

CPC**COOPERATIVE PATENT CLASSIFICATION****F28F****DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS, OF GENERAL APPLICATION** (water and air traps, air venting [F16](#))**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 2001/027

- • {with dimples}

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 2001/428 . . . {Particular methods for manufacturing outside or inside fins}
- 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 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Rotary drums or rollers
F28F 5/04	<ul style="list-style-type: none"> Hollow impellers, e.g. stirring vane
F28F 5/06	<ul style="list-style-type: none"> Hollow screw conveyers
F28F 7/00	Elements not covered by group F28F 1/00, F28F 3/00 or F28F 5/00
F28F 7/02	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> {Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core}
F28F 9/002	<ul style="list-style-type: none"> <ul style="list-style-type: none"> {with fastening means for other structures}
F28F 2009/004	<ul style="list-style-type: none"> <ul style="list-style-type: none"> {Common frame elements for multiple cores}
F28F 9/005	<ul style="list-style-type: none"> {Other auxiliary members within casings, e.g. internal filling means or sealing means}
F28F 9/007	<ul style="list-style-type: none"> Auxiliary supports for elements
F28F 9/0075	<ul style="list-style-type: none"> <ul style="list-style-type: none"> {Supports for plates or plate assemblies}
F28F 9/013	<ul style="list-style-type: none"> <ul style="list-style-type: none"> for tubes or tube-assemblies
F28F 9/0131	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by plates (F28F 9/0138 takes precedence)}
F28F 9/0132	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by slats, tie-rods, articulated or expandable rods}
F28F 9/0133	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by concentric strips}
F28F 9/0135	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by grids having only one tube per closed grid opening (F28F 9/0132 and F28F 9/0133 take precedence)}
F28F 9/0136	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by intersecting strips}
F28F 9/0137	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by wires, e.g. helically coiled (F28F 9/0135 takes precedence)}
F28F 9/0138	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {formed by sleeves for finned tubes}
F28F 9/02	<ul style="list-style-type: none"> Header boxes; End plates
F28F 9/0202	<ul style="list-style-type: none"> <ul style="list-style-type: none"> {Header boxes having their inner space divided by partitions}
F28F 9/0204	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {for elongated header box, e.g. with transversal and longitudinal partitions}
F28F 9/0207	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {the longitudinal or transversal partitions being separate elements attached to header boxes (F28F 9/0212, F28F 9/0217 take precedence)}
F28F 9/0209	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {having only transversal partitions}
F28F 9/0212	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {the partitions being separate elements attached to header boxes}
F28F 9/0214	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {having only longitudinal partitions}
F28F 9/0217	<ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> <ul style="list-style-type: none"> {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 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 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 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 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 9/0246](#)})
- 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 2013/001
 - {Particular heat conductive materials, e.g. superconductive elements (for thermal joints [F28F 2013/006](#))}
- F28F 13/003
 - {by using permeable mass, perforated or porous materials ([F28F 13/18](#) takes precedence)}
- F28F 2013/005
 - {Thermal joints}
- F28F 2013/006
 - . {Heat conductive materials}
- F28F 2013/008
 - . {Variable conductance materials; Thermal switches}
- 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 2025/005	<ul style="list-style-type: none"> • {Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid}
F28F 25/02	<ul style="list-style-type: none"> • for distributing, circulating, and accumulating liquid (spraying or atomising in general B05B, B05D)
F28F 25/04	<ul style="list-style-type: none"> • . Distributing or accumulator troughs
F28F 25/06	<ul style="list-style-type: none"> • . Spray nozzles or spray pipes
F28F 25/08	<ul style="list-style-type: none"> • . 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	<ul style="list-style-type: none"> • . . {Spaced elongated bars, laths; Supports therefor}
F28F 25/085	<ul style="list-style-type: none"> • . . {Substantially horizontal grids; Blocks}
F28F 25/087	<ul style="list-style-type: none"> • . . {Vertical or inclined sheets; Supports or spacers}
F28F 25/10	<ul style="list-style-type: none"> • for feeding gas or vapour
F28F 25/12	<ul style="list-style-type: none"> • . 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	<ul style="list-style-type: none"> • {specially adapted for cooling towers}
F28F 27/006	<ul style="list-style-type: none"> • {specially adapted for regenerative heat-exchange apparatus}
F28F 27/02	<ul style="list-style-type: none"> • 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
F28F 2200/00	Prediction; Simulation; Testing (measuring quantity of heat conveyed by flowing mediums G01K 17/06)
F28F 2200/005	<ul style="list-style-type: none"> • Testing heat pipes
F28F 2210/00	Heat exchange conduits
F28F 2210/02	<ul style="list-style-type: none"> • with particular branching, e.g. fractal conduit arrangements
F28F 2210/04	<ul style="list-style-type: none"> • Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
F28F 2210/06	<ul style="list-style-type: none"> • having walls comprising obliquely extending corrugations, e.g. in the form of threads
F28F 2210/08	<ul style="list-style-type: none"> • Assemblies of conduits having different features
F28F 2210/10	<ul style="list-style-type: none"> • Particular layout, e.g. for uniform temperature distribution
F28F 2215/00	Fins
F28F 2215/02	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> Communication passages between channels
F28F 2250/06	<ul style="list-style-type: none"> Derivation channels, e.g. bypass
F28F 2250/08	<ul style="list-style-type: none"> Fluid driving means, e.g. pumps, fans
F28F 2250/10	<ul style="list-style-type: none"> Particular pattern of flow of the heat exchange media
F28F 2250/102	<ul style="list-style-type: none"> <ul style="list-style-type: none"> with change of flow direction
F28F 2250/104	<ul style="list-style-type: none"> <ul style="list-style-type: none"> with parallel flow
F28F 2250/106	<ul style="list-style-type: none"> <ul style="list-style-type: none"> with cross flow
F28F 2250/108	<ul style="list-style-type: none"> <ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Flexible elements
F28F 2255/04	<ul style="list-style-type: none"> comprising shape memory alloys or bimetallic elements
F28F 2255/06	<ul style="list-style-type: none"> composite, e.g. polymers with fillers or fibres
F28F 2255/08	<ul style="list-style-type: none"> 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 B23K 2201/14](#))

- 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