

CPC**COOPERATIVE PATENT CLASSIFICATION****F28F****DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS,
OF GENERAL APPLICATION** ([water and air traps](#), [air venting F16](#))**Guidance heading:**

- F28F 1/00** **Tubular elements; Assemblies of tubular elements** ([specially adapted for movement F28F 5/00](#))
- F28F 1/003 . { [Multiple wall conduits, e.g. for leak detection \(leak-detection in metal cooled nuclear reactor steam generators F22B 1/066\)](#) }
- F28F 1/006 . {[with variable shape, e.g. with modified tube ends, with different geometrical features \(F28F 1/025, F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence\)](#) }
- F28F 1/02 . Tubular elements of cross-section which is non-circular ([F28F 1/08, F28F 1/10 take precedence](#))
- F28F 1/022 . . {[with multiple channels](#) }
- F28F 1/025 . . {[with variable shape, e.g. with modified tube ends, with different geometrical features \(F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence\)](#) }
- F28F 1/04 . . polygonal, e.g. rectangular { ([F28F 1/022 takes precedence](#)) }
- F28F 1/045 . . . {[with assemblies of stacked elements](#) }
- F28F 1/06 . . crimped or corrugated in cross-section
- F28F 1/08 . Tubular elements crimped or corrugated in longitudinal section
- F28F 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](#))
- F28F 1/105 . . {[the means being corrugated elements extending around the tubular elements](#) }
- F28F 1/12 . . the means being only outside the tubular element
- F28F 1/122 . . . {[and being formed of wires](#) }
- F28F 1/124 . . . {[and being formed of pins](#) }
- F28F 1/126 . . . {[consisting of zig-zag shaped fins \(F28F 1/105 takes precedence\)](#) }
- F28F 1/128 . . . {[Fins with openings, e.g. louvered fins](#) }
- F28F 1/14 . . and extending longitudinally ([F28F 1/38 takes precedence](#))
- F28F 1/16 . . . the means being integral with the element, e.g. formed by extrusion ([F28F 1/22 takes precedence](#))
- F28F 1/18 the element being built-up from finned sections
- F28F 1/20 . . . the means being attachable to the element ([F28F 1/22 takes precedence](#))
- F28F 1/22 . . . the means having portions engaging further tubular elements
- F28F 1/24 . . and extending transversely ([F28F 1/38 takes precedence](#))
- F28F 1/26 . . . the means being integral with the element ([F28F 1/32 takes precedence](#))
- F28F 1/28 the element being built-up from finned sections

- F28F 1/30 the means being attachable to the element ([F28F 1/32 takes precedence](#))
- F28F 1/32 the means having portions engaging further tubular elements
- F28F 1/325 {Fins with openings }
- F28F 1/34 . . . and extending obliquely ([F28F 1/38 takes precedence](#))
- F28F 1/36 the means being helically wound fins or wire spirals
- F28F 1/38 . . . and being staggered to form tortuous fluid passages
- F28F 1/40 . . the means being only inside the tubular element
- F28F 1/405 . . . {and being formed of wires }
- F28F 1/42 . . the means being both outside and inside the tubular element
- F28F 1/422 . . . { with outside means integral with the tubular element and inside means integral with the tubular element ([F28F 1/424 takes precedence](#)) }
- F28F 1/424 . . . { Means comprising outside portions integral with inside portions }
- F28F 1/426 { the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex }
- F28F 1/44 . . . and being formed of wire mesh

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

- F28F 3/005 . {Arrangements for preventing direct contact between different heat-exchange media ([F28F 3/10 takes precedence](#)) }
- F28F 3/02 . Elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with recesses, with corrugations ([F28F 3/08](#) {[F28F 3/08D](#) } takes precedence)
- F28F 3/022 . . {the means being wires or pins }
- F28F 3/025 . . {the means being corrugated, plate-like elements }
- F28F 3/027 . . . {with openings, e.g. louvered corrugated fins; Assemblies of corrugated strips }
- F28F 3/04 . . the means being integral with the element
- F28F 3/042 . . . { in the form of local deformations of the element }
- F28F 3/044 { the deformations being pontual, e.g. dimples }
- F28F 3/046 { the deformations being linear, e.g. corrugations }
- F28F 3/048 . . . { in the form of ribs integral with the element or local variations in thickness of the element, e.g. grooves, microchannels }
- F28F 3/06 . . the means being attachable to the element
- F28F 3/08 . Elements constructed for building-up into stacks, e.g. capable of being taken apart for cleaning
- F28F 3/083 . . {capable of being taken apart }
- F28F 3/086 . . {having one or more openings therein forming tubular heat-exchange passages }
- F28F 3/10 . . Arrangements for sealing the margins
- F28F 3/12 . Elements constructed in the shape of a hollow panel, e.g. with channels { ([F28D 1/02](#), [F28D 1/03 take precedence](#)) }
- F28F 3/14 . . by separating portions of a pair of joined sheets to form channels, e.g. by inflation ([manufacture thereof B23P](#))

F28F 5/00 **Elements specially adapted for movement** ([arrangements for moving the elements](#),

see the appropriate subclass for the apparatus concerned)

F28F 5/02 . Rotary drums or rollers

F28F 5/04 . Hollow impellers, e.g. stirring vane

F28F 5/06 . Hollow screw conveyers

F28F 7/00 Elements not covered by group [F28F 1/00](#), [F28F 3/00](#) or [F28F 5/00](#)

F28F 7/02 . Blocks traversed by passages for heat-exchange media { ([F28D 7/0008](#) takes precedence) }

F28F 9/00 Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings

F28F 9/001 . { Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core }

F28F 9/002 . . {with fastening means for other structures }

F28F 9/005 . { Other auxiliary members within casings, e.g. internal filling means or sealing means }

F28F 9/007 . Auxiliary supports for elements

F28F 9/0075 . . {Supports for plates or plate assemblies }

F28F 9/013 . . for tubes or tube-assemblies

F28F 9/0131 . . . { formed by plates ([F28F 9/0138](#) takes precedence) }

F28F 9/0132 . . . {formed by slats, tie-rods, articulated or expandable rods }

F28F 9/0133 . . . {formed by concentric strips }

F28F 9/0135 . . . {formed by grids having only one tube per closed grid opening ([F28F 9/0132](#) and [F28F 9/0133](#) take precedence) }

F28F 9/0136 {formed by intersecting strips }

F28F 9/0137 . . . {formed by wires, e.g. helically coiled ([F28F 9/0135](#) takes precedence) }

F28F 9/0138 . . . { formed by sleeves for finned tubes }

F28F 9/02 . Header boxes; End plates

F28F 9/0202 . . {Header boxes having their inner space divided by partitions }

F28F 9/0204 . . . {for elongated header box, e.g. with transversal and longitudinal partitions }

F28F 9/0207 { the longitudinal or transversal partitions being separate elements attached to header boxes ([F28F 9/0212](#), [F28F 9/0217](#) take precedence) }

F28F 9/0209 {having only transversal partitions }

F28F 9/0212 {the partitions being separate elements attached to header boxes }

F28F 9/0214 {having only longitudinal partitions }

F28F 9/0217 {the partitions being separate elements attached to header boxes }

F28F 9/0219 . . {Arrangements for sealing end plates into casing or header box; Header box sub-elements ([F28F 9/0236](#) takes precedence) }

F28F 9/0221	...	{Header boxes or end plates formed by stacked elements }
F28F 9/0224	...	{Header boxes formed by sealing end plates into covers (F28F 9/0221 takes precedence) }
F28F 9/0226	....	{with resilient gaskets }
F28F 9/0229	..	{Double end plates; Single end plates with hollow spaces }
F28F 9/0231	..	{Header boxes having an expansion chamber }
F28F 9/0234	..	{having a second heat exchanger disposed there within, e.g. oil cooler }
F28F 9/0236	..	{floating elements }
F28F 9/0239	...	{floating header boxes }
F28F 9/0241	...	{floating end plates }
F28F 9/0243	..	{Header boxes having a circular cross-section }
F28F 9/0246	..	{ Arrangements for connecting header boxes with flow lines }
F28F 9/0248	...	{ Arrangements for sealing connectors to header boxes }
F28F 9/0251	...	{ Massive connectors, e.g. blocks; Plate-like connectors }
F28F 9/0253	....	{ with multiple channels, e.g. with combined inflow and outflow channels }
F28F 9/0256	...	{ Arrangements for coupling connectors with flow lines }
F28F 9/0258	....	{ of quick acting type, e.g. with snap action }
F28F 9/026	..	{ with static flow control means, e.g. with means for uniformly distributing heat exchange media into conduits }
F28F 9/0263	...	{ by varying the geometry or cross-section of header box }
F28F 9/0265	...	{ by using guiding means or impingement means inside the header box }
F28F 9/0268	....	{ in the form of multiple deflectors for channeling the heat exchange medium }
F28F 9/027	...	{ in the form of distribution pipes }
F28F 9/0273	....	{ with multiple holes }
F28F 9/0275	....	{ with multiple branch pipes }
F28F 9/0278	...	{ in the form of stacked distribution plates or perforated plates arranged over end plates }
F28F 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 }
F28F 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 }
F28F 9/04	..	Arrangements for sealing elements into header boxes or end plates { arrangements for sealing flow lines connectors to header boxes F28F 9/0248 }
F28F 9/06	...	by dismountable joints
F28F 9/08	....	by wedge-type connections, e.g. taper ferrule
F28F 9/10	....	by screw-type connections, e.g. gland
F28F 9/12	....	by flange-type connections
F28F 9/14	....	by force-joining
F28F 9/16	...	by permanent joints, e.g. by rolling (metal-working procedures in general B21 , B32 ; particularly B21D 39/06, B23K)
F28F 9/162	....	{by using bonding or sealing substances, e.g. adhesives (F28F 9/18 takes precedence) }
F28F 9/165	....	{by using additional preformed parts, e.g. sleeves, gaskets (F28F 9/185 takes precedence) }

- F28F 9/167 {the parts being inserted in the heat-exchange conduits }
- F28F 9/18 by welding
- F28F 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 }
- F28F 9/185 {with additional preformed parts }
- F28F 9/187 {at least one of the parts being non-metallic, e.g. heat-sealing plastic elements }

- F28F 9/20 . Arrangements of heat reflectors, e.g. separately-insertible reflecting walls
- F28F 9/22 . Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates
- F28F 9/24 . Arrangements for promoting turbulent flow of heat-exchange media, e.g. by plates ([F28F 1/38](#) takes precedence; in general [F15D](#))
- F28F 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 9/04B](#) })
- F28F 9/262 . . { for radiators ([F28D 1/0408](#) takes precedence) }
- F28F 9/264 . . . {by sleeves, nipples }
- F28F 9/266 . . . {by screw-type connections }
- F28F 9/268 . . . {by permanent joints, e.g. by welding }

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

- F28F 13/00** **Arrangements for modifying heat-transfer, e.g. increasing, decreasing** ([F28F 1/00](#) to [F28F 11/00](#) take precedence)
- F28F 13/003 . {by using permeable mass, perforated or porous materials ([F28F 13/18](#) takes precedence) }
- F28F 13/02 . by influencing fluid boundary (boundary-layer control in general [F15D](#))
- F28F 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)
- F28F 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](#)) }
- F28F 13/08 . . by varying the cross-section of the flow channels

- F28F 13/10 . . . by imparting a pulsating motion to the flow, e.g. by sonic vibration
- F28F 13/12 . . . by creating turbulence, e.g. by stirring, by increasing the force of circulation
(F28F 13/08 takes precedence)
- F28F 13/125 . . . {by stirring }
- F28F 13/14 . . . by endowing the walls of conduits with zones of different degrees of conduction of heat
- F28F 13/16 . . . by applying an electrostatic field to the body of the heat-exchange medium
- F28F 13/18 . . . by applying coatings, e.g. radiation-absorbing, radiation-reflecting; by surface treatment, e.g. polishing
- F28F 13/182 . . . {especially adapted for evaporator or condenser surfaces (F28F 13/187 takes precedence) }
- F28F 13/185 . . . {Heat-exchange surfaces provided with microstructures or with porous coatings }
- F28F 13/187 . . . {especially adapted for evaporator surfaces or condenser surfaces, e.g. with nucleation sites }

- F28F 17/00** **Removing ice or water from heat-exchange apparatus**
- F28F 17/005 . . . {Means for draining condensates from heat exchangers, e.g. from evaporators (F28B 9/08 takes precedence) }

- F28F 19/00** **Preventing the formation of deposits or corrosion, e.g. by using filters {or scrapers }**
- F28F 19/002 . . . {by using inserts or attachments }
- F28F 19/004 . . . {by using protective electric currents, voltages, cathodes, anodes, electric short-circuits }
- F28F 19/006 . . . {Preventing deposits of ice }
- F28F 19/008 . . . {by using scrapers }
- F28F 19/01 . . . by using means for separating solid materials from heat-exchange fluids, e.g. filters
- F28F 19/02 . . . by using coatings, e.g. vitreous or enamel coatings
- F28F 19/04 . . . of rubber; of plastics material; of varnish
- F28F 19/06 . . . of metal

- F28F 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) }**
- F28F 21/003 . . . {for domestic or space-heating systems }
- F28F 21/006 . . . {of glass }
- F28F 21/02 . . . of carbon, e.g. graphite

- F28F 21/04 . of ceramic; of concrete; of natural stone
- F28F 21/045 .. {for domestic or space-heating systems }
- F28F 21/06 . of plastics material
- F28F 21/061 .. {for domestic or space-heating systems }
- F28F 21/062 .. {the heat-exchange apparatus employing tubular conduits }
- F28F 21/063 ... {for domestic or space-heating systems }
- F28F 21/065 .. {the heat-exchange apparatus employing plate-like or laminated conduits }
- F28F 21/066 ... {for domestic or space-heating systems }
- F28F 21/067 .. {Details }
- F28F 21/068 ... {for domestic or space-heating systems }
- F28F 21/08 . of metal
- F28F 21/081 .. { Heat exchange elements made from metals or metal alloys }
- F28F 21/082 ... { from steel or ferrous alloys }
- F28F 21/083 { from stainless steel }
- F28F 21/084 ... { from aluminium or aluminium alloys }
- F28F 21/085 ... { from copper or copper alloys }
- F28F 21/086 ... { from titanium or titanium alloys }
- F28F 21/087 ... { from nickel or nickel alloys }
- F28F 21/088 .. {for domestic or space-heating systems }
- F28F 21/089 .. { Coatings, claddings or bonding layers made from metals or metal alloys
([F28F 19/06](#) takes precedence) }
- F28F 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](#))
- F28F 23/02 . Arrangements for obtaining or maintaining same in a liquid state
- F28F 25/00** **Component parts of trickle coolers** (arrangements for increasing heat transfer [F28F 13/00](#); controlling arrangements [F28F 27/00](#))
- F28F 25/02 . for distributing, circulating, and accumulating liquid ([spraying or atomising in general B05B , B05D](#))
- F28F 25/04 .. Distributing or accumulator troughs
- F28F 25/06 .. Spray nozzles or spray pipes
- F28F 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](#))
- F28F 25/082 ... {Spaced elongated bars, laths; Supports therefor }
- F28F 25/085 ... {Substantially horizontal grids; Blocks }
- F28F 25/087 ... {Vertical or inclined sheets; Supports or spacers }
- F28F 25/10 . for feeding gas or vapour
- F28F 25/12 .. Ducts; Guide vanes, e.g. for carrying currents to distinct zones

- F28F 27/00** **Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus** ([control arrangements in general G05](#))
- F28F 27/003 . {specially adapted for cooling towers }
- F28F 27/006 . {specially adapted for regenerative heat-exchange apparatus }
- F28F 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](#))

F28F 99/00 **Subject matter not provided for in other groups of this subclass**

Guidance heading:

- F28F 2001/00** **Tubular elements; Assemblies of tubular elements** ([specially adapted for movement F28F 5/00](#))
- F28F 2001/02 . Tubular elements of cross-section which is non-circular ([F28F 1/08](#), [F28F 1/10](#) take precedence)
- F28F 2001/027 . . with dimples
- F28F 2001/10 . 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](#))
- F28F 2001/42 . . the means being both outside and inside the tubular element
- F28F 2001/428 . . . Particular methods for manufacturing outside or inside fins
- F28F 2009/00** **Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings**
- F28F 2009/001 . { Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core }
- F28F 2009/004 . . Common frame elements for multiple cores
- F28F 2009/02 . Header boxes; End plates
- F28F 2009/0285 . . Other particular headers or end plates
- F28F 2009/0287 . . . having passages for different heat exchange media
- F28F 2009/029 . . . with increasing or decreasing cross-section, e.g. having conical shape
- F28F 2009/0292 . . . with fins
- F28F 2009/0295 . . . comprising cooling circuits
- F28F 2009/0297 . . . Side headers, e.g. for radiators having conduits laterally connected to common header
- F28F 2009/22 . Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates

- F28F 2009/222 . . Particular guide plates, baffles or deflectors, e.g. having particular orientation relative to an elongated casing or conduit
- F28F 2009/224 . . . Longitudinal partitions
- F28F 2009/226 . . . Transversal partitions
- F28F 2009/228 . . . Oblique partitions

- F28F 2013/00** **Arrangements for modifying heat-transfer, e.g. increasing, decreasing** ([F28F 1/00](#) to [F28F 11/00](#) take precedence)

- F28F 2013/001 . Particular heat conductive materials, e.g. superconductive elements ([for thermal joints F28F 2013/006](#))
- F28F 2013/005 . Thermal joints
- F28F 2013/006 . . Heat conductive materials
- F28F 2013/008 . . Variable conductance materials; Thermal switches

- F28F 2025/00** **Component parts of trickle coolers** ([arrangements for increasing heat transfer F28F 13/00](#); [controlling arrangements F28F 27/00](#))

- F28F 2025/005 . Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid

- Guidance heading:**

- F28F 2200/00** **Prediction; Simulation; Testing** ([measuring quantity of heat conveyed by flowing mediums G01K 17/06](#))

- F28F 2200/005 . Testing heat pipes

- Guidance heading:**

- F28F 2210/00** **Heat exchange conduits**

- F28F 2210/02 . with particular branching, e.g. fractal conduit arrangements
- F28F 2210/04 . Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
- F28F 2210/06 . having walls comprising obliquely extending corrugations, e.g. in the form of threads
- F28F 2210/08 . Assemblies of conduits having different features
- F28F 2210/10 . Particular layout, e.g. for uniform temperature distribution

- F28F 2215/00** **Fins**

- F28F 2215/02 . Arrangements of fins common to different heat exchange sections, the fins being in contact with different heat exchange media

F28F 2215/04	<ul style="list-style-type: none"> Assemblies of fins having different features, e.g. with different fin densities
F28F 2215/06	<ul style="list-style-type: none"> Hollow fins; fins with internal circuits
F28F 2215/08	<ul style="list-style-type: none"> 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)
F28F 2215/10	<ul style="list-style-type: none"> Secondary fins, e.g. projections or recesses on main fins
F28F 2215/12	<ul style="list-style-type: none"> with U-shaped slots for laterally inserting conduits
F28F 2215/14	<ul style="list-style-type: none"> in the form of movable or loose fins
F28F 2220/00	Closure means, e.g. end caps on header boxes or plugs on conduits
F28F 2225/00	Reinforcing means
F28F 2225/02	<ul style="list-style-type: none"> for casings
F28F 2225/04	<ul style="list-style-type: none"> for conduits
F28F 2225/06	<ul style="list-style-type: none"> for fins
F28F 2225/08	<ul style="list-style-type: none"> for header boxes
F28F 2230/00	Sealing means
F28F 2235/00	Means for filling gaps between elements, e.g. between conduits within casings
F28F 2240/00	Spacing means
F28F 2245/00	Coatings; Surface treatments
F28F 2245/02	<ul style="list-style-type: none"> hydrophilic
F28F 2245/04	<ul style="list-style-type: none"> hydrophobic
F28F 2245/06	<ul style="list-style-type: none"> having particular radiating, reflecting or absorbing features, e.g. for improving heat transfer by radiation
F28F 2245/08	<ul style="list-style-type: none"> self-cleaning
F28F 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
F28F 2250/02	<ul style="list-style-type: none"> Streamline-shaped elements

F28F 2250/04	. Communication passages between channels
F28F 2250/06	. Derivation channels, e.g. bypass
F28F 2250/08	. Fluid driving means, e.g. pumps, fans
F28F 2250/10	. Particular pattern of flow of the heat exchange media
F28F 2250/102	. . with change of flow direction
F28F 2250/104	. . with parallel flow
F28F 2250/106	. . with cross flow
F28F 2250/108	. . with combined cross flow and parallel flow
F28F 2255/00	Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes
F28F 2255/02	. Flexible elements
F28F 2255/04	. comprising shape memory alloys or bimetallic elements
F28F 2255/06	. composite, e.g. polymers with fillers or fibres
F28F 2255/08	. pressed; stamped; deep-drawn
F28F 2255/10	. made by hydroforming
F28F 2255/12	. expanded or perforated metal plate
F28F 2255/14	. molded
F28F 2255/143	. . injection molded
F28F 2255/146	. . overmolded
F28F 2255/16	. extruded
F28F 2255/18	. sintered
F28F 2255/20	. with nanostructures
F28F 2260/00	Heat exchangers or heat exchange elements having special size, e.g. microstructures (micro heat pipes F28D 2015/0225 ; nanostructures F28F 2255/20)
F28F 2260/02	. having microchannels
F28F 2265/00	Safety or protection arrangements; Arrangements for preventing malfunction (control or monitoring devices F28F 27/00)
F28F 2265/02	. in the form of screens or covers (heat shields F28F 2265/10)
F28F 2265/06	. by using means for draining heat exchange media from heat exchangers

- F28F 2265/10 . for preventing overheating, e.g. heat shields ([thermal insulation F28F 2270/00](#))
- F28F 2265/12 . for preventing overpressure
- F28F 2265/14 . for preventing damage by freezing, e.g. for accommodating volume expansion
- F28F 2265/16 . for preventing leakage
- F28F 2265/18 . for removing contaminants, e.g. for degassing
- F28F 2265/20 . for preventing development of microorganisms
- F28F 2265/22 . for draining
- F28F 2265/24 . for electrical insulation
- F28F 2265/26 . for allowing differential expansion between elements ([floating header box elements F28F 9/0236](#))
- F28F 2265/28 . for preventing noise ([by preventing vibrations F28F 2265/30](#))
- F28F 2265/30 . for preventing vibrations
- F28F 2265/32 . for limiting movements, e.g. stops, locking means
- F28F 2270/00 Thermal insulation; Thermal decoupling**
- F28F 2270/02 . by using blind conduits
- F28F 2275/00 Fastening; Joining**
- F28F 2275/02 . by using bonding materials ([brazing F28F 2275/04](#)) ; by embedding elements in particular materials
- F28F 2275/025 . . by using adhesives
- F28F 2275/04 . by brazing ([brazing heat exchangers B23K 1/0012](#))
- F28F 2275/045 . . with particular processing steps, e.g. by allowing displacement of parts during brazing or by using a reservoir for storing brazing material
- F28F 2275/06 . by welding ([welding heat exchangers L23K 101/14](#))
- F28F 2275/061 . . by diffusion bonding
- F28F 2275/062 . . by impact pressure or friction welding
- F28F 2275/064 . . by induction welding or by using microwaves
- F28F 2275/065 . . by ultrasonic or vibration welding
- F28F 2275/067 . . by laser welding
- F28F 2275/068 . . by explosive welding
- F28F 2275/08 . by clamping or clipping

- F28F 2275/085 . . with snap connection
- F28F 2275/10 . by force joining
- F28F 2275/12 . by methods involving deformation of the elements
- F28F 2275/122 . . by crimping, caulking or clinching
- F28F 2275/125 . . by bringing elements together and expanding
- F28F 2275/127 . . by shrinking
- F28F 2275/14 . by using form fitting connection, e.g. with tongue and groove
- F28F 2275/143 . . with pin and hole connections
- F28F 2275/146 . . with bayonet connections
- F28F 2275/16 . with toothed elements, e.g. with serrations
- F28F 2275/18 . by using wedge effect
- F28F 2275/20 . with threaded elements
- F28F 2275/205 . . with of tie-rods
- F28F 2275/22 . by using magnetic effect
- F28F 2280/00 Mounting arrangements; Arrangements for facilitating assembling or disassembling of heat exchanger parts**
- F28F 2280/02 . Removable elements
- F28F 2280/04 . Means for preventing wrong assembling of parts
- F28F 2280/06 . Adapter frames, e.g. for mounting heat exchanger cores on other structure and for allowing fluidic connections
- F28F 2280/08 . Tolerance compensating means
- F28F 2280/10 . Movable elements, e.g. being pivotable ([elements specially adapted for movements F28F 5/00](#))
- F28F 2280/105 . . with hinged connections