ranges from freezing to 80°C when they are

sitting idle on a roof under summer heatwave conditions. Therefor there needs to be an allowance for approx 64.0mm expansion over 80°C range for a 4.0m long collector. If units are installed on a cold day without clearance, then collectors will buckle & damage. Also, if they are installed on a hot day without clearance they will pull out of the clamps under cold conditions.

[0024] This invention addresses this problem by letting the collector manifolds float in the clamps. The installer always places the bottom manifold in the bottom clamps first. The top manifold clamp is engraved with a temperature scale ranging from zero to 40°C. Depending on the temperature at the time of installation, the installer fixes the top clamps with the centre of the top manifold lining up with the 0-40°C temperature scale according to the approximate day temp. This will ensure that there will always be enough clearance for expansion.

Brief Description of the Drawings

[0025] In order that the invention may be more fully understood there will now be described, by way of example only, preferred embodiments and other elements of the invention with reference to the accompanying drawings where:

Figure 1 is a perspective view from above of a solar heat exchange assembly according to a first embodiment of this invention and comprising a modular solar mat and manifold system;

Figure 2 is a perspective view from below of the assembly in Figure 1;

Figure 3 is a perspective view of a manifold body component forming part of the assembly in Figure 1;

Figure 4 is a view from above of portion of the manifold body component shown in Figure 3;

Figure 5 is an enlarged partial cutaway view of portion of the assembly in Figure 1;

Figure 6 is an enlargement of portion of Figure 5 which has been cut away further;

Figure 7 is a perspective view of a locking ring used in the heat exchange assembly in Figure 1;

Figure 8 is an exploded view of portion of the assembly in Figure 1 prior to being assembled;

Figure 9 is a view showing the components of Figure 8 partially assembled;

Figure 10 is a view showing the components in Figure 8 when assembled;

Figure 11 shows a locking tool for use in this invention;

Figure 12 is an enlarged detail from Figure 2 showing an underneath view of an arrangement for fixing the upper end of the heat exchange assembly to a roof of a house;

Figure 13 shows a topside view of the fixing arrangement in Figure 12;

Figure 14 shows a further enlarged detail of portion of Figure 13;

Figure 15 is an enlarged detail from Figure 2 showing an arrangement for fixing the lower end of the heat exchange assembly to the roof of a house;

Figure 16 is a topside view of the fixing arrangement in Figure 15;

Figure 17 is a further detail from Figure 2 showing an arrangement for affixing the return pipe to the house roof;

Figure 18 is a topside view of part of the layout in Figure 17,

Figure 19 is a view of a tube-spacer component of the assembly in Figure 1;

Figure 20 is an enlarged detail from Figure 2 showing the tube-spacer engaged with tubes in the assembly'

Figure 21 is a further enlargement of portion of Figure 20;

Figure 22 is a topside view of the components in Figure 21; and

Figure 23 shows a return pipe bracket previously seen in Figure 13.

Detailed Description of Embodiments of the Invention

[0026] The solar heating assembly 5 in Figures 1 and 2 is a heat exchanger for collecting solar radiation and using it to heat water, preferably for warming a swimming pool. It includes a solar mat 40, comprising an array of parallel tubes 41 whose lower ends 6 are affixed to an inlet manifold assembly 24, and whose upper ends 7 are affixed to an outlet manifold assembly 25. Associated pipework 38 brings water to the inlet manifold assembly and receives warmed water from the outlet manifold assembly.

[0027] The upper and lower manifold assemblies each comprise two identical manifolds 10 connected end to end by means of a locking ring at each connection 48. Identical locking rings are also used to connect the manifold assemblies to the associated pipework 38.

[0028] Each manifold 10 is a single rigid injection moulding having a tubular body 9 and an array of spigots 11 along its length. Each spigot is adapted to receive a respective tube 41 slid over it and incorporates an annular external recess 12 at its base adjacent the manifold from which it extends. When manufacturing the assembly, the tubular ends of the tubes 41 of the mat 40 are slid onto their respective spigots 11. To complete the joining of the injection moulded manifold 10 to the mat 40, the junction of the mat 40 and manifold spigots 11 is overmoulded with a polymer composition 30 that adheres to the surfaces of the tubes 41 and the manifold 10. Preferably the overmoulding compound is a thermoplastic elastomer (TPE) or rubber-like material which is cured in the mould. Within the mould the composition 30 flows around the tubes 41 and fills the recesses 12 at the base of the spigots 11 so that when the overmould composition is cured. The overmoulding is continuous between adjacent spigots. The overmould's penetration into the annular recess 12 on each spigot provides a mechanical lock of the mat onto the manifold that is resistant to forces that could separate the mat from the manifold or initiate leaks at the join.. This provides superior resistance to leaking. Fig 6 shows various cutaway views of tubes, spigots and overmoulding composition at a series of adjacent spigots. .

[0029] A locking element 50 in the form of a ring (best seen in Figure 7) provides a clamp 60. The manifold is a rigid injection moulding and solar mat tubing is made of a semi flexible polypropylene.

[0030] A more robust connection between the tubes and the manifold is achieved by joining an injection moulded manifold to the tubes and overmolding with a polymer that fills recesses around the tubes and mechanically anchors the tubes to the manifold while being chemically adhered to both the tubes and the manifold. As a result of the overmoulding, the solar heat exchanger has a higher pressure rating and is more impact resistant.

[0031] The solar tubes are first pushed onto an injection moulded manifold which has an array of spigots and then this assembly is overmoulded with a plastic compound that adheres to both manifold and tube. The overmoulding also flows into a recess at the base of each spigot that mechanically anchors the 3 pieces together. Tests show that this does not create any weak points and improves the pressure rating and protects the connection from impact.

[0032] Each manifold 10 has a male end 13 carrying a square-section annular seal 14 and two O rings 15 in respective circumferential grooves. Each manifold 10 also has a female end 17 which has an internal diameter to match the external diameter of the male end 13. Both ends 13 and 17 have complementary lugs 16 and 18 which engage when a male and female end are joined. A recessed annular face 19 of the female end 17 bears against the seal 14 and the O-rings 15 bear outwards against the inside cylindrical wall of the female end.

[0033] An end cap 20 for closing one end of a manifold 10 with a male end 13 may be attached in the same way.

[0034] The locking ring 50 has tapered internal recesses 52 to accommodate the tapered lugs 16 and 18 and has external grooves 53 to accommodate a turning tool 55. The tool 55 is seen in Figure 11. The lugs 57 on the tool 57 engage the external grooves 53 of the locking ring 50. The locking ring 50 has the form of a cam lock nut. It is made of a glass filled nylon, which holds its memory under tension. An advantage of the cam lock system is that no matter what the strength of the installer, the cam lock cannot be either under or over tightened due to the notch lock. The same cannot be said for threaded couplings that are currently in use.

[0035] The internal recesses 52 are cammed so that a 1/8 turn of the nut 50 applies a sealing pressure on the joined ends with the triple seal of seal 14 and O rings 15. The length of the nut 50 provides support against bending of the manifolds at the join.

[0036] Clip-on clamps 72 tie the associated pipework 38 to nearby manifold portions.

[0037] Figures 12 to 17 illustrate the system for anchoring the assembled manifold and solar mat onto a tiled roof.

[0038] The clamp 60 consists of a base 61, which forms a lower jaw of the clamp, and an upper portion 62, which forms an upper jaw. A hook 66 engages a roof batten from between a pair of tiles and the adjustable slider 64 is set to apply tension to the mat 40. Spacers 75, into which the tubes engage, provide clearance between the mat 40 and the roof. Adjacent pacers are linked by linking members 77. The bracket 70 (see Figure 18) is used to locate the return line relative to the manifold.

[0039] From the above it can be seen that the present invention addresses several of the problems encountered with prior art systems.

[0040] Whilst the above description includes the preferred embodiments of the invention, it is to be understood that many variations, alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the essential features or the spirit or ambit of the invention. Those skilled in the art will realise that this invention may be implemented in embodiments other than those described without departing from the core teachings of this invention.

[0041] It will be also understood that where the word "comprise", and variations such as "comprises" and "comprising", are used in this specification, unless the context requires otherwise such use is intended to imply the inclusion of a stated feature or features but is not to be taken as excluding the presence of other feature or features.

[0042] The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge.

Claims

1. A method of joining adjacent manifolds together using a cam locking system with a triple seal, to provide improved leak resistance and prevent loosening when exposed to repeated thermal expansion and contraction cycles.

2. A solar heat exchanger in which the manifolds are connected together using a threadless connection arrangement in which the end of one manifold tube carries at least two annular seals and the internal bore of the end of the adjacent manifold tube is cammed and when locked, the connection of the two manifolds is resistant to loosening when exposed to repeated thermal expansion and contraction cycles.

3. A system for securing a solar heat exchanger to a tiled roof which includes
a wire hook for attachment to a roof batten under the tiles
an adjustable connection strip connected to said wire hook
a manifold clamp attached to said adjustable connection strip.

AMENDED CLAIMS
received by the International Bureau on 09 April 2019 (09.04.2019)

1. A solar heating assembly for collecting solar radiation and using it to heat water, said assembly comprising an array of parallel tubes whose first ends are affixed to an inlet manifold assembly and whose second ends are affixed to an outlet manifold assembly, each said manifold assembly comprising tubular manifolds connected together end to end using a threadless connection arrangement in which:

- a male end of one said manifold is joined with a female end of an adjoining said manifold,
- tapered lugs on said male end are engaged with complementary tapered lugs on said female end, and
- tapered recesses on a locking ring accommodate all said tapered lugs and apply sealing pressure to said connection.

2. A solar heating assembly according to claim 1 wherein a locking element in the form of a ring clamps said male end and said female end together.

3. A solar heating assembly according to claim 1 or 2 wherein said manifolds are identical in shape.

4. A solar heating assembly according to any one of claims 1 to 3 wherein said manifolds are rigid injection mouldings.

5. A solar heating assembly according to any one of claims 1 to 4 wherein each said manifold has an array of spigots along its body, and said spigots engage with said parallel tubes.

6. A solar heating assembly according to any one of claims 1 to 5 wherein a square-section annular seal is held between said male and female ends and said male end carries on its external surface two O rings in respective circumferential grooves.

7. A method of joining adjacent manifolds together end to end in a manifold assembly of a solar heating assembly used for collecting solar radiation and using it to heat water, said method comprising:

- connecting a male end of a first said manifold to a female end of said adjacent manifold,
- aligning tapered lugs on said male end with complementary tapered lugs on said female end,
- engaging a locking nut with said tapered lugs and turning said nut to engage said tapered lugs with tapered internal recesses within said nut to thereby apply a sealing pressure to the connection by a cam lock action.

8. A system for securing a solar heat exchanger to a tiled roof which includes
a wire hook for attachment to a roof batten under the tiles
an adjustable connection strip connected to said wire hook
a manifold clamp attached to said adjustable connection strip.

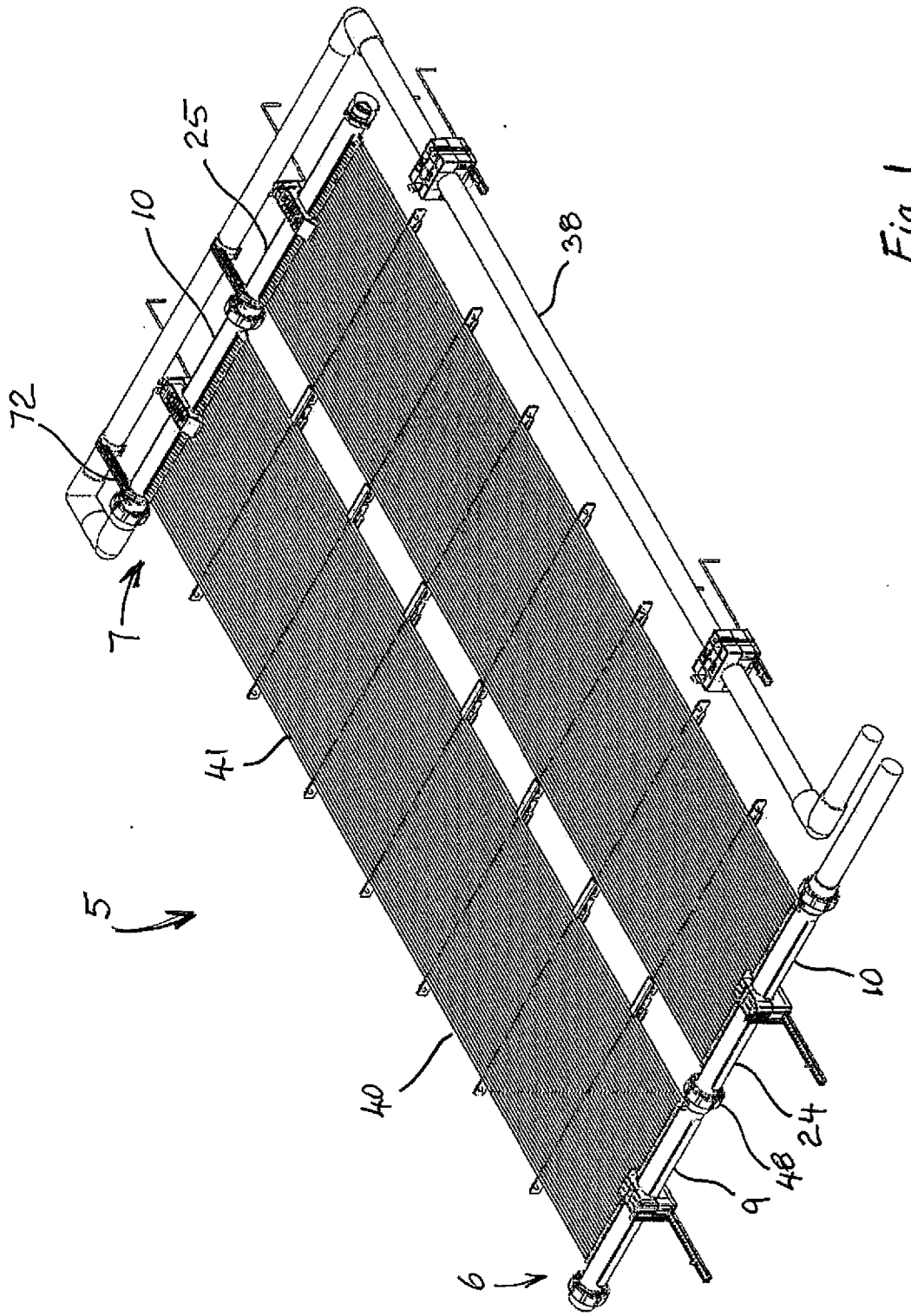


Fig. 1

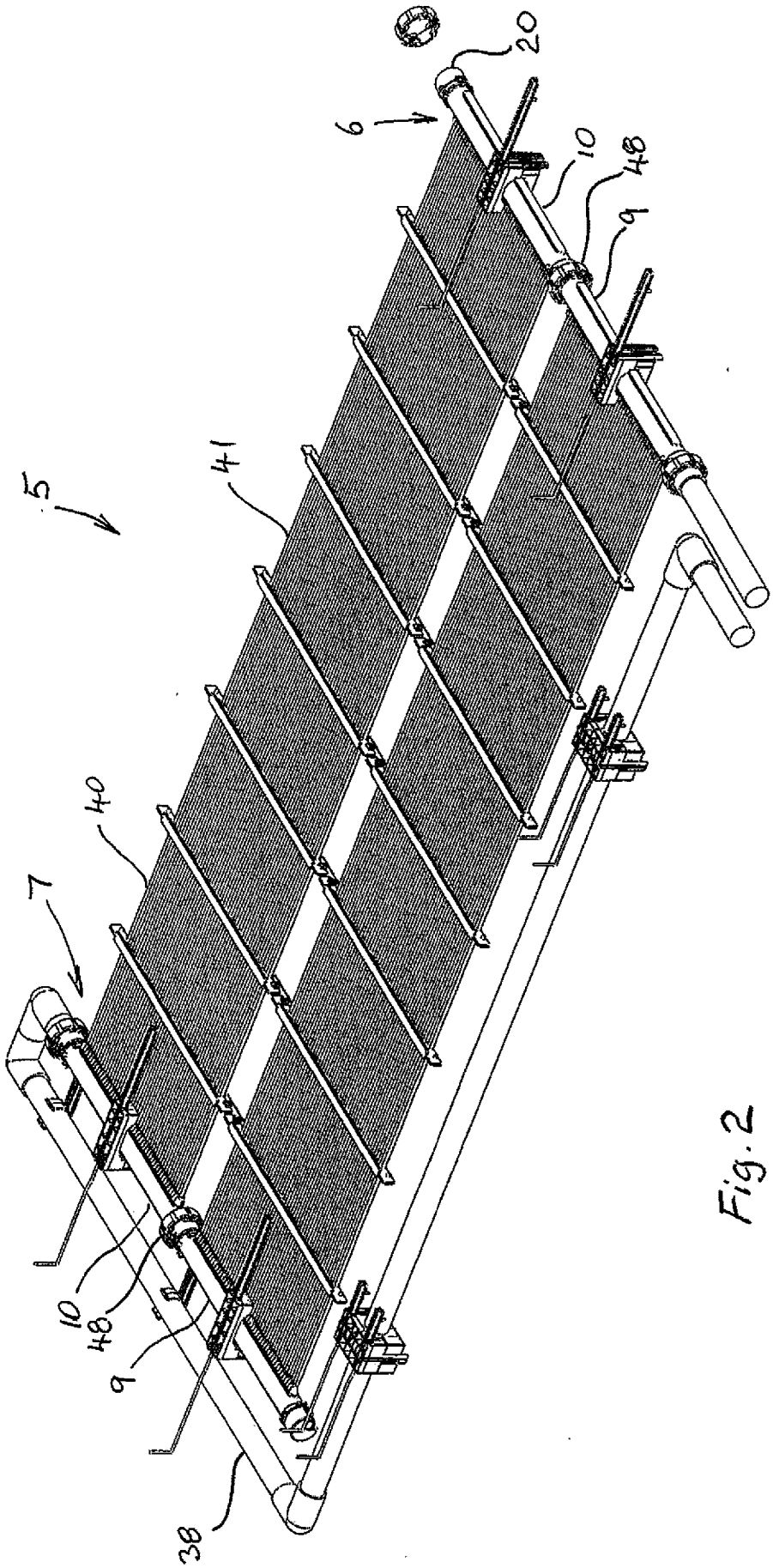


Fig. 2

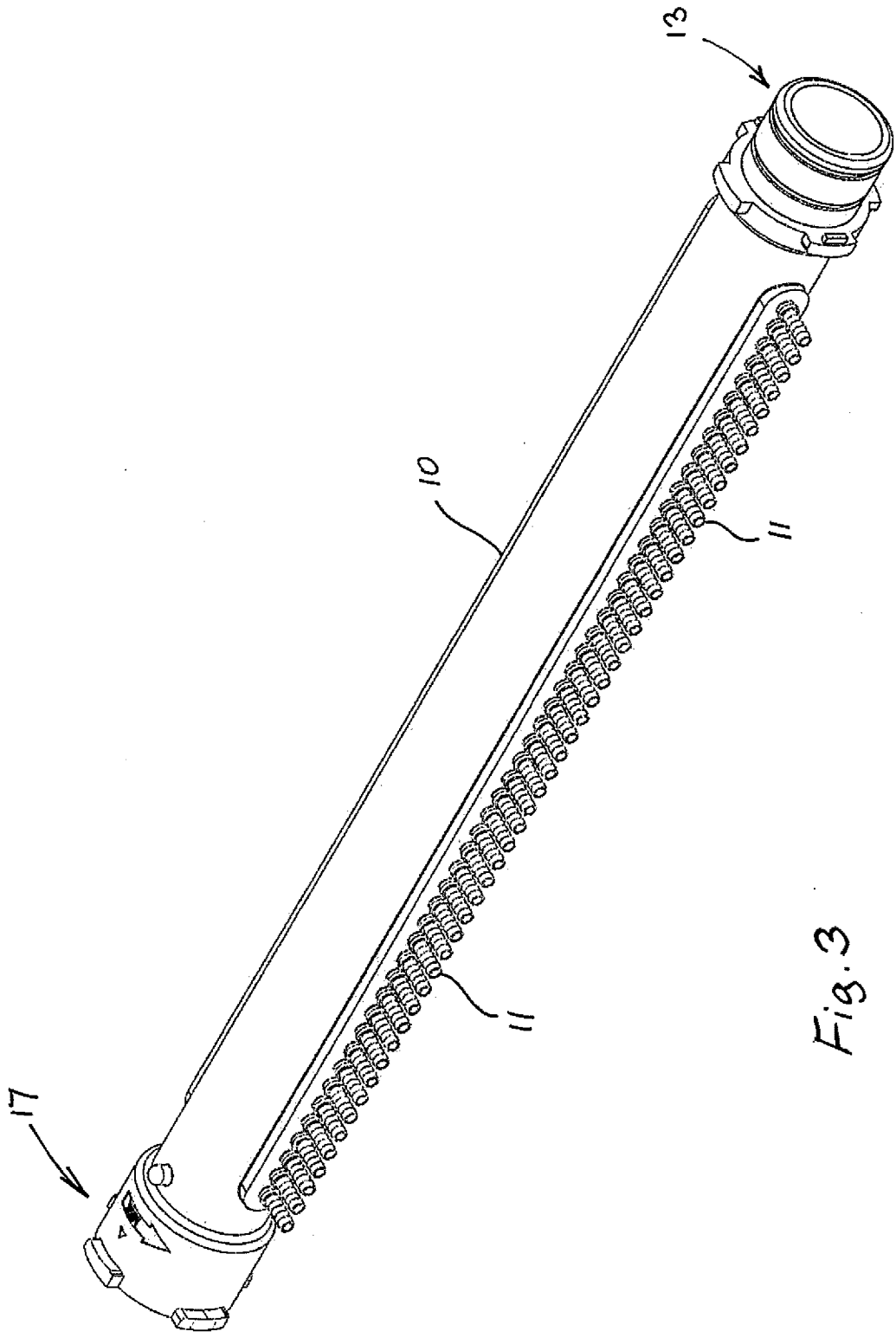


Fig. 3

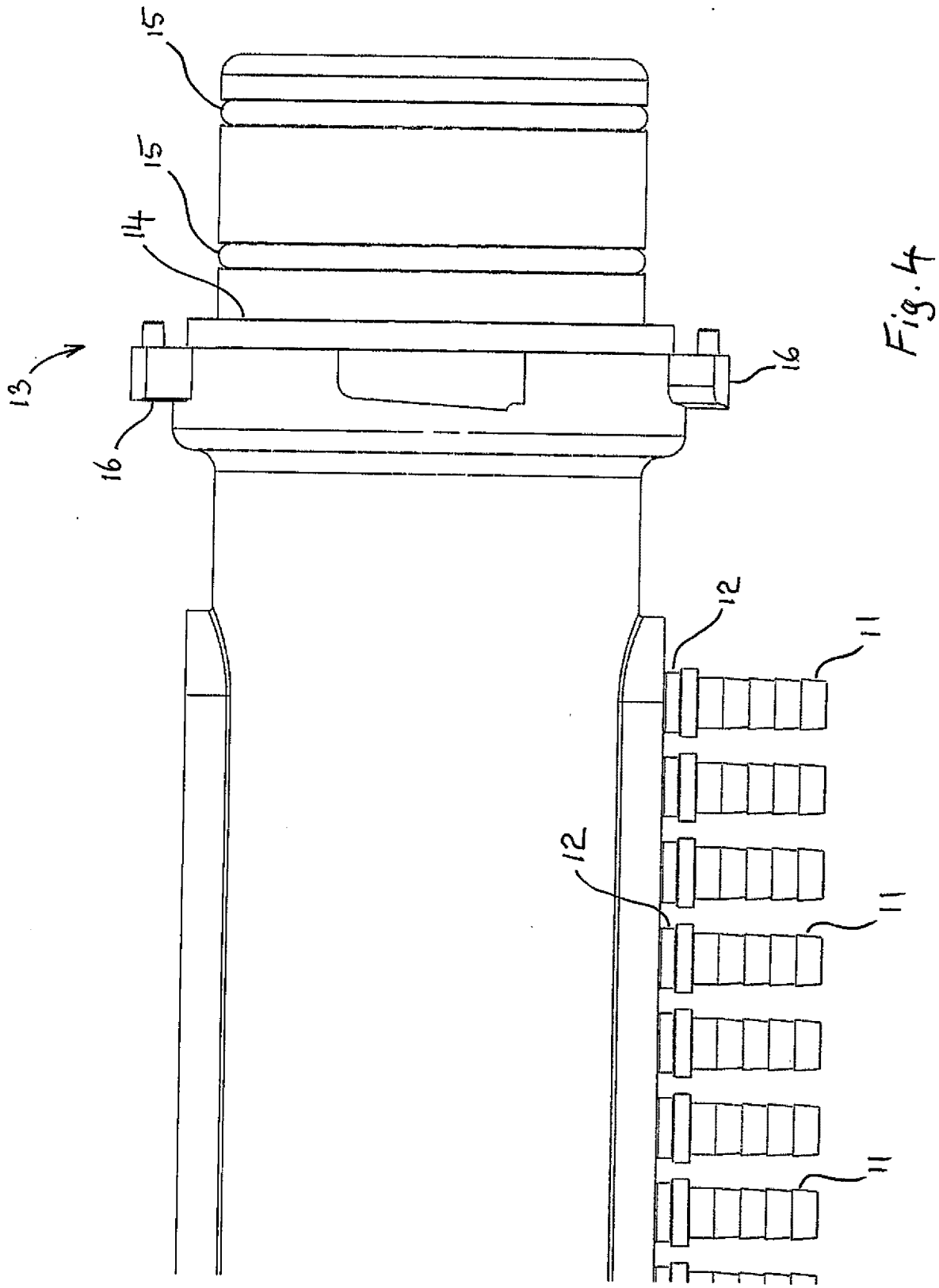


Fig. 4

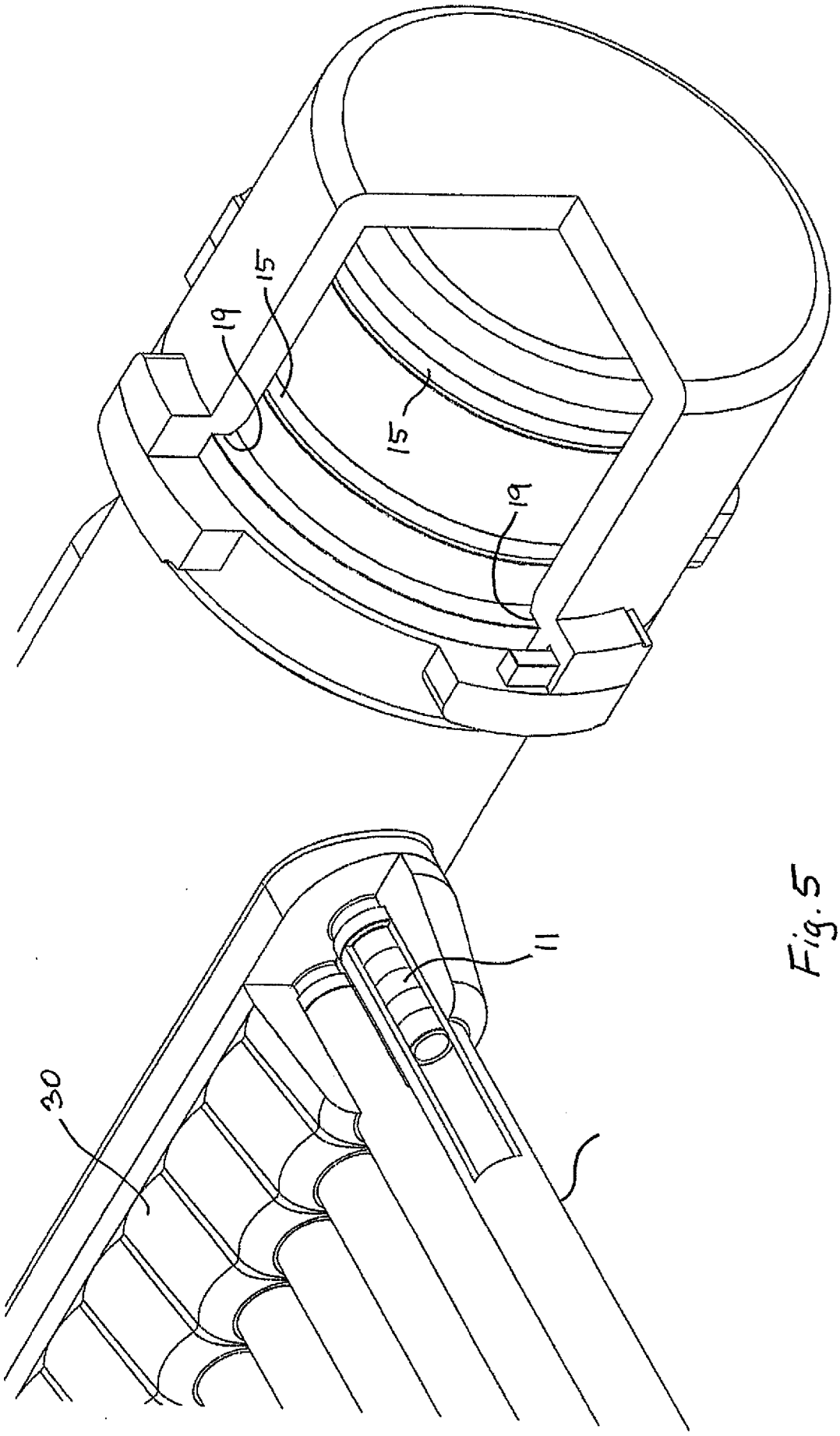


Fig. 5

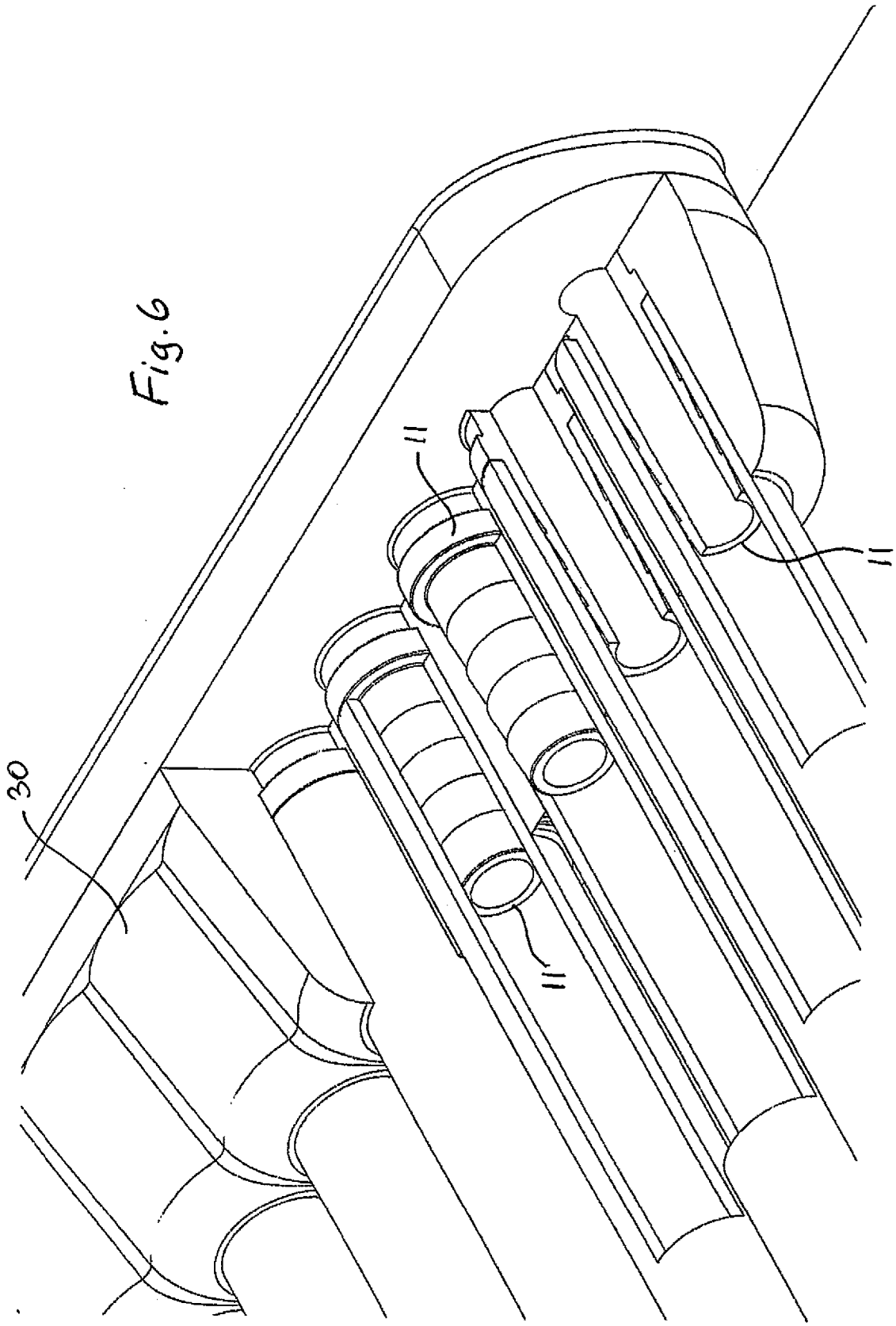


Fig. 6

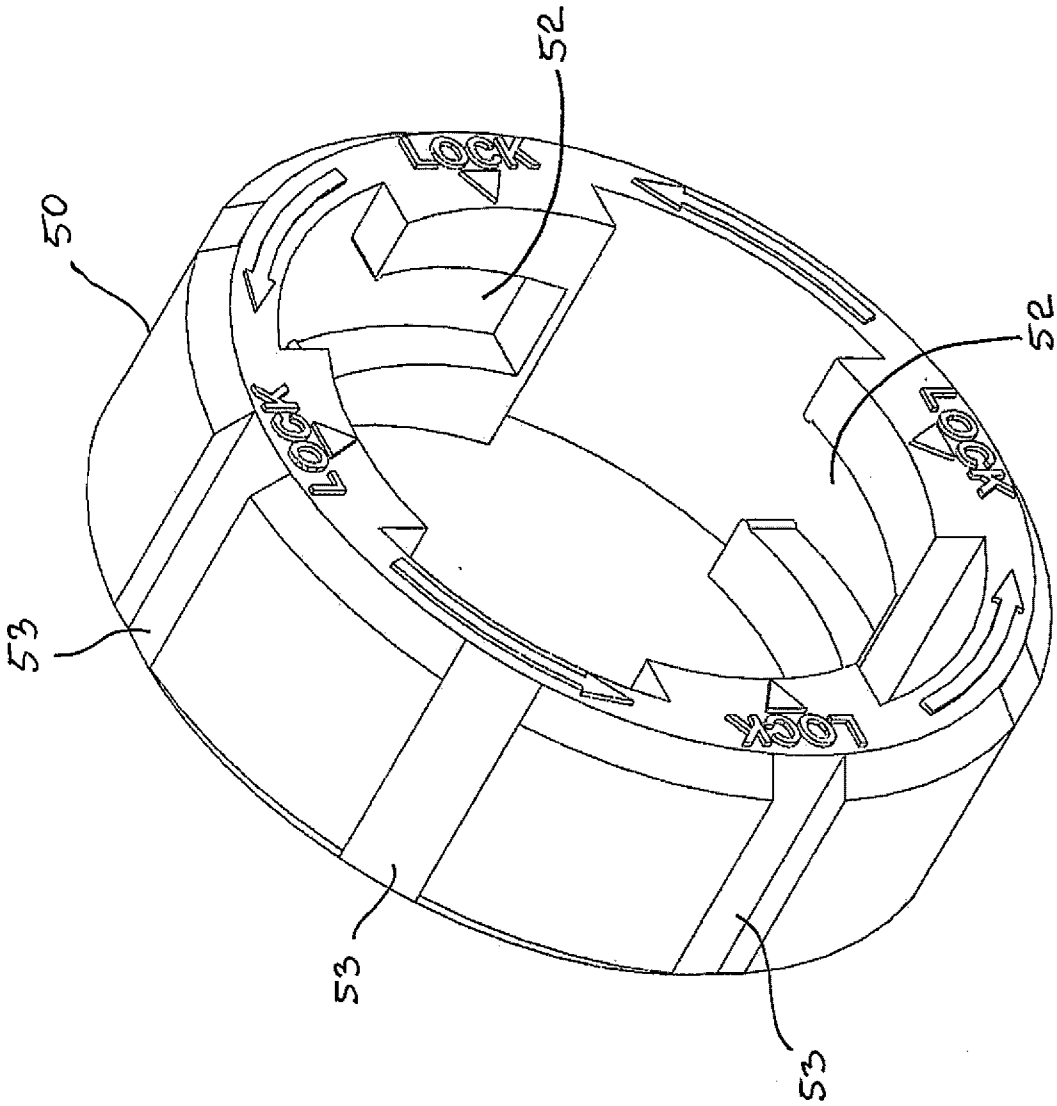


Fig. 7

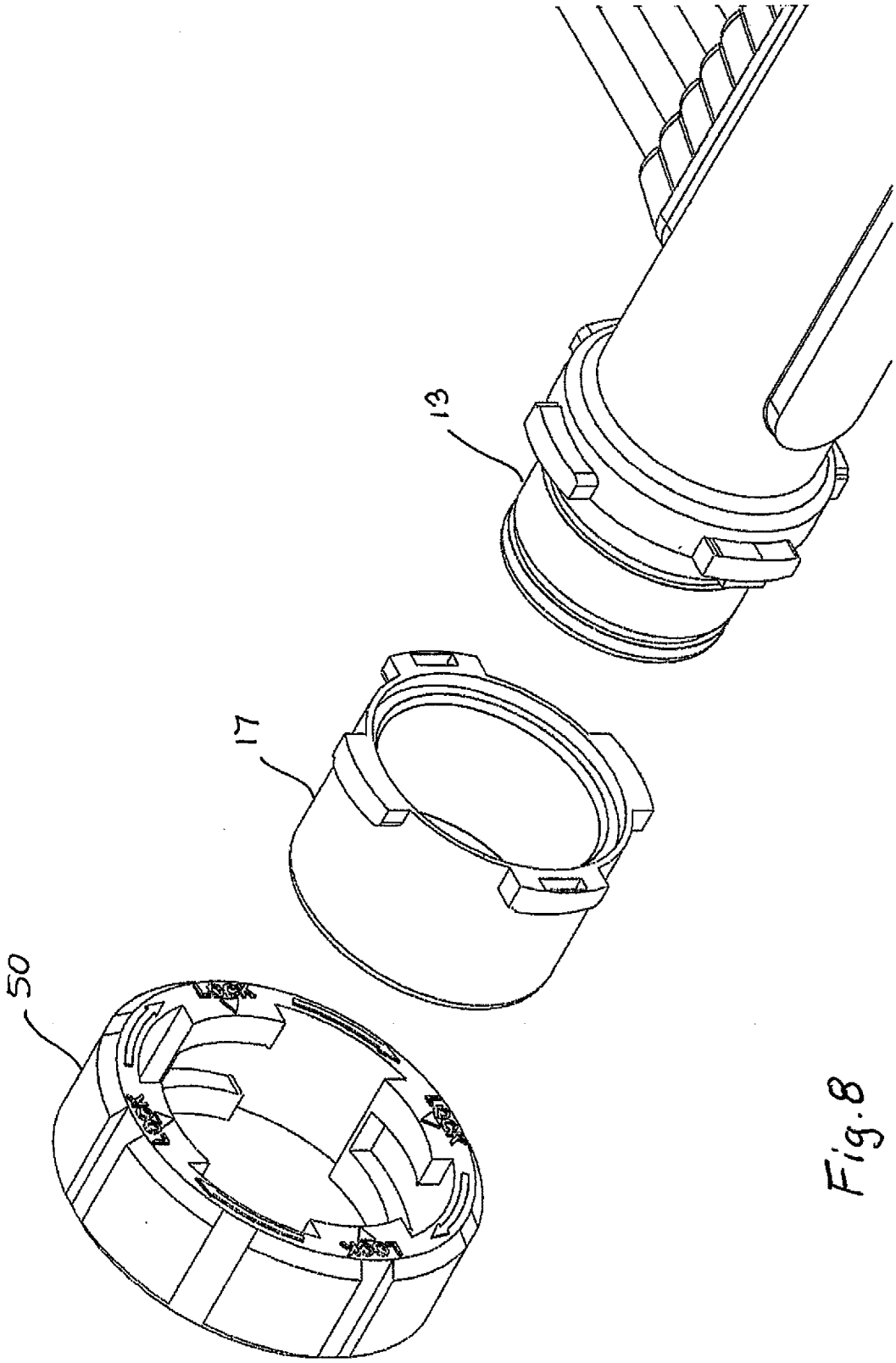
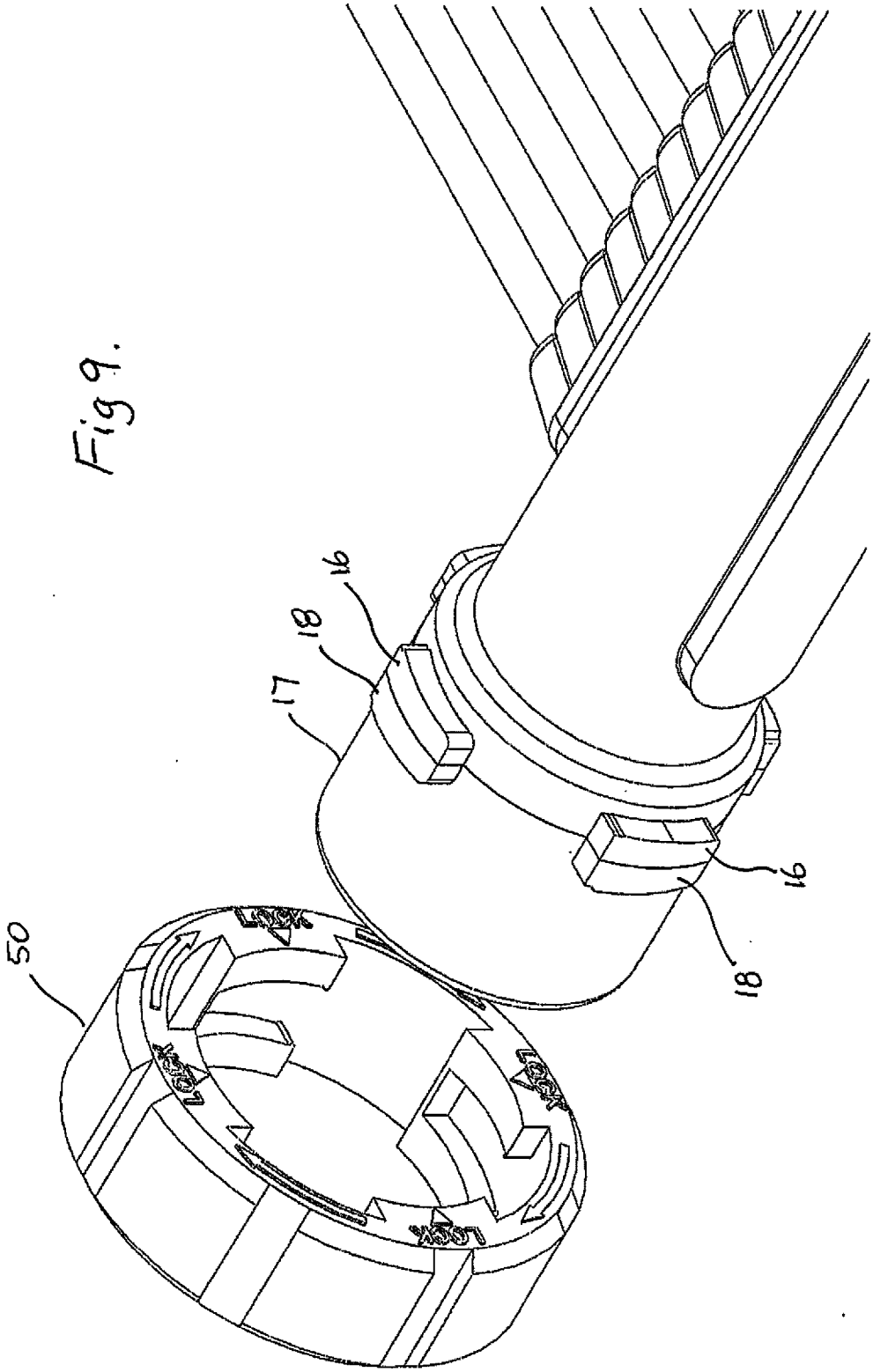


Fig.8

Fig 9.



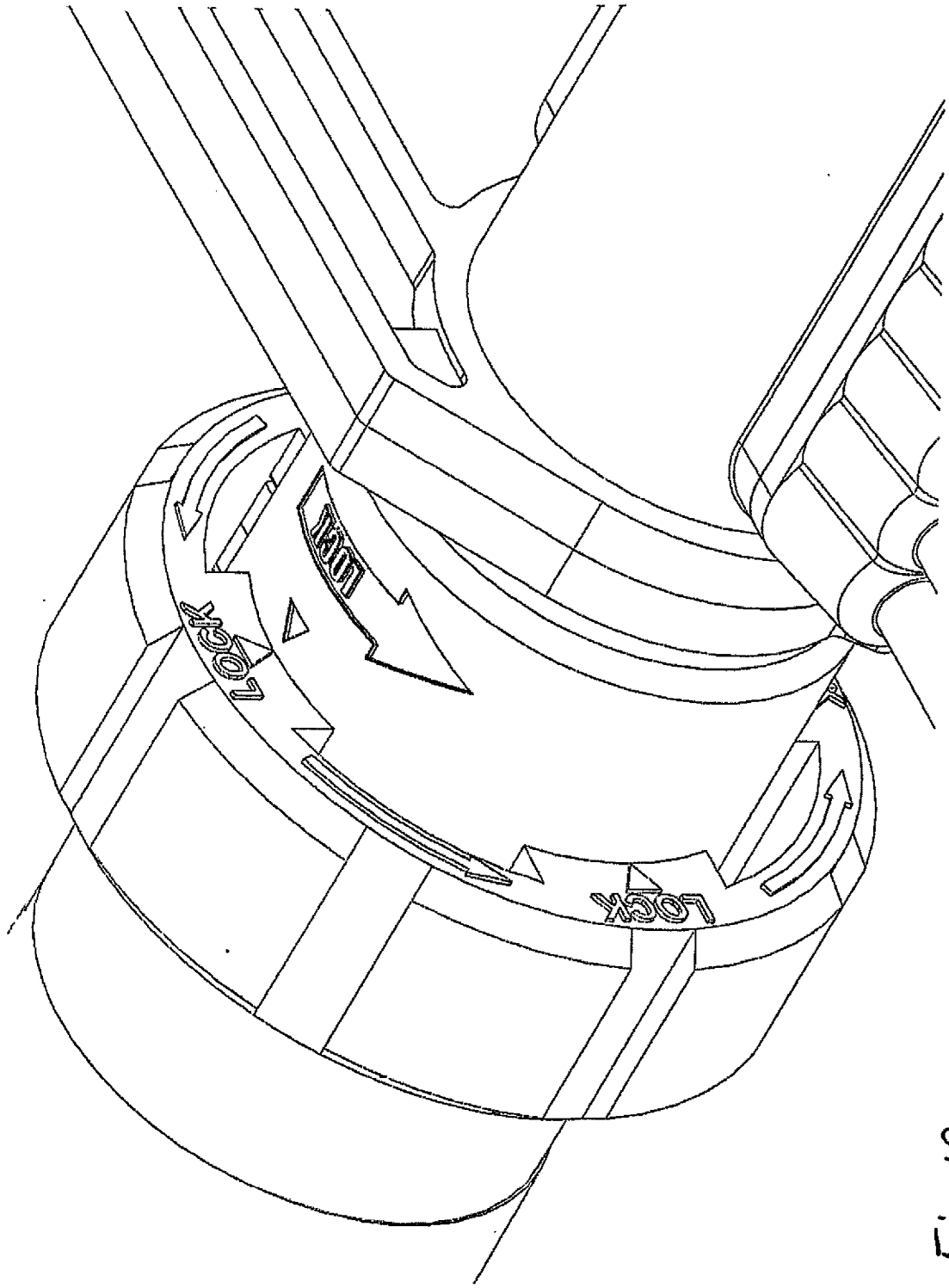


Fig. 10

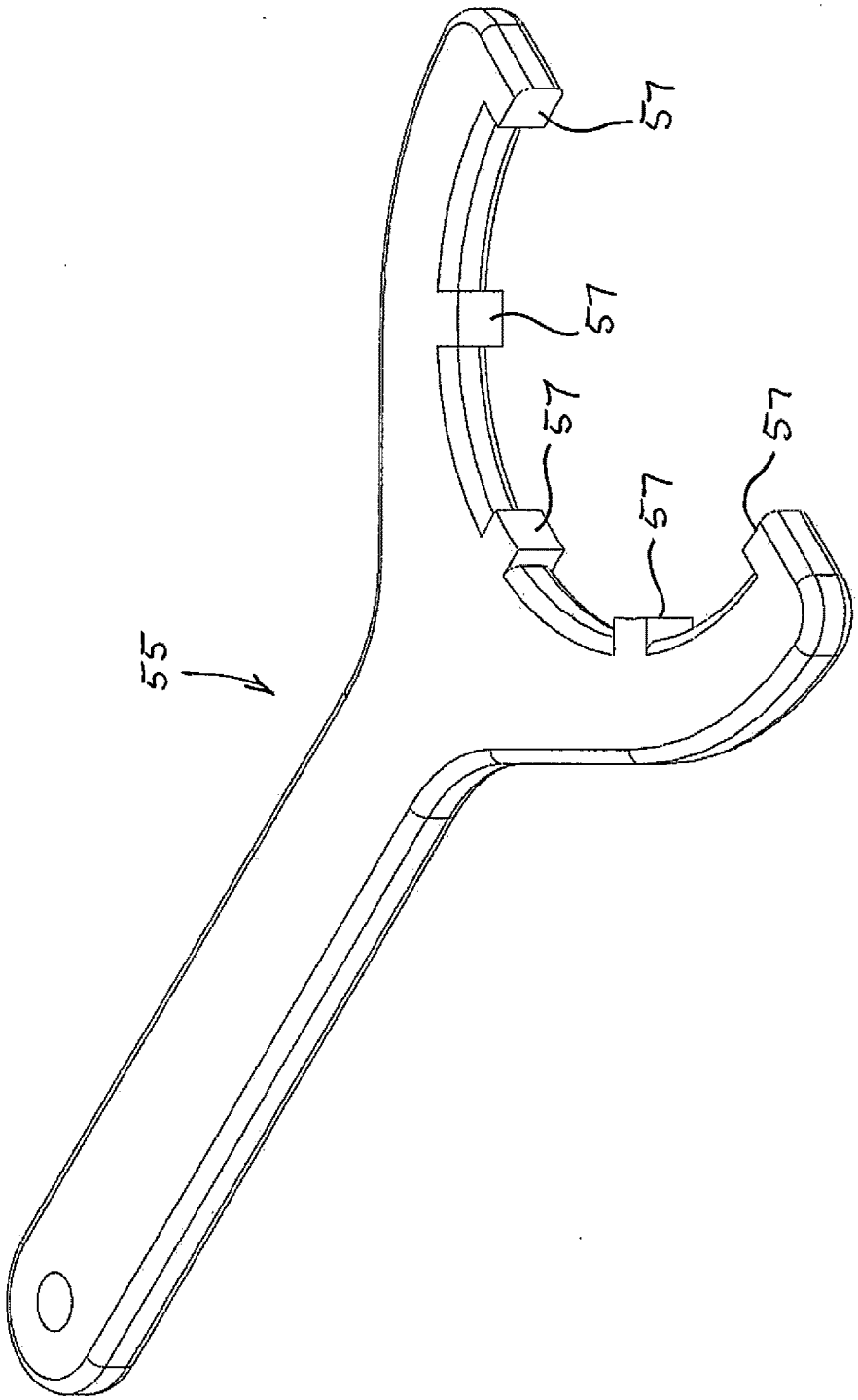


Fig. 11

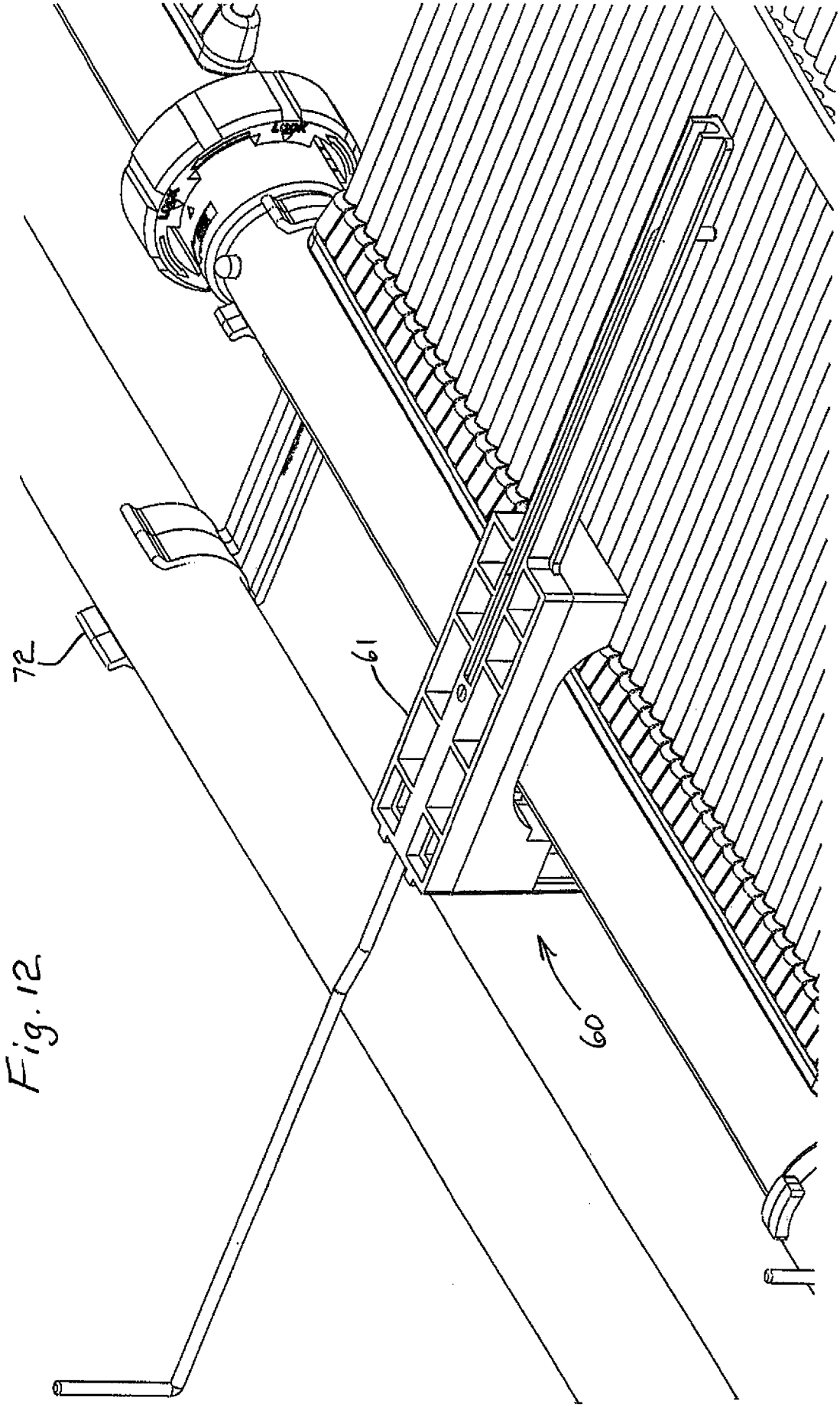


Fig. 12

Fig. 13

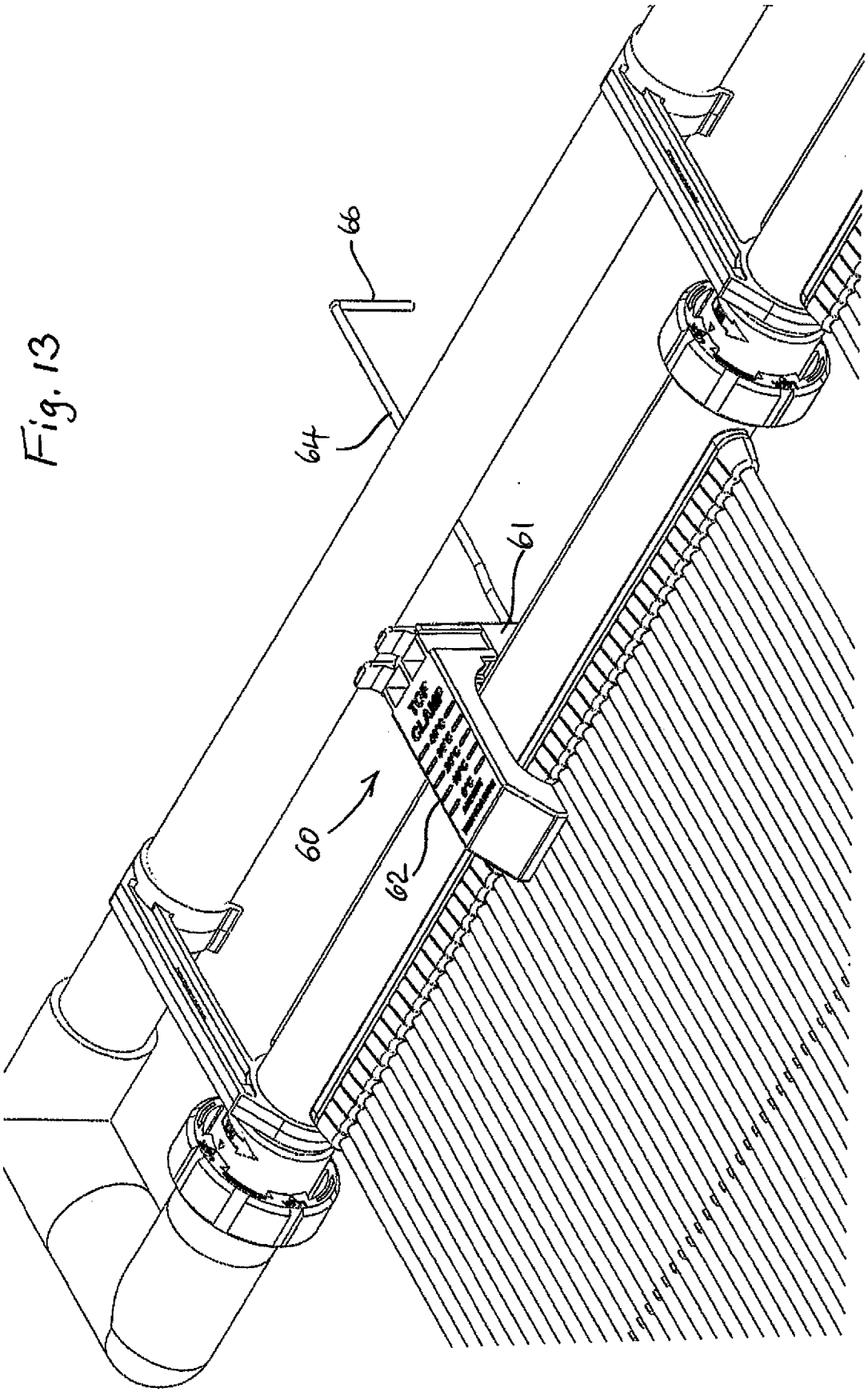
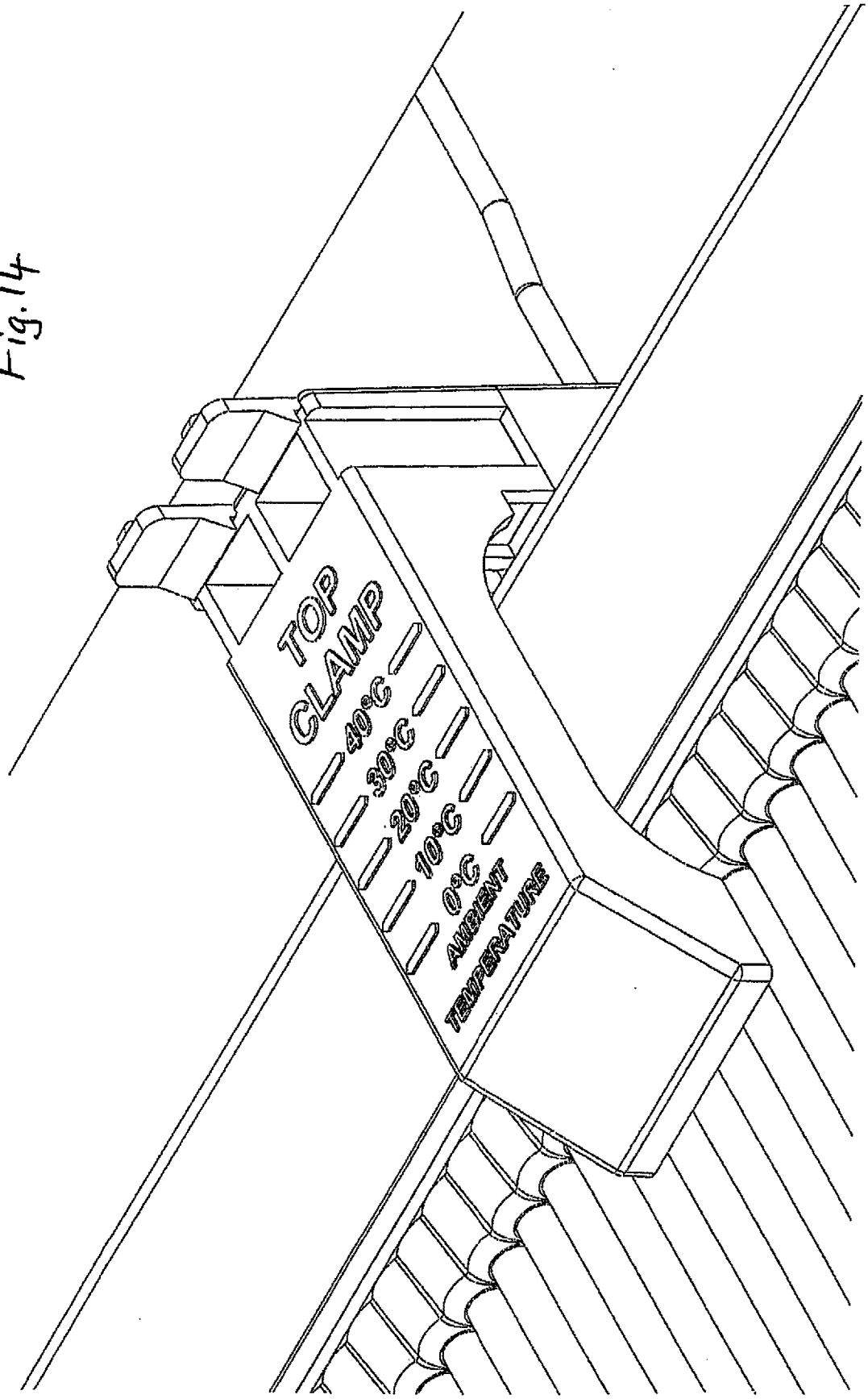


Fig. 14



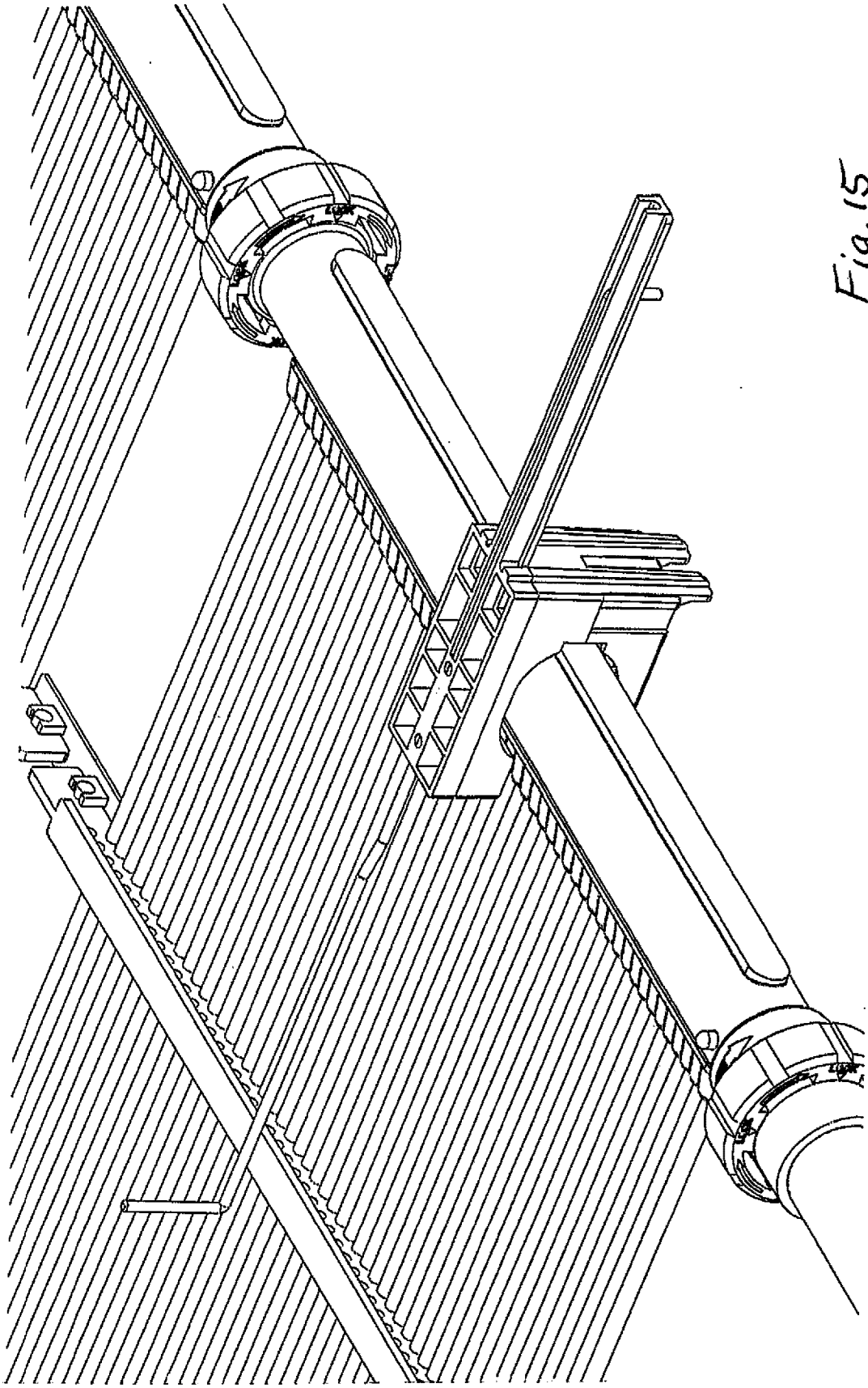


Fig. 15

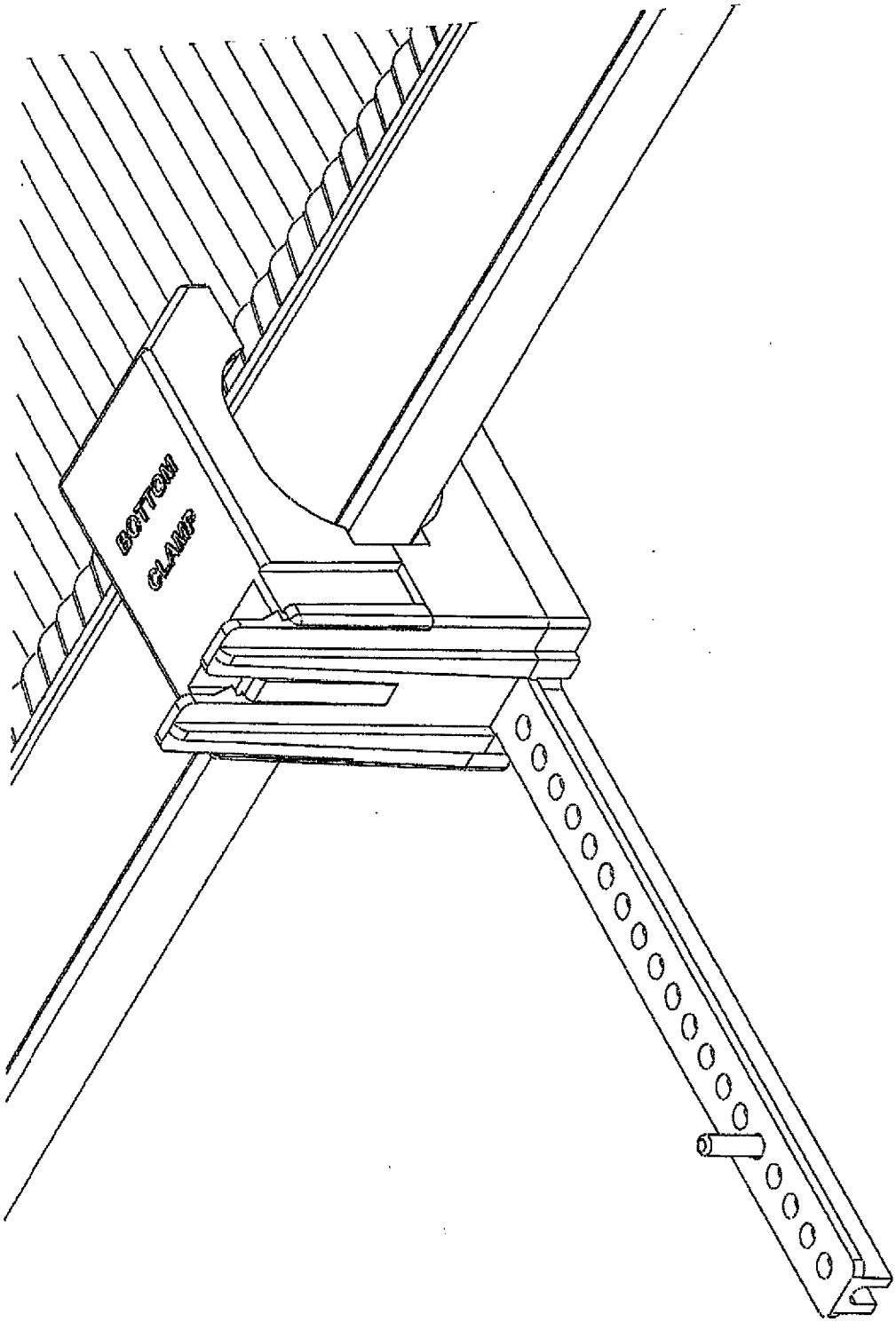


Fig. 16

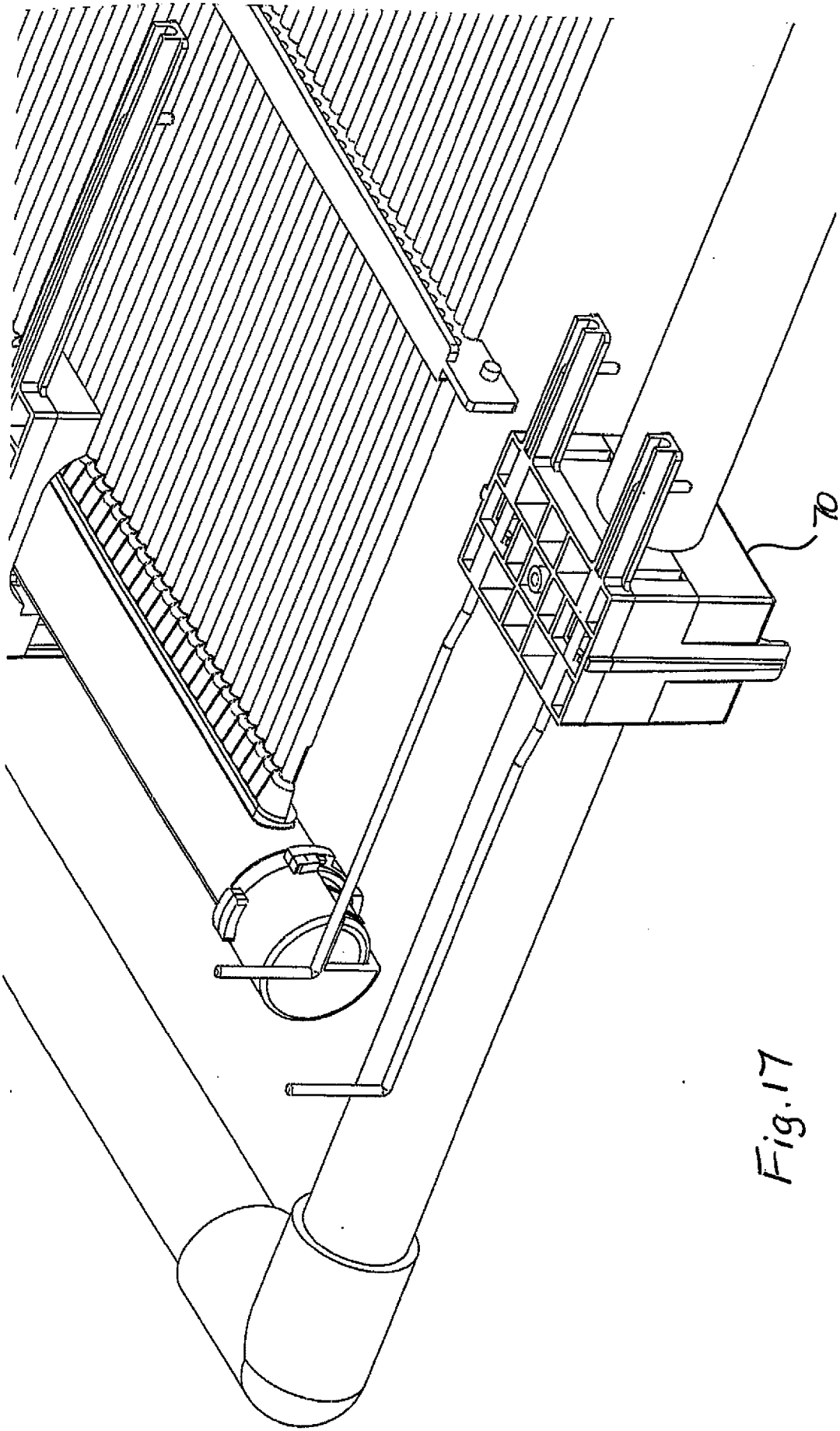


Fig. 17

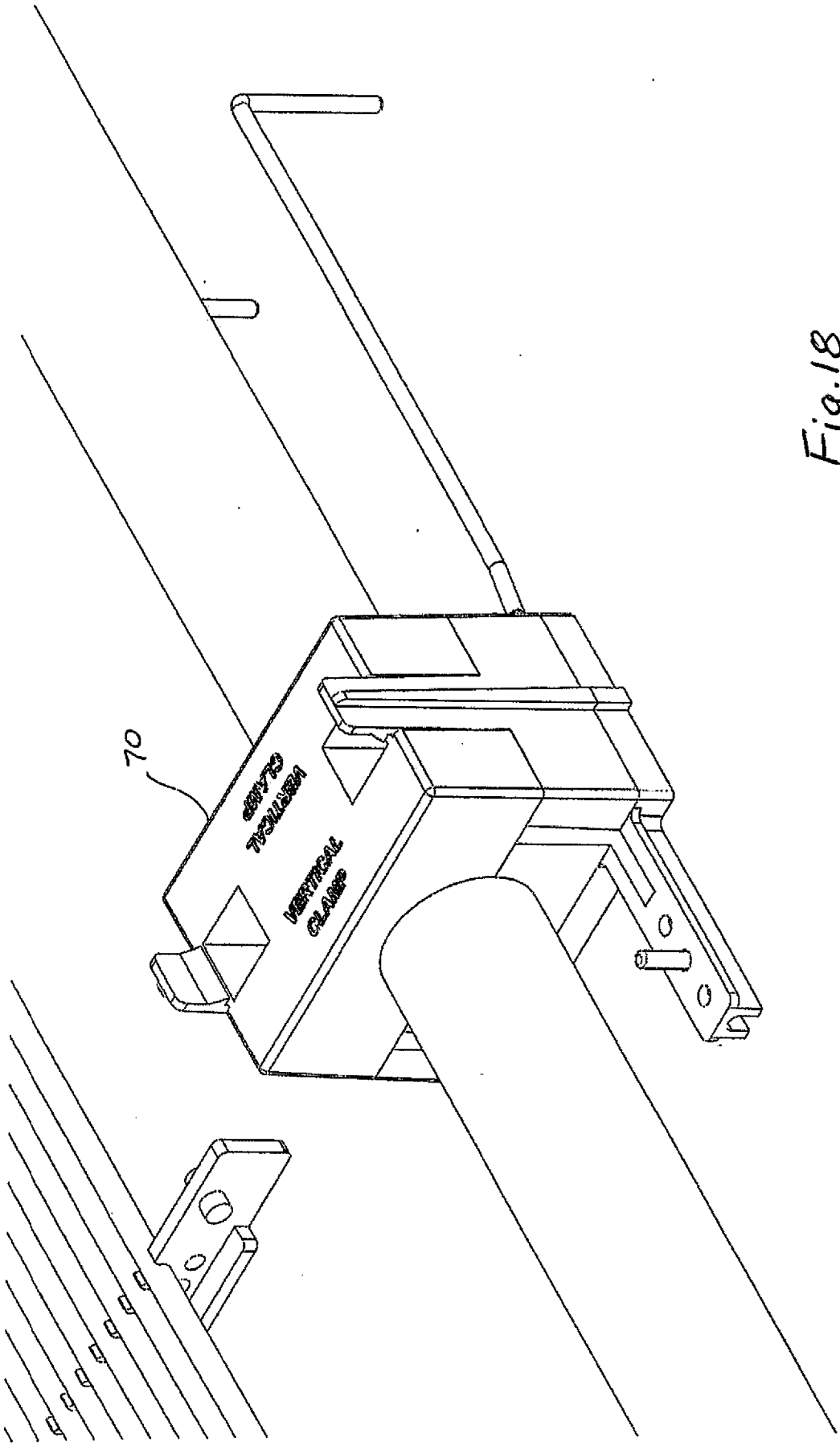


Fig.18

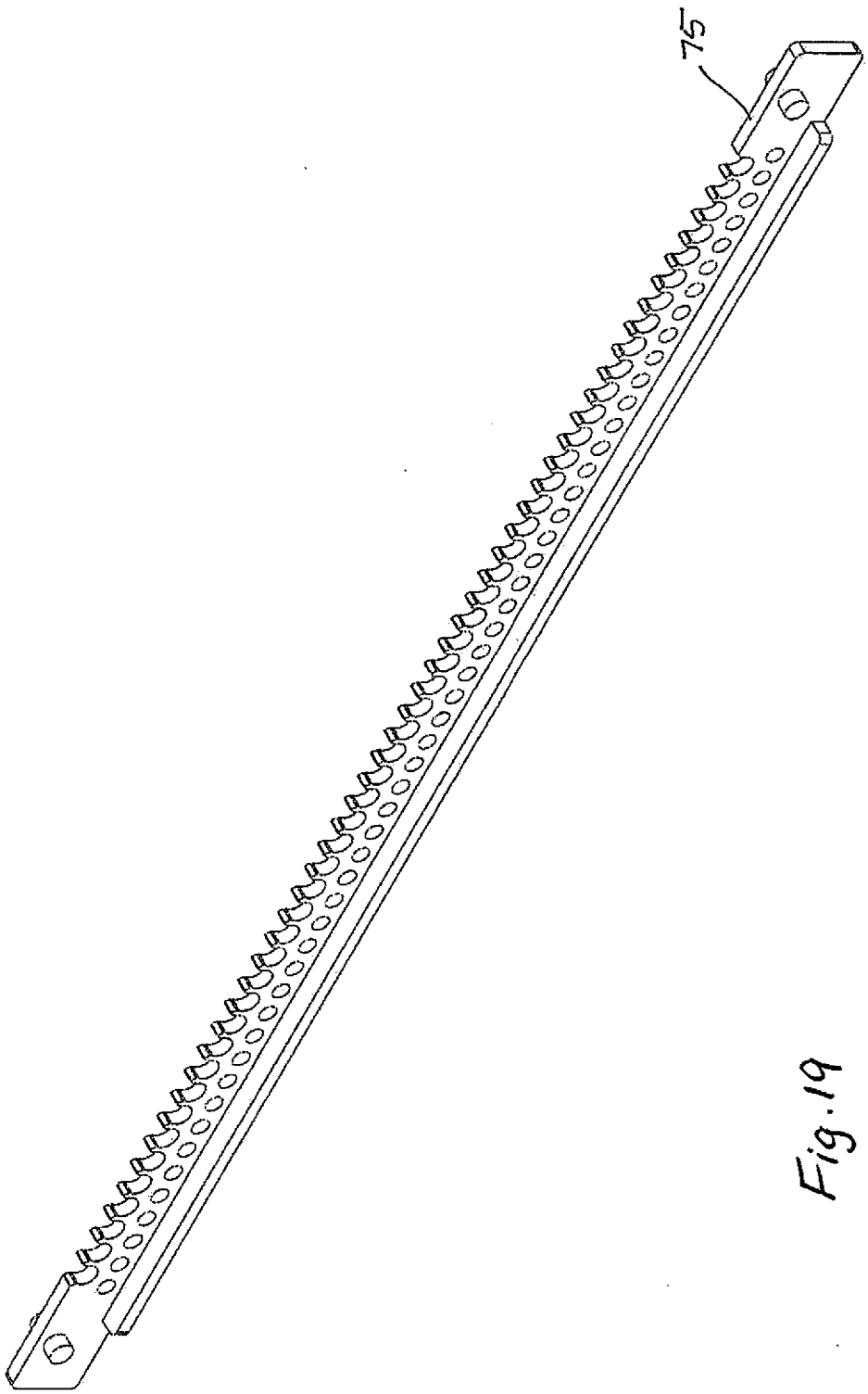


Fig. 19

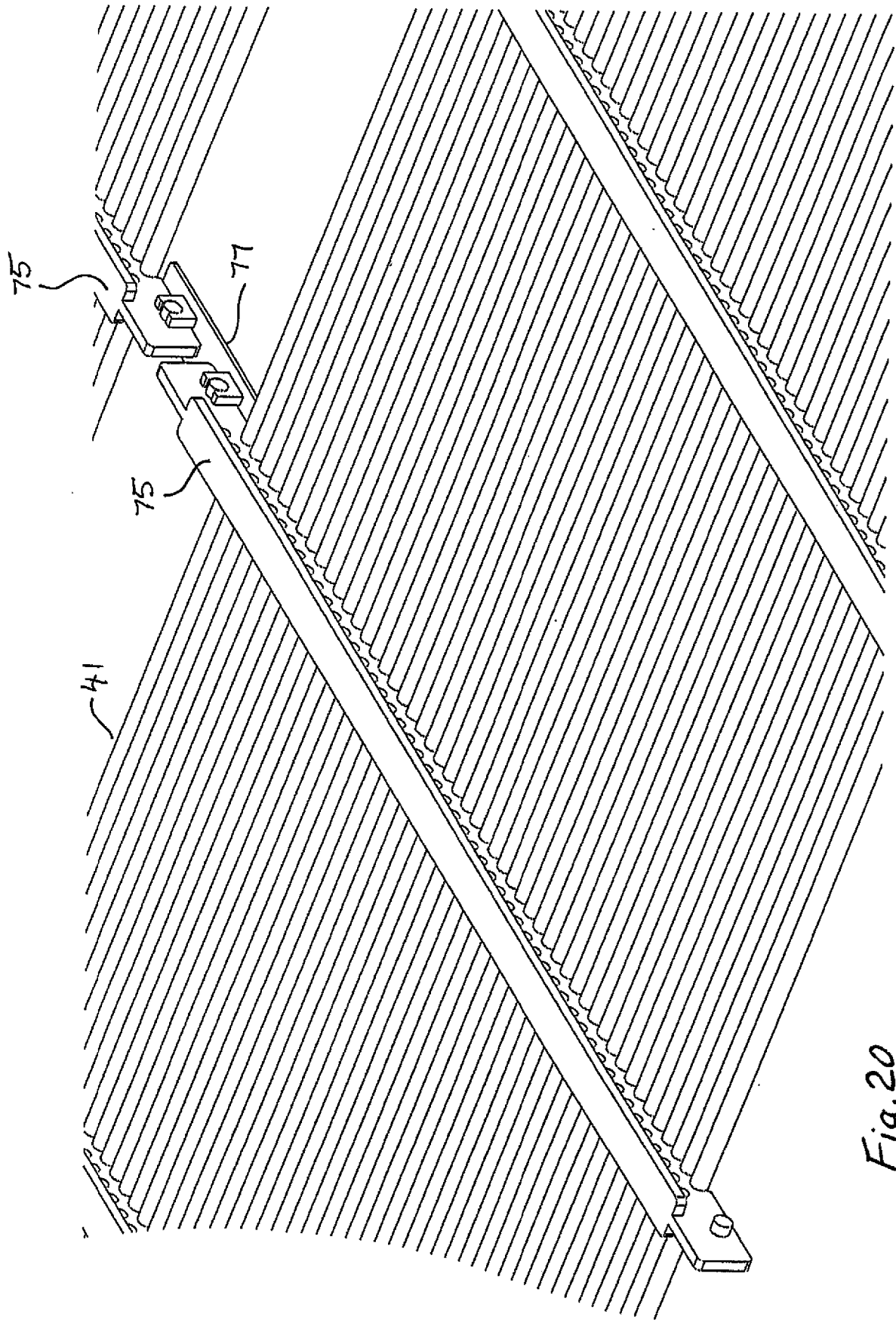


Fig. 20

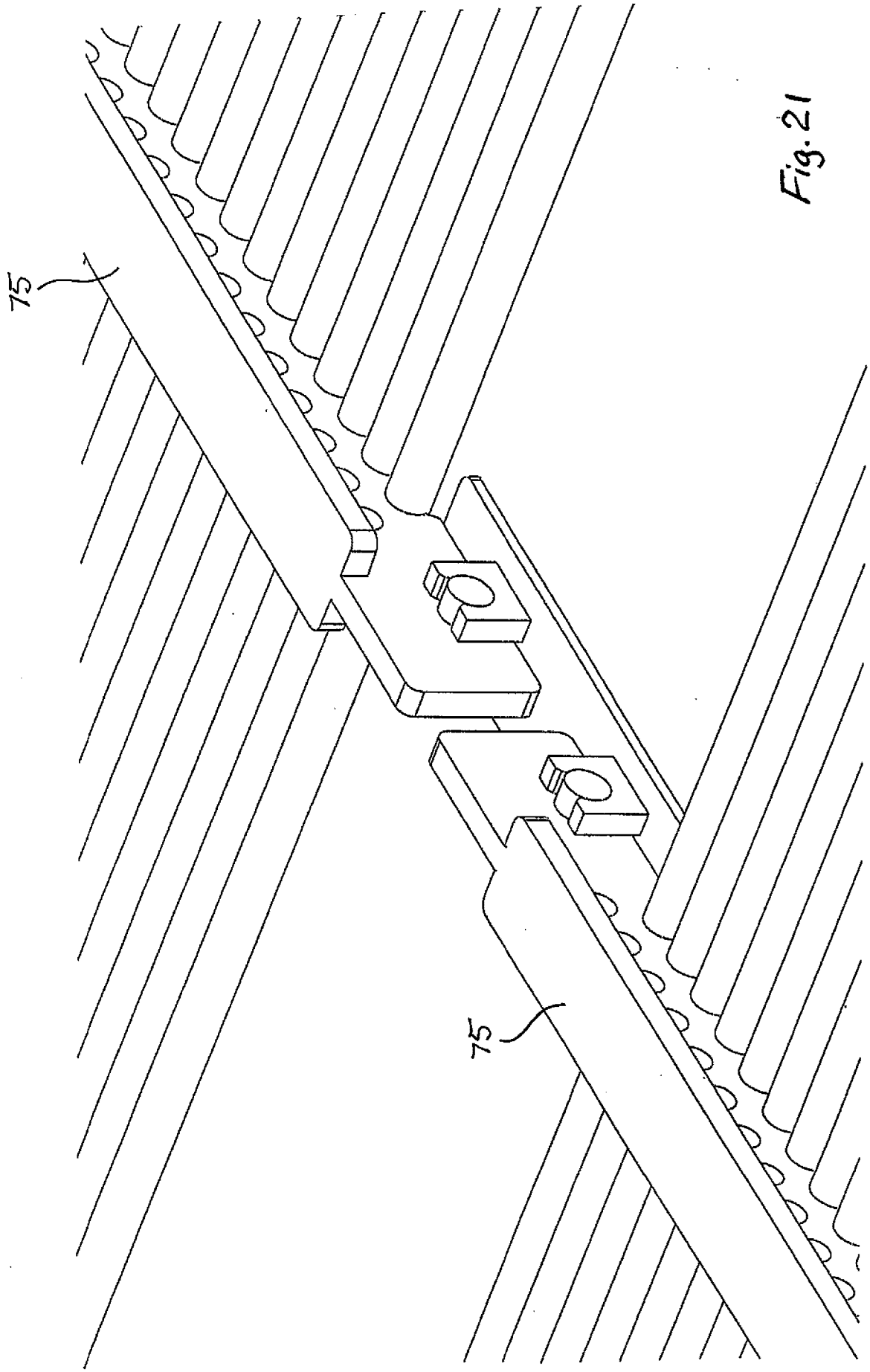


Fig. 21

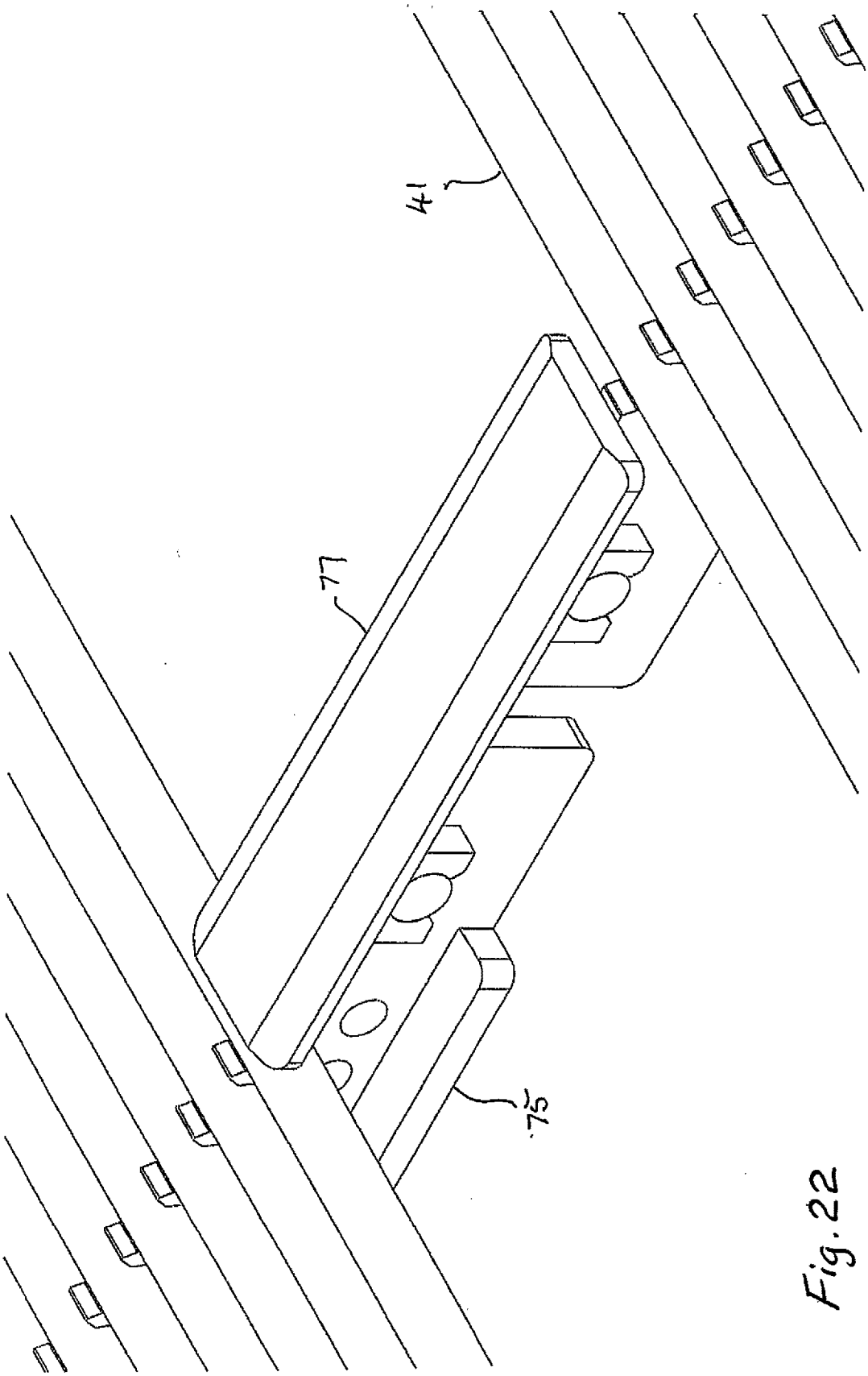


Fig. 22

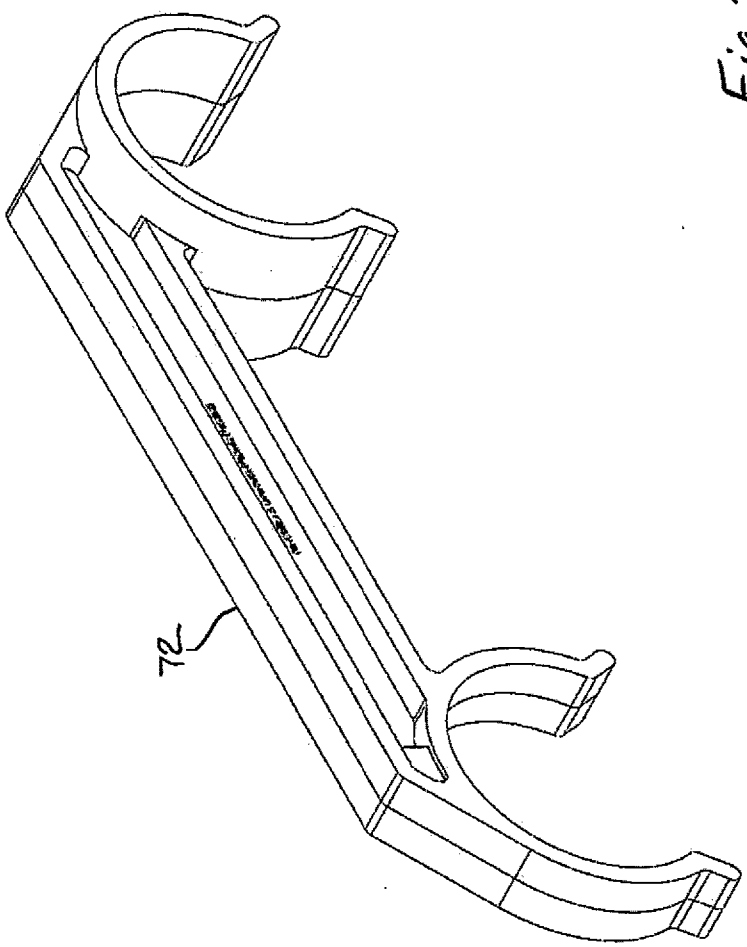


Fig. 23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2018/000221

A. CLASSIFICATION OF SUBJECT MATTER

F24S 80/70 (2018.01) F24S 80/30 (2018.01) F24S 10/00 (2018.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW: IPC/CPC Marks- F28F5/00, H02S40/00, F24S2025/6003, F24S80/70, F24S2025/6005, F24S80/30, Y02E10/44, F28F2255/143, Y02B10/10, Y02B10/20, F16L37/091 with Key Words- MANIFOLD+, PIP+, TWIST, ROTAT+, CAM, MULTIPLE, SEAL+ and like words

X-FULL: Key word search- HEATER?, HEAT D EXCHANGE+, MANIFOLD?, CONNECT+, JOIN+, CAM, TWIST, LOCK+

Applicant/Inventor name search in ESPACENET, AUSPAT and internal databases provided by IP Australia: Search criteria- Applicant: Aspire Polymers; Inventor: Carroll, Paul

GOOGLE PATENTS: Word search with various combinations of- Heat, Exchanger, Manifold, Join/Lock/Coupling

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 February 2019	01 February 2019
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Pathma Fernando AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61262837948

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/AU2018/000221**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0349178 A1 (FAFCO INCORPORATED) 03 December 2015 Abstract; paragraphs [0080]-[0081]; figs 2, 17, 19, 20	1, 2
A	US 2003/0209281 A1 (HAAS ET AL.) 13 November 2003 Abstract; paragraph [0055]; figs 2, 11	
A	US 6913294 B2 (TREVERTON ET AL.) 05 July 2005 Abstract; figs 6-9C	
X	WO 2011/058401 A1 (WATERCO LIMITED) 19 May 2011 Abstract; paragraphs [0036]-[0037]; figs 1, 2	1, 2
A	WO 2008/120178 A1 (KINGSPAN HOLDINGS (IRL) LIMITED) 09 October 2008 Abstract; fig 9	
A	US 2010/0108055 A1 (DAVIS ET AL.) 06 May 2010 Abstract; figs 1-9	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2018/000221

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1, 2

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1 and 2 are directed to a method of joining adjacent manifolds together using a cam locking system and a solar heat exchanger in which the manifolds are connected together using a threadless connection arrangement. The feature of the cam locking system to provide improved leak resistance and prevent loosening when exposed to repeated thermal expansion and contraction cycles is specific to this group of claims.
- Claim 3 is directed to a system for securing a solar heat exchanger to a tiled roof. The features of a wire hook for attachment to a roof batten under the tiles; an adjustable connection strip connected to the wire hook; and a manifold clamp attached to the adjustable connection strip are specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2018/000221**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2015/0349178 A1	03 December 2015	US 2015349178 A1	03 Dec 2015
		EP 3149776 A1	05 Apr 2017
		KR 20170031671 A	21 Mar 2017
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		US 2015349177 A1	03 Dec 2015
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		US 8297274 B2	30 Oct 2012
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		AU 2008256262 B2	23 Feb 2012
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		CN 101688693 B	18 Jul 2012
		CN 102706001 A	03 Oct 2012

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2018/000221**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
		EP 2149017 A1	03 Feb 2010
		GB 2449766 A	03 Dec 2008
		GB 2449766 B	05 Jun 2013
		GB 2488949 A	12 Sep 2012
		GB 2488949 B	05 Jun 2013
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		IE 86365 B1	26 Mar 2014
		IE 86509 B1	11 Mar 2015
		IE 20130370 A1	11 Mar 2015
		NZ 580798 A	26 Oct 2012
		US 2013228164 A1	05 Sep 2013
		US 8602021 B2	10 Dec 2013
		WO 2008146269 A1	04 Dec 2008
		ZA 200907488 B	30 Jun 2010

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.