### 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)

**WARNING**

In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Description</th>
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<tbody>
<tr>
<td>1/00</td>
<td>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)</td>
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<tr>
<td>1/02</td>
<td>. with heat-exchange conduits immersed in the body of fluid</td>
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<tr>
<td>1/0206</td>
<td>. . [Heat exchangers immersed in a large body of liquid (apparatus using liquid heat storage material F28D 20/0034)]</td>
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<tr>
<td>1/0213</td>
<td>. . . [for heating or cooling a liquid in a tank]</td>
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<td>1/022</td>
<td>. . . [for immersion in a natural body of water, e.g. marine radiators]</td>
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<tr>
<td>1/0226</td>
<td>. . . [with an intermediate heat-transfer medium, e.g. thermosiphon radiators]</td>
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<tr>
<td>1/0233</td>
<td>. . . [with air flow channels]</td>
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<tr>
<td>1/024</td>
<td>. . . [with an air driving element]</td>
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<tr>
<td>1/0246</td>
<td>. . . [heat-exchange elements having several adjacent conduits forming a whole, e.g. blocks]</td>
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<tr>
<td>2001/0253</td>
<td>. . . [Particular components]</td>
</tr>
<tr>
<td>2001/026</td>
<td>. . . [Cores]</td>
</tr>
<tr>
<td>2001/0266</td>
<td>. . . . . [Particular core assemblies, e.g. having different orientations or having different geometric features]</td>
</tr>
<tr>
<td>2001/0273</td>
<td>. . . [having special shape, e.g. curved, annular]</td>
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<tr>
<td>2001/028</td>
<td>. . . [with empty spaces or with additional elements integrated into the cores]</td>
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<tr>
<td>2001/0286</td>
<td>. . . [Radiating plates; Decorative panels]</td>
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<tr>
<td>2001/0293</td>
<td>. . . [with grooves for integration of conduits]</td>
</tr>
<tr>
<td>1/03</td>
<td>. . . [with plate-like or laminated conduits ((stacked plates having one or more openings therein to form tubular heat-exchange passages F28F 3/086))]</td>
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<tr>
<td>1/0308</td>
<td>. . . . [the conduits being formed by paired plates touching each other (F28D 1/0358 takes precedence)]</td>
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<tr>
<td>1/0316</td>
<td>. . . . [Assemblies of conduits in parallel (F28D 1/0325, F28D 1/035 take precedence)]</td>
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</tbody>
</table>
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 takes 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 1/0538 takes precedence)]
1/05316 . . . . . [Assemblies of conduits connected to common headers, e.g. core type radiators (F28D 1/0536 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 1/05383 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 7/0048, F28D 7/0058 takes 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 7/002, F28D 7/004, F28D 7/006, F28D 7/114 takes 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]
7/003 . . . [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]
7/009 . . . [the supplementary medium flowing in series through the units]
7/02 . . . the conduits being helically coiled [(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 7/0016 and F28D 7/0033 take precedence)]
7/06 . . . the conduits having a single U-bend [(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 7/0016 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 9/004 take precedence)]
9/0037 . . . . . . [the conduits for the other heat-exchange medium also being formed by paired plates touching each other (F28D 9/0042 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 9/004 take precedence)]
9/0068 . . . . . . [with means for changing flow direction of one heat exchange medium, e.g. using deflecting zones]
Associated 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

- [using granular particles]
- [using rigid bodies, e.g. of porous material]
- [Sealing means]
- [Bearings; Driving means]

Distributing arrangements for the heat-exchange medium

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)

- [using granular particles]
- [using rigid bodies, e.g. mounted on a movable carrier]
- [with axial flow through the intermediate heat-transfer medium]
- [Rotors; Assemblies of heat absorbing masses]
- [shaped in sector form, e.g. with baskets]
- [with radial flow through the intermediate heat-transfer medium]
- [Sealing means]
- [Bearings; Driving means]

Heat storage plants or apparatus in general; Regenerative heat-exchange apparatus not covered by groups [F28D 17/00] or [F28D 19/00]

- [Particular heat storage apparatus]
- [the heat storage material being enclosed in plate-like or laminated elements, e.g. in plates having internal compartments]
- [the heat storage material being enclosed in elements attached to or integral with heat exchanger conduits]
- [the heat storage material being enclosed in porous or cellular or fibrous structures (phase-change materials) [F28D 20/0231]]
- [the heat storage material being enclosed in loose or stacked elements]
- [the heat storage material being enclosed in mobile containers for transporting thermal energy]
- [using thermochemical reactions]
- [using liquid heat storage material]
- [with stratification of the heat storage material]
- [specially adapted for long-term heat storage; Underground tanks; Floating reservoirs; Pools; Ponds ([F28D 20/00052] takes precedence)]
- [using molten salts or liquid metals]
- [using the ground body or aquifers as heat storage medium]
- [using solid heat storage material ([F28D 20/00052] takes precedence)]
- [Heat storage systems not otherwise provided for]
- [Details, e.g. particular heat storage tanks, auxiliary members within tanks]
Heat-exchange apparatus employing intermediate heat-transfer media or bodies

F28D

2021/0094
{for refrigerant cycles F28D 2021/0068; heat pipes F28D 15/02; for phase-change applications (for refrigerant cycles F28D 2021/0068; heat pipes F28D 15/02); for medical applications (heating or cooling appliances for medical treatment A61F 7/00) for mixers}

2021/005
{for nuclear applications (cooling arrangements for nuclear reactors G21C 15/00) for ovens or furnaces (for boilers F28D 2021/0024; arrangements for using waste heat in furnaces F27D 17/00) for melting materials}

2021/0059
{for petrochemical plants for mixers}
Heat-exchange apparatus employing intermediate heat-transfer media or bodies

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)]