

**ECLA****EUROPEAN CLASSIFICATION****F28F****DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS,  
OF GENERAL APPLICATION (water and air traps, air venting F16)****F28F1/00****Tubular elements; Assemblies of tubular elements** (specially adapted for movement [F28F5/00](#))**F28F1/00B**

- [N: Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators [F22B1/06B2](#))]

**F28F1/00C**

- [N: with variable shape, e.g. with modified tube ends, with different geometrical features ([F28F1/02C](#), [F28F1/06](#), [F28F1/08](#), [F28F9/16](#), [F28F9/18](#) take precedence)] [N9912]

**F28F1/02**

- Tubular elements of cross-section which is non-circular ([F28F1/08](#), [F28F1/10](#) take precedence)

**F28F1/02B**

- [N: with multiple channels ] [N9912] [C0509]

**F28F1/02C**

- [N: with variable shape. e.g. with modified tube ends, with different geometrical features ([F28F1/06](#), [F28F1/08](#), [F28F9/16](#), [F28F9/18](#) take precedence)] [N9912]

**F28F1/04**

- polygonal, e.g. rectangular [N: ([F28F1/02B](#) takes precedence)] [C0509]

**F28F1/04B**

- [N: with assemblies of stacked elements] [N9912] [C0509]

**F28F1/06**

- crimped or corrugated in cross-section

**F28F1/08**

- Tubular elements crimped or corrugated in longitudinal section

**F28F1/10**

- Tubular elements and assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with projections, with recesses (crimped or corrugated elements [F28F1/06](#), [F28F1/08](#))

**F28F1/10B**

- [N: the means being corrugated elements extending around the tubular elements] [N9810]

**F28F1/12**

- the means being only outside the tubular element

**F28F1/12B**

- [N: and being formed of wires]

**F28F1/12C**

- [N: and being formed of pins]

**F28F1/12D**

- [N: consisting of zig-zag shaped fins ([F28F1/10B](#) takes precedence)] [C9810]

**F28F1/12D2**

- [N: Fins with openings, e.g. louvered fins] [N9810]

**F28F1/14**

- and extending longitudinally ([F28F1/38](#) takes precedence)

**F28F1/16**

- the means being integral with the element, e.g. formed by extrusion ([F28F1/22](#) takes precedence)

**F28F1/18**

- the element being built-up from finned sections

**F28F1/20**

- the means being attachable to the element ([F28F1/22](#) takes precedence)

**F28F1/22**

- the means having portions engaging further tubular elements

**F28F1/24**

- and extending transversely ([F28F1/38](#) takes precedence)

**F28F1/26**

- the means being integral with the element ([F28F1/32](#) takes precedence)

**F28F1/28**

- the element being built-up from finned sections

**F28F1/30**

- the means being attachable to the element ([F28F1/32](#) takes precedence)

- F28F1/32 . . . . the means having portions engaging further tubular elements
- F28F1/32B . . . . . [N: Fins with openings]
- F28F1/34 . . . . and extending obliquely (F28F1/38 takes precedence)
- F28F1/36 . . . . the means being helically wound fins or wire spirals
- F28F1/38 . . . . and being staggered to form tortuous fluid passages
- F28F1/40 . . the means being only inside the tubular element
- F28F1/40B . . . . [N: and being formed of wires]
- F28F1/42 . . the means being both outside and inside the tubular element [N1204]
- F28F1/42B . . . . [N: with outside means integral with the tubular element and inside means integral with the tubular element (F28F1/42C takes precedence)] [N1204]
- F28F1/42C . . . . [N: Means comprising outside portions integral with inside portions] [N1204]
- F28F1/42C4 . . . . . [N: the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex] [N1204]
- F28F1/44 . . . . and being formed of wire mesh
  
- F28F3/00** **Plate-like or laminated elements; Assemblies of plate-like or laminated elements (specially adapted for movement F28F5/00)**
  
- F28F3/00B . . [N: Arrangements for preventing direct contact between different heat-exchange media (F28F3/10 takes precedence)]
  
- F28F3/02 . Elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with recesses, with corrugations (F28F3/08 [N: F28F3/08D] takes precedence) [C9409]
- F28F3/02B . . [N: the means being wires or pins] [N9409]
- F28F3/02D . . [N: the means being corrugated, plate-like elements] [N9409]
- F28F3/02D2 . . . . [N: with openings, e.g. louvered corrugated fins; Assemblies of corrugated strips] [N0203]
- F28F3/04 . . the means being integral with the element
- F28F3/04B . . . . [N: in the form of local deformations of the element] [N0701]
- F28F3/04B2 . . . . . [N: the deformations being pontual, e.g. dimples] [N0701]
- F28F3/04B4 . . . . . [N: the deformations being linear, e.g. corrugations] [N0701]
- F28F3/04C . . . . [N: in the form of ribs integral with the element or local variations in thickness of the element, e.g. grooves, microchannels] [N0701]
- F28F3/06 . . the means being attachable to the element
  
- F28F3/08 . Elements constructed for building-up into stacks, e.g. capable of being taken apart for cleaning
- F28F3/08B . . [N: capable of being taken apart]
- F28F3/08C . . [N: having one or more openings therein forming tubular heat-exchange passages]
- F28F3/10 . . Arrangements for sealing the margins
  
- F28F3/12 . Elements constructed in the shape of a hollow panel, e.g. with channels [N: (F28D1/02, F28D1/03 take precedence)]
- F28F3/14 . . by separating portions of a pair of joined sheets to form channels, e.g. by inflation (manufacture thereof B23P)
  
- F28F5/00** **Elements specially adapted for movement (arrangements for moving the elements,**

**see the appropriate subclass for the apparatus concerned)**

- F28F5/02 . Rotary drums or rollers
- F28F5/04 . Hollow impellers, e.g. stirring vane
- F28F5/06 . Hollow screw conveyers
- F28F7/00** **Elements not covered by group [F28F1/00](#), [F28F3/00](#) or [F28F5/00](#)**
- F28F7/02 . Blocks traversed by passages for heat-exchange media [N: ([F28D7/00B](#) takes precedence)] [C0509]
- F28F9/00** **Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings**
- F28F9/00A . [N: Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core] [N1204]
- F28F9/00A2 . . [N: with fastening means for other structures] [N9703]
- F28F9/00C . [N: Other auxiliary members within casings, e.g. internal filling means or sealing means] [N1204]
- F28F9/007 . Auxiliary supports for elements
- F28F9/007A . . [N: Supports for plates or plate assemblies]
- F28F9/013 . . for tubes or tube-assemblies
- F28F9/013B . . . [N: formed by plates ([F28F9/013S](#) takes precedence)]
- F28F9/013D . . . [N: formed by slats, tie-rods, articulated or expandable rods]
- F28F9/013E . . . [N: formed by concentric strips]
- F28F9/013F . . . [N: formed by grids having only one tube per closed grid opening ([F28F9/013D](#) and [F28F9/013E](#) take precedence)]
- F28F9/013F6 . . . . [N: formed by intersecting strips]
- F28F9/013H . . . [N: formed by wires, e.g. helically coiled ([F28F9/013F](#) takes precedence)]
- F28F9/013S . . . [N: formed by sleeves for finned tubes]
- F28F9/02 . Header boxes; End plates
- F28F9/02A . . [N: Header boxes having their inner space divided by partitions]
- F28F9/02A2 . . . [N: for elongated header box, e.g. with transversal and longitudinal partitions] [N0509]
- F28F9/02A2B . . . . [N: the longitudinal or transversal partitions being separate elements attached to header boxes ([F28F9/02A2C2](#), [F28F9/02A2D2](#) take precedence)] [N1204]
- F28F9/02A2C . . . . [N: having only transversal partitions] [N0509]
- F28F9/02A2C2 . . . . . [N: the partitions being separate elements attached to header boxes] [N0509]
- F28F9/02A2D . . . . [N: having only longitudinal partitions] [N0509]

F28F9/02A2D2	. . . . .	[N: the partitions being separate elements attached to header boxes] [N0509]
F28F9/02B	. .	[N: Arrangements for sealing end plates into casing or header box; Header box sub-elements ( <a href="#">F28F9/02F</a> takes precedence)] [C9707]
F28F9/02B2	. . .	[N: Header boxes or end plates formed by stacked elements] [N9707]
F28F9/02B4	. . .	[N: Header boxes formed by sealing end plates into covers ( <a href="#">F28F9/02B2</a> takes precedence)] [N9707]
F28F9/02B4B	. . . .	[N: with resilient gaskets] [N9707]
F28F9/02C	. .	[N: Double end plates; Single end plates with hollow spaces]
F28F9/02D	. .	[N: Header boxes having an expansion chamber]
F28F9/02E	. .	[N: having a second heat exchanger disposed there within, e.g. oil cooler]
F28F9/02F	. .	[N: floating elements]
F28F9/02F2	. . .	[N: floating header boxes]
F28F9/02F4	. . .	[N: floating end plates]
F28F9/02H	. .	[N: Header boxes having a circular cross-section]
F28F9/02K	. .	[N: Arrangements for connecting header boxes with flow lines] [N0910]
F28F9/02K2	. . .	[N: Arrangements for sealing connectors to header boxes] [N0910]
F28F9/02K4	. . .	[N: Massive connectors, e.g. blocks; Plate-like connectors] [N0910]
F28F9/02K4B	. . . .	[N: with multiple channels, e.g. with combined inflow and outflow channels] [N0910]
F28F9/02K6	. . .	[N: Arrangements for coupling connectors with flow lines] [N0910]
F28F9/02K6B	. . . .	[N: of quick acting type, e.g. with snap action] [N0910]
F28F9/02S	. .	[N: with static flow control means, e.g. with means for uniformly distributing heat exchange media into conduits] [N0910]
F28F9/02S2	. . .	[N: by varying the geometry or cross-section of header box] [N0910]
F28F9/02S4	. . .	[N: by using guiding means or impingement means inside the header box] [N0910]
F28F9/02S4B	. . . .	[N: in the form of multiple deflectors for channeling the heat exchange medium] [N0910]
F28F9/02S6	. . .	[N: in the form of distribution pipes] [N0910]
F28F9/02S6B	. . . .	[N: with multiple holes] [N0910]
F28F9/02S6C	. . . .	[N: with multiple branch pipes] [N0910]
F28F9/02S8	. . .	[N: in the form of stacked distribution plates or perforated plates arranged over end plates] [N0910]
F28F9/02S10	. . .	[N: 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] [N0910]
F28F9/02S12	. . .	[N: 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] [N0910]
F28F9/04	. .	Arrangements for sealing elements into header boxes or end plates [N: arrangements for sealing flow lines connectors to header boxes <a href="#">F28F9/02K2</a> ] [C0910]
F28F9/06	. . .	by dismountable joints [C0910]
F28F9/08	. . . .	by wedge-type connections, e.g. taper ferrule
F28F9/10	. . . .	by screw-type connections, e.g. gland
F28F9/12	. . . .	by flange-type connections

- F28F9/14 . . . . by force-joining
- F28F9/16 . . . . by permanent joints, e.g. by rolling ([metal-working procedures in general B21, B32; particularly B21D39/06, B23K](#))
- F28F9/16B . . . . [N: by using bonding or sealing substances, e.g. adhesives ([F28F9/18 takes precedence](#))] [N9907]
- F28F9/16C . . . . [N: by using additional preformed parts, e.g. sleeves, gaskets ([F28F9/18C takes precedence](#))] [N9907]
- F28F9/16C2 . . . . . [N: the parts being inserted in the heat-exchange conduits] [N9907]
- F28F9/18 . . . . by welding
- F28F9/18B . . . . . [N: 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] [N9907]
- F28F9/18C . . . . . [N: with additional preformed parts] [N9907]
- F28F9/18D . . . . . [N: at least one of the parts being non-metallic, e.g. heat-sealing plastic elements] [N9907]
  
- F28F9/20 . Arrangements of heat reflectors, e.g. separately-insertible reflecting walls
- F28F9/22 . Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates
- F28F9/24 . Arrangements for promoting turbulent flow of heat-exchange media, e.g. by plates ([F28F1/38 takes precedence](#); in general [F15D](#))
- F28F9/26 . Arrangements for connecting different sections of heat-exchange elements, e.g. of radiators ([connecting different sections in water heaters F24H9/14, \[N: connecting headers with inlet or outlet fittings F28F9/04B\]](#)) [C0509]
- F28F9/26B . . [N: for radiators ([F28D1/04E takes precedence](#))]
- F28F9/26B1 . . . [N: by sleeves, nipples]
- F28F9/26B2 . . . [N: by screw-type connections]
- F28F9/26B3 . . . [N: by permanent joints, e.g. by welding]
  
- F28F11/00** **Arrangements for sealing leaky tubes and conduits** ([stopping flow from or in pipes in general F16L55/10](#))
- F28F11/02 . using obturating elements, e.g. washers, inserted and operated independently of each other ([F28F11/06 takes precedence](#))
- F28F11/04 . using pairs of obturating elements, e.g. washers, mounted upon central operating rods ([F28F11/06 takes precedence](#))
- F28F11/06 . using automatic tube obturating appliances
  
- F28F13/00** **Arrangements for modifying heat-transfer, e.g. increasing, decreasing** ([F28F1/00 to F28F11/00 take precedence](#))
- F28F13/00B . [N: by using permeable mass, perforated or porous materials ([F28F13/18 takes precedence](#))] [N9509]
- F28F13/02 . by influencing fluid boundary ([boundary-layer control in general F15D](#))

- F28F13/04 . by preventing the formation of continuous films of condensate on heat-exchange surfaces, e.g. by promoting droplet formation [N: [F28F13/18](#) takes precedence] [C0509]
- F28F13/06 . by affecting the pattern of flow of the heat-exchange media [N: ([F28F13/00B](#) takes precedence; static flow control means in header boxes [F28F9/02S](#) )] [C0910]
- F28F13/08 . . by varying the cross-section of the flow channels
- F28F13/10 . . by imparting a pulsating motion to the flow, e.g. by sonic vibration
- F28F13/12 . . by creating turbulence, e.g. by stirring, by increasing the force of circulation ([F28F13/08](#) takes precedence)
- F28F13/12B . . . [N: by stirring]
- F28F13/14 . by endowing the walls of conduits with zones of different degrees of conduction of heat
- F28F13/16 . by applying an electrostatic field to the body of the heat-exchange medium
- F28F13/18 . by applying coatings, e.g. radiation-absorbing, radiation-reflecting; by surface treatment, e.g. polishing
- F28F13/18B . . [N: especially adapted for evaporator or condenser surfaces ([F28F13/18C2](#) takes precedence)] [N0509]
- F28F13/18C . . [N: Heat-exchange surfaces provided with microstructures or with porous coatings] [N0509]
- F28F13/18C2 . . . [N: especially adapted for evaporator surfaces or condenser surfaces, e.g. with nucleation sites] [N0509]
- F28F17/00 Removing ice or water from heat-exchange apparatus**
- F28F17/00B . [N: Means for draining condensates from heat exchangers, e.g. from evaporators ([F28B9/08](#) takes precedence)] [N0501]
- F28F19/00 Preventing the formation of deposits or corrosion, e.g. by using filters [N: or scrapers]**
- F28F19/00B . [N: by using inserts or attachments]
- F28F19/00C . [N: by using protective electric currents, voltages, cathodes, anodes, electric short-circuits]
- F28F19/00D . [N: Preventing deposits of ice]
- F28F19/00F . [N: by using scrapers]
- F28F19/01 . by using means for separating solid materials from heat-exchange fluids, e.g. filters
- F28F19/02 . by using coatings, e.g. vitreous or enamel coatings
- F28F19/04 . . of rubber; of plastics material; of varnish
- F28F19/06 . . of metal
- F28F21/00 Constructions of heat-exchange apparatus characterised by the selection of**

**particular materials** [N: (coatings for modifying heat-transfer [F28F13/18](#); coatings for preventing the formation of deposits or corrosion [F28F19/02](#))] [C0509]

- F28F21/00A . [N: for domestic or space-heating systems]
- F28F21/00B . [N: of glass]
- F28F21/02 . of carbon, e.g. graphite
- F28F21/04 . of ceramic; of concrete; of natural stone
- F28F21/04B . . [N: for domestic or space-heating systems]
- F28F21/06 . of plastics material
- F28F21/06A . . [N: for domestic or space-heating systems]
- F28F21/06B . . [N: the heat-exchange apparatus employing tubular conduits]
- F28F21/06B2 . . . [N: for domestic or space-heating systems]
- F28F21/06C . . [N: the heat-exchange apparatus employing plate-like or laminated conduits]
- F28F21/06C2 . . . [N: for domestic or space-heating systems]
- F28F21/06D . . [N: Details]
- F28F21/06D2 . . . [N: for domestic or space-heating systems]
- F28F21/08 . of metal
- F28F21/08A . . [N: Heat exchange elements made from metals or metal alloys] [N1204]
- F28F21/08A2 . . . [N: from steel or ferrous alloys] [N1204]
- F28F21/08A2B . . . . [N: from stainless steel] [N1204]
- F28F21/08A4 . . . [N: from aluminium or aluminium alloys] [N1204]
- F28F21/08A6 . . . [N: from copper or copper alloys] [N1204]
- F28F21/08A8 . . . [N: from titanium or titanium alloys] [N1204]
- F28F21/08A10 . . . [N: from nickel or nickel alloys] [N1204]
- F28F21/08B . . [N: for domestic or space-heating systems]
- F28F21/08C . . [N: Coatings, claddings or bonding layers made from metals or metal alloys (F28F19/06 takes precedence)] [N1204]
- F28F23/00** **Features relating to the use of intermediate heat-exchange materials, e.g. selection of compositions** (heat-transfer, heat-exchange or heat-storage materials [C09K5/00](#)) [C9906]
- F28F23/02 . Arrangements for obtaining or maintaining same in a liquid state
- F28F25/00** **Component parts of trickle coolers** (arrangements for increasing heat transfer [F28F13/00](#); controlling arrangements [F28F27/00](#))
- F28F25/02 . for distributing, circulating, and accumulating liquid (spraying or atomising in general [B05B](#), [B05D](#))
- F28F25/04 . . Distributing or accumulator troughs

- F28F25/06 . . Spray nozzles or spray pipes
- F28F25/08 . . 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 B01J19/30, B01J19/32](#))
- F28F25/08B . . . [N: Spaced elongated bars, laths; Supports therefor]
- F28F25/08D . . . [N: Substantially horizontal grids; Blocks]
- F28F25/08E . . . [N: Vertical or inclined sheets; Supports or spacers]
- F28F25/10 . for feeding gas or vapour
- F28F25/12 . . Ducts; Guide vanes, e.g. for carrying currents to distinct zones
- F28F27/00** **Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05) [C0901]**
- F28F27/00B . [N: specially adapted for cooling towers]
- F28F27/00D . [N: specially adapted for regenerative heat-exchange apparatus]
- F28F27/02 . for controlling the distribution of heat-exchange media between different channels ([N: static flow control means in header boxes [F28F9/02S](#)]; arrangements of guide plates or guide vanes [F28F9/22, F28F25/12](#)) [C0910]
- F28F99/00** **Subject matter not provided for in other groups of this subclass [N0704]**