

**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

.. generating heat by heating radiant bodies

F23C 2700/06

. Combustion apparatus using pulverized fuel

- F23C 2700/063 . . Arrangements for igniting, flame-guiding, air supply in
- F23C 2700/066 . . Other special arrangements

**F23C 2900/00 Special features of, or arrangements for combustion apparatus using fluid fuels or solid fuels suspended in air; Combustion processes therefor**

- F23C 2900/01001 . Co-combustion of biomass with coal
- F23C 2900/03001 . Miniaturized combustion devices using fluid fuels
- F23C 2900/03002 . Combustion apparatus adapted for incorporating a fuel reforming device
- F23C 2900/03003 . Annular combustion chambers ([for gas turbines F23R 3/50](#))
- F23C 2900/03004 . Tubular combustion chambers with swirling fuel/air flow
- F23C 2900/03005 . 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
- F23C 2900/03006 . Reverse flow combustion chambers
- F23C 2900/03007 . Sealed combustion chambers with balanced flue
- F23C 2900/03008 . Spherical or bulb-shaped combustion chambers
- F23C 2900/03009 . Elongated tube-shaped combustion chambers
- F23C 2900/05081 . Disposition of burners relative to each other creating specific heat patterns
- F23C 2900/05082 . Disposition of radial jet burners in relation to an impingement surface, e.g. a heat transfer surface, to obtain flame re-attachment combustion
- F23C 2900/06041 . Staged supply of oxidant
- F23C 2900/06042 . Annular arrangement of burners in a furnace, e.g. in a gas turbine, operated in alternate lean-rich mode
- F23C 2900/06043 . Burner staging, i.e. radially stratified flame core burners
- F23C 2900/07001 . Air swirling vanes incorporating fuel injectors
- F23C 2900/07002 . Premix burners with air inlet slots obtained between offset curved wall surfaces, e.g. double cone burners
- F23C 2900/07021 . Details of lances
- F23C 2900/07022 . Delaying secondary air introduction into the flame by using a shield or gas curtain
- F23C 2900/09001 . Cooling flue gas before returning them to flame or combustion chamber
- F23C 2900/09002 . Specific devices inducing or forcing flue gas recirculation
- F23C 2900/10001 . Use of special materials for the fluidized bed
- F23C 2900/10002 . Treatment devices for the fluidizing gas, e.g. cooling, filtering
- F23C 2900/10003 . Fluidized beds with expanding freeboard, i.e. cross-section increasing upwardly
- F23C 2900/10004 . Adding inert bed material to maintain proper fluidized bed inventory
- F23C 2900/10005 . Arrangement comprising two or more beds in separate enclosures
- F23C 2900/10006 . Pressurized fluidized bed combustors
- F23C 2900/10007 . Spouted fluidized bed combustors
- F23C 2900/10008 . Special arrangements of return flow seal valve in fluidized bed combustors
- F23C 2900/13001 . Details of catalytic combustors
- 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 rapes
- 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>