

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](#))

1/00	Tubular elements; Assemblies of tubular elements (specially adapted for movement F28F 5/00)	1/24	. . . and extending transversely (F28F 1/38 takes precedence)
1/003	. {Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators F22B 1/066)}	1/26	. . . the means being integral with the element (F28F 1/32 takes precedence)
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)}	1/28	. . . . the element being built-up from finned sections
1/02	. Tubular elements of cross-section which is non-circular (F28F 1/08 , F28F 1/10 take precedence)	1/30	. . . . the means being attachable to the element (F28F 1/32 takes precedence)
1/022	. . {with multiple channels}	1/32	. . . . the means having portions engaging further tubular elements
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)}	1/325	. . . . {Fins with openings}
2001/027	. . {with dimples}	1/34	. . . and extending obliquely (F28F 1/38 takes precedence)
1/04	. . polygonal, e.g. rectangular {(F28F 1/022 takes precedence)}	1/36	. . . . the means being helically wound fins or wire spirals
1/045	. . . {with assemblies of stacked elements}	1/38	. . . and being staggered to form tortuous fluid passages
1/06	. . crimped or corrugated in cross-section	1/40	. . the means being only inside the tubular element
1/08	. Tubular elements crimped or corrugated in longitudinal section	1/405	. . . {and being formed of wires}
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)	1/42	. . the means being both outside and inside the tubular element
1/105	. . {the means being corrugated elements extending around the tubular elements}	1/422	. . . {with outside means integral with the tubular element and inside means integral with the tubular element (F28F 1/424 takes precedence)}
1/12	. . the means being only outside the tubular element	1/424	. . . {Means comprising outside portions integral with inside portions}
1/122	. . . {and being formed of wires}	1/426	. . . . {the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex}
1/124	. . . {and being formed of pins}	2001/428	. . . {Particular methods for manufacturing outside or inside fins}
1/126	. . . {consisting of zig-zag shaped fins (F28F 1/105 takes precedence)}	1/44	. . . and being formed of wire mesh
1/128	. . . . {Fins with openings, e.g. louvered fins}	3/00	Plate-like or laminated elements; Assemblies of plate-like or laminated elements (specially adapted for movement F28F 5/00)
1/14	. . . and extending longitudinally (F28F 1/38 takes precedence)	3/005	. {Arrangements for preventing direct contact between different heat-exchange media (F28F 3/10 takes precedence)}
1/16	. . . . the means being integral with the element, e.g. formed by extrusion (F28F 1/22 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)
1/18	. . . . the element being built-up from finned sections	3/022	. . {the means being wires or pins}
1/20	. . . . the means being attachable to the element (F28F 1/22 takes precedence)	3/025	. . {the means being corrugated, plate-like elements}
1/22	. . . . the means having portions engaging further tubular elements	3/027	. . . {with openings, e.g. louvered corrugated fins; Assemblies of corrugated strips}

3/04	. . the means being integral with the element	9/0207	. . . . {the longitudinal or transversal partitions being separate elements attached to header boxes (F28F 9/0212 , F28F 9/0217 take precedence)}
3/042	. . . {in the form of local deformations of the element}	9/0209	. . . . {having only transversal partitions}
3/044	. . . . {the deformations being pontual, e.g. dimples}	9/0212	. . . . . {the partitions being separate elements attached to header boxes}
3/046	. . . . {the deformations being linear, e.g. corrugations}	9/0214	. . . . {having only longitudinal partitions}
3/048	. . . {in the form of ribs integral with the element or local variations in thickness of the element, e.g. grooves, microchannels}	9/0217	. . . . . {the partitions being separate elements attached to header boxes}
3/06	. . the means being attachable to the element	9/0219	. . {Arrangements for sealing end plates into casing or header box; Header box sub-elements (F28F 9/0236 takes precedence)}
3/08	. Elements constructed for building-up into stacks, e.g. capable of being taken apart for cleaning	9/0221	. . . {Header boxes or end plates formed by stacked elements}
3/083	. . {capable of being taken apart}	9/0224	. . . {Header boxes formed by sealing end plates into covers (F28F 9/0221 takes precedence)}
3/086	. . {having one or more openings therein forming tubular heat-exchange passages}	9/0226	. . . . {with resilient gaskets}
3/10	. . Arrangements for sealing the margins	9/0229	. . {Double end plates; Single end plates with hollow spaces}
3/12	. Elements constructed in the shape of a hollow panel, e.g. with channels {(F28D 1/02 , F28D 1/03 take precedence)}	9/0231	. . {Header boxes having an expansion chamber}
3/14	. . by separating portions of a pair of joined sheets to form channels, e.g. by inflation (manufacture thereof B23P)	9/0234	. . {having a second heat exchanger disposed there within, e.g. oil cooler}
5/00	Elements specially adapted for movement (arrangements for moving the elements, see the appropriate subclass for the apparatus concerned)	9/0236	. . {floating elements}
5/02	. Rotary drums or rollers	9/0239	. . . {floating header boxes}
5/04	. Hollow impellers, e.g. stirring vane	9/0241	. . . {floating end plates}
5/06	. Hollow screw conveyors	9/0243	. . {Header boxes having a circular cross-section}
7/00	Elements not covered by group F28F 1/00, F28F 3/00 or F28F 5/00	9/0246	. . {Arrangements for connecting header boxes with flow lines}
7/02	. Blocks traversed by passages for heat-exchange media {(F28D 7/0008 takes precedence)}	9/0248	. . . {Arrangements for sealing connectors to header boxes}
9/00	Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings	9/0251	. . . {Massive connectors, e.g. blocks; Plate-like connectors}
9/001	. {Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core}	9/0253	. . . . {with multiple channels, e.g. with combined inflow and outflow channels}
9/002	. . {with fastening means for other structures}	9/0256	. . . {Arrangements for coupling connectors with flow lines}
2009/004	. . {Common frame elements for multiple cores}	9/0258	. . . . {of quick acting type, e.g. with snap action}
9/005	. {Other auxiliary members within casings, e.g. internal filling means or sealing means}	9/026	. . {with static flow control means, e.g. with means for uniformly distributing heat exchange media into conduits}
9/007	. Auxiliary supports for elements	9/0263	. . . {by varying the geometry or cross-section of header box}
9/0075	. . {Supports for plates or plate assemblies}	9/0265	. . . {by using guiding means or impingement means inside the header box}
9/013	. . for tubes or tube-assemblies	9/0268	. . . . {in the form of multiple deflectors for channeling the heat exchange medium}
9/0131	. . . {formed by plates (F28F 9/0138 takes precedence)}	9/027	. . . {in the form of distribution pipes}
9/0132	. . . {formed by slats, tie-rods, articulated or expandable rods}	9/0273	. . . . {with multiple holes}
9/0133	. . . {formed by concentric strips}	9/0275	. . . . {with multiple branch pipes}
9/0135	. . . {formed by grids having only one tube per closed grid opening (F28F 9/0132 and F28F 9/0133 take precedence)}	9/0278	. . . {in the form of stacked distribution plates or perforated plates arranged over end plates}
9/0136	. . . . {formed by intersecting strips}	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}
9/0137	. . . {formed by wires, e.g. helically coiled (F28F 9/0135 takes precedence)}	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}
9/0138	. . . {formed by sleeves for finned tubes}	2009/0285	. . {Other particular headers or end plates}
9/02	. Header boxes; End plates	2009/0287	. . . {having passages for different heat exchange media}
9/0202	. . {Header boxes having their inner space divided by partitions}		
9/0204	. . . {for elongated header box, e.g. with transversal and longitudinal partitions}		

2009/029	. . . {with increasing or decreasing cross-section, e.g. having conical shape}	11/02	. using obturating elements, e.g. washers, inserted and operated independently of each other (F28F 11/06 takes precedence)
2009/0292	. . . {with fins}	11/04	. using pairs of obturating elements, e.g. washers, mounted upon central operating rods (F28F 11/06 takes precedence)
2009/0295	. . . {comprising cooling circuits}	11/06	. using automatic tube obturating appliances
2009/0297	. . . {Side headers, e.g. for radiators having conduits laterally connected to common header}	13/00	Arrangements for modifying heat-transfer, e.g. increasing, decreasing (F28F 1/00 - F28F 11/00 take precedence)
9/04	. . Arrangements for sealing elements into header boxes or end plates (arrangements for sealing flow lines connectors to header boxes F28F 9/0248)	2013/001	. {Particular heat conductive materials, e.g. superconductive elements (for thermal joints F28F 2013/006)}
9/06	. . . by dismountable joints	13/003	. {by using permeable mass, perforated or porous materials (F28F 13/18 takes precedence)}
9/08	. . . . by wedge-type connections, e.g. taper ferrule	2013/005	. {Thermal joints}
9/10	. . . . by screw-type connections, e.g. gland	2013/006	. . {Heat conductive materials}
9/12	. . . . by flange-type connections	2013/008	. . {Variable conductance materials; Thermal switches}
9/14	. . . . by force-joining	13/02	. by influencing fluid boundary (boundary-layer control in general F15D)
9/16	. . . by permanent joints, e.g. by rolling (metal-working procedures in general B21, B32; particularly B21D 39/06, B23K)	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)
9/162	. . . . {by using bonding or sealing substances, e.g. adhesives (F28F 9/18 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)
9/165	. . . . {by using additional preformed parts, e.g. sleeves, gaskets (F28F 9/185 takes precedence)}	13/08	. . by varying the cross-section of the flow channels
9/167	. . . . . {the parts being inserted in the heat-exchange conduits}	13/10	. . by imparting a pulsating motion to the flow, e.g. by sonic vibration
9/18	. . . . by welding	13/12	. . by creating turbulence, e.g. by stirring, by increasing the force of circulation (F28F 13/08 takes precedence)
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}	13/125	. . . {by stirring}
9/185	. . . . . {with additional preformed parts}	13/14	. by endowing the walls of conduits with zones of different degrees of conduction of heat
9/187	. . . . . {at least one of the parts being non-metallic, e.g. heat-sealing plastic elements}	13/16	. by applying an electrostatic field to the body of the heat-exchange medium
9/20	. Arrangements of heat reflectors, e.g. separately-insertible reflecting walls	13/18	. by applying coatings, e.g. radiation-absorbing, radiation-reflecting; by surface treatment, e.g. polishing
9/22	. Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates	13/182	. . {especially adapted for evaporator or condenser surfaces (F28F 13/187 takes precedence)}
2009/222	. . {Particular guide plates, baffles or deflectors, e.g. having particular orientation relative to an elongated casing or conduit}	13/185	. . {Heat-exchange surfaces provided with microstructures or with porous coatings}
2009/224	. . . {Longitudinal partitions}	13/187	. . . {especially adapted for evaporator surfaces or condenser surfaces, e.g. with nucleation sites}
2009/226	. . . {Transversal partitions}	17/00	Removing ice or water from heat-exchange apparatus
2009/228	. . . {Oblique partitions}	17/005	. {Means for draining condensates from heat exchangers, e.g. from evaporators (F28B 9/08 takes precedence)}
9/24	. Arrangements for promoting turbulent flow of heat-exchange media, e.g. by plates (F28F 1/38 takes precedence ; in general F15D)	19/00	Preventing the formation of deposits or corrosion, e.g. by using filters {or scrapers}
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)	19/002	. {by using inserts or attachments}
9/262	. . {for radiators (F28D 1/0408 takes precedence)}	19/004	. {by using protective electric currents, voltages, cathodes, anodes, electric short-circuits}
9/264	. . . {by sleeves, nipples}	19/006	. {Preventing deposits of ice}
9/266	. . . {by screw-type connections}	19/008	. {by using scrapers}
9/268	. . . {by permanent joints, e.g. by welding}	19/01	. by using means for separating solid materials from heat-exchange fluids, e.g. filters
11/00	Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general F16L 55/10)		

19/02	• by using coatings, e.g. vitreous or enamel coatings	25/12	• . Ducts; Guide vanes, e.g. for carrying currents to distinct zones
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})	27/00	Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05)
21/003	• {for domestic or space-heating systems}	27/003	• {specially adapted for cooling towers}
21/006	• {of glass}	27/006	• {specially adapted for regenerative heat-exchange apparatus}
21/02	• of carbon, e.g. graphite	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)
21/04	• of ceramic; of concrete; of natural stone		
21/045	• . {for domestic or space-heating systems}	99/00	Subject matter not provided for in other groups of this subclass
21/06	• of plastics material		
21/061	• . {for domestic or space-heating systems}	2200/00	Prediction; Simulation; Testing (measuring quantity of heat conveyed by flowing mediums G01K 17/06)
21/062	• . {the heat-exchange apparatus employing tubular conduits}	2200/005	• Testing heat pipes
21/063	• . . {for domestic or space-heating systems}	2210/00	Heat exchange conduits
21/065	• . {the heat-exchange apparatus employing plate-like or laminated conduits}	2210/02	• with particular branching, e.g. fractal conduit arrangements
21/066	• . . {for domestic or space-heating systems}	2210/04	• Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
21/067	• . {Details}	2210/06	• having walls comprising obliquely extending corrugations, e.g. in the form of threads
21/068	• . . {for domestic or space-heating systems}	2210/08	• Assemblies of conduits having different features
21/08	• of metal	2210/10	• Particular layout, e.g. for uniform temperature distribution
21/081	• . {Heat exchange elements made from metals or metal alloys}	2215/00	Fins
21/082	• . . {from steel or ferrous alloys}	2215/02	• Arrangements of fins common to different heat exchange sections, the fins being in contact with different heat exchange media
21/083	• . . . {from stainless steel}	2215/04	• Assemblies of fins having different features, e.g. with different fin densities
21/084	• . . {from aluminium or aluminium alloys}	2215/06	• Hollow fins; fins with internal circuits
21/085	• . . {from copper or copper alloys}	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)
21/086	• . . {from titanium or titanium alloys}	2215/10	• Secondary fins, e.g. projections or recesses on main fins
21/087	• . . {from nickel or nickel alloys}	2215/12	• with U-shaped slots for laterally inserting conduits
21/088	• . {for domestic or space-heating systems}	2215/14	• in the form of movable or loose fins
21/089	• . {Coatings, claddings or bonding layers made from metals or metal alloys (F28F 19/06 takes precedence)}	2220/00	Closure means, e.g. end caps on header boxes or plugs on conduits
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)	2225/00	Reinforcing means
23/02	• Arrangements for obtaining or maintaining same in a liquid state	2225/02	• for casings
25/00	Component parts of trickle coolers (arrangements for increasing heat transfer F28F 13/00; controlling arrangements F28F 27/00)	2225/04	• for conduits
2025/005	• {Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid}	2225/06	• for fins
25/02	• for distributing, circulating, and accumulating liquid (spraying or atomising in general B05B, B05D)	2225/08	• for header boxes
25/04	• . Distributing or accumulator troughs	2230/00	Sealing means
25/06	• . Spray nozzles or spray pipes	2235/00	Means for filling gaps between elements, e.g. between conduits within casings
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)	2240/00	Spacing means
25/082	• . . {Spaced elongated bars, laths; Supports therefor}	2245/00	Coatings; Surface treatments
25/085	• . . {Substantially horizontal grids; Blocks}	2245/02	• hydrophilic
25/087	• . . {Vertical or inclined sheets; Supports or spacers}		
25/10	• for feeding gas or vapour		

- 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 2201/14)
 - 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