CPC COOPERATIVE PATENT CLASSIFICATION

F01D NON-POSITIVE DISPLACEMENT MACHINES OR ENGINES, e.g. STEAM TURBINES (machines or engines for liquids F03; non-positive displacement pumps F04D)

NOTE

This subclass covers:

- non-positive-displacement engines for elastic fluids, e.g. steam turbines;
- non-positive-displacement engines for liquids and elastic fluids;
- non-positive-displacement machines for elastic fluids;
- non-positive-displacement machines for liquids and elastic fluids.

Attention is drawn to the Notes preceding class F01, especially as regards the definitions of "reaction type", e.g. with airfoil-like blades, and "impulse type", e.g. bucket turbines.

WARNING

The following IPC groups are not used in the CPC system. Subject matter covered by these groups is classified in the following CPC groups:

F01D 5/32 covered by F01D 5/30

F01D 1/00 **Non-positive-displacement machines or engines, e.g. steam turbines** (wit working-fluid flows in opposite axial directions for balancing axial thrust F01D 3/02; with other than pure rotation F01D 23/00; turbines characterised by their use in special steam systems, cycles, or processes, regulating devices therefor F01K)

F01D 1/02 . with stationary working-fluid guiding means and bladed or like rotor, { e.g. multi-bladed impulse steam turbines } (F01D 1/24 takes precedence; without stationary working-fluid guiding means F01D 1/18)

F01D 1/023 . . { the working-fluid being divided into several separate flows (F01D 3/02 takes precedence); several seperate fluid flows being united in a single flow; the machine or engine having provision for two or more different possible fluid flow paths }

F01D 1/026 . . { Impact turbines with buckets, i.e. impulse turbines e.g. Pelton turbines (F01D 1/16, F01D 1/34 take precedence)}

F01D 1/04 . . traversed by the working-fluid substantially axially

F01D 1/06 . . traversed by the working-fluid substantially radially

F01D 1/08 . . . having inward flow

F01D 1/10 . . having two or more stages subjected to working-fluid flow without essential intermediate pressure change, i.e. with velocity stages (F01D 1/12 takes precedence)

F01D 1/12 . . with repeated action on same blade ring

F01D 1/14 . . . traversed by the working-fluid substantially radially

F01D 1/16 . . characterised by having both reaction stages and impulse stages

F01D 1/18 . without stationary working-fluid guiding means; (F01D 1/24, F01D 1/32, F01D 1/34 take precedence; { with pressure-velocity transformation exclusively in rotor F01D 1/32 })

F01D 1/20 . . traversed by the working-fluid substantially axially

F01D 1/22 . . traversed by the working-fluid substantially radially

F01D 1/24 . characterised by counter-rotating rotors subjected to same working fluid stream without intermediate stator blades or the like

F01D 1/26 . . traversed by the working-fluid substantially axially

F01D 1/28 . . traversed by the working-fluid substantially radially

F01D 1/30 . characterised by having a single rotor operable in either direction of rotation, e.g. by reversing of blades (combinations of machines or engines F01D 13/00)

F01D 1/32 . with pressure velocity transformation exclusively in rotor, e.g. the rotor rotating under the influence of jets issuing from the rotor, { e.g. Heron turbines (the working fluid being a combustion products F02C 3/165; jet propulsion plants per se F02K)}

F01D 1/34 . characterised by non-bladed rotor, e.g. with drilled holes (F01D 1/32 takes precedence; sirens G10K 7/00 { impact turbines with buckets F01D 1/026; hand-held tools with a non-bladed rotor F01D 15/067 })

F01D 1/36 . . using fluid friction

F01D 1/38 . . of the screw type

F01D 3/00 **Machines or engines with axial-thrust balancing effected by working-fluid**

F01D 3/02 . characterised by having one fluid flow in one axial direction and another fluid flow in the opposite direction

F01D 3/025 . . { with a centrally disposed radial stage }

F01D 3/04 . axial thrust being compensated by thrust-balancing dummy piston or the like

F01D 5/00 **Blades; Blade-carrying members** (nozzle boxes F01D 9/02)**; Heating, heat-insulating, cooling or anti-vibration means on the blades or the members** { special arrangements in rotors dealing with breaking off of part thereof F01D 21/045 }

F01D 5/005 . { Repairing methods or devices }

F01D 5/02 . Blade-carrying members, e.g. rotors (rotors of non-bladed type F01D 1/34; stators F01D 9/00) { selecting particular materials F01D 5/28 }

F01D 5/021 . . { for flow machines or engines with only one axial stage (for more than one stage F01D 5/06)}

F01D 5/022 . . { with concentric rows of axial blades }

F01D 5/023 . . { of the screw type }

F01D 5/025 . . { Fixing blade carrying members on shafts (attachment of a member on a shaft in general F16D 1/06; for non-positive displacement pumps F04D 29/00)}

F01D 5/026 . . { Shaft to shaft connections }

F01D 5/027 . . { Arrangements for balancing (for balancing rotating bodies in general F16F 15/32; for compensating unbalance G01M 1/36)}

F01D 5/028 . . { the rotor disc being formed of sheet laminae (rotor blade aggregates of unitary construction F01D 5/34)}

F01D 5/03 . . Annular blade-carrying members having blades on the inner periphery of the annulus and extending inwardly radially, i.e. inverted rotors

F01D 5/04 . . for radial-flow machines or engines

F01D 5/041 . . . { of the Ljungström type }

F01D 5/043 . . . { of the axial inlet- radial outlet, or vice-versa, type }

F01D 5/045 . . . . { the wheel comprising two adjacent bladed wheel portions e.g. with interengaging blades for damping vibrations }

F01D 5/046 . . . . { Heating, heat insulation or cooling means }

F01D 5/048 . . . . { Form or construction }

F01D 5/06 . . Rotors for more than one axial stage, e.g. of drum or multiple disc type; Details thereof, e.g. shafts, shaft connections { F01D 5/022, F01D 5/023 take precedence }

F01D 5/063 . . . { Welded rotors (welding per se B23K)}

F01D 5/066 . . . { Connecting means for joining rotor-discs or rotor-elements together, e.g. by a central bolt, by clamps }

F01D 5/08 . . Heating, heat-insulating or cooling means { specially adapted for radial flow machines or engines F01D 5/04 }

F01D 5/081 . . . { Cooling fluid being directed on the side of the rotor disc or at the roots of the blades (F01D 5/087 takes precedence)}

F01D 5/082 . . . . { on the side of the rotor disc }

F01D 5/084 . . . . { the fluid circulating at the periphery of a multistage rotor, e.g. of drum type }

F01D 5/085 . . . { cooling fluid circulating inside the rotor }

F01D 5/087 . . . . { in the radial passages of the rotor disc }

F01D 5/088 . . . . { in a closed cavity }

F01D 5/10 . . Anti- vibration means {(specially adapted for radial flow machines or engines F01D 5/04)}

F01D 5/12 . Blades ({ specially adapted for radial flow machines or engines F01D 5/04 }; blade roots F01D 5/30; rotors with blades adjustable in operation F01D 7/00; stator blades F01D 9/02)

F01D 5/14 . . Form or construction (selecting particular materials, measures against erosion or corrosion F01D 5/28)

F01D 5/141 . . . { Shape, i.e. outer, aerodynamic form (F01D 5/148 to F01D 5/20 take precedence; blade construction F01D 5/147)}

F01D 5/142 . . . . { of the blades of successive rotor or stator blade-rows }

F01D 5/143 . . . . . { Contour of the outer or inner working fluid flow path wall, i.e. shroud or hub contour }

F01D 5/145 . . . . { Means for influencing boundary layers or secondary circulations (for compressors F04D 29/68)}

F01D 5/146 . . . . { of blades with tandem configuration, split blades or slotted blades }

F01D 5/147 . . . { Construction, i.e. structural features, e.g. of weight-saving hollow blades (F01D 5/148, F01D 5/16 and F01D 5/20 take precedence; blade shape F01D 5/141; blades with cooling or heating channels or cavities F01D 5/18; heating, heat-insulating or cooling means on blades F01D 5/18)}

F01D 5/148 . . . { Blades with variable camber, e.g. by ejection of fluid }

F01D 5/16 . . . for counteracting blade vibration

F01D 5/18 . . . Hollow blades, { i.e. blades with cooling or heating channels or cavities (structure of hollow blades in general F01D 5/147)}; Heating, heat-insulating or cooling means on blades

F01D 5/181 . . . . { Blades having a closed internal cavity containing a cooling medium, e.g. sodium }

F01D 5/182 . . . . { Transpiration cooling }

F01D 5/183 . . . . . { Blade walls being porous }

F01D 5/184 . . . . . { Blade walls being made of perforated sheet laminae }

F01D 5/185 . . . . { Liquid cooling (F01D 5/181 takes precedence)}

F01D 5/186 . . . . { Film cooling (F01D 5/187 takes precedence)}

F01D 5/187 . . . . { Convection cooling }

F01D 5/188 . . . . . { with an insert in the blade cavity to guide the cooling fluid, e.g. forming a separation wall }

F01D 5/189 . . . . . { the insert having a tubular cross-section, e.g. airfoil shape }

F01D 5/20 . . . Specially-shaped blade tips to seal space between tips and stator {(F01D 5/225 takes precedence)}

F01D 5/22 . . Blade-to-blade connections, { e.g. for damping vibrations }

F01D 5/225 . . . { by shrouding }

F01D 5/24 . . . using wire or the like

F01D 5/26 . . Antivibration means not restricted to blade form or construction or to blade-to-blade connections { or to the use of particular materials }

F01D 5/28 . . Selecting particular materials; { Particular measures relating thereto; } Measures against erosion or corrosion

F01D 5/282 . . . { Selecting composite materials, e.g. blades with reinforcing filaments }

F01D 5/284 . . . { Selection of ceramic materials }

F01D 5/286 . . . { Particular treatment of blades, e.g. to increase durability or resistance against corrosion or erosion (F01D 5/288 takes precedence)}

F01D 5/288 . . . { Protective coatings for blades }

F01D 5/30 . Fixing blades to rotors; Blade roots; { Blade spacers }

F01D 5/3007 . . { of axial insertion type }

F01D 5/3015 . . . { with side plates }

F01D 5/3023 . . { of radial insertion type, e.g. in individual recesses }

F01D 5/303 . . . { in a circumferential slot }

F01D 5/3038 . . . . { the slot having inwardly directed abutment faces on both sides }

F01D 5/3046 . . . { the rotor having ribs around the circumference }

F01D 5/3053 . . { by means of pins }

F01D 5/3061 . . { by welding, brazing }

F01D 5/3069 . . { between two discs or rings }

F01D 5/3076 . . { Sheet metal discs }

F01D 5/3084 . . { the blades being made of ceramics }

F01D 5/3092 . . { Protective layers between blade root and rotor disc surfaces, e.g. anti-friction layers (F01D 5/288 takes precedence)}

F01D 5/32 . . Locking, e.g. by final locking blades or keys

F01D 5/323 . . { Locking of axial insertion type blades by means of a key or the like parallel to the axis of the rotor }

F01D 5/326 . . { Locking of axial insertion type blades by other means }

F01D 5/34 . Rotor-blade aggregates of unitary construction { e.g. formed of sheet laminae; (discs formed of sheet laminae F01D 5/028; Ceramic materials F01D 5/284, composite materials F01D 5/282)}

F01D 7/00 **Rotors with blades adjustable in operation; Control thereof** (for reversing F01D 1/30)

F01D 7/02 . having adjustment responsive to speed

F01D 9/00 **Stators** (non-fluid guiding aspects of casings, regulating, controlling, or safety aspects, see the relevant groups)

F01D 9/02 . Nozzles; Nozzle boxes; Stator blades; Guide conduits { e.g. individual nozzles (nozzle boxes F01D 9/047)}

F01D 9/023 . . { Transition ducts between combustor cans and first stage of the turbine in gas-turbine engines; their cooling or sealings }

F01D 9/026 . . { Scrolls for radial machines or engines }

F01D 9/04 . . forming ring or sector

F01D 9/041 . . . { using blades (F01D 5/148 takes precedence)}

F01D 9/042 . . . { fixing blades to stators (fixing stator-rings in the casing or to each other F01D 25/246)}

F01D 9/044 . . . . { permanently, e.g. by welding, brazing, casting or the like }

F01D 9/045 . . . { for radial flow machines or engines }

F01D 9/047 . . . { Nozzle boxes }

F01D 9/048 . . . { for radial admission }

F01D 9/06 . Fluid supply conduits to nozzles or the like

F01D 9/065 . . { Fluid supply or removal conduits traversing the working fluid flow, e.g. for lubrication-, cooling- ,or sealing fluids (see also F01D 25/16, F01D 25/24 and F01D 25/26)}

F01D 11/00 **Preventing or minimising internal leakage of working-fluid, e.g. between stages** (sealings in general F16J) { sealing arrangements for transition ducts of combustor cans F01D 9/023 }

F01D 11/001 . { for sealing space between stator blade and rotor }

F01D 11/003 . { by packing rings; Mechanical seals }

F01D 11/005 . { Sealing means between non relatively rotating elements }

F01D 11/006 . . { Sealing the gap between rotor blades or blades and rotor }

F01D 11/008 . . . { by spacer elements between the blades, e.g. independent interblade platforms }

F01D 11/02 . by non-contact sealings, e.g. of labyrinth type (for sealing space between rotor blade

tips and stator F01D 11/08)

F01D 11/025 . . { Seal clearance control; Floating assembly; Adaptation means to differential thermal dilatations }

F01D 11/04 . . using sealing fluid, e.g. steam

F01D 11/06 . . . Control thereof

F01D 11/08 . for sealing space between rotor blade tips and stator (specially-shaped blade tips therefor F01D 5/20)

F01D 11/10 . . using sealing fluid, e.g. steam

F01D 11/12 . . using a rubstrip, e.g. erodible. deformable or resiliently-biased part

F01D 11/122 . . . { with erodable or abradable material (blades having cutting or grinding tips F01D 5/20)}

F01D 11/125 . . . . { with a reinforcing structure }

F01D 11/127 . . . { with a deformable or crushable structure, e.g. honeycomb }

F01D 11/14 . . Adjusting or regulating tip-clearance, i.e distance between rotor-blade tips and stator casing (rotors with blades adjustable in operation F01D 7/00)

F01D 11/16 . . . by self-adjusting means (F01D 11/12 takes precedence)

F01D 11/18 . . . . using stator or rotor components with predetermined thermal response, e.g. selective insulation, thermal inertia, differential expansion

F01D 11/20 . . . Actively adjusting tip-clearance

F01D 11/22 . . . . by mechanically actuating the stator or rotor components, e.g. moving shroud sections relative to the rotor

F01D 11/24 . . . . by selectively cooling-heating stator or rotor components

F01D 13/00 **Combinations of two or more machines or engines** (F01D 15/00 takes precedence; regulating or controlling, see the relevant groups; combinations of two or more pumps F04; fluid gearing F16H)

F01D 13/003 . { with at least two independent shafts, i.e. cross-compound }

F01D 13/006 . { one being a reverse turbine }

F01D 13/02 . Working-fluid interconnection of machines or engines

F01D 15/00 **Adaptations of machines or engines for special use; Combinations of engines with devices driven thereby** (regulating or controlling see the relevant groups; aspects predominantly concerning driven devices, see the relevant classes for the devices)

F01D 15/005 . { Adaptations for refrigeration plants }

F01D 15/02 . Adaptations for driving vehicles, e.g. locomotives (arrangement in vehicles, see the relevant vehicle classes)

F01D 15/04 . . the vehicles being waterborne vessels

F01D 15/045 . . . { Control thereof }

F01D 15/06 . Adaptations for driving, or combinations with, hand-held tools or the like { control thereof }

F01D 15/062 . . { Controlling means specially adapted therefor }

F01D 15/065 . . { with pressure-velocity transformation exclusively in rotor }

F01D 15/067 . . { characterised by non-bladed rotor }

F01D 15/08 . Adaptations for driving, or combinations with, pumps

F01D 15/10 . Adaptations for driving, or combinations with, electric generators

F01D 15/12 . Combinations with mechanical gearing (driven by multiple engines F01D 13/00)

F01D 17/00 **Regulating or controlling by varying flow** (for reversing F01D 1/30; by varying rotor-blade position F01D 7/00; specially for starting F01D 19/00; shutting-down F01D 21/00; regulating or controlling in general G05) { specially adapted for hand-held tools or the like F01D 15/06 }

F01D 17/02 . Arrangement of sensing elements (sensing elements per se: see the relevant subclasses)

F01D 17/04 . . responsive to load

F01D 17/06 . . responsive to speed

F01D 17/08 . . responsive to condition of working-fluid, e.g. pressure

F01D 17/085 . . . { to temperature }

F01D 17/10 . Final actuators (valves in general F16K) { blades with variable camber F01D 5/148 }

F01D 17/105 . . { by passing part of the fluid }

F01D 17/12 . . arranged in stator parts

F01D 17/14 . . . varying effective cross-sectional area of nozzles or guide conduits

F01D 17/141 . . . . { by means of shiftable members or valves obturating part of the flow path }

F01D 17/143 . . . . . { the shiftable member being a wall, or part thereof of a radial diffuser }

F01D 17/145 . . . . . { by means of valves, e.g. for steam turbines (valves in general F16K)}

F01D 17/146 . . . . { by throttling the volute inlet of radial machines or engines }

F01D 17/148 . . . . { by means of rotatable members, e.g. butterfly valves }

F01D 17/16 . . . . by means of nozzle vanes

F01D 17/162 . . . . . { for axial flow; i.e. the vanes turning around axes which are essentially perpendicular to the rotor centre line (F01D 17/167 takes precedence)}

F01D 17/165 . . . . . { for radial flow; i.e. the vanes turning around axes which are essentially parallel to the rotor centre line (F01D 17/167 takes precedence)}

F01D 17/167 . . . . . { of vanes moving in translation }

F01D 17/18 . . . varying effective number of nozzles or guide conduits { e.g. sequentially operable valves for steam turbines }

F01D 17/20 . Devices dealing with sensing elements or final actuators or transmitting means between them, e.g. power-assisted (sensing elements alone F01D 17/02; final actuators alone F01D 17/10)

F01D 17/205 . . { Centrifugal governers directly linked to valves }

F01D 17/22 . . the operation or power assistance being predominantly non-mechanical

F01D 17/24 . . . electrical

F01D 17/26 . . . fluid, e.g. hydraulic

F01D 19/00 **Starting of machines or engines; Regulating, controlling, or safety means in connection therewith** (warming-up before starting F01D 25/10; turning or inching gear F01D 25/34)

F01D 19/02 . dependent on temperature of component parts, e.g. of turbine-casing

F01D 21/00 **Shutting-down of machines or engines, e.g. in emergency; Regulating, controlling, or safety means not otherwise provided for**

F01D 21/003 . { Arrangements for testing or measuring (for measuring vibrations G01H)}

F01D 21/006 . { Arrangements of brakes (brakes per se F16D)}

F01D 21/02 . Shutting-down responsive to overspeed

F01D 21/04 . responsive to undesired position of rotor relative to stator { or to breaking-off of a part of the rotor }, e.g. indicating such position

F01D 21/045 . . { special arrangements in stators or in rotors dealing with breaking-off of part of rotor }

F01D 21/06 . . Shutting-down

F01D 21/08 . . Restoring position

F01D 21/10 . responsive to unwanted deposits on blades, in working-fluid conduits or the like

F01D 21/12 . responsive to temperature

F01D 21/14 . responsive to other specific conditions

F01D 21/16 . Trip gear

F01D 21/18 . . involving hydraulic means

F01D 21/20 . Checking operation of shut-down devices

F01D 23/00 **Non-positive-displacement machines or engines with movement other than pure rotation, e.g. of endless-chain type**

F01D 25/00 **Component parts, details, or accessories, not provided for in, or of interest apart from, other groups**

F01D 25/002 . { Cleaning of turbomachines }

F01D 25/005 . { Selecting particular materials }

F01D 25/007 . { Preventing corrosion }

F01D 25/02 . De-icing means for engines having icing phenomena

F01D 25/04 . Antivibration arrangements

F01D 25/06 . . for preventing blade vibration (means on blade-carrying members or blades F01D 5/00)

F01D 25/08 . Cooling (of machines or engines in general F01P); Heating; Heat-insulation (of blade-carrying members, of blades F01D 5/00)

F01D 25/10 . . Heating, e.g. warming-up before starting

F01D 25/12 . . Cooling

F01D 25/125 . . . { of bearings }

F01D 25/14 . . Casings modified therefor (double casings F01D 25/26)

F01D 25/145 . . . { Thermally insulated casings }

F01D 25/16 . Arrangement of bearings; Supporting or mounting bearings in casings (bearings per se F16C)

F01D 25/162 . . { Bearing supports }

F01D 25/164 . . . { Flexible supports; Vibration damping means associated with the bearing }

F01D 25/166 . . { Sliding contact bearing (gas bearings F01D 25/22)}

F01D 25/168 . . . { for axial load mainly }

F01D 25/18 . Lubricating arrangements (of machines or engines in general F01M)

F01D 25/183 . . { Sealing means }

F01D 25/186 . . . { for sliding contact bearing }

F01D 25/20 . . using lubrication pumps

F01D 25/22 . . using working-fluid or other gaseous fluid as lubricant

F01D 25/24 . Casings (modified for heating or cooling F01D 25/14); Casing parts, e.g. diaphragms, casing fastenings (casings for rotary machines or engines in general F16M) { special arrangements in stators dealing with breaking-off of part of rotor F01D 21/045 }

F01D 25/243 . . { Flange connections; Bolting arrangements (F01D 25/265 takes precedence)}

F01D 25/246 . . { Fastening of diaphragms or stator-rings }

F01D 25/26 . . Double casings; Measures against temperature strain in casings

F01D 25/265 . . . { Vertically split casings; Clamping arrangements therefor }

F01D 25/28 . Supporting or mounting arrangements, e.g. for turbine casing

F01D 25/285 . . { Temporary support structures, e.g. for testing, assembling, installing, repairing; Assembly methods using such structures }

F01D 25/30 . Exhaust heads, chambers, or the like

F01D 25/305 . . { with fluid, e.g. liquid injection }

F01D 25/32 . Collecting of condensation water; Drainage { Removing solid particles }

F01D 25/34 . Turning or inching gear

F01D 25/36 . . using electric motors