

ECLA**EUROPEAN CLASSIFICATION****F28D**

HEAT-EXCHANGE APPARATUS, NOT PROVIDED FOR IN ANOTHER SUBCLASS, IN WHICH THE HEAT-EXCHANGE MEDIA DO NOT COME INTO DIRECT CONTACT (fluid heaters having heat generating means and heat transferring means F24H; furnaces F27; details of heat-exchange apparatus of general)

F28D1/00

Heat-exchange apparatus having stationary conduit assemblies for one heat-exchange medium only, the media being in contact with different sides of the conduit wall, in which the other heat-exchange medium is a large body of fluid, e.g. domestic or motor car radiators ([F28D5/00](#) takes precedence)

F28D1/02

- . with heat-exchange conduits immersed in the body of fluid

F28D1/02A

- . . [N: Heat exchangers immersed in a large body of liquid (apparatus using liquid heat storage material F28D20/00C)] [[N1204](#)]

F28D1/02A4

- . . . [N: for heating or cooling a liquid in a tank] [[N1204](#)]

F28D1/02A6

- . . . [N: for immersion in a natural body of water, e.g. marine radiators] [[N1204](#)]

F28D1/02B

- . . [[N: with an intermediate heat-transfer medium, e.g. thermosiphon radiators](#)] [[N0105](#)]

F28D1/02C

- . . [N: with air flow channels]

F28D1/02C2

- . . . [N: with an air driving element]

F28D1/02E

- . . [[N: heat-exchange elements having several adjacent conduits forming a whole, e.g. blocks](#)]

F28D1/03

- . . with plate-like or laminated conduits [N: (stacked plates having one or more openings therein to form tubular heat-exchange passages F28F3/08C)] [[N1204](#)]

F28D1/03F

- . . . [[N: the conduits being formed by paired plates touching each other](#)] ([F28D1/03H](#) takes precedence)

F28D1/03F2

- [[N: Assemblies of conduits in parallel](#)] ([F28D1/03F4](#), [F28D1/03F6](#) take precedence) [[C9604](#)]

F28D1/03F4

- [[N: the plates having lateral openings therein for circulation of the heat-exchange medium from one conduit to another](#)]

F28D1/03F4B

- [[N: the plates having integrated connecting members](#)]

F28D1/03F4B2

- [[N: with U-flow or serpentine-flow inside the conduits](#)] [[N9604](#)]

F28D1/03F6

- [[N: with U-flow or serpentine-flow inside the conduits](#)] ([F28D1/03F4B2](#) takes precedence) [[N9604](#)]

F28D1/03H

- . . . [[N: the conduits being formed by bent plates](#)] [[C9604](#)]

F28D1/03K

- . . . [[N: the conduits being formed by spaced plates with inserted elements](#)] ([F28D1/03H](#) takes precedence)

F28D1/03K4

- [[N: the plates having lateral openings therein for circulation of the heat-exchange medium from one conduit to another](#)]

F28D1/03K6

- [[N: with U-flow or serpentine-flow inside the conduits](#)] [[N9604](#)]

F28D1/03L

- . . . [[N: a single plate being bent to form one or more conduits](#)]

F28D1/04

- . . with tubular conduits [N: ([F28D1/02E](#) takes precedence)]

F28D1/04E	. . .	[N: Multi-circuit heat exchangers, e.g. integrating different heat exchange sections in the same unit or heat exchangers for more than two fluids (F28F9/02E takes precedence)] [C0904]
F28D1/04E2	. . . .	[N: with particular circuits for the same heat exchange medium, e.g. with the heat exchange medium flowing through sections having different heat exchange capacities or for heating/cooling the heat exchange medium at different temperatures] [N0904]
F28D1/04E4	. . . .	[N: with units having particular arrangement relative to the large body of fluid, e.g. with interleaved units or with adjacent heat exchange units in common air flow or with units extending at an angle to each other or with units arranged around a central element] [N0904]
F28D1/04E4C	. . . . .	[N: Combination of units extending one behind the other (F28D1/04E4E takes precedence)] [C0904]
F28D1/04E4D	. . . . .	[N: Combination of units extending one beside or one above the other (F28D1/04E4E takes precedence)] [C0904]
F28D1/04E4E	. . . . .	[N: Combination of units extending one behind the other with units extending one beside or one above the other] [N0904]
F28D1/04E6	. . . .	[N: Combination of different types of heat exchanger, e.g. radiator combined with tube-and-shell heat exchanger; Arrangement of conduits for heat exchange between at least two media and for heat exchange between at least one medium and the large body of fluid] [N0904]
F28D1/047	. . .	the conduits being bent, e.g. in a serpentine or zig-zag
F28D1/047B	. . . .	[N: the conduits having a non-circular cross-section (F28D1/047D2 , F28D1/047E2 , F28D1/047F2 take precedence)] [N0305]
F28D1/047D	. . . .	[N: the conduits being helically or spirally coiled]
F28D1/047D2	. . . . .	[N: the conduits having a non-circular cross-section] [N0305]
F28D1/047E	. . . .	[N: the conduits having a single U-bend]
F28D1/047E2	. . . . .	[N: the conduits having a non-circular cross-section] [N0305]
F28D1/047F	. . . .	[N: the conduits being bent in a serpentine or zig-zag]
F28D1/047F2	. . . . .	[N: the conduits having a non-circular cross-section] [N0305]
F28D1/053	. . .	the conduits being straight
F28D1/053B	. . . .	[N: Assemblies of conduits connected side by side or with individual headers, e.g. section type radiators (F28D1/053E4 takes precedence)] [N1204]
F28D1/053C	. . . .	[N: Assemblies of conduits connected to common headers, e.g. core type radiators (F28D1/053E6 takes precedence)] [N0509]
F28D1/053C4	. . . . .	[N: with particular pattern of flow, e.g. change of flow direction (F28D1/053C8 takes precedence)] [N0509]
F28D1/053C6	. . . . .	[N: with multiple rows of conduits or with multi-channel conduits (F28D1/053C8 takes precedence)] [N0509]
F28D1/053C8	. . . . .	[N: with multiple rows of conduits or with multi-channel conduits combined with a particular flow pattern, e.g. multi-row multi-stage radiators] [N1204]
F28D1/053E	. . . .	[N: the conduits having a non-circular cross-section] [C0509]
F28D1/053E4	. . . . .	[N: Assemblies of conduits connected side by side or with individual headers, e.g. section type radiators] [N0509]
F28D1/053E6	. . . . .	[N: Assemblies of conduits connected to common headers, e.g. core type radiators] [N0509]
F28D1/053E6B	. . . . .	[N: with particular pattern of flow, e.g. change of flow direction (F28D1/053E6D takes precedence)] [N0509]

- F28D1/053E6C [N: with multiple rows of conduits or with multi-channel conduits (F28D1/053E6D takes precedence)] [N0509]
- F28D1/053E6D [N: with multiple rows of conduits or with multi-channel conduits combined with a particular flow pattern, e.g. multi-row multi-stage radiators] [N1204]
- F28D1/06 . with the heat-exchange conduits forming part of, or being attached to, the tank containing the body of fluid
- F28D3/00** **Heat-exchange apparatus having stationary conduit assemblies for one heat-exchange medium only, the media being in contact with different sides of the conduit wall, in which the other heat-exchange medium flows in a continuous film, or trickles freely, over the conduits (F28D5/00 takes precedence)**
- F28D3/02 . with tubular conduits
- F28D3/04 . Distributing arrangements
- F28D5/00** **Heat-exchange apparatus having stationary conduit assemblies for one heat-exchange medium only, the media being in contact with different sides of the conduit wall, using the cooling effect of natural or forced evaporation**
- F28D5/02 . in which the evaporating medium flows in a continuous film or trickles freely over the conduits
- F28D7/00** **Heat-exchange apparatus having stationary tubular conduit assemblies for both heat-exchange media, the media being in contact with different sides of a conduit wall**
- F28D7/00B . [N: the conduits for one medium being in heat conductive contact with the conduits for the other medium] [N1204]
- F28D7/00B2 . . [N: the conduits for one medium or the conduits for both media being bent (F28D7/00B4B takes precedence)] [N0509]
- F28D7/00B4 . . [N: the conduits for one medium or the conduits for both media being flat tubes or arrays of tubes] [N0509]
- F28D7/00B4B . . . [N: the conduits for one medium or the conduits for both media being bent] [N0509]
- F28D7/00D . [N: the conduits for only one medium being tubes having parts touching each other or tubes assembled in panel form (F28D7/00B, F28D7/00H take precedence)] [N0009]
- F28D7/00F . [N: the conduits for only one medium being tubes having bent portions or being assembled from bent tubes or being tubes having a toroidal configuration (F28D7/00B, F28D7/02, F28D7/04, F28D7/06, F28D7/14 take precedence)] [N0009]
- F28D7/00H . [N: the conduits for only one medium being tubes having different orientations to each other or crossing the conduit for the other heat exchange medium (F28D7/00B takes precedence)] [N0009]
- F28D7/00K . [N: Multi-circuit heat-exchangers, e.g. integrating different heat exchange sections in the same unit or heat-exchangers for more than two fluids (F28D7/10E takes precedence)] [N0009]

- F28D7/00K2
 - [N: with particular circuits for the same heat exchange medium, e.g. with the same heat exchange medium flowing through sections having different heat exchange capacities or for heating or cooling the same heat exchange medium at different temperatures] [N1204]
- F28D7/00K4
 - [N: with units having particular arrangement relative to a supplementary heat exchange medium, e.g. with interleaved units or with adjacent units arranged in common flow of supplementary heat exchange medium] [N1204]
- F28D7/00K4C
 - [N: the supplementary medium flowing in serie through the units] [N1204]
- F28D7/02
 - the conduits being helically coiled ([F28D7/10](#) takes precedence) [N: [F28D7/00B2](#) and [F28D7/00B4B](#) take precedence] [C0509]
- F28D7/02C
 - [N: the conduits of two or more media in heat-exchange relationship being helically coiled, the coils having a cylindrical configuration]
- F28D7/02D
 - [N: the conduits of only one medium being helically coiled tubes, the coils having a cylindrical configuration]
- F28D7/02E
 - [N: the conduits of only one medium being helically coiled and formed by bent members, e.g. plates, the coils having a cylindrical configuration]
- F28D7/02F
 - [N: the conduits of at least one medium being helically coiled, the coils having a conical configuration]
- F28D7/04
 - the conduits being spirally coiled ([F28D7/10](#) takes precedence) [N: ([F28D7/00B2](#) and [F28D7/00B4B](#) take precedence)] [C0509]
- F28D7/06
 - the conduits having a single U-bend ([F28D7/10](#) takes precedence) [N: ([F28D7/00B2](#) and [F28D7/00B4B](#) take precedence)] [C0509]
- F28D7/08
 - the conduits being otherwise bent, e.g. in a serpentine or zig-zag ([F28D7/10](#) takes precedence) [N: ([F28D7/00B2](#) and [F28D7/00B4B](#) take precedence)] [C0509]
- F28D7/08B
 - [N: with serpentine or zig-zag configuration] [N1204]
- F28D7/08B2
 - [N: in the form of parallel conduits coupled by bent portions] [N1204]
- F28D7/08B2A
 - [N: assembled in arrays, each array being arranged in the same plane] [N1204]
- F28D7/10
 - the conduits being arranged one within the other, e.g. concentrically [N: (multiple wall tubes for leak detection [F28F1/00B](#))] [C0509]
- F28D7/10E
 - [N: consisting of more than two coaxial conduits or modules of more than two coaxial conduits] [C0509]
- F28D7/10F
 - [N: consisting of two coaxial conduits or modules of two coaxial conduits] [C0509]
- F28D7/12
 - the surrounding tube being closed at one end, e.g. return type ([F28D7/14](#) takes precedence) [C0509]
- F28D7/14
 - both tubes being bent [C0509]
- F28D7/16
 - the conduits being arranged in parallel spaced relation ([N: F28D7/00B to F28D7/00H take precedence]; F28D7/02 - F28D7/10 take precedence) [N1204]
- F28D7/16C
 - [N: with particular pattern of flow of the heat exchange media, e.g. change of flow direction ([F28D7/16D2](#), [F28D7/16F2](#), [F28D7/16F4B](#), [F28D7/16F6B](#), [F28D7/16H2](#) take precedence)] [N0310]
- F28D7/16D
 - [N: the conduits being inside a casing and extending at an angle to the longitudinal axis of the casing; the conduits crossing the conduit for the other heat exchange medium] [N0310]
- F28D7/16D2
 - [N: with particular pattern of flow of the heat exchange media, e.g. change of

	flow direction] [N0310]
F28D7/16F	<ul style="list-style-type: none"> [N: with conduit assemblies having a particular shape, e.g. square or annular; with assemblies of conduits having different geometrical features; with multiple groups of conduits connected in serie or parallel and arranged inside common casing (F28D7/16D takes precedence)] [N0310]
F28D7/16F2	<ul style="list-style-type: none"> [N: with particular pattern of flow or the heat exchange medium flowing inside the conduits assemblies, e.g. change of flow direction from one conduit assembly to another one (F28D7/16F4B, F28D7/16F6B take precedence)] [N0310]
F28D7/16F2B	<ul style="list-style-type: none"> [N: with particular pattern of flow of the heat exchange medium flowing outside the conduit assemblies, e.g. change of flow direction] [N0310]
F28D7/16F4	<ul style="list-style-type: none"> [N: the conduit assemblies having a square or rectangular shape] [N0310]
F28D7/16F4B	<ul style="list-style-type: none"> [N: with particular pattern of flow of the heat exchange media, e.g. change of flow direction] [N0310]
F28D7/16F6	<ul style="list-style-type: none"> [N: the conduit assemblies having an annular shape; the conduits being assembled around a central distribution tube] [N0310]
F28D7/16F6B	<ul style="list-style-type: none"> [N: with particular pattern of flow of the heat exchange media, e.g. change of flow direction] [N0310]
F28D7/16H	<ul style="list-style-type: none"> [N: the conduits having a non-circular cross-section] [N0310]
F28D7/16H2	<ul style="list-style-type: none"> [N: with particular pattern of flow of the heat exchange media, e.g. change of flow direction] [N0310]
F28D9/00	Heat-exchange apparatus having stationary plate-like or laminated conduit assemblies for both heat-exchange media, the media being in contact with different sides of a conduit wall [N: F28F3/08B , F28F3/08C take precedence]
F28D9/00B	<ul style="list-style-type: none"> [N: the plate-like or laminated conduits being enclosed within a pressure vessel]
F28D9/00D	<ul style="list-style-type: none"> [N: the apparatus having an annular form]
F28D9/00D2	<ul style="list-style-type: none"> [N: without any annular circulation of the heat exchange media]
F28D9/00E	<ul style="list-style-type: none"> [N: the conduits being formed by zig-zag bend plates]
F28D9/00F	<ul style="list-style-type: none"> [N: the conduits for one heat-exchange medium being formed by paired plates touching each other (F28D9/00D, F28D9/00E, F28D9/00L, F28D9/04 take precedence)]
F28D9/00F2	<ul style="list-style-type: none"> [N: the conduits for the other heat-exchange medium also being formed by paired plates touching each other (F28D9/00F4 takes precedence)]
F28D9/00F4	<ul style="list-style-type: none"> [N: the plates having openings therein for circulation of at least one heat-exchange medium from one conduit to another] [C0009]
F28D9/00F4B	<ul style="list-style-type: none"> [N: the plates having openings therein for both heat-exchange media] [N0009]
F28D9/00F4R	<ul style="list-style-type: none"> [N: with U-flow or serpentine-flow inside conduits; with centrally arranged openings on the plates] [N1204]
F28D9/00K	<ul style="list-style-type: none"> [N: the conduits for one heat-exchange medium being formed by spaced plates with inserted elements (F28D9/00D, F28D9/00E, F28D9/00L, F28D9/04 take precedence)]
F28D9/00K2	<ul style="list-style-type: none"> [N: with means for changing flow direction of one heat exchange medium, e.g. using deflecting zones] [N9910]
F28D9/00K4	<ul style="list-style-type: none"> [N: the plates having openings therein for circulation of the heat-exchange medium from one conduit to another]

- F28D9/00L . [N: the conduits for one heat-exchange medium being formed by a single plate-like element ([F28D9/00D](#) takes precedence); the conduits for one heat-exchange medium being integrated in one single plate-like element ([F28D9/00D](#) takes precedence)]
- F28D9/00M . [N: with flexible plates]
- F28D9/00P . [N: Multi-circuit heat-exchangers, e.g. integrating different heat exchange sections in the same unit or heat-exchangers for more than two fluids] [C0009]
- F28D9/02 . the heat-exchange media travelling at an angle to one another ([F28D9/04](#) takes precedence) [N: not used, see [F28D9/00](#) and other subgroups]
- F28D9/04 . the conduits being formed by spirally-wound plates or laminae [C0811]
- F28D11/00** **Heat-exchange apparatus employing moving conduits** [N: ([F28D15/02A](#) takes precedence)]
- F28D11/02 . the movement being rotary, e.g. performed by a drum or roller ([F28D11/08](#) takes precedence)
- F28D11/02B . . [N: Motor car radiators]
- F28D11/04 . . performed by a tube or a bundle of tubes
- F28D11/06 . the movement being reciprocating or oscillating ([F28D11/08](#) takes precedence)
- F28D11/08 . more than one conduit assembly performing independent movements, e.g. rotary bundle of tubes in a rotary drum
- F28D13/00** **Heat-exchange apparatus using a fluidised bed**
- Guide heading:** **Heat-exchange apparatus employing intermediate heat-transfer media or bodies**
- F28D15/00** **Heat-exchange apparatus with the intermediate heat-transfer medium in closed tubes passing into or through the conduit walls;** [N: Heat-exchange apparatus employing intermediate heat-transfer medium or bodies ([F28D17/00](#), [F28D19/00](#), [F28D20/00](#) take precedence)] [C0509]
- F28D15/02 . in which the medium condenses and evaporates, e.g. heat pipes [N: (heat pipes used in solar heat collectors [F24J2/32](#); in radiators [F28D1/02B](#); in nuclear reactors [G21C15/24F](#))] [C0105]
- F28D15/02A . . [N: using moving tubes]
- F28D15/02E . . [N: the conduits having a particular shape, e.g. non-circular cross-section, annular ([F28D15/02F](#), [F28D15/02M](#) take precedence)]
- F28D15/02F . . [N: the tubes being flexible]
- F28D15/02H . . [N: having non-capillary condensate return means]
- F28D15/02L . . [N: with means to remove contaminants, e.g. getters]
- F28D15/02M . . [N: with separate evaporating and condensing chambers connected by at least one conduit; Loop-type heat pipes; with multiple or common evaporating or condensing chambers ([F28D15/04A](#) takes precedence)] [C9906]

- F28D15/02N
 - . . [N: Arrangements for coupling heat-pipes together or with other structures, e.g. with base blocks; Heat pipe cores] [N1204]
- F28D15/02P
 - . . [N: Means for filling or sealing heat pipes]
- F28D15/04
 - . . with tubes having a capillary structure
- F28D15/04A
 - . . . [N: forming loops, e.g. capillary pumped loops] [N9906]
- F28D15/04B
 - . . . [N: characterised by the material or the construction of the capillary structure]
- F28D15/06
 - . . Control arrangements therefor

- F28D17/00**
Regenerative heat-exchange apparatus in which a stationary intermediate heat-transfer medium or body is contacted successively by each heat-exchange medium, e.g. using granular particles
- F28D17/00B
 - . [N: using granular particles]
- F28D17/02
 - . using rigid bodies, e.g. of porous material
- F28D17/02B
 - . . [N: Sealing means]
- F28D17/02C
 - . . [N: Bearings; Driving means]
- F28D17/04
 - . Distributing arrangements for the heat-exchange media

- F28D19/00**
Regenerative heat-exchange apparatus in which the intermediate heat-transfer medium or body is moved successively into contact with each heat-exchange medium [N: [F28D15/02](#) takes precedence]
- F28D19/02
 - . using granular particles
- F28D19/04
 - . using rigid bodies, e.g. mounted on a movable carrier
- F28D19/04B
 - . . [N: with axial flow through the intermediate heat-transfer medium]
- F28D19/04B2
 - . . . [N: Rotors; Assemblies of heat absorbing masses] [N9707]
- F28D19/04B2B
 - [N: shaped in sector form, e.g. with baskets] [N9707]
- F28D19/04C
 - . . [N: with radial flow through the intermediate heat-transfer medium]
- F28D19/04D
 - . . [N: Sealing means]
- F28D19/04F
 - . . [N: Bearings; Driving means]

- F28D20/00**
Heat storage plants or apparatus in general (specially adapted for particular applications, see the relevant places, e.g. [F24D15/02](#)); Regenerative heat-exchange apparatus not covered by groups [F28D17/00](#) or [F28D19/00](#)
- F28D20/00B
 - . [N: using thermochemical reactions]
- F28D20/00C
 - . [N: using liquid heat storage material] [C9908]
- F28D20/00C2
 - . . [N: with stratification of the heat storage material] [N9803]
- F28D20/00C4
 - . . [N: specially adapted for long-term heat storage; Underground tanks; Floating reservoirs; Pools; Ponds ([F28D20/00D](#) takes precedence)] [N9908]
- F28D20/00D
 - . [N: using the ground body or aquifers as heat storage medium] [C9908]
- F28D20/00E
 - . [N: using solid heat storage material ([F28D20/00D](#) takes precedence)] [N9803]

- F28D20/02 . using latent heat
- F28D20/02A . . [N: the latent heat storage material and the heat-exchanging means being enclosed in one container ([F28D20/02B](#) to [F28D20/02F](#) take precedence)]
- F28D20/02B . . [N: the latent heat storage material being enclosed in granular particles or dispersed in a porous, fibrous or cellular structure]
- F28D20/02D . . [N: the latent heat storage material being in direct contact with a heat-exchange medium or with another heat storage material ([F28D20/00B](#) takes precedence)]
- F28D20/02E . . [N: with different heat storage materials not coming into direct contact]
- F28D20/02F . . [N: Control arrangements therefor] [M1207]

- F28D21/00** **Heat-exchange apparatus not covered by any of the groups F28D1/00 to F28D20/00**
[N: Note: Particular use of heat exchangers is classified in F28D21/00 and subgroups, whereas additionally the type of the heat exchangers is classified in the groups F28D1/00 to F28D20/00] [N1204]

- F28D21/00A . [N: Recuperative heat exchangers] [N1204]

[N: **WARNING**
the groups [F28D21/00A-F28D21/00A8](#) are not complete, pending reorganisation. See also [F28D21/00](#)
]
- F28D21/00A4 . . [N: the heat being recuperated from exhaust gases ([F28D21/00A8](#) takes precedence)] [N1204]
- F28D21/00A4B . . . [N: for domestic or space-heating systems] [N1204]
- F28D21/00A4B4 [N: Water heaters] [N1204]
- F28D21/00A4B6 [N: Air heaters] [N1204]
- F28D21/00A4E . . . [N: for thermal power plants or industrial processes] [N1204]
- F28D21/00A6 . . [N: the heat being recuperated from waste water or from condensates] [N1204]
- F28D21/00A8 . . [N: the heat being recuperated from waste air or from vapors (for air conditioning [F24F12/00B](#))] [N1204]

- F28D21/00D . [N: Heat and mass exchangers, e.g. with permeable walls] [N1204]

- F28D21/00F . [N: Flooded core heat exchangers (in large body of fluid [F28D1/02A](#))] [N1204]