

**CPC****COOPERATIVE PATENT CLASSIFICATION****F23C**

**COMBUSTION APPARATUS USING FLUENT FUEL** (combustion apparatus for solid fuel only [F23B](#); burners [F23D](#); constructional details of combustion chambers not otherwise provided for [F23M](#); combustion chambers for generating combustion products of high pressure or high velocity [F23R](#))

**F23C 1/00**

**Combustion apparatus specially adapted for combustion of two or more kinds of fuel simultaneously or alternately, at least one kind of fuel being fluent** (combustion apparatus characterised by the combination of two or more combustion chambers [F23C 6/00](#); pilot flame igniters [F23Q 9/00](#))

[F23C 1/02](#)

- lump or liquid fuel

[F23C 1/04](#)

- lump or gaseous fuel

[F23C 1/06](#)

- lump or pulverulent fuel

[F23C 1/08](#)

- liquid or gaseous fuel

[F23C 1/10](#)

- liquid or pulverulent fuel

[F23C 1/12](#)

- gaseous or pulverulent fuel

**F23C 3/00**

**Combustion apparatus characterised by the shape of the combustion chamber**

[F23C 3/002](#)

- {the chamber having an elongated tubular form, e.g. for a radiant tube}

[F23C 3/004](#)

- {the chamber being arranged for submerged combustion ([F23C 3/002](#) takes precedence)}

[F23C 3/006](#)

- {the chamber being arranged for cyclonic combustion (for waste [F23G 5/32](#))}

[F23C 3/008](#)

- . {for pulverulent fuel}

**F23C 5/00**

**Disposition of burners with respect to the combustion chamber or to one another; Mounting of burners in combustion apparatus** ([F23C 1/00](#), [F23C 15/00](#) take precedence)

[F23C 5/02](#)

- Structural details of mounting

[F23C 5/06](#)

- . Provision for adjustment of burner position during operation

[F23C 5/08](#)

- Disposition of burners

[F23C 5/10](#)

- . {to obtain a flame ring}

[F23C 5/12](#)

- . . {for pulverulent fuel}

[F23C 5/14](#)

- . to obtain a single flame of concentrated or substantially planar form, e.g. pencil or sheet flame ([F23C 5/32](#) takes precedence)

[F23C 5/24](#)

- . to obtain a loop flame

[F23C 5/28](#)

- . to obtain flames in opposing directions, e.g. impacting flames

[F23C 5/32](#)

- . to obtain rotating flames i.e. flames moving helically or spirally

**F23C 6/00**

**Combustion apparatus characterised by the combination of two or more combustion chambers** {or combustion zones, e.g. for staged combustion}

[F23C 6/02](#)

- in parallel arrangement

- F23C 6/04
  - in series connection (consuming smoke or fumes in separate combustion apparatus [F23G 7/06](#))
- F23C 6/042
  - • {with fuel supply in stages (for staged combustion [F23C 6/047](#))}
- F23C 6/045
  - • {with staged combustion in a single enclosure}
- F23C 6/047
  - • • {with fuel supply in stages}
- F23C 7/00**

**Combustion apparatus characterised by arrangements for air supply (inlets for fluidisation air [F23C 10/20](#))**
- F23C 7/002
  - {the air being submitted to a rotary or spinning motion (cyclonic combustion chamber [F23C 3/006](#))}
- F23C 7/004
  - • {using vanes}
- F23C 7/006
  - • • {adjustable}
- F23C 7/008
  - {Flow control devices ([F23C 7/006](#) takes precedence)}
- F23C 7/02
  - Disposition of air supply not passing through burner (to obtain a cyclonic tapering flame when burning pulverulent fuel [F23C 5/32](#))
- F23C 7/04
  - • to obtain maximum heat transfer to wall of combustion chamber
- F23C 7/06
  - • for heating the incoming air (arrangements of regenerators and recuperators [F23L 15/00](#))
- F23C 7/08
  - • • indirectly by a secondary fluid other than the combustion products
- F23C 9/00**

**Combustion apparatus characterised by arrangements for returning combustion products or flue gases to the combustion chamber (fluidised bed combustion apparatus with means for recirculation of particles entrained from the bed [F23C 10/02](#); fluidised bed combustion apparatus with devices for removal and partial reintroduction of material from the bed [F23C 10/26](#))**
- F23C 9/003
  - {for pulverulent fuel (for fluidized bed [F23C 10/02](#))}
- F23C 9/006
  - {the recirculation taking place in the combustion chamber}
- F23C 9/06
  - for completing combustion
- F23C 9/08
  - for reducing temperature in combustion chamber e.g. for protecting walls of combustion chamber
- F23C 10/00**

**Fluidised bed combustion apparatus**
- F23C 10/002
  - {for pulverulent solid fuel ([F23C 10/005](#) to [F23C 10/32](#) take precedence)}
- F23C 10/005
  - {comprising two or more beds}
- F23C 10/007
  - {comprising a rotating bed}
- F23C 10/01
  - in a fluidised bed of catalytic particles
- F23C 10/02
  - with means specially adapted for achieving or promoting a circulating movement of particles within the bed or for a recirculation of particles entrained from the bed
- F23C 10/04
  - • the particles being circulated to a section, e.g. a heat-exchange section or a return duct, at least partially shielded from the combustion zone, before being reintroduced into the combustion zone
- F23C 10/06
  - • • the circulating movement being promoted by inducing differing degrees of fluidisation in different parts of the bed
- F23C 10/08
  - • • characterised by the arrangement of separation apparatus, e.g. cyclones, for separating particles from the flue gases

- F23C 10/10
  - . . . . the separation apparatus being located outside the combustion chamber
- F23C 10/12
  - . the particles being circulated exclusively within the combustion zone
- F23C 10/14
  - . . . the circulating movement being promoted by inducing differing degrees of fluidisation in different parts of the bed
- F23C 10/16
  - specially adapted for operation at superatmospheric pressures, e.g. by the arrangement of the combustion chamber and its auxiliary systems inside a pressure vessel
- F23C 10/18
  - Details; Accessories
- F23C 10/20
  - . Inlets for fluidisation air, e.g. grids; Bottoms
- F23C 10/22
  - . Fuel feeders specially adapted for fluidised bed combustion apparatus ([F23C 10/26](#) takes precedence)
- F23C 10/24
  - . Devices for removal of material from the bed ([devices for controlling the level of the bed or the amount of material in the bed F23C 10/30](#))
- F23C 10/26
  - . . . combined with devices for partial reintroduction of material into the bed, e.g. after separation of agglomerated parts
- F23C 10/28
  - . Control devices specially adapted for fluidised bed, combustion apparatus
- F23C 10/30
  - . . . for controlling the level of the bed or the amount of material in the bed
- F23C 10/32
  - . . . . by controlling the rate of recirculation of particles separated from the flue gases
  
- F23C 13/00**
**Apparatus in which combustion takes place in the presence of catalytic material** ([in a fluidised bed of catalytic particles F23C 10/01](#); [radiant gas burners using catalysis for flameless combustion F23D 14/18](#))
  - F23C 13/02
    - characterised by arrangements for starting the operation, e.g. for heating the catalytic material to operating temperature
  - F23C 13/04
    - characterised by arrangements of two or more catalytic elements in series connection
  - F23C 13/06
    - in which non-catalytic combustion takes place in addition to catalytic combustion, e.g. downstream of a catalytic element
  - F23C 13/08
    - characterised by the catalytic material
  
- F23C 15/00**
**Apparatus in which combustion takes place in pulses influenced by acoustic resonance in a gas mass** [{\(for generating combustion products of high pressure or high velocity F23R 7/00; starting devices F23D 11/42\)}](#)
  
- F23C 99/00**
**Subject-matter not provided for in other groups of this subclass**
  - F23C 99/001
    - [{Applying electric means or magnetism to combustion \(for combustion engines F02B 51/04, F02M 27/04\)}](#)
  - F23C 99/003
    - [{Combustion process using sound or vibrations \(for combustion engines F02B 51/06, F02M 27/08; liquid fuel burners using ultrasonic means for spraying the fuel F23D 11/34\)}](#)
  - F23C 99/005
    - [{Suspension-type burning, i.e. fuel particles carried along with a gas flow while burning \(fluidized-bed combustion apparatus F23C 10/00\)}](#)
  - F23C 99/006
    - [{Flameless combustion stabilised within a bed of porous heat-resistant material \(F23C 13/00 takes precedence; gas burners with radiant combustion on a porous surface F23D 14/16\)}](#)

- F23C 99/008
  - {Combustion methods wherein flame cooling techniques other than fuel or air staging or fume recirculation are used}

## **F23C 2200/00      Combustion techniques for fluent fuel**

### **F23C 2201/00      Staged combustion**

- F23C 2201/10
  - Furnace staging
- F23C 2201/101
  - • in vertical direction, e.g. alternating lean and rich zones
- F23C 2201/102
  - • in horizontal direction
- F23C 2201/20
  - Burner staging
- F23C 2201/30
  - Staged fuel supply
- F23C 2201/301
  - • with different fuels in stages
- F23C 2201/40
  - Intermediate treatments between stages
- F23C 2201/401
  - • Cooling

### **F23C 2202/00      Fluegas recirculation**

- F23C 2202/10
  - Premixing fluegas with fuel and combustion air
- F23C 2202/20
  - Premixing fluegas with fuel
- F23C 2202/30
  - Premixing fluegas with combustion air
- F23C 2202/40
  - Inducing local whirls around flame
- F23C 2202/50
  - Control of recirculation rate

### **F23C 2203/00      Flame cooling methods otherwise than by staging or recirculation**

- F23C 2203/10
  - using heat exchanger
- F23C 2203/20
  - using heat absorbing device in flame ([F23C 2203/10](#) takes precedence)
- F23C 2203/30
  - Injection of tempering fluids

### **F23C 2205/00      Pulsating combustion**

- F23C 2205/10
  - with pulsating fuel supply
- F23C 2205/20
  - with pulsating oxidant supply

### **F23C 2206/00      Fluidised bed combustion**

- F23C 2206/10
  - Circulating fluidised bed
- F23C 2206/101
  - • Entrained or fast fluidised bed
- F23C 2206/102
  - • Control of recirculation rate
- F23C 2206/103
  - • Cooling recirculating particles

### **F23C 2700/00      Special arrangements for combustion apparatus using fluent fuel**

- F23C 2700/02
  - Combustion apparatus using liquid fuel
- F23C 2700/023
  - • without pre-vaporising means
- F23C 2700/026
  - • with pre-vaporising means
- F23C 2700/04
  - Combustion apparatus using gaseous fuel
- F23C 2700/043
  - • for surface combustion

F23C 2700/046	<ul style="list-style-type: none"> <li>generating heat by heating radiant bodies</li> </ul>
F23C 2700/06	<ul style="list-style-type: none"> <li>Combustion apparatus using pulverized fuel</li> </ul>
F23C 2700/063	<ul style="list-style-type: none"> <li>Arrangements for igniting, flame-guiding, air supply in</li> </ul>
F23C 2700/066	<ul style="list-style-type: none"> <li>Other special arrangements</li> </ul>
<b>F23C 2900/00</b>	<b>Special features of, or arrangements for combustion apparatus using fluid fuels or solid fuels suspended in air; Combustion processes therefor</b>
F23C 2900/01001	<ul style="list-style-type: none"> <li>Co-combustion of biomass with coal</li> </ul>
F23C 2900/03001	<ul style="list-style-type: none"> <li>Miniaturized combustion devices using fluid fuels</li> </ul>
F23C 2900/03002	<ul style="list-style-type: none"> <li>Combustion apparatus adapted for incorporating a fuel reforming device</li> </ul>
F23C 2900/03003	<ul style="list-style-type: none"> <li>Annular combustion chambers (<a href="#">for gas turbines F23R 3/50</a>)</li> </ul>
F23C 2900/03004	<ul style="list-style-type: none"> <li>Tubular combustion chambers with swirling fuel/air flow</li> </ul>
F23C 2900/03005	<ul style="list-style-type: none"> <li>Burners with an internal combustion chamber, e.g. for obtaining an increased heat release, a high speed jet flame or being used for starting the combustion</li> </ul>
F23C 2900/03006	<ul style="list-style-type: none"> <li>Reverse flow combustion chambers</li> </ul>
F23C 2900/03007	<ul style="list-style-type: none"> <li>Sealed combustion chambers with balanced flue</li> </ul>
F23C 2900/03008	<ul style="list-style-type: none"> <li>Spherical or bulb-shaped combustion chambers</li> </ul>
F23C 2900/03009	<ul style="list-style-type: none"> <li>Elongated tube-shaped combustion chambers</li> </ul>
F23C 2900/05081	<ul style="list-style-type: none"> <li>Disposition of burners relative to each other creating specific heat patterns</li> </ul>
F23C 2900/05082	<ul style="list-style-type: none"> <li>Disposition of radial jet burners in relation to an impingement surface, e.g. a heat transfer surface, to obtain flame re-attachment combustion</li> </ul>
F23C 2900/06041	<ul style="list-style-type: none"> <li>Staged supply of oxidant</li> </ul>
F23C 2900/06042	<ul style="list-style-type: none"> <li>Annular arrangement of burners in a furnace, e.g. in a gas turbine, operated in alternate lean-rich mode</li> </ul>
F23C 2900/06043	<ul style="list-style-type: none"> <li>Burner staging, i.e. radially stratified flame core burners</li> </ul>
F23C 2900/07001	<ul style="list-style-type: none"> <li>Air swirling vanes incorporating fuel injectors</li> </ul>
F23C 2900/07002	<ul style="list-style-type: none"> <li>Premix burners with air inlet slots obtained between offset curved wall surfaces, e.g. double cone burners</li> </ul>
F23C 2900/07021	<ul style="list-style-type: none"> <li>Details of lances</li> </ul>
F23C 2900/07022	<ul style="list-style-type: none"> <li>Delaying secondary air introduction into the flame by using a shield or gas curtain</li> </ul>
F23C 2900/09001	<ul style="list-style-type: none"> <li>Cooling flue gas before returning them to flame or combustion chamber</li> </ul>
F23C 2900/09002	<ul style="list-style-type: none"> <li>Specific devices inducing or forcing flue gas recirculation</li> </ul>
F23C 2900/10001	<ul style="list-style-type: none"> <li>Use of special materials for the fluidized bed</li> </ul>
F23C 2900/10002	<ul style="list-style-type: none"> <li>Treatment devices for the fluidizing gas, e.g. cooling, filtering</li> </ul>
F23C 2900/10003	<ul style="list-style-type: none"> <li>Fluidized beds with expanding freeboard, i.e. cross-section increasing upwardly</li> </ul>
F23C 2900/10004	<ul style="list-style-type: none"> <li>Adding inert bed material to maintain proper fluidized bed inventory</li> </ul>
F23C 2900/10005	<ul style="list-style-type: none"> <li>Arrangement comprising two or more beds in separate enclosures</li> </ul>
F23C 2900/10006	<ul style="list-style-type: none"> <li>Pressurized fluidized bed combustors</li> </ul>
F23C 2900/10007	<ul style="list-style-type: none"> <li>Spouted fluidized bed combustors</li> </ul>
F23C 2900/10008	<ul style="list-style-type: none"> <li>Special arrangements of return flow seal valve in fluidized bed combustors</li> </ul>
F23C 2900/13001	<ul style="list-style-type: none"> <li>Details of catalytic combustors</li> </ul>

- F23C 2900/13002 . Catalytic combustion followed by a homogeneous combustion phase or stabilizing a homogeneous combustion phase
- F23C 2900/99001 . Cold flame combustion or flameless oxidation processes
- F23C 2900/99003 . Combustion techniques using laser or light beams as ignition, stabilization or combustion enhancing means
- F23C 2900/99004 . Combustion process using petroleum coke or any other fuel with a very low content in volatile matters
- F23C 2900/99005 . Combustion techniques using plasma gas
- F23C 2900/99006 . Arrangements for starting combustion
- F23C 2900/99008 . Unmixed combustion, i.e. without direct mixing of oxygen gas and fuel, but using the oxygen from a metal oxide, e.g. FeO
- F23C 2900/99009 . Combustion process using vegetable derived fuels, e.g. from rapeseeds
- F23C 2900/9901 . Combustion process using hydrogen, hydrogen peroxide water or brown gas as fuel
- F23C 2900/99011 . Combustion process using synthetic gas as a fuel, i.e. a mixture of CO and H<sub>2</sub>