

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)	1/20	. . . . the means being attachable to the element (F28F 1/22 takes precedence)
1/003	. {Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators F22B 1/066)}	1/22	. . . . the means having portions engaging further tubular elements
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)}	1/24	. . . and extending transversely (F28F 1/38 takes precedence)
1/02	. Tubular elements of cross-section which is non- circular (F28F 1/08 , F28F 1/10 take precedence)	1/26	. . . . the means being integral with the element (F28F 1/32 takes precedence)
1/022	. . {with multiple channels}	1/28	. . . . . the element being built-up from finned sections
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)}	1/30	. . . . the means being attachable to the element (F28F 1/32 takes precedence)
2001/027	. . {with dimples}	1/32	. . . . the means having portions engaging further tubular elements
1/04	. . polygonal, e.g. rectangular {(F28F 1/022 takes precedence)}	1/325	. . . . . {Fins with openings}
1/045	. . . {with assemblies of stacked elements}	1/34	. . . and extending obliquely (F28F 1/38 takes precedence)
1/06	. . crimped or corrugated in cross-section	1/36	. . . . the means being helically wound fins or wire spirals
1/08	. Tubular elements crimped or corrugated in longitudinal section	1/38	. . . and being staggered to form tortuous fluid passages
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)	1/40	. . the means being only inside the tubular element
1/105	. . {the means being corrugated elements extending around the tubular elements}	1/405	. . . {and being formed of wires}
1/12	. . the means being only outside the tubular element	1/42	. . the means being both outside and inside the tubular element
1/122	. . . {and being formed of wires}	1/422	. . . {with outside means integral with the tubular element and inside means integral with the tubular element (F28F 1/424 takes precedence)}
1/124	. . . {and being formed of pins}	1/424	. . . {Means comprising outside portions integral with inside portions}
1/126	. . . {consisting of zig-zag shaped fins (F28F 1/105 takes precedence)}	1/426	. . . . {the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex}
1/128	. . . . {Fins with openings, e.g. louvered fins}	2001/428	. . . {Particular methods for manufacturing outside or inside fins}
1/14	. . . and extending longitudinally (F28F 1/38 takes precedence)	1/44	. . . and being formed of wire mesh
1/16	. . . . the means being integral with the element, e.g. formed by extrusion (F28F 1/22 takes precedence)	3/00	Plate-like or laminated elements; Assemblies of plate-like or laminated elements (specially adapted for movement F28F 5/00)
1/18	. . . . . the element being built-up from finned sections	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**
(arrangements for moving the elements, see the appropriate subclass for the apparatus concerned)
- 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}	9/266	. . . {by screw-type connections}
2009/0285	. . . {Other particular headers or end plates}	9/268	. . . {by permanent joints, e.g. by welding}
2009/0287	. . . {having passages for different heat exchange media}	11/00	Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general F16L 55/10)
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)}		
9/264	. . . {by sleeves, nipples}		

19/004	. {by using protective electric currents, voltages, cathodes, anodes, electric short-circuits}	25/082	. . . {Spaced elongated bars, laths; Supports therefor}
19/006	. {Preventing deposits of ice}	25/085	. . . {Substantially horizontal grids; Blocks}
19/008	. {by using scrapers}	25/087	. . . {Vertical or inclined sheets; Supports or spacers}
19/01	. by using means for separating solid materials from heat-exchange fluids, e.g. filters	25/10	. for feeding gas or vapour
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		
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)		

2235/00	Means for filling gaps between elements, e.g. between conduits within casings	2265/24	• for electrical insulation
2240/00	Spacing means	2265/26	• for allowing differential expansion between elements (floating header box elements F28F 9/0236)
2245/00	Coatings; Surface treatments	2265/28	• for preventing noise (by preventing vibrations F28F 2265/30)
2245/02	• hydrophilic	2265/30	• for preventing vibrations
2245/04	• hydrophobic	2265/32	• for limiting movements, e.g. stops, locking means
2245/06	• having particular radiating, reflecting or absorbing features, e.g. for improving heat transfer by radiation	2270/00	Thermal insulation; Thermal decoupling
2245/08	• self-cleaning	2270/02	• by using blind conduits
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	2275/00	Fastening; Joining
2250/02	• Streamline-shaped elements	2275/02	• by using bonding materials (brazing F28F 2275/04); by embedding elements in particular materials
2250/04	• Communication passages between channels	2275/025	• • by using adhesives
2250/06	• Derivation channels, e.g. bypass	2275/04	• by brazing (brazing heat exchangers B23K 1/0012)
2250/08	• Fluid driving means, e.g. pumps, fans	2275/045	• • with particular processing steps, e.g. by allowing displacement of parts during brazing or by using a reservoir for storing brazing material
2250/10	• Particular pattern of flow of the heat exchange media	2275/06	• by welding (welding heat exchangers B23K 2101/14)
2250/102	• • with change of flow direction	2275/061	• • by diffusion bonding
2250/104	• • with parallel flow	2275/062	• • by impact pressure or friction welding
2250/106	• • with cross flow	2275/064	• • by induction welding or by using microwaves
2250/108	• • with combined cross flow and parallel flow	2275/065	• • by ultrasonic or vibration welding
2255/00	Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes	2275/067	• • by laser welding
2255/02	• Flexible elements	2275/068	• • by explosive welding
2255/04	• comprising shape memory alloys or bimetallic elements	2275/08	• by clamping or clipping
2255/06	• composite, e.g. polymers with fillers or fibres	2275/085	• • with snap connection
2255/08	• pressed; stamped; deep-drawn	2275/10	• by force joining
2255/10	• made by hydroforming	2275/12	• by methods involving deformation of the elements
2255/12	• expanded or perforated metal plate	2275/122	• • by crimping, caulking or clinching
2255/14	• molded	2275/125	• • by bringing elements together and expanding
2255/143	• • injection molded	2275/127	• • by shrinking
2255/146	• • overmolded	2275/14	• by using form fitting connection, e.g. with tongue and groove
2255/16	• extruded	2275/143	• • with pin and hole connections
2255/18	• sintered	2275/146	• • with bayonet connections
2255/20	• with nanostructures	2275/16	• with toothed elements, e.g. with serrations
2260/00	Heat exchangers or heat exchange elements having special size, e.g. microstructures (microheat pipes F28D 2015/0225; nanostructures F28F 2255/20)	2275/18	• by using wedge effect
2260/02	• having microchannels	2275/20	• with threaded elements
2265/00	Safety or protection arrangements; Arrangements for preventing malfunction (control or monitoring devices F28F 27/00)	2275/205	• • with of tie-rods
2265/02	• in the form of screens or covers (heat shields F28F 2265/10)	2275/22	• by using magnetic effect
2265/06	• by using means for draining heat exchange media from heat exchangers	2280/00	Mounting arrangements; Arrangements for facilitating assembling or disassembling of heat exchanger parts
2265/10	• for preventing overheating, e.g. heat shields (thermal insulation F28F 2270/00)	2280/02	• Removable elements
2265/12	• for preventing overpressure	2280/04	• Means for preventing wrong assembling of parts
2265/14	• for preventing damage by freezing, e.g. for accommodating volume expansion	2280/06	• Adapter frames, e.g. for mounting heat exchanger cores on other structure and for allowing fluidic connections
2265/16	• for preventing leakage	2280/08	• Tolerance compensating means
2265/18	• for removing contaminants, e.g. for degassing	2280/10	• Movable elements, e.g. being pivotable (elements specially adapted for movements F28F 5/00)
2265/20	• for preventing development of microorganisms	2280/105	• • with hinged connections
2265/22	• for draining		