### CPC - COOPERATIVE PATENT CLASSIFICATION

#### F

**MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING**

(NOTE omitted)

#### LIGHTING; HEATING

**F28**

**HEAT EXCHANGE IN GENERAL**

(NOTES omitted)

**F28F**

**DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS, OF GENERAL APPLICATION** (water and air traps, air venting F16)

**WARNING**

In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

<table>
<thead>
<tr>
<th>subclass</th>
<th>description</th>
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<tbody>
<tr>
<td>1/00</td>
<td>Tubular elements; Assemblies of tubular elements (specially adapted for movement F28F 5/00)</td>
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<tr>
<td>1/003</td>
<td>[Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators F22B 1/066)]</td>
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<tr>
<td>1/006</td>
<td>[with variable shape, e.g. with modified tube ends, with different geometrical features (F28F 1/025, F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence)]</td>
</tr>
<tr>
<td>1/02</td>
<td>Tubular elements of cross-section which is non-circular (F28F 1/08, F28F 1/10 take precedence)</td>
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<tr>
<td>1/022</td>
<td>[with multiple channels]</td>
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<tr>
<td>1/025</td>
<td>[with variable shape, e.g. with modified tube ends, with different geometrical features (F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence)]</td>
</tr>
<tr>
<td>1/04</td>
<td>polygonal, e.g. rectangular ([F28F 1/022 takes precedence])</td>
</tr>
<tr>
<td>1/045</td>
<td>[with assemblies of stacked elements]</td>
</tr>
<tr>
<td>1/06</td>
<td>crimped or corrugated in cross-section</td>
</tr>
<tr>
<td>1/08</td>
<td>Tubular elements crimped or corrugated in longitudinal section</td>
</tr>
<tr>
<td>1/10</td>
<td>Tubular elements and assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with projections, with recesses (crimped or corrugated elements F28F 1/06, F28F 1/08)</td>
</tr>
<tr>
<td>1/105</td>
<td>[the means being corrugated elements extending around the tubular elements]</td>
</tr>
<tr>
<td>1/12</td>
<td>the means being only outside the tubular element</td>
</tr>
<tr>
<td>1/122</td>
<td>[and being formed of wires]</td>
</tr>
<tr>
<td>1/124</td>
<td>[and being formed of pins]</td>
</tr>
<tr>
<td>1/126</td>
<td>[consisting of zig-zag shaped fins (F28F 1/105 takes precedence)]</td>
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<tr>
<td>1/128</td>
<td>[Fins with openings, e.g. louvered fins and extending longitudinally (F28F 1/38 takes precedence)]</td>
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<tr>
<td>1/14</td>
<td>[the means being integral with the element, e.g. formed by extrusion (F28F 1/22 takes precedence)]</td>
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<tr>
<td>1/16</td>
<td>the means being integral with the element (F28F 1/12 takes precedence)</td>
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<tr>
<td>1/18</td>
<td>the element being built-up from finned sections</td>
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<tr>
<td>1/20</td>
<td>[Fins with openings]</td>
</tr>
<tr>
<td>1/22</td>
<td>the means having portions engaging further tubular elements</td>
</tr>
<tr>
<td>1/24</td>
<td>and extending transversely (F28F 1/38 takes precedence)</td>
</tr>
<tr>
<td>1/26</td>
<td>the means being integral with the element (F28F 1/32 takes precedence)</td>
</tr>
<tr>
<td>1/28</td>
<td>the element being built-up from finned sections</td>
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<tr>
<td>1/30</td>
<td>the means being attachable to the element (F28F 1/32 takes precedence)</td>
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<tr>
<td>1/32</td>
<td>the means having portions engaging further tubular elements</td>
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<tr>
<td>1/325</td>
<td>[Fins with openings]</td>
</tr>
<tr>
<td>1/34</td>
<td>and extending obliquely (F28F 1/38 takes precedence)</td>
</tr>
<tr>
<td>1/36</td>
<td>the means being helically wound fins or wire spirals</td>
</tr>
<tr>
<td>1/38</td>
<td>[Means comprising outside portions integral with inside portions]</td>
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<tr>
<td>1/40</td>
<td>the means being only inside the tubular element</td>
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<tr>
<td>1/405</td>
<td>[and being formed of wires]</td>
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<tr>
<td>1/42</td>
<td>the means being both outside and inside the tubular element</td>
</tr>
<tr>
<td>1/422</td>
<td>[with outside means integral with the tubular element and inside means integral with the tubular element (F28F 1/424 takes precedence)]</td>
</tr>
<tr>
<td>1/424</td>
<td>[Means comprising outside portions integral with inside portions]</td>
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<tr>
<td>1/426</td>
<td>[the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex]</td>
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<tr>
<td>2001/428</td>
<td>[Particular methods for manufacturing outside or inside fins]</td>
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<tr>
<td>1/44</td>
<td>and being formed of wire mesh</td>
</tr>
<tr>
<td>3/00</td>
<td>Plate-like or laminated elements; Assemblies of plate-like or laminated elements (specially adapted for movement F28F 5/00)</td>
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<tr>
<td>3/005</td>
<td>[Arrangements for preventing direct contact between different heat-exchange media (F28F 3/10 takes precedence)]</td>
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</tbody>
</table>
Elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with recesses, with corrugations (F28F 3/08 takes precedence)
Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general)

11/00 Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general)

11/02 . . . using obturating elements, e.g. washers, inserted and operated independently of each other

11/04 . . . using pairs of obturating elements, e.g. washers, mounted upon central operating rods

11/06 . . . using automatic tube obturating apparatus

13/00 Arrangements for modifying heat-transfer, e.g. increasing, decreasing

2013/001 . . . (Particular heat conductive materials, e.g. superconductive elements (for thermal joints)

13/003 . . . by using permeable mass, perforated or porous materials

13/005 . . . (Thermal joints)

13/006 . . . (Heat conductive materials)

13/008 . . . (Variable conductance materials; Thermal switches)

13/02 . . . by influencing fluid boundary (boundary-layer control in general F15D)

13/04 . . . by preventing the formation of continuous films of condensate on heat-exchange surfaces, e.g. by promoting droplet formation

13/06 . . . by affecting the pattern of flow of the heat-exchange media

13/08 . . . by varying the cross-section of the flow channels

13/10 . . . by imparting a pulsating motion to the flow, e.g. by sonic vibration

13/12 . . . by creating turbulence, e.g. by stirring, by increasing the force of circulation

13/125 . . . (by stirring)

13/14 . . . by endowing the walls of conduits with zones of different degrees of conduction of heat

13/16 . . . by applying an electrostatic field to the body of the heat-exchange medium

13/18 . . . by applying coatings, e.g. radiation-absorbing, radiation-reflecting; by surface treatment, e.g. polishing

13/182 . . . (especially adapted for evaporator or condenser surfaces)

13/185 . . . (Heat-exchange surfaces provided with microstructures or with porous coatings)

13/187 . . . (especially adapted for evaporator surfaces or condenser surfaces, e.g. with nucleation sites)

17/00 Removing ice or water from heat-exchange apparatus

17/005 . . . (Means for draining condensates from heat exchangers, e.g. from evaporators)

19/00 Preventing the formation of deposits or corrosion, e.g. by using filters or scrapers

19/002 . . . by using inserts or attachments
for increasing heat transfer F28F 13/00
controlling (heat-transfer, heat-exchange or heat-storage materials, e.g. selection of compositions
Features relating to the use of intermediate heat-exchange materials, e.g. selection of compositions (heat-transfer, heat-exchange or heat-storage materials C09K 5/00)
Arrangements for obtaining or maintaining same in a liquid state
Component parts of trickle coolers (arrangements for increasing heat transfer F28F 13/00; controlling arrangements F28F 27/00)
[Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid]
for distributing, circulating, and accumulating liquid (spraying or atomising in general B05B, B05D)
Distribution or accumulator troughs
Spray nozzles or spray pipes
Splashing boards or grids, e.g. for converting liquid sprays into liquid films; Elements or beds for increasing the area of the contact surface (packing elements per se B01J 19/30, B01J 19/32)
Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05)
Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05)
particularly for fins, for conduits
control means in header boxes F28F 9/026; arrangements of guide plates or guide vanes F28F 9/22, F28F 25/12)

Subject matter not provided for in other groups of this subclass

Prediction; Simulation; Testing (measuring quantity of heat conveyed by flowing mediums G01K 17/06)
Testing heat pipes
Heat exchange conduits
with particular branching, e.g. fractal conduit arrangements
Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
having walls comprising obliquely extending corrugations, e.g. in the form of threads
Assemblies of conduits having different features
Particular layout, e.g. for uniform temperature distribution
Fins
Arrangements of fins common to different heat exchange sections, the fins being in contact with different heat exchange media
Assemblies of fins having different features, e.g. with different fin densities
Hollow fins; fins with internal circuits
with openings, e.g. louvers (zig-zag fins with openings F28F 1/128, common transversal fins with openings F28F 1/325, corrugated fins with openings F28F 3/027)
Secondary fins, e.g. projections or recesses on main fins
with U-shaped slots for laterally inserting conduits
in the form of movable or loose fins
Closure means, e.g. end caps on header boxes or plugs on conduits
Reinforcing means
for casings
for conduits
for fins
for header boxes
Sealing means
Means for filling gaps between elements, e.g. between conduits within casings

Spacing means

Coatings; Surface treatments
- hydrophilic
- hydrophobic
- having particular radiating, reflecting or absorbing features, e.g. for improving heat transfer by radiation
- self-cleaning

Arrangements for modifying the flow of the heat exchange media (in general F28F 13/06), e.g. flow guiding means (in casings F28F 9/22); Particular flow patterns
- Streamline-shaped elements
- Communication passages between channels
- Derivation channels, e.g. bypass
- Fluid driving means, e.g. pumps, fans
- Particular pattern of flow of the heat exchange media
  - with change of flow direction
  - with parallel flow
  - with cross flow
  - with combined cross flow and parallel flow

Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes
- Flexible elements
- comprising shape memory alloys or bimetallic elements
- composite, e.g. polymers with fillers or fibres
- pressed; stamped; deep-drawn
- made by hydroforming
- expanded or perforated metal plate
- molded
- injection molded
- overmolded
- extruded
- sintered
- with nanostructures

Heat exchangers or heat exchange elements having special size, e.g. microstructures (microheat pipes F28D 2015/0225; nanostructures F28F 2255/20)
- having microchannels

Safety or protection arrangements; Arrangements for preventing malfunction (control or monitoring devices F28F 27/00)
- in the form of screens or covers (heat shields F28F 2265/10)
- by using means for draining heat exchange media from heat exchangers
- for preventing overheating, e.g. heat shields (thermal insulation F28F 2270/00)
- for preventing overpressure
- for preventing damage by freezing, e.g. for accommodating volume expansion
- for preventing leakage
- for removing contaminants, e.g. for degassing
- for preventing development of microorganisms
- for draining

for electrical insulation
for allowing differential expansion between elements (floating header box elements F28F 9/0236)
for preventing noise (by preventing vibrations F28F 2265/30)
for preventing vibrations
for limiting movements, e.g. stops, locking means

Thermal insulation; Thermal decoupling
- by using blind conduits

Fastening; Joining
- by using bonding materials (brazeing F28F 2275/04);
- by using adhesives
- by brazing (brazeing heat exchangers B23K 1/0012)
- with particular processing steps, e.g. by allowing displacement of parts during brazing or by using a reservoir for storing brazing material
- by welding (welding heat exchangers B23K 2101/14)
- by diffusion bonding
- by impact pressure or friction welding
- by induction welding or by using microwaves
- by ultrasonic or vibration welding
- by laser welding
- by explosive welding
- by clamping or clipping
- with snap connection
- by force joining
- by methods involving deformation of the elements
- by crimping, caulking or clinching
- by bringing elements together and expanding
- by shrinking
- by using form fitting connection, e.g. with tongue and groove
- with pin and hole connections
- with bayonet connections
- with toothed elements, e.g. with serrations
- by using wedge effect
- with threaded elements
- with tie-rods
- by using magnetic effect

Mounting arrangements; Arrangements for facilitating assembling or disassembling of heat exchanger parts
- Removable elements
- Means for preventing wrong assembling of parts
- Adapter frames, e.g. for mounting heat exchanger cores on other structure and for allowing fluidic connections
- Tolerance compensating means
- Movable elements, e.g. being pivotal (elements specially adapted for movements F28F 5/00)
- with hinged connections