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

F02 COMBUSTION ENGINES; HOT-GAS OR COMBUSTION-PRODUCT ENGINE PLANTS

F02B INTERNAL-COMBUSTION PISTON ENGINES; COMBUSTION ENGINES IN GENERAL (cyclically operating valves therefor F01L; lubricating internal-combustion engines F01M; gas-flow silencers or exhaust apparatus therefor F01N; cooling of internal-combustion engines F01P; internal-combustion turbines F02C; plants in which engines use combustion products F02C, F02G)

Note(s)

1. In this subclass, the following terms or expression are used with the meanings indicated:
   - "positive ignition" means ignition by a source external to the working fluid, e.g. by spark or incandescent source;
   - "charging" means forcing air or fuel-air mixture into engine cylinders, and thus includes supercharging;
   - "scavenging" means forcing the combustion residues from the cylinders other than by movement of the working pistons, and thus includes tuned exhaust systems.
2. Attention is drawn to the Notes preceding class F01, especially as regards Note (1).
3. Engines with specified cycles or number of cylinders are classified in group F02B 75/02 or F02B 75/16, unless other classifying features predominate.

Subclass index

Engines characterised by the working fluid to be compressed or characterised by the type of ignition

1/00 **Engines characterised by fuel-air mixture compression** (characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition F02B 11/00; characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

1/02 • with positive ignition (with non-timed positive ignition F02B 9/06)

1/04 • • with fuel-air mixture admission into cylinder

1/06 • • • Methods of operating

1/08 • • with separate admission of air and fuel into cylinder

1/10 • • • Methods of operating

1/12 • with compression ignition (with fuel-air charge ignited by compression ignition of an additional fuel F02B 7/00)

1/14 • • Methods of operating

3/00 **Engines characterised by air compression and subsequent fuel addition** (characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition F02B 11/00; characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

3/02 • with positive ignition (with non-timed positive ignition F02B 9/06)

3/04 • • Methods of operating

3/06 • with compression ignition (F02B 13/02 takes precedence; with fuel-air charge ignited by compression ignition of an additional fuel F02B 7/00)

3/08 • • Methods of operating (F02B 3/12 takes precedence)

3/10 • • with intermittent fuel introduction

3/12 • • • Methods of operating

5/00 **Engines characterised by positive ignition** (F02B 1/02, F02B 3/02 take precedence; with non-timed positive ignition F02B 9/06; characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition F02B 11/00; characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

5/02 • Methods of operating

7/00 **Engines characterised by the fuel-air charge being ignited by compression ignition of an additional fuel** (characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition F02B 11/00; characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

7/02 • the fuel in the charge being liquid

7/04 • • Methods of operating

7/06 • the fuel in the charge being gaseous

7/08 • • Methods of operating

9/00 **Engines characterised by other types of ignition** (characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition F02B 11/00; characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

9/02 • with compression ignition (F02B 1/12, F02B 3/06 take precedence)

9/04 • • Methods of operating

9/06 • with non-timed positive ignition, e.g. with hot-spots

9/08 • • with incandescent chambers

9/10 • • • Chamber shapes or constructions

11/00 **Engines characterised by both fuel-air mixture compression and air compression, or characterised by both positive ignition and compression ignition, e.g. in different cylinders** (characterised by precombustion chambers F02B 19/00; characterised by air-storage chambers F02B 21/00; characterised by special shape or construction of combustion chambers F02B 23/00)

11/02 • convertible from fuel-air mixture compression to air compression or vice versa

Engines characterised by the method of introducing liquid fuel into cylinders

13/00 **Engines characterised by the introduction of liquid fuel into cylinders by use of auxiliary fluid**

13/02 • Compression ignition engines using air or gas for blowing fuel into compressed air in cylinder

13/04 • • Arrangements or adaptations of pumps

13/06 • Engines having secondary air mixed with fuel in pump, compressed therein without ignition, and fuel-air mixture being injected into air in cylinder

13/08 • • Arrangements or adaptations of pumps

13/10 • Use of specific auxiliary fluids, e.g. steam, combustion gas

15/00 **Engines characterised by the method of introducing liquid fuel into cylinders and not otherwise provided for**

15/02 • having means for sucking fuel directly into cylinder

17/00 **Engines characterised by means for effecting stratification of charge in cylinders**

Engines characterised by precombustion chambers or air-storage chambers, or characterised by special shape or construction of combustion chambers to improve operation

19/00 **Engines characterised by precombustion chambers** (engines with incandescent chambers F02B 9/08)

19/02 • the chamber being periodically isolated from its cylinder

19/04 • • the isolation being effected by a protuberance on piston or cylinder head

19/06 • with auxiliary piston in chamber for transferring ignited charge to cylinder space

19/08 • the chamber being of air-swirl type

19/10 • with fuel introduced partly into pre-combustion chamber, and partly into cylinder (F02B 19/02-F02B 19/08 take precedence)

19/12 • with positive ignition (F02B 19/02-F02B 19/10 take precedence)
19/14 • with compression ignition (F02B 19/02-F02B 19/10 take precedence)
19/16 • Chamber shapes or constructions not specific to groups F02B 19/02-F02B 19/10
19/18 • • Transfer passages between chamber and cylinder

21/00 Engines characterised by air-storage chambers
21/02 • Chamber shapes or constructions

23/00 Other engines characterised by special shape or construction of combustion chambers to improve operation (engines with incandescent chambers F02B 9/08)
23/02 • with compression ignition
23/04 • • the combustion space being subdivided into two or more chambers (with pre-combustion chambers F02B 19/00)
23/06 • • the combustion space being arranged in working piston (F02B 23/04 takes precedence)
23/08 • with positive ignition
23/10 • • with separate admission of air and fuel into cylinder

Engines characterised by provision for charging or scavenging

25/00 Engines characterised by using fresh charge for scavenging cylinders (aspects characterised by provision of driven charging or scavenging pumps F02B 33/00-F02B 39/00)
25/02 • using unidirectional scavenging
25/04 • • Engines having ports both in cylinder head and in cylinder wall near bottom of piston stroke
25/06 • • • the cylinder-head ports being controlled by working pistons, e.g. by sleeve-shaped extensions thereof
25/08 • • Engines with oppositely-moving reciprocating working pistons
25/10 • • • with one piston having a smaller diameter or shorter stroke than the other
25/12 • • Engines with U-shaped cylinders, having ports in each arm
25/14 • using reverse-flow scavenging, e.g. with both inlet and outlet ports arranged near bottom of piston stroke
25/16 • • the charge flowing upward essentially along cylinder wall opposite the inlet ports
25/18 • • the charge flowing upward essentially along cylinder wall adjacent the inlet ports, e.g. by means of deflection rib on piston
25/20 • Means for reducing the mixing of charge and combustion residues or for preventing escape of fresh charge through outlet ports, not provided for in, or of interest apart from, groups F02B 25/02-F02B 25/18
25/22 • • by forming air cushion between charge and combustion residues
25/24 • • Inlet or outlet openings being timed asymmetrically relative to bottom dead-centre
25/26 • Multi-cylinder engines other than those provided for in, or of interest apart from, groups F02B 25/02-F02B 25/24 (internal-combustion aspects of rotary engines with movable cylinders F02B 57/00)
25/28 • • with V-, fan-, or star-arrangement of cylinders

27/00 Use of kinetic or wave energy of charge in induction systems, or of combustion residues in exhaust systems, for improving quantity of charge or for increasing removal of combustion residues (aspects characterised by provision of driven charging or scavenging pumps F02B 33/00-F02B 39/00, e.g. use of driven apparatus for immediate conversion of combustion gas pressure into pressure of fresh charge F02B 33/42)
27/02 • the systems having variable, i.e. adjustable, cross-sectional areas, chambers of variable volume, or like variable means (in exhaust systems only F02B 27/06)
27/04 • in exhaust systems only, e.g. for sucking-off combustion gases
27/06 • • the systems having variable, i.e. adjustable, cross-sectional areas, chambers of variable volume, or like variable means

29/00 Engines characterised by provision for charging or scavenging not provided for in groups F02B 25/00, F02B 27/00 or F02B 33/00-F02B 39/00; Details thereof
29/02 • Other fluid-dynamic features of induction systems for improving quantity of charge (for also imparting a rotation to the charge in the cylinder F02B 31/00; structural features of induction systems F02M)
29/04 • Cooling of air intake supply
29/06 • After-charging, i.e. supplementary charging after scavenging
29/08 • Modifying distribution valve timing for charging purposes (F02B 29/06 takes precedence; valve-gear therefor F01L)

31/00 Modifying induction systems for imparting a rotation to the charge in the cylinder (structural features of induction systems F02M)
31/02 • in engines having inlet valves arranged eccentrically to cylinder axis (F02B 31/08 takes precedence) **[6]**
31/04 • by means within the induction channel, e.g. deflectors **[6]**
31/06 • • Movable means, e.g. butterfly valves **[6]**
31/08 • having multiple air inlets **[6]**

Engines characterised by provision of driven charging or scavenging pumps

33/00 Engines characterised by provision of pumps for charging or scavenging (characterised by the introduction of liquid fuel into cylinders by use of auxiliary fluid F02B 13/00; characterised by after-charging F02B 29/06; characterised by provision of pumps for sucking combustion residues from cylinders F02B 35/00; characterised by provision of exhaust-driven pumps F02B 37/00)
33/02 • Engines with reciprocating-piston pumps; Engines with crankcase pumps
33/04 • • with simple crankcase pumps, i.e. with the rear face of a non-stepped working piston acting as sole pumping member in co-operation with the crankcase
33/06 • • with reciprocating-piston pumps other than simple crankcase pumps
33/08 • • • with the working-cylinder head arranged between working and pumping cylinders

33/10 • • • with the pumping cylinder situated between working cylinder and crankcase, or with the pumping cylinder surrounding working cylinder
33/12 • • • • the rear face of working piston acting as pumping member and co-operating with a pumping chamber isolated from crankcase, the connecting-rod passing through the chamber and co-operating with movable isolating member
33/14 • • • • working and pumping pistons forming stepped piston
33/16 • • • • working and pumping pistons having differing movements
33/18 • • • with crankshaft being arranged between working and pumping cylinders
33/20 • • • with pumping-cylinder axis arranged at an angle to working-cylinder axis, e.g. at an angle of 90°
33/22 • • • with pumping cylinder situated at side of working cylinder, e.g. the cylinders being parallel
33/24 • • with crankcase pumps other than with reciprocating pistons only
33/26 • • Four-stroke engines characterised by having crankcase pumps
33/28 • • Component parts, details, or accessories of crankcase pumps not provided for in, or of interest apart from, groups F02B 33/02-F02B 33/26
33/30 • • • Control of inlet or outlet ports (controlling only working-cylinder inlets F01L)
33/32 • Engines with pumps other than of reciprocating-piston type (with crankcase pumps F02B 33/02)
33/34 • • with rotary pumps (with cell-type pressure exchangers or the like F02B 33/42)
33/36 • • • of positive-displacement type
33/38 • • • • of Roots type
33/40 • • • of non-positive-displacement type
33/42 • • with driven apparatus for immediate conversion of combustion gas pressure into pressure of fresh charge, e.g. with cell-type pressure exchangers (pressure exchangers per se F04F 13/00)
33/44 • Passages conducting the charge from the pump to the engine inlet, e.g. reservoirs (cooling of charge after leaving pump F02B 29/04)

35/00 Engines characterised by provision of pumps for sucking combustion residues from cylinders

35/02 • using rotary pumps

37/00 Engines characterised by provision of pumps driven at least for part of the time by exhaust (characterised by the introduction of liquid fuel into cylinders by use of auxiliary fluid F02B 13/00; characterised by after-charging F02B 29/06; characterised by passages conducting the charge from the pump to the engine inlet F02B 33/44)

37/007 • with exhaust-driven pumps arranged in parallel **[6]**
37/013 • with exhaust-driven pumps arranged in series **[6]**
37/02 • Gas passages between engine outlet and pump drive, e.g. reservoirs
37/04 • Engines with exhaust drive and other drive of pumps, e.g. with exhaust-driven pump and mechanically-driven second pump
37/10 • • at least one pump being alternately driven by exhaust and other drive **[3]**
37/11 • • • driven by other drive at starting only **[6]**
37/12 • Control of the pumps **[3]**
37/14 • • of the alternation between exhaust drive and other drive of a pump, e.g. dependent on speed **[3]**
37/16 • • by bypassing charging air **[6]**
37/18 • • by bypassing exhaust **[6]**
37/20 • • by increasing exhaust energy, e.g. using combustion chambers **[6]**
37/22 • • by varying the cross-section of exhaust passages or air passages **[6]**
37/24 • • by using pumps or turbines with adjustable guide vanes **[6]**

39/00 Component parts, details, or accessories relating to driven charging or scavenging pumps, not provided for in groups F02B 33/00-F02B 37/00

39/02 • Drives of pumps (exhaust drives or combined exhaust and other drives F02B 37/00); Varying pump drive gear ratio (control acting both on engine and on pump drive gear ratio F02D)
39/04 • • Mechanical drives; Variable-gear-ratio drives (non-mechanical pump drives having variable gear ratio F02B 39/08)
39/06 • • • the engine torque being divided by a differential gear for driving a pump and the engine output shaft
39/08 • • Non-mechanical drives, e.g. fluid drives having variable gear ratio
39/10 • • • electric
39/12 • • Drives characterised by use of couplings or clutches therein (using fluid slip couplings for varying gear ratio F02B 39/08)
39/14 • Lubrication of pumps; Safety measures therefor
39/16 • Other safety measures for, or other control of, pumps

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41/00 Engines characterised by special means for improving conversion of heat or pressure energy into mechanical power

41/02 • Engines with prolonged expansion
41/04 • • in main cylinders
41/06 • • in compound cylinders
41/08 • • • Two-stroke compound engines
41/10 • • using exhaust turbines (use of exhaust turbines for charging F02B 37/00; turbine constructions F01D; gas-turbine plants F02C)

Engines operating on non-liquid fuels; Plants including such engines, i.e. combinations of the engine with fuel-generating apparatus

43/00 Engines characterised by operating on gaseous fuels; Plants including such engines (engines characterised by the gas-air charge being ignited by compression ignition of an additional fuel F02B 7/06; engines convertible from gas to other fuel consumption F02B 69/04)

43/02 • Engines characterised by means for increasing operating efficiency
43/04 • • for improving efficiency of combustion
43/06 • • for enlarging charge
43/08 • Plants characterised by the engines using gaseous fuel generated in the plant from solid fuel, e.g. wood
43/10 • Engines or plants characterised by use of other specific gases, e.g. acetylene, oxyhydrogen
43/12 • • Methods of operating

45/00 **Engines characterised by operating on non-liquid fuels other than gas; Plants including such engines** (plants involving generation of gaseous fuel from solid fuel F02B 43/08; engines convertible from gas to other fuel consumption F02B 69/04)

45/02 • operating on powdered fuel, e.g. powdered coal (operating on fuel containing oxidant F02B 45/06)

45/04 • • Plants, e.g. having coal-grinding apparatus

45/06 • operating on fuel containing oxidant

45/08 • operating on other solid fuels

45/10 • operating on mixtures of liquid and non-liquid fuels, e.g. in pasty or foamed state

Methods of operating engines involving specific pre-treating of, or adding specific substances to, combustion air, fuel or fuel-air mixture of the engines, and not otherwise provided for

47/00 **Methods of operating engines involving adding non-fuel substances or anti-knock agents to combustion air, fuel, or fuel-air mixtures of engines**

47/02 • the substances being water or steam

47/04 • the substances being other than water or steam only

47/06 • • the substances including non-airborne oxygen (F02B 47/10 takes precedence)

47/08 • • the substances including exhaust gas

47/10 • • • Circulation of exhaust gas in closed or semi-closed circuits, e.g. with simultaneous addition of oxygen

49/00 **Methods of operating air-compressing compression-ignition engines involving introduction of small quantities of fuel in the form of a fine mist into the air in the engine's intake**

51/00 **Other methods of operating engines involving pre-treating of, or adding substances to, combustion air, fuel, or fuel-air mixture of the engines**

51/02 • involving catalysts

51/04 • involving electricity or magnetism

51/06 • involving rays or sound waves

Internal-combustion aspects of rotary-piston or oscillating-piston engines

53/00 **Internal-combustion aspects of rotary-piston or oscillating-piston engines** (internal-combustion aspects of rotary pistons or outer members for co-operation therewith F02B 55/00)

53/02 • Methods of operating

53/04 • Charge admission or combustion-gas discharge

53/06 • • Valve control therefor

53/08 • • Charging, e.g. by means of rotary-piston pump

53/10 • Fuel supply; Introducing fuel to combustion space

53/12 • Ignition

53/14 • Adaptations of engines for driving, or engine combinations with, other devices (aspects predominantly concerning such devices, see the relevant classes for the devices)

55/00 **Internal-combustion aspects of rotary pistons; Outer members for co-operation with rotary pistons**

55/02 • Pistons

55/04 • • Cooling thereof

55/06 • • • by air or other gas

55/08 • Outer members for co-operation with rotary pistons; Casings

55/10 • • Cooling thereof

55/12 • • • by air or other gas

55/14 • Shapes or constructions of combustion chambers

55/16 • Admission or exhaust passages in pistons or outer members

Internal-combustion aspects of reciprocating-piston engines with movable cylinders

57/00 **Internal-combustion aspects of rotary engines in which the combusted gases displace one or more reciprocating pistons**

57/02 • Fuel or combustion-air supply (cylinder-charge admission or exhaust control F02B 57/04)

57/04 • Control of cylinder-charge admission or exhaust (peculiar to two-stroke engines or to other engines with working-piston-controlled charge admission or exhaust F02B 57/06)

57/06 • Two-stroke engines or other engines with working-piston-controlled cylinder-charge admission or exhaust (with combustion space in centre of star F02B 57/10)

57/08 • Engines with star-shaped cylinder arrangements

57/10 • • with combustion space in centre of star

59/00 **Internal-combustion aspects of other reciprocating-piston engines with movable, e.g. oscillating, cylinders** (with yieldable walls F02B 75/38)

Adaptations of engines for special use; Combinations of engines with devices other than engine parts or auxiliaries

61/00 **Adaptations of engines for driving vehicles or for driving propellers; Combinations of engines with gearing** (the engine torque being divided by a differential gear for driving a scavenging or charging pump and the engine output shaft F02B 39/06; adaptations or combinations of rotary-piston or oscillating-piston engines F02B 53/14; arrangements in vehicles, see the relevant classes for vehicles)

61/02 • for driving cycles

61/04 • for driving propellers

61/06 • Combinations of engines with mechanical gearing (F02B 61/02, F02B 61/04 take precedence)

63/00 **Adaptations of engines for driving pumps, hand-held tools or electric generators; Portable combinations of engines with engine-driven devices** (of rotary-piston or oscillating-piston engines F02B 53/14)

63/02 • for hand-held tools

63/04 • for electric generators

63/06 • for pumps

65/00 **Adaptations of engines for special uses not provided for in groups F02B 61/00 or F02B 63/00; Combinations of engines with other devices, e.g. with non-driven apparatus** (of rotary-piston or oscillating-piston engines F02B 53/14; combinations of prime-movers consisting of electric motors and internal combustion engines for mutual or common propulsion B60K 6/20)

Engines with pertinent characteristics other than those provided for in, or of interest apart from, preceding main groups

67/00 Engines characterised by the arrangement of auxiliary apparatus not being otherwise provided for, e.g. the apparatus having different functions; Driving auxiliary apparatus from engines, not otherwise provided for

67/04 • of mechanically-driven auxiliary apparatus

67/06 • • driven by means of chains, belts, or like endless members

67/08 • of non-mechanically driven auxiliary apparatus

67/10 • of charging or scavenging apparatus **[5]**

69/00 Internal-combustion engines convertible into other combustion-engine type, not provided for in group F02B 11/00; Internal-combustion engines of different types characterised by constructions facilitating use of same main engine-parts in different types

69/02 • for different fuel types, other than engines indifferent to fuel consumed, e.g. convertible from light to heavy fuel

69/04 • • for gaseous and non-gaseous fuels

69/06 • for different cycles, e.g. convertible from two-stroke to four-stroke

71/00 Free-piston engines; Engines without rotary main shaft

71/02 • Starting

71/04 • Adaptations of such engines for special use; Combinations of such engines with apparatus driven thereby (aspects predominantly concerning driven apparatus, see the relevant classes for such apparatus)

71/06 • • Free-piston combustion gas generators

73/00 Combinations of two or more engines, not otherwise provided for

75/00 Other engines, e.g. single-cylinder engines

75/02 • Engines characterised by their cycles, e.g. six-stroke

75/04 • Engines with variable distances between pistons at top dead-centre positions and cylinder heads

75/06 • Engines with means for equalising torque (compensations of inertial forces, suppression of vibration in systems F16F)

75/08 • Engines with means for preventing corrosion in gas-swept spaces

75/10 • Engines with means for rendering exhaust gases innocuous (apparatus for rendering exhaust gases innocuous per se F01N 3/08)

75/12 • Other methods of operation

75/16 • Engines characterised by number of cylinders, e.g. single-cylinder engines (F02B 75/26 takes precedence)

75/18 • • Multi-cylinder engines (scavenging aspects F02B 25/00)

75/20 • • • with cylinders all in one line

75/22 • • • with cylinders in V-, fan-, or star-arrangement

75/24 • • • with cylinders arranged oppositely relative to main shaft and of "flat" type

75/26 • Engines with cylinder axes coaxial with, or parallel or inclined to, main-shaft axis; Engines with cylinder axes arranged substantially tangentially to a circle centred on main-shaft axis

75/28 • Engines with two or more pistons reciprocating within same cylinder or within essentially coaxial cylinders (arranged oppositely relative to main shaft F02B 75/24)

75/30 • • with one working piston sliding inside another

75/32 • Engines characterised by connections between pistons and main shafts and not specific to preceding main groups

75/34 • Ultra-small engines, e.g. for driving models

75/36 • Engines with parts of combustion- or working-chamber walls resiliently yielding under pressure

75/38 • • Reciprocating-piston engines (F02B 75/04 takes precedence; with resiliently-urged auxiliary piston in pre-combustion chamber F02B 19/06)

75/40 • Other reciprocating-piston engines

77/00 Component parts, details, or accessories, not otherwise provided for

77/02 • Surface coverings of combustion-gas-swept parts (of pistons or cylinders only F02F)

77/04 • Cleaning of, preventing corrosion or erosion in, or preventing unwanted deposits in, combustion engines

77/08 • Safety, indicating, or supervising devices (thermal insulation F02B 77/11; monitoring or diagnostic devices for exhaust-gas treatment apparatus F01N 11/00)

77/10 • • Safety means relating to crankcase explosions

77/11 • Thermal or acoustic insulation **[3]**

77/13 • • Acoustic insulation **[3]**

77/14 • Engine-driven auxiliary devices combined into units

79/00 Running-in of internal-combustion engines (lubrication thereof F01M)