

F28F

DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS, OF GENERAL APPLICATION (water and air traps, air venting [F16](#))

Definition statement

This place covers:

Particular elements of heat exchangers; details of heat transfer devices; means for modifying heat transfer; control arrangements for heat exchangers.

F28F 1/00

Tubular elements; Assemblies of tubular elements (specially adapted for movement [F28F 5/00](#))

Definition statement

This place covers:

Tubular elements; assemblies of tubular elements, e.g. particular shape, construction, geometry of individual tubular element, e.g. multiple wall conduits, tubes with variable shape.

Tubular elements of cross-section which is non circular, e.g. flat tubes, flat multichannel tubes.

Tubular elements of cross-section which is polygonal, e.g. square, rectangular.

Tubular elements which are crimped or corrugated in cross-section.

Tubular elements which are crimped or corrugated in longitudinal section.

Means for increasing heat transfer area, e.g. fins, ribs.

References

Limiting references

This place does not cover:

Elements specially adapted for movement	F28F 5/00
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Tube-rolling by rollers arranged outside the work	B21B 19/00
Making tubes by extrusion	B21C 23/08
Making finned tubes by extrusion	B21C 23/10
Making tubes or metal hoses; Combined procedures for making tubes, e.g. for making multi-wall tubes	B21C 37/06
Making tubes with welded or soldered seams	B21C 37/08
Making tubes of special shape, e.g. multi-wall tubes, tubes with non-circular cross-section; tubes with multiple passages	B21C 37/15
Making helical or similar guides in or on tubes without removing material, e.g. by drawing same over mandrels, by pushing same through dies	B21C 37/20
Making finned or ribbed tubes by fixing strip or like material to tubes	B21C 37/22

Making annularly-ribbed tubes	B21C 37/24
Making helically-ribbed tubes	B21C 37/26
Application of procedures in order to alter the diameter of tube ends	B21C41/00
Making heat exchangers	B21D 53/02
Moulds for making ribbed tubes	B22C 9/26

Special rules of classification

The fins are either outside the tubular elements: **F28F/12** or inside the tubular elements: [F28F 1/40](#). The subgroup [F28F 1/42](#) covers fins being both inside and outside the elements.

Outside fins can either extend longitudinally: [F28F 1/14](#), or laterally: [F28F 1/24](#) or obliquely: **F28F/34**, relative to the axis of the tubular elements..

Longitudinal fins can be integral with the elements, e.g. extruded as unitary element,: [F28F 1/16](#) or can be attachable to the element (removable): [F28F 1/20](#), or can have portions which are common to several tubular elements: [F28F 1/22](#).

Transversal fins can be integral with the elements,: [F28F 1/26](#) or can be attachable to the element (removable): [F28F 1/30](#), or can have portions which are common to several tubular elements: [F28F 1/32](#).

Oblique fins can be in the form of helically wound fins or wire spirals: [F28F 1/36](#).

Corrugated fins are classified in [F28F 1/12](#).

Tubular elements which made from finned sections are classified in [F28F 1/18](#) or [F28F 1/28](#).

Staggered fins to form tortuous passages are in [F28F 1/38](#).

F28F 3/00

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

Definition statement

This place covers:

Plate-like or laminated elements; assemblies of plate-like or laminated elements,e.g. particular shape, construction, geometry of individual plate-like or laminated element, e.g. arrangements for preventing direct contact between different heat-exchange media.

Relationships with other classification places

Heat exchangers formed by stacked plates permanently fixed together (not capable of being taken apart) are normally classified only in [F28F 9/00](#) and not in [F28F 3/08](#).

References

Limiting references

This place does not cover:

Elements specially adapted for movement	F28F 5/00
Fins to facilitate cooling of reflectors for light sources	F21V 29/505
Fins for nuclear reactor fuel elements	G21C 3/08

Heat sinks for resistors	H01C 1/084
Cooling fins for transformers	H01F 27/02 , H01F 27/08
Heat sinks for cooling semiconductor	H01L 23/36
Cooling facilitated by shape of device, e.g. foil, wire, pin	H01L 23/367
Heat dissipation bodies for electric apparatus	H05K 7/20

Informative references

Attention is drawn to the following places, which may be of interest for search:

Shaping by applying fluid pressure	B21D 26/02
Making heat exchanger of sheet metal	B21D 53/04

Special rules of classification

The subgroup [F28F 3/02](#) covers elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, wires, pins, corrugated plates.

The subgroup [F28F 3/04](#) covers means which are integral with the plate-like or laminated element, e.g. in the form of local deformations of the elements, e.g. dimples, corrugations, or in the form of ribs.

The subgroup [F28F 3/06](#) covers means which are attachable to the elements (removable).

The subgroup [F28F 3/08](#) covers elements constructed for building-up into stacks, e.g. capable of being taken apart, stacked plates with openings forming tubular heat-exchange passages.

The subgroup [F28F 3/10](#) covers sealing means, e.g. gaskets at plate margins.

The subgroup [F28F 3/12](#) covers elements constructed in the shape of a hollow panel, e.g. with channels, e.g. cold plate. Panels manufactured by inflation (roll-bonding, hydro-forming) are classified in [F28F 3/14](#).

F28F 5/00

Elements specially adapted for movement (arrangements for moving the elements, see the appropriate subclass for the apparatus concerned)

Definition statement

This place covers:

Particular type of moving elements, e.g. rotary drums or rollers ([F28F 5/02](#)), hollow impellers ([F28F 5/04](#)), hollow screw conveyors ([F28F 5/06](#)).

References

Limiting references

This place does not cover:

Movable elements inside conduits, e.g. stirring means	F28F 13/12
Cooling or heating rolls for rolling of metal	B21B 27/06 , B21B 27/08 , B21B 27/10
Cooled casting wheels	B22D 11/06

Rollers for mixing or kneading devices for preparation of plastic material	B29B 7/62
Rolls calenders or drums for shaping plastic material	B29C 33/04
Rollers for thermal treatment of textiles	D06B 23/02
Drying cylinders for paper-making	D21F 5/02
Heating or cooling calender rolls for paper-making	D21G 1/02
Heated or cooled rollers or drums or cylinders for drying fabrics, fibres, yarns, or other material	F26B 13/18
Movable cleaning elements	F28G

F28F 7/00

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

Definition statement

This place covers:

Elements not covered by group [F28F 1/00](#), [F28F 3/00](#) or [F28F 5/00](#), e.g. particular heat-exchange elements not in the form of tubular or plate-like elements.

F28F 7/02

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

References

Informative references

Attention is drawn to the following places, which may be of interest for search:

Manufacture of articles from metallic powder, e.g. by sintering characterised by the special shape of the product of articles with cavities or holes	B22F 5/10
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F28F 9/00

Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings

Definition statement

This place covers:

Particular construction of casings or shells; particular frame elements, e.g. side plates for radiator cores; auxiliary members within casings, e.g. filling means, sealing means.

Auxiliary supports for elements

Supports for tubes or tube-assemblies, e.g. formed by plates, by slats, by tie-rods, by strips, by wires.

Header boxes (manifold, tank), end plates, e.g. header boxes with inner space divided by partitions or baffles; arrangements for fastening header box or end plate with casing; arrangements for fastening header (cover) with end plate; double end plates or hollow end plates; expansion chambers; header boxes with second heat exchanger disposed inside; floating elements; arrangements for connecting header boxes with flow lines; static flow control, e.g. heat exchange media distributing means.

Arrangements for connecting elements to header boxes or end plates, either by dismountable joints ([F28F 9/06](#)), or by permanent joints ([F28F 9/16](#)).

Dismountable joints can be: wedge-type connections, e.g. taper ferrule ([F28F 9/08](#)), or screw-type connection, e.g. gland, stuffing box ([F28F 9/10](#)), or flange-type connection, or made by force-joining, e.g. the elements are forced into the end plate, generally with a gasket ([F28F 9/14](#)).

Permanent joints means: using a working procedure for permanently deforming the elements or using bonding materials, e.g. adhesive, brazing or welding material for permanently joining the elements with the end plate or header box: the subgroup [F28F 9/18](#) covers permanent joint by welding.

Arrangement of heat reflectors, e.g. protective walls inside casings.

Arrangement of guide plates inside casing, e.g. longitudinal, transversal or oblique baffles for guiding the heat exchange medium flowing inside the casing

Arrangements for promoting turbulent flow inside casing

Arrangements for connection different heat-exchange sections, e.g. elbows, connecting sleeves, nipples.

References

Limiting references

This place does not cover:

Arrangements or mounting of radiators on vehicles	B60K 11/04
Mounting of radiators on vehicles front or rear portions	B62D 25/08
Arrangements or mountings of liquid-to-air heat exchangers for cooling engines	F01P 3/18
Arrangement of fans or blowers for cooling engines	F01P 5/02
Filling caps, deaeration devices for motor car radiators	F01P 11/02
Guiding or ducting cooling air to or from liquid-to-air heat exchangers	F01P 11/10
Arrangement of mountings or supports for central heating radiators	F04D 19/02
Mounting of ventilators	F04D 29/60
Supporting arrangements for steam generators	F22B 37/20
Drums, headers for steam generators	F22B 37/22
Casings, cover lids or ornamental panels for domestic radiators.	F24D 19/06
Casings for air-conditioning units; arrangements for mounting of heat exchangers	F24F 13/00
Casings, cover lids or ornamental panels for fluid heaters having heat generating means	F24H 9/02
Arrangement of supports for fluid heaters	F24H 9/06
Connecting heaters to circulation pipes	F24H 9/12

Informative references

Attention is drawn to the following places, which may be of interest for search:

Application of procedures in order to connect tubes with tubes	B21D 39/04
Procedures for connecting tubes in openings, e.g. rolling-in	B21D 39/06

Making heat exchangers of both metal tubes and sheet metal	B21D 53/08
Brazing, welding	B23K
Adhesives	C09J
Connections of tubes mutually, including resilient connections	F16B 7/00
Connections of rods or tubular parts to flat surfaces at an angle	F16B 9/00
Supports for pipes	F16L 3/00
Quick acting couplings	F16L 37/00
Branching pipes to walls	F16L 41/08
Joining pipes to walls	F16L 41/08

F28F 11/00

Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general [F16L 55/10](#))

Definition statement

This place covers:

Devices or processes for repairing damaged heat exchange conduits

[F28F 11/02](#): using obturating elements, e.g. washers, plugs

References

Limiting references

This place does not cover:

Stopping flow from or in pipes in general	F16L 55/10
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Extracting tube bundles	B23P 19/02
Plugs	F16L 55/11
Caps	F16L 55/115
Devices for covering leaks in pipes	F16L 55/16
Investigating fluid-tightness of structures	G01M 3/00

F28F 13/00

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

Definition statement

This place covers:

Means for optimizing heat transfer (increasing heat transfer), other than fins; Heat insulating means (decreasing heat transfer); e.g. thermal joints, use of particular conductive materials, thermal barriers, use of permeable mass, perforated or porous materials.

Relationships with other classification places

Increasing heat transfer by using means for increasing heat transfer area, e.g. fins: [F28F 1/10](#), [F28F 3/02](#)

References

Limiting references

This place does not cover:

Particular heat transfer materials	C09K 5/00
Pulse tube cooler	F25B 9/14
Cooling semiconductors with porous structures	H01L 23/373
Cooling semiconductors by jet impingement	H01L23/4373

Informative references

Attention is drawn to the following places, which may be of interest for search:

Making porous articles	B22F 3/11
Coating compositions	C09
Coating processes	C23
Electroplating	C25D
Influencing flow of fluids	F15D 1/00
Influencing fluid boundary layer of a fluid	F15D 1/06 , F15D 1/12
Compound tubes	F16L 9/14
Photomechanical, e.g. lithographic production of textured or patterned surfaces	G03F

Special rules of classification

The following classification applies depending on the means for modifying heat transfer

[F28F 13/02](#): by influencing fluid boundary

[F28F 13/04](#): by preventing the formation of continuous films of condensate on heat-exchange surface, e.g. by promoting droplet formation (enhancing dropwise condensation)

[F28F 13/06](#): by affecting the pattern of flow of the heat-exchange media, e.g. with inserts, deflectors, vortex generators.

[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 13/14](#): by endowing the walls of conduits with zones of different degrees of conduction of heat, e.g. heat conductive elements having heat insulating portions.

[F28F 13/16](#): by applying an electrostatic field to the body of heat-exchange medium, e.g. enhancing heat transfer by electro hydrodynamic effects

[F28F 13/18](#): by applying coatings, e.g. radiation-absorbing, radiation-reflecting, hydrophilic coatings, hydrophobic coatings, conductive coatings; porous coatings; by surface treatment, e.g. polishing,

obtaining rough surfaces; heat exchange surfaces having microstructures, e.g. nucleation sites for enhancing nucleate boiling.

F28F 17/00

Removing ice or water from heat-exchange apparatus

Definition statement

This place covers:

Means for draining water from heat exchangers, e.g. means for draining condensates from evaporators

References

Limiting references

This place does not cover:

Removing condensates in steam condensers	F28B 9/08
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F28F 19/00

Preventing the formation of deposits or corrosion, e.g. by using filters {or scrapers}

Definition statement

This place covers:

Means for preventing corrosion, abrasion, erosion, damages in heat exchangers, e.g. by using inserts or attachments, by using protective electric currents; preventing deposits of ice, means for preventing freezing of heat exchange media; by using scrapers

References

Limiting references

This place does not cover:

Coatings for modifying heat transfer	F28F 13/18
Removing ice from heat exchangers	F28F 17/00
Preventing or removing incrustations in thermal cracking apparatus	C10G 9/16
Preventing clogging by frost in cooling towers	F28C 1/12
Cleaning heat exchangers	F28G

Informative references

Attention is drawn to the following places, which may be of interest for search:

Filters in general	B01D 24/00 - B01D 41/00 , B01D 46/00
Shaped ceramic products	C04B 35/00
Coating compositions	C09D
Antifouling paints	C09D 5/16
Coating processes	C23C

Inhibiting corrosion of metallic material	C23F 11/00
Inhibiting corrosion of metals by anodic or cathodic protection	C23F 13/00
Devices preventing bursting of pipes by freezing	E03B 7/10
Preventing icing in gas-turbine plants	F02C 7/047
Protection of pipes against corrosion	F16L 58/00
Use of special steel alloy in steam boilers	F22B 37/04
Protection of water tubes in steam boilers	F22B 37/10
Devices for preventing or removing corrosion, slime or scale in heating systems	F24D 19/00
Dispositions against corrosion of combustion products	F24H 9/00
Preventing corrosion in refrigeration machines	F25B 47/00
Removing ice by scraping	F25C 1/14
Defrosting refrigerators	F25D 21/14
Linings for furnaces	F27D 1/00
Measuring thickness	G01B 21/08

Special rules of classification

Depending on the preventing means, the following classification applies:

[F28F 19/01](#) by using means for separating solid materials from heat-exchange fluid, e.g. filters

[F28F 19/02](#) by using coatings

[F28F 19/04](#) plastic coatings

[F28F 19/06](#) metallic coatings

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](#))}

Definition statement

This place covers:

Heat exchanging elements made by particular materials, e.g. glass.

References

Limiting references

This place does not cover:

Particular coatings for modifying heat transfer	F28F 13/18
Particular coatings for preventing corrosion	F28F 19/02

Informative references

Attention is drawn to the following places, which may be of interest for search:

Manufacture of metal sheets, metal tubes	B21C
Manufacture of metal sheets, metal tubes by drawing	B21C 1/00
Extruding metal	B21C 23/00
Manufacture of tubes of special shape	B21C 37/00
Working or processing of sheet metal or metal tubes without removing material	B21D
Bending sheet metal	B21D 5/00
Bending tubes	B21D 7/00 , B21D 9/00
Stamping, deep-drawing	B21D 22/00
Procedures in order to connect objects	B21D 39/00
Making heat exchangers	B21D 53/02
Casting; Powder metallurgy	B22
Pressure die casting or injection die casting	B22D 17/00
Manufacture of articles from metallic powders	B22F
Manufacture of articles from metallic powder characterised by the manner of compacting or sintering	B22F 3/00
Making articles with cavities or holes	B22F 5/00
Brazing, welding	B23K
Production of ceramic shaped elements	B28B 23/00
Shaping or joining of plastics	B29C
Shaping by casting	B29C 35/00
Compression moulding	B29C 43/00
Injection moulding	B29C 45/00
Extrusion moulding	B29C 48/00
Blow moulding	B29C 49/00
Shaping by thermoforming	B29C 51/00
Shaping by bending, folding, twisting, straightening or flattening	B29C 53/00
Surface shaping, e.g. embossing	B29C 59/00
Joining of preformed parts	B29C 65/00
Producing particular articles from plastics	B29D
Manufacturing plastic heat exchangers	B29L 2031/18
Joining glass to other material	C03C 27/00
Shaped ceramic products	C04B 35/00
Porous mortars, concrete, artificial stone or ceramic ware	C04B 38/00
Polymers	C08
Alloys	C22C
Ferrous alloys, e.g. steel alloys	C22C 38/00

Special rules of classification

Depending on the material, the following classification applies:

[F28F 21/02](#): carbon, e.g. graphite

[F28F 21/04](#): ceramic e.g. alumina, beryllia, zirconia carbide, boride, nitride, silicide; concrete; natural stone.

[F28F 21/06](#): plastics, e.g. resins, polymeric materials, reinforced plastics.

[F28F 21/08](#): metal, e.g. steel or ferrous alloys, stainless steel, aluminium or aluminium alloys, copper or copper alloys, titanium, nickel

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](#))

Definition statement

This place covers:

Particular intermediate heat exchange materials

References

Limiting references

This place does not cover:

Chemical compositions of heat transfer materials	C09K 5/00
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Heat exchangers using intermediate heat exchange materials	F28D 15/00
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F28F 25/00

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

Definition statement

This place covers:

Arrangements for distributing, circulation or accumulating liquid

Distributing or accumulator troughs

Spray nozzles

Splashing boards or grids, e.g. for converting liquid sprays into liquid films; Elements or beds for increasing the area of the contact surface, e.g. in the form of spaced elongated bars, laths, horizontal grids, vertical or inclined sheets

Gas or vapour feeding

Ducts; Guide vanes

References

Limiting references

This place does not cover:

Packing elements for chemical reactors	B01J 19/30 , B01J 19/32
Packings; Fillings; Grids in apparatus for biological treatment of water	C02F 3/10

Informative references

Attention is drawn to the following places, which may be of interest for search:

Spraying or atomising in general	B05D
Water treatment	C02F

F28F 27/00

Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general [G05](#))

Definition statement

This place covers:

Controlling, monitoring heat exchangers, e.g. temperature control, pressure control, flow control, heat transfer control; Safety means.

The feature "controlling" means influencing a variable in any way e.g. changing its value, maintaining it constant, limiting its range of variation; "regulating" means maintaining a variable automatically at a desired value or within a desired range of values. The desired value may be fixed, manually varied or may vary with time according to a predetermined "programme". Regulation is a form of control.

Controlling the distribution of heat exchange media between different channels, e.g. flow control means in heat exchangers, e.g. valves

References

Limiting references

This place does not cover:

Static flow control means for distributing a heat exchange medium into conduits	F28F 9/02
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Informative references

Attention is drawn to the following places, which may be of interest for search:

Thermostatic control in engine cooling systems	F01P 7/16
Valves	F16K
Control or safety means in heating systems	F24D 19/10
Control or safety systems or apparatus for air conditioning	F24F 11/00
Control or safety means in fluid heaters	F24H 9/20

Arrangements or mounting of control or safety devices in refrigeration systems	F25B 49/00
Measuring the volume flow or mass flow	G01F 1/00
Measuring quantity of heat; testing heat pipes	G01K 17/00
Measuring quantity of heat conveyed by flowing media	G01K 17/06
Thermal testing	G01M19/00
Investigating thermal conductivity	G01N 25/18
Control of flow	G05D 7/00
Ratio control	G05D 11/00
Control of fluid pressure	G05D 16/00
Control of temperature	G05D 23/00
Control of temperature by using electric means	G05D 23/19
Simultaneous control of variables	G05D 27/00
Digital computing or data processing equipment or methods	G06F 17/00
Computer-aided design, simulations	G06F 17/50