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

**F**  
MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING  
*(NOTE omitted)*

**ENGINES OR PUMPS**

**F01**  
MACHINES OR ENGINES IN GENERAL; ENGINE PLANTS IN GENERAL; STEAM ENGINES

**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).

**WARNING**  
In this subclass non-limiting references (in the sense of paragraph 39 of the Guide to the IPC) may still be displayed in the scheme.

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

| 1/081 | *(by passing the gases through a mass of particles)* |
| 1/082 | *(the gases passing through porous members (F01N 1/081 takes precedence))* |
| 1/083 | *(using transversal baffles defining a tortuous path for the gases or successively throttling gas flow)* |
| 1/084 | *(the gases flowing through the silencer two or more times longitudinally in opposite directions, e.g. using parallel or concentric tubes)* |
| 1/085 | *(using a central core throttling gas passage)* |
| 1/086 | *(having means to impart whirling motion to the gases (with helically or spirally shaped channels F01N 1/12)* |
| 1/087 | *(using tangential inlets into a circular chamber)* |
| 1/088 | *(using vanes arranged on gas flow path or gas flow tubes with tangentially directed apertures)* |
| 1/089 | *(using two or more expansion chambers in series (F01N 1/083, F01N 1/084, F01N 1/086 take precedence))* |
3/023 . . . using means for regenerating the filters, e.g.
by burning trapped particles (by electrically
controlling the supply of combustible mixture
or its constituents only F02D 41/0235)
3/0231 . . . . using special exhaust apparatus upstream of
the filter for producing nitrogen dioxide, e.g.
for continuous filter regeneration systems
[CRT]
3/0232 . . . . (removing incombustible material from a
particle filter, e.g. ash)
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)
3/0234 . . . . (using heat exchange means in the exhaust
line)
3/0235 . . . . (using exhaust gas throttling means)
3/0236 . . . . (using turbine waste gate valve)
3/0237 . . . . (for regenerating ex situ)
3/0238 . . . . (for regenerating during engine standstill)
3/025 . . . using fuel burner or by adding fuel to
exhaust
3/0253 . . . . . . (adding fuel to exhaust gases)
3/0256 . . . . . . (the fuel being ignited by electrical
means)
3/027 . . . using electric or magnetic heating means
3/0275 . . . . (using electric discharge means)
3/028 . . . using microwaves
3/029 . . . by adding non-fuel substances to exhaust
3/0293 . . . . (injecting substances in exhaust stream)
3/0296 . . . . . . (having means for preheating additional
substances)
3/031 . . . . having means for by-passing filters, e.g. when
clogged or during cold engine start
3/032 . . . . during filter regeneration only
3/033 . . . . in combination with other devices { (with
adsorbents or absorbents F01N 3/0821) }
3/0335 . . . . . . (with exhaust silencers in a single housing)
3/035 . . . . with catalytic reactors {, e.g. catalysed diesel
particulate filters}
3/037 . . . by means of inertial or centrifugal separators,
e.g. of cyclone type, optionally combined or
associated with agglomerators
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
3/04 . . . using liquids
3/043 . . . . . . (without contact between liquid and exhaust
gases)
3/046 . . . . (Exhaust manifolds with cooling jacket)
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 13/0822))
3/055 . . . . . . (without contact between air and exhaust
gases)
3/06 . . . . for extinguishing sparks
3/08 . . . . for rendering innocuous (using electric or
electrostatic separators F01N 3/01; chemical aspects
B01D 53/92)
3/0807 . . . [by using absorbents or adsorbents]
3/0814 . . . [combined with catalytic converters, e.g. NOx absorption/storage reduction catalysts]
3/0821 . . . [combined with particulate filters (catalysed diesel particulate filters F01N 3/035)]
3/0828 . . . [characterised by the absorbed or adsorbed substances]
3/0835 . . . [Hydrocarbons]
3/0842 . . . [Nitrogen oxides]
3/085 . . . [Sulfur or sulfur oxides]
3/0857 . . . [Carbon oxides]
3/0864 . . . [Oxygen]
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)]
3/0878 . . . [Bypassing absorbents or adsorbents]
3/0885 . . . [Regeneration of deteriorated absorbents or adsorbents, e.g. desulfurization of NOx traps]
3/0892 . . . [Electric or magnetic treatment, e.g. dissociation of noxious components (electric filters F01N 3/01; regeneration of exhaust filters F01N 3/0232; heating catalytic converters F01N 3/2006)]
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)
3/101 . . . [Three-way catalysts]
3/103 . . . [Oxidation catalysts for HC and CO only]
3/105 . . . [General auxiliary catalysts, e.g. upstream or downstream of the main catalyst]
3/106 . . . [Auxiliary oxidation catalysts]
3/108 . . . [Auxiliary reduction catalysts]
3/18 . . . [characterised by methods of operation; Control of additional air supply only, e.g. using by-passes or variable air pump drives]
3/20 . . . [specially adapted for catalytic conversion (F01N 3/22 takes precedence) ; Methods of operation or control of catalytic converters]
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 F02D 41/0235)]
3/2013 . . . [using electric or magnetic heating means]
3/202 . . . . . . . . . . . . . . . . . . [using microwaves]
3/2026 . . . . . . . . . . . . . . . . . . [directly electrifying the catalyst substrate, i.e. heating the electrically conductive catalyst substrate by joule effect]
3/2033 . . . . . . . . . . . . . . . . . . [using a fuel burner or introducing fuel into exhaust duct]
3/204 . . . . . . . . . . . . . . . . . . [using an exhaust gas igniter, e.g. a spark or glow plug, without introducing fuel into exhaust duct]
3/2046 . . . . . . . . . . . . . . . . . . [Periodically cooling catalytic reactors]
3/2053 . . . . . . . . . . . . . . . . . . [By-passing catalytic reactors, e.g. to prevent overheating]
3/206 . . . . . . . . . . . . . . . . . . [Adding periodically or continuously substances to exhaust gases for promoting purification, e.g. catalytic material in liquid form, NOx reducing agents (F01N 3/2066 takes precedence)]
3/2066 . . . . . . . . . . . . . . . . . . [Selective catalytic reduction [SCR]]
3/2073 . . . . . . . . . . . . . . . . . . [with means for generating a reducing substance from the exhaust gases]
3/208 . . . . . . . . . . . . . . . . . . [Control of selective catalytic reduction [SCR], e.g. dosing of reducing agent]
3/2086 . . . . . . . . . . . . . . . . . . [Activating the catalyst by light, photo-catalysts]
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]
3/22 . . . . . . . . . . . . . . . . . . [Control of additional air supply only, e.g. using by-passes or variable air pump drives]
3/222 . . . . . . . . . . . . . . . . . . [using electric valves only]
3/225 . . . . . . . . . . . . . . . . . . [Electric control of additional air supply]
3/227 . . . . . . . . . . . . . . . . . . [using pneumatically operated valves, e.g. membrane valves]
3/24 . . . . . . . . . . . . . . . . . . [characterised by constructional aspects of converting apparatus (filtering in combination with catalytic reactors F01N 3/2035)]
3/26 . . . . . . . . . . . . . . . . . . [Construction of thermal reactors]
3/28 . . . . . . . . . . . . . . . . . . [Construction of catalytic reactors]
3/2803 . . . . . . . . . . . . . . . . . . [characterised by structure, by material or by manufacturing of catalyst support]
3/2807 . . . . . . . . . . . . . . . . . . [Metal other than sintered metal (F01N 3/2832 and F01N 3/2835 take precedence)]
3/281 . . . . . . . . . . . . . . . . . . [Metallic honeycomb monoliths made of stacked or rolled sheets, foils or plates]
3/2814 . . . . . . . . . . . . . . . . . . [all sheets, plates or foils being corrugated]
3/2817 . . . . . . . . . . . . . . . . . . [only with non-corrugated sheets, plates or foils]
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]
3/2825 . . . . . . . . . . . . . . . . . . [Ceramics (F01N 3/2832, F01N 3/2835 take precedence)]
3/2828 . . . . . . . . . . . . . . . . . . [Ceramic multi-channel monoliths, e.g. honeycombs]
3/2832 . . . . . . . . . . . . . . . . . . [granular, e.g. pellets]
3/2835 . . . . . . . . . . . . . . . . . . [fibrous]
3/2839 . . . . . . . . . . . . . . . . . . [Arrangements for mounting catalyst support in housing, e.g. with means for compensating thermal expansion or vibration]
3/2842 . . . . . . . . . . . . . . . . . . [specially adapted for monolithic supports, e.g. of honeycomb type (F01N 3/2833 - F01N 3/2871 take precedence)]
3/2846 . . . . . . . . . . . . . . . . . . [specially adapted for granular supports, e.g. pellets]
3/285 . . . . . . . . . . . . . . . . . . [specially adapted for fibrous supports, e.g. held in place by screens]
3/2853 . . . . . . [using mats or gaskets between catalyst body and housing]
3/2857 . . . . . . . . [the mats or gaskets being at least partially made of intumescent material, e.g. unexpanded vermiculite]
3/286 . . . . . . . . [the mats or gaskets having corrugations or cavities]
3/2864 . . . . . . . . [the mats or gaskets comprising two or more insulation layers]
3/2867 . . . . . . . . [the mats or gaskets being placed at the front or end face of catalyst body]
3/2871 . . . . . . . . [the mats or gaskets having an additional, e.g. non-insulating or non-cushioning layer, a metal foil or an adhesive layer]
3/2875 . . . . . . . . [by using elastic means, e.g. spring leaves, for retaining catalyst body in the housing (F01N 3/2853 - F01N 3/2871 take precedence)]
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]
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 F01N 3/0814; combined with particulate filters F01N 3/035)]
3/2885 . . . . . . . . [with exhaust silencers in a single housing]
3/2889 . . . . . . . . [with heat exchangers in a single housing]
3/2892 . . . . . . . . [Exhaust flow directors or the like, e.g. upstream of catalytic device]
3/2896 . . . . . . . . [Liquid catalyst carrier]
3/30 . . . . . . . . . . . . Arrangements for supply of additional air (control, e.g. using by-passes or variable air pump drives, F01N 3/22)
3/303 . . . . . . . . . . . . [Filtering additional air]
3/306 . . . . . . . . . . . . [Preheating additional air]
3/32 . . . . . . . . . . . . [using air pump (using jet air pumps F01N 3/34; pumps in general F04)]
3/323 . . . . . . . . . . . . [Electrically driven air pumps]
3/326 . . . . . . . . . . . . [Engine-driven air pumps]
3/34 . . . . . . . . . . . . [using air conduits or jet air pumps, e.g. near the engine exhaust port]
3/36 . . . . . . . . . . . . Arrangements for supply of additional fuel
3/38 . . . . . . . . . . . . Arrangements for igniting
5/00 Exhaust or silencing apparatus combined or associated with devices profiting from exhaust energy (using kinetic or wave energy of exhaust gases in exhaust systems for charging F02B; predominant aspects of such devices, see the relevant classes for the devices)
5/02 . . . . . . . . . . . . the devices using heat
5/025 . . . . . . . . . . . . [the device being thermolectric generators]
5/04 . . . . . . . . . . . . the devices using kinetic energy
9/00 Electrical control of exhaust gas treating apparatus (monitoring or diagnostic devices for exhaust-gas treatment apparatus F01N 1/00; conjoint electrical control of two or more combustion engine functions F02D 43/40)
9/002 . . . . . . . . . . . . [of filler regeneration, e.g. detection of clogging]
9/005 . . . . . . . . . . . . [using models instead of sensors to determine operating characteristics of exhaust systems, e.g. calculating catalyst temperature instead of measuring it directly]
9/007 . . . . . . . . . . . . [Storing data relevant to operation of exhaust systems for later retrieval and analysis, e.g. to research exhaust system malfunctions]
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)
11/002 . . . . . . . . . . . . [the diagnostic devices measuring or estimating temperature or pressure in, or downstream of the exhaust apparatus]
11/005 . . . . . . . . . . . . [the temperature or pressure being estimated, e.g. by means of a theoretical model]
11/007 . . . . . . . . . . . . [the diagnostic devices measuring oxygen or air concentration downstream of the exhaust apparatus]
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 - F01N 5/00, F01N 9/00, F01N 11/00)
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)]
13/002 . . . . . . . . . . . . [Apparatus adapted for particular uses, e.g. for portable devices driven by machines or engines]
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)]
13/005 . . . . . . . . . . . . [with parts constructed of non-metallic material, e.g. of rubber]
13/007 . . . . . . . . . . . . [Apparatus used as intake or exhaust silencer (silencing methods F01N 1/00; intake silencers F02M 35/12)]
13/008 . . . . . . . . . . . . [Mounting or arrangement of exhaust sensors in or on exhaust apparatus (sensor arrangements for engine control F02D 41/1439)]
13/009 . . . . . . . . . . . . [having two or more separate purifying devices arranged in series]
13/0093 . . . . . . . . . . . . [the purifying devices are of the same type]
13/0097 . . . . . . . . . . . . [the purifying devices are arranged in a single housing]
13/011 . . . . . . . . . . . . [having two or more purifying devices arranged in parallel]
13/017 . . . . . . . . . . . . [the purifying devices are arranged in a single housing]
13/02 . . . . . . . . . . . . [having two or more separate silencers in series]
13/04 . . . . . . . . . . . . [having two or more silencers in parallel, e.g. having interconnections for multi-cylinder engines]
13/06 . . . . . . . . . . . . [specially adapted for star-arrangement of cylinders, e.g. exhaust manifolds]
Construction facilitating manufacture, assembly, or selection of particular materials

having thermal insulation (exhaust manifolds [F01N 13/102])

having the form of a chamber directly connected to the cylinder head, e.g. without having tubes connected between cylinder head and chamber)

More than one exhaust manifold or exhaust collector)

specially adapted for submerged exhausting

having thermal insulation (exhaust manifolds [F01N 13/102])

Double-walled exhaust pipes or housings)

with air filling the space between both walls

with gas other than air filling the space between both walls

with vacuum in the space between both walls

Multiple layers of insulating material

Selection of particular materials

Construction facilitating manufacture, assembly, or disassembly

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 [B66K])

with means permitting relative movement, e.g. compensation of thermal expansion or vibration)

the pipe sections being joined together by flexible tubular elements only, e.g. using bellows or strip-wound pipes)

for fixing exhaust pipes or devices to vehicle body

Sealings specially adapted for exhaust systems (sealings in general [F16J 15/00])

specially adapted for small internal combustion engines, e.g. used in model applications)

characterised by the type of connection between parts of exhaust or silencing apparatus, e.g. between housing and tubes, between tubes and baffles]

Mechanical joints]

the connection being realised by deforming housing, tube, baffle, plate, or parts thereof]

the connection being realised by using bolts, screws, rivets or the like)

the assembly using parts formed by casting or moulding)

the channels or tubes thereof being made integrally with the housing)
Structure of catalyst support or particle filter

Selection of sound absorbing or insulating material

Movable parts or members in exhaust systems for other than for control purposes

Selection of sound absorbing or insulating material

Structure of catalyst support or particle filter

Arrangements for fitting catalyst support or particle filter element in the housing

Selection of materials for exhaust purification

Arrangements for controlling or regulating exhaust apparatus

By-passing, at least partially, exhaust from inlet to outlet of apparatus, to atmosphere or to other device
in case of high temperature, e.g. overheating of catalytic reactor

in case of low temperature

during regeneration period, e.g. of particle filter

at cold starting

in case of clogging, e.g. of particle filter

for reducing flow resistance, e.g. to obtain more engine power

case of absorption, adsorption or desorption of exhaust gas constituents

in case of excessive pressure, e.g. using a safety valve

Influencing exhaust purification, e.g. starting of catalytic reaction, filter regeneration, or the like, by controlling engine operating characteristics

by cutting out a part of engine cylinders

by adding non-fuel substances to combustion air or fuel, e.g. additives

by varying fuel-air ratio, e.g. by enriching fuel-air mixture

by modifying ignition or injection timing

. . at least a part of the injection taking place during expansion or exhaust stroke

by modifying inlet or exhaust valve timing

Methods or apparatus for fitting, inserting or repairing different elements

Fitting monolithic blocks into the housing

Filling or emptying a chamber with granular material

Inserting sound absorbing material into a chamber

Repairing the housing or pipe-joints

Fitting temporarily exhaust apparatus on exhaust conduit, e.g. in confined environment, garage or the like

. by using threaded joints

. by using quick-active type locking mechanisms, e.g. clips

by mechanical joints, e.g. by deforming housing, tube, baffle plate or parts thereof

by welding or brazing

by bolts, screws, rivets or the like

by bayonet fittings

by using adhesive material, e.g. cement

Removable or rechangeable blocks or cartridges, e.g. for filters

Retrofitting exhaust apparatus

Structure or shape of gas passages, pipes or tubes

Tubes being perforated

. . characterised by shape, disposition or dimensions of apertures

Tubes being formed by assembly of stamped or otherwise deformed sheet-metal

Gas passages being formed between the walls of an outer shell and an inner chamber

Tubes having non-circular cross section

Tubes being corrugated

Plurality of outlet tubes, e.g. in parallel or with different length

Plurality of inlet tubes, e.g. discharging into different chambers

the axis of inlet or outlet tubes being other than the longitudinal axis of apparatus

Dimensional characteristics of tubes, e.g. length, diameter

Inlet and outlet tubes being positioned on the same side of the apparatus

Concentric tubes or tubes being concentric to housing, e.g. telescopically assembled

Tubes being formed by extrusion, drawing or rolling

Tubes being formed by moulding or casting x

Tubes with restrictions, i.e. venturi or the like, e.g. for sucking air or measuring mass flow

Structure, disposition or shape of gas-chambers

Two or more expansion chambers in series connected by means of tubes

. the gases flowing longitudinally from inlet to outlet only in one direction

. the gases flowing longitudinally from inlet to outlet in opposite directions

Two or more expansion chambers in series separated by apertured walls only

Two or more expansion chambers in parallel

Chambers having variable volumes

Dead or resonance chambers connected to gas flow tube by relatively short side-tubes

Plurality of resonance or dead chambers

being disposed one after the other in flow direction

Chambers with particular shapes, e.g. spherical

Dimensional characteristics of gas chambers

Chambers being formed inside the exhaust pipe without enlargement of the cross section of the pipe, e.g. resonance chambers

Surface coverings

for thermal insulation

for sound absorption

for exhaust purification, e.g. catalytic reaction

usable with leaded fuels

zeolites

for reducing soot ignition temperature

usable with sulfurised fuels

characterised by the distribution of the catalytic coatings

having a discontinuous, uneven or partially overlapping coating of catalytic material, e.g. higher amount of material upstream than downstream or vice versa

having more than one coating layer, e.g. multi-layered coatings

for corrosion prevention

for preventing carbon deposits, e.g. chromium

for smell removal

for dehydrating

Selection of materials for tubes, chambers or housings

Corrosion resistive metals

Steel alloys, e.g. stainless steel

Aluminium or alloys thereof

Plastics material, e.g. polyester resin

reinforced with mineral or metallic fibres

Flexible elastomeric material

Sintered porous material, e.g. bronze, aluminium or wood

Flexible, i.e. rubber or plastic

Catalytic media, e.g. zeolites, palladium, rhodium, ruthenium, etc.

Permeable material, e.g. felt or gauze

Permeability layers, e.g. asbestos, paper, aluminised paper

Gas passages being formed between the walls of an outer shell and an inner chamber

Tubes having non-circular cross section

Tubes being corrugated

Plurality of outlet tubes, e.g. in parallel or with different length

Plurality of inlet tubes, e.g. discharging into different chambers

the axis of inlet or outlet tubes being other than the longitudinal axis of apparatus
Multi-layered walls

Monitoring or diagnosing the deterioration of exhaust systems

Catalytic activity of catalytic converters

Sorption activity of sorbents or absorbents

Filtering activity of particulate filters

Systems for adding substances into exhaust

By-pass systems

of catalytic converters

of particulate filters

Systems for adding secondary air into exhaust

Monitoring artificially aged exhaust systems

of electric heaters for exhaust systems or their power supply

Determining the presence or absence of an exhaust treating device

Exhaust systems with means for detecting or measuring exhaust gas components or characteristics

the means being an exhaust gas sensor

for measuring or detecting ammonia NH\(_3\)

for measuring or detecting CO or CO\(_2\)

for measuring or detecting HC

for measuring or detecting hydrogen H\(_2\)

for measuring or detecting O\(_2\), e.g. lambda sensors

for measuring or detecting NOx

for measuring or detecting SOx

the means being a particulate sensor

the means being a temperature sensor

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

the means being a pressure sensor

Other sensor principles, e.g. using electro conductivity of substrate or radio frequency

having more than one sensor of one kind

Sensor having heating means

Exhaust treating apparatus eliminating, absorbing or adsorbing specific elements or compounds

Lead

Sulfur or sulfur oxides

Zinc

Phosphorus

Carbon or carbon oxides

Hydrocarbons

Nitrogen oxides

Dinitrogen oxide

Oxygen

Ammonia

Formaldehyde

Water or humidity

Hydrogen sulfide (H\(_2\)S)

Exhaust or silencing apparatus adapted to particular use, e.g. for military applications, airplanes, submarines

for marine vessels or naval applications

for outboard engines

for jetskis

for motorcycles

for hand-held tools or portable devices

for heavy duty applications, e.g. trucks, buses, tractors, locomotives

for stationary applications

for hybrid vehicles

Adding substances to exhaust gases

the substance being catalytic material in liquid form

the substance being ammonia or urea

the substance being hydrocarbons, e.g. engine fuel

the substance being hydrogen

the substance being carbon monoxide

the substance being in the gaseous form

with prior mixing of the substances with a gas, e.g. air

Controlling the air supply

the substance being heated, e.g. by heating tank or supply line of the added substance

after addition to exhaust gases, e.g. by a passively or actively heated surface in the exhaust conduit

Control thereof

using glow plug heating elements

the substance or part of the dosing system being cooled

the substance being in solid form, e.g. pellets or powder

Arrangements for the supply of substances, e.g. conduits

Storage means for substances, e.g. tanks or reservoirs

Inlet and filling arrangements therefore

Controlling the filling of the tank

Filtration means

Pumps

Control thereof

Sprayers or atomisers; Arrangement thereof in the delivery system, e.g. by puffer volumes or throttling

Sprayers or atomisers; Arrangement thereof in the exhaust apparatus

Control thereof, e.g. control of injectors or injection valves

Means for venting air out of conduits or tanks

Overflow or return means for the substances, e.g. conduits or valves for the return path

Arrangement of sensors

Means to prevent the substance from freezing

Purging the reducing agent out of the conduits or nozzle

Details of electrical control or of the monitoring of the exhaust gas treating apparatus

Methods of control or diagnosing

using adaptive learning

using a data filter

using a model with a division of the catalyst or filter in several cells

using a feed-back loop

using a feed-forward control

using pre-calibrated maps, tables or charts

using a state observer
using the state of a sensor, e.g. of an exhaust gas sensor
using integration or an accumulated value within an elapsed period
using an increment counter when a predetermined event occurs
measuring the elapsed time
Parameters used for exhaust control or diagnosing
being estimated
Electrical exhaust heater signals
said parameters being related to the engine
said parameters being related to the vehicle or its components
Travelling distance
Battery status
said parameters being related to the vehicle exterior
said parameters being related to the exhaust gas
Exhaust gas composition
Exhaust gas temperature
Exhaust gas pressure
Exhaust gas flow rate, e.g. mass flow rate or volumetric flow rate
said parameters being related to the exhaust apparatus, e.g. particulate filter or catalyst
Temperature of exhaust gas apparatus
Particle filter loading or soot amount
Particle filter ash amount
SOx amount trapped in catalyst
NOx amount trapped in catalyst
NH3-slip from catalyst
HC-slip from catalyst
Catalyst conversion efficiency
Catalyst reducing agent absorption capacity or consumption amount
Catalyst oxygen storage capacity
Catalyst activation temperature
Moisture amount in exhaust apparatus
Heat amount provided to exhaust apparatus
said parameters being related to the system for adding a substance into the exhaust
Properties of secondary air added directly to the exhaust
Properties of reducing agent or dosing system
Pressure
Temperature
Flow rate
Tank level
Concentration of the reducing agent
Injector parameters
Pump parameters
Properties of the air to be mixed with added substances, e.g. air pressure or air temperature