

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

- . . [N. 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 11/04 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 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 H₂