

CPC**COOPERATIVE PATENT 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)

F28D 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)

[F28D 1/02](#)

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

[F28D 1/0206](#)

- • {Heat exchangers immersed in a large body of liquid (apparatus using liquid heat storage material [F28D 20/0034](#))}

[F28D 1/0213](#)

- • • {for heating or cooling a liquid in a tank}

[F28D 1/022](#)

- • • {for immersion in a natural body of water, e.g. marine radiators}

[F28D 1/0226](#)

- • {with an intermediate heat-transfer medium, e.g. thermosiphon radiators}

[F28D 1/0233](#)

- • {with air flow channels}

[F28D 1/024](#)

- • • {with an air driving element}

[F28D 1/0246](#)

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

[F28D 2001/0253](#)

- • {Particular components}

[F28D 2001/026](#)

- • • {Cores}

[F28D 2001/0266](#)

- • • • {Particular core assemblies, e.g. having different orientations or having different geometric features}

[F28D 2001/0273](#)

- • • • {having special shape, e.g. curved, annular}

[F28D 2001/028](#)

- • • • {with empty spaces or with additional elements integrated into the cores}

[F28D 2001/0286](#)

- • • {Radiating plates; Decorative panels}

[F28D 2001/0293](#)

- • • • {with grooves for integration of conduits}

[F28D 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](#))}

[F28D 1/0308](#)

- • • {the conduits being formed by paired plates touching each other ([F28D 1/0358](#) takes precedence)}

[F28D 1/0316](#)

- • • • {Assemblies of conduits in parallel ([F28D 1/0325](#), [F28D 1/035](#) take precedence)}

[F28D 1/0325](#)

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

[F28D 1/0333](#)

- • • • • {the plates having integrated connecting members}

[F28D 1/0341](#)

- • • • • {with U-flow or serpentine-flow inside the conduits}

[F28D 1/035](#)

- • • • {with U-flow or serpentine-flow inside the conduits ([F28D 1/0341](#) takes precedence)}

[F28D 1/0358](#)

- • • {the conduits being formed by bent plates}

- F28D 1/0366 . . . {the conduits being formed by spaced plates with inserted elements
([F28D 1/0358 takes precedence](#))}
- F28D 1/0375 {the plates having lateral openings therein for circulation of the heat-
exchange medium from one conduit to another}
- F28D 1/0383 {with U-flow or serpentine-flow inside the conduits}
- F28D 1/0391 . . . {a single plate being bent to form one or more conduits}
- F28D 1/04 . . with tubular conduits ([F28D 1/0246 takes precedence](#))}
- F28D 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](#))}
- F28D 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}
- F28D 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}
- F28D 1/0435 {Combination of units extending one behind the other
([F28D 1/0452 takes precedence](#))}
- F28D 1/0443 {Combination of units extending one beside or one above the other
([F28D 1/0452 takes precedence](#))}
- F28D 1/0452 {Combination of units extending one behind the other with units
extending one beside or one above the other}
- F28D 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}
- F28D 1/047 . . . the conduits being bent, e.g. in a serpentine or zig-zag
- F28D 1/0471 {the conduits having a non-circular cross-section ([F28D 1/0473](#),
[F28D 1/0476](#), [F28D 1/0478 take precedence](#))}
- F28D 1/0472 {the conduits being helically or spirally coiled}
- F28D 1/0473 {the conduits having a non-circular cross-section}
- F28D 1/0475 {the conduits having a single U-bend}
- F28D 1/0476 {the conduits having a non-circular cross-section}
- F28D 1/0477 {the conduits being bent in a serpentine or zig-zag}
- F28D 1/0478 {the conduits having a non-circular cross-section}
- F28D 1/053 . . . the conduits being straight
- F28D 1/05308 {Assemblies of conduits connected side by side or with individual
headers, e.g. section type radiators ([F28D 1/05358 takes
precedence](#))}
- F28D 1/05316 {Assemblies of conduits connected to common headers, e.g. core
type radiators ([F28D 1/05366 takes precedence](#))}
- F28D 1/05325 {with particular pattern of flow, e.g. change of flow direction
([F28D 1/05341 takes precedence](#))}

- F28D 1/05333 {with multiple rows of conduits or with multi-channel conduits
([F28D 1/05341](#) takes precedence)}
- F28D 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}
- F28D 1/0535 {the conduits having a non-circular cross-section}
- F28D 1/05358 {Assemblies of conduits connected side by side or with individual
headers, e.g. section type radiators}
- F28D 1/05366 {Assemblies of conduits connected to common headers, e.g. core
type radiators}
- F28D 1/05375 {with particular pattern of flow, e.g. change of flow direction
([F28D 1/05391](#) takes precedence)}
- F28D 1/05383 {with multiple rows of conduits or with multi-channel conduits
([F28D 1/05391](#) takes precedence)}
- F28D 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}
- F28D 1/06 . with the heat-exchange conduits forming part of, or being attached to, the tank
containing the body of fluid

- F28D 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)
- F28D 3/02 . with tubular conduits
- F28D 3/04 . Distributing arrangements

- F28D 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**
- F28D 5/02 . in which the evaporating medium flows in a continuous film or trickles freely
over the conduits

- F28D 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**
- F28D 7/0008 . {the conduits for one medium being in heat conductive contact with the conduits
for the other medium}
- F28D 7/0016 . . {the conduits for one medium or the conduits for both media being bent
([F28D 7/0033](#) takes precedence)}
- F28D 7/0025 . . {the conduits for one medium or the conduits for both media being flat tubes
or arrays of tubes}
- F28D 7/0033 . . . {the conduits for one medium or the conduits for both media being bent}
- F28D 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)}

- F28D 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)}
- F28D 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)}
- F28D 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)}
- F28D 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}
- F28D 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}
- F28D 7/0091
 - • • {the supplementary medium flowing in serie through the units}
- F28D 7/02
 - the conduits being helically coiled ([F28D 7/10](#) takes precedence {[F28D 7/0016](#) and [F28D 7/0033](#) take precedence})
- F28D 7/022
 - • {the conduits of two or more media in heat-exchange relationship being helically coiled, the coils having a cylindrical configuration}
- F28D 7/024
 - • {the conduits of only one medium being helically coiled tubes, the coils having a cylindrical configuration}
- F28D 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}
- F28D 7/028
 - • {the conduits of at least one medium being helically coiled, the coils having a conical configuration}
- F28D 7/04
 - the conduits being spirally coiled ([F28D 7/10](#) takes precedence) { ([F28D 7/0016](#) and [F28D 7/0033](#) take precedence)}
- F28D 7/06
 - the conduits having a single U-bend ([F28D 7/10](#) takes precedence) { ([F28D 7/0016](#) and [F28D 7/0033](#) take precedence)}
- F28D 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)}
- F28D 7/082
 - • {with serpentine or zig-zag configuration}
- F28D 7/085
 - • • {in the form of parallel conduits coupled by bent portions}
- F28D 7/087
 - • • • {assembled in arrays, each array being arranged in the same plane}
- F28D 7/10
 - the conduits being arranged one within the other, e.g. concentrically {(multiple wall tubes for leak detection [F28F 1/003](#))}
- F28D 7/103
 - • {consisting of more than two coaxial conduits or modules of more than two coaxial conduits}
- F28D 7/106
 - • {consisting of two coaxial conduits or modules of two coaxial conduits}
- F28D 7/12
 - • the surrounding tube being closed at one end, e.g. return type ([F28D 7/14](#) takes precedence)
- F28D 7/14
 - • both tubes being bent
- F28D 7/16
 - the conduits being arranged in parallel spaced relation ({[F28D 7/0008](#) to [F28D 7/0058](#) take precedence}; [F28D 7/02](#) - [F28D 7/10](#) take precedence)

- F28D 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)}
- F28D 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}
- F28D 7/1623
 - • • {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
- F28D 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 serie or parallel and arranged inside common casing ([F28D 7/1615](#) takes precedence)}
- F28D 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)}
- F28D 7/1646
 - • • • {with particular pattern of flow of the heat exchange medium flowing outside the conduit assemblies, e.g. change of flow direction}
- F28D 7/1653
 - • • {the conduit assemblies having a square or rectangular shape}
- F28D 7/1661
 - • • • {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
- F28D 7/1669
 - • • {the conduit assemblies having an annular shape; the conduits being assembled around a central distribution tube}
- F28D 7/1676
 - • • • {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}
- F28D 7/1684
 - • {the conduits having a non-circular cross-section}
- F28D 7/1692
 - • • {with particular pattern of flow of the heat exchange media, e.g. change of flow direction}

- F28D 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)}
- F28D 9/0006
 - {the plate-like or laminated conduits being enclosed within a pressure vessel}
- F28D 9/0012
 - {the apparatus having an annular form}
- F28D 9/0018
 - • {without any annular circulation of the heat exchange media}
- F28D 9/0025
 - {the conduits being formed by zig-zag bend plates}
- F28D 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)}
- F28D 9/0037
 - • {the conduits for the other heat-exchange medium also being formed by paired plates touching each other ([F28D 9/0043](#) takes precedence)}
- F28D 9/0043
 - • {the plates having openings therein for circulation of at least one heat-exchange medium from one conduit to another}
- F28D 9/005
 - • • {the plates having openings therein for both heat-exchange media}
- F28D 9/0056
 - • • {with U-flow or serpentine-flow inside conduits; with centrally arranged openings on the plates}

- F28D 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)}
- F28D 9/0068 . . {with means for changing flow direction of one heat exchange medium, e.g. using deflecting zones}
- F28D 9/0075 . . {the plates having openings therein for circulation of the heat-exchange medium from one conduit to another}
- F28D 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)}
- F28D 9/0087 . {with flexible plates}
- F28D 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}
- F28D 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})
- F28D 9/04 . the conduits being formed by spirally-wound plates or laminae
- F28D 11/00** **Heat-exchange apparatus employing moving conduits** {([F28D 15/0208](#) takes precedence)}
- F28D 11/02 . the movement being rotary, e.g. performed by a drum or roller ([F28D 11/08](#) takes precedence)
- F28D 11/025 . . {Motor car radiators}
- F28D 11/04 . . performed by a tube or a bundle of tubes
- F28D 11/06 . the movement being reciprocating or oscillating ([F28D 11/08](#) takes precedence)
- F28D 11/08 . more than one conduit assembly performing independent movements, e.g. rotary bundle of tubes in a rotary drum

F28D 13/00 **Heat-exchange apparatus using a fluidised bed**

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

- F28D 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)}
- F28D 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](#))}
- F28D 15/0208 . . {using moving tubes}
- F28D 2015/0216 . . {having particular orientation, e.g. slanted, or being orientation-independent}
- F28D 2015/0225 . . {Micro-heat pipes}
- F28D 15/0233 . . {the conduits having a particular shape, e.g. non-circular cross-section, annular ([F28D 15/0241](#), [F28D 15/0266](#) take precedence)}
- F28D 15/0241 . . {the tubes being flexible}
- F28D 15/025 . . {having non-capillary condensate return means}

- F28D 15/0258 . . {with means to remove contaminants, e.g. getters}
- F28D 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)}
- F28D 15/0275 . . {Arrangements for coupling heat-pipes together or with other structures, e.g. with base blocks; Heat pipe cores}
- F28D 15/0283 . . {Means for filling or sealing heat pipes}
- F28D 2015/0291 . . {comprising internal rotor means, e.g. turbine driven by the working fluid}
- F28D 15/04 . . with tubes having a capillary structure
- F28D 15/043 . . . {forming loops, e.g. capillary pumped loops}
- F28D 15/046 . . . {characterised by the material or the construction of the capillary structure}
- F28D 15/06 . . Control arrangements therefor

F28D 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**

- F28D 17/005 . {using granular particles}
- F28D 17/02 . using rigid bodies, e.g. of porous material
- F28D 17/023 . . {Sealing means}
- F28D 17/026 . . {Bearings; Driving means}
- F28D 17/04 . Distributing arrangements for the heat-exchange media

F28D 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)}**

- F28D 19/02 . using granular particles
- F28D 19/04 . using rigid bodies, e.g. mounted on a movable carrier
- F28D 19/041 . . {with axial flow through the intermediate heat-transfer medium}
- F28D 19/042 . . . {Rotors; Assemblies of heat absorbing masses}
- F28D 19/044 {shaped in sector form, e.g. with baskets}
- F28D 19/045 . . {with radial flow through the intermediate heat-transfer medium}
- F28D 19/047 . . {Sealing means}
- F28D 19/048 . . {Bearings; Driving means}

F28D 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**

- F28D 2020/0004 . {Particular heat storage apparatus}
- F28D 2020/0008 . . {the heat storage material being enclosed in plate-like or laminated elements, e.g. in plates having internal compartments}
- F28D 2020/0013 . . {the heat storage material being enclosed in elements attached to or integral with heat exchange conduits}
- F28D 2020/0017 . . {the heat storage material being enclosed in porous or cellular or fibrous structures (phase-change materials F28D 20/023)}

- F28D 20/0021 . . {the heat storage material being enclosed in loose or stacked elements}
- F28D 20/0026 . . {the heat storage material being enclosed in mobile containers for transporting thermal energy}
- F28D 20/003 . {using thermochemical reactions}
- F28D 20/0034 . {using liquid heat storage material}
- F28D 20/0039 . . {with stratification of the heat storage material}
- F28D 20/0043 . . {specially adapted for long-term heat storage; Underground tanks; Floating reservoirs; Pools; Ponds ([F28D 20/0052](#) takes precedence)}
- F28D 20/0047 . . {using molten salts or liquid metals}
- F28D 20/0052 . {using the ground body or aquifers as heat storage medium}
- F28D 20/0056 . {using solid heat storage material ([F28D 20/0052](#) takes precedence)}
- F28D 20/006 . {Heat storage systems not otherwise provided for}
- F28D 20/0065 . {Details, e.g. particular heat storage tanks, auxiliary members within tanks}
- F28D 20/0069 . . {Distributing arrangements; Fluid deflecting means}
- F28D 20/0073 . . . {movable}
- F28D 20/0078 . . {Heat exchanger arrangements}
- F28D 20/0082 . . {Multiple tanks arrangements, e.g. adjacent tanks, tank in tank}
- F28D 20/0086 . . {Partitions}
- F28D 20/0091 . . . {flexible}
- F28D 20/0095 . . . {movable or floating}
- F28D 20/02 . using latent heat
- F28D 20/021 . . {the latent heat storage material and the heat-exchanging means being enclosed in one container ([F28D 20/023](#) to [F28D 20/028](#) take precedence)}
- F28D 20/023 . . {the latent heat storage material being enclosed in granular particles or dispersed in a porous, fibrous or cellular structure}
- F28D 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)}
- F28D 20/026 . . {with different heat storage materials not coming into direct contact}
- F28D 20/028 . . {Control arrangements therefor}

F28D 21/00 Heat-exchange apparatus not covered by any of the groups [F28D 1/00](#) to [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](#) to [F28D 20/00](#)}

- F28D 21/0001 . {Recuperative heat exchangers}

WARNING

the groups [F28D 21/0001](#)-[F28D 21/0014](#) are not complete, pending reorganisation. See also [F28D 21/00](#)

- F28D 21/0003
 - {the heat being recuperated from exhaust gases ([F28D 21/0014](#) takes precedence)}
- F28D 21/0005
 - {for domestic or space-heating systems}
- F28D 21/0007
 - {Water heaters}
- F28D 21/0008
 - {Air heaters}
- F28D 21/001
 - {for thermal power plants or industrial processes}
- F28D 21/0012
 - {the heat being recuperated from waste water or from condensates}
- F28D 21/0014
 - {the heat being recuperated from waste air or from vapors (for air conditioning [F24F 12/001](#))}
- F28D 21/0015
 - {Heat and mass exchangers, e.g. with permeable walls}
- F28D 21/0017
 - {Flooded core heat exchangers (in large body of fluid [F28D 1/0206](#))}
- F28D 2021/0019
 - {Other heat exchangers for particular applications; Heat exchange systems not otherwise provided for}
- F28D 2021/0021
 - {for aircrafts or cosmonautics (air-treatment for aircraft [B64D 13/00](#), temperature control of cosmonautic vehicles [B64G 1/50](#))}
- F28D 2021/0022
 - {for chemical reactors}
- F28D 2021/0024
 - {for combustion apparatus, e.g. for boilers}
- F28D 2021/0026
 - {for combustion engines, e.g. for gas turbines or for Stirling engines (engine cooling systems [F28D 2021/004](#))}
- F28D 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](#))}
- F28D 2021/0029
 - {Heat sinks}
- F28D 2021/0031
 - {Radiators for recooling a coolant of cooling systems}
- F28D 2021/0033
 - {for cryogenic applications (air separation [F25J 3/04](#), cold heat exchange systems [F25J 1/0262](#))}
- F28D 2021/0035
 - {for domestic or space heating, e.g. heating radiators (for vehicles [F28D 2021/0096](#))}
- F28D 2021/0036
 - {Radiators for drying, e.g. towel radiators}
- F28D 2021/0038
 - {for drying or dehumidifying gases or vapours (by refrigeration [B01D 53/265](#))}
- F28D 2021/004
 - {for engine or machine cooling systems (for vehicles [F28D 2021/0094](#); marine radiators [F28D 1/022](#))}
- F28D 2021/0042
 - {for foodstuffs}
- F28D 2021/0043
 - {for fuel cells (heat exchange in fuel cell [H01M 8/04007](#))}
- F28D 2021/0045
 - {for granular materials (fluidised beds [F28D 13/00](#))}
- F28D 2021/0047
 - {for hydrogen or other compressed gas storage tanks}
- F28D 2021/0049
 - {for lubricants, e.g. oil coolers (for vehicles [F28D 2021/0089](#))}
- F28D 2021/005
 - {for medical applications (heating or cooling appliances for medical treatment [A61F 7/00](#))}
- F28D 2021/0052
 - {for mixers}
- F28D 2021/0054
 - {for nuclear applications (cooling arrangements for nuclear reactors [G21C 15/00](#))}

- F28D 2021/0056 . . {for ovens or furnaces (for boilers [F28D 2021/0024](#), arrangements for using waste heat in furnaces [F27D 17/00](#))}
- F28D 2021/0057 . . . {for melting materials}
- F28D 2021/0059 . . {for petrochemical plants}
- F28D 2021/0061 . . {for phase-change applications (for refrigerant cycles [F28D 2021/0068](#); heat pipes [F28D 15/02](#))}
- F28D 2021/0063 . . . {Condensers (steam or vapour condensers [F28B](#))}
- F28D 2021/0064 . . . {Vaporizers, e.g. evaporators}
- F28D 2021/0066 . . . {with combined condensation and evaporation}
- F28D 2021/0068 . . {for refrigerant cycles}
- F28D 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](#))}
- F28D 2021/0071 . . . {Evaporators (for vehicles [F28D 2021/0085](#), for compression systems [F25B 39/02](#))}
- F28D 2021/0073 . . . {Gas coolers}
- F28D 2021/0075 . . {for syngas or cracked gas cooling systems (cooling of cracked gas [C10G 9/002](#))}
- F28D 2021/0077 . . {for tempering, e.g. with cooling or heating circuits for temperature control of elements}
- F28D 2021/0078 . . . {in the form of cooling walls}
- F28D 2021/008 . . {for vehicles (for aircrafts [F28D 2021/0021](#))}
- F28D 2021/0082 . . . {Charged air coolers (cooling of air intake supply [F02B 29/04](#))}
- F28D 2021/0084 . . . {Condensers}
- F28D 2021/0085 . . . {Evaporators}
- F28D 2021/0087 . . . {Fuel coolers (apparatus for cooling fuel on vehicles [F02M 31/20](#))}
- F28D 2021/0089 . . . {Oil coolers (heating or cooling lubricants in vehicles [F01M 5/00](#))}
- F28D 2021/0091 . . . {Radiators}
- F28D 2021/0092 {with particular location on vehicle, e.g. under floor or on roof}
- F28D 2021/0094 {for recooling the engine coolant (arrangements of liquid-to-air heat exchangers on vehicles [F01P 3/18](#))}
- F28D 2021/0096 {for space heating (for air-conditioning in vehicles [B60H 1/00321](#))}
- F28D 2021/0098 . . {for viscous or semi-liquid materials, e.g. for processing sludge (for foodstuffs [F28D 2021/0042](#))}