Electronic Acknowledgement Receipt

EFS ID:	37928746
Application Number:	62943482
International Application Number:	
Confirmation Number:	9869
Title of Invention:	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps
First Named Inventor/Applicant Name:	William P. Bernardi
Customer Number:	28289
Filer:	Richard L. Byrne/Cheri Leone
Filer Authorized By:	Richard L. Byrne
Attorney Docket Number:	6178-1908689
Receipt Date:	04-DEC-2019
Filing Date:	
Time Stamp:	15:37:13
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$140
RAM confirmation Number	E2019B4F37469811
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	CoverSheet.pdf	173423 a9ab8151c3db4e12837dd3cbff23240302a23d79	no	3
Warnings:					
This is not a USPTO supplied Provisional Cover Sheet SB16 form.					
Information:					
2	Application Data Sheet	FillableADS.pdf	1255853 2ad1b758dcbaccbf4e1f7009b82a8a1761f5b137	no	8
Warnings:					
Information:					
3	Specification	Application.pdf	402276 34ae2086d3c55d305b07923c370e48770cb071ad	no	12
Warnings:					
Information:					
4	Drawings-only black and white line drawings	Drawings.pdf	965174 a8462c139381e81355f4a314128900c6317432d0	no	9
Warnings:					
Information:					
5	Appendix to the Specification	AppendixA.pdf	2160350 e760771e4b9f12389397561d57bea6317d599c11	no	17
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30265 313472d36855ceddde24b920bf6fe09ef213915d	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	4987341

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps
First Named Inventor/Applicant Name:	William P. Bernardi
Filer:	Richard L. Byrne/Cheri Leone
Attorney Docket Number:	6178-1908689

Filed as Small Entity

Filing Fees for Provisional

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PROVISIONAL APPLICATION FILING FEE	2005	1	140	140
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**140**

PTO/SB/16 (10-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Priority Mail Express® Label No. _____

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
William P.	Bernardi	Ligonier Twp., PA

Additional inventors are being named on the _____ separately numbered sheets attached hereto.

TITLE OF THE INVENTION (500 characters max):

Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ The address corresponding to Customer Number: 28289

OR

☐ Firm or Individual Name

Address

City	State	Zip
Country	Telephone	Email

ENCLOSED APPLICATION PARTS (*check all that apply*)

- ■ Application Data Sheet. See 37 CFR 1.76.
- ☐ CD(s), Number of CDs _____
- ☑ Drawing(s) *Number of Sheets* 9
- ☑ Other (specify) Appendix
- ☑ Specification (e.g., description of the invention) *Number of Pages* 12

Fees Due: Filing Fee of $280 ($140 for small entity) ($70 for micro entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is $400 ($200 for small entity) ($100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

- ☑ Applicant asserts small entity status. See 37 CFR 1.27.
- ☐ Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ☐ A check or money order made payable to the *Director of the United States Patent and Trademark Office* is enclosed to cover the filing fee and application size fee (if applicable).
- ☑ Payment by credit card.
- ☑ The Director is hereby authorized to charge the filing fee and application size fee (if applicable) or credit any overpayment to Deposit Account Number: 23-0650.

140.00

TOTAL FEE AMOUNT ($)

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 2 of 2

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government. (NOTE: Providing this information on a provisional cover sheet, such as this Provisional Application for Patent Cover Sheet (Form PTO/SB/16), does not satisfy the requirement of 35 U.S.C. 202(c)(6), which requires that the *specification* contain a statement specifying that the invention was made with Government support and that the Government has certain rights in the invention.)

☑ No.

☐ Yes, the invention was made by an agency of the U.S. Government. The U.S. Government agency name is:

_____

☐ Yes, the invention was made under a contract with an agency of the U.S. Government.

The contract number is: _____

The U.S. Government agency name is: _____

_____

In accordance with 35 U.S.C. 202(c)(6) and 37 CFR 401.14(f)(4), the specifications of any United States patent applications and any patent issuing thereon covering the invention, including the enclosed provisional application, must state the following:

''This invention was made with government support under [IDENTIFY THE CONTRACT] awarded by [IDENTIFY THE FEDERAL AGENCY]. The government has certain rights in the invention."

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

SIGNATURE /Richard L. Byrne/ DATE December 4, 2019

TYPED OR PRINTED NAME Richard L. Byrne REGISTRATION NO. 28498 (*if appropriate*)

TELEPHONE 412-471-8815 DOCKET NUMBER 6178-1908689

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	William	P.	Bernardi	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Ligonier Twp.	State/Province	PA	Country of Residence	US

Mailing Address of Inventor:

Address 1	516 Darlington Road		
Address 2			
City	Ligonier Twp.	State/Province	PA
Postal Code	15658	Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	28289		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps		
Attorney Docket Number	6178-1908689	Small Entity Status Claimed	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	9	Suggested Figure for Publication (if any)	

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	28289		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	United States ThermoAmp Inc.

Mailing Address Information For Applicant:

Address 1	1223 Walnut Street		
Address 2			
City	Latrobe	**State/Province**	PA
Country	US	Postal Code	15650
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Richard L. Byrne/			Date (YYYY-MM-DD)	2019-12-04
First Name	Richard L.	Last Name	Byrne	Registration Number	28498

Additional Signature may be generated within this form by selecting the Add button.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	6178-1908689
	Application Number	
Title of Invention	Method and Condensing Heat Exchanger for Air to Liquid Heat Pumps	

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

METHOD AND CONDENSING HEAT EXCHANGER FOR AIR TO LIQUID HEAT PUMPS

FIELD OF THE INVENTION

An improved condensing heat exchanger for use in air source to liquid heat pumps, such as a swimming pool heat pump or liquid to liquid heat pumps and other applications.

BACKGROUND OF THE INVENTION

Air source heat pumps have been used in various applications to remove heat from outdoor air and move it to another fluid or heat sink for space and water heating as well as other applications, including process heat for industrial and commercial applications including agricultural aquariums, fish ponds, etc.

Heat pumps are increasingly replacing fossil fuel heaters, especially where they are already the most cost effective heating method, where the cost per delivered Btu is greater than the cost of the electricity required to move a Btu of heat from the air using a heat pump.

One such application, swimming pool heat pumps, have been manufactured for over 50 years. In the past, due to their unfamiliarity and higher initial cost, they have been overlooked by many pool owners.

In the last few decades, however, swimming pool heat pumps have become increasingly popular as a more efficient and cost effective alternative to fossil fuel pool heaters, such as natural gas, propane and oil fired units, due to their significant operating cost savings, which quickly offset the higher initial cost of swimming pool heat pumps.

It is not uncommon for a swimming pool heat pump to have a payback period of one or two seasons.

As a result, all major fossil fuel pool heater manufacturers now also make and sell heat pump models. However, due to the higher initial cost and recent drops in the prices of fossil fuels resulting from fracking, fossil fuel pool heaters still have the larger market share.

The higher cost of a swimming pool heat pump compared to a fossil fuel pool heater is due to the additional fan motor and air moving components, the refrigeration system piping, and the compressor. In addition, cost is increased by the need for two heat exchangers, namely, an evaporator for removing heat from the air to cooler low pressure evaporating refrigerant and a condenser for transferring that heat from the hotter compressed high pressure refrigerant gas to the swimming pool or spa water.

The first swimming pool heat pumps in the 1980s originally adopted two of the controls as well as the heat exchanger tube material used by the fossil fuel pool heater:

1. A water pressure switch to detect water flow by sensing the back pressure the pump creates as water is pumped through an eyeball fitting in a return line back to the pool.

2. A mechanical thermostat to monitor water temperature which uses a copper bulb in a well, and a capillary tube connected to a diaphragm, to actuate a micro-switch.

3. Copper and later Cupronickel heat exchanger material, until chlorinated water corrosion caused leaks, which ruined the heat pump systems. Then Cupronickel, as well as some coatings, were tried to stop corrosion. Titanium was first adopted by the Heat Siphon brand swimming pool heat pumps in 1991 to solve this problem.

Current Heat Exchangers in Swimming Pool Heat Pumps

Controls - Modern swimming pool heat pumps and many gas heaters now use an electronic controller which is more reliable and allows less expensive, and simpler thermistors to monitor water temperature.

Heat Exchanger Tube Material - Swimming pool heat pumps almost all have adopted the use of titanium tubing in the water side heat exchanger, and all use either a titanium spiral tube inside a plastic tube, or a titanium tube helical coil inside a plastic shell.

The following are images of the heat exchangers in current swimming pool heat pumps, which are either tube in shell or tube in tube:

The titanium tubes in tube and shell type heat exchangers are estimated to be 30 to 80 feet in length, with spiral tube in tube types having about the same equivalent length since a smooth tube is twisted in a spiral significantly shortening it. Water flows over the titanium tube and refrigerant flows inside.

The Heat Siphon brand uses a helical coil some 50 feet long inside a PVC shell in its 50,000 btuh model and 75 feet long in larger models.

The tube in shell heat exchangers use some type of baffle to increase velocity to improve efficiency.

AQUACAL


Raypak Heat Exchanger Kit 3350-4350

The tube in tube heat exchangers use a spiral tube inside a smooth PVC pipe jacket coiled in a tight helix to conserve space, however the length of starting titanium tube is still two to three times the final twisted length.

SUMMARY OF THE INVENTION

This invention is an improvement on the current art both in its efficiency as well as the reduced cost to manufacture.

Very shallow dimples are made in the outer titanium tube so they touch the inner tube. They are made in pairs at 90 degree angles, with four dimples in one circle, and each set is alternately rotated 45 degrees, making a total of eight rows axially down the tubes length.

The result is a micro channel of typically .035 inches wide with the dimples holding the inner tube in the center of the outer tube and allowing the pair of tubes to be coiled and assembled inside.

This results in:

1. Very little shortening of the outer tube thus much less length of tubing required

2. Increased heat transfer due to the micro channel gap which further shortens the length of tube required

3. Increased heat transfer due to the heated fluid being in direct contact with the inner and outer tubes in a single pass which further reduces tube length needed.

The first test of this invention confirmed that the smallest Heat Siphon model, which has an output of approximately 50,000 btuh, and which has a tube in shell type heat exchanger and two helically wound tube coils, uses 35 feet of titanium tubing, when equipped with the tube in tube dimpled heat exchanger invention only required ten feet total inner plus outer tube to achieve same heat output and at an efficiency slightly greater. This saves 25 feet of titanium tubing and increased the efficiency of the model.

BRIEF DESCRIPTION OF THE DRAWINGS

Throughout this application, parts, and descriptions refer to the Figures appended hereto, and the part numbers and names refer to the item numbers in the referenced Figures.

Reference Number List:

20. PVC Flexible SCH 40 Pipe
21. External PVC Pool Piping
22. PVC Tee - 1.0” x 1.5 x 1.5” Sch 40
23. PVC Seal Fitting Bushing
24. PVC Seal Fitting Nut
25. Tube - 5/8” Titanium Pressure Relief
26. Tube - 1/2” Titanium Refrigerant Inlet
27. Tube - 1/2” Titanium Refrigerant Outlet
28. Tube - 5/8” Titanium Dimpled Outer

29. Tube - 1/2" Titanium Inner Annulus
30. Titanium Weld Fitting - Water Seal
31. Titanium Weld Fitting - Pressure Relief Tube
32. Titanium Weld Fitting - Annulus Tee
33. Titanium Weld Fitting - Refrigerant Tube
34. O-ring - Refrigerant
35. O-ring - Pressure Relief
36. Viton Water Seal Ring
37. Dimple Tube Depression
38. Refrigerant / Annulus Flow Path
39. Orbital Weld Bead - Annulus Tee to Outer Dimple Tube
40. Welded Titanium Annulus Tee Assembly
41. Water Flow Path
42. Orbital Weld Bead - Annulus Tee to Inner Dimple Tube
43. Weld Metal - Annulus Tee to Water Tube Seal Fitting
44. Orbital Weld Bead - Refrigerant Inlet/Outlet- Tubes to Weld Fitting
45. Orbital Weld Bead - Pressure Relief Tube to Weld Fitting
46. Internal Titanium Tubing Assembly
47. Welded Pressure Relief Tube & Fitting Assy
48. Welded Refrigerant Inlet/outlet Tube & Fitting Assy
49. Annulus surface inside tee
50. Mating Surface to inner dimple tube
51. Mating Surface to Outer Dimple Tube
52. Stop Ledge Surface for Water Seal Weld Fitting
53. Pressure Relief Leak Flow Path
54. Isolation Fitting (patent 9,255,656)
100. Tyoical Air Source to Liquid Heat Pump
101. Air Moving Device
102. Refrigerant Evaporator
103. Refrigerant Compressor
104. Refrigerant Condensor
105. Piping from Swimming Pool
106. Piping to Swimming Pool
107. Refrigerant Metering / Expansion Device
108. Dimple Forming Wheel

FIG. 1 Air Source Heat Pump with Invention Installed
FIG. 2 Heat Exchanger Assembly
FIG. 3 Titanium Tube Assembly
FIG. 4 Tee / Fitting Assembly Sectional View
FIG. 5 Sectional View of Welded Titanium Annulus Tee Assembly
FIG. 6 Sectional View of Welded Titanium Pressure Relief Tube Assembly
FIG. 7 Sectional View of Welded Titanium Inlet or Outlet Tube Assembly
FIG. 8 Exploded View of Welded Titanium Tube Assembly
FIG. 9 Sectional View of Refrigerant Tube Weld Fitting

FIG. 10 Sectional View of Pressure Relief Weld Fitting
FIG. 11 Sectional View of Water Seal Weld Fitting
FIG. 12 Front View of Dimpled Inner and Outer Tubes
FIG. 13 Inner Annulus and Outer Dimpled Tubes Positioned Together
FIG. 14 Inner Annulus and Outer Dimpled Tubes Bent in Half Circle
FIG. 15 Assembled Heat Exchanger Coil showing 1.5 Wraps Embodiment
FIG. 16 Enlarged Sectional View of Titanium Fittings Assembly
FIG. 17 Sectional View of Titanium Annulus Tee Fitting
FIG. 18 Dimple Forming Wheel with Dimple Spheres
FIG. 19 Sectional View of Simple Dimple Forming Block

DESCRIPTION OF THE INVENTION

The term “water” and “heated fluid” are interchangeable throughout this description where water is used in conjunction with swimming pool heat pump applications for clarity while heated fluid is the more accurate to all other applications.

For a fuller understanding of the nature of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawings of one or more preferred embodiments of the invention:

Figure 1 shows the invention 200 where the preferred embodiment is assembled and installed in a heated fluid piping system and in the refrigeration tubing of a typical air source to liquid heat pump 100. A heat pump’s refrigeration circuit must include four components to work as shown by Figure 1:

1. an air moving device 101 and an evaporating heat exchanger 102 to extract heat from the air

2. a refrigerant compressor 103 to compress and thereby heat up the refrigerant gas

3. a condensing heat exchanger 104 to deliver the heat to the water which passes to it from the pool at 105 and returns to the pool at 106 via the filter pump circulation plumbing

4. a metering expansion device 107 between the two heat exchangers to create a high pressure zone for condensing the hot compressed refrigerant gas, and low pressure side to evaporate the cool liquid refrigerant.

In addition, Figure 1 shows the installation of two isolation fittings 54, the subject of patent 9,255,656 (attached hereto as Appendix A), which as mentioned later herein, will allow repair or replacement of the heat exchanger invention without cutting tubes or brazing or welding by simply unscrewing the fittings.

Figure 2 shows the invention heat exchanger assembly 200, which consists of a flexible schedule 40 PVC pipe 20 of a length and straight or curved to accommodate the required length of heat exchanger, which is typically solvent welded (glued) to the 1.0 inch x 1.5 inch x 1.5 inch PVC sch 40 tees 22 at each end. A PVC bushing 23 is glued into the 1 inch port of the tee and a fitting

nut 24 screws into the bushing 23 and squeezes a suitable rubber rectangular or o-ring (not visible) against the titanium pressure relief tube 25 to seal and prevent the heated fluid inside the heat exchanger from leaking out. Inside the relief tube 25, is a smaller diameter titanium refrigerant inlet tube 26 or outlet tube 27 depending on which end of the heat exchanger, one is referring. External swimming pool piping 21 is shown in place.

Figure 3 shows the internal titanium tube assembly 46 which has identical tubes and fittings at each end inside each PVC tee 22.

These assemblies are composed of the refrigerant inlet tube 26 and outlet tube 27, which protrude inside the pressure relief tubes 25, that are orbital welded to the titanium pressure relief tube weld fittings 31.

As shown in figure 3, these fittings 31, screw into the titanium water seal weld fittings 30. The titanium water seal weld fittings 30, are welded into the titanium annulus tee 32, which is in turn orbital welded to the inner annulus titanium tube 29, and the outer titanium dimpled tube 28.

Figure 4 is a sectional view of one end of the heat exchanger assembly 200, and shows the water 41, and refrigerant 38, flow channels, the pressure relief flow channel 53, and the various internal tubes, seals, weld beads, and fittings.

Figure 4 also delineates an enlarged view shown by Figure 16 to provide a more detailed clear view of the parts and the flow paths of the water and refrigerant. Figure 17 is a sectional view of the annulus tee 32 and more clearly shows the details of its cavity and how the dimple tubes 28 and 29 fit.

Water Flow Path

Figure 4 shows the outer PVC tee 22 which directs the water at 41, both around the titanium tube assembly 46 as well as through the inner titanium tube 29. In more detail, the water flows over titanium annulus tee 32, over all of the numerous dimple tube depressions 37, made in the outer tube 28 which should disrupt any laminar flow and cause turbulence enhancing the heat transfer between the hotter titanium tubes and the water.

At the other end of the assembly, the tee 22 gathers the heated water from these two flow paths and returns it to the pool. This doubles the surface area transferring heat from the refrigerant to the water over the length of the heat exchanger since both the inside of the inner tube 29 and outside diameter of the dimpled tube 28 are in direct contact with the pool water 41.

Refrigerant Flow Path

As shown in figure 4 the refrigerant flow path 38, enters the titanium inlet tube 26 which is welded by the weld bead 44 to the tube fitting 33, which is threaded into the titanium water seal fitting 30, and flows into the annulus tee 32.

The titanium weld 43 joins the titanium annulus tee 32 to the titanium water seal fitting 30, separating the heated fluid and refrigerant, thus the refrigerant path continues into the annulus formed by the inner titanium tube 29 and the outer titanium dimpled tube 28.

The refrigerant is prevented from leaking out to the pressure relief tube 25 annulus by the o-ring 34.

As figure 4 shows, through a combination of o-rings and titanium welds, that the flow path of the heated fluid and the refrigerant are kept separated and a leak path is provided such that if either o-ring is breached the refrigerant or the heated fluid will weep out of the pressure relief tube to atmosphere instead of possibly contaminating the heat pump refrigerant system.

The seal points are as follows:

1. Orbital weld 44 seals the titanium inlet tube 26 to the titanium refrigerant weld fitting 33.

2. O-ring 34 seals the titanium refrigerant weld fitting 33 and the titanium water seal weld fitting 30.

3. Weld 43 seals the titanium water seal weld fitting 30 to the titanium annulus tee 32.

4. Orbital weld 42 seals the titanium outer dimple tube 28 to the titanium annulus tee 32 on each end of the heat exchanger.

5. Orbital weld 39 seals the titanium inner annulus tube 29 to the titanium annulus tee 32 on each end of the heat exchanger.

Thus items 1-5 above establish the flow path for the refrigerant sealed from the heated fluid.

6. Orbital weld 45 seals the titanium pressure relief tube 25 to the titanium pressure relief weld fitting 31.

7. O-ring 35 seals the titanium pressure relief weld fitting 31 and titanium refrigerant weld fitting 33 from the heated fluid.

8. O-ring / Seal Ring 36 compressed by PVC nut 24 and PVC bushing 23 which squeeze the seal against the pressure relief tube 25, and seals the heated fluid in tee 22.

9. O-ring 34 also seals any heated fluid which may have leaked from O-ring 35 from entering the refrigerant system which leaves an open path for any such leak to escape down the pressure relief tube open to atmosphere.

Figure 5 shows a sectional view of the welded titanium annulus tee assembly 40 consisting of the annulus tee 32 and the outer and inner dimple tubes 28 and 29 sealed by orbital welds 39 and 42 respectively to it, and the titanium water seal 30, welded to it also by weld 43 with the water seal o-ring 35, in place.

Figure 5 also shows the heated fluid flow path 41 and the refrigerant flow path 38.

Figure 6 is a sectional view of welded pressure relief tube fitting assembly 47 showing the fitting 31 and pressure relief tube 25 welded together by orbital weld bead 45.

Figure 7 is a sectional view of the welded titanium inlet tube & fitting assembly 48, consisting of inlet tube 26 and fitting 33 welded by orbital weld bead 44.

In order for the welded annulus tee assembly 40 to fit in the PVC tee 22, it is necessary for the tubes 28 & 29, tee 32 and fitting 30 to be all welded together and inserted into the PVC tee 22's 1.5 inch port and flexible tube 20 prior to screwing in the welded inlet tube & fitting assembly 48 shown in Figure 7 and the welded pressure relief tube fitting assembly 47 shown in figure 6.

Figure 7 also shows the heated fluid flow path 41 and the refrigerant flow path 38.

Figure 8 is an exploded view of the internal titanium tube assembly 46, showing the outer dimple tube 28 and inner tube 29, annulus tee 32, water seal weld fitting 30, pressure relief o-ring 35, refrigerant o-ring seal 34, refrigerant weld fitting 33, pressure relief fitting 31, pressure relief tube 25 and refrigerant inlet fitting 26.

Figure 9 is a sectional view of fitting 33.

Figure 10 is a sectional view of fitting 31.

Figure 11 is a sectional view of fitting 30.

Figure 12 is a frontal view of Figure 13 the outer dimple tube and inner tube assembled together. Figure 12 shows the locations of the dimples and how they capture the inner tube and provide the annulus micro channel for the refrigerant to flow and condense.

Figure 14 shows the outer dimpled tube 28 and the inner tube 29 bent into a curve after assembling together.

Figure 15 shows the complete heat exchanger 201 in the preferred embodiment with inlet and outlet tube 27 and 26, pressure relief tube 25, PVC nut 24 and bushing fitting 25, PVC tee 22, and inside the tee the welded annulus tee assembly.

Figure 16 is an enlarged view of the area delineated by the dashed circle in sectional view of figure 3 to more clearly show the water and refrigerant flow paths 38 and 41, and the various seals, fittings and tubes. At the top is a partial view of the PVC tee 22. The annulus tee 32, the two orbital weld beads 39 and 42 which seal and attach the outer dimple tube 28 and inner annulus tube 29 to the annulus tee 32 are shown clearly.

Below those, the titanium water seal fitting 30 has its pressure relief o-ring seal 35 in place and is attached to the annulus tee 32 by weld 43.

The pressure relief weld fitting is partially shown assembled in place threaded on to the end of titanium water seal fitting 30.

Also shown are the titanium weld fitting 33 with its refrigerant o-ring 34 in place, threaded into the water seal fitting 30. Attached to this fitting by orbital weld beads 44 is the titanium inlet tube 26.

Figure 17 is a sectional view showing the titanium annulus tee 32 with the annulus surface 49 that allows the refrigerant to flow from the inlet tube into the tee and around the inner tube 29 then continues between the outside diameter of the inner tube and the inside diameter of the outer dimple tube 28 both shown in figure 16.

Figure 17 also shows the mating surfaces of the two tubes and one fitting that are seal welded to the tee. Surface 50 mates with and is seal welded to the inner tube 29.
Surface 51 mates with and is seal welded to the outer dimple tube 28. Surface 52 is the ledge stop for the titanium water seal weld fitting 30 as it is inserted into the annulus tee 32 and seal welded 43 to it.

Figure 18 shows a wheel 108 used in the device shown in figure 19 to put the dimples into the outer tube. The wheel is machined to fit around the OD of the outer tube 180 degrees and has three spherical projections 109 affixed to the center of the inside radius 120 degree apart.

Figure 19 is a sectional view of such a device where two wheels 108 are placed on two shafts 111 which are inserted into two end blocks 110 to fix the distance between the wheels so they touch. One could add bearings and various mechanisms to pull the outer tube through the wheels to form the dimples in the tube.

The function of this invention for a swimming pool heat pump and other applications is to provide an improved heat exchanger that uses half or less titanium than the current art by improving heat transfer efficiency while maintaining a low water pressure drop.

The following details of the invention are important to its successful implementation.

1. The .035 inch wide annulus formed by the outside diameter of the inner titanium 1/2 inch tube 29 and the inside diameter of the outer tube 28 which is 5/8 inch OD x .028 inch wall is optimal for rapid micro channel condensing of the hot refrigerant gas and greatly increases the btuh heat transfer rate per unit length over the existing spiral tube heat exchangers as well as tube coil in shell heat exchangers.

2. In order to assemble the heat exchanger in a standard PVC tee and flexible pipe, it is preferred to use a two piece approach. This provides a solution by creating the titanium annulus fitting assembly 40 as shown in figure 5 which is inserted in the tee 22. Then, the welded titanium inlet/outlet tube & fitting assembly 48 shown in figure 7, is threaded into the titanium water seal fitting 30 through the 1 inch port of the tee 22, followed by the welded pressure relief fitting 47 shown in figure 6, which is threaded onto the threads on the OD of the titanium water seal fitting 30.

3. In this invention dependable and long life water and refrigerant seals are both made by seal welding various parts together and the use of o-rings of viton or other rubber material compatible with the liquid being heated by the heat pump in those applications.

4. By using standard PVC fittings and pipes and titanium tubes readily available, as titanium has continued to drop in price as it has been adopted in many industries, this invention will result a lower cost heat exchanger.

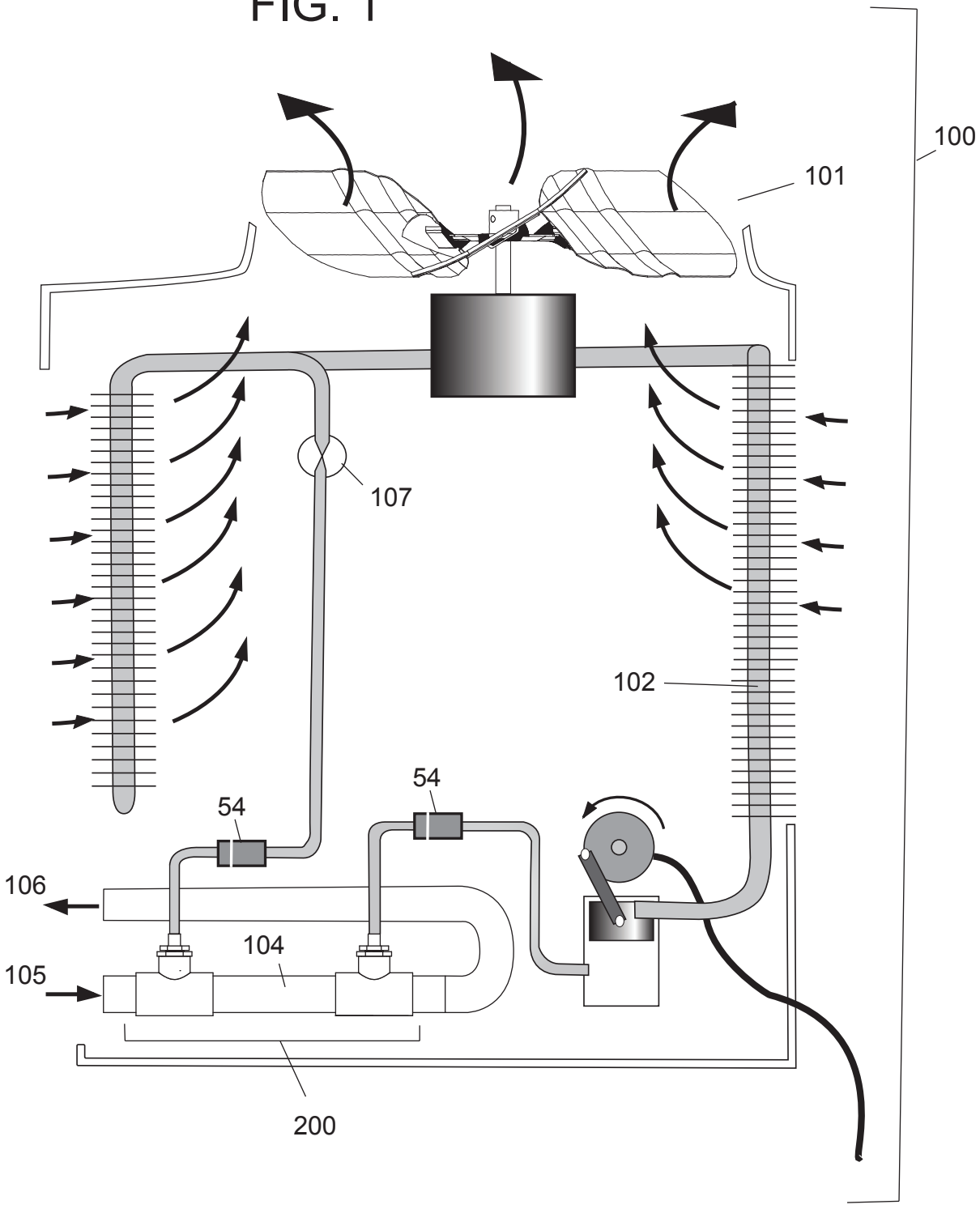
5. By using only titanium and PVC and a suitable o-ring seal material, the heat exchanger is more broadly applicable to the heating of many other corrosive liquids than swimming pool water which further reduces cost by increasing the number and volume of its uses.

6. The use of staggered dimples in the outer tube 28 by this invention as shown in figures 12, 13 and 14 and which are easily made by the method and devices similar to that shown by figures 18 and 19, maintains the close annulus spacing, keeps the tubes centered about each other and allows the modest bending into a coiled housing 20 as shown in figure 15. These dimples also create turbulent flow of the heated water further increasing heat transfer as is known to those familiar with this technology similar to a golf ball.

7. The invention provides the added protection from contaminating the refrigerant system with the heated fluid, by adopting the design and arrangement of parts to provide the pressure relief leak path 53 shown in figure 4. This “double wall” type seal will significantly increase the life of the heat pump and minimize the impact of a leak on the compressor and the heat pump system. Since the fluid seal breached will become clear by the loss of refrigerant or the presence of water around the heat exchanger, a breach will cause minimal disruption and make repair much less involved.

8. The invention makes repair of the heat exchanger as simple as possible and by using the isolation fittings 54 installed in a heat pump as shown in figure 1 allows repair or replacement of the heat exchanger invention without brazing or welding by simply unscrewing the fittings.

FIG. 1



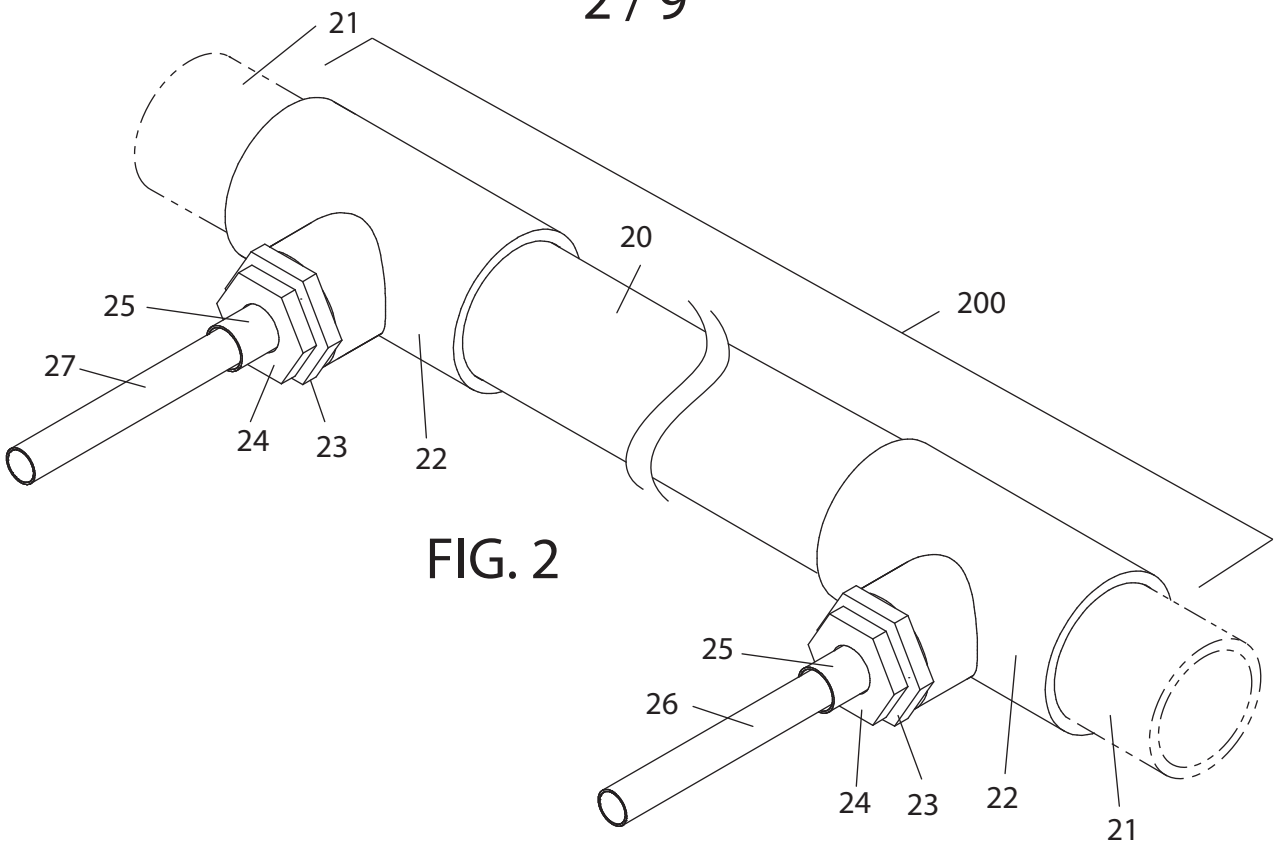

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FIG. 2

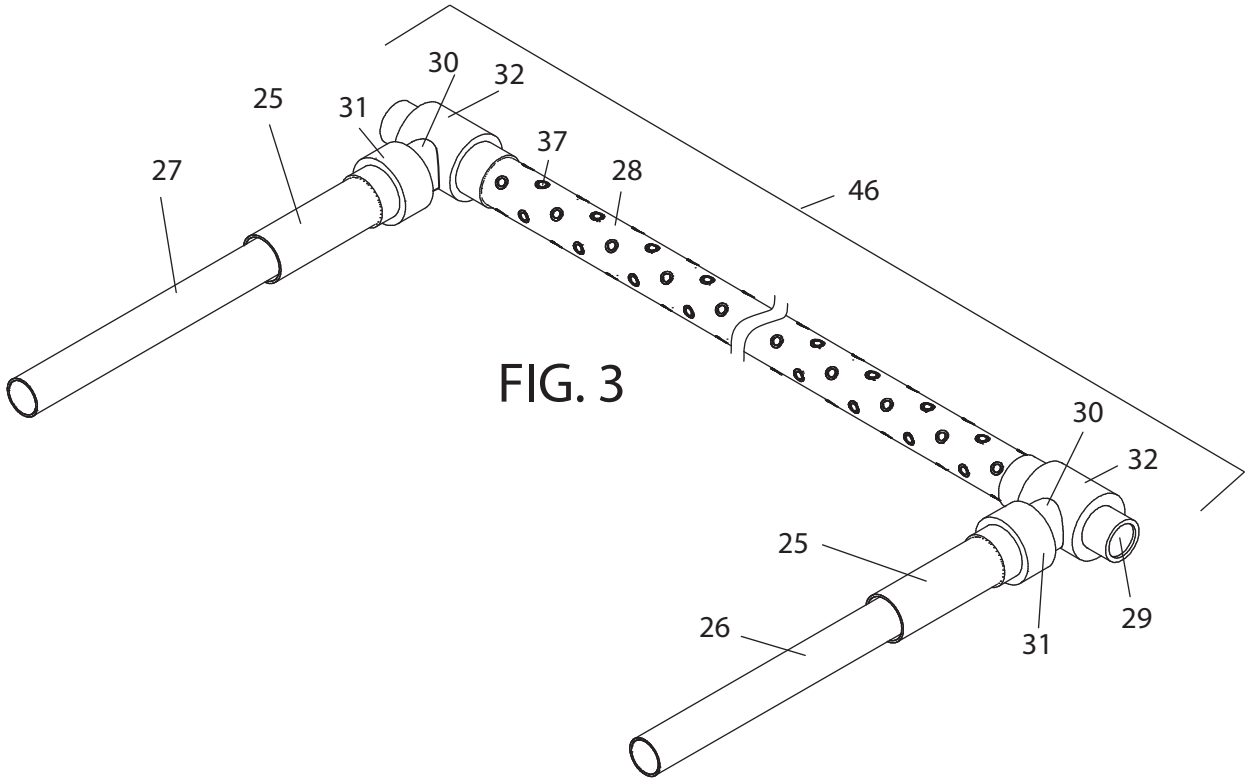
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FIG. 3

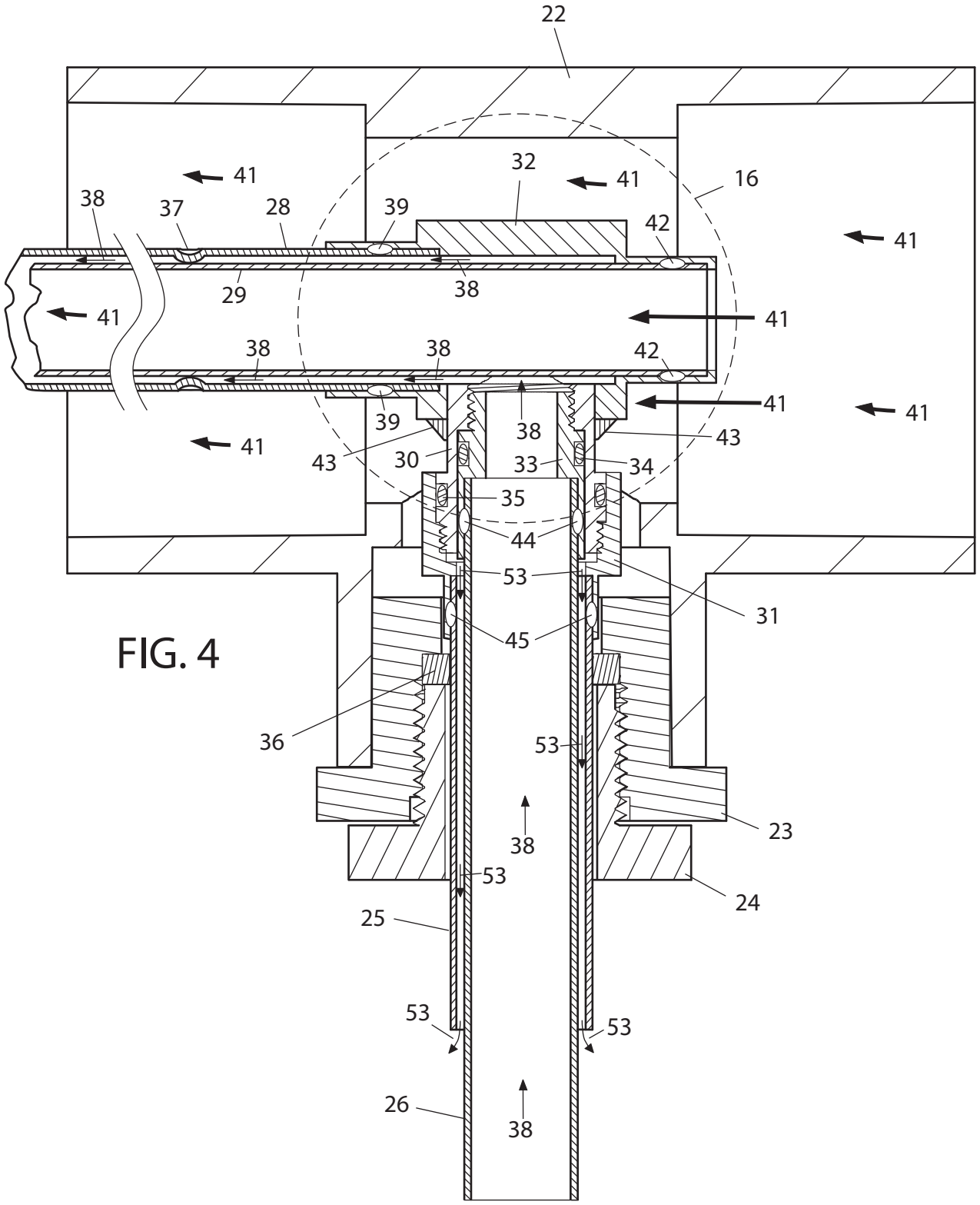
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FIG. 4

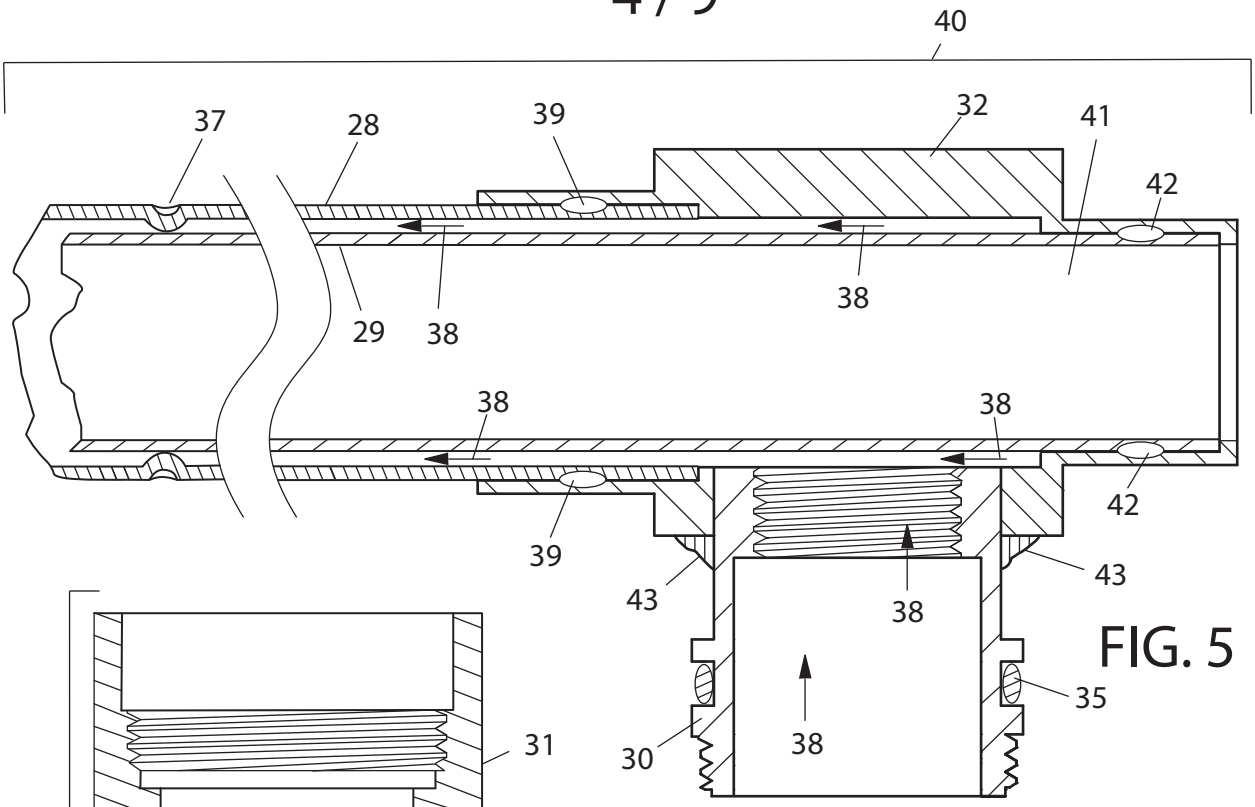


FIG. 5

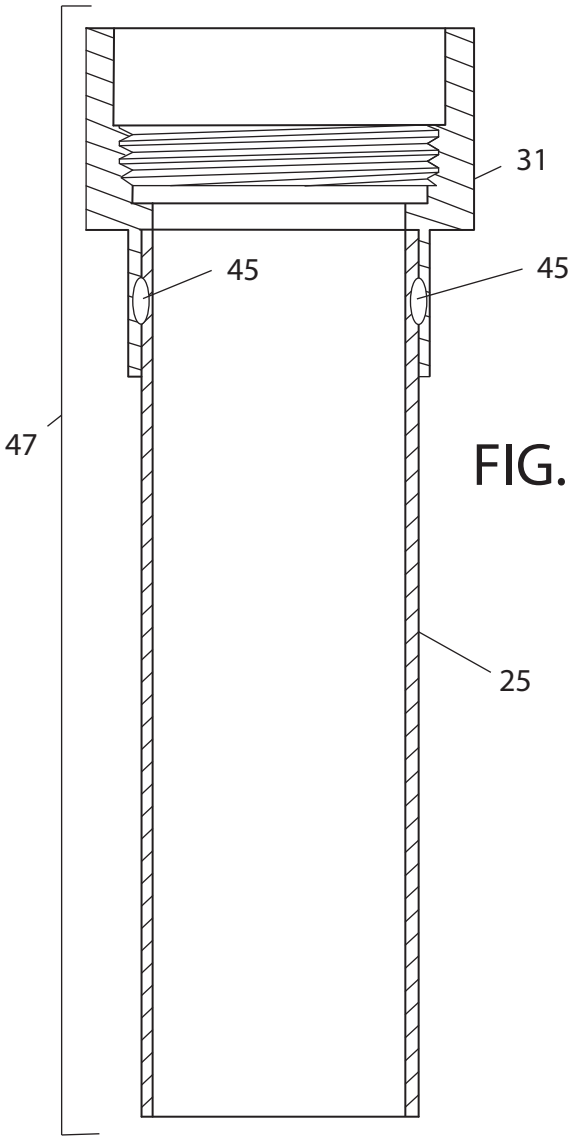


FIG. 6

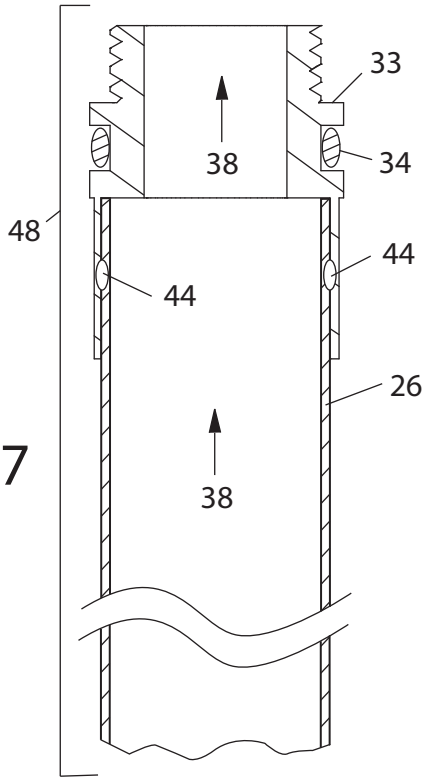


FIG. 7

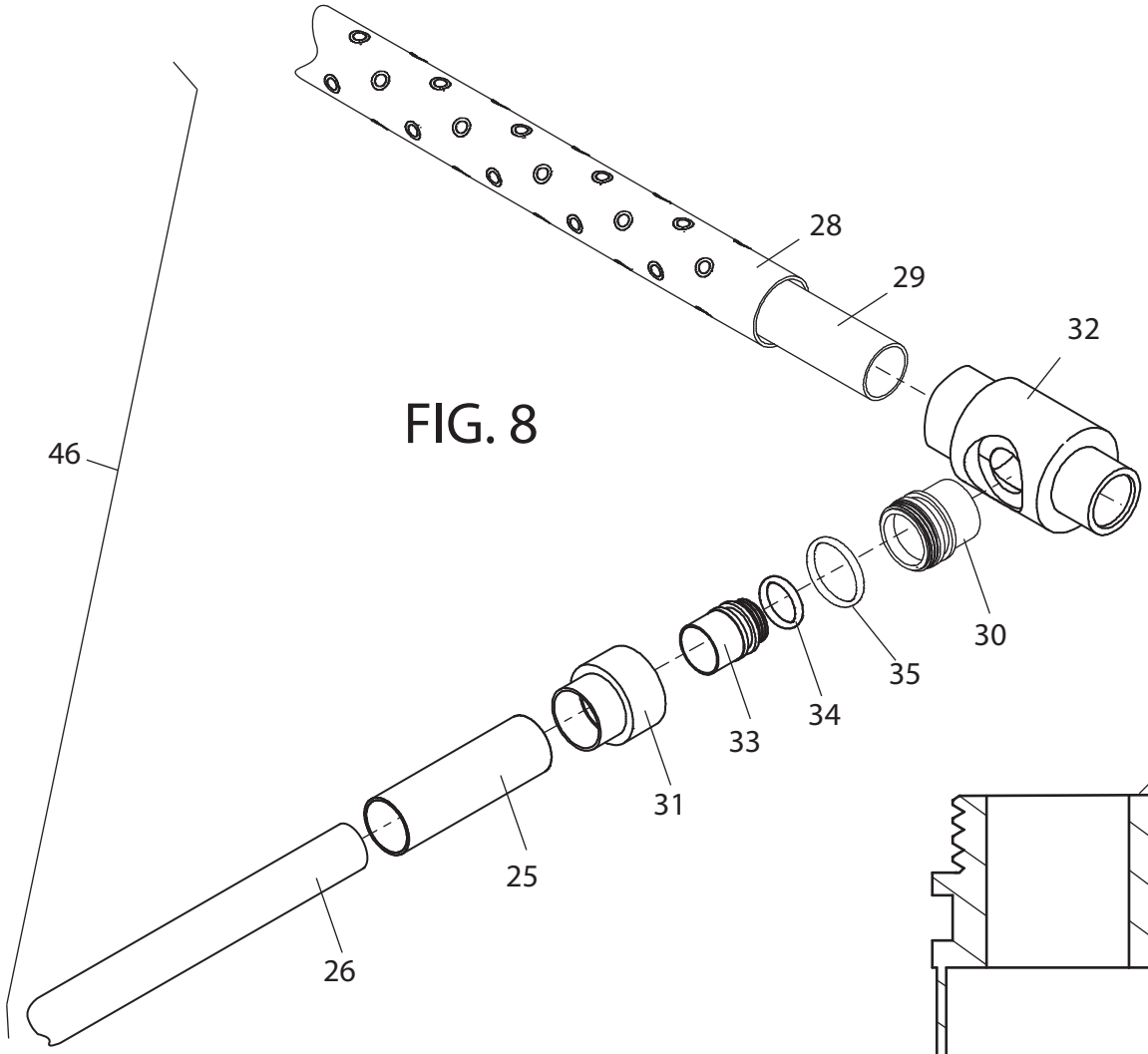


FIG. 8

FIG. 9

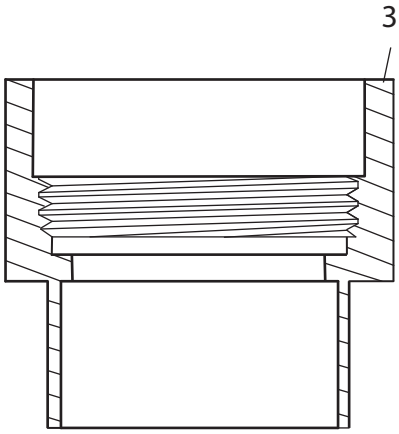


FIG. 10

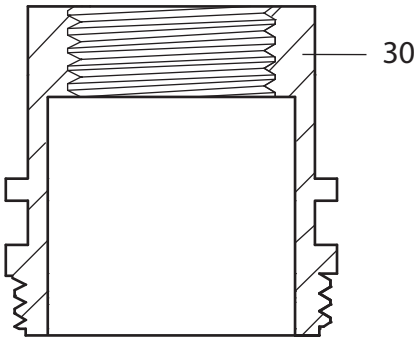


FIG. 11

FIG. 12

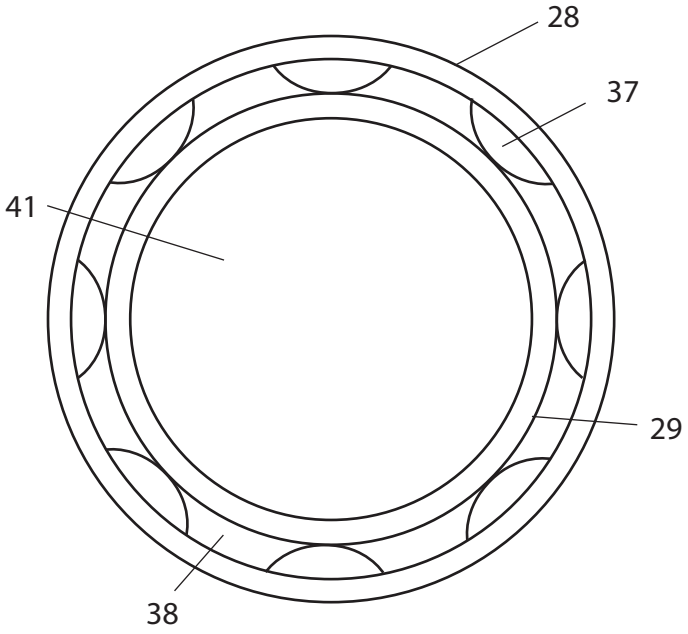


FIG. 13

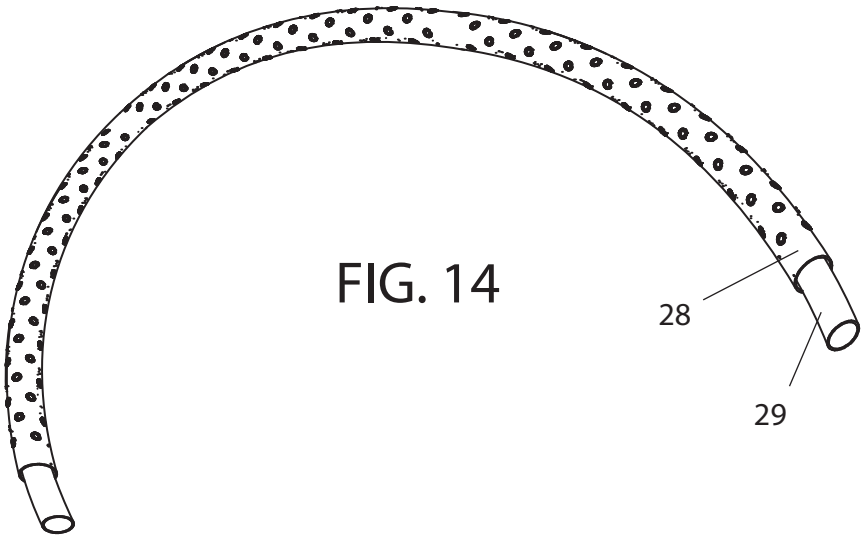


FIG. 14

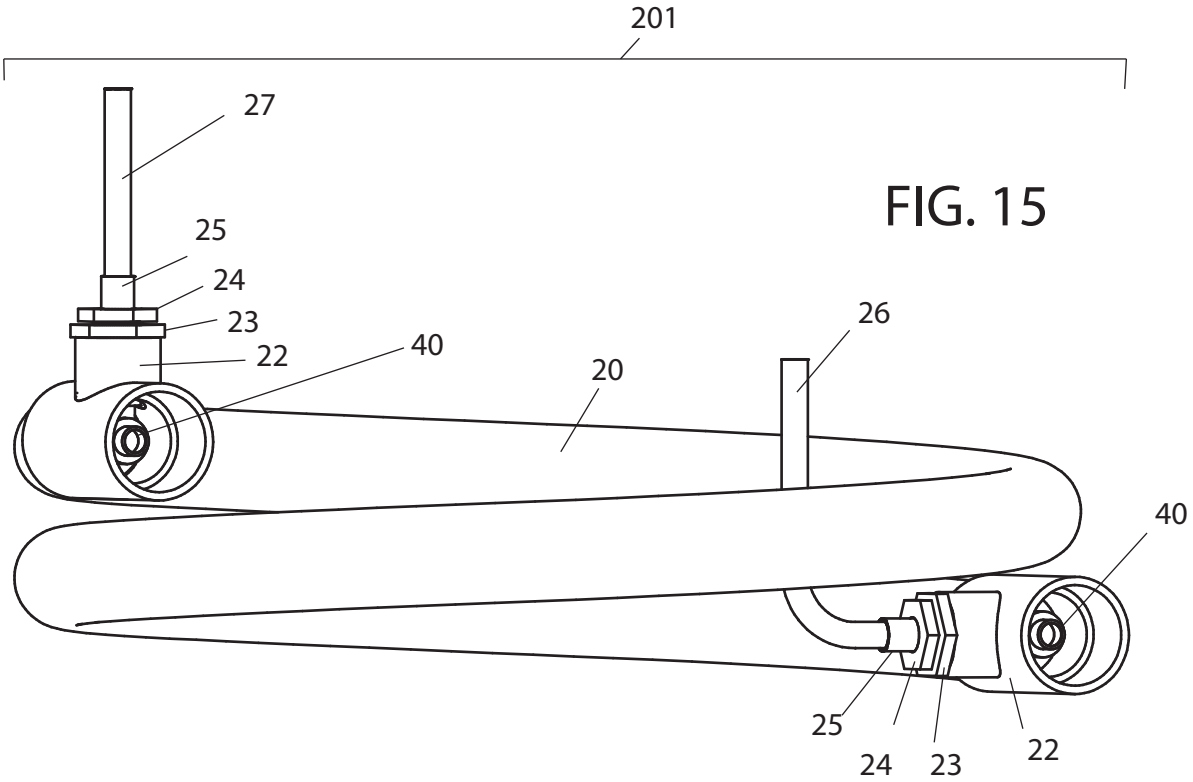
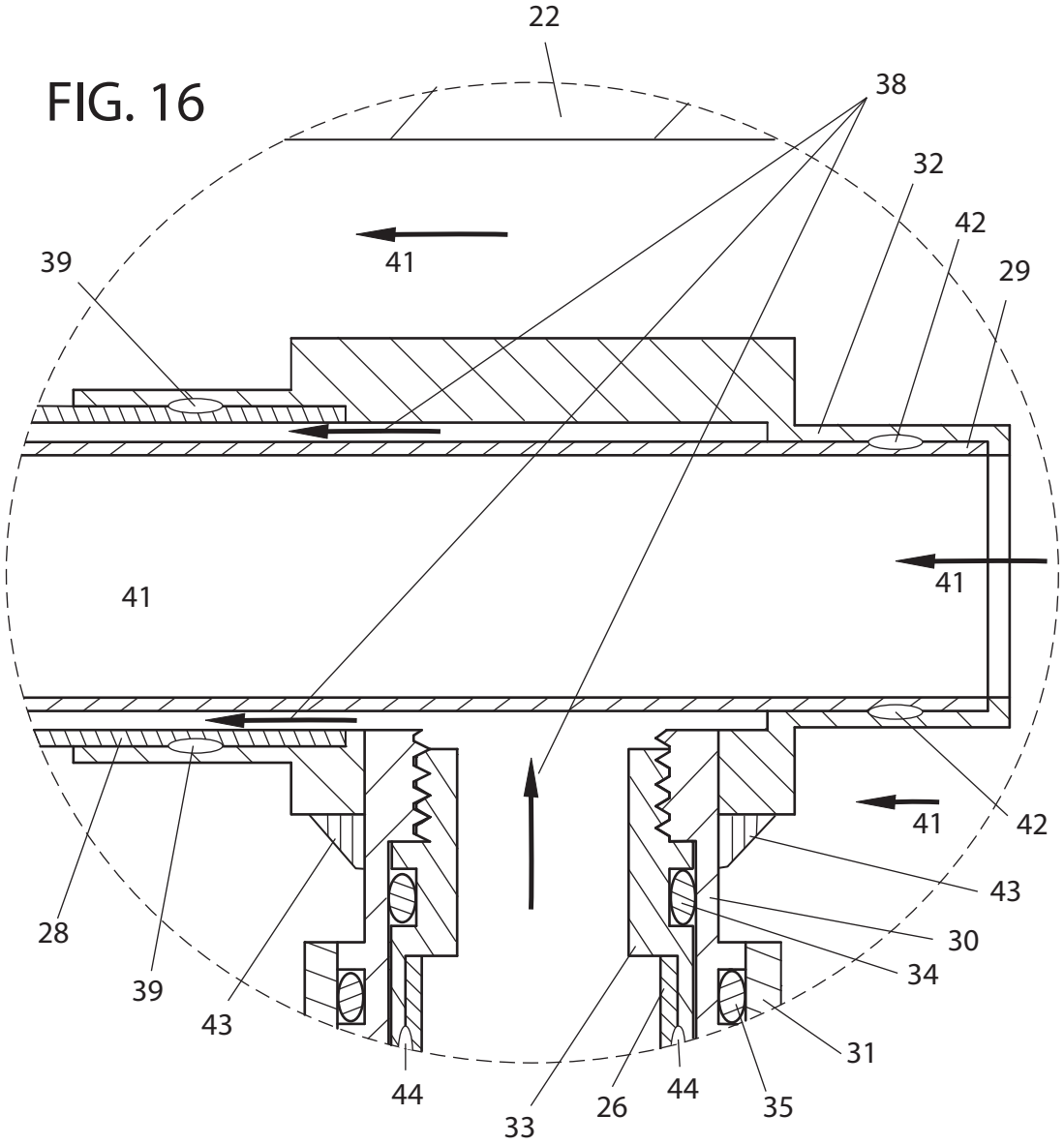


FIG. 15

FIG. 16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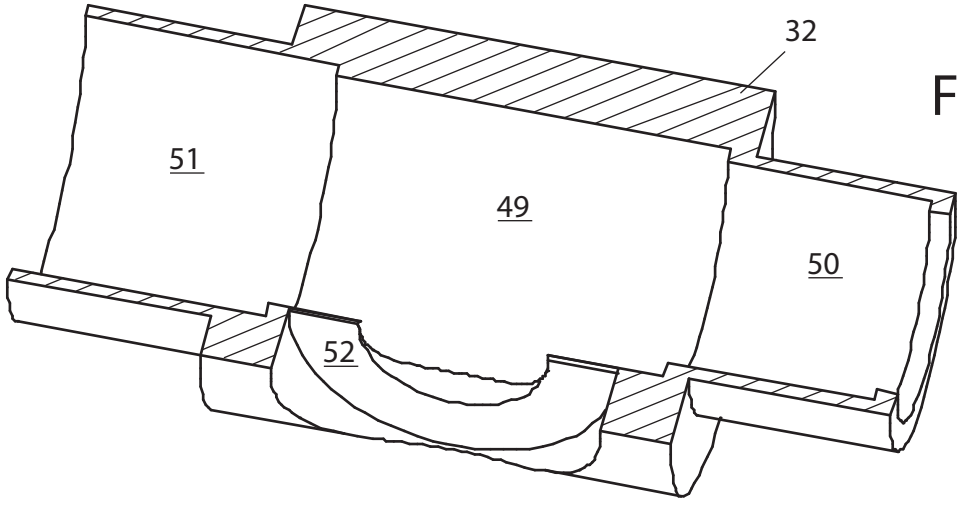
32
51
49
50
52

FIG. 17

FIG. 18

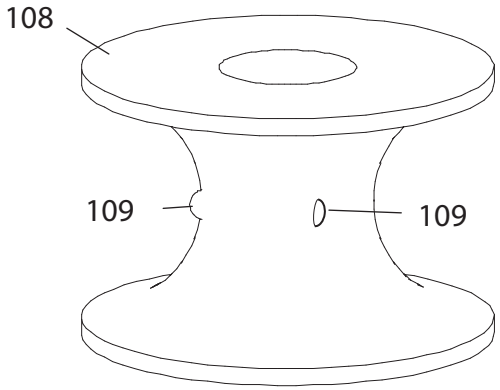

FIG. 19