

CPC COOPERATIVE PATENT CLASSIFICATION

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

LIGHTING; HEATING

F28 HEAT EXCHANGE IN GENERAL (NOTES omitted)

F28F DETAILS OF HEAT-EXCHANGE AND HEAT-TRANSFER APPARATUS, OF GENERAL APPLICATION (water and air traps, air venting [F16](#))

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.

<p>1/00 Tubular elements; Assemblies of tubular elements (specially adapted for movement F28F 5/00)</p> <p>1/003 . {Multiple wall conduits, e.g. for leak detection (leak-detection in metal cooled nuclear reactor steam generators F22B 1/066)}</p> <p>1/006 . {with variable shape, e.g. with modified tube ends, with different geometrical features (F28F 1/025, F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence)}</p> <p>1/02 . Tubular elements of cross-section which is non-circular (F28F 1/08, F28F 1/10 take precedence)</p> <p>1/022 . . {with multiple channels}</p> <p>1/025 . . {with variable shape, e.g. with modified tube ends, with different geometrical features (F28F 1/06, F28F 1/08, F28F 9/16, F28F 9/18 take precedence)}</p> <p>2001/027 . . {with dimples}</p> <p>1/04 . . polygonal, e.g. rectangular {(F28F 1/022 takes precedence)}</p> <p>1/045 . . . {with assemblies of stacked elements}</p> <p>1/06 . . crimped or corrugated in cross-section</p> <p>1/08 . Tubular elements crimped or corrugated in longitudinal section</p> <p>1/10 . Tubular elements and assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with projections, with recesses (crimped or corrugated elements F28F 1/06, F28F 1/08)</p> <p>1/105 . . {the means being corrugated elements extending around the tubular elements}</p> <p>1/12 . . the means being only outside the tubular element</p> <p>1/122 . . . {and being formed of wires}</p> <p>1/124 . . . {and being formed of pins}</p> <p>1/126 . . . {consisting of zig-zag shaped fins (F28F 1/105 takes precedence)}</p> <p>1/128 {Fins with openings, e.g. louvered fins}</p> <p>1/14 . . . and extending longitudinally (F28F 1/38 takes precedence)</p> <p>1/16 the means being integral with the element, e.g. formed by extrusion (F28F 1/22 takes precedence)</p> <p>1/18 the element being built-up from finned sections</p>	<p>1/20 the means being attachable to the element (F28F 1/22 takes precedence)</p> <p>1/22 the means having portions engaging further tubular elements</p> <p>1/24 . . . and extending transversely (F28F 1/38 takes precedence)</p> <p>1/26 the means being integral with the element (F28F 1/32 takes precedence)</p> <p>1/28 the element being built-up from finned sections</p> <p>1/30 the means being attachable to the element (F28F 1/32 takes precedence)</p> <p>1/32 the means having portions engaging further tubular elements</p> <p>1/325 {Fins with openings}</p> <p>1/34 . . . and extending obliquely (F28F 1/38 takes precedence)</p> <p>1/36 the means being helically wound fins or wire spirals</p> <p>1/38 . . . and being staggered to form tortuous fluid passages</p> <p>1/40 . . the means being only inside the tubular element</p> <p>1/405 . . . {and being formed of wires}</p> <p>1/42 . . the means being both outside and inside the tubular element</p> <p>1/422 . . . {with outside means integral with the tubular element and inside means integral with the tubular element (F28F 1/424 takes precedence)}</p> <p>1/424 . . . {Means comprising outside portions integral with inside portions}</p> <p>1/426 {the outside portions and the inside portions forming parts of complementary shape, e.g. concave and convex}</p> <p>2001/428 . . . {Particular methods for manufacturing outside or inside fins}</p> <p>1/44 . . . and being formed of wire mesh</p> <p>3/00 Plate-like or laminated elements; Assemblies of plate-like or laminated elements (specially adapted for movement F28F 5/00)</p> <p>3/005 . {Arrangements for preventing direct contact between different heat-exchange media (F28F 3/10 takes precedence)}</p>
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- 3/02 . Elements or assemblies thereof with means for increasing heat-transfer area, e.g. with fins, with recesses, with corrugations ([F28F 3/08 takes precedence](#))
- 3/022 . . {the means being wires or pins}
- 3/025 . . {the means being corrugated, plate-like elements}
- 3/027 . . . {with openings, e.g. louvered corrugated fins; Assemblies of corrugated strips}
- 3/04 . . the means being integral with the element
- 3/042 . . . {in the form of local deformations of the element}
- 3/044 {the deformations being pontual, e.g. dimples}
- 3/046 {the deformations being linear, e.g. corrugations}
- 3/048 . . . {in the form of ribs integral with the element or local variations in thickness of the element, e.g. grooves, microchannels}
- 3/06 . . the means being attachable to the element
- 3/08 . Elements constructed for building-up into stacks, e.g. capable of being taken apart for cleaning
- 3/083 . . {capable of being taken apart}
- 3/086 . . {having one or more openings therein forming tubular heat-exchange passages}
- 3/10 . . Arrangements for sealing the margins
- 3/12 . Elements constructed in the shape of a hollow panel, e.g. with channels ([F28D 1/02](#), [F28D 1/03 take precedence](#))
- 3/14 . . by separating portions of a pair of joined sheets to form channels, e.g. by inflation ([manufacture thereof B23P](#))
- 5/00 Elements specially adapted for movement**
(arrangements for moving the elements, [see the appropriate subclass for the apparatus concerned](#))
- 5/02 . Rotary drums or rollers
- 5/04 . Hollow impellers, e.g. stirring vane
- 5/06 . Hollow screw conveyors
- 7/00 Elements not covered by group [F28F 1/00](#), [F28F 3/00](#) or [F28F 5/00](#)**
- 7/02 . Blocks traversed by passages for heat-exchange media ([F28D 7/0008 takes precedence](#))
- 9/00 Casings; Header boxes; Auxiliary supports for elements; Auxiliary members within casings**
- 9/001 . {Casings in the form of plate-like arrangements; Frames enclosing a heat exchange core}
- 9/002 . . {with fastening means for other structures}
- 2009/004 . . {Common frame elements for multiple cores}
- 9/005 . {Other auxiliary members within casings, e.g. internal filling means or sealing means}
- 9/007 . Auxiliary supports for elements
- 9/0075 . . {Supports for plates or plate assemblies}
- 9/013 . . for tubes or tube-assemblies
- 9/0131 . . . {formed by plates ([F28F 9/0138 takes precedence](#))}
- 9/0132 . . . {formed by slats, tie-rods, articulated or expandable rods}
- 9/0133 . . . {formed by concentric strips}
- 9/0135 . . . {formed by grids having only one tube per closed grid opening ([F28F 9/0132](#) and [F28F 9/0133 take precedence](#))}
- 9/0136 {formed by intersecting strips}
- 9/0137 . . . {formed by wires, e.g. helically coiled ([F28F 9/0135 takes precedence](#))}
- 9/0138 . . . {formed by sleeves for finned tubes}
- 9/02 . Header boxes; End plates
- 9/0202 . . {Header boxes having their inner space divided by partitions}
- 9/0204 . . . {for elongated header box, e.g. with transversal and longitudinal partitions}
- 9/0207 {the longitudinal or transversal partitions being separate elements attached to header boxes ([F28F 9/0212](#), [F28F 9/0217 take precedence](#))}
- 9/0209 {having only transversal partitions}
- 9/0212 {the partitions being separate elements attached to header boxes}
- 9/0214 {having only longitudinal partitions}
- 9/0217 {the partitions being separate elements attached to header boxes}
- 9/0219 . . {Arrangements for sealing end plates into casing or header box; Header box sub-elements ([F28F 9/0236 takes precedence](#))}
- 9/0221 . . . {Header boxes or end plates formed by stacked elements}
- 9/0224 . . . {Header boxes formed by sealing end plates into covers ([F28F 9/0221 takes precedence](#))}
- 9/0226 {with resilient gaskets}
- 9/0229 . . {Double end plates; Single end plates with hollow spaces}
- 9/0231 . . {Header boxes having an expansion chamber}
- 9/0234 . . {having a second heat exchanger disposed there within, e.g. oil cooler}
- 9/0236 . . {floating elements}
- 9/0239 . . . {floating header boxes}
- 9/0241 . . . {floating end plates}
- 9/0243 . . {Header boxes having a circular cross-section}
- 9/0246 . . {Arrangements for connecting header boxes with flow lines}
- 9/0248 . . . {Arrangements for sealing connectors to header boxes}
- 9/0251 . . . {Massive connectors, e.g. blocks; Plate-like connectors}
- 9/0253 {with multiple channels, e.g. with combined inflow and outflow channels}
- 9/0256 . . . {Arrangements for coupling connectors with flow lines}
- 9/0258 {of quick acting type, e.g. with snap action}
- 9/026 . . {with static flow control means, e.g. with means for uniformly distributing heat exchange media into conduits}
- 9/0263 . . . {by varying the geometry or cross-section of header box}
- 9/0265 . . . {by using guiding means or impingement means inside the header box}
- 9/0268 {in the form of multiple deflectors for channeling the heat exchange medium}
- 9/027 . . . {in the form of distribution pipes}
- 9/0273 {with multiple holes}
- 9/0275 {with multiple branch pipes}
- 9/0278 . . . {in the form of stacked distribution plates or perforated plates arranged over end plates}
- 9/028 . . . {by using inserts for modifying the pattern of flow inside the header box, e.g. by using flow restrictors or permeable bodies or blocks with channels}

- 9/0282 . . . {by varying the geometry of conduit ends, e.g. by using inserts or attachments for modifying the pattern of flow at the conduit inlet or outlet}
- 2009/0285 . . . {Other particular headers or end plates}
- 2009/0287 . . . {having passages for different heat exchange media}
- 2009/029 . . . {with increasing or decreasing cross-section, e.g. having conical shape}
- 2009/0292 . . . {with fins}
- 2009/0295 . . . {comprising cooling circuits}
- 2009/0297 . . . {Side headers, e.g. for radiators having conduits laterally connected to common header}
- 9/04 . . Arrangements for sealing elements into header boxes or end plates ([arrangements for sealing flow lines connectors to header boxes F28F 9/0248](#))
- 9/06 . . . by dismantable joints
- 9/08 by wedge-type connections, e.g. taper ferrule
- 9/10 by screw-type connections, e.g. gland
- 9/12 by flange-type connections
- 9/14 by force-joining
- 9/16 . . . by permanent joints, e.g. by rolling ([metal-working procedures in general B21, B32; particularly B21D 39/06, B23K](#))
- 9/162 {by using bonding or sealing substances, e.g. adhesives ([F28F 9/18 takes precedence](#))}
- 9/165 {by using additional preformed parts, e.g. sleeves, gaskets ([F28F 9/185 takes precedence](#))}
- 9/167 {the parts being inserted in the heat-exchange conduits}
- 9/18 by welding
- 9/182 {the heat-exchange conduits having ends with a particular shape, e.g. deformed; the heat-exchange conduits or end plates having supplementary joining means, e.g. abutments}
- 9/185 {with additional preformed parts}
- 9/187 {at least one of the parts being non-metallic, e.g. heat-sealing plastic elements}
- 9/20 . . Arrangements of heat reflectors, e.g. separately-insertible reflecting walls
- 9/22 . . Arrangements for directing heat-exchange media into successive compartments, e.g. arrangements of guide plates
- 2009/222 . . . {Particular guide plates, baffles or deflectors, e.g. having particular orientation relative to an elongated casing or conduit}
- 2009/224 . . . {Longitudinal partitions}
- 2009/226 . . . {Transversal partitions}
- 2009/228 . . . {Oblique partitions}
- 9/24 . . Arrangements for promoting turbulent flow of heat-exchange media, e.g. by plates ([F28F 1/38 takes precedence; in general F15D](#))
- 9/26 . . Arrangements for connecting different sections of heat-exchange elements, e.g. of radiators ([connecting different sections in water heaters F24H 9/14](#) {, [connecting headers with inlet or outlet fittings F28F 9/0246](#)})
- 9/262 . . . {for radiators ([F28D 1/0408 takes precedence](#))}
- 9/264 . . . {by sleeves, nipples}
- 9/266 . . . {by screw-type connections}
- 9/268 . . . {by permanent joints, e.g. by welding}
- 11/00 Arrangements for sealing leaky tubes and conduits (stopping flow from or in pipes in general [F16L 55/10](#))**
- 11/02 . . using obturating elements, e.g. washers, inserted and operated independently of each other ([F28F 11/06 takes precedence](#))
- 11/04 . . using pairs of obturating elements, e.g. washers, mounted upon central operating rods ([F28F 11/06 takes precedence](#))
- 11/06 . . using automatic tube obturating appliances
- 13/00 Arrangements for modifying heat-transfer, e.g. increasing, decreasing ([F28F 1/00 - F28F 11/00 take precedence](#))**
- 2013/001 . . {Particular heat conductive materials, e.g. superconductive elements (for thermal joints [F28F 2013/006](#))}
- 13/003 . . {by using permeable mass, perforated or porous materials ([F28F 13/18 takes precedence](#))}
- 2013/005 . . {Thermal joints}
- 2013/006 . . . {Heat conductive materials}
- 2013/008 . . . {Variable conductance materials; Thermal switches}
- 13/02 . . by influencing fluid boundary ([boundary-layer control in general F15D](#))
- 13/04 . . by preventing the formation of continuous films of condensate on heat-exchange surfaces, e.g. by promoting droplet formation ([F28F 13/18 takes precedence](#))}
- 13/06 . . by affecting the pattern of flow of the heat-exchange media ([F28F 13/003 takes precedence; static flow control means in header boxes F28F 9/026](#))}
- 13/08 . . . by varying the cross-section of the flow channels
- 13/10 . . . by imparting a pulsating motion to the flow, e.g. by sonic vibration
- 13/12 . . . by creating turbulence, e.g. by stirring, by increasing the force of circulation ([F28F 13/08 takes precedence](#))
- 13/125 . . . {by stirring}
- 13/14 . . by endowing the walls of conduits with zones of different degrees of conduction of heat
- 13/16 . . by applying an electrostatic field to the body of the heat-exchange medium
- 13/18 . . by applying coatings, e.g. radiation-absorbing, radiation-reflecting; by surface treatment, e.g. polishing
- 13/182 . . . {especially adapted for evaporator or condenser surfaces ([F28F 13/187 takes precedence](#))}
- 13/185 . . . {Heat-exchange surfaces provided with microstructures or with porous coatings}
- 13/187 . . . {especially adapted for evaporator surfaces or condenser surfaces, e.g. with nucleation sites}
- 17/00 Removing ice or water from heat-exchange apparatus**
- 17/005 . . {Means for draining condensates from heat exchangers, e.g. from evaporators ([F28B 9/08 takes precedence](#))}
- 19/00 Preventing the formation of deposits or corrosion, e.g. by using filters {or scrapers}**
- 19/002 . . {by using inserts or attachments}

19/004	. {by using protective electric currents, voltages, cathodes, anodes, electric short-circuits}	25/082	. . . {Spaced elongated bars, laths; Supports therefor}
19/006	. {Preventing deposits of ice}	25/085	. . . {Substantially horizontal grids; Blocks}
19/008	. {by using scrapers}	25/087	. . . {Vertical or inclined sheets; Supports or spacers}
19/01	. by using means for separating solid materials from heat-exchange fluids, e.g. filters	25/10	. for feeding gas or vapour
19/02	. by using coatings, e.g. vitreous or enamel coatings	25/12	. . Ducts; Guide vanes, e.g. for carrying currents to distinct zones
19/04	. . of rubber; of plastics material; of varnish		
19/06	. . of metal		
21/00	Constructions of heat-exchange apparatus characterised by the selection of particular materials {(coatings for modifying heat-transfer F28F 13/18 ; coatings for preventing the formation of deposits or corrosion F28F 19/02)}	27/00	Control arrangements or safety devices specially adapted for heat-exchange or heat-transfer apparatus (control arrangements in general G05)
21/003	. {for domestic or space-heating systems}	27/003	. {specially adapted for cooling towers}
21/006	. {of glass}	27/006	. {specially adapted for regenerative heat-exchange apparatus}
21/02	. of carbon, e.g. graphite	27/02	. for controlling the distribution of heat-exchange media between different channels ({static flow control means in header boxes F28F 9/026 }; arrangements of guide plates or guide vanes F28F 9/22 , F28F 25/12)
21/04	. of ceramic; of concrete; of natural stone		
21/045	. . {for domestic or space-heating systems}	99/00	Subject matter not provided for in other groups of this subclass
21/06	. of plastics material	2200/00	Prediction; Simulation; Testing (measuring quantity of heat conveyed by flowing mediums G01K 17/06)
21/061	. . {for domestic or space-heating systems}	2200/005	. Testing heat pipes
21/062	. . {the heat-exchange apparatus employing tubular conduits}	2210/00	Heat exchange conduits
21/063	. . . {for domestic or space-heating systems}	2210/02	. with particular branching, e.g. fractal conduit arrangements
21/065	. . {the heat-exchange apparatus employing plate-like or laminated conduits}	2210/04	. Arrangements of conduits common to different heat exchange sections, the conduits having channels for different circuits
21/066	. . . {for domestic or space-heating systems}	2210/06	. having walls comprising obliquely extending corrugations, e.g. in the form of threads
21/067	. . {Details}	2210/08	. Assemblies of conduits having different features
21/068	. . . {for domestic or space-heating systems}	2210/10	. Particular layout, e.g. for uniform temperature distribution
21/08	. of metal	2215/00	Fins
21/081	. . {Heat exchange elements made from metals or metal alloys}	2215/02	. Arrangements of fins common to different heat exchange sections, the fins being in contact with different heat exchange media
21/082	. . . {from steel or ferrous alloys}	2215/04	. Assemblies of fins having different features, e.g. with different fin densities
21/083 {from stainless steel}	2215/06	. Hollow fins; fins with internal circuits
21/084	. . . {from aluminium or aluminium alloys}	2215/08	. with openings, e.g. louvers (zig-zag fins with openings F28F 1/128 , common transversal fins with openings F28F 1/325 , corrugated fins with openings F28F 3/027)
21/085	. . . {from copper or copper alloys}	2215/10	. Secondary fins, e.g. projections or recesses on main fins
21/086	. . . {from titanium or titanium alloys}	2215/12	. with U-shaped slots for laterally inserting conduits
21/087	. . . {from nickel or nickel alloys}	2215/14	. in the form of movable or loose fins
21/088	. . {for domestic or space-heating systems}	2220/00	Closure means, e.g. end caps on header boxes or plugs on conduits
21/089	. . {Coatings, claddings or bonding layers made from metals or metal alloys (F28F 19/06 takes precedence)}	2225/00	Reinforcing means
23/00	Features relating to the use of intermediate heat-exchange materials, e.g. selection of compositions (heat-transfer, heat-exchange or heat-storage materials C09K 5/00)	2225/02	. for casings
23/02	. Arrangements for obtaining or maintaining same in a liquid state	2225/04	. for conduits
25/00	Component parts of trickle coolers (arrangements for increasing heat transfer F28F 13/00 ; controlling arrangements F28F 27/00)	2225/06	. for fins
2025/005	. {Liquid collection; Liquid treatment; Liquid recirculation; Addition of make-up liquid}	2225/08	. for header boxes
25/02	. for distributing, circulating, and accumulating liquid (spraying or atomising in general B05B , B05D)	2230/00	Sealing means
25/04	. . Distributing or accumulator troughs		
25/06	. . Spray nozzles or spray pipes		
25/08	. . Splashing boards or grids, e.g. for converting liquid sprays into liquid films; Elements or beds for increasing the area of the contact surface (packing elements per se B01J 19/30 , B01J 19/32)		

- 2235/00** Means for filling gaps between elements, e.g. between conduits within casings
- 2240/00** Spacing means
- 2245/00** Coatings; Surface treatments
- 2245/02 . hydrophilic
- 2245/04 . hydrophobic
- 2245/06 . having particular radiating, reflecting or absorbing features, e.g. for improving heat transfer by radiation
- 2245/08 . self-cleaning
- 2250/00** Arrangements for modifying the flow of the heat exchange media (in general [F28F 13/06](#)), e.g. flow guiding means (in casings [F28F 9/22](#)); Particular flow patterns
- 2250/02 . Streamline-shaped elements
- 2250/04 . Communication passages between channels
- 2250/06 . Derivation channels, e.g. bypass
- 2250/08 . Fluid driving means, e.g. pumps, fans
- 2250/10 . Particular pattern of flow of the heat exchange media
- 2250/102 . . with change of flow direction
- 2250/104 . . with parallel flow
- 2250/106 . . with cross flow
- 2250/108 . . with combined cross flow and parallel flow
- 2255/00** Heat exchanger elements made of materials having special features or resulting from particular manufacturing processes
- 2255/02 . Flexible elements
- 2255/04 . comprising shape memory alloys or bimetallic elements
- 2255/06 . composite, e.g. polymers with fillers or fibres
- 2255/08 . pressed; stamped; deep-drawn
- 2255/10 . made by hydroforming
- 2255/12 . expanded or perforated metal plate
- 2255/14 . molded
- 2255/143 . . injection molded
- 2255/146 . . overmolded
- 2255/16 . extruded
- 2255/18 . sintered
- 2255/20 . with nanostructures
- 2260/00** Heat exchangers or heat exchange elements having special size, e.g. microstructures ([microheat pipes F28D 2015/0225](#); [nanostructures F28F 2255/20](#))
- 2260/02 . having microchannels
- 2265/00** Safety or protection arrangements; Arrangements for preventing malfunction (control or monitoring devices [F28F 27/00](#))
- 2265/02 . in the form of screens or covers ([heat shields F28F 2265/10](#))
- 2265/06 . by using means for draining heat exchange media from heat exchangers
- 2265/10 . for preventing overheating, e.g. heat shields ([thermal insulation F28F 2270/00](#))
- 2265/12 . for preventing overpressure
- 2265/14 . for preventing damage by freezing, e.g. for accommodating volume expansion
- 2265/16 . for preventing leakage
- 2265/18 . for removing contaminants, e.g. for degassing
- 2265/20 . for preventing development of microorganisms
- 2265/22 . for draining
- 2265/24 . for electrical insulation
- 2265/26 . for allowing differential expansion between elements ([floating header box elements F28F 9/0236](#))
- 2265/28 . for preventing noise (by preventing vibrations [F28F 2265/30](#))
- 2265/30 . for preventing vibrations
- 2265/32 . for limiting movements, e.g. stops, locking means
- 2270/00** Thermal insulation; Thermal decoupling
- 2270/02 . by using blind conduits
- 2275/00** Fastening; Joining
- 2275/02 . by using bonding materials ([brazing F28F 2275/04](#)); by embedding elements in particular materials
- 2275/025 . . by using adhesives
- 2275/04 . by brazing ([brazing heat exchangers B23K 1/0012](#))
- 2275/045 . . with particular processing steps, e.g. by allowing displacement of parts during brazing or by using a reservoir for storing brazing material
- 2275/06 . by welding ([welding heat exchangers B23K 2101/14](#))
- 2275/061 . . by diffusion bonding
- 2275/062 . . by impact pressure or friction welding
- 2275/064 . . by induction welding or by using microwaves
- 2275/065 . . by ultrasonic or vibration welding
- 2275/067 . . by laser welding
- 2275/068 . . by explosive welding
- 2275/08 . by clamping or clipping
- 2275/085 . . with snap connection
- 2275/10 . by force joining
- 2275/12 . by methods involving deformation of the elements
- 2275/122 . . by crimping, caulking or clinching
- 2275/125 . . by bringing elements together and expanding
- 2275/127 . . by shrinking
- 2275/14 . by using form fitting connection, e.g. with tongue and groove
- 2275/143 . . with pin and hole connections
- 2275/146 . . with bayonet connections
- 2275/16 . with toothed elements, e.g. with serrations
- 2275/18 . by using wedge effect
- 2275/20 . with threaded elements
- 2275/205 . . with of tie-rods
- 2275/22 . by using magnetic effect
- 2280/00** Mounting arrangements; Arrangements for facilitating assembling or disassembling of heat exchanger parts
- 2280/02 . Removable elements
- 2280/04 . Means for preventing wrong assembling of parts
- 2280/06 . Adapter frames, e.g. for mounting heat exchanger cores on other structure and for allowing fluidic connections
- 2280/08 . Tolerance compensating means
- 2280/10 . Movable elements, e.g. being pivotable ([elements specially adapted for movements F28F 5/00](#))
- 2280/105 . . with hinged connections