

**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 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>