

SEÑORES  
DIVISION DE NUEVAS CREACIONES  
SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO  
E. S. D.

SUPERINDUSTRIA Y COMERCIO  
Radicación : 04109305 00000002 Folios: 52  
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Trámite : 002 PATENTES D 1 REGISTRO/ 329 COMPLETOS  
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

COD:01

REF: SOLICITUD N° 04109305  
FECHA SOLICITUD: OCTUBRE 29, 2004  
DISEÑO DE INTERCAMBIADOR DE CALOR CON DISPOSICIÓN DE  
TUBO FLEXIBLE  
SOLICITANTE: BRAZEWAY, INC.

ASUNTO: PRESENTACIÓN DEL DOCUMENTO DE PRIORIDAD

DILIA RODRIGUEZ D'ALEMAN, en mi condición de apoderada de la sociedad  
solicitante, en esta oportunidad por el presente escrito me permito  
presentar:

- Copia certificada de la prioridad Estadounidense reivindicada N°  
10/696,913 de Octubre 30 de 2003.
- Su traducción al español

Esta prioridad está siendo presentada dentro del término de 16 meses  
que exige la Decisión 486 de Diciembre 1 de 2.000.

Ruego a usted continuar con el presente trámite.

Señor Jefe,

  
DILIA RODRIGUEZ D'ALEMAN

CCR/sir

p-592

WR

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TRADUCCIÓN OFICIAL No. 04/549 de un documento escrito en inglés, el cual para su identificación se adjunta al sello del traductor al tiempo con la presente. Esta traducción ha sido preparada por Juan Pablo Piedrahita Aguilera, Traductor e Intérprete Oficial debidamente reconocido de conformidad con el Certificado de Idoneidad Profesional No. 0045 expedido por la Universidad Nacional de Colombia, por el Ministerio de Relaciones Exteriores y autorizado por el Ministerio del Interior y de Justicia, por resolución número 718 de 2003.

(Se traduce el Certificado de la Oficina de Patentes y Marcas de los EE.UU. de una Solicitud de Registro de Patente No. 10 /696,913, y las Reivindicaciones, escritos en inglés.)

## **ESTADOS UNIDOS DE AMÉRICA**

**A TODOS A QUIENES ESTOS PRESENTES LLEGAREN:**

**DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS**

**OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS UNIDOS**

**Noviembre 01, 2004**

POR EL PRESENTE CERTIFICO QUE ADJUNTA SE ENCUENTRA UNA COPIA FIEL DE LOS ARCHIVOS DE LA OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS UNIDOS DE AQUELLOS DOCUMENTOS DE LA SOLICITUD DE PATENTE IDENTIFICADA A CONTINUACIÓN, QUE CUMPLIÓ CON LOS REQUISITOS PARA QUE LE FUESE OTORGADA UN NÚMERO DE PRESENTACIÓN BAJO EL TÍTULO 35 DEL CÓDIGO DE LOS ESTADOS UNIDOS SECCIÓN 111.

SOLICITUD DE SOLICITUD: **10/696,913**

FECHA DE PRESENTACIÓN: **Octubre 30, 2003**

**Certificado por la Autoridad del  
COMISARIO DE PATENTES Y MARCAS  
(Firmado) TRUDIE WALLACE**

**(SELLO DE OBLEA EN RELIEVE DE LA OFICINA DE PATENTES Y MARCAS  
DE LOS ESTADOS UNIDOS DE AMÉRICA)**

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**REIVINDICACIONES**

1. Una aleta universal para uso en una aleta sobre un tubo intercambiador de calor, la aleta universal que comprende:

una hoja de material conductor de calor, configurada para estar separada de una o de más aletas usadas en la aleta sobre un tubo intercambiador de calor, independientemente del número de pares horizontales y verticales de segmentos de tubo en dicho intercambiador de calor, dicha hoja con un espesor y una altura; y

una pluralidad de aperturas en dicha hoja, con cada una de dichas aperturas configuradas para permitir generalmente el paso de segmentos de tubos paralelos a través del intercambiador de calor, con dichas aperturas chaflanadas en referencia al espesor y altura de dicha hoja, dichas aperturas dispuestas en dicha lámina en un arreglo de una pluralidad de filas y una pluralidad de columnas cuyas filas adyacentes están igualmente espaciadas una de otra y cuyas columnas adyacentes están igualmente espaciadas una de otra, y el espaciamiento entre filas y columnas se dimensiona para permitir que dicha lámina esté separada entre por lo menos una de dichas filas adyacentes y dichas columnas adyacentes para formar una o más aletas, cada una de las cuales contiene una pluralidad de aperturas por lo menos igual al número total de pares de segmentos de tubo en el intercambiador de calor.

2. La aleta universal de la reivindicación 1, donde dichas aperturas son aperturas alargadas con cada una de las aperturas presentando porciones de

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extremos opuestos interconectados por una porción central.

3. La aleta universal de la reivindicación 2, donde dichas aperturas tiene forma de hueso para perro.

4. La aleta universal de la reivindicación 1, que además comprende señalizaciones que indican las localizaciones donde dicha hoja se puede separar de dichas aletas, dichas señalizaciones extendiéndose a lo largo de dicha hoja entre por lo menos una de dichas columnas y dichas filas.

5. La aleta universal de la reivindicación 4, donde dichas señalizaciones son perforaciones en dicha hoja.

6. La aleta universal de la reivindicación 1, donde dichas columnas están espaciadas entre sí en tal forma que una porción de dichas aperturas en una de dichas columnas se traslapa con una porción de dichas aperturas en una de las columnas adyacentes.

7. La aleta universal de la reivindicación 6, donde dichas columnas adyacentes presentan un borde ondulado, al estar separadas.

8. La aleta universal de la reivindicación 1, donde dicho espaciamiento entre filas adyacentes es generalmente igual a dicho espaciamiento entre columnas adyacentes.

9. La aleta universal de la reivindicación 1, donde cada una de dichas aperturas son generalmente idénticas.

10. Una aleta en un tubo intercambiador de calor, con una aleta formada de una hoja de aleta universal, el intercambiador de calor comprendiendo:

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RES. 718 DE MAYO 2013  
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una porción tubular con una pluralidad de segmentos rectos de tubos interconectados por una pluralidad de segmentos conectores de tubería, con cada segmento conector interconectando dos segmentos rectos de tubería, dichos segmentos conectores y segmentos rectos dentro de un arreglo de configuración intrincada, con dicha porción de tubo conteniendo una cantidad conocida de pares horizontales y verticales de tubos pasando; y

por lo menos una aleta en dicha porción tubular, con dicha aleta separada de una hoja de aleta universal con un espesor y una altura, y una pluralidad de aperturas con cada apertura configurada para permitir el paso de pares de tubos a través suyo, con dichas aperturas dispuestas en dicha lámina de aleta universal en un arreglo de una pluralidad de filas y una pluralidad de columnas cuyas filas adyacentes están generalmente igualmente espaciadas entre sí y cuyas columnas adyacentes están igualmente espaciadas entre sí, y dicho espaciamiento entre filas y columnas adyacentes se dimensiona en tal forma que dicha hoja de aleta universal se pueda separar entre por lo menos una de dichas filas adyacentes y columnas adyacentes para formar dicha aleta con una cantidad de aperturas por lo menos igual a dicho número de pares de tubos que la atraviesan, independientemente del número de pares horizontales y verticales de tubos que la atraviesan en dicha porción tubular,

donde dicha aleta tiene una cantidad de aperturas por lo menos igual al número de pares de tubos que atraviesan en dicha porción tubular y dicha aleta está dispuesta sobre dicha porción tubular con cada par de tubos que

atraviesan dicha porción tubular, a través de dichas aperturas de dicha aleta.

11. El intercambiador de calor de la reivindicación 10, donde dicha porción tubular es un solo tubo continuo.

12. El intercambiador de calor de la reivindicación 10, donde por lo menos una dicha aleta es una de las de la pluralidad de aletas y dicha pluralidad de aletas están alineadas generalmente en una configuración paralela con dichas aperturas en dichas aletas alineadas para formar un banco de aletas que se encuentra en un arreglo en dicha porción tubular.

13. El intercambiador de calor de la reivindicación 10, donde dicha porción tubular contiene más tubos atravesando verticalmente que los tubos atravesando horizontalmente.

14. El intercambiador de calor de la reivindicación 10, donde dicha porción tubular contiene más tubos atravesando horizontalmente que los tubos atravesando verticalmente.

15. El intercambiador de calor de la reivindicación 10, donde dichas aperturas en dicha hoja de aleta universal se encuentran chaflanadas respecto de al espesor y a la altura de dicha hoja de aleta universal.

16. El intercambiador de calor de la reivindicación 10, donde dicho espaciamiento entre filas adyacentes es generalmente igual a dicho espaciamiento entre columnas adyacentes.

17. El intercambiador de calor de la reivindicación 10, donde dichas aperturas en dicha hoja de aleta universal son aperturas alargadas, con cada

una de las aperturas incluyendo extremos opuestos interconectados por una porción central.

18. El intercambiador de calor de la reivindicación 10, donde dichas columnas de dicha hoja de aleta universal están espaciadas entre sí en tal forma que una porción de dichas aperturas en una de dichas columnas se traslapa con una porción de dichas aperturas en una columna adyacente y tal aleta tiene un borde ondulado.

19. Un método para fabricar una aleta en un tubo intercambiador de calor, el método consiste en los siguientes pasos:

(a) separar por lo menos una aleta que contiene una cantidad predeterminada de aperturas de una hoja de aleta universal pre-formada, que está configurada para ser separada para proveer una o más aletas para ser usadas en el intercambiador de calor, independientemente del número de pares de tubos atravesando horizontalmente y verticalmente en una porción tubular del intercambiador de calor en el cual por lo menos se usará una aleta; y

(b) colocar dicha aleta en posición sobre la porción tubular de dicho intercambiador de calor, con pares de tubos que pasan a través de dichas aperturas.

20. El método de la reivindicación 19, donde (a) incluye hacer dicha hoja de aleta universal de tal forma que dicha hoja de aleta universal tenga un espesor y una altura, y una pluralidad de aperturas, con cada una de las aperturas configurada en tal forma que permita el paso de un par de tubos a través del

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intercambiador de calor, dichas aperturas configuradas sobre dicha hoja de aleta universal en un arreglo de una pluralidad de filas y una pluralidad de columnas, con las filas adyacentes generalmente igualmente espaciadas entre sí, y con las columnas adyacentes generalmente igualmente espaciadas entre sí, y dicho espaciamiento entre filas adyacentes y columnas adyacentes dimensionado en forma tal que dicha hoja de aleta universal pueda separarse entre por lo menos una de las filas adyacentes y columnas adyacentes para formar por lo menos la dicha aleta unitaria, independientemente del número de pares de tubos que atraviesan verticalmente y horizontalmente.

21. El método de la reivindicación 20, donde el hacer dicha hoja de aleta universal incluye la colocación de señalizaciones sobre dicha hoja de aleta universal entre por lo menos una de dichas columnas y dichas filas, con dichas señalizaciones indicando las localizaciones en las cuales dicha hoja de aleta universal puede separarse para formar por lo menos una sola aleta.

22. El método de la reivindicación 21, donde dichas señalizaciones son perforaciones en dicha hoja de aleta universal.

23. El método de la reivindicación 20, donde (a) incluye marcación con tinta impresa sobre dicha hoja de aleta universal a partir de un material conductor de calor.

24. El método de la reivindicación 20, donde al pre-formar dicha hoja de aleta universal incluye pre-formar dicha hoja de aleta universal con dicha pluralidad de aperturas chaflanadas respecto de al espesor y a la altura de dicha hoja

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aleta universal.

25. El método de la reivindicación 19, que además comprende la formación de una porción tubular con un número predeterminado de pares de tubos atravesando verticalmente y horizontalmente.

26. El método de la reivindicación 25, donde la formación de dicho tubo incluye la formación de la porción tubular con un mayor número de pares de tubos atravesando horizontalmente, que el número de tubos atravesando verticalmente.

27. El método de la reivindicación 25, donde la formación de dicho tubo incluye la formación de la porción tubular con un mayor número de pares de tubos atravesando verticalmente, que el número de tubos atravesando horizontalmente.

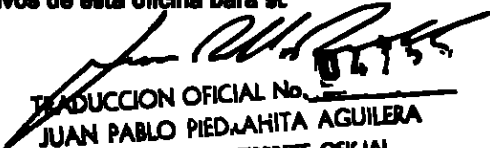
28. El método de la reivindicación 25, donde la formación de dicho tubo incluye el doblamiento de una longitud continua de tubería en tal forma que dicha tubería forme dicha porción tubular.

29. El método de la reivindicación 19, donde (a) incluye el corte de por lo menos dicha aleta unitaria a partir de dicha hoja de aleta universal.

30. El método de la reivindicación 19, donde las porciones de las aperturas en una columna se traslapan con las porciones de aperturas en una columna adyacente y donde dicha aleta tiene un borde ondulado.

ES TRADUCCIÓN FIEL Y COMPLETA de la cual se deja copia en los archivos de esta oficina para su confrontación y a la cual me remito.

Bogotá, Noviembre 29, 2004.

  
TRADUCCION OFICIAL No. 0675  
JUAN PABLO PIEDRAHITA AGUILERA  
TRADUCTOR E INTERPRETE OFICIAL  
RES. 718 DE MAYO 2003  
DEL MIN. INTERIOR Y DE JUSTICIA

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PA 1243035



# THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

November 01, 2004

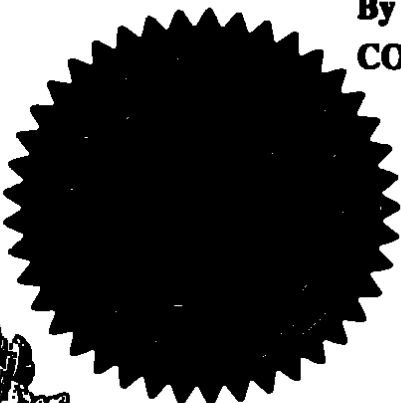
THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE UNDER 35 USC 111.

APPLICATION NUMBER: 10/696,913

FILING DATE: October 30, 2003

06/54  
TRADUCCION OFICIAL No. \_\_\_\_\_  
JUAN PABLO PIEDRAHITA AGUILERA  
TRADUCTOR E INTERPRETE OFICIAL  
718 DE MAYO 2003  
MEX. INTERIOR Y DE JUSTICIA

By Authority of the  
COMMISSIONER OF PATENTS AND TRADEMARKS



*Trudie Wallace*  
TRUDIE WALLACE  
Certifying Officer

Please type a plus sign (+) inside this box → ☒

PTO/SB/05 (05-03)

Approved for use through 10/31/2002. OMB 0851-0032  
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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# UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket No. 7947-00025

First Inventor David W. Smith et al.

Title FLEXIBLE TUBE ARRANGEMENT-HEAT EXCHANGER DESIGN

(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))

Express Mail Label No. EL 823910788US

## APPLICATION ELEMENTS

See MPEP chapter 800 concerning utility patent application contents.

## ADDRESS TO:

Mail Stop Patent Application  
Commissioner for Patents  
P.O. Box 1480  
Alexandria, VA 22313-1480

17548 U.S. PTO  
10/898613



1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2. ☐ Applicant claims small entity status.  
See 37 CFR 1.27.
3. ☒ Specification (Total Pages )  
(preferred arrangement set forth below)
  - Descriptive title of the invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to sequence listing, a table, or a computer program listing appendix
  - Background of the invention
  - Brief Summary of the invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure

Specification filed in English
4. ☒ Drawing(s) (35 U.S.C. 113) (Total Sheets )
5. Oath or Declaration (Total Pages )
  - a. ☒ Newly executed (original or copy)
  - b. ☐ Copy from a prior application (37 CFR 1.63 (d))  
(for a continuation/divisional with Box 18 completed)
6. ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. 1.53(d)(2) and 1.53(b).
6. ☒ Application Data Sheet. See 37 CFR 1.78

7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
  - a. ☐ Computer Readable Form (CRF)
  - b. Specification Sequence Listing on:
    1. ☐ CD-ROM or CD-R (2 copies); or
    2. ☐ paper
  - c. ☐ Statements verifying identity of above copies

## ACCOMPANYING APPLICATIONS PARTS

9. ☒ Assignment Papers (cover sheet & document(s))
10. ☐ 37 C.F.R. § 3.73(b) Statement of Power of Attorney (when there is an assignee)
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☐ Request and Non Publication under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other: \_\_\_\_\_

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.78:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. \_\_\_\_ / \_\_\_\_  
Prior application Information: Examiner \_\_\_\_\_ Group / Art Unit: \_\_\_\_\_

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

## 17. CORRESPONDENCE ADDRESS

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48303

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United States of America

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Fax

248-641-0270

Name (Print/Type)

Jeffrey H. Urien

Registration No. (Attorney/Agent)

48,232

Signature

Date

October 30, 2003

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|                                                                                                      |  |                          |                         |
|------------------------------------------------------------------------------------------------------|--|--------------------------|-------------------------|
| <b>FEE TRANSMITTAL<br/>for FY 2004</b><br><small>Patent fees are subject to annual revision.</small> |  | <b>Complete if Known</b> |                         |
| <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27                       |  | Application Number       | To be assigned          |
| <b>TOTAL AMOUNT OF PAYMENT</b> (\$) 990                                                              |  | Filing Date              | Herewith                |
|                                                                                                      |  | First Named Inventor     | David W. Smithay et al. |
|                                                                                                      |  | Examiner Name            | To be assigned          |
|                                                                                                      |  | Group / Art Unit         | To be assigned          |
|                                                                                                      |  | Attorney Docket No.      | 7847-00025              |

| <b>METHOD OF PAYMENT (check all that apply)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          | <b>FEE CALCULATION (continued)</b>                                                                                                                 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| <input checked="" type="checkbox"/> Check <input type="checkbox"/> Credit card <input type="checkbox"/> Money Order <input type="checkbox"/> Other <input type="checkbox"/> None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          | <b>2. ADDITIONAL FEES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| <input type="checkbox"/> Deposit Account:<br><br>Deposit Account Number: 00-0750<br><br>Deposit Account Name: Harman, Dickey & Pines, P.L.C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          | <table><thead><tr><th colspan="2">Large Entity</th><th colspan="2">Small Entity</th><th rowspan="2">Fee Description</th><th rowspan="2">Fee Paid</th></tr><tr><th>Fee Code</th><th>Fee (\$)</th><th>Fee Code</th><th>Fee (\$)</th></tr></thead><tbody><tr><td>1001</td><td>130</td><td>2001</td><td>65</td><td>Surcharge - late filing fee or oath</td><td></td></tr><tr><td>1002</td><td>80</td><td>2002</td><td>25</td><td>Surcharge - late provisional filing fee or cover sheet</td><td></td></tr><tr><td>1005</td><td>130</td><td>1003</td><td>130</td><td>Non-English specification</td><td></td></tr><tr><td>1012</td><td>2,500</td><td>1012</td><td>2,500</td><td>For filing a request for reexamination</td><td></td></tr><tr><td>1004</td><td>930*</td><td>1004</td><td>930*</td><td>Requesting publication of BIR prior to Examiner action</td><td></td></tr><tr><td>1005</td><td>1,040*</td><td>1005</td><td>1,040*</td><td>Requesting publication of BIR after Examiner action</td><td></td></tr><tr><td>1201</td><td>110</td><td>2201</td><td>50</td><td>Extension for reply within first month</td><td></td></tr><tr><td>1202</td><td>430</td><td>2202</td><td>210</td><td>Extension for reply within second month</td><td></td></tr><tr><td>1203</td><td>890</td><td>2203</td><td>475</td><td>Extension for reply within third month</td><td></td></tr><tr><td>1204</td><td>1,400</td><td>2204</td><td>740</td><td>Extension for reply within fourth month</td><td></td></tr><tr><td>1205</td><td>2,010</td><td>2205</td><td>1,005</td><td>Extension for reply within fifth month</td><td></td></tr><tr><td>1401</td><td>330</td><td>2401</td><td>165</td><td>Notice of Appeal</td><td></td></tr><tr><td>1402</td><td>330</td><td>2402</td><td>165</td><td>Filing a brief in support of an appeal</td><td></td></tr><tr><td>1403</td><td>290</td><td>2403</td><td>145</td><td>Request for oral hearing</td><td></td></tr><tr><td>1401</td><td>1,510</td><td>1401</td><td>1,510</td><td>Petition to institute a public use proceeding</td><td></td></tr><tr><td>1402</td><td>110</td><td>2402</td><td>55</td><td>Petition to revive - unavoidable</td><td></td></tr><tr><td>1403</td><td>1,320</td><td>2403</td><td>660</td><td>Petition to revive - unintentional</td><td></td></tr><tr><td>1501</td><td>1,330</td><td>2501</td><td>665</td><td>Utility issue fee (or release)</td><td></td></tr><tr><td>1802</td><td>480</td><td>2802</td><td>240</td><td>Design issue fee</td><td></td></tr><tr><td>1803</td><td>640</td><td>2803</td><td>320</td><td>Plant issue fee</td><td></td></tr><tr><td>1400</td><td>130</td><td>1400</td><td>130</td><td>Petitions to the Commissioner</td><td></td></tr><tr><td>1807</td><td>80</td><td>1807</td><td>80</td><td>Processing fee under 37 CFR 1.17 (g)</td><td></td></tr><tr><td>1808</td><td>180</td><td>1808</td><td>180</td><td>Submission of Information Disclosure Sheet</td><td></td></tr><tr><td>8021</td><td>40</td><td>8021</td><td>40</td><td>Recording each patent assignment per property (lines number of properties)</td><td>40</td></tr><tr><td>1809</td><td>770</td><td>2809</td><td>385</td><td>Filing a submission after final rejection (37 CFR § 1.128(b))</td><td></td></tr><tr><td>1810</td><td>770</td><td>2810</td><td>385</td><td>For each additional invention to be examined (37 CFR § 1.128(b))</td><td></td></tr><tr><td>1801</td><td>770</td><td>2801</td><td>385</td><td>Request for Continued Examination (RCE)</td><td></td></tr><tr><td>1802</td><td>900</td><td>1802</td><td>900</td><td>Request for expedited examination of a design application</td><td></td></tr></tbody></table> |          | Large Entity                                                               |          | Small Entity    |                | Fee Description | Fee Paid       | Fee Code | Fee (\$) | Fee Code | Fee (\$)           | 1001 | 130   | 2001                   | 65  | Surcharge - late filing fee or oath |     | 1002 | 80  | 2002                              | 25 | Surcharge - late provisional filing fee or cover sheet |     | 1005 | 130 | 1003                                   | 130 | Non-English specification |     | 1012 | 2,500 | 1012                                               | 2,500 | For filing a request for reexamination |     | 1004 | 930* | 1004                                                       | 930* | Requesting publication of BIR prior to Examiner action |  | 1005 | 1,040* | 1005 | 1,040* | Requesting publication of BIR after Examiner action |  | 1201 | 110 | 2201 | 50 | Extension for reply within first month |  | 1202 | 430 | 2202 | 210 | Extension for reply within second month |  | 1203 | 890 | 2203 | 475 | Extension for reply within third month |  | 1204 | 1,400 | 2204 | 740 | Extension for reply within fourth month |  | 1205 | 2,010 | 2205 | 1,005 | Extension for reply within fifth month |  | 1401 | 330 | 2401 | 165 | Notice of Appeal |  | 1402 | 330 | 2402 | 165 | Filing a brief in support of an appeal |  | 1403 | 290 | 2403 | 145 | Request for oral hearing |  | 1401 | 1,510 | 1401 | 1,510 | Petition to institute a public use proceeding |  | 1402 | 110 | 2402 | 55 | Petition to revive - unavoidable |  | 1403 | 1,320 | 2403 | 660 | Petition to revive - unintentional |  | 1501 | 1,330 | 2501 | 665 | Utility issue fee (or release) |  | 1802 | 480 | 2802 | 240 | Design issue fee |  | 1803 | 640 | 2803 | 320 | Plant issue fee |  | 1400 | 130 | 1400 | 130 | Petitions to the Commissioner |  | 1807 | 80 | 1807 | 80 | Processing fee under 37 CFR 1.17 (g) |  | 1808 | 180 | 1808 | 180 | Submission of Information Disclosure Sheet |  | 8021 | 40 | 8021 | 40 | Recording each patent assignment per property (lines number of properties) | 40 | 1809 | 770 | 2809 | 385 | Filing a submission after final rejection (37 CFR § 1.128(b)) |  | 1810 | 770 | 2810 | 385 | For each additional invention to be examined (37 CFR § 1.128(b)) |  | 1801 | 770 | 2801 | 385 | Request for Continued Examination (RCE) |  | 1802 | 900 | 1802 | 900 | Request for expedited examination of a design application |  |
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                                                                                                                                                                                                                                                                                                                                                                                                     | 210      | Extension for reply within second month                                    |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |           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| 1203                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 890      | 2203                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 475      | Extension for reply within third month                                     |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |           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| 1204                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1,400    | 2204                                                                                                                                               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                             |     |      |      |                                                            |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                               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| 1205                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2,010    | 2205                                                                                                                                               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| 1401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 330      | 2401                                                                                                                                               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| 1402                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 330      | 2402                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 165      | Filing a brief in support of an appeal                                     |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |           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| 1401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1,510    | 1401                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1,510    | Petition to institute a public use proceeding                              |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |                                        |     |      |      |                                                            |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                               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| 1402                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 110      | 2402                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 55       | Petition to revive - unavoidable                                           |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |                                        |     |      |      |                                                            |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                                    |  |      |       |      |     |                                |  |      |     |      |     |                  |  |      |     |      |     |                 |  |      |     |      |     |                               |  |      |    |      |    |                                      |  |      |     |      |     |                                            |  |      |    |      |    |                                                                            |    |      |     |      |     |                                                               |  |      |     |      |     |                                                                  |  |      |     |      |     |                                         |  |      |     |      |     |                                                           |  |
| 1403                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1,320    | 2403                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 660      | Petition to revive - unintentional                                         |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |                                        |     |      |      |                                                            |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                                    |  |      |       |      |     |                                |  |      |     |      |     |                  |  |      |     |      |     |                 |  |      |     |      |     |                               |  |      |    |      |    |                                      |  |      |     |      |     |                                            |  |      |    |      |    |                                                                            |    |      |     |      |     |                                                               |  |      |     |      |     |                                                                  |  |      |     |      |     |                                         |  |      |     |      |     |                                                           |  |
| 1501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1,330    | 2501                                                                                                                                               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| 1802                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 480      | 2802                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 240      | Design issue fee                                                           |          |                 |                |                 |                |          |          |          |                    |      |       |                        |     |                                     |     |      |     |                                   |    |                                                        |     |      |     |                                        |     |                           |     |      |       |                                                    |       |           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| 1803                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 640      | 2803                                                                                                                                               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     |  |      |       |      |     |                                |  |      |     |      |     |                  |  |      |     |      |     |                 |  |      |     |      |     |                               |  |      |    |      |    |                                      |  |      |     |      |     |                                            |  |      |    |      |    |                                                                            |    |      |     |      |     |                                                               |  |      |     |      |     |                                                                  |  |      |     |      |     |                                         |  |      |     |      |     |                                                           |  |
| 1400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 130      | 1400                                                                                                                                               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| 1807                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 80       | 1807                                                                                                                                               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| 8021                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 40       | 8021                                                                                                                                               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| 1809                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 770      | 2809                                                                                                                                               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| <b>1. BASIC FILING FEE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          | <b>Other fee (specify) _____</b>                                                                                                                           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| <table><thead><tr><th colspan="2">Large Entity</th><th colspan="2">Small Entity</th><th rowspan="2">Fee Description</th><th rowspan="2">Fee Paid</th></tr><tr><th>Fee Code</th><th>Fee (\$)</th><th>Fee Code</th><th>Fee (\$)</th></tr></thead><tbody><tr><td>1001</td><td>770</td><td>2001</td><td>385</td><td>Utility filing fee</td><td>770</td></tr><tr><td>1002</td><td>340</td><td>2002</td><td>170</td><td>Design filing fee</td><td></td></tr><tr><td>1003</td><td>830</td><td>2003</td><td>265</td><td>Plant filing fee</td><td></td></tr><tr><td>1004</td><td>770</td><td>2004</td><td>385</td><td>Release filing fee</td><td></td></tr><tr><td>1005</td><td>100</td><td>2005</td><td>50</td><td>Provisional filing fee</td><td></td></tr></tbody></table>                                                                                                   |          | Large Entity                                                                                                                                       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                             | 100 | 2005 | 50   | Provisional filing fee                                     |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                               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| <b>SUBTOTAL (1)</b> (\$) 770                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          | <b>SUBTOTAL (2)</b> (\$) 180                                                                                                                       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| <b>2. EXTRA CLAIM FEES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |                                                                                                                                                            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| <table><tr><td>Total Claims</td><td>30</td><td>- 30 =</td><td>0</td><td>Extra Claims</td><td>10</td><td>X</td><td>Fee from below</td><td>18</td><td>=</td><td>180</td></tr><tr><td>Independent Claims</td><td>3</td><td>- 3 =</td><td>0</td><td></td><td>0</td><td>X</td><td></td><td></td><td>=</td><td>0</td></tr><tr><td>Multiple Dependent</td><td></td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td><td>=</td><td>0</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                          |          | Total Claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 30       | - 30 =                                                                     | 0        | Extra Claims    | 10             | X               | Fee from below | 18       | =        | 180      | Independent Claims | 3    | - 3 = | 0                      |     | 0                                   | X   |      |     | =                                 | 0  | Multiple Dependent                                     |     |      |     |                                        |     | X                         |     |      | =     | 0                                                  |       |                                        |     |      |      |                                                            |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                                    |  |      |       |      |     |                                |  |      |     |      |     |                  |  |      |     |      |     |                 |  |      |     |      |     |                               |  |      |    |      |    |                                      |  |      |     |      |     |                                            |  |      |    |      |    |                                                                            |    |      |     |      |     |                                                               |  |      |     |      |     |                                                                  |  |      |     |      |     |                                         |  |      |     |      |     |                                                           |  |
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| <table><thead><tr><th colspan="2">Large Entity</th><th colspan="2">Small Entity</th><th rowspan="2">Fee Description</th><th rowspan="2">Fee Paid</th></tr><tr><th>Fee Code</th><th>Fee (\$)</th><th>Fee Code</th><th>Fee (\$)</th></tr></thead><tbody><tr><td>1202</td><td>18</td><td>2202</td><td>9</td><td>Claims in excess of 20</td><td></td></tr><tr><td>1201</td><td>88</td><td>2201</td><td>43</td><td>Independent claims in excess of 3</td><td></td></tr><tr><td>1203</td><td>290</td><td>2203</td><td>148</td><td>Multiple dependent claims, if not paid</td><td></td></tr><tr><td>1204</td><td>88</td><td>2204</td><td>43</td><td>** Release independent claims over original patent</td><td></td></tr><tr><td>1205</td><td>18</td><td>2205</td><td>9</td><td>** Release claims in excess of 20 and over original patent</td><td></td></tr></tbody></table> |          | Large Entity                                                                                                                                       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                             | 18  | 2205 | 9    | ** Release claims in excess of 20 and over original patent |      |                                                        |  |      |        |      |        |                                                     |  |      |     |      |    |                                        |  |      |     |      |     |                                         |  |      |     |      |     |                                        |  |      |       |      |     |                                         |  |      |       |      |       |                                        |  |      |     |      |     |                  |  |      |     |      |     |                                        |  |      |     |      |     |                          |  |      |       |      |       |                                               |  |      |     |      |    |                                  |  |      |       |      |     |                               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| Fee Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Fee (\$) | Fee Code                                                                                                                                           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| 1202                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 18       | 2202                                                                                                                                               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| 1201                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 88       | 2201                                                                                                                                               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| 1203                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 290      | 2203                                                                                                                                               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| 1204                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 88       | 2204                                                                                                                                               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| 1205                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 18       | 2205                                                                                                                                               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| *or number previously paid, if greater; For Release, see above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          | <b>*Reduced by Basic Filing Fee Paid</b> <b>SUBTOTAL (3)</b> (\$) 40                                                                               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|---------------------|------------------|---------------------------------|------------------|
| <b>Submitted by</b> |                  | <b>Complete if applicable</b>   |                  |
| Name (Print/Type)   | Jeffrey H. Upton | Registration No. Attorney/Agent | 48,232           |
| Signature           |                  | Telephone                       | (240) 841-1600   |
|                     |                  | Date                            | October 30, 2003 |

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## FLEXIBLE TUBE ARRANGEMENT-HEAT EXCHANGER DESIGN

### FIELD OF THE INVENTION

**[0001]** The present invention relates to heat exchangers, and more particularly to universal fins that can be used in fin on tube heat exchangers.

### BACKGROUND OF THE INVENTION

**[0002]** Heat exchangers are used in a wide variety of applications and come in a wide variety of configurations to fit these various applications. One particular application in which heat exchangers are used is as condensers in refrigeration cabinets. The condensers in the refrigeration cabinets can come in a variety of configurations. When a condenser is installed underneath the refrigeration cabinet, the heat exchanger is generally a wire-on-tube condenser. These condensers underneath the refrigeration cabinet have a much larger horizontal dimension than vertical dimension, assuming a horizontal air flow. When the condensers are installed in the machine compartment of the refrigeration cabinet, the condensers will have a larger vertical dimension than horizontal dimension, assuming a horizontal air flow. Because these condensers have a larger vertical dimension than horizontal dimension, the configuration of these condensers is typically that of a jelly-roll condenser or a multi-layer wire-on-tube configuration. Therefore, the configuration of the condenser in a refrigeration cabinet can vary depending on whether the condenser is positioned

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undemeath the refrigeration cabinet or within a machine compartment of the cabinet.

[0003] Because the configurations vary, a manufacturer of refrigeration cabinets must have available a variety of heat exchanger configurations dependent on where the condenser is to be placed. In an effort to simplify the manufacturing process and to reduce cost, it would be desirable to have a common condenser configuration that can be used in either location. It would be further desirable if the common condenser configuration can utilize a universal fin that could be cut or separated to form one or more fins for either configuration regardless of the vertical or horizontal dimensions of the condenser configuration.

[0004] In domestic refrigerators, heat exchangers are used to form both evaporators and condensers. When the heat exchangers are configured to be evaporators in domestic refrigerators, they have a relatively small inlet for air and a comparably long air path through the evaporator. That is, assuming a vertical airflow, the evaporators are configured to have a much larger vertical dimension than horizontal dimension.

[0005] The heat exchangers that are typically configured to perform as either evaporators or condensers for domestic refrigerators use a tube and fin pattern that is different depending upon whether the heat exchangers are configured as evaporators or condensers. The different configurations do not allow for the use of a common fin to make the heat exchangers. Therefore, a manufacturer of these heat exchangers must maintain not only different

configurations but also a variety of fin patterns that can be used on the differing configurations of the heat exchangers. It would be desirable if the configurations of the heat exchangers were similar enough that a universal or common fin pattern could be used to provide fins for the heat exchanger regardless of whether the heat exchangers are configured as condensers or as evaporators. The use of a universal or common fin pattern will reduce the cost of manufacturing the heat exchanger by reducing the variety of fins the manufacturer of heat exchangers will be required to produce and/or stock and reducing the capital investment required to purchase and maintain stamping dies for each different fin pattern.

[0006] Therefore, it would be desirable to provide a heat exchanger that can be configured with either a larger number of tube passes parallel to the airflow or tube passes perpendicular to the airflow and that will utilize the same universal or common fin pattern. The use of a common or universal fin pattern thereby reduces the cost to manufacture and provide heat exchangers of varying configurations. Additionally, it would be desirable if the tube pattern were such that the tube passes were oriented relative to the airflow for an optimal or highly efficient heat transfer.

### SUMMARY OF THE INVENTION

[0007] The present invention allows for the construction of heat exchangers that can be configured as either evaporators or condensers and utilize a common or universal fin regardless of the number of vertical and

horizontal tube passes in the heat exchangers. A universal fin for use in a fin on tube heat exchanger according to the principles of the present invention includes a sheet of heat conducting material that is configured to be separated to form one or more fins for use on the fin on tube heat exchanger regardless of a number of vertical and horizontal pairs of tubing segments in the heat exchanger. The sheet has a width and a height. There are a plurality of openings in the sheet. Each of the openings is configured to allow a pair of generally parallel tubing segments of the heat exchanger to pass therethrough. The openings are canted relative to the width and height of the sheet. The openings are arranged on the sheet into a plurality of rows and a plurality of columns with adjacent rows being generally equally spaced apart and adjacent columns being generally equally spaced apart. The spacing between adjacent rows and adjacent columns is dimensioned to allow the sheet to be separated between at least one of the adjacent rows and the adjacent columns to form one or more fins that each contain a plurality of openings at least equal to a number of pairs of tubing segments in the heat exchanger.

[0008] A fin on tube heat exchanger having a fin formed from a universal fin sheet is also disclosed. The heat exchanger includes a tube portion having a plurality of straight segments of tubing interconnected by a plurality of connecting segments of tubing with each connecting segment interconnecting two straight segments. The straight and connecting segments are arranged in a sinuous configuration. The tube portion has a known quantity of vertical and horizontal pairs of tube passes. There is at least one fin on the tube portion. The

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fin is separated from a universal fin sheet having a width, a height and a plurality of openings with each opening configured to allow a pair of tube passes to pass therethrough. The openings are arranged on the universal fin sheet into a plurality of rows and a plurality of columns with adjacent rows being generally equally spaced apart and adjacent columns being generally equally spaced apart. The spacing between adjacent rows and adjacent columns is dimensioned so that the universal fin sheet can be separated between at least one of the adjacent rows and adjacent columns to form the fin having a quantity of openings at least equal to the number of pairs of tube passes regardless of a number of vertical and horizontal pairs of tube passes in the tube portion. The fin formed thereby has a quantity of openings at least equal to the number of pairs of tube passes in the tube portion and is arranged on the tube portion with each pair of tube passes of the tube portion passing through one of the openings in the fin.

[0009] The present invention also discloses a method of making a fin on tube heat exchanger. The method includes: (1) separating at least one fin having a predetermined quantity of openings from a preformed universal fin sheet that is configured to be separated to provide one or more fins for use on a heat exchanger regardless of a number of vertical and horizontal pairs of tube passes in a tube portion of the heat exchanger on which the at least one fin is to be used; and (2) positioning the fin on the tube portion of the heat exchanger with pairs of tube passes passing through the openings.

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**[0010]** Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0011]** The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

**[0012]** Figure 1A is a front elevation view of a universal fin according to the principles of the present invention;

**[0013]** Figures 1B and 1C are front elevation views of continuous fins that can be formed from the universal fin in Figure 1A;

**[0014]** Figure 2 is a perspective view of a tube portion of a heat exchanger according to the principles of the present invention;

**[0015]** Figure 3 is a perspective view of a heat exchanger according to the principles of the present invention having more vertical tube passes than horizontal tube passes;

**[0016]** Figure 4 is a perspective view of a heat exchanger according to the principles of the present invention having more horizontal tube passes than vertical tube passes;

**[0017]** Figure 5 is a perspective view of a universal fin according to the principles of the present invention being stamped from a sheet of heat conducting material;

**[0018]** Figure 6 is a perspective view of continuous fins made from the universal fin of Figure 1 being arranged on the tube portion of Figure 2;

**[0019]** Figure 7 is a perspective view of the tube portion of Figure 2 being formed by bending a length of continuous tubing;

**[0020]** Figure 8A is a front elevation view of a second preferred embodiment of a universal fin according to the principles of the present invention;

**[0021]** Figures 8B-D are front elevation views of exemplary continuous fins that can be formed from the universal fin of Figure 8A; and

**[0022]** Figure 9 is a perspective view of a heat exchanger having fins formed from the universal fin according to the second preferred embodiment of the present invention.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

**[0023]** The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

**[0024]** Referring now to Figure 1A, there is shown a universal fin 20 in accordance with the principles of the present invention. The universal fin 20 has a plurality of openings 22 that are each configured and adapted to allow tube passes on a heat exchanger to pass therethrough when the universal fin 20 or a

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portion of the universal fin 20 is used as a fin on a fin on tube heat exchanger, as will be explained in more detail below. The universal fin 20 has a height H and a width W. The openings 22 are arranged into a plurality of columns 24 and a plurality of rows 26. The columns 24 and the rows 26 are spaced apart such that the universal fin 20 can be separated between the columns 24 or between the rows 26 to form one or more fins 28, such as those shown in Figures 1B and 1C, for use on a tube portion 30, such as that shown in Figure 2, of a fin on tube heat exchanger 32, as will be discussed in more detail below.

[0025] Referring now to Figure 2, there is shown a tube portion 30 that can be used to make a fin on tube heat exchanger 32 according to the principles of the present invention. The tube portion 30 is comprised of a plurality of straight segments 34 and a plurality of connecting segments 36. Each connecting segment 36 interconnects two straight segments 34 so that all of the straight segments 34 are interconnected and form the tube portion 30 for use in the heat exchanger 32. The tube portion 30, as is known in the art, has at least one internal passageway (not shown) that allows a fluid to flow through the tube portion 30.

[0026] The tube portion 30 has a plurality of horizontal and vertical tube passes 38. A tube pass 38 is defined as the part of the tube portion 30 that passes through a common opening 22 in a fin 28. The tube portion 30 will be configured for the specific application in which the heat exchanger 32 is desired to be used. That is, the number of vertical and horizontal tube passes 38 will vary depending upon the application in which the heat exchanger 32 formed from

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the tube portion 30 is to be used. For example, as shown in Figures 2 and 3, the tube portion 30 can be configured to have two horizontal tube passes 38 and eight vertical tube passes 38 (a 2x8 configuration) or, as shown in Figure 4, the tube portion 30 can be configured to have eight horizontal tube passes 38 and four vertical tube passes 38 (an 8x4 configuration). Preferably, the tube portion 30 is configured so that the tube passes 38 are canted so that the heat exchanger 32 formed from the tube portion 30 efficiently transfers heat.

[0027] Each tube pass 38 is comprised of a pair 40 of straight segments 34 which pass through all or a portion of the fins 28 on the heat exchanger 32. The two straight segments 34 are interconnected by a connecting segment 36. The straight segments 34 and the connecting segments 36 are formed into a sinuous or serpentine tube portion 30, as is known in the art, to be used in the heat exchanger 32. Preferably, each straight segment 34 that forms a pair 40 of straight segments are parallel to one another. Even more preferably, all the straight segments 34 that comprise tube passes 38 are generally parallel. A single straight segment 34 could also pass through all or a portion of each fin 28 on the heat exchanger 32.

[0028] Preferably, the tube portion 30 is configured so that adjacent horizontal tube passes 38 are uniformly spaced apart. Also preferably, adjacent vertical tube passes 38 are uniformly spaced apart. Even more preferably, the spacing between adjacent horizontal tube passes 38 is generally the same as the spacing between adjacent vertical tube passes 38. The uniform spacing between adjacent horizontal and vertical tube passes 38 enables the universal fin

20 to provide one or more fins 28 to be used with the tube portion 30 to form heat exchangers 32 regardless of the number of horizontal and vertical tube passes 38, as will be described in more detail below.

[0029] The tube portion 30 can be made in a variety of manners. For example, as shown in Figure 7, the tube portion 30 can be made by bending a piece of continuous tubing 42 into the desired configuration. While the piece of continuous tubing 42 is shown in Figure 7 as being bent by a tube bender 44, it should be understood that other methods of bending a piece of continuous tubing 42 into a tube portion 30 having a desired configuration, as will be apparent to those skilled in the art, can be employed and still be within the scope of the invention as defined by the claims. Alternatively, the tube portion 30 can be formed by connecting independent straight segments 34 with independent connecting segments 36. That is, the tube portion 30, as is known in the art, can be assembled from a plurality of discrete components. The connecting segments 36 can be connected to the straight segments 34 by brazing, adhesives, or other means known in the art, without departing from the scope of the invention as defined by the claims. The connecting segments 36, regardless of being discrete components or part of the tube is slightly flattened in a rectangular die (not shown) to facilitate insertion through openings 22 in universal fin 20.

[0030] Referring now to Figure 1A, it can be seen that the openings 22 in the universal fin 20 are configured to allow a tube pass 38 to pass therethrough. That is, the openings 22 are configured to allow a pair 40 of straight segments and a slightly flattened connecting segment 36 to pass through

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the opening 22. The openings 22, are comprised of end portions 46 connected by a central portion 48. The end portions 46 are rounded and substantially complementary to the straight segments 34 that make up the tube portion 30. End portions 34 have a collar or flange portion 49 (shown in Figure 6 only) that contacts straight segments 34. End portions 46 have a radius that is slightly less than a radius of the straight segments 34 to allow a press-fit connection with good surface contact between straight segments 34 and fins 28. The central portion 48 connects the end portions 46 and allows the slightly flattened connecting segment 36 attached to the pair of straight segments 40 to pass therethrough so that a fin 28 having the openings 22 can be positioned on a tube portion 30 with each tube pass 38 passing through different openings 22 to form a heat exchanger 32. Preferably, the end portions 46 and the intermediate portion 48 are configured to form a "dog-bone" shape, as is known in the art. Even more preferably, each opening 22 in the universal fin 20 is generally identical. The openings 22 are canted relative to the height H and width W. The tube portion 30 is configured so that the tube passes 38 are also canted and are complementary to the canting of the openings 22.

[0031] As was stated above, the universal fin 20 is configured so that one or more fins 28 can be separated from the universal fin 20 and used on a heat exchanger 32 regardless of the number of horizontal or vertical tube passes 38 that comprise the heat exchanger 32. To enable the universal fin 20 to provide one or more fins 28 for use on a heat exchanger 32 regardless of the number of horizontal and vertical tube passes 38, the spacing between the

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openings 22 on the universal fin 20 generally need to be the same as the spacing between the tube passes 38 on a tube portion 30. Preferably, adjacent columns 24 of openings 22 are generally equally spaced apart. Also preferably, adjacent rows 26 of openings 22 are generally equally spaced apart. The tube portion 30 is configured so that the spacing between vertical tube passes 38 is generally the same as the spacing between adjacent rows 26 of openings 22 in the universal fin 20 and the spacing between horizontal tube passes 38 is generally the same as the spacing between adjacent columns 24 of openings 22 in the universal fin 20.

[0032] Because the tube portion 30 is configured so that the spacing between vertical and horizontal tube passes 38 are the same as the spacing between the columns 24 and the rows 26, the universal fin 20 can be separated between the rows 26 and/or columns 24 to form one or more continuous fins 28 that can be used on the tube portion 30 to form a heat exchanger 32 regardless of the number of horizontal and vertical tube passes 38. For example, when the tube portion 30 is configured into the shape shown in Figures 2 and 3, the tube portion 30 has two horizontal tube passes 38 and eight vertical tube passes 38, a 2x8 configuration. To make a continuous fin 28 for use on the 2x8 configuration, the universal fin 20 is separated between adjacent columns 24 and adjacent rows 26 so that a continuous fin 28, as shown in Figure 1B, is formed that has two columns 24 of openings 22 and eight rows 26 of openings 22. The fin 28, shown in Figure 1B, can then be used on the tube portion 30 shown in Figure 2 to form the heat exchanger 32 shown in Figure 3.

The universal fin 20 can also be used to provide one or more continuous fins 28 for use on a tube portion 30 having eight horizontal tube passes 38 and four vertical tube passes 38, an 8x4 configuration, as shown in Figure 4. A fin 28 for use on the tube portion 30 shown in Figure 4 can be separated from the universal fin 20. That is, the universal fin 20 is separated between adjacent columns 24 and adjacent rows 26 to form a continuous fin 28, as shown in Figure 1C, that has eight columns 24 of openings 22 and four rows 26 of openings 22. The fin 28 shown in Figure 1C can then be used on a tube portion 30 shown in Figure 4 to form the heat exchanger 32 shown in Figure 4.

[0033] Preferably, the universal fin 20 is separated so as to form a plurality of continuous fins 28 having the same number of columns 24 and rows 26 so that the plurality of fins 28 can be aligned to form a fin bank 50 through which the tube passes 38 of the tube portion 30 pass. That is, the plurality of fins 28 formed from a universal fin 20 are positioned on the tube portion 30 and spaced along the tube passes 38 to form an efficient heat exchanger 32. It should be appreciated that the universal fin 20 can be separated so as to form continuous fins 28 having more or less number of columns 24 and/or rows 26 than the number of horizontal and/or vertical tube passes 38 if desired and still be within the scope of the present invention.

[0034] Optionally, to facilitate the separation of the universal fin 20 to form one or more continuous fins 28, the universal fin 20 can be provided with indicia 51 that extends between the adjacent columns 24 and/or between adjacent rows 26. The indicia 51 indicates locations on the universal fin 20

where the universal fin 20 can be separated to form the one or more fins 28. The indicia 51 can be perforations in the universal fin 20. The perforations facilitate the separating of the one or more fins 28 from the universal fin 20.

[0035] The one or more continuous fins 28 formed from the universal fin 20 are assembled on the tube portion 30 by either sliding the tube passes 38 through the openings 22 until the fins 28 are positioned in desired locations on the tube portion 30, or by sliding the fins 28 along the tube passes 38 until the fins 28 are located at desired positions on the tube portion 30. The fins 28 can then be secured to the tube portion 30, by a variety of methods. Preferably the fins 28 are attached to the tube portion by a mechanical or interference fit. The openings 22 can be configured so that the end portions 48 deform slightly as a result of the tube passes 38 extending through the openings 22. The deformation of the end portions 48 mechanically retain the fins 28 at desired locations on the tube portion 30 and provide good surface contact between fins 28 and tube portion 30. Alternatively, other methods of attaching the fins 28 to the desired location of the tube portion 30, such as by brazing and/or adhesives, may be employed.

[0036] The one or more continuous fins 28 that are made from the universal fin 20 can be separated from the universal fin 20 in a variety of ways. For example, the universal fin 20 can be cut between adjacent rows 26 and/or adjacent columns 24 to form the one or more fins 28 having a desired number of columns 24 and rows 26 of openings 22. Other methods of separating the universal fin 20 between the columns 24 and/or rows 26, as will be apparent to

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those skilled in the art, can also be employed without departing from the scope of the invention as defined by the claims.

**[0037]** The universal fin 20 can be formed by a variety of methods, as will be apparent to those skilled in the art. For example, as shown in Figure 5, the universal fin 20 can be die stamped from a sheet 52 of heat conducting material. The sheet 52 of heat conducting material is positioned within a die stamp 54. The die stamp then stamps the sheet 52 of heat conducting material into the form of a universal fin 20, as is known in the art.

**[0038]** As was mentioned above, the configuration of the tube portion 30 in a heat exchanger 32 will vary depending upon the application in which the heat exchanger 32 is desired to be used. For example, when the heat exchanger 32 is desired to be used in a domestic refrigerator, the heat exchanger 32 can be configured to be either an evaporator 56 or a condenser 58. When heat exchanger 32 is configured to be a condenser 58 for application in a machine compartment, the heat exchanger 32 will have a general shape as shown in Figure 3. The condenser 58 is characterized by having a relatively large inlet for air flow and a short path through the condenser 58 through which the air flows. That is, the condenser 58 will have significantly more vertical tube passes 38 than horizontal tube passes 38 with a horizontal air flow. While the condenser 58 is shown as a 2x8 configuration, it should be understood the actual configuration will vary and such variations are within the scope of the invention. To make the condenser 58, the tube portion 30 is formed into the configuration shown in Figure 2. Fins 28 having the same number of horizontal rows 28 and

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vertical columns 24 as the number of horizontal and vertical tube passes 38 (one-half the number of rows 26 and columns 24 as the number of straight segments 34) are removed from the universal fin 20. The plurality of fins 28 and the tube portion 30 are then assembled, as shown in Figure 6, to form the condenser 58.

[0039] The tube portion 30 can also be configured so the heat exchanger 32 takes the form of an evaporator or a condenser 56 for application underneath a refrigerator. The evaporator or condenser 56 is characterized having a relatively small inlet for air flow and a comparably long path through the evaporator or condenser 56 through which the air flows. Therefore, as can be seen in Figure 4, the evaporator or condenser 56 is characterized by having a significantly larger number of horizontal tube passes 38 than vertical tube passes 38 with a horizontal air flow. While the evaporator or condenser 56 is shown as an 8x4 configuration, it should be understood that the actual configuration will vary and such variations are within the scope of the invention. One or more continuous fins 28, as shown in Figure 1C, are separated from the universal fin 20 so that the number of rows 26 and columns 24 of openings 22 on the fins 28 equals the number of horizontal and vertical tube passes 38 (one-half the number of rows 26 and columns 24 as the number of straight segments 34) of the tube portion 30. The fins 28 and tube portion 30 are then assembled to form the evaporator 56.

[0040] Optionally, but preferably, the spacing between adjacent columns 24 is generally equal to the spacing between adjacent rows 26. When

the spacing between adjacent columns 24 and adjacent rows 26 is the same, the tube portion 30 which is configured to use one or more continuous fins 28 from the universal fin 20 has the vertical and horizontal tube passes 38 also equally spaced apart and equal to the spacings between the adjacent columns 24 and adjacent rows 26. The tube portion 30 can then utilize the universal fin 20 to provide one or more continuous fins 28 to be assembled with the tube portion 30 to form a heat exchanger 32 having any desired number of vertical and horizontal tube passes 38.

[0041] Referring now to Figure 8A, a second preferred embodiment of a universal fin 20' is shown. In this embodiment, the openings 22' are arranged in a tighter configuration such that a straight line cannot be drawn between adjacent columns 24' of openings 22'. That is, openings 22' are canted and the columns 24' are spaced apart a distance such that an upper portion of one of the openings 22' will overlap a lower portion of an opening 22' in an adjacent column 24'. With this spacing between adjacent columns 24', a straight cut between columns 24' is not possible. Rather, adjacent columns 24' are separated by making a scalloped or undulating cut between adjacent columns 24'; such as shown in Figures 8B-D which are fins 28' of varying number of columns 24' that were cut from universal fin 20' and have undulating edges.

[0042] The partial overlapping of an opening 22' in one column 24' with an opening 22' in an adjacent column 24' allows for closer spacing between tube passes 38' in a heat exchanger 32' formed with scalloped fins 28', such as the heat exchanger 32' shown in Figure 9. The universal fin 20' can be cut or

separated between adjacent columns 24' and/or rows 26' to form a fin 28' with a desired number of columns 24' and rows 26', such as fins 28' shown in Figures 8B-D. Optionally, as shown in Figure 8A, universal fin 20' can have a lower most row 60 which has a generally horizontal opening 62 for every two columns 24'. Openings 62 are designed to correspond with a tube pass that goes from one column 24' to an adjacent column 24'. Thus, universal fin 20' is substantially the same as universal fin 20 with the positioning of adjacent columns 24' being different along with the optional addition of a lowermost row 60 of openings 62.

[0043] As will be apparent to those skilled in the art, the universal fin 20 can be used to provide one or more continuous fins 28, 28' for a variety of configurations of a heat exchanger 32, 32' that has horizontal and vertical tube passes that are spaced apart generally equal to the spacings between the columns 24, 24' and rows 26, 26' of openings 22, 22' in the universal fin 20, 20'. Therefore, while the universal fin 20, 20' has been shown as being able to provide one or more continuous fins 28, 28' for use in a 2x8 configuration and an 8x4 configuration, it should be understood that universal fin 20, 20' can be used to provide fins 28, 28' for n x n configurations, where n is a positive integer, without departing from the scope of the invention as defined by the claims.

[0044] The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

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## CLAIMS

What is claimed is:

1. A universal fin for use in a fin on tube heat exchanger, the universal fin comprising:

a sheet of heat conducting material configured to be separated to form one or more fins for use on the fin on tube heat exchanger regardless of a number of vertical and horizontal pairs of tubing segments in said heat exchanger, said sheet having a width and a height; and

a plurality of openings in said sheet, each of said openings configured to allow a pair of generally parallel tubing segments of the heat exchanger to pass therethrough, said openings being canted relative to said width and height of said sheet, said openings being arranged on said sheet into a plurality of rows and a plurality of columns with adjacent rows being generally equally spaced apart and adjacent columns being generally equally spaced apart, and said spacing between adjacent rows and adjacent columns being dimensioned to allow said sheet to be separated between at least one of said adjacent rows and said adjacent columns to form one or more fins each containing a plurality of openings at least equal to a total number of pairs of tubing segments in the heat exchanger.

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2. The universal fin of claim 1, wherein said openings are elongated openings with each opening having opposite end portions interconnected by a central portion.

3. The universal fin of claim 2, wherein said openings are dog-bone shaped.

4. The universal fin of claim 1, further comprising indicia on said sheet indicating locations where said sheet can be separated to form said fins, said indicia extending along said sheet between at least one of said columns and said rows.

5. The universal fin of claim 4, wherein said indicia is perforations in said sheet.

6. The universal fin of claim 1, wherein said columns are spaced apart such that a portion of said openings in one of said columns overlaps a portion of said openings in an adjacent column.

7. The universal fin of claim 6, wherein said adjacent columns when separated have an undulating edge.

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8. The universal fin of claim 1, wherein said spacing between adjacent rows is generally equal to said spacing between adjacent columns.

9. The universal fin of claim 1, wherein each of said openings are generally identical.

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10. A fin on tube heat exchanger having a fin formed from a universal fin sheet, the heat exchanger comprising:

a tube portion having a plurality of straight segments of tubing interconnected by a plurality of connecting segments of tubing with each connecting segment interconnecting two straight segments, said straight and connecting segments being arranged in a sinuous configuration, said tube portion having a known quantity of vertical and horizontal pairs of tube passes; and

at least one fin on said tube portion, said fin being separated from a universal fin sheet having a width, a height and a plurality of openings with each opening configured to allow a pair of tube passes to pass therethrough, said openings being arranged on said universal fin sheet into a plurality of rows and a plurality of columns with adjacent rows being generally equally spaced apart and adjacent columns being generally equally spaced apart, and said spacing between adjacent rows and adjacent columns being dimensioned so that said universal fin sheet can be separated between at least one of said adjacent rows and adjacent columns to form said fin having a quantity of openings at least equal to said number of pairs of tube passes regardless of a number of vertical and horizontal pairs of tube passes in said tube portion,

wherein said fin has a quantity of said openings at least equal to said number of pairs of tube passes in said tube portion and said fin is arranged on said tube portion with each pair of tube passes of said tube portion passing through one of said openings in said fin.

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11. The heat exchanger of claim 10, wherein said tube portion is a single continuous tube.

12. The heat exchanger of claim 10, wherein said at least one fin is one of a plurality of fins and said plurality of fins are aligned in a generally parallel configuration with said openings in said fins being aligned to form a fin bank that is arranged on said tube portion.

13. The heat exchanger of claim 10, wherein said tube portion has more vertical tube passes than horizontal tube passes.

14. The heat exchanger of claim 10, wherein said tube portion has more horizontal tube passes than vertical tube passes.

15. The heat exchanger of claim 10, wherein said openings in said universal fin sheet are canted relative to said width and said height of said universal fin sheet.

16. The heat exchanger of claim 10, wherein said spacing between adjacent rows is generally equal to said spacing between adjacent columns.

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17. The heat exchanger of claim 10, wherein said openings in said universal fin sheet are elongated openings with each opening having opposite end portions interconnected by a central portion.

18. The heat exchanger of claim 10, wherein said columns of said universal fin sheet are spaced apart such that a portion of said openings in one of said columns overlaps a portion of said openings in an adjacent column and said fin has an undulating edge.

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**19. A method of making a fin on tube heat exchanger, the method comprising the steps of:**

(a) separating at least one fin having a predetermined quantity of openings from a preformed universal fin sheet that is configured to be separated to provide one or more fins for use on a heat exchanger regardless of a number of vertical and horizontal pairs of tube passes in a tube portion of the heat exchanger on which said at least one fin is to be used; and

(b) positioning said fin on said tube portion of said heat exchanger with pairs of tube passes passing through said openings.

20. The method of claim 19, wherein (a) includes preforming said universal fin sheet so that said universal fin sheet has a width, a height and a plurality of openings with each opening configured to allow a pair of tube passes of the heat exchanger to pass therethrough, said openings being arranged on said universal fin sheet into a plurality of rows and a plurality of columns with adjacent rows being generally equally spaced apart and adjacent columns being generally equally spaced apart, and said spacing between adjacent rows and adjacent columns being dimensioned so that said universal fin can be separated between at least one of said adjacent rows and adjacent columns to form said at least one fin regardless of a number of horizontal and vertical pairs of tube passes.

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21. The method of claim 20, wherein preforming said universal fin sheet includes placing indicia on said universal fin sheet between at least one of said columns and said rows, said indicia indicating locations where said universal fin sheet can be separated to form said at least one fin.

22. The method of claim 21, wherein said indicia are perforations in said universal fin.

23. The method of claim 20, wherein (a) includes die stamping said universal fin sheet from a sheet of heat conducting material.

24. The method of claim 20, wherein preforming said universal fin sheet includes preforming said universal fin sheet with said plurality of openings canted relative to said width and height of said universal fin sheet.

25. The method of claim 19, further comprising forming a tube portion having a predetermined number of vertical and horizontal pairs of tube passes.

26. The method of claim 25, wherein forming said tube portion includes forming said tube portion with a greater number of horizontal pairs of tube passes than vertical pairs of tube passes.

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27. The method of claim 25, wherein forming said tube portion includes forming said tube portion with a greater number of vertical pairs of tube passes than horizontal pairs of tube passes.

28. The method of claim 25, wherein forming said tube portion includes bending a continuous length of tubing so that said tubing forms said tube portion.

29. The method of claim 19, wherein (a) includes cutting said at least one fin from said preformed universal fin sheet.

30. The method of claim 19, wherein portions of openings in one column overlap portions of openings in an adjacent column and said fin has an undulating edge.

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# **ABSTRACT OF THE DISCLOSURE**

A universal fin for use on a heat exchanger having a known number of vertical and horizontal tube passes. The universal fin has a plurality of openings arranged in equally spaced columns and equally spaced rows. One or more continuous fins having columns and rows of openings equal to the known number of tube passes can be removed from the universal fin and assembled with a tube portion to form the heat exchanger. The openings on the universal fin are configured so that one or more fins can be separated from the universal fin for use on a heat exchanger regardless of the number of horizontal and vertical passes that comprise the heat exchanger.

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**DECLARATION AND POWER OF ATTORNEY**

Atty. Docket No. 7647-000025

**DECLARATION**

As a below named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated below next to my name,

I believe that I am the original and first inventor or inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**FLEXIBLE TUBE ARRANGEMENT-HEAT EXCHANGER DESIGN**

the specification of which (check one)

- ☒ is attached hereto.
- or
- ☐ was filed on \_\_\_\_\_ as Application Serial No. or PCT International Application No. \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. §§ 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or any PCT international application having a filing date before that of the application on which priority is claimed:

| PRIOR FOREIGN APPLICATION(S) |         |                            |                          |                          |
|------------------------------|---------|----------------------------|--------------------------|--------------------------|
| APPN. SERIAL NO.             | COUNTRY | DATE FILED<br>(MM/DD/YYYY) | PRIORITY CLAIM           |                          |
|                              |         |                            | Yes                      | No                       |
|                              |         |                            | <input type="checkbox"/> | <input type="checkbox"/> |
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**DECLARATION AND POWER OF ATTORNEY**

Atty. Docket No. 7847-000025

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**POWER OF ATTORNEY**

I hereby appoint each practitioner at Customer No. 27572 of Harness, Dickey & Pierce, P.L.C., my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

**CORRESPONDENCE ADDRESS**

I request the Patent and Trademark Office to direct all correspondence and telephone calls relative to this application to Customer No. 27572, Harness, Dickey & Pierce, P.L.C., P. O. Box 828, Bloomfield Hills, Michigan 48303 (248) 641-1600.

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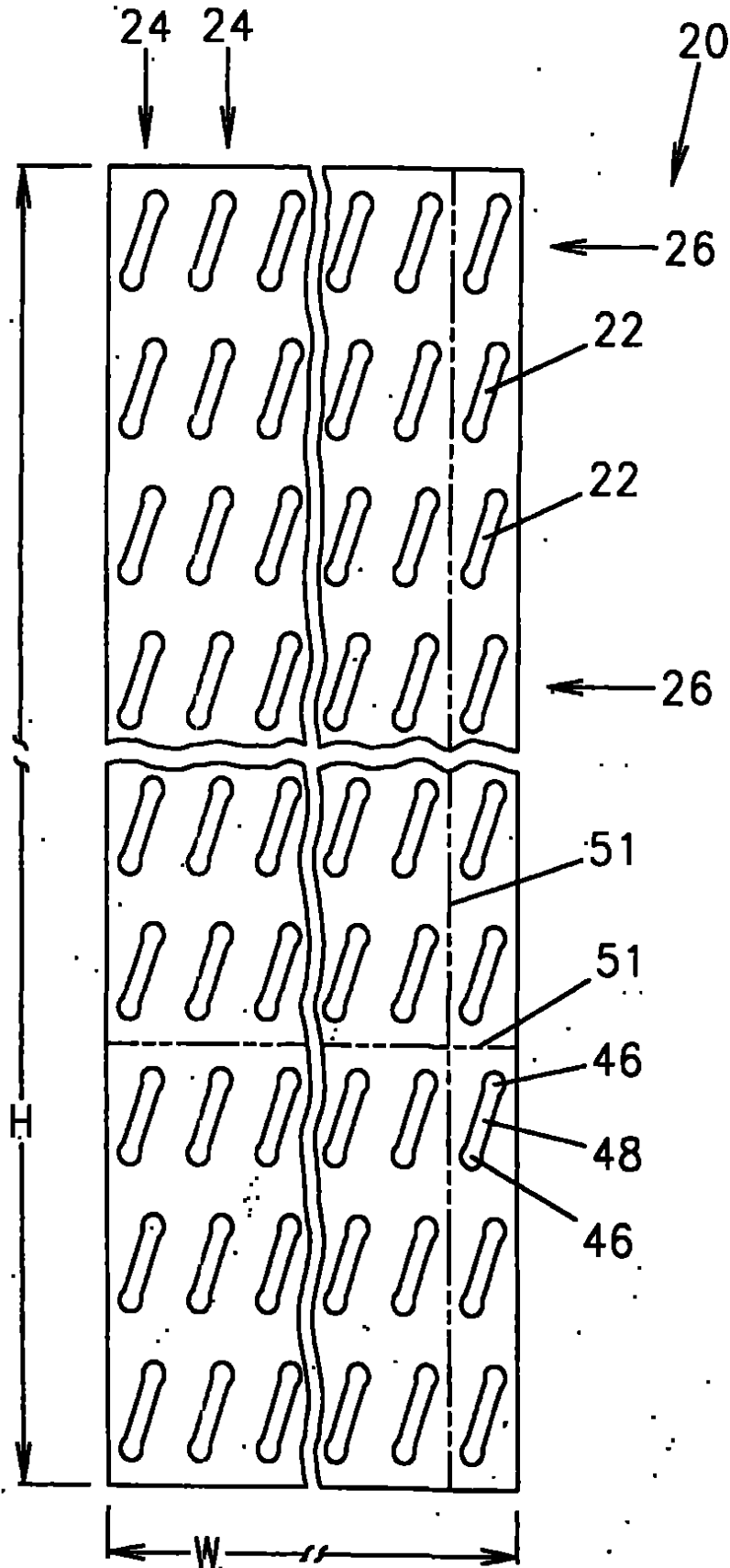


Fig 1A

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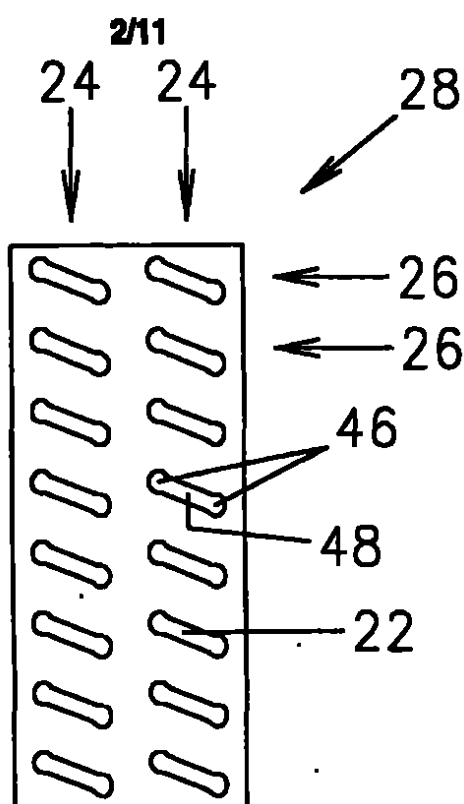


Fig 1B

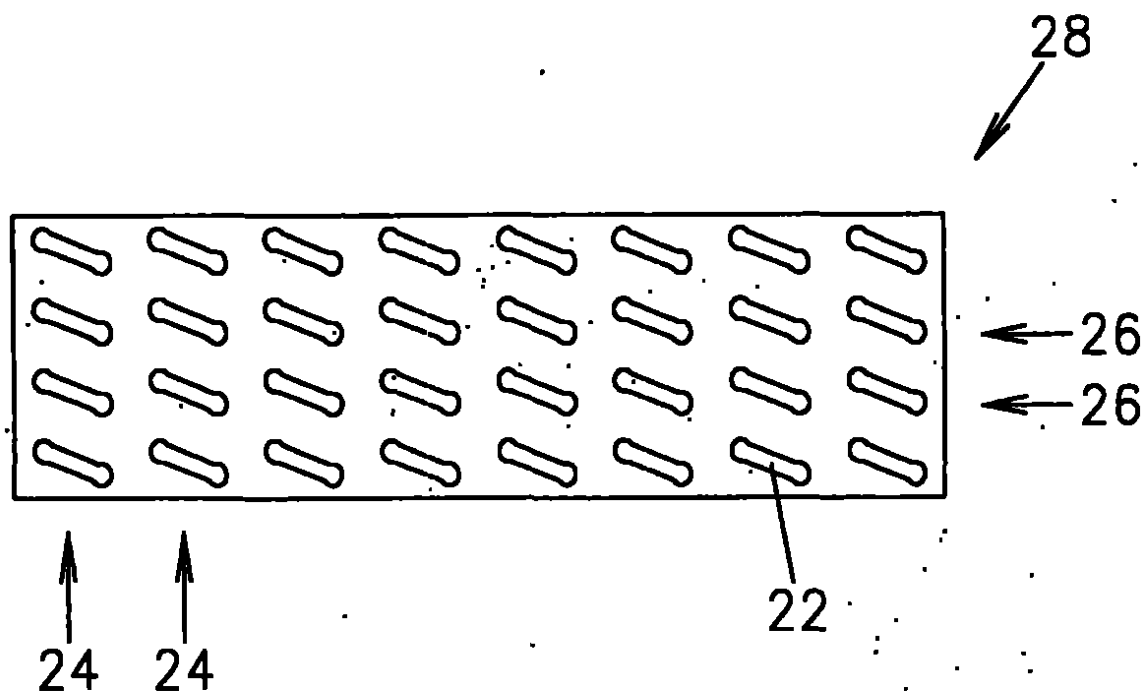


Fig 1C

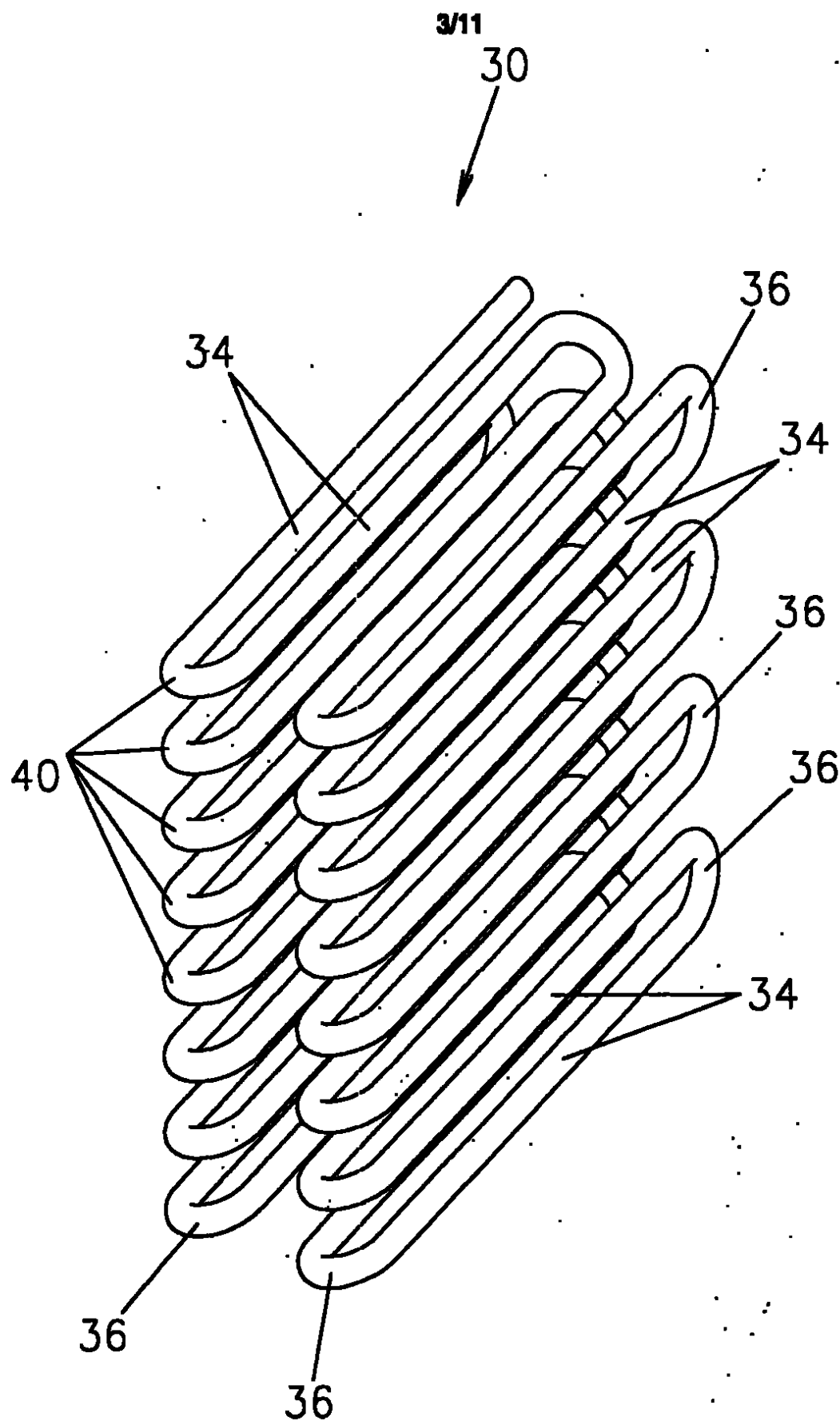


Fig 2

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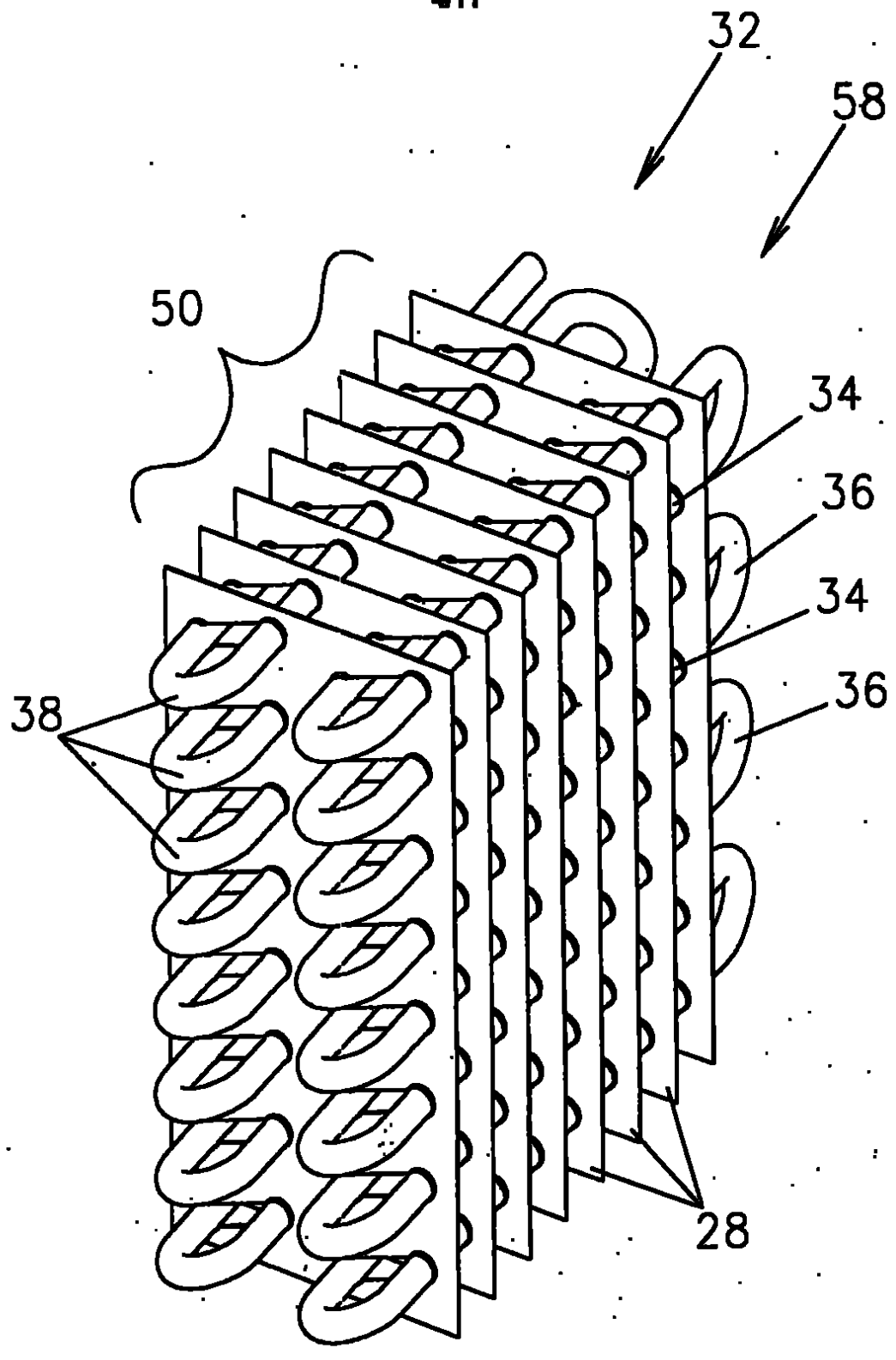


Fig 3

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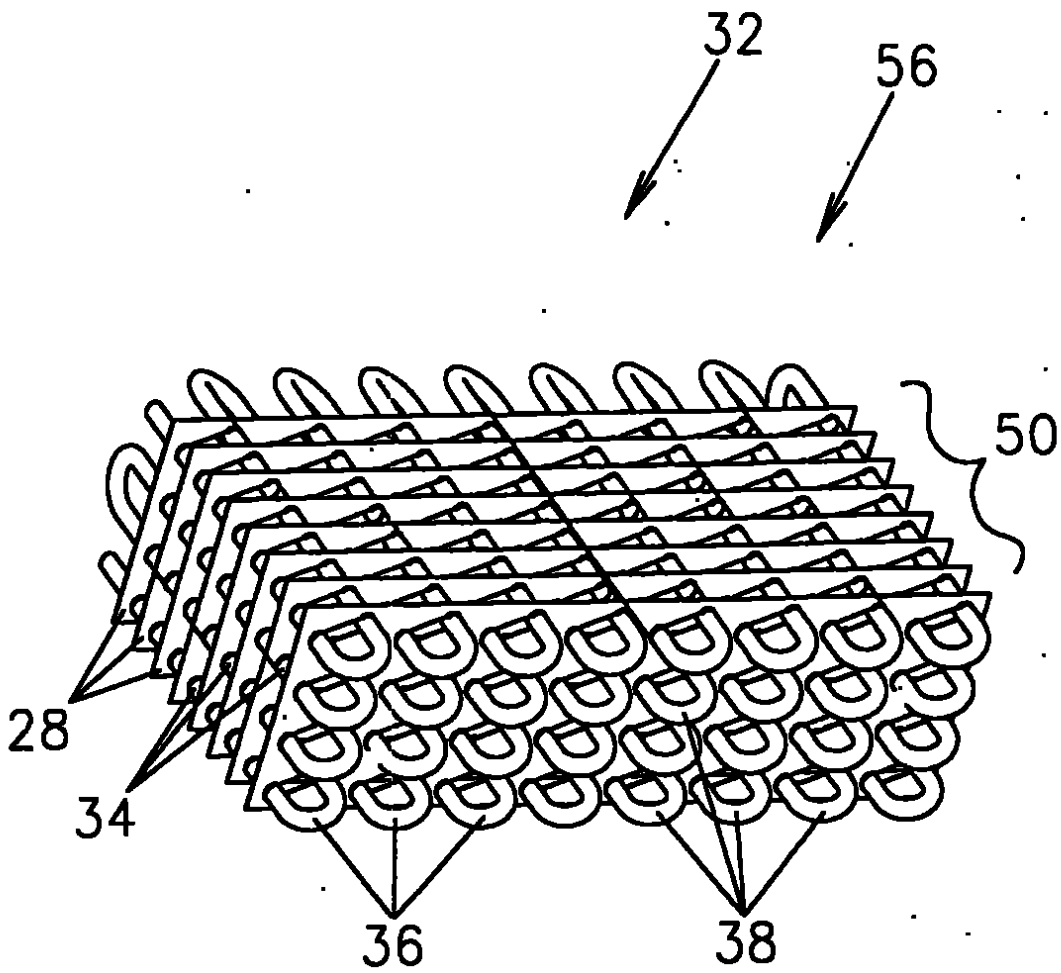


Fig 4

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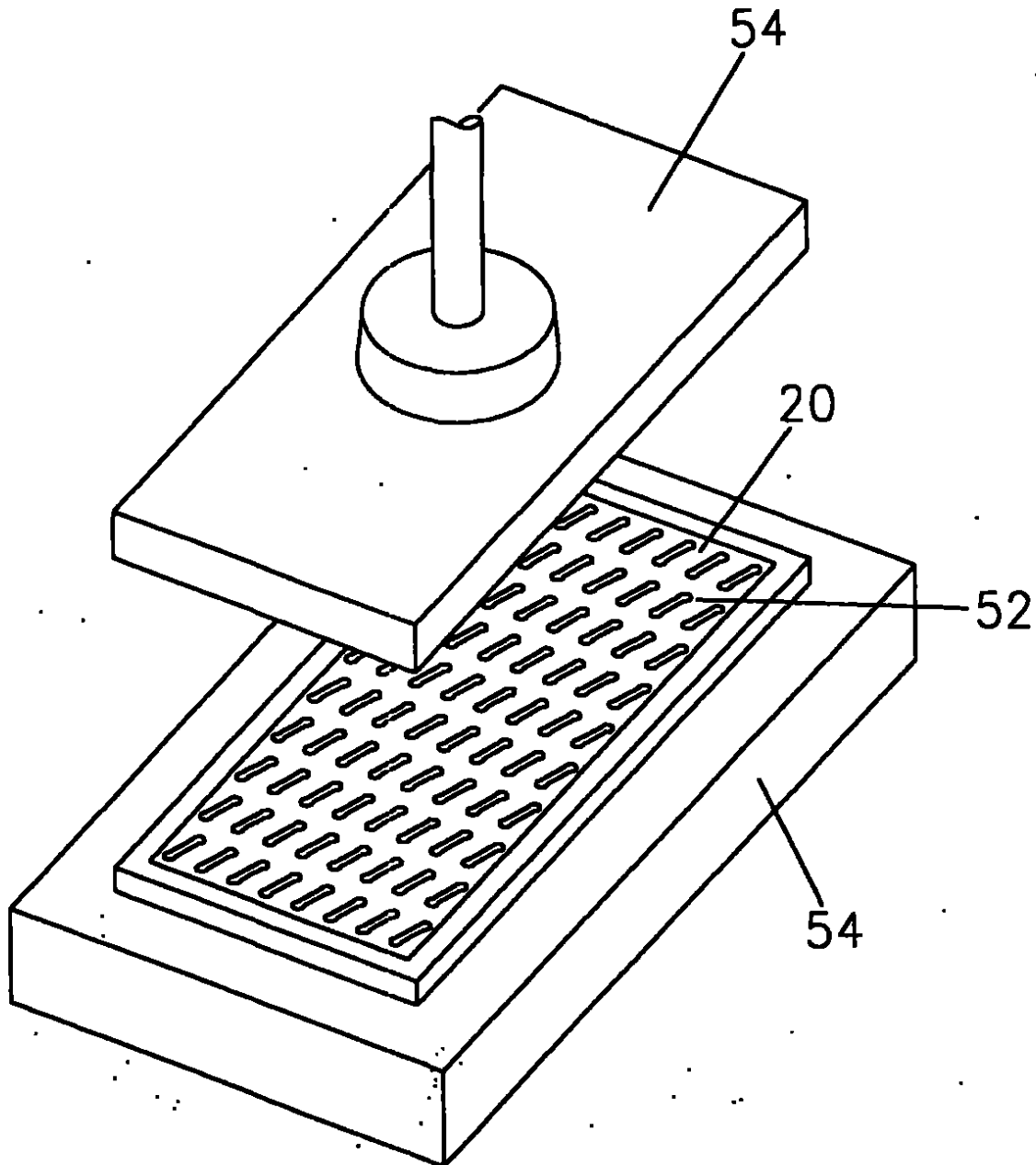


Fig 5

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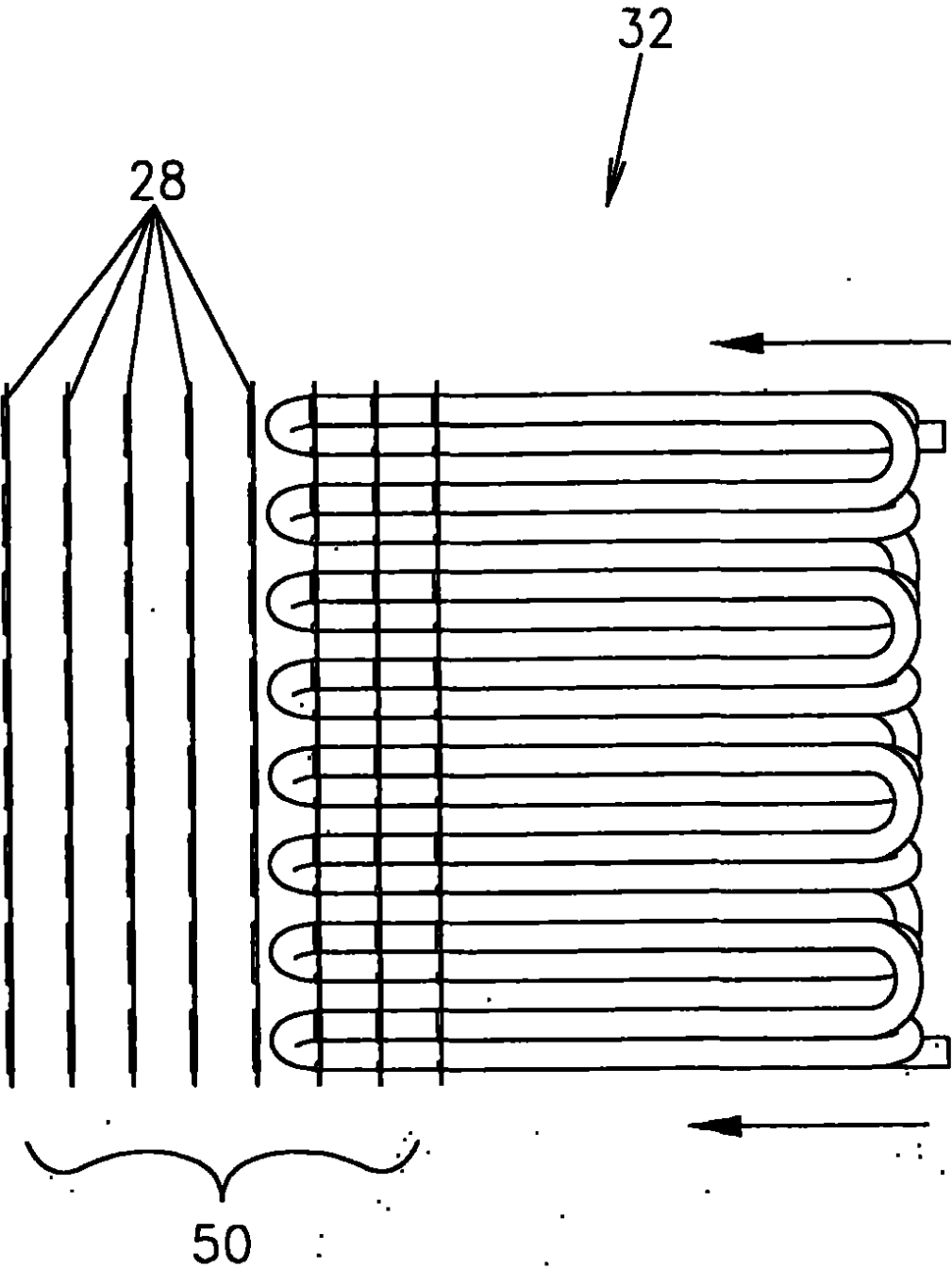
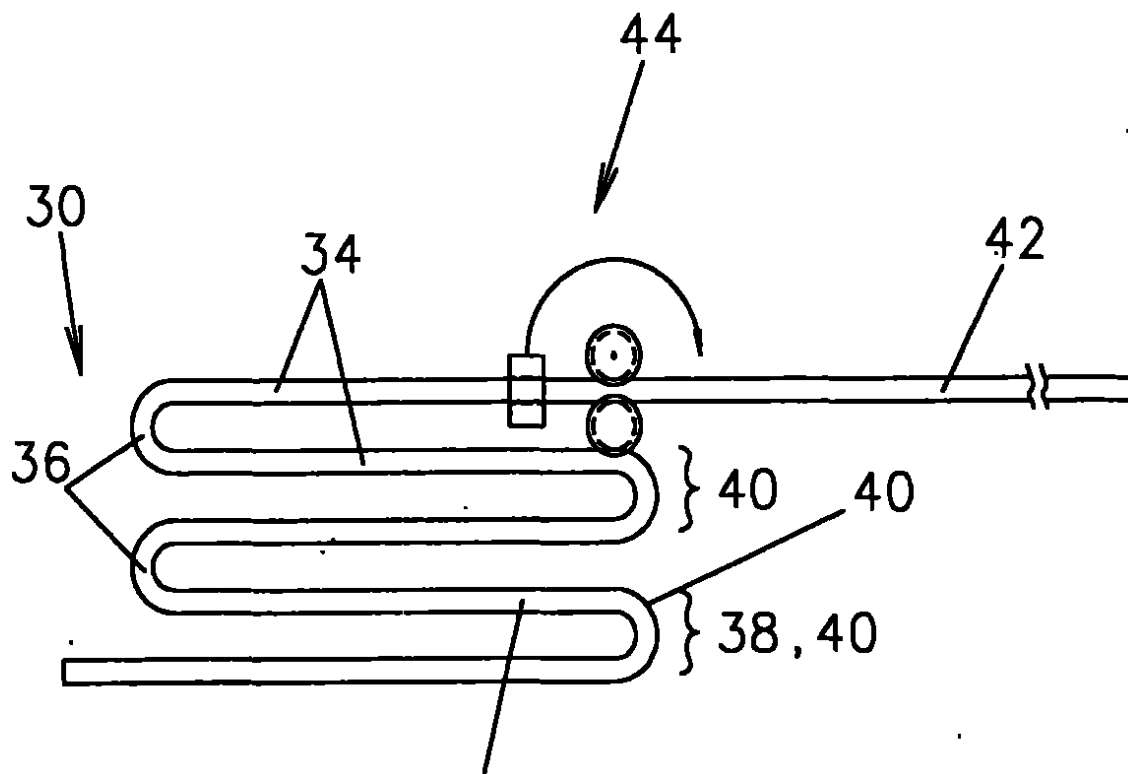


Fig 6

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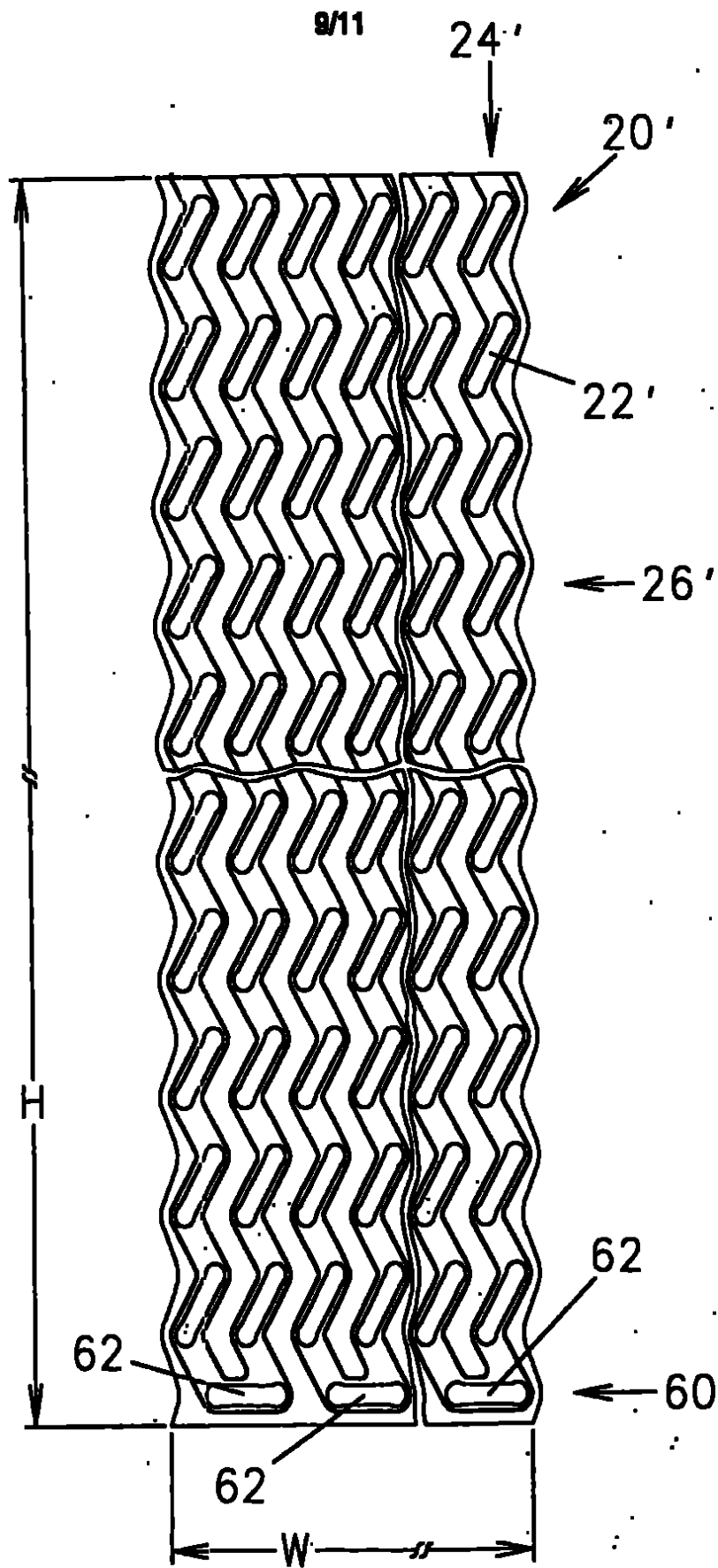


Fig 8A

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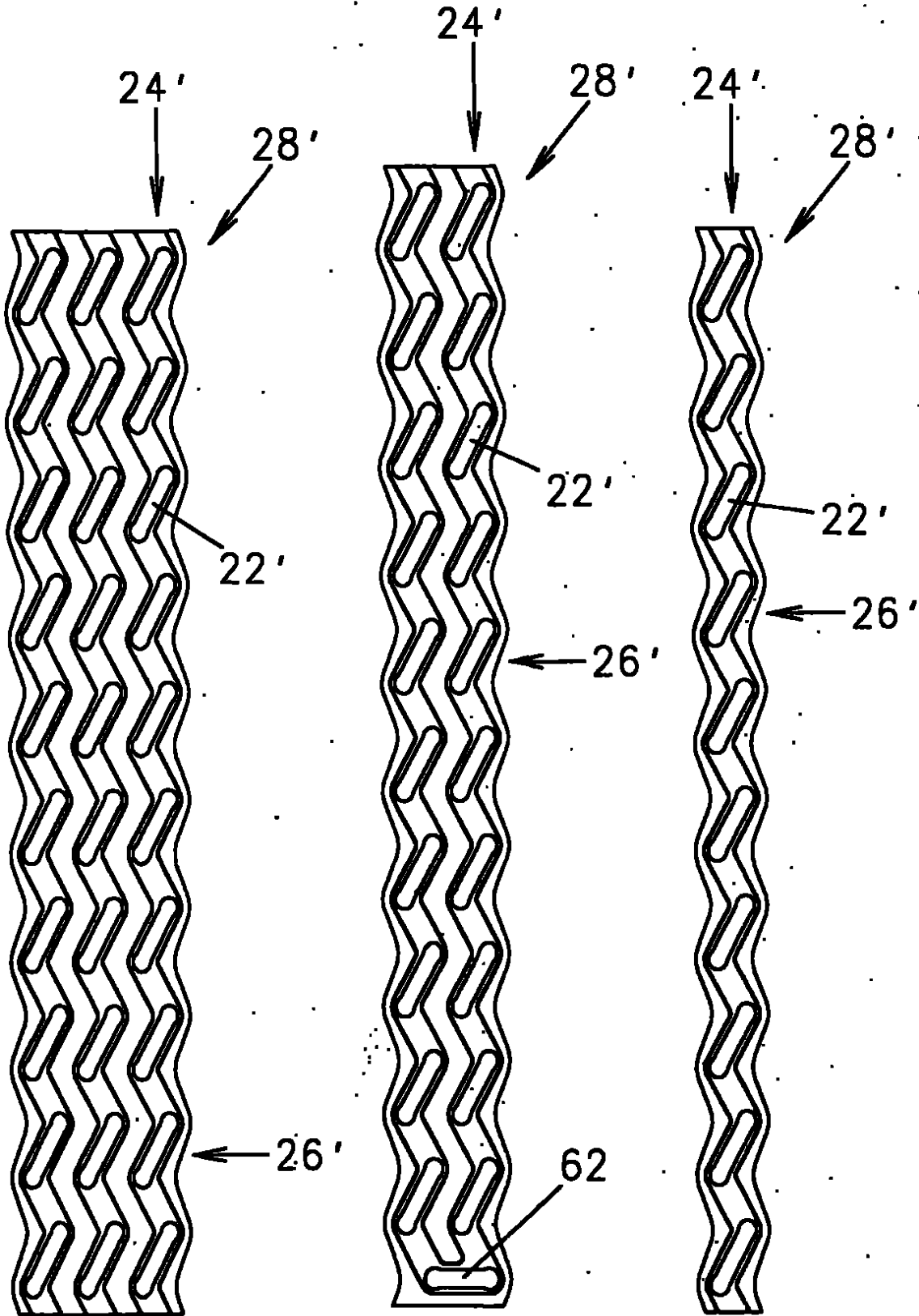


Fig 8B

Fig 8C

Fig 8D

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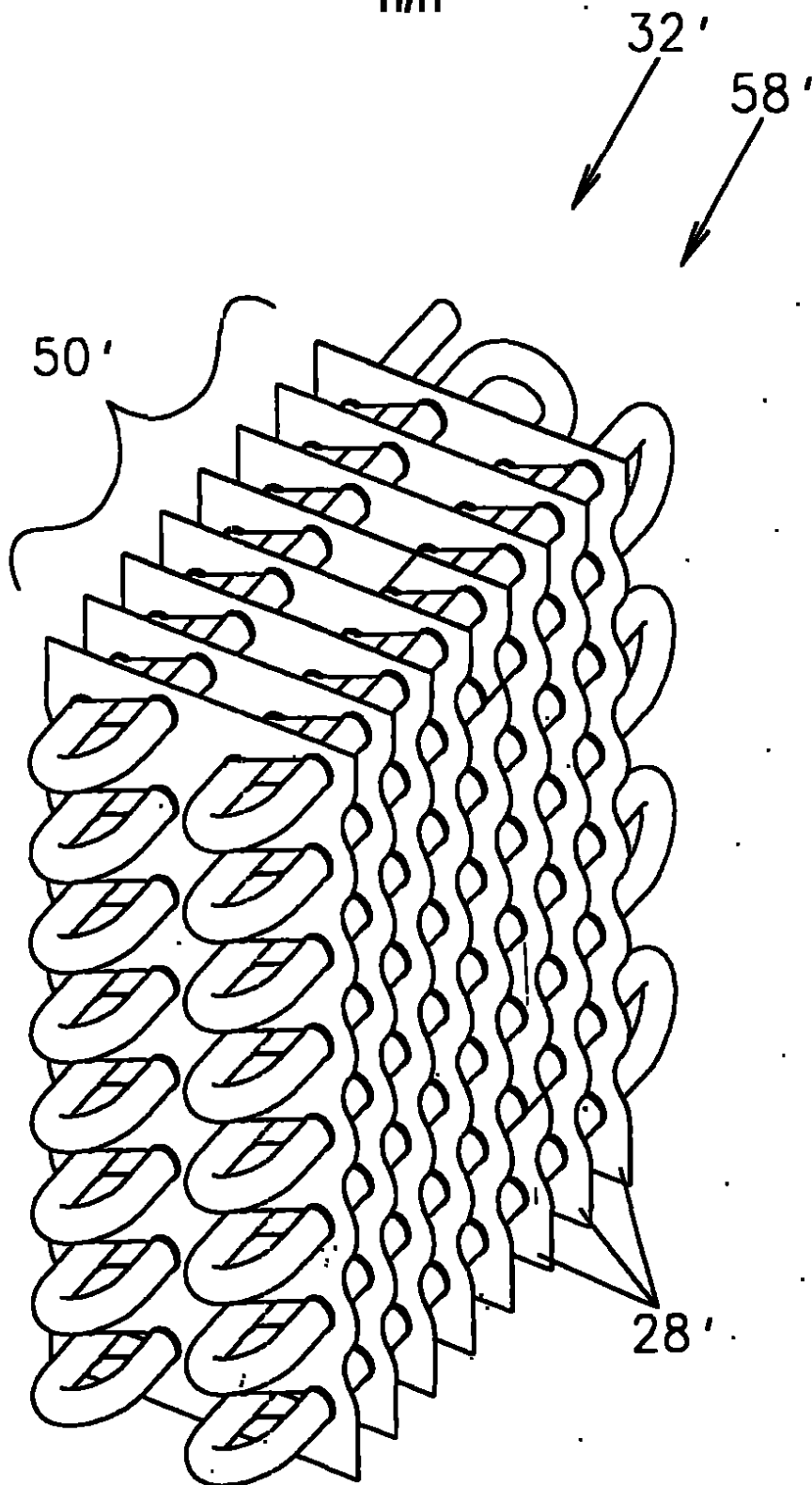


Fig 9