

**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**

1. 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.
2. 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** (with 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 separate 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 ( <a href="#">F01D 5/181</a> takes precedence)}
F01D 5/186	....	{Film cooling ( <a href="#">F01D 5/187</a> 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 {( <a href="#">F01D 5/225</a> 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 ( <a href="#">F01D 5/288</a> 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 ( <a href="#">F01D 5/288</a> 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 governors 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
<b>F01D 23/00</b>	<b>Non-positive-displacement machines or engines with movement other than pure rotation, e.g. of endless-chain type</b>
<b>F01D 25/00</b>	<b>Component parts, details, or accessories, not provided for in, or of interest apart from, other groups</b>
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 <a href="#">F01D 5/00</a> )
F01D 25/08	. Cooling (of machines or engines in general <a href="#">F01P</a> ); Heating; Heat-insulation (of blade-carrying members, of blades <a href="#">F01D 5/00</a> )
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 <a href="#">F01D 25/26</a> )
F01D 25/145	... {Thermally insulated casings}
F01D 25/16	. Arrangement of bearings; Supporting or mounting bearings in casings (bearings per se <a href="#">F16C</a> )
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 <a href="#">F01D 25/22</a> )}
F01D 25/168	... {for axial load mainly}
F01D 25/18	. Lubricating arrangements (of machines or engines in general <a href="#">F01M</a> )
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