CPC COOPERATIVE PATENT CLASSIFICATION

F MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING
(NOTE omitted)

LIGHTING; HEATING

F28 HEAT EXCHANGE IN GENERAL
(NOTES omitted)

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)

1/00 **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** (F28D 5/00 takes precedence)

1/02 . with heat-exchange conduits immersed in the body of fluid

1/0206 . . {Heat exchangers immersed in a large body of liquid (apparatus using liquid heat storage material F28D 20/0034)}

1/0213 . . . {for heating or cooling a liquid in a tank}

1/022 . . . {for immersion in a natural body of water, e.g. marine radiators}

1/0226 . . {with an intermediate heat-transfer medium, e.g. thermosiphon radiators}

1/0233 . . {with air flow channels}

1/024 . . . {with an air driving element}

1/0246 . . {heat-exchange elements having several adjacent conduits forming a whole, e.g. blocks}

2001/0253 . . {Particular components}

2001/026 . . . {Cores}

2001/0266 . . . . {Particular core assemblies, e.g. having different orientations or having different geometric features}

2001/0273 . . . . {having special shape, e.g. curved, annular}

2001/028 . . . . {with empty spaces or with additional elements integrated into the cores}

2001/0286 . . . {Radiating plates; Decorative panels}

2001/0293 . . . . {with grooves for integration of conduits}

1/03 . . with plate-like or laminated conduits {(stacked plates having one or more openings therein to form tubular heat-exchange passages F28F 3/086)}

1/0308 . . . {the conduits being formed by paired plates touching each other (F28D 1/0358 takes precedence)}

1/0316 . . . . {Assemblies of conduits in parallel (F28D 1/0325, F28D 1/035 take precedence)}

1/0325 . . . . {the plates having lateral openings therein for circulation of the heat-exchange medium from one conduit to another}

1/0333 . . . . . {the plates having integrated connecting members}

1/0341 . . . . . {with U-flow or serpentine-flow inside the conduits}

1/035 . . . . {with U-flow or serpentine-flow inside the conduits (F28D 1/0341 takes precedence)}

1/0358 . . . {the conduits being formed by bent plates}

1/0366 . . . {the conduits being formed by spaced plates with inserted elements (F28D 1/0358 takes precedence)}

1/0375 . . . . {the plates having lateral openings therein for circulation of the heat-exchange medium from one conduit to another}

1/0383 . . . . {with U-flow or serpentine-flow inside the conduits}

1/0391 . . . {a single plate being bent to form one or more conduits}

1/04 . . with tubular conduits {(F28D 1/0246 takes precedence)}

1/0408 . . . {Multi-circuit heat exchangers, e.g. integrating different heat exchange sections in the same unit or heat exchangers for more than two fluids (F28F 9/0234 takes precedence)}

1/0417 . . . . {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}

1/0426 . . . . {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}

1/0435 . . . . . {Combination of units extending one behind the other (F28D 1/0452 takes precedence)}

1/0443 . . . . . {Combination of units extending one beside or one above the other (F28D 1/0452 takes precedence)}

1/0452 . . . . . {Combination of units extending one behind the other with units extending one beside or one above the other}

1/0461 . . . . {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}
1/047 . . . the conduits being bent, e.g. in a serpentine or zig-zag
1/0471 . . . . {the conduits having a non-circular cross-section (F28D 1/0473, F28D 1/0476, F28D 1/0478 take precedence)}
1/0472 . . . . {the conduits being helically or spirally coiled}
1/0473 . . . . . {the conduits having a non-circular cross-section}
1/0475 . . . . {the conduits having a single U-bend}
1/0476 . . . . . {the conduits having a non-circular cross-section}
1/0477 . . . . {the conduits being bent in a serpentine or zig-zag}
1/0478 . . . . . {the conduits having a non-circular cross-section}
1/053 . . . the conduits being straight
1/05308 . . . . {Assemblies of conduits connected side by side or with individual headers, e.g. section type radiators (F28D 1/05358 takes precedence)}
1/05316 . . . . {Assemblies of conduits connected to common headers, e.g. core type radiators (F28D 1/05366 takes precedence)}
1/05325 . . . . . {with particular pattern of flow, e.g. change of flow direction (F28D 1/05341 takes precedence)}
1/05333 . . . . . {with multiple rows of conduits or with multi-channel conduits (F28D 1/05341 takes precedence)}
1/05341 . . . . . {with multiple rows of conduits or with multi-channel conduits combined with a particular flow pattern, e.g. multi-row multi-stage radiators}
1/0535 . . . . {the conduits having a non-circular cross-section}
1/05358 . . . . . {Assemblies of conduits connected side by side or with individual headers, e.g. section type radiators}
1/05366 . . . . . {Assemblies of conduits connected to common headers, e.g. core type radiators}
1/05375 . . . . . {with particular pattern of flow, e.g. change of flow direction (F28D 1/05391 takes precedence)}
1/05383 . . . . . {with multiple rows of conduits or with multi-channel conduits (F28D 1/05391 takes precedence)}
1/05391 . . . . . {with multiple rows of conduits or with multi-channel conduits combined with a particular flow pattern, e.g. multi-row multi-stage radiators}
1/06 . with the heat-exchange conduits forming part of, or being attached to, the tank containing the body of fluid

3/00 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 (F28D 5/00 takes precedence)
3/02 . with tubular conduits
3/04 . Distributing arrangements

5/00 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
5/02 . in which the evaporating medium flows in a continuous film or trickles freely over the conduits

7/00 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
7/0008 . {the conduits for one medium being in heat conductive contact with the conduits for the other medium}
7/0016 . . {the conduits for one medium or the conduits for both media being bent (F28D 7/0033 takes precedence)}
7/0025 . . {the conduits for one medium or the conduits for both media being flat tubes or arrays of tubes}
7/0033 . . . {the conduits for one medium or the conduits for both media being bent}
7/0041 . {the conduits for only one medium being tubes having parts touching each other or tubes assembled in panel form (F28D 7/0008, F28D 7/0058 take precedence)}
7/005 . {the conduits for only one medium being tubes having bent portions or being assembled from bent tubes or being tubes having a toroidal configuration (F28D 7/0008, F28D 7/02, F28D 7/04, F28D 7/06, F28D 7/14 take precedence)}
7/0058 . {the conduits for only one medium being tubes having different orientations to each other or crossing the conduit for the other heat exchange medium (F28D 7/0008 takes precedence)}
7/0066 . {Multi-circuit heat-exchangers, e.g. integrating different heat exchange sections in the same unit or heat-exchangers for more than two fluids (F28D 7/103 takes precedence)}
7/0075 . . {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}
7/0083 . . {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}
7/0091 . . . {the supplementary medium flowing in series through the units}
7/02 . the conduits being helically coiled (F28D 7/10 takes precedence {F28D 7/0016 and F28D 7/0033 take precedence})

7/022 . . {the conduits of two or more media in heat-exchange relationship being helically coiled, the coils having a cylindrical configuration}
7/024 . . {the conduits of only one medium being helically coiled tubes, the coils having a cylindrical configuration}
7/026 . . {the conduits of only one medium being helically coiled and formed by bent members, e.g. plates, the coils having a cylindrical configuration}
7/028 . . {the conduits of at least one medium being helically coiled, the coils having a conical configuration}
7/04 . the conduits being spirally coiled (F28D 7/10 takes precedence) { (F28D 7/0016 and F28D 7/0033 take precedence)}
7/06 . the conduits having a single U-bend (F28D 7/10 takes precedence) { (F28D 7/0016 and F28D 7/0033 take precedence)}
7/08 . the conduits being otherwise bent, e.g. in a serpentine or zig-zag (F28D 7/10 takes precedence) { (F28D 7/0016 and F28D 7/0033 take precedence)}
7/082 . . {with serpentine or zig-zag configuration}
7/085 . . . {in the form of parallel conduits coupled by bent portions}
7/087 . . . . {assembled in arrays, each array being arranged in the same plane}
7/10 . the conduits being arranged one within the other, e.g. concentrically {(multiple wall tubes for leak detection F28F 1/003)}
7/103 . . {consisting of more than two coaxial conduits or modules of more than two coaxial conduits}
7/106 . . {consisting of two coaxial conduits or modules of two coaxial conduits}
7/12 . . the surrounding tube being closed at one end, e.g. return type (F28D 7/14 takes precedence)
7/14 . . both tubes being bent
7/16 . the conduits being arranged in parallel spaced relation ({F28D 7/0008 - F28D 7/0058 take precedence}; F28D 7/02 - F28D 7/10 take precedence)
7/1607 . . {with particular pattern of flow of the heat exchange media, e.g. change of flow direction (F28D 7/1623, F28D 7/1638, F28D 7/1661, F28D 7/1676, F28D 7/1692 take precedence)}
7/1615 . . {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}
7/1623 . . . {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
7/163 . . {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 series or parallel and arranged inside common casing (F28D 7/1615 takes precedence)}
7/1638 . . . {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 (F28D 7/1661, F28D 7/1676 take precedence)}
7/1646 . . . . {with particular pattern of flow of the heat exchange medium flowing outside the conduit assemblies, e.g. change of flow direction}
7/1653 . . . {the conduit assemblies having a square or rectangular shape}
7/1661 . . . . {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
7/1669 . . . {the conduit assemblies having an annular shape; the conduits being assembled around a central distribution tube}
7/1676 . . . . {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
7/1684 . . {the conduits having a non-circular cross-section}
7/1692 . . . {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}

9/00 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 {(F28F 3/083, F28F 3/086 take precedence)}

9/0006 . {the plate-like or laminated conduits being enclosed within a pressure vessel}
9/0012 . {the apparatus having an annular form}
9/0018 . . {without any annular circulation of the heat exchange media}
9/0025 . {the conduits being formed by zig-zag bend plates}
9/0031 . {the conduits for one heat-exchange medium being formed by paired plates touching each other (F28D 9/0012, F28D 9/0025, F28D 9/0081, F28D 9/04 take precedence)}
9/0037 . . {the conduits for the other heat-exchange medium also being formed by paired plates touching each other (F28D 9/0043 takes precedence)}
9/0043 . . {the plates having openings therein for circulation of at least one heat-exchange medium from one conduit to another}
9/005 . . . {the plates having openings therein for both heat-exchange media}
9/0056 . . . {with U-flow or serpentine-flow inside conduits; with centrally arranged openings on the plates}
9/0062 . {the conduits for one heat-exchange medium being formed by spaced plates with inserted elements (F28D 9/0012, F28D 9/0025, F28D 9/0081, F28D 9/04 take precedence)}
9/0068 . . {with means for changing flow direction of one heat exchange medium, e.g. using deflecting zones}
9/0075 . . {the plates having openings therein for circulation of the heat-exchange medium from one conduit to another}
9/0081 . {the conduits for one heat-exchange medium being formed by a single plate-like element (F28D 9/0012 takes precedence); the conduits for one heat-exchange medium being integrated in one single plate-like element (F28D 9/0012 takes precedence)}
9/0087 . {with flexible plates}
9/0093 . {Multi-circuit heat-exchangers, e.g. integrating different heat exchange sections in the same unit or heat-exchangers for more than two fluids}
9/02 . the heat-exchange media travelling at an angle to one another (F28D 9/04 takes precedence {not used, see F28D 9/00 and other subgroups})
9/04 . the conduits being formed by spirally-wound plates or laminae

11/00 **Heat-exchange apparatus employing moving conduits {(F28D 15/0208 takes precedence)}**

11/02 . the movement being rotary, e.g. performed by a drum or roller (F28D 11/08 takes precedence)

11/025 . . {Motor car radiators}

11/04 . . performed by a tube or a bundle of tubes

11/06 . the movement being reciprocating or oscillating (F28D 11/08 takes precedence)

11/08 . more than one conduit assembly performing independent movements, e.g. rotary bundle of tubes in a rotary drum

13/00 **Heat-exchange apparatus using a fluidised bed**

Heat-exchange apparatus employing intermediate heat-transfer media or bodies

15/00 **Heat-exchange apparatus with the intermediate heat-transfer medium in closed tubes passing into or through the conduit walls {; Heat-exchange apparatus employing intermediate heat-transfer medium or bodies (F28D 17/00, F28D 19/00, F28D 20/00 take precedence)}**

15/02 . in which the medium condenses and evaporates, e.g. heat pipes {(heat pipes used in solar heat collectors F24J 2/32; in radiators F28D 1/0226; in nuclear reactors G21C 15/257)}

15/0208 . . {using moving tubes}

2015/0216 . . {having particular orientation, e.g. slanted, or being orientation-independent}

2015/0225 . . {Microheat pipes}

15/0233 . . {the conduits having a particular shape, e.g. non-circular cross-section, annular (F28D 15/0241, F28D 15/0266 take precedence)}

15/0241 . . {the tubes being flexible}

15/025 . . {having non-capillary condensate return means}

15/0258 . . {with means to remove contaminants, e.g. getters}

15/0266 . . {with separate evaporating and condensing chambers connected by at least one conduit; Loop-type heat pipes; with multiple or common evaporating or condensing chambers (F28D 15/043 takes precedence)}

15/0275 . . {Arrangements for coupling heat-pipes together or with other structures, e.g. with base blocks; Heat pipe cores}

15/0283 . . {Means for filling or sealing heat pipes}

2015/0291 . . {comprising internal rotor means, e.g. turbine driven by the working fluid}

15/04 . . with tubes having a capillary structure

15/043 . . . {forming loops, e.g. capillary pumped loops}

15/046 . . . {characterised by the material or the construction of the capillary structure}

15/06 . . Control arrangements therefor

17/00 **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**

17/005 . {using granular particles}

17/02 . using rigid bodies, e.g. of porous material

17/023 . . {Sealing means}

17/026 . . {Bearings; Driving means}

17/04 . Distributing arrangements for the heat-exchange media

19/00 **Regenerative heat-exchange apparatus in which the intermediate heat-transfer medium or body is moved successively into contact with each heat-exchange medium {(F28D 15/02 takes precedence)}**

19/02 . using granular particles

19/04 . using rigid bodies, e.g. mounted on a movable carrier

19/041 . . {with axial flow through the intermediate heat-transfer medium}

19/042 . . . {Rotors; Assemblies of heat absorbing masses}

19/044 . . . . {shaped in sector form, e.g. with baskets}

19/045 . . {with radial flow through the intermediate heat-transfer medium}

19/047 . . {Sealing means}

19/048 . . {Bearings; Driving means}

20/00 **Heat storage plants or apparatus in general (specially adapted for particular applications, see the relevant places, e.g. F24D 15/02); Regenerative heat-exchange apparatus not covered by groups F28D 17/00 or F28D 19/00**

2020/0004 . {Particular heat storage apparatus}

2020/0008 . . {the heat storage material being enclosed in plate-like or laminated elements, e.g. in plates having internal compartments}

2020/0013 . . {the heat storage material being enclosed in elements attached to or integral with heat exchange conduits}

2020/0017 . . {the heat storage material being enclosed in porous or cellular or fibrous structures (phase-change materials F28D 20/023)}

2020/0021 . . {the heat storage material being enclosed in loose or stacked elements}

2020/0026 . . {the heat storage material being enclosed in mobile containers for transporting thermal energy}

20/003 . {using thermochemical reactions}

20/0034 . {using liquid heat storage material}

20/0039 . . {with stratification of the heat storage material}

20/0043 . . {specially adapted for long-term heat storage; Underground tanks; Floating reservoirs; Pools; Ponds (F28D 20/0052 takes precedence)}

2020/0047 . . {using molten salts or liquid metals}

20/0052 . {using the ground body or aquifers as heat storage medium}

20/0056 . {using solid heat storage material (F28D 20/0052 takes precedence)}

2020/006 . {Heat storage systems not otherwise provided for}

2020/0065 . {Details, e.g. particular heat storage tanks, auxiliary members within tanks}

2020/0069 . . {Distributing arrangements; Fluid deflecting means}

2020/0073 . . . {movable}

2020/0078 . . {Heat exchanger arrangements}

2020/0082 . . {Multiple tanks arrangements, e.g. adjacent tanks, tank in tank}

2020/0086 . . {Partitions}

2020/0091 . . . {flexible}

2020/0095 . . . {movable or floating}

20/02 . using latent heat

20/021 . . {the latent heat storage material and the heat-exchanging means being enclosed in one container (F28D 20/023 - F28D 20/028 take precedence)}

20/023 . . {the latent heat storage material being enclosed in granular particles or dispersed in a porous, fibrous or cellular structure}

20/025 . . {the latent heat storage material being in direct contact with a heat-exchange medium or with another heat storage material (F28D 20/003 takes precedence)}

20/026 . . {with different heat storage materials not coming into direct contact}

20/028 . . {Control arrangements therefor}

21/00 Heat-exchange apparatus not covered by any of the groups F28D 1/00 - F28D 20/00

NOTE

{ Particular use of heat exchangers is classified in F28D 21/00 and subgroups, whereas additionally the type of the heat exchangers is classified in the groups F28D 1/00 - F28D 20/00}

21/0001 . {Recuperative heat exchangers}

21/0003 . . {the heat being recuperated from exhaust gases (F28D 21/0014 takes precedence)}

21/0005 . . . {for domestic or space-heating systems}

21/0007 . . . . {Water heaters}

21/0008 . . . . {Air heaters}

21/001 . . . {for thermal power plants or industrial processes}

21/0012 . . {the heat being recuperated from waste water or from condensates}

21/0014 . . {the heat being recuperated from waste air or from vapors (for air conditioning F24F 12/001)}

21/0015 . {Heat and mass exchangers, e.g. with permeable walls}

21/0017 . {Flooded core heat exchangers (in large body of fluid F28D 1/0206)}

2021/0019 . {Other heat exchangers for particular applications; Heat exchange systems not otherwise provided for}

2021/0021 . . {for aircrafts or cosmonautics (air-treatment for aircraft B64D 13/00, temperature control of cosmonautic vehicles B64G 1/50)}

2021/0022 . . {for chemical reactors}

2021/0024 . . {for combustion apparatus, e.g. for boilers}

2021/0026 . . {for combustion engines, e.g. for gas turbines or for Stirling engines (engine cooling systems F28D 2021/004)}

2021/0028 . . {for cooling heat generating elements, e.g. for cooling electronic components or electric devices (for cooling semiconductors H01L 23/34, for cooling electric apparatus H05K 7/20)}

2021/0029 . . . {Heat sinks}

2021/0031 . . . {Radiators for recooling a coolant of cooling systems}

2021/0033 . . {for cryogenic applications (air separation F25J 3/04, cold heat exchange systems F25J 1/0262)}

2021/0035 . . {for domestic or space heating, e.g. heating radiators (for vehicles F28D 2021/0096)}

2021/0036 . . . {Radiators for drying, e.g. towel radiators}

2021/0038 . . {for drying or dehumidifying gases or vapours (by refrigeration B01D 53/265)}

2021/004 . . {for engine or machine cooling systems (for vehicles F28D 2021/0094; marine radiators F28D 1/022)}

2021/0042 . . {for foodstuffs}

2021/0043 . . {for fuel cells (heat exchange in fuel cell H01M 8/04007)}

2021/0045 . . {for granular materials (fluidised beds F28D 13/00)}

2021/0047 . . {for hydrogen or other compressed gas storage tanks}

2021/0049 . . {for lubricants, e.g. oil coolers (for vehicles F28D 2021/0089)}

2021/005 . . {for medical applications (heating or cooling appliances for medical treatment A61F 7/00)}

2021/0052 . . {for mixers}

2021/0054 . . {for nuclear applications (cooling arrangements for nuclear reactors G21C 15/00)}

2021/0056 . . {for ovens or furnaces (for boilers F28D 2021/0024, arrangements for using waste heat in furnaces F27D 17/00)}

2021/0057 . . . {for melting materials}

2021/0059 . . {for petrochemical plants}

2021/0061 . . {for phase-change applications (for refrigerant cycles F28D 2021/0068; heat pipes F28D 15/02)}

2021/0063 . . . {Condensers (steam or vapour condensers F28B)}

2021/0064 . . . {Vaporizers, e.g. evaporators}

2021/0066 . . . {with combined condensation and evaporation}

2021/0068 . . {for refrigerant cycles}

2021/007 . . . {Condensers (for vehicles F28D 2021/0084; for compression systems F25B 39/04, cold exchangers for separating constituents of gaseous mixtures F25J 3/06)}

2021/0071 . . . {Evaporators (for vehicles F28D 2021/0085, for compression systems F25B 39/02)}

2021/0073 . . . {Gas coolers}

2021/0075 . . {for syngas or cracked gas cooling systems (cooling of cracked gas C10G 9/002)}

2021/0077 . . {for tempering, e.g. with cooling or heating circuits for temperature control of elements}

2021/0078 . . . {in the form of cooling walls}

2021/008 . . {for vehicles (for aircrafts F28D 2021/0021)}

2021/0082 . . . {Charged air coolers (cooling of air intake supply F02B 29/04)}

2021/0084 . . . {Condensers}

2021/0085 . . . {Evaporators}

2021/0087 . . . {Fuel coolers (apparatus for cooling fuel on vehicles F02M 31/20)}

2021/0089 . . . {Oil coolers (heating or cooling lubricants in vehicles F01M 5/00)}

2021/0091 . . . {Radiators}

2021/0092 . . . . {with particular location on vehicle, e.g. under floor or on roof}

2021/0094 . . . . {for recooling the engine coolant (arrangements of liquid-to-air heat exchangers on vehicles F01P 3/18)}

2021/0096 . . . . {for space heating (for air-conditioning in vehicles B60H 1/00321)}

2021/0098 . . {for viscous or semi-liquid materials, e.g. for processing sludge (for foodstuffs F28D 2021/0042)}