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.

1/00 **Tubular elements; Assemblies of tubular elements** (specially adapted for movement F28F 5/00)

1/003 . {Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators F22B 1/066)}

1/006 . {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)}

1/02 . Tubular elements of cross-section which is non-circular (F28F 1/08, F28F 1/10 take precedence)

1/022 . . {with multiple channels}

1/025 . . {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)}

2001/027 . . {with dimples}

1/04 . . polygonal, e.g. rectangular {(F28F 1/022 takes precedence)}

1/045 . . . {with assemblies of stacked elements}

1/06 . . crimped or corrugated in cross-section

1/08 . Tubular elements crimped or corrugated in longitudinal section

1/10 . 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)

1/105 . . {the means being corrugated elements extending around the tubular elements}

1/12 . . the means being only outside the tubular element

1/122 . . . {and being formed of wires}

1/124 . . . {and being formed of pins}

1/126 . . . {consisting of zig-zag shaped fins (F28F 1/105 takes precedence)}

1/128 . . . . {Fins with openings, e.g. louvered fins}

1/14 . . . and extending longitudinally (F28F 1/38 takes precedence)

1/16 . . . . the means being integral with the element, e.g. formed by extrusion (F28F 1/22 takes precedence)

1/18 . . . . . the element being built-up from finned sections

1/20 . . . . the means being attachable to the element (F28F 1/22 takes precedence)

1/22 . . . . the means having portions engaging further tubular elements

1/24 . . . and extending transversely (F28F 1/38 takes precedence)

1/26 . . . . the means being integral with the element (F28F 1/32 takes precedence)

1/28 . . . . . the element being built-up from finned sections

1/30 . . . . the means being attachable to the element (F28F 1/32 takes precedence)

1/32 . . . . the means having portions engaging further tubular elements

1/325 . . . . . {Fins with openings}

1/34 . . . and extending obliquely (F28F 1/38 takes precedence)

1/36 . . . . the means being helically wound fins or wire spirals

1/38 . . . and being staggered to form tortuous fluid passages

1/40 . . the means being only inside the tubular element

1/405 . . . {and being formed of wires}

1/42 . . the means being both outside and inside the tubular element

1/422 . . . {with outside means integral with the tubular element and inside means integral with the tubular element (F28F 1/424 takes precedence)}

1/424 . . . {Means comprising outside portions integral with inside portions}

1/426 . . . . {the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex}

2001/428 . . . {Particular methods for manufacturing outside or inside fins}

1/44 . . . and being formed of wire mesh

3/00 **Plate-like or laminated elements; Assemblies of plate-like or laminated elements** (specially adapted for movement F28F 5/00)

3/005 . {Arrangements for preventing direct contact between different heat-exchange media (F28F 3/10 takes precedence)}

3/02 . Elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with recesses, with corrugations (F28F 3/08 takes precedence)
3/022 . . {the means being wires or pins}
3/025 . . {the means being corrugated, plate-like elements}
3/027 . . . {with openings, e.g. louvered corrugated fins; Assemblies of corrugated strips}
3/04 . . the means being integral with the element
3/042 . . . {in the form of local deformations of the element}
3/044 . . . . {the deformations being pontual, e.g. dimples}
3/046 . . . . {the deformations being linear, e.g. corrugations}
3/048 . . . {in the form of ribs integral with the element or local variations in thickness of the element, e.g. grooves, microchannels}
3/06 . . the means being attachable to the element
3/08 . Elements constructed for building-up into stacks, e.g. capable of being taken apart for cleaning
3/083 . . {capable of being taken apart}
3/086 . . {having one or more openings therein forming tubular heat-exchange passages}
3/10 . . Arrangements for sealing the margins
3/12 . Elements constructed in the shape of a hollow panel, e.g. with channels {(F28D 1/02, F28D 1/03 take precedence)}
3/14 . . by separating portions of a pair of joined sheets to form channels, e.g. by inflation (manufacture thereof B23P)

5/00 Elements specially adapted for movement
5/02 . Rotary drums or rollers
5/04 . Hollow impellers, e.g. stirring vane
5/06 . Hollow screw conveyors

7/00 Elements not covered by group F28F 1/00, F28F 3/00 or F28F 5/00
7/02 . Blocks traversed by passages for heat-exchange media {(F28D 7/0008 takes precedence)}

9/00 Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings
9/001 . {Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core}
9/002 . . {with fastening means for other structures}
2009/004 . . {Common frame elements for multiple cores}
9/005 . {Other auxiliary members within casings, e.g. internal filling means or sealing means}
9/007 . Auxiliary supports for elements
9/0075 . . {Supports for plates or plate assemblies}
9/013 . . for tubes or tube-assemblies
9/0131 . . . {formed by plates (F28F 9/0138 takes precedence)}
9/0132 . . . {formed by slats, tie-rods, articulated or expandable rods}
9/0133 . . . {formed by concentric strips}
9/0135 . . . {formed by grids having only one tube per closed grid opening (F28F 9/0132 and F28F 9/0133 take precedence)}
9/0136 . . . . {formed by intersecting strips}
9/0137 . . . {formed by wires, e.g. helically coiled (F28F 9/0135 takes precedence)}
9/0138 . . . {formed by sleeves for finned tubes}
9/02 . Header boxes; End plates
9/0202 . . {Header boxes having their inner space divided by partitions}
9/0204 . . . {for elongated header box, e.g. with transversal and longitudinal partitions}
9/0207 . . . . {the longitudinal or transversal partitions being separate elements attached to header boxes (F28F 9/0212, F28F 9/0217 take precedence)}
9/0209 . . . . {having only transversal partitions}
9/0212 . . . . . {the partitions being separate elements attached to header boxes}
9/0214 . . . . {having only longitudinal partitions}
9/0217 . . . . . {the partitions being separate elements attached to header boxes}
9/0219 . . {Arrangements for sealing end plates into casing or header box; Header box sub-elements (F28F 9/0236 takes precedence)}
9/0221 . . . {Header boxes or end plates formed by stacked elements}
9/0224 . . . {Header boxes formed by sealing end plates into covers (F28F 9/0221 takes precedence)}
9/0226 . . . . {with resilient gaskets}
9/0229 . . {Double end plates; Single end plates with hollow spaces}
9/0231 . . {Header boxes having an expansion chamber}
9/0234 . . {having a second heat exchanger disposed there within, e.g. oil cooler}
9/0236 . . {floating elements}
9/0239 . . . {floating header boxes}
9/0241 . . . {floating end plates}
9/0243 . . {Header boxes having a circular cross-section}
9/0246 . . {Arrangements for connecting header boxes with flow lines}
9/0248 . . . {Arrangements for sealing connectors to header boxes}
9/0251 . . . {Massive connectors, e.g. blocks; Plate-like connectors}
9/0253 . . . . {with multiple channels, e.g. with combined inflow and outflow channels}
9/0256 . . . {Arrangements for coupling connectors with flow lines}
9/0258 . . . . {of quick acting type, e.g. with snap action}
9/026 . . {with static flow control means, e.g. with means for uniformly distributing heat exchange media into conduits}
9/0263 . . . {by varying the geometry or cross-section of header box}
9/0265 . . . {by using guiding means or impingement means inside the header box}
9/0268 . . . . {in the form of multiple deflectors for channeling the heat exchange medium}
9/027 . . . {in the form of distribution pipes}
9/0273 . . . . {with multiple holes}
9/0275 . . . . {with multiple branch pipes}
9/0278 . . . {in the form of stacked distribution plates or perforated plates arranged over end plates}
9/028 . . . {by using inserts for modifying the pattern of flow inside the header box, e.g. by using flow restrictors or permeable bodies or blocks with channels}

9/0282 . . . {by varying the geometry of conduit ends, e.g. by using inserts or attachments for modifying the pattern of flow at the conduit inlet or outlet}
2009/0285 . . {Other particular headers or end plates}
2009/0287 . . . {having passages for different heat exchange media}
2009/029 . . . {with increasing or decreasing cross-section, e.g. having conical shape}
2009/0292 . . . {with fins}
2009/0295 . . . {comprising cooling circuits}
2009/0297 . . . {Side headers, e.g. for radiators having conduits laterally connected to common header}
9/04 . . Arrangements for sealing elements into header boxes or end plates {(arrangements for sealing flow lines connectors to header boxes F28F 9/0248)}
9/06 . . . by dismountable joints
9/08 . . . . by wedge-type connections, e.g. taper ferrule
9/10 . . . . by screw-type connections, e.g. gland
9/12 . . . . by flange-type connections
9/14 . . . . by force-joining
9/16 . . . by permanent joints, e.g. by rolling (metal-working procedures in general B21, B32; particularly B21D 39/06, B23K)
9/162 . . . . {by using bonding or sealing substances, e.g. adhesives (F28F 9/18 takes precedence)}
9/165 . . . . {by using additional preformed parts, e.g. sleeves, gaskets (F28F 9/185 takes precedence)}
9/167 . . . . . {the parts being inserted in the heat-exchange conduits}
9/18 . . . . by welding
9/182 . . . . . {the heat-exchange conduits having ends with a particular shape, e.g. deformed; the heat-exchange conduits or end plates having supplementary joining means, e.g. abutments}
9/185 . . . . . {with additional preformed parts}
9/187 . . . . . {at least one of the parts being non-metallic, e.g. heat-sealing plastic elements}
9/20 . Arrangements of heat reflectors, e.g. separately-insertible reflecting walls
9/22 . Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates
2009/222 . . {Particular guide plates, baffles or deflectors, e.g. having particular orientation relative to an elongated casing or conduit}
2009/224 . . . {Longitudinal partitions}
2009/226 . . . {Transversal partitions}
2009/228 . . . {Oblique partitions}
9/24 . Arrangements for promoting turbulent flow of heat-exchange media, e.g. by plates (F28F 1/38 takes precedence; in general F15D)
9/26 . Arrangements for connecting different sections of heat-exchange elements, e.g. of radiators (connecting different sections in water heaters F24H 9/14 {, connecting headers with inlet or outlet fittings F28F 9/0246})
9/262 . . {for radiators (F28D 1/0408 takes precedence)}
9/264 . . . {by sleeves, nipples}
9/266 . . . {by screw-type connections}
9/268 . . . {by permanent joints, e.g. by welding}

11/00 Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general F16L 55/10)
11/02 . using obturating elements, e.g. washers, inserted and operated independently of each other (F28F 11/06 takes precedence)
11/04 . using pairs of obturating elements, e.g. washers, mounted upon central operating rods (F28F 11/06 takes precedence)
11/06 . using automatic tube obturating appliances

13/00 Arrangements for modifying heat-transfer, e.g. increasing, decreasing (F28F 1/00 - F28F 11/00 take precedence)
2013/001 . {Particular heat conductive materials, e.g. superconductive elements (for thermal joints F28F 2013/006)}
13/003 . {by using permeable mass, perforated or porous materials (F28F 13/18 takes precedence)}
2013/005 . {Thermal joints}
2013/006 . . {Heat conductive materials}
2013/008 . . {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 {(F28F 13/18 takes precedence)}
13/06 . by affecting the pattern of flow of the heat-exchange media {(F28F 13/003 takes precedence; static flow control means in header boxes F28F 9/026)}
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 (F28F 13/08 takes precedence)
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 (F28F 13/187 takes precedence)}
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 (F28B 9/08 takes precedence)}

19/00 Preventing the formation of deposits or corrosion, e.g. by using filters {or scrapers}
19/002 . {by using inserts or attachments}

19/004 . {by using protective electric currents, voltages, cathodes, anodes, electric short-circuits}
19/006 . {Preventing deposits of ice}
19/008 . {by using scrapers}
19/01 . by using means for separating solid materials from heat-exchange fluids, e.g. filters
19/02 . by using coatings, e.g. vitreous or enamel coatings
19/04 . . of rubber; of plastics material; of varnish
19/06 . . of metal

21/00 Constructions of heat-exchange apparatus characterised by the selection of particular materials {(coatings for modifying heat-transfer F28F 13/18; coatings for preventing the formation of deposits or corrosion F28F 19/02)**}**
21/003 . {for domestic or space-heating systems}
21/006 . {of glass}
21/02 . of carbon, e.g. graphite
21/04 . of ceramic; of concrete; of natural stone
21/045 . . {for domestic or space-heating systems}
21/06 . of plastics material
21/061 . . {for domestic or space-heating systems}
21/062 . . {the heat-exchange apparatus employing tubular conduits}
21/063 . . . {for domestic or space-heating systems}
21/065 . . {the heat-exchange apparatus employing plate-like or laminated conduits}
21/066 . . . {for domestic or space-heating systems}
21/067 . . {Details}
21/068 . . . {for domestic or space-heating systems}
21/08 . of metal
21/081 . . {Heat exchange elements made from metals or metal alloys}
21/082 . . . {from steel or ferrous alloys}
21/083 . . . . {from stainless steel}
21/084 . . . {from aluminium or aluminium alloys}
21/085 . . . {from copper or copper alloys}
21/086 . . . {from titanium or titanium alloys}
21/087 . . . {from nickel or nickel alloys}
21/088 . . {for domestic or space-heating systems}
21/089 . . {Coatings, claddings or bonding layers made from metals or metal alloys (F28F 19/06 takes precedence)}

23/00 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)
23/02 . Arrangements for obtaining or maintaining same in a liquid state

25/00 Component parts of trickle coolers (arrangements for increasing heat transfer F28F 13/00; controlling arrangements F28F 27/00)
2025/005 . {Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid}
25/02 . for distributing, circulating, and accumulating liquid (spraying or atomising in general B05B, B05D)
25/04 . . Distributing or accumulator troughs
25/06 . . Spray nozzles or spray pipes
25/08 . . 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)
25/082 . . . {Spaced elongated bars, laths; Supports therefor}
25/085 . . . {Substantially horizontal grids; Blocks}
25/087 . . . {Vertical or inclined sheets; Supports or spacers}
25/10 . for feeding gas or vapour
25/12 . . Ducts; Guide vanes, e.g. for carrying currents to distinct zones

27/00 Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05)
27/003 . {specially adapted for cooling towers}
27/006 . {specially adapted for regenerative heat-exchange apparatus}
27/02 . for controlling the distribution of heat-exchange media between different channels ({static flow control means in header boxes F28F 9/026}; arrangements of guide plates or guide vanes F28F 9/22, F28F 25/12)

99/00 Subject matter not provided for in other groups of this subclass

2200/00 Prediction; Simulation; Testing (measuring quantity of heat conveyed by flowing mediums G01K 17/06)
2200/005 . Testing heat pipes

2210/00 Heat exchange conduits
2210/02 . with particular branching, e.g. fractal conduit arrangements
2210/04 . Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
2210/06 . having walls comprising obliquely extending corrugations, e.g. in the form of threads
2210/08 . Assemblies of conduits having different features
2210/10 . Particular layout, e.g. for uniform temperature distribution

2215/00 Fins
2215/02 . Arrangements of fins common to different heat exchange sections, the fins being in contact with different heat exchange media
2215/04 . Assemblies of fins having different features, e.g. with different fin densities
2215/06 . Hollow fins; fins with internal circuits
2215/08 . 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)
2215/10 . Secondary fins, e.g. projections or recesses on main fins
2215/12 . with U-shaped slots for laterally inserting conduits
2215/14 . in the form of movable or loose fins

2220/00 Closure means, e.g. end caps on header boxes or plugs on conduits

2225/00 Reinforcing means
2225/02 . for casings
2225/04 . for conduits
2225/06 . for fins
2225/08 . for header boxes

2230/00 Sealing means

2235/00 **Means for filling gaps between elements, e.g. between conduits within casings**

2240/00 **Spacing means**

2245/00 **Coatings; Surface treatments**
2245/02 . hydrophilic
2245/04 . hydrophobic
2245/06 . having particular radiating, reflecting or absorbing features, e.g. for improving heat transfer by radiation
2245/08 . self-cleaning

2250/00 **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**
2250/02 . Streamline-shaped elements
2250/04 . Communication passages between channels
2250/06 . Derivation channels, e.g. bypass
2250/08 . Fluid driving means, e.g. pumps, fans
2250/10 . Particular pattern of flow of the heat exchange media
2250/102 . . with change of flow direction
2250/104 . . with parallel flow
2250/106 . . with cross flow
2250/108 . . with combined cross flow and parallel flow

2255/00 **Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes**
2255/02 . Flexible elements
2255/04 . comprising shape memory alloys or bimetallic elements
2255/06 . composite, e.g. polymers with fillers or fibres
2255/08 . pressed; stamped; deep-drawn
2255/10 . made by hydroforming
2255/12 . expanded or perforated metal plate
2255/14 . molded
2255/143 . . injection molded
2255/146 . . overmolded
2255/16 . extruded
2255/18 . sintered
2255/20 . with nanostructures

2260/00 **Heat exchangers or heat exchange elements having special size, e.g. microstructures** (microheat pipes F28D 2015/0225; nanostructures F28F 2255/20)
2260/02 . having microchannels

2265/00 **Safety or protection arrangements; Arrangements for preventing malfunction** (control or monitoring devices F28F 27/00)
2265/02 . in the form of screens or covers (heat shields F28F 2265/10)
2265/06 . by using means for draining heat exchange media from heat exchangers
2265/10 . for preventing overheating, e.g. heat shields (thermal insulation F28F 2270/00)
2265/12 . for preventing overpressure
2265/14 . for preventing damage by freezing, e.g. for accommodating volume expansion
2265/16 . for preventing leakage
2265/18 . for removing contaminants, e.g. for degassing
2265/20 . for preventing development of microorganisms
2265/22 . for draining
2265/24 . for electrical insulation
2265/26 . for allowing differential expansion between elements (floating header box elements F28F 9/0236)
2265/28 . for preventing noise (by preventing vibrations F28F 2265/30)
2265/30 . for preventing vibrations
2265/32 . for limiting movements, e.g. stops, locking means

2270/00 **Thermal insulation; Thermal decoupling**
2270/02 . by using blind conduits

2275/00 **Fastening; Joining**
2275/02 . by using bonding materials (brazing F28F 2275/04); by embedding elements in particular materials
2275/025 . . by using adhesives
2275/04 . by brazing (brazing heat exchangers B23K 1/0012)
2275/045 . . with particular processing steps, e.g. by allowing displacement of parts during brazing or by using a reservoir for storing brazing material
2275/06 . by welding (welding heat exchangers B23K 2101/14)
2275/061 . . by diffusion bonding
2275/062 . . by impact pressure or friction welding
2275/064 . . by induction welding or by using microwaves
2275/065 . . by ultrasonic or vibration welding
2275/067 . . by laser welding
2275/068 . . by explosive welding
2275/08 . by clamping or clipping
2275/085 . . with snap connection
2275/10 . by force joining
2275/12 . by methods involving deformation of the elements
2275/122 . . by crimping, caulking or clinching
2275/125 . . by bringing elements together and expanding
2275/127 . . by shrinking
2275/14 . by using form fitting connection, e.g. with tongue and groove
2275/143 . . with pin and hole connections
2275/146 . . with bayonet connections
2275/16 . with toothed elements, e.g. with serrations
2275/18 . by using wedge effect
2275/20 . with threaded elements
2275/205 . . with of tie-rods
2275/22 . by using magnetic effect

2280/00 **Mounting arrangements; Arrangements for facilitating assembling or disassembling of heat exchanger parts**
2280/02 . Removable elements
2280/04 . Means for preventing wrong assembling of parts
2280/06 . Adapter frames, e.g. for mounting heat exchanger cores on other structure and for allowing fluidic connections
2280/08 . Tolerance compensating means
2280/10 . Movable elements, e.g. being pivotable (elements specially adapted for movements F28F 5/00)
2280/105 . . with hinged connections