SECTION F — MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING

F04 POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS; PUMPS FOR LIQUIDS OR ELASTIC FLUIDS

F04B **POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS; PUMPS** (engine fuel-injection pumps F02M; machines for liquids, or pumps, of rotary-piston or oscillating-piston type F04C; non-positive-displacement pumps F04D; pumping of fluid by direct contact of another fluid or by using inertia of fluid to be pumped F04F; crankshafts, crossheads, connecting-rods F16C; flywheels F16F; gearings for interconverting rotary motion and reciprocating motion in general F16H; pistons, piston-rods, cylinders, in general F16J; ion pumps H01J 41/12; electrodynamic pumps H02K 44/02)

Note(s) [7, 2009.01]

1. In this subclass, the following term is used with the meaning indicated:
   - "piston" also covers a plunger.
2. Attention is drawn to the Notes following the titles of class B81 and subclass B81Brelating to "micro-structural devices" and "micro-structural systems".
3. Attention is drawn to the Notes preceding class F01, especially as regards the definitions of "machines", "pumps", and "positive-displacement".
4. Machines, pumps or pumping installations having flexible working members are classified in groups F04B 43/00 or F04B 45/00.

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POSITIVE-DISPLACEMENT MACHINES FOR LIQUIDS, PUMPS IN GENERAL
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Pumps for liquids or for liquid and elastic fluids; Positive-displacement machines for liquids

1/00 **Multi-cylinder machines or pumps characterised by number or arrangement of cylinders** (F04B 3/00 takes precedence; fluid-driven pumps F04B 9/08; control of reciprocating machines or pumps in general F04B 49/00) **[1, 2006.01]**

1/02 • having two cylinders (in V-arrangement F04B 1/04) **[1, 2006.01]**

1/04 • having cylinders in star- or fan-arrangement **[1, 6, 2006.01]**

1/047 • • with an actuating or actuated element at the outer ends of the cylinders **[6, 2006.01]**

1/053 • • with an actuating or actuated element at the inner ends of the cylinders **[6, 2006.01]**

1/06 • • Control **[1, 2006.01]**
1/07 • • • by varying the relative eccentricity between two members, e.g. a cam and a drive shaft **[6, 2006.01]**
1/08 • • • regulated by delivery pressure **[1, 2006.01]**
1/10 • • the cylinders being movable, e.g. rotary **[1, 6, 2006.01]**
1/107 • • • with an actuating or actuated element at the outer ends of the cylinders **[6, 2006.01]**
1/113 • • • with an actuating or actuated element at the inner ends of the cylinders **[6, 2006.01]**
1/12 • having cylinder axes coaxial with, or parallel or inclined to, main shaft axis **[1, 2006.01]**
1/14 • • having stationary cylinders **[1, 2006.01]**
1/16 • • • having two or more sets of cylinders or pistons **[1, 2006.01]**
1/18 • • • having self-acting distribution members, i.e. actuated by working fluid **[1, 2006.01]**
1/20 • • having rotary cylinder block **[1, 2006.01]**
1/22 • • • having two or more sets of cylinders or pistons **[1, 2006.01]**
1/24 • • • • inclined to main shaft axis **[1, 2006.01]**
1/26 • • Control **[1, 2006.01]**
1/28 • • • for machines or pumps with stationary cylinders **[1, 2006.01]**
1/29 • • • • by varying the relative positions of a swash plate and a cylinder block **[6, 2006.01]**
1/30 • • • for machines or pumps with rotary cylinder block **[1, 2006.01]**
1/32 • • • • by varying the relative positions of a swash plate and a cylinder block **[6, 2006.01]**
1/34 • Control not provided for in a single group of groups F04B 1/02-F04B 1/32 **[6, 2006.01]**

3/00 Machines or pumps with pistons coacting within one cylinder, e.g. multi-stage [1, 2006.01]

5/00 Machines or pumps with differential-surface pistons [1, 2006.01]
5/02 • with double-acting pistons **[6, 2006.01]**

7/00 Piston machines or pumps characterised by having positively-driven valving (with cylinders in star- or fan-arrangement F04B 1/04; with cylinder axes coaxial with, or parallel or inclined to, main shaft axis F04B 1/12) **[1, 2006.01]**
7/02 • the valving being fluid-actuated **[1, 2006.01]**
7/04 • in which the valving is performed by pistons and cylinders coacting to open and close intake or outlet ports **[1, 3, 2006.01]**
7/06 • • the pistons and cylinders being relatively reciprocated and rotated **[1, 3, 2006.01]**

9/00 Piston machines or pumps characterised by the driving or driven means to or from their working members [1, 2006.01]
9/02 • the means being mechanical **[1, 2006.01]**
9/04 • • the means being cams, eccentrics, or pin-and-slot mechanisms (with cylinder axes coaxial with, or parallel or inclined to, main shaft axis F04B 1/12) **[1, 2006.01]**
9/06 • • the means including spring- or weight-loaded lost-motion devices **[1, 2006.01]**
9/08 • the means being fluid **[1, 2006.01]**
9/10 • • the fluid being liquid **[1, 2006.01]**
9/103 • • • having only one pumping chamber **[6, 2006.01]**
9/105 • • • • reciprocating movement of the pumping member being obtained by a double-acting liquid motor **[6, 2006.01]**
9/107 • • • • rectilinear movement of the pumping member in the working direction being obtained by a single-acting liquid motor, e.g. actuated in the other direction by gravity or a spring **[6, 2006.01]**
9/109 • • • having plural pumping chambers **[6, 2006.01]**
9/111 • • • • with two mechanically connected pumping members **[6, 2006.01]**
9/113 • • • • • reciprocating movement of the pumping members being obtained by a double-acting liquid motor **[6, 2006.01]**
9/115 • • • • • reciprocating movement of the pumping members being obtained by two single-acting liquid motors, each acting in one direction **[6, 2006.01]**
9/117 • • • • the pumping members not being mechanically connected to each other **[6, 2006.01]**
9/12 • • the fluid being elastic, e.g. steam or air **[1, 2006.01]**
9/123 • • • having only one pumping chamber **[6, 2006.01]**
9/125 • • • • reciprocating movement of the pumping member being obtained by a double-acting elastic-fluid motor **[6, 2006.01]**
9/127 • • • • rectilinear movement of the pumping member in the working direction being obtained by a single-acting elastic-fluid motor, e.g. actuated in the other direction by gravity or a spring **[6, 2006.01]**
9/129 • • • having plural pumping chambers **[6, 2006.01]**
9/131 • • • • with two mechanically connected pumping members **[6, 2006.01]**
9/133 • • • • • reciprocating movement of the pumping members being obtained by a double-acting elastic-fluid motor **[6, 2006.01]**
9/135 • • • • • reciprocating movement of the pumping members being obtained by two single-acting elastic-fluid motors, each acting in one direction **[6, 2006.01]**
9/137 • • • • the pumping members not being mechanically connected to each other **[6, 2006.01]**
9/14 • Pumps characterised by muscle-power operation **[1, 2006.01]**

11/00 Equalisation of pulses, e.g. by use of air vessels; Counteracting cavitation [1, 2006.01]

13/00 Pumps specially modified to deliver fixed or variable measured quantities (for transferring liquid from bulk storage containers or reservoirs into vehicles or into portable containers B67D 7/58) **[1, 2006.01]**
13/02 • of two or more fluids at the same time **[1, 2006.01]**

15/00 Pumps adapted to handle specific fluids, e.g. by selection of specific materials for pumps or pump parts [1, 2006.01]
15/02 • the fluids being viscous or non-homogeneous **[1, 2006.01]**
15/04 • the fluids being hot or corrosive (F04B 15/06 takes precedence) **[1, 2006.01]**
15/06 • for liquids near their boiling point, e.g. under subnormal pressure **[1, 2006.01]**
15/08 • • the liquids having low boiling points **[1, 2006.01]**

17/00 Pumps characterised by combination with, or adaptation to, specific driving engines or motors [1, 2006.01]
17/02 • driven by wind motors **[1, 2006.01]**
17/03 • driven by electric motors **[6, 2006.01]**
17/04 • • using solenoids **[1, 6, 2006.01]**
17/05 • driven by internal-combustion engines **[6, 2006.01]**
17/06 • Mobile combinations **[1, 2006.01]**

19/00 Machines or pumps having pertinent characteristics not provided for in, or of interest apart from, groups F04B 1/00-F04B 17/00 [1, 2006.01]
19/02 • having movable cylinders **[1, 2006.01]**
19/04 • Pumps for special use (for transferring liquids from bulk storage containers or reservoirs into vehicles or into portable containers B67D 7/58) **[1, 2006.01]**
19/06 • • Pumps for delivery of both liquid and elastic fluids at the same time (wet gas pumps F04B 37/20) **[1, 6, 2006.01]**
19/08 • Scoop devices **[1, 2006.01]**
19/10 • • of wheel type **[1, 2006.01]**
19/12 • • of helical or screw type **[1, 2006.01]**
19/14 • • of endless-chain type, e.g. with the chains carrying pistons co-operating with open-ended cylinders **[1, 2006.01]**
19/16 • Adhesion-type liquid-lifting devices **[1, 2006.01]**
19/18 • • Adhesion members therefor **[1, 2006.01]**
19/20 • Other positive-displacement pumps **[1, 2006.01]**
19/22 • • of reciprocating-piston type **[1, 2006.01]**
19/24 • • Pumping by heat expansion of pumped fluid **[1, 2006.01]**

23/00 Pumping installations or systems (F04B 17/00 takes precedence) **[1, 2006.01]**
23/02 • having reservoirs **[1, 2006.01]**
23/04 • Combinations of two or more pumps **[1, 2006.01]**
23/06 • • the pumps being all of reciprocating positive-displacement type **[1, 2006.01]**
23/08 • • the pumps being of different types **[1, 2006.01]**
23/10 • • • at least one pump being of the reciprocating positive-displacement type **[1, 2006.01]**
23/12 • • • at least one pump being of the rotary-piston positive-displacement type (F04B 23/10 takes precedence) **[1, 2006.01]**
23/14 • • • at least one pump being of the non-positive-displacement type (F04B 23/10, F04B 23/12 take precedence) **[1, 2006.01]**

<u>Pumps specially adapted for elastic fluids</u>

25/00 Multi-stage pumps specially adapted for elastic fluids [1, 2006.01]
25/02 • of stepped-piston type **[1, 2006.01]**
25/04 • having cylinders coaxial with, or parallel or inclined to, main shaft axis **[1, 2006.01]**

27/00 Multi-cylinder pumps specially adapted for elastic fluids and characterised by number or arrangement of cylinders (F04B 25/00 takes precedence; control of reciprocating machines or pumps in general F04B 49/00) **[1, 2006.01]**
27/02 • having cylinders arranged oppositely relative to main shaft **[1, 2006.01]**
27/04 • having cylinders in star- or fan-arrangement **[1, 6, 2006.01]**
27/047 • • with an actuating element at the outer ends of the cylinders **[6, 2006.01]**
27/053 • • with an actuating element at the inner ends of the cylinders **[6, 2006.01]**
27/06 • • the cylinders being movable, e.g. rotary **[1, 2006.01]**
27/067 • • Control **[6, 2006.01]**
27/073 • • • by varying the relative eccentricity between two members, e.g. a cam and a drive shaft **[6, 2006.01]**
27/08 • having cylinders coaxial with, or parallel or inclined to, main shaft axis **[1, 2006.01]**
27/10 • • having stationary cylinders **[6, 2006.01]**
27/12 • • • having plural sets of cylinders or pistons **[6, 2006.01]**
27/14 • • Control **[6, 2006.01]**
27/16 • • • of pumps with stationary cylinders **[6, 2006.01]**
27/18 • • • • by varying the relative positions of a swash plate and a cylinder block **[6, 2006.01]**
27/20 • • • of pumps with rotary cylinder block **[6, 2006.01]**
27/22 • • • • by varying the relative positions of a swash plate and a cylinder block **[6, 2006.01]**
27/24 • Control not provided for in a single group of groups F04B 27/02-F04B 27/22 **[6, 2006.01]**

31/00 Free-piston pumps specially adapted for elastic fluids; Systems incorporating such pumps (muscle-driven pumps in which the stroke is not defined by gearing F04B 33/00; free-piston combustion engines, free-piston gas generators F02B 71/00; systems predominated by prime mover aspects, <u>see</u> the relevant class for the prime mover) **[1, 2006.01]**

33/00 Pumps specially adapted for elastic fluids actuated by muscle power, e.g. for inflating [1, 2006.01]
33/02 • with intermediate gearing **[1, 2006.01]**

35/00 Piston pumps specially adapted for elastic fluids and characterised by the driving means to their working members, or by combination with, or adaptation to, specific driving engines or motors, not otherwise provided for (predominant aspects of the engines or motors, <u>see</u> the relevant classes) **[1, 2006.01]**
35/01 • the means being mechanical **[6, 2006.01]**
35/02 • the means being fluid **[1, 2006.01]**
35/04 • the means being electric **[1, 2006.01]**
35/06 • Mobile combinations **[1, 2006.01]**

37/00 Pumps specially adapted for elastic fluids and having pertinent characteristics not provided for in, or of interest apart from, groups F04B 25/00-F04B 35/00 [1, 2006.01]
37/02 • for evacuating by absorption or adsorption (absorption or adsorption in general B01J) **[1, 2006.01]**
37/04 • • Selection of specific absorption or adsorption materials **[1, 2006.01]**
37/06 • for evacuating by thermal means **[1, 2006.01]**
37/08 • • by condensing or freezing, e.g. cryogenic pumps (cold traps B01D 8/00) **[1, 2006.01]**
37/10 • for special use (F04B 37/02, F04B 37/06 take precedence) **[1, 2006.01]**
37/12 • • to obtain high pressure **[1, 2006.01]**
37/14 • • to obtain high vacuum **[1, 2006.01]**
37/16 • • • Means for nullifying unswept space **[1, 2006.01]**
37/18 • • for specific elastic fluids **[1, 2006.01]**

37/20 • • • for wet gases, e.g. wet air **[1, 2006.01]**

39/00 Component parts, details, or accessories, of pumps or pumping systems specially adapted for elastic fluids, not otherwise provided for in, or of interest apart from, groups F04B 25/00-F04B 37/00 (for controlling F04B 49/00) **[1, 2006.01]**

39/02 • Lubrication (of machines or engines in general F01M) **[1, 2006.01]**

39/04 • Measures to avoid lubricant contaminating the pumped fluid **[1, 2006.01]**

39/06 • Cooling (of machines or engines in general F01P); Heating; Prevention of freezing **[1, 2006.01]**

39/08 • Actuation of distribution members **[1, 2006.01]**

39/10 • Adaptation or arrangement of distribution members **[1, 2006.01]**

39/12 • Casings (casings for machines or engines in general F16M); Cylinders; Cylinder heads; Fluid connections **[1, 2006.01]**

39/14 • Provisions for readily assembling or disassembling **[1, 2006.01]**

39/16 • Filtration; Moisture separation **[1, 2006.01]**

41/00 Pumping installations or systems specially adapted for elastic fluids (F04B 31/00, F04B 35/00 take precedence) **[1, 2006.01]**

41/02 • having reservoirs **[1, 2006.01]**

41/04 • Conversion of internal-combustion engine cylinder units to pumps **[1, 2006.01]**

41/06 • Combinations of two or more pumps **[1, 2006.01]**

Machines or pumps having flexible working members

43/00 Machines, pumps, or pumping installations having flexible working members (pumps or pumping installations specially adapted for elastic fluids F04B 45/00) **[1, 2006.01]**

43/02 • having plate-like flexible members, e.g. diaphragms (F04B 43/14 takes precedence) **[1, 3, 2006.01]**

43/04 • • Pumps having electric drive **[1, 2006.01]**

43/06 • • Pumps having fluid drive **[1, 2006.01]**

43/067 • • • the fluid being actuated directly by a piston **[6, 2006.01]**

43/073 • • • the actuating fluid being controlled by at least one valve **[6, 2006.01]**

43/08 • having tubular flexible members (F04B 43/12 takes precedence) **[1, 2006.01]**

43/09 • • Pumps having electric drive **[6, 2006.01]**

43/10 • • Pumps having fluid drive **[1, 2006.01]**

43/107 • • • the fluid being actuated directly by a piston **[6, 2006.01]**

43/113 • • • the actuating fluid being controlled by at least one valve **[6, 2006.01]**

43/12 • having peristaltic action **[1, 2006.01]**

43/14 • • having plate-like flexible members **[3, 2006.01]**

45/00 Pumps or pumping installations having flexible working members and specially adapted for elastic fluids [1, 2006.01]

45/02 • having bellows **[1, 2006.01]**

45/027 • • having electric drive **[6, 2006.01]**

45/033 • • having fluid drive **[6, 2006.01]**

45/04 • having plate-like flexible members, e.g. diaphragms (F04B 45/10 takes precedence) **[1, 3, 2006.01]**

45/047 • • Pumps having electric drive **[6, 2006.01]**

45/053 • • Pumps having fluid drive **[6, 2006.01]**

45/06 • having tubular flexible members (F04B 45/02, F04B 45/08 take precedence) **[1, 3, 2006.01]**

45/067 • • Pumps having electric drive **[6, 2006.01]**

45/073 • • Pumps having fluid drive **[6, 2006.01]**

45/08 • having peristaltic action **[1, 3, 2006.01]**

45/10 • • having plate-like flexible members **[3, 2006.01]**

47/00 Pumps or pumping installations specially adapted for raising fluids from great depths, e.g. well pumps (by using positive or negative pressurised fluid medium acting directly on the liquid to be pumped F04F 1/00) **[1, 2006.01]**

47/02 • the driving mechanisms being situated at ground level (F04B 47/12 takes precedence) **[1, 2006.01]**

47/04 • • the driving means incorporating fluid means **[1, 2006.01]**

47/06 • having motor-pump units situated at great depth **[1, 2006.01]**

47/08 • • the motors being actuated by fluid **[1, 2006.01]**

47/10 • • • the units or parts thereof being liftable to ground level by fluid pressure **[1, 2006.01]**

47/12 • having free plunger lifting the fluid to the surface **[1, 2006.01]**

47/14 • Counterbalancing **[1, 2006.01]**

49/00 Control of, or safety measures for, machines, pumps, or pumping installations, not otherwise provided for in, or of interest apart from, groups F04B 1/00-F04B 47/00 [1, 2006.01]

49/02 • Stopping, starting, unloading, or idling control (controlled electrically F04B 49/06) **[1, 6, 2006.01]**

49/025 • • by means of floats **[6, 2006.01]**

49/03 • • by means of valves **[6, 2006.01]**

49/035 • • • Bypassing **[6, 2006.01]**

49/04 • Regulating by means of floats (F04B 49/025 takes precedence) **[1, 6, 2006.01]**

49/06 • Control using electricity (regulating by means of floats actuating electric switches F04B 49/04) **[1, 2006.01]**

49/08 • Regulating by delivery pressure **[1, 2006.01]**

49/10 • Other safety measures **[1, 2006.01]**

49/12 • by varying the length of stroke of the working members **[6, 2006.01]**

49/14 • • Adjusting abutments located in the path of reciprocation **[6, 2006.01]**

49/16 • by adjusting the capacity of dead spaces of working chambers **[6, 2006.01]**

49/18 • by changing the effective cross-section of the working surface of the piston **[6, 2006.01]**

49/20 • by changing the driving speed (controlled electrically F04B 49/06) **[6, 2006.01]**

49/22 • by means of valves (F04B 49/03 takes precedence) **[6, 2006.01]**

49/24 • • Bypassing **[6, 2006.01]**

51/00 Testing machines, pumps, or pumping installations [1, 2006.01]

53/00 Component parts, details or accessories not provided for in, or of interest apart from, groups F04B 1/00-F04B 23/00 or F04B 39/00-F04B 47/00 [6, 2006.01]

53/02 • Packing the free space between cylinders and pistons **[6, 2006.01]**

53/04 • Draining **[6, 2006.01]**

53/06 • Venting **[6, 2006.01]**

53/08 • Cooling (of machines or engines in general F01P); Heating; Preventing freezing **[6, 2006.01]**

53/10 • Valves; Arrangement of valves **[6, 2006.01]**

53/12 • • arranged in or on pistons **[6, 2006.01]**

53/14 • Pistons, piston-rods or piston-rod connections **[6, 2006.01]**

53/16 • Casings; Cylinders; Cylinder liners or heads; Fluid connections **[6, 2006.01]**

53/18 • Lubricating (of machines or engines in general F01M) **[6, 2006.01]**

53/20 • Filtering **[6, 2006.01]**

53/22 • Arrangements for enabling ready assembly or disassembly **[6, 2006.01]**