

**CPC****COOPERATIVE PATENT CLASSIFICATION****F01N**

**GAS-FLOW SILENCERS OR EXHAUST APPARATUS FOR MACHINES OR ENGINES IN GENERAL ; GAS-FLOW SILENCERS OR EXHAUST APPARATUS FOR INTERNAL COMBUSTION ENGINES** ( { evacuation of fumes from the area where they are produced [B08B 15/00](#) ; arrangement of exhaust or silencing apparatus on percussive tools [B25D 17/12](#) } ; arrangements in connection with gas exhaust of propulsion units in vehicles [B60K 13/00](#) , { on ships or other waterborne vessels [B63H 21/32](#) , on aircraft [B64D 33/04](#) ; arrangement of exhaust or silencing apparatus on firearms [F41A 21/30](#) ; ground installations for reducing aircraft engine or jet noise [B64F 1/26](#) ; silencers specially adapted for steam engines [F01B 31/16](#) ; air-intake silencers for gas turbine or jet propulsion plants [F02C 7/045](#) ; jet pipe or nozzles for jet propulsion plants [F02K](#) } ; combustion-air intake silencers specially adapted for, or arranged on, internal-combustion engines [F02M 35/00](#) ; { combating noise or silencing in positive displacement machines or pumps [F04B 39/0027](#) , in rotary-piston machines or pumps [F04C 29/06](#) , in non-positive displacement pumps [F04D 29/66](#) ; means in valves for absorbing noise [F16K 47/02](#) ; noise absorbers in pipe system [F16L 55/02](#) ; conducting smoke or fumes from various locations to the outside [F23J 11/00](#) ; means for preventing or suppressing noise in air-conditioning or ventilation systems [F24F 13/24](#) } ; protecting against, or damping, noise in general [G10K 11/16](#) )

**NOTE**

Attention is drawn to the notes preceding Class [F01](#) , especially as regards Note 2(b).

**Guidance heading:**

- F01N 1/00**      **Silencing apparatus characterised by method of silencing** { by cooling [F01N 3/02](#) ; using liquids [F01N 3/04](#) }
- F01N 1/003**      . { by using dead chambers communicating with gas flow passages ( resonance chambers [F01N 1/02](#) ; chambers containing sound-absorbing materials [F01N 1/24](#) ) }
- F01N 1/006**      .. { comprising at least one perforated tube extending from inlet to outlet of the silencer }
- F01N 1/02**      . by using resonance
- F01N 1/023**      .. { Helmholtz resonators }
- F01N 1/026**      .. { Annular resonance chambers arranged concentrically to an exhaust passage and communicating with it, e.g. via at least one opening in the exhaust passage }
- F01N 1/04**      .. having sound-absorbing materials in resonance chambers
- F01N 1/06**      . by using interference effect
- F01N 1/065**      .. { by using an active noise source, e.g. speakers }
- F01N 1/08**      . by reducing exhaust energy by throttling or whirling

- F01N 1/081 . . { by passing the gases through a mass of particles }
- F01N 1/082 . . { the gases passing through porous members ( [F01N 1/081](#) takes precedence ) }
- F01N 1/083 . . { using transversal baffles defining a tortuous path for the gases or successively throttling gas flow }
- F01N 1/084 . . { the gases flowing through the silencer two or more times longitudinally in opposite directions, e.g. using parallel or concentric tubes }
- F01N 1/085 . . { using a central core throttling gas passage }
- F01N 1/086 . . { having means to impart whirling motion to the gases ( with helically or spirally shaped channels [F01N 1/12](#) ) }
- F01N 1/087 . . . { using tangential inlets into a circular chamber }
- F01N 1/088 . . . { using vanes arranged on gas flow path or gas flow tubes with tangentially directed apertures }
- F01N 1/089 . . { using two or more expansion chambers in series ( [F01N 1/083](#) , [F01N 1/084](#) , [F01N 1/086](#) take precedence ) }
- F01N 1/10 . . in combination with sound-absorbing materials ( [F01N 1/125](#) takes precedence )
- F01N 1/12 . . using spirally or helically shaped channels ( cyclones [B04C](#) )
- F01N 1/125 . . . { in combination with sound-absorbing materials }
  
- F01N 1/14 . by adding air to exhaust gases { ( in tailpipes [F01N 13/082](#) , [F01N 13/20](#) ) }
  
- F01N 1/16 . by using movable parts
- F01N 1/161 . . { for adjusting resonance or dead chambers or passages to resonance or dead chambers }
- F01N 1/163 . . . { by means of valves }
- F01N 1/165 . . { for adjusting flow area }
- F01N 1/166 . . { for changing gas flow path through the silencer or for adjusting the dimensions of a chamber or a pipe ( [F01N 1/165](#) takes precedence ) }
- F01N 1/168 . . { for controlling or modifying silencing characteristics only }
- F01N 1/18 . . having rotary movement
- F01N 1/20 . . having oscillating or vibrating movement { the parts being resilient walls [F01N 1/22](#) }
- F01N 1/22 . . the parts being resilient walls
  
- F01N 1/24 . by using sound-absorbing materials ( [F01N 1/04](#) , [F01N 1/06](#) , [F01N 1/10](#) , [F01N 1/14](#) , [F01N 1/16](#) take precedence )
  
- F01N 3/00** **Exhaust or silencing apparatus having means for purifying, rendering innocuous, or otherwise treating exhaust** ( electric control [F01N 9/00](#) ; monitoring or diagnostic devices for exhaust-gas treatment apparatus [F01N 11/00](#) ; { collecting or removing exhaust gases of vehicle engines in workshops [B08B 15/00](#) , on highways [E01C 1/005](#) } )
  
- F01N 3/005 . { for draining or otherwise eliminating condensates or moisture accumulating in the apparatus ( [F01N 3/02](#) takes precedence ) } [c0809]
  
- F01N 3/01 . by means of electric or electrostatic separators
  
- F01N 3/02 . for cooling, or for removing solid constituents of, exhaust ( by means of electric or electrostatic separators [F01N 3/01](#) ; { mixing air with exhaust in tailpipes [F01N 13/082](#) , [F01N 13/20](#) } )

F01N 3/0205	..	{ using heat exchangers }
F01N 3/021	..	by means of filters
F01N 3/0211	...	{ Arrangements for mounting filtering elements in housing, e.g. with means for compensating thermal expansion or vibration }
F01N 3/0212	...	{ with one or more perforated tubes surrounded by filtering material, e.g. filter candles }
F01N 3/0214	...	{ with filters comprising movable parts, e.g. rotating filters }
F01N 3/0215	...	{ the filtering elements having the form of disks or plates }
F01N 3/0217	...	{ the filtering elements having the form of hollow cylindrical bodies }
F01N 3/0218	...	{ the filtering elements being made from spirally-wound filtering material }
F01N 3/022	...	characterised by specially adapted filtering structure, e.g. honeycomb, mesh or fibrous
F01N 3/0222	....	{ the structure being monolithic, e.g. honeycombs }
F01N 3/0224	....	{ the structure being granular }
F01N 3/0226	....	{ the structure being fibrous }
F01N 3/0228	....	{ the structure being made of foamed rubber or plastics }
F01N 3/023	...	using means for regenerating the filters, e.g. by burning trapped particles ( <a href="#">by electrically controlling the supply of combustible mixture or its constituents only F02D 41/0235</a> )
F01N 3/0231	....	{ using special exhaust apparatus upstream of the filter for producing nitrogen dioxide, e.g. for continuous filter regeneration systems (CRT) }
F01N 3/0232	....	{ removing incombustible material from a particle filter, e.g. ash }
F01N 3/0233	....	{ periodically cleaning filter by blowing a gas through the filter in a direction opposite to exhaust flow, e.g. exposing filter to engine air intake }
F01N 3/0234	....	{ using heat exchange means in the exhaust line }
F01N 3/0235	....	{ using exhaust gas throttling means }
F01N 3/0236	....	{ using turbine waste gate valve }
F01N 3/0237	....	{ for regenerating ex situ }
F01N 3/0238	....	{ for regenerating during engine standstill }
F01N 3/025	....	using fuel burner or by adding fuel to exhaust
F01N 3/0253	.....	{ adding fuel to exhaust gases }
F01N 3/0256	.....	{ the fuel being ignited by electrical means }
F01N 3/027	....	using electric or magnetic heating means
F01N 3/0275	.....	{ using electric discharge means }
F01N 3/028	.....	using microwaves
F01N 3/029	....	by adding non-fuel substances to exhaust
F01N 3/0293	.....	{ injecting substances in exhaust stream }
F01N 3/0296	.....	{ having means for preheating additional substances }
F01N 3/031	...	having means for by-passing filters, e.g. when clogged or during cold engine start
F01N 3/032	....	during filter regeneration only
F01N 3/033	...	in combination with other devices { with adsorbents or absorbents <a href="#">F01N 3/0821</a> }
F01N 3/0335	....	{ with exhaust silencers in a single housing }
F01N 3/035	....	with catalytic reactors, { e.g. catalysed diesel particulate filters }

- F01N 3/037 .. by means of inertial or centrifugal separators, e.g. of cyclone type, optionally combined or associated with agglomerators
- F01N 3/038 .. by means of perforated plates defining expansion chambers associated with condensation and collection chambers, e.g. for adiabatic expansion of gases and subsequent collection of condensed liquids
- F01N 3/04 .. using liquids
- F01N 3/043 ... { without contact between liquid and exhaust gases }
- F01N 3/046 .... { Exhaust manifolds with cooling jacket }
- F01N 3/05 .. by means of air, e.g. by mixing exhaust with air ( silencers working by addition of air to exhaust [F01N 1/14](#) ; arrangements for the supply of additional air for the thermal or catalytic conversion of noxious components of exhaust [F01N 3/30](#) ; { in tailpipes [F01N 13/082](#) } )
- F01N 3/055 ... { without contact between air and exhaust gases }
- F01N 3/06 . for extinguishing sparks
- F01N 3/08 . for rendering innocuous ( using electric or electrostatic separators [F01N 3/01](#) ; chemical aspects [B01D 53/92](#) )
- F01N 3/0807 .. { by using absorbents or adsorbents }
- F01N 3/0814 ... { combined with catalytic converters, e.g. NOx absorption/storage reduction catalysts }
- F01N 3/0821 ... { combined with particulate filters ( catalysed diesel particulate filters [F01N 3/035](#) ) }
- F01N 3/0828 ... { characterised by the absorbed or adsorbed substances }
- F01N 3/0835 .... { Hydrocarbons }
- F01N 3/0842 .... { Nitrogen oxides }
- F01N 3/085 .... { Sulfur or sulfur oxides }
- F01N 3/0857 .... { Carbon oxides }
- F01N 3/0864 .... { Oxygen }
- F01N 3/0871 ... { Regulation of absorbents or adsorbents, e.g. purging ( by electrically controlling the supply of combustible mixture or its constituents only [F02D 41/0235](#) ) }
- F01N 3/0878 .... { Bypassing absorbents or adsorbents }
- F01N 3/0885 .... { Regeneration of deteriorated absorbents or adsorbents, e.g. desulfurization of NOx traps }
- F01N 3/0892 .. { Electric or magnetic treatment, e.g. dissociation of noxious components ( electric filters [F01N 3/01](#) ; regeneration of exhaust filters [F01N 3/023](#) ; heating catalytic converters [F01N 3/2006](#) ) }
- F01N 3/10 .. by thermal or catalytic conversion of noxious components of exhaust ( by using other chemical processes, chemical aspects of catalytic conversion, e.g. using specified catalysts, [B01D 53/34](#) )

### **WARNING**

New subgroups of [F01N 3/10](#) are not complete pending a reorganisation

- F01N 3/101 ... { Three-way catalysts }
- F01N 3/103 ... { Oxidation catalysts for HC and CO only }
- F01N 3/105 ... { General auxiliary catalysts, e.g. upstream or downstream of the main catalyst }

F01N 3/106	....	{ Auxiliary oxidation catalysts }
F01N 3/108	....	{ Auxiliary reduction catalysts }
F01N 3/18	...	characterised by methods of operation ; Regulation
F01N 3/20	....	specially adapted for catalytic conversion; { Methods of operation or regulation of catalytic converters } ( <a href="#">F01N 3/22</a> takes precedence )
F01N 3/2006	.....	{ Periodically heating or cooling catalytic reactors, e.g. at cold starting or overheating ( by electrically controlling the supply of combustible mixture or its constituents only <a href="#">F02D 41/0235</a> ) }
F01N 3/2013	.....	{ using electric or magnetic heating means }
F01N 3/202	.....	{ using microwaves }
F01N 3/2026	.....	{ directly electrifying the catalyst substrate, i.e. heating the electrically conductive catalyst substrate by joule effect }
F01N 3/2033	.....	{ using a fuel burner or introducing fuel into exhaust duct }
F01N 3/204	.....	{ using an exhaust gas igniter, e.g. a spark or glow plug, without introducing fuel into exhaust duct }
F01N 3/2046	.....	{ Periodically cooling catalytic reactors }
F01N 3/2053	.....	{ By-passing catalytic reactors, e.g. to prevent overheating }
F01N 3/206	.....	{ Adding periodically or continuously substances to exhaust gases for promoting purification, e.g. catalytic material in liquid form, NOx reducing agents ( <a href="#">F01N 3/2066</a> takes precedence ) }
F01N 3/2066	.....	{ Selective catalytic reduction (SCR) }

#### **WARNING**

This subgroup is not complete pending a reorganisation. See also group [F01N 3/206](#) for documents published before March 2004.

F01N 3/2073	.....	{ with means for generating a reducing substance from the exhaust gases }
F01N 3/208	.....	{ Control of selective catalytic reduction (SCR), e.g. dosing of reducing agent }
F01N 3/2086	.....	{ Activating the catalyst by light, photo-catalysts }
F01N 3/2093	.....	{ Periodically blowing a gas through the converter, e.g. in a direction opposite to exhaust gas flow or by reversing exhaust gas flow direction }
F01N 3/22	....	Regulation of additional air supply only, e.g. using by-passes or variable air pump drives
F01N 3/222	.....	{ using electric valves only }
F01N 3/225	.....	{ Electric control of additional air supply }
F01N 3/227	.....	{ using pneumatically operated valves, e.g. membrane valves }
F01N 3/24	...	characterised by constructional aspects of converting apparatus ( <a href="#">filtering in combination with catalytic reactors</a> <a href="#">F01N 3/035</a> )
F01N 3/26	....	Construction of thermal reactors
F01N 3/28	....	Construction of catalytic reactors
F01N 3/2803	.....	{ characterised by structure, by material or by manufacturing of catalyst support }
F01N 3/2807	.....	{ Metal other than sintered metal ( <a href="#">F01N 3/2832</a> and <a href="#">F01N 3/2835</a> take precedence ) }
F01N 3/281	.....	{ Metallic honeycomb monoliths made of stacked or rolled sheets,

		foils or plates }
F01N 3/2814	.....	{ all sheets, plates or foils being corrugated }
F01N 3/2817	.....	{ only with non-corrugated sheets, plates or foils }
F01N 3/2821	.....	{ the support being provided with means to enhance the mixing process inside the converter, e.g. sheets, plates or foils with protrusions or projections to create turbulence }
F01N 3/2825	.....	{ Ceramics ( <a href="#">F01N 3/2832</a> , <a href="#">F01N 3/2835</a> take precedence ) }
F01N 3/2828	.....	{ Ceramic multi-channel monoliths, e.g. honeycombs }
F01N 3/2832	.....	{ granular, e.g. pellets }
F01N 3/2835	.....	{ fibrous }
F01N 3/2839	.....	{ Arrangements for mounting catalyst support in housing, e.g. with means for compensating thermal expansion or vibration }
F01N 3/2842	.....	{ specially adapted for monolithic supports, e.g. of honeycomb type ( <a href="#">F01N 3/2853</a> to <a href="#">F01N 3/2871</a> take precedence ) }
F01N 3/2846	.....	{ specially adapted for granular supports, e.g. pellets }
F01N 3/285	.....	{ specially adapted for fibrous supports, e.g. held in place by screens }
F01N 3/2853	.....	{ using mats or gaskets between catalyst body or housing }
F01N 3/2857	.....	{ the mats or gaskets being at least partially made of intumescent material, e.g. unexpanded vermiculite }
F01N 3/286	.....	{ the mats or gaskets having corrugations or cavities }

**WARNING**

This group is not complete pending a reorganisation. See also [F01N 3/2853](#) and [F01N 3/2857](#)

F01N 3/2864	.....	{ the mats or gaskets comprising two or more insulation layers }
F01N 3/2867	.....	{ the mats or gaskets being placed at the front or end face of catalyst body }

**WARNING**

This group is not complete pending a reorganisation. See also [F01N 3/2853](#) and [F01N 3/2857](#)

F01N 3/2871	.....	{ the mats or gaskets having an additional, e.g. non-insulating or non-cushioning layer, a metal foil or an adhesive layer }
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**WARNING**

This group is not complete pending a reorganisation. See also [F01N 3/2853](#) and [F01N 3/2857](#)

F01N 3/2875	.....	{ by using elastic means, e.g. spring leaves, for retaining catalyst body in the housing ( <a href="#">F01N 3/2853</a> to <a href="#">F01N 3/2871</a> take precedence ) }
F01N 3/2878	.....	{ by using non-elastic means for retaining catalyst body in the housing, e.g. a metal chamfer, or by corrugation or deformation of the metal housing }
F01N 3/2882	.....	{ Catalytic reactors combined or associated with other devices, e.g. exhaust silencers or other exhaust purification devices ( combined with absorbents or adsorbents only <a href="#">F01N 3/0814</a> ; combined with particulate

		filters <a href="#">F01N 3/035</a> ) }
<a href="#">F01N 3/2885</a>	.....	{ with exhaust silencers in a single housing }
<a href="#">F01N 3/2889</a>	.....	{ with heat exchangers in a single housing }
<a href="#">F01N 3/2892</a>	.....	{ Exhaust flow directors or the like, e.g. upstream of catalytic device }
<a href="#">F01N 3/2896</a>	.....	{ Liquid catalyst carrier }
<a href="#">F01N 3/30</a>	....	Arrangements for supply of additional air ( regulation, e.g. using air by-passes or variable air pump drives <a href="#">F01N 3/22</a> )
<a href="#">F01N 3/303</a>	.....	{ Filtering additional air }
<a href="#">F01N 3/306</a>	.....	{ Preheating additional air }
<a href="#">F01N 3/32</a>	.....	using air pump ( using jet air pumps <a href="#">F01N 3/34</a> ; pumps in general <a href="#">F04</a> )
<a href="#">F01N 3/323</a>	.....	{ Electrically driven air pumps }
<a href="#">F01N 3/326</a>	.....	{ Engine-driven air pumps }
<a href="#">F01N 3/34</a>	.....	using air conduits or jet air pumps, e.g. near the engine exhaust port
<a href="#">F01N 3/36</a>	....	Arrangements for supply of additional fuel
<a href="#">F01N 3/38</a>	....	Arrangements for igniting

**F01N 5/00** **Exhaust or silencing apparatus combined or associated with devices profiting by exhaust energy** ( predominant aspects of such devices, see the relevant classes for the devices; using kinetic or wave energy of exhaust gases in exhaust systems for charging [F02B](#) )

#### **NOTE**

- in this group the following indexing code is used: [F02M 2700/31](#)

<a href="#">F01N 5/02</a>	. the devices using heat
<a href="#">F01N 5/025</a>	.. { the device being thermoelectric generators }

#### **WARNING**

This group is not complete pending a reorganisation. See also [F01N 5/02](#)

<a href="#">F01N 5/04</a>	. the devices using kinetic energy
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**F01N 9/00** **Electrical control of exhaust gas treating apparatus** ( monitoring or diagnostic devices for exhaust-gas treatment apparatus [F01N 11/00](#) ; { electrical control of supply of combustible mixture or its constituents in relation with the state of the exhaust gas treating apparatus [F02D 41/0235](#) } ; controlling combustion engines conjoint electrical control of two or more combustion engine functions [F02D 43/00](#) )

<a href="#">F01N 9/002</a>	. { of filter regeneration, e.g. detection of clogging }
<a href="#">F01N 9/005</a>	. { using models instead of sensors to determine operating characteristics of exhaust systems, e.g. calculating catalyst temperature instead of measuring it directly }
<a href="#">F01N 9/007</a>	. { Storing data relevant to operation of exhaust systems for later retrieval and analysis, e.g. to research exhaust system malfunctions }



**F01N 11/00**      **Monitoring or diagnostic devices for exhaust-gas treatment apparatus, { e.g. for catalytic activity ( safety, indicating or supervising devices for internal combustion engines [F02B 77/08](#) ; testing of machines [G01M 13/00](#) ) }**

- F01N 11/002      . { the diagnostic devices measuring or estimating temperature or pressure in, or downstream of the exhaust apparatus }
- F01N 11/005      . . { the temperature or pressure being estimated, e.g. by means of a theoretical model }
- F01N 11/007      . { the diagnostic devices measuring oxygen or air concentration downstream of the exhaust apparatus }

**Guidance heading:**

**F01N 13/00**      **Exhaust or silencing apparatus characterised by constructional features; { Exhaust or silencing apparatus, or parts thereof, having pertinent characteristics not provided for in, or of interest apart from, groups [F01N 1/00](#) to [F01N 5/00](#) , [F01N 9/00](#) , [F01N 11/00](#) }**

- F01N 13/001      . { Gas flow channels or gas chambers being at least partly formed in the structural parts of the engine or machine ( using structural parts of the vehicle [B60K 13/06](#) ) }
- F01N 13/002      . { Apparatus adapted for particular uses, e.g. for portable devices driven by machines or engines }
- F01N 13/004      . { specially adapted for marine propulsion, i.e. for receiving simultaneously engine exhaust gases and engine cooling water ( for submerged exhausting [F01N 13/12](#) ; treating exhaust by using liquids [F01N 3/04](#) ) }
- F01N 13/005      . . { with parts constructed of non-metallic material, e.g. of rubber }
- F01N 13/007      . { Apparatus used as intake or exhaust silencer ( silencing methods [F01N 1/00](#) ; intake silencers [F02M 35/12](#) ) }
- F01N 13/008      . { Mounting or arrangement of exhaust sensors in or on exhaust apparatus ( sensor arrangements for engine control [F02D 41/1439](#) ) }
- F01N 13/02      . having two or more separate silencers in series
- F01N 2013/023      . . with two or more of the same type of purifying devices in series
- F01N 2013/026      . . in a single housing
- F01N 13/04      . having two or more silencers in parallel e.g. having interconnections for multi-cylinder engines
- F01N 2013/045      . . in a single housing
- F01N 13/06      . specially adapted for star-arrangement of cylinders, e.g. exhaust manifolds
- F01N 13/08      . Other arrangements or adaptations of exhaust conduits ( { pipes, joints or supports therefor in general [F16L](#) ; collecting or removing exhaust gases of vehicle engines in workshops [B08B 15/00](#) , on highways [E01C 1/005](#) } )
- F01N 13/082      . . { of tailpipe, e.g. with means for mixing air with exhaust for exhaust cooling, dilution or evacuation ( [F01N 13/20](#) takes precedence ) }



- F01N 13/085 . . { having means preventing foreign matter from entering exhaust conduit }
- F01N 13/087 . . { having valves upstream of silencing apparatus for by-passing at least part of exhaust directly to atmosphere ( valves for changing gas flow path through the silencer [F01N 1/166](#) ) }
- F01N 13/10 . . of exhaust manifolds { ( with cooling jacket [F01N 3/046](#) ) }
- F01N 13/102 . . . { having thermal insulation }
- F01N 13/105 . . . { having the form of a chamber directly connected to the cylinder head, e.g. without having tubes connected between cylinder head and chamber }
- F01N 13/107 . . . { More than one exhaust manifold or exhaust collector }
- F01N 13/12 . specially adapted for submerged exhausting
- F01N 13/14 . having thermal insulation { ( exhaust manifolds [F01N 13/102](#) ) }
- F01N 13/141 . . { Double-walled exhaust pipes or housings }
- F01N 13/143 . . . { with air filling the space between both walls }
- F01N 13/145 . . . { with gas other than air filling the space between both walls }
- F01N 13/146 . . . { with vacuum in the space between both walls }
- F01N 13/148 . . { Multiple layers of insulating material }
- F01N 13/16 . Selection of particular materials
- F01N 13/18 . Construction facilitating manufacture, assembly, or disassembly
- F01N 13/1805 . . { Fixing exhaust manifolds, exhaust pipes or pipe sections to each other, to engine or to vehicle body ( pipe joints in general [F16L](#) ; fixing auxiliaries in motor vehicles in general [B60K](#) ) }
- F01N 13/1811 . . . { with means permitting relative movement, e.g. compensation of thermal expansion or vibration }
- F01N 13/1816 . . . . { the pipe sections being joined together by flexible tubular elements only, e.g. using bellows or strip-wound pipes }
- F01N 13/1822 . . . . { for fixing exhaust pipes or devices to vehicle body }
- F01N 13/1827 . . { Sealings specially adapted for exhaust systems ( sealings in general [F16J 15/00](#) ) }
- F01N 13/1833 . . { specially adapted for small internal combustion engines, e.g. used in model applications }
- F01N 13/1838 . . { characterised by the type of connection between parts of exhaust or silencing apparatus, e.g. between housing and tubes, between tubes and baffles }
- F01N 13/1844 . . . { Mechanical joints }
- F01N 13/185 . . . . { the connection being realised by deforming housing, tube, baffle, plate, or parts thereof }
- F01N 13/1855 . . . . { the connection being realised by using bolts, screws, rivets or the like }
- F01N 13/1861 . . { the assembly using parts formed by casting or moulding }
- F01N 13/1866 . . . { the channels or tubes thereof being made integrally with the housing }
- F01N 13/1872 . . { the assembly using stamp-formed parts or otherwise deformed sheet-metal }
- F01N 13/1877 . . . { the channels or tubes thereof being made integrally with the housing }
- F01N 13/1883 . . { manufactured by hydroforming }
- F01N 13/1888 . . { the housing of the assembly consisting of two or more parts, e.g. two half-shells }
- F01N 13/1894 . . . { the parts being assembled in longitudinal direction }

- F01N 13/20 . having flared outlets, e.g. of fish-tail shape

**Guidance heading:**

**F01N 2210/00      Combination of methods of silencing**

- F01N 2210/02 . Resonance and interference
- F01N 2210/04 . Throttling-expansion and resonance
- F01N 2210/06 . Throttling-expansion and interference

**Guidance heading:**

**F01N 2230/00      Combination of silencers and other devices**

- F01N 2230/02 . Exhaust filters
- F01N 2230/04 . Catalytic converters
- F01N 2230/06 . Spark arresters
- F01N 2230/08 . Thermal reactors

**F01N 2240/00      Combination or association of two or more different exhaust treating devices, or of at least one such device with an auxiliary device, not covered by indexing codes [F01N 2230/00](#) or [F01N 2250/00](#) , one of the devices being**

- F01N 2240/02 . a heat exchanger
- F01N 2240/04 . an electric, e.g. electrostatic, device other than a heater
- F01N 2240/05 . a magnetic, e.g. electromagnetic, device other than a valve
- F01N 2240/06 . an inertial, e.g. centrifugal, device
- F01N 2240/10 . a heat accumulator
- F01N 2240/12 . a thermal reactor
- F01N 2240/14 . a fuel burner
- F01N 2240/16 . an electric heater, i.e. a resistance heater
- F01N 2240/18 . an adsorber or absorber
- F01N 2240/20 . a flow director or deflector

- F01N 2240/22 . a condensation chamber
- F01N 2240/25 . an ammonia generator
- F01N 2240/26 . an exhaust gas reservoir, e.g. emission buffer
- F01N 2240/28 . a plasma reactor
- F01N 2240/30 . a fuel reformer
- F01N 2240/32 . a fuel cell
- F01N 2240/34 . an electrolyser
- F01N 2240/36 . an exhaust flap
- F01N 2240/38 . an ozone (O<sub>3</sub>) generator, e.g. for adding ozone after generation of ozone from air
- F01N 2240/40 . a hydrolysis catalyst

#### **F01N 2250/00 Combinations of different methods of purification**

- F01N 2250/02 . filtering and catalytic conversion
- F01N 2250/04 . afterburning and catalytic conversion
- F01N 2250/06 . afterburning and filtering
- F01N 2250/08 . filtering and inertial particulate separation
- F01N 2250/10 . cooling and filtering
- F01N 2250/12 . absorption or adsorption, and catalytic conversion
- F01N 2250/14 . absorption or adsorption, and filtering

#### **F01N 2260/00 Exhaust treating devices having provisions not otherwise provided for**

- F01N 2260/02 . for cooling the device
- F01N 2260/022 . . using air
- F01N 2260/024 . . using a liquid
- F01N 2260/04 . for regeneration or reactivation, e.g. of catalyst
- F01N 2260/06 . for improving exhaust evacuation or circulation, or reducing back-pressure
- F01N 2260/08 . for preventing heat loss or temperature drop, using other means than layers of heat-insulating material
- F01N 2260/10 . for avoiding stress caused by expansions or contractions due to temperature

variations

- F01N 2260/12 . for resisting high pressure
- F01N 2260/14 . for modifying or adapting flow area or back-pressure
- F01N 2260/16 . for reducing exhaust flow pulsations
- F01N 2260/18 . for improving rigidity, e.g. by wings, ribs
- F01N 2260/20 . for heat or sound protection, e.g. using a shield or specially shaped outer surface of exhaust device
- F01N 2260/22 . for preventing theft of exhaust parts or devices, e.g. anti-theft arrangements
- F01N 2260/24 . for identifying exhaust parts or devices, e.g. by labels, stickers or directly printing
- F01N 2260/26 . for preventing enter of dirt into the device

#### **F01N 2270/00      Mixing air with exhaust gases**

- F01N 2270/02 . for cooling exhaust gases or the apparatus
- F01N 2270/04 . for afterburning
- F01N 2270/06 . for silencing
- F01N 2270/08 . for evacuation of exhaust gases, e.g. in tail-pipes
- F01N 2270/10 . for rendering exhaust innocuous, e.g. by dilution

#### **F01N 2290/00      Movable parts or members in exhaust systems for other than for control purposes**

- F01N 2290/02 . with continuous rotary movement
- F01N 2290/04 . . driven by exhaust gases
- F01N 2290/06 . . driven by auxiliary drive
- F01N 2290/08 . with oscillating or vibrating movement
- F01N 2290/10 . . actuated by pressure of exhaust gases, e.g. exhaust pulses

#### **F01N 2310/00      Selection of sound absorbing or insulating material**

- F01N 2310/02 . Mineral wool, e.g. glass wool, rock wool, asbestos or the like
- F01N 2310/04 . Metallic wool, e.g. steel wool, copper wool or the like
- F01N 2310/06 . Porous ceramics
- F01N 2310/08 . Exfoliated vermiculite, e.g. zonolite, coke, pumice

F01N 2310/10	. Plastic foam
F01N 2310/12	. Granular material
F01N 2310/14	. Wire mesh fabric, woven glass cloth or the like
<b>F01N 2330/00</b>	<b>Structure of catalyst support or particle filter</b>
F01N 2330/02	. Metallic plates or honeycombs, e.g. superposed or rolled-up corrugated or otherwise deformed sheet metal
F01N 2330/04	. . Methods of manufacturing
F01N 2330/06	. Ceramic, e.g. monoliths
F01N 2330/08	. Granular material
F01N 2330/10	. Fibrous material, e.g. mineral or metallic wool
F01N 2330/101	. . using binders, e.g. to form a permeable mat, paper or the like
F01N 2330/102	. . . fibrous material being fiber reinforced polymer made of plastic matrix reinforced by fine glass or in the form of a loose mass of filaments or fibers
F01N 2330/12	. Metallic wire mesh fabric or knitting
F01N 2330/14	. Sintered material
F01N 2330/18	. Composite material
F01N 2330/20	. Plastics, e.g. polymers, polyester, polyurethane
F01N 2330/22	. Metal foam
F01N 2330/30	. Honeycomb supports characterised by their structural details
F01N 2330/32	. . characterised by the shape, form or number of corrugations of plates, sheets or foils
F01N 2330/321	. . . with two or more different kinds of corrugations in the same substrate
F01N 2330/322	. . . Corrugations of trapezoidal form
F01N 2330/323	. . . Corrugations of saw-tooth or triangular form
F01N 2330/324	. . . Corrugations of rectangular form
F01N 2330/325	. . . Corrugations of omega form
F01N 2330/34	. . with flow channels of polygonal cross section
F01N 2330/36	. . with flow channels formed by tubes
F01N 2330/38	. . flow channels with means to enhance flow mixing, ( e.g. protrusions or projections )
F01N 2330/40	. . made of a single sheet, foil or plate
F01N 2330/42	. . made of three or more different sheets, foils or plates stacked one on the other
F01N 2330/44	. . made of stacks of sheets, plates or foils that are folded in S-form
F01N 2330/48	. . characterised by the number of flow passages, e.g. cell density
F01N 2330/60	. Discontinuous, uneven properties of filter material, e.g. different material thickness

along the longitudinal direction ; Higher filter capacity upstream than downstream in same housing

**F01N 2340/00**      **Dimensional characteristics of the exhaust system, e.g. length, diameter or volume of the apparatus ; Spatial arrangements of exhaust apparatuses**

- F01N 2340/02      . characterised by the distance of the apparatus to the engine, or the distance between two exhaust treating apparatuses
- F01N 2340/04      . characterised by the arrangement of an exhaust pipe, manifold or apparatus in relation to vehicle frame or particular vehicle parts
- F01N 2340/06      . characterised by the arrangement of the exhaust apparatus relative to the turbine of a turbocharger

**F01N 2350/00**      **Arrangements for fitting catalyst support or particle filter element in the housing**

- F01N 2350/02      . Fitting ceramic monoliths in a metallic housing
- F01N 2350/04      . . with means compensating thermal expansion
- F01N 2350/06      . . with means preventing gas flow by-pass or leakage
- F01N 2350/08      . with means for compressing granular material

**F01N 2370/00**      **Selection of materials for exhaust purification**

- F01N 2370/02      . used in catalytic reactors
- F01N 2370/04      . . Zeolitic material
- F01N 2370/22      . used in non-catalytic purification apparatus
- F01N 2370/24      . . Zeolitic material
- F01N 2370/30      . . Materials having magnetic properties
- F01N 2370/40      . Activated carbon or charcoal

**F01N 2390/00**      **Arrangements for controlling or regulating exhaust apparatus**

- F01N 2390/02      . using electric components only
- F01N 2390/04      . using electropneumatic components
- F01N 2390/06      . using pneumatic components only
- F01N 2390/08      . using mechanical components only, e.g. actuated manually

**F01N 2410/00**      **By-passing, at least partially, exhaust from inlet to outlet of apparatus, to atmosphere or to other device**

- F01N 2410/02      . in case of high temperature, e.g. overheating of catalytic reactor

- F01N 2410/03 . in case of low temperature
- F01N 2410/04 . during regeneration period, e.g. of particle filter
- F01N 2410/06 . at cold starting
- F01N 2410/08 . in case of clogging, e.g. of particle filter
- F01N 2410/10 . for reducing flow resistance, e.g. to obtain more engine power
- F01N 2410/12 . in case of absorption, adsorption or desorption of exhaust gas constituents
- F01N 2410/14 . in case of excessive pressure, e.g. using a safety valve
- F01N 2430/00      Influencing exhaust purification, e.g. starting of catalytic reaction, filter regeneration, or the like, by controlling engine operating characteristics**
- F01N 2430/02 . by cutting out a part of engine cylinders
- F01N 2430/04 . by adding non-fuel substances to combustion air or fuel, e.g. additives
- F01N 2430/06 . by varying fuel-air ratio, e.g. by enriching fuel-air mixture
- F01N 2430/08 . by modifying ignition or injection timing
- F01N 2430/085 . . at least a part of the injection taking place during expansion or exhaust stroke
- F01N 2430/10 . by modifying inlet or exhaust valve timing
- F01N 2450/00      Methods or apparatus for fitting, inserting or repairing different elements**
- F01N 2450/02 . Fitting monolithic blocks into the housing
- F01N 2450/04 . Filling or emptying a chamber with granular material
- F01N 2450/06 . Inserting sound absorbing material into a chamber
- F01N 2450/08 . Repairing the housing or pipe-joints
- F01N 2450/10 . Fitting temporarily exhaust apparatus on exhaust conduit, e.g. in confined environment, garage or the like
- F01N 2450/16 . by using threaded joints
- F01N 2450/18 . by using quick-active type locking mechanisms, e.g. clips
- F01N 2450/20 . by mechanical joints, e.g. by deforming housing, tube, baffle plate or parts thereof
- F01N 2450/22 . by welding or brazing
- F01N 2450/24 . by bolts, screws, rivets or the like



- F01N 2450/26 . by bayonet fittings
- F01N 2450/28 . by using adhesive material, e.g. cement
- F01N 2450/30 . Removable or rechargeable blocks or cartridges, e.g. for filters
- F01N 2450/40 . Retrofitting exhaust apparatus

#### **F01N 2470/00      Structure or shape of gas passages, pipes or tubes**

- F01N 2470/02 . Tubes being perforated
- F01N 2470/04 . . characterised by shape, disposition or dimensions of apertures
- F01N 2470/06 . Tubes being formed by assembly of stamped or otherwise deformed sheet-metal
- F01N 2470/08 . Gas passages being formed between the walls of an outer shell and an inner chamber
- F01N 2470/10 . Tubes having non-circular cross section
- F01N 2470/12 . Tubes being corrugated
- F01N 2470/14 . Plurality of outlet tubes, e.g. in parallel or with different length
- F01N 2470/16 . Plurality of inlet tubes, e.g. discharging into different chambers
- F01N 2470/18 . the axis of inlet or outlet tubes being other than the longitudinal axis of apparatus
- F01N 2470/20 . Dimensional characteristics of tubes, e.g. length, diameter
- F01N 2470/22 . Inlet and outlet tubes being positioned on the same side of the apparatus
- F01N 2470/24 . Concentric tubes or tubes being concentric to housing, e.g. telescopically assembled
- F01N 2470/26 . Tubes being formed by extrusion, drawing or rolling
- F01N 2470/28 . Tubes being formed by moulding or casting x
- F01N 2470/30 . Tubes with restrictions, i.e. venturi or the like, e.g. for sucking air or measuring mass flow

#### **F01N 2490/00      Structure, disposition or shape of gas-chambers**

- F01N 2490/02 . Two or more expansion chambers in series connected by means of tubes
- F01N 2490/04 . . the gases flowing longitudinally from inlet to outlet only in one direction
- F01N 2490/06 . . the gases flowing longitudinally from inlet to outlet in opposite directions
- F01N 2490/08 . Two or more expansion chambers in series separated by apertured walls only
- F01N 2490/10 . Two or more expansion chambers in parallel

- F01N 2490/12 . Chambers having variable volumes
- F01N 2490/14 . Dead or resonance chambers connected to gas flow tube by relatively short side-tubes
- F01N 2490/15 . Plurality of resonance or dead chambers
- F01N 2490/155 . . being disposed one after the other in flow direction
- F01N 2490/16 . Chambers with particular shapes, e.g. spherical
- F01N 2490/18 . Dimensional characteristics of gas chambers
- F01N 2490/20 . Chambers being formed inside the exhaust pipe without enlargement of the cross section of the pipe, e.g. resonance chambers

#### **F01N 2510/00 Surface coverings**

- F01N 2510/02 . for thermal insulation
- F01N 2510/04 . for sound absorption
- F01N 2510/06 . for exhaust purification, e.g. catalytic reaction
- F01N 2510/061 . . usable with leaded fuels
- F01N 2510/063 . . zeolites
- F01N 2510/065 . . for reducing soot ignition temperature
- F01N 2510/067 . . usable with sulfurised fuels
- F01N 2510/068 . . characterised by the distribution of the catalytic coatings
- F01N 2510/0682 . . . having a discontinuous, uneven or partially overlapping coating of catalytic material, e.g. higher amount of material upstream than downstream or vice-versa
- F01N 2510/0684 . . . having more than one coating layer, e.g. multi-layered coatings
- F01N 2510/08 . for corrosion prevention
- F01N 2510/10 . for preventing carbon deposits, e.g. chromium
- F01N 2510/12 . for smell removal
- F01N 2510/14 . for dehydrating

#### **F01N 2530/00 Selection of materials for tubes, chambers or housings**

- F01N 2530/02 . Corrosion resistive metals
- F01N 2530/04 . . Steel alloys, e.g. stainless steel
- F01N 2530/06 . Aluminium or alloys thereof
- F01N 2530/18 . Plastics material, e.g. polyester resin

F01N 2530/20 . . reinforced with mineral or metallic fibres

F01N 2530/22 . Flexible elastomeric material

F01N 2530/24 . Sintered porous material, e.g. bronze, aluminium or the like

F01N 2530/26 . Multi-layered walls

### **F01N 2550/00 Monitoring or diagnosing the deterioration of exhaust systems**

F01N 2550/02 . Catalytic activity of catalytic converters

F01N 2550/03 . of sorbing activity of adsorbents or absorbents

F01N 2550/04 . Filtering activity of particulate filters

F01N 2550/05 . Systems for adding substances into exhaust

F01N 2550/06 . By-pass systems

F01N 2550/10 . . of catalytic converters

F01N 2550/12 . . of particulate filters

F01N 2550/14 . Systems for adding secondary air into exhaust

F01N 2550/20 . Monitoring artificially aged exhaust systems

F01N 2550/22 . of electric heaters for exhaust systems or their power supply

F01N 2550/24 . Determining the presence or absence of an exhaust treating device

### **F01N 2560/00 Exhaust systems with means for detecting or measuring exhaust gas components or characteristics**

F01N 2560/02 . the means being an exhaust gas sensor

F01N 2560/021 . . for measuring or detecting ammonia NH<sub>3</sub>

F01N 2560/022 . . for measuring or detecting CO or CO<sub>2</sub>

F01N 2560/023 . . for measuring or detecting HC

F01N 2560/024 . . for measuring or detecting hydrogen H<sub>2</sub>

F01N 2560/025 . . for measuring or detecting O<sub>2</sub>, e.g. lambda sensors

F01N 2560/026 . . for measuring or detecting NO<sub>x</sub>

F01N 2560/027 . . for measuring or detecting SO<sub>x</sub>

F01N 2560/028 . . for measuring or detecting humidity or water

F01N 2560/05 . the means being a particulate sensor

F01N 2560/06 . the means being a temperature sensor

F01N 2560/07 . the means being an exhaust gas flow rate or velocity meter or sensor, intake flow meters only when exclusively used to determine exhaust gas parameters

- F01N 2560/08 . the means being a pressure sensor
- F01N 2560/12 . Other sensor principles, e.g. using electro conductivity of substrate or radio frequency
- F01N 2560/14 . having more than one sensor of one kind
- F01N 2560/20 . Sensor having heating means
- F01N 2570/00 Exhaust treating apparatus eliminating, absorbing or adsorbing specific elements or compounds**
- F01N 2570/02 . Lead
- F01N 2570/04 . Sulfur or sulfur oxides
- F01N 2570/06 . Zinc
- F01N 2570/08 . Phosphorus
- F01N 2570/10 . Carbon or carbon oxides
- F01N 2570/12 . Hydrocarbons
- F01N 2570/14 . Nitrogen oxides
- F01N 2570/145 . . Dinitrogen oxide
- F01N 2570/16 . Oxygen
- F01N 2570/18 . Ammonia
- F01N 2570/20 . Formaldehyde
- F01N 2570/22 . Water or humidity
- F01N 2570/24 . Hydrogen sulfide (H<sub>2</sub>S)
- F01N 2590/00 Exhaust or silencing apparatus adapted to particular use, e.g. for military applications, airplanes, submarines**
- F01N 2590/02 . for marine vessels or naval applications
- F01N 2590/021 . . for outboard engines
- F01N 2590/022 . . for jetskis
- F01N 2590/04 . for motorcycles
- F01N 2590/06 . for hand-held tools or portables devices
- F01N 2590/08 . for heavy duty applications, e.g. trucks, buses, tractors, locomotives
- F01N 2590/10 . for stationary applications

- F01N 2590/11 . . for hybrid vehicles
- F01N 2610/00 Adding substances to exhaust gases**
- F01N 2610/01 . . the substance being catalytic material in liquid form
- F01N 2610/02 . . the substance being ammonia or urea
- F01N 2610/03 . . the substance being hydrocarbons, e.g. engine fuel
- F01N 2610/04 . . the substance being hydrogen
- F01N 2610/05 . . the substance being carbon monoxide
- F01N 2610/06 . . the substance being in the gaseous form
- F01N 2610/08 . . with prior mixing of the substances with a gas, e.g. air
- F01N 2610/085 . . . Controlling the air supply
- F01N 2610/10 . . the substance being heated, e.g. by heating tank or supply line of the added substance
- F01N 2610/102 . . . after addition to exhaust gases, e.g. by a passively or actively heated surface in the exhaust conduit
- F01N 2610/105 . . . Control thereof
- F01N 2610/107 . . . using glow plug heating elements
- F01N 2610/11 . . the substance or part of the dosing system being cooled
- F01N 2610/12 . . the substance being in solid form, e.g. pellets or powder
- F01N 2610/14 . . Arrangements for the supply of substances, e.g. conduits
- F01N 2610/1406 . . . Storage means for substances, e.g. tanks or reservoirs
- F01N 2610/1413 . . . . Inlet and filling arrangements therefore
- F01N 2610/142 . . . . Controlling the filling of the tank
- F01N 2610/1426 . . . Filtration means
- F01N 2610/1433 . . . Pumps
- F01N 2610/144 . . . . Control thereof
- F01N 2610/1446 . . . Means for damping of pressure fluctuations in the delivery system, e.g. by puffer volumes or throttling
- F01N 2610/1453 . . . Sprayers or atomisers ; Arrangement thereof in the exhaust apparatus
- F01N 2610/146 . . . . Control thereof, e.g. control of injectors or injection valves
- F01N 2610/1466 . . . Means for venting air out of conduits or tanks
- F01N 2610/1473 . . . Overflow or return means for the substances, e.g. conduits or valves for the return path
- F01N 2610/148 . . . Arrangement of sensors
- F01N 2610/1486 . . . Means to prevent the substance from freezing
- F01N 2610/1493 . . . Means for prevention of purging or clogging

**Guidance heading:****F01N 2900/00****Details of electrical control or of the monitoring of the exhaust gas treating apparatus**

- F01N 2900/04 . Methods of control or diagnosing
- F01N 2900/0402 . . using adaptive learning
- F01N 2900/0404 . . using a data filter
- F01N 2900/0406 . . using a model with a division of the catalyst or filter in several cells
- F01N 2900/0408 . . using a feed-back loop
- F01N 2900/0411 . . using a feed-forward control
- F01N 2900/0412 . . using pre-calibrated maps, tables or charts
- F01N 2900/0414 . . using a state observer
- F01N 2900/0416 . . using the state of a sensor, e.g. of an exhaust gas sensor
- F01N 2900/0418 . . using integration or an accumulated value within an elapsed period
- F01N 2900/0421 . . using an increment counter when a predetermined event occurs
- F01N 2900/0422 . . measuring the elapsed time
  
- F01N 2900/06 . Parameters used for exhaust control or diagnosing
- F01N 2900/0601 . . being estimated
- F01N 2900/0602 . . Electrical exhaust heater signals
- F01N 2900/08 . . said parameters being related to the engine
- F01N 2900/10 . . said parameters being related to the vehicle or its components
- F01N 2900/102 . . . Travelling distance
- F01N 2900/104 . . . Battery status
- F01N 2900/12 . . said parameters being related to the vehicle exterior
- F01N 2900/14 . . said parameters being related to the exhaust gas
- F01N 2900/1402 . . . Exhaust gas composition
- F01N 2900/1404 . . . Exhaust gas temperature
- F01N 2900/1406 . . . Exhaust gas pressure
- F01N 2900/1411 . . . Exhaust gas velocity
- F01N 2900/16 . . said parameters being related to the exhaust apparatus, e.g. particulate filter or catalyst
- F01N 2900/1602 . . . Temperature of exhaust gas apparatus
- F01N 2900/1606 . . . Particle filter loading or soot amount
- F01N 2900/1611 . . . Particle filter ash amount
- F01N 2900/1612 . . . SOx amount trapped in catalyst
- F01N 2900/1614 . . . NOx amount trapped in catalyst
- F01N 2900/1616 . . . NH3-slip from catalyst
- F01N 2900/1618 . . . HC-slip from catalyst
- F01N 2900/1621 . . . Catalyst conversion efficiency
- F01N 2900/1622 . . . Catalyst reducing agent absorption capacity or consumption amount

F01N 2900/1624	...	Catalyst oxygen storage capacity
F01N 2900/1626	...	Catalyst activation temperature
F01N 2900/1628	...	Moisture amount in exhaust apparatus
F01N 2900/1631	...	Heat amount provided to exhaust apparatus
F01N 2900/18	..	said parameters being related to the system for adding a substance into the exhaust
F01N 2900/1804	...	Properties of secondary air added directly to the exhaust
F01N 2900/1806	...	Properties of reducing agent or dosing system
F01N 2900/1808	....	Pressure
F01N 2900/1811	....	Temperature
F01N 2900/1812	....	Flow rate
F01N 2900/1814	....	Tank level
F01N 2900/1818	....	Concentration of the reducing agent
F01N 2900/1821	....	Injector parameters
F01N 2900/1822	....	Pump parameters
F01N 2900/1824	....	Properties of the air to be mixed with added substances, e.g. air pressure or air temperature