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(54) **EXHAUST SYSTEMS FOR VEHICLES**

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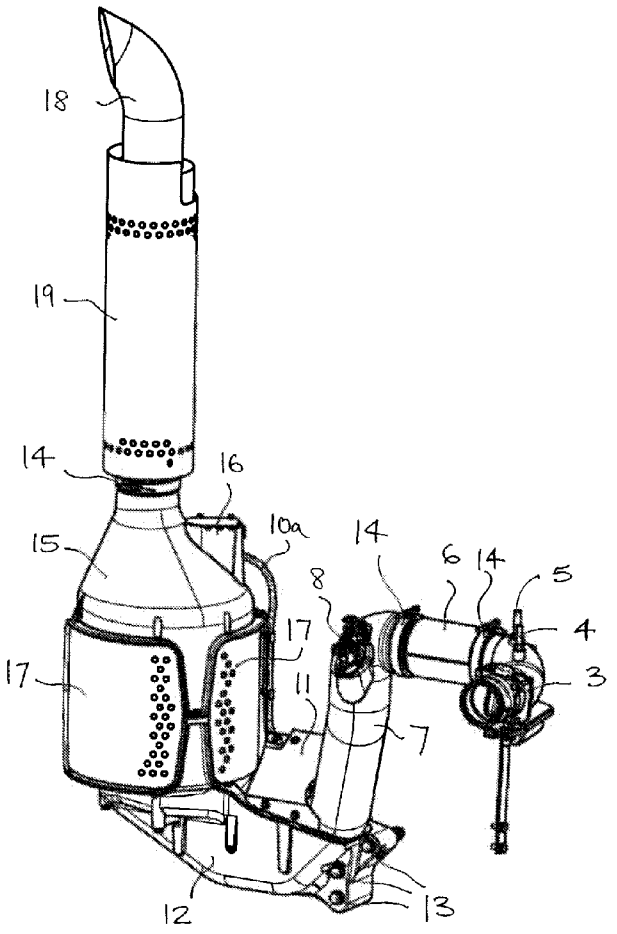
(57) **ABSTRACT**

An exhaust system for a vehicle having a cab (**53**) and an internal combustion engine (**1**) located in an engine compartment (**51**). The system includes an exhaust gas treatment unit (**9**) located outside the engine compartment and having an inlet (**9***a*) which receives exhaust gases from the engine and an outlet (**9***e*) which passes treated gases into a final portion (E) of the exhaust system. The treatment unit (**9**) is arranged to extend generally vertically with the outlet (**9***e*) generally vertically above the inlet (**9***a*) and adjacent a corner post (**52**) of the cab of the vehicle to reduce impact on the visibility from the cab. A cage (C) surrounds the exhaust gas treatment unit (**9**) and has a support means (**12**) for attachment to a chassis of the vehicle and an outlet (**15***e*) which the outlet (**9***e*) of the treatment unit is connected. The final portion (E) of the exhaust system is connected with and supported from the cage outlet (**15***e*) to relieve the treatment unit (**9**) from supporting the weight of the final portion of the exhaust system.



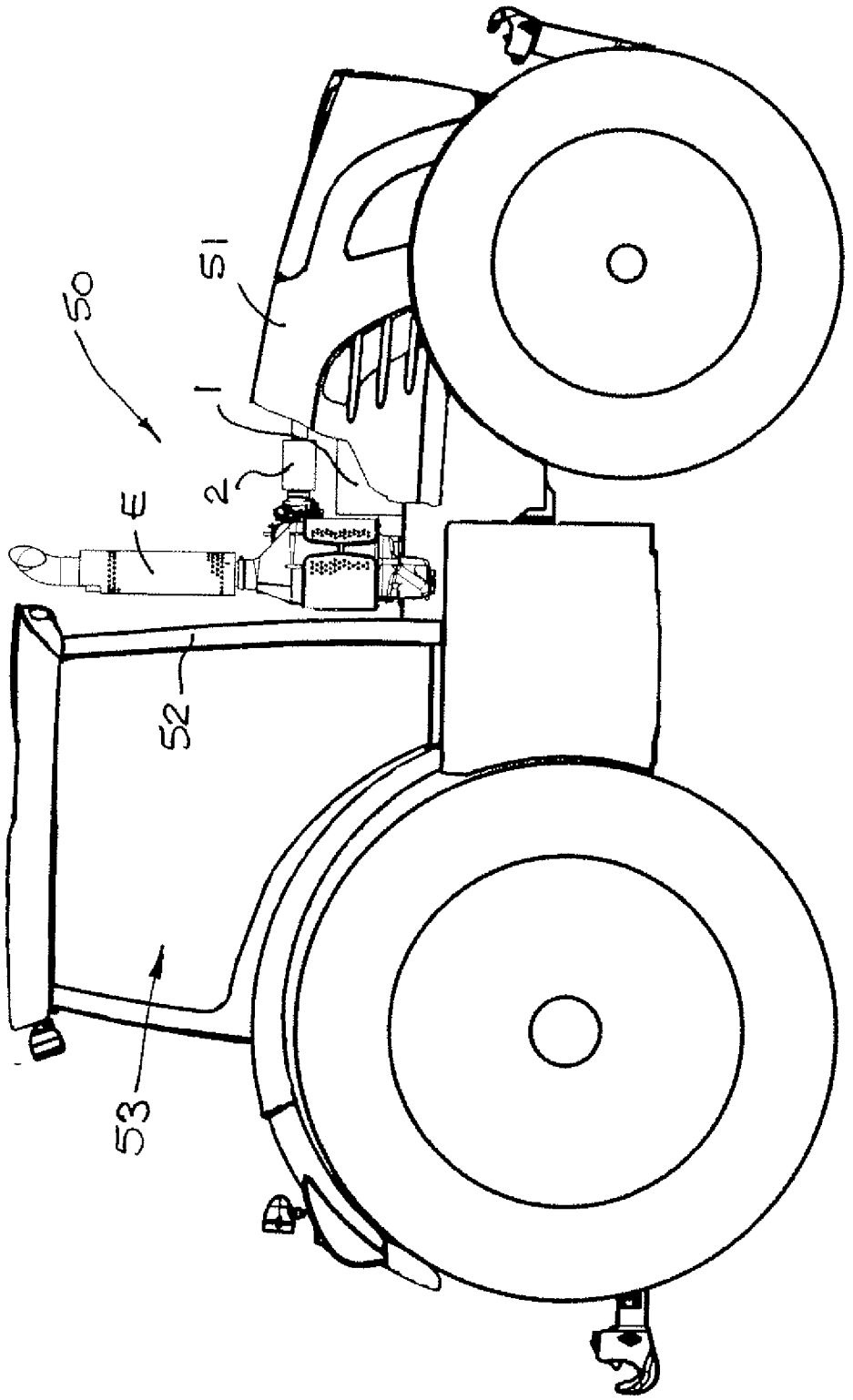


FIG. 1.

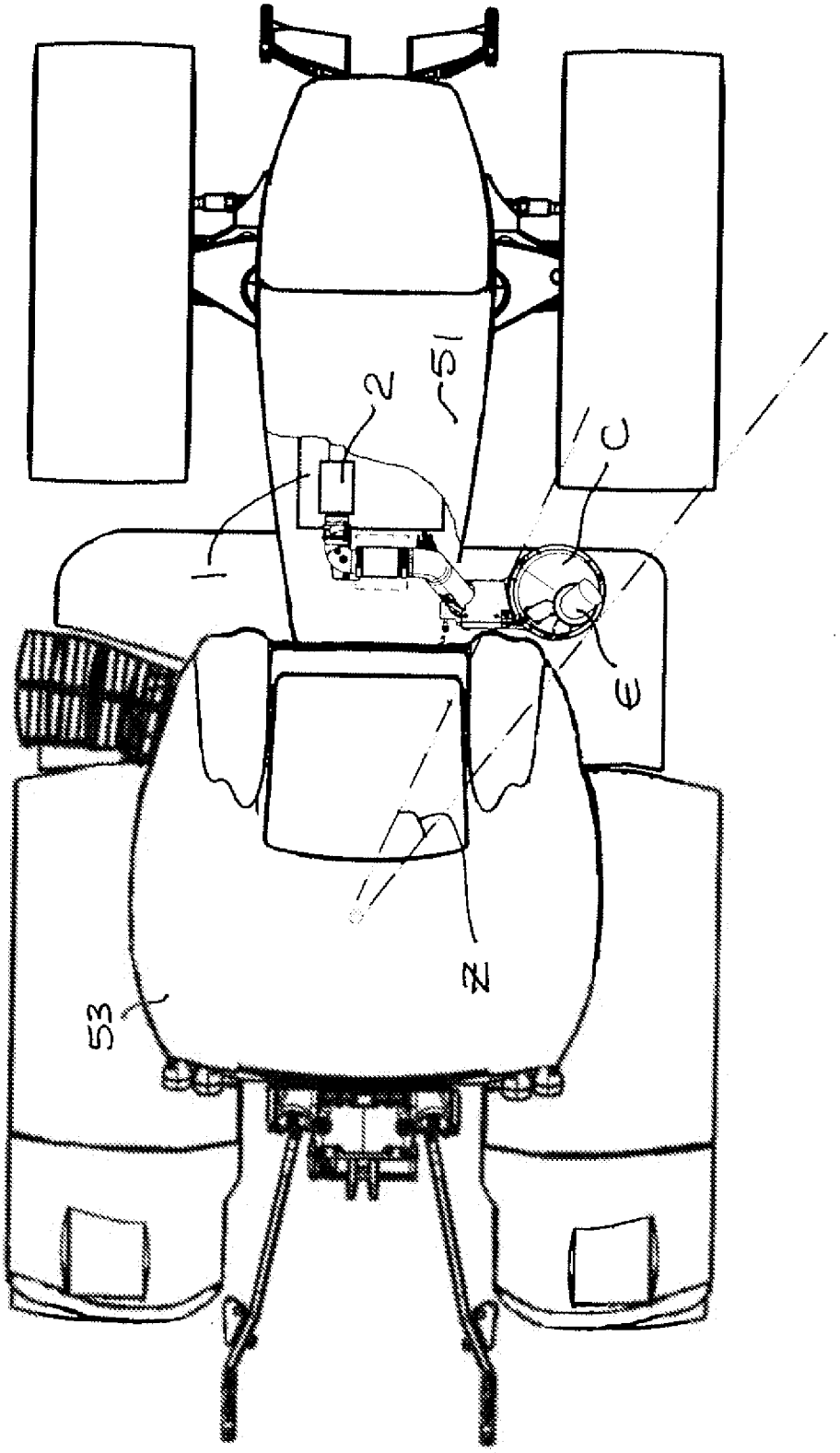


FIG. 2.

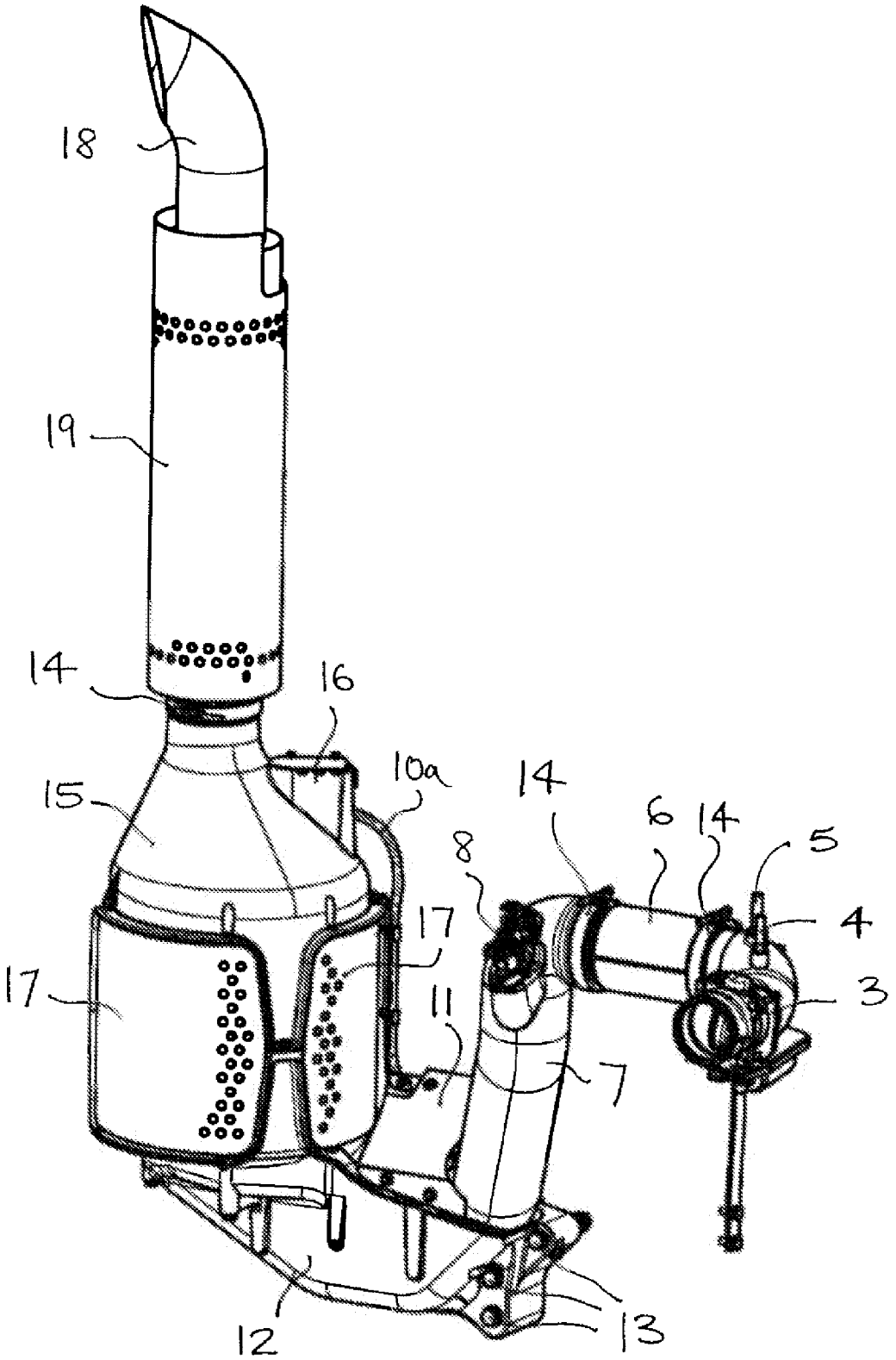


FIG. 3.

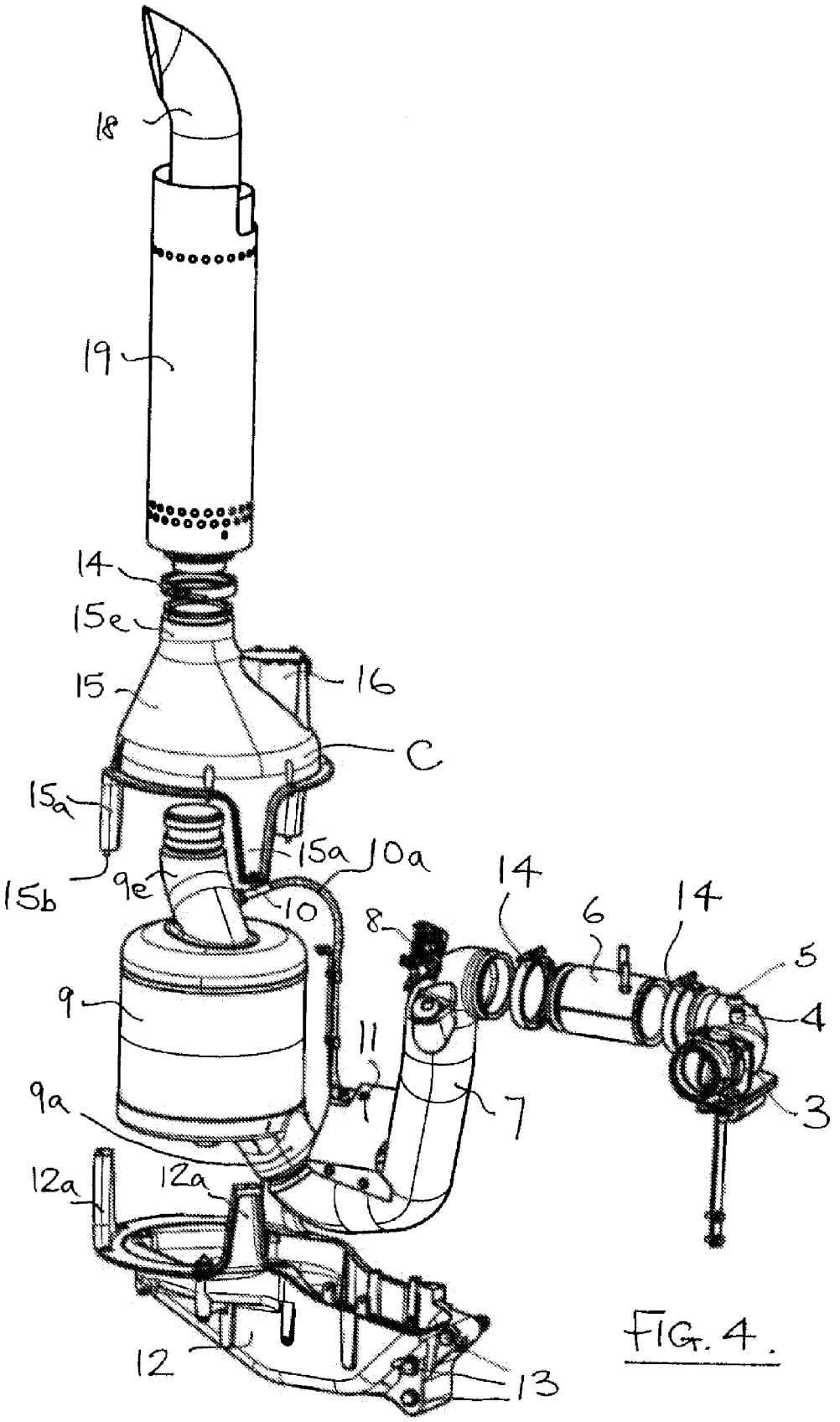

18
19
14
15e
15
16
C
15a
15b
9e
15a
10a
10
14
8
6
14
5
4
3
9
11
7
9a
12a
12a
12
13

FIG. 4.

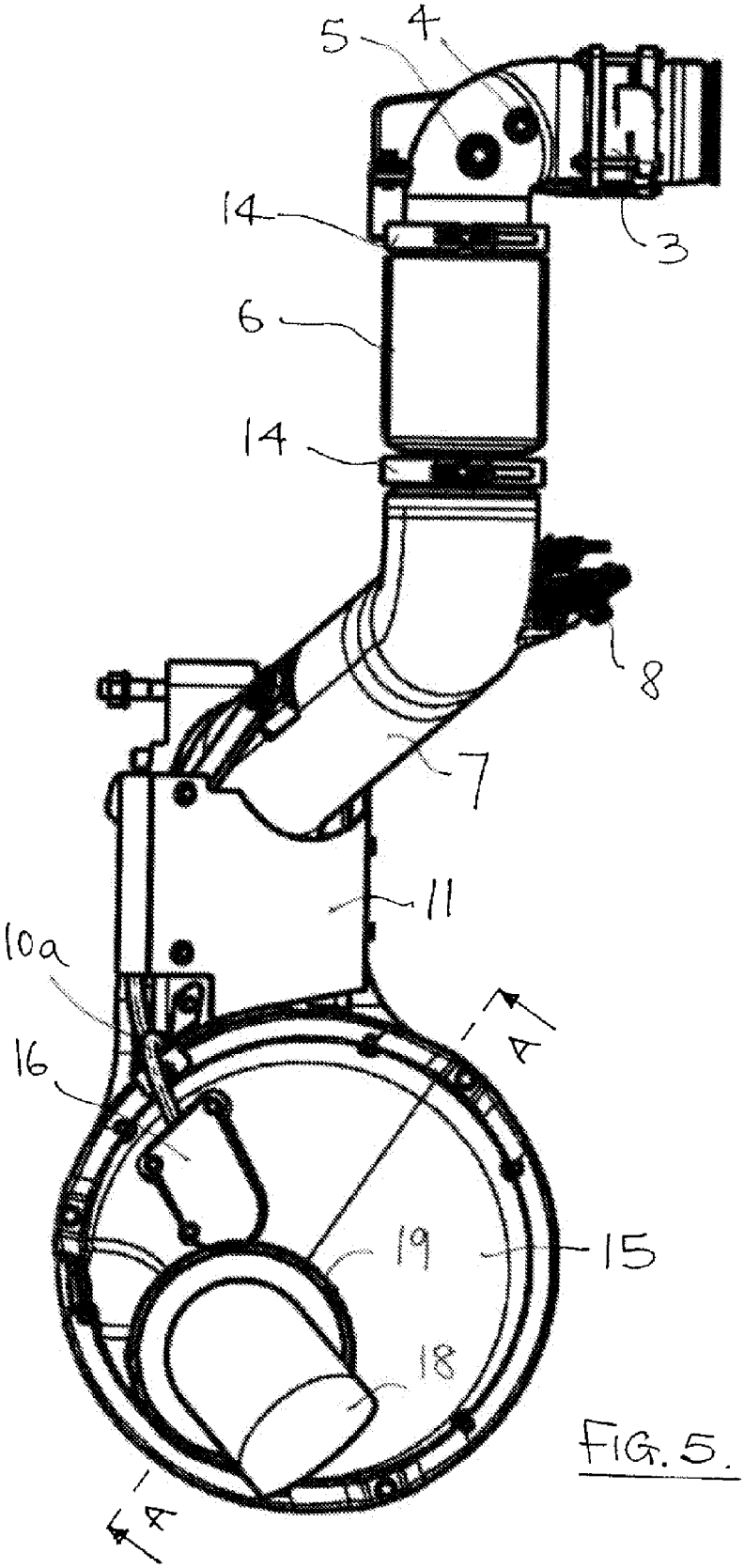


FIG. 5.

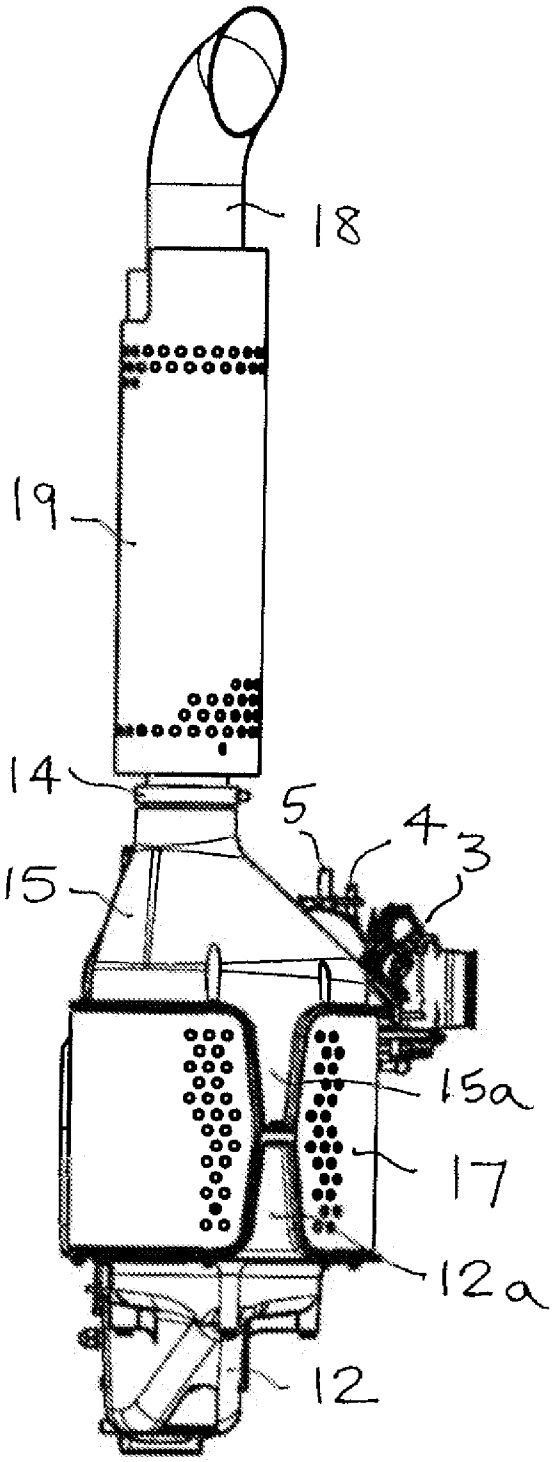


FIG. 6.

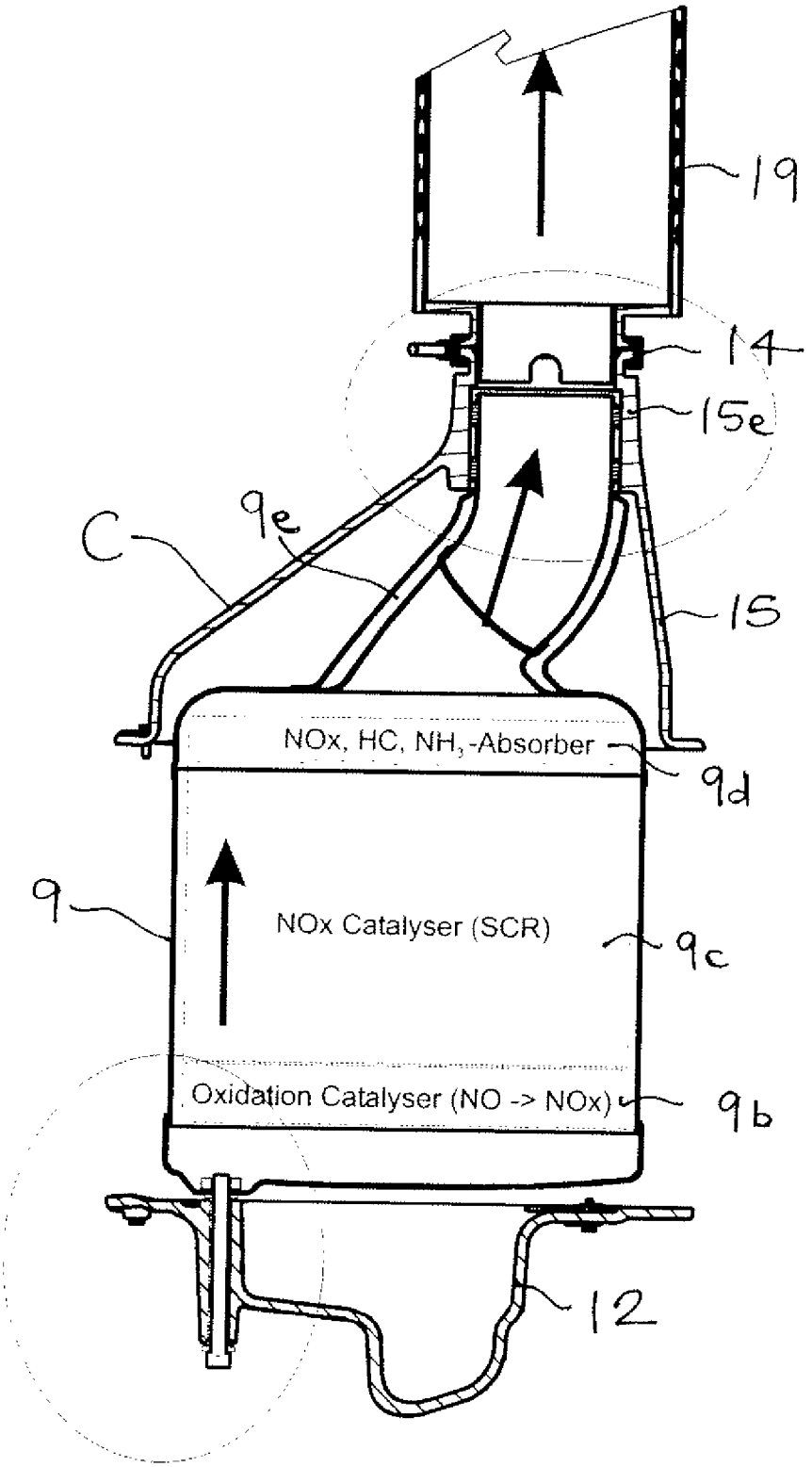

19
14
15e
C
9e
15
NOx, HC, NH3-Absorber
9d
9
NOx Catalyser (SCR)
9c
Oxidation Catalyser (NO -> NOx)
9b
12

FIG. 7.

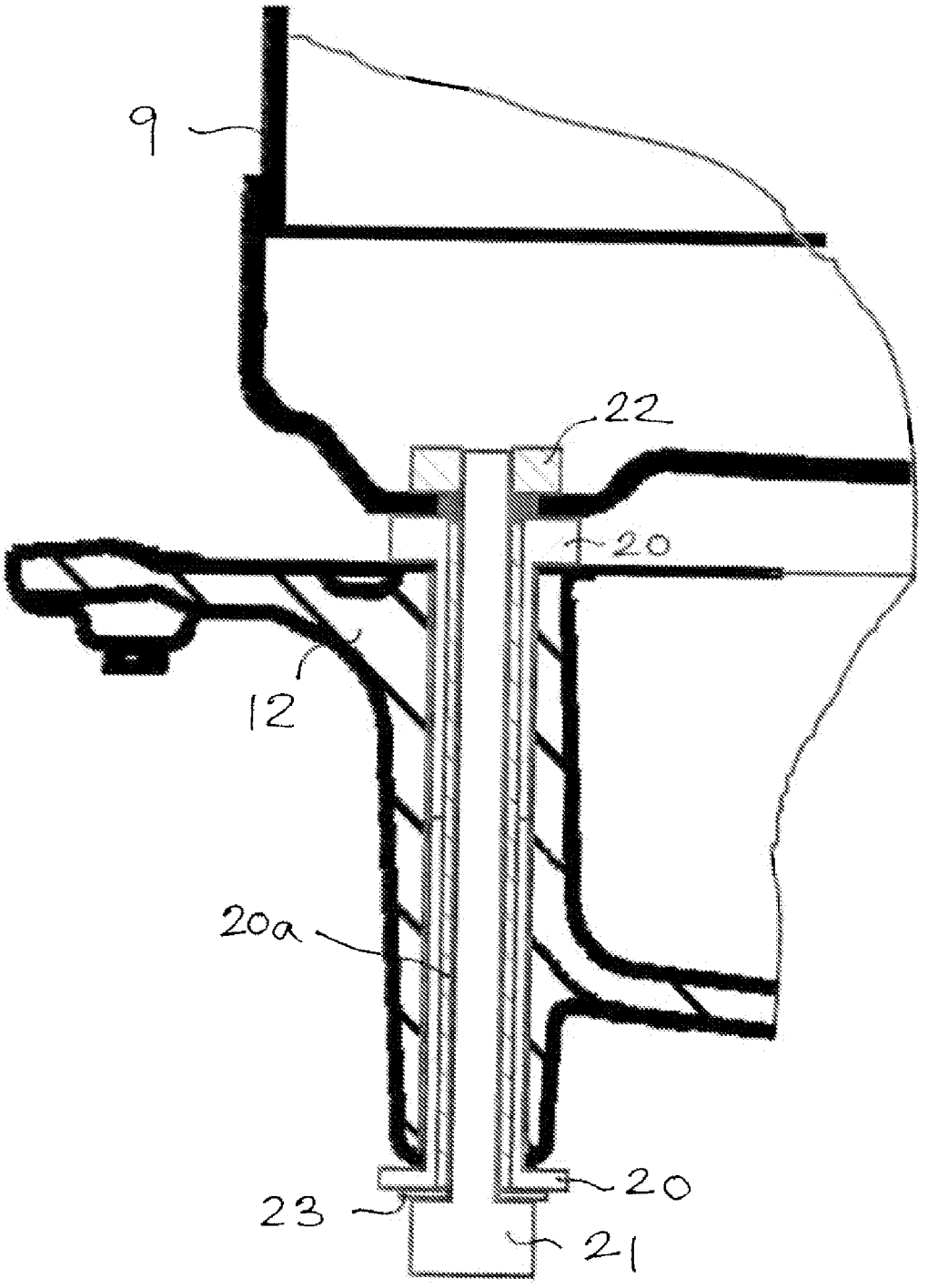


FIG. 8.

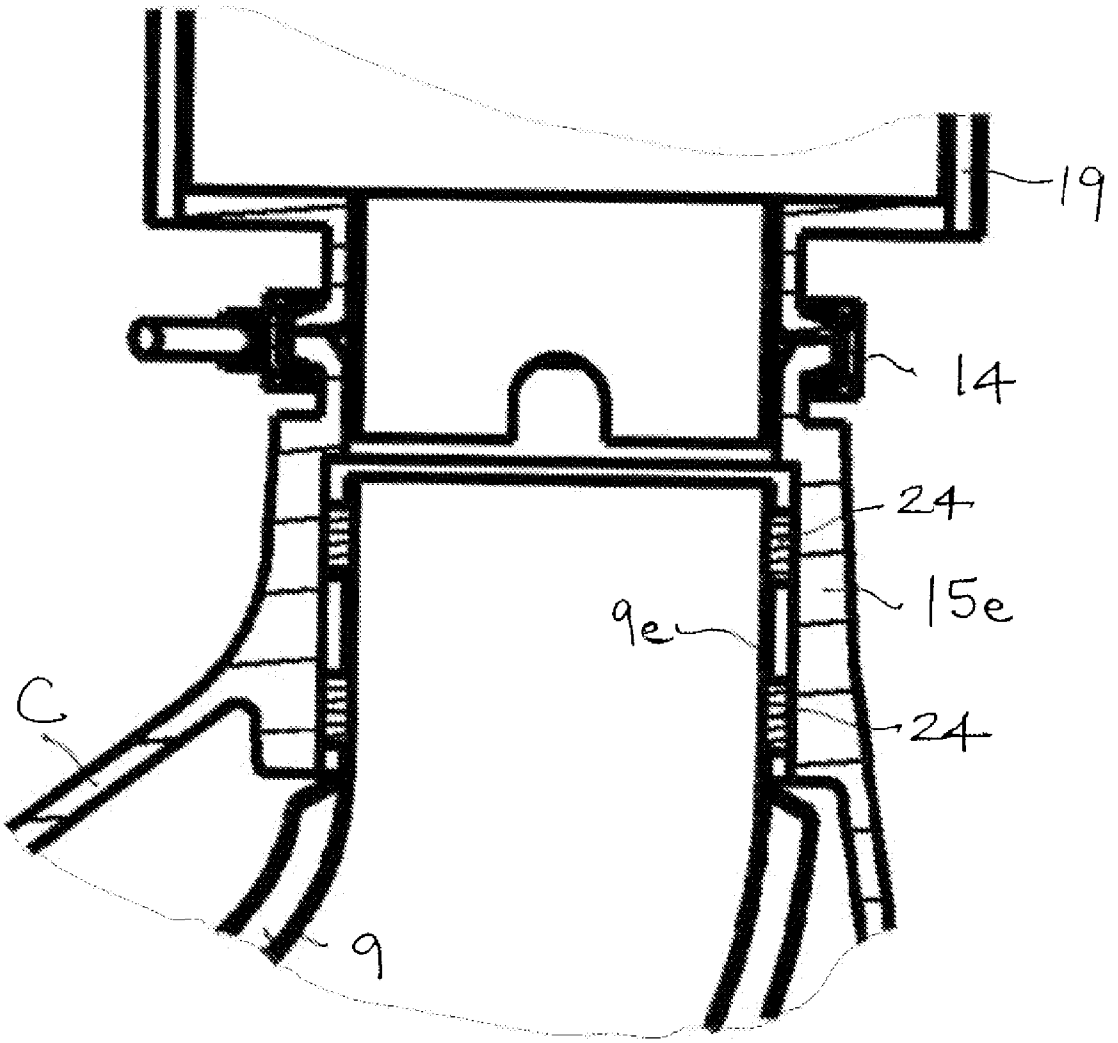


FIG. 9.

EXHAUST SYSTEMS FOR VEHICLES

[0001] This invention relates to exhaust systems for vehicles, and in particular to such systems for agricultural and/or industrial tractors, which includes and exhaust gas treatment unit to reduce the level of gas contaminants to the legally required levels.

[0002] It is an object of the present invention to provide such an exhaust system which allows the treatment unit to be conveniently fitted external to the engine compartment to the vehicle in an efficient and low cost manner which has minimum impact on the design of the remainder of the vehicle.

[0003] Thus according to the present invention there is provided an exhaust system for a vehicle having a cab and an internal combustion engine located in an engine compartment, the system including an exhaust gas treatment unit located outside the engine compartment and having an inlet which receives exhaust gases from the engine and an outlet which passes treated gases into a final portion of the exhaust system, the treatment unit being arranged to extend generally vertically with the outlet generally vertically above the inlet and adjacent a corner post of the cab of the vehicle to reduce impact on the visibility from the cab.

[0004] Preferably a cage a cage surrounds the exhaust gas treatment unit and has a support means for attachment to a chassis of the vehicle and an outlet to which the outlet of the treatment unit is connected, and the final portion of the exhaust system is connected with and supported from the cage outlet to relieve the treatment unit from supporting the weight of the final portion of the exhaust system.

[0005] Such an exhaust system can be fitted with the final portion of the exhaust system extending generally vertically and positioned close to the right-hand A-pillar of the tractor cab where it has only a small impact on visibility. Also, as the exhaust gas treatment unit is not required to support the weight of the final portion of the exhaust system, the design of the treatment unit can be simplified and made cheaper and useable in different engine installations or, under certain circumstances, a standard unit kit can be used. In addition as the unit is completely isolated by using shock-absorbing and vibration-absorbing means, pressure surges caused by exhaust gas are reduced. Since such treatment units involve catalytic coatings on relatively fragile support materials the fact that the treatment unit is not stressed by the weight or vibrations of the final portion of the exhaust system is an additional advantage.

[0006] Additionally by locating the exhaust gas treatment unit outside the engine compartment it is less exposed to high ambient heat levels and heat emanating from the unit does not impact on the under bonnet installations. Also there is more room in the engine compartment for other elements of the exhaust system such as particulate filters should these be required. Also existing vehicle engine installations can easily be upgraded to include improved exhaust gas treatment.

[0007] Also by locating the treatment unit immediately adjacent to the final portion of the exhaust system, which can include the silencer, back pressure can be reduced to improve exhaust gas flow.

[0008] As the exhaust gas treatment unit is located towards the end of the exhaust system Urea solutions can be injected into the exhaust system further away from the treatment unit and will thus mix fully with the exhaust gases prior to reaching the treatment unit without requiring a mixer which would introduce back pressure. As the mixing area is mainly outside the engine compartment, the urea solution is not heated up which would tend to reduce it's efficiency or destroy the Urea. Also by injecting the Urea into the system closer to the hot turbo charger improved operation of the system is obtained.

[0009] In a preferred construction the cage has an upper portion with the cage outlet and a lower portion with the support means, the upper and lower portion being detachably interconnected to give access to the treatment unit for servicing/replacement.

[0010] The upper and lower portions of the cage may be provided with generally vertically extending fingers which extend towards each other and whose adjacent ends are interconnected to support the upper portion of the cage from the lower portion.

[0011] The invention also provides an exhaust system for an internal combustion engine for a vehicle, the system including:

[0012] an exhaust gas treatment unit having an inlet and an outlet;

[0013] a cage which surrounds the exhaust gas treatment unit and has a support means for attachment to a chassis of the vehicle and an outlet to which the outlet of the treatment unit is connected, and

[0014] a final portion of the exhaust system connected with and supported from the cage outlet to relieve the treatment unit from supporting the weight of the final portion of the exhaust system.

[0015] The present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

[0016] FIG. **1** shows an agricultural tractor fitted with an exhaust system in accordance with the present invention adjacent the right-hand front A-pillar of the cab and with part of the engine cover removed for clarity;

[0017] FIG. **2** shows a plan view of the tractor of FIG. **1**;

[0018] FIG. **3** shows a perspective view of the exhaust system of the present invention.

[0019] FIG. **4** shows an exploded version of FIG. **3**;

[0020] FIG. **5** shows a plan view of the exhaust system of FIG. **3**;

[0021] FIG. **6** shows a side view of the exhaust system of FIG. **3**;

[0022] FIG. **7** shows a section of on the line A-A of FIG. **5**;

[0023] FIG. **8** shows details of the attachment of an exhaust gas treatment unit to its surrounding cage, and

[0024] FIG. **9** shows details of the independent attachment of the gas treatment unit and final portion of the exhaust system to the surrounding cage.

[0025] Referring to the drawings, an agricultural tractor **50** has an engine **1** with an exhaust mounted turbo charger **2** with an engine cover **51**, part of which is cut-away in FIGS. **1** and **2**.

[0026] Turbo charger **2** feeds an exhaust system which includes an engine braking throttle valve **3**, an exhaust temperature sensor **4** and a first NOx sensor **5**. These components are all directly mounted on the engine downstream of the turbo charger **2**.

[0027] A vibration isolating element **6** is connected by V-clamps **14** to the exhaust portion **7** which includes a urea injection unit **8**. Exhaust section **7** is connected with an inlet **9***a* (see FIG. **4**) of an exhaust treatment unit **9** which includes an oxidation catalysers **9***b*, NOx catalysers **9***c* and an absorber **9***d* (see FIGS. **4** and **7**) for NOx, HC, and NH_3.

[0028] In accordance with the present invention the exhaust gas treatment unit **9** is supported within a cage C in the form of a lower support part **12** and an upper support part **15**. Each of these two parts of the cage C is provided with circumferentially spaced axially extending fingers **12***a* and **15***a* whose adjacent ends are secured together by bolts **15***b*. Perforated heat shields **17** bridge the gaps between fingers **12***a* and **15***a* to prevent accidental contact with the hot exhaust gas treatment unit **9**.

[0029] The upper support portion **15** has an outlet **15***e* (FIGS. **7** and **9**) to which an outlet **9***e* of the gas treatment unit is connected. The outlet **15***e* also supports a final portion **18** of the vehicle exhaust system (which includes a silencer etc) via a further V-clamp **14**. A heat shield **19** surrounds the final portion of the exhaust system to prevent accidental contact with the exhaust.

[0030] As can be seen from FIGS. **7** and **8**, the gas treatment unit **9** is secured to the lower support part **12** by a bolt **21** which extends through a rubber collar **20** within which a metal sleeve **20***a* is provided to ensure that, when the bolt **21** is tightened to engage a nut **22** which is welded internally to the gas treatment unit **9**, the correct pre-loading of the rubber sleeve **20** occurs via washer **23**. As will be appreciated several bolts **21** with cooperating nuts **22** and sleeves **20**,**20***a* may be used at different locations to resiliently mount the unit **9** on the lower support part **12**.

[0031] FIGS. **7** and **9** shows the detail of the connection of the outlet **9***d* of the gas control unit **9** with the outlet **15***e* of the upper support part **15**. Two rectangular cross section rings **24** of knitted metal fabric (or alternatively heat resistant rubber material such as high temperature polysiloxane) are provided. These rings provide a gas tight seal and also some level of vibration isolation of the inner gas treatment unit **9** from the outer support cage C.

[0032] Additionally the output **9***d* of the gas treatment unit **9** is provided with a second NOx sensor **10** which can be accessed for maintenance via a cover **16** on the cage C. The electronic control unit for the second NOx sensor is protected by a cover **11** which is carried by the exhaust section **7**, and connected thereto by leads **10***a*.

[0033] As will be appreciated, the lower support part **12** of the cage C is connected with the tractor chassis by bolts **13** so that the entire weight of the exhaust system is carried by the cage C and not transferred to the inner gas treatment unit **9** which can therefore be of a lighter construction.

[0034] Also, by positioning the gas treatment unit and the final portion of the exhaust system extending generally vertically and adjacent the right-hand A-pillar **52** of the cab **53** of the tractor the effective of this unit on the visibility from the cab is minimized, as can be seen from FIG. **2**, in which the obscured portion of the driver's view marked Z largely corresponds with the field of view which is normally blocked by the front right-hand wheel of the tractor.

[0035] As referred to previously, the exhaust system of the present invention allows the main exhaust treatment unit to be mounted outside the normal engine compartment cover and in a position which does not have a great effect on the visibility from the cab.

[0036] Also by making the exhaust treatment unit **9** a non-stressed unit (as it does not have to support the weight of the exhaust system), the construction of the exhaust gas treatment unit can be made considerably lighter and less expensive and can be designed to be useable on more than one tractor model. Advantageously this enables the installation of a standard buy-in unit kit which can be used on other types of vehicles.

[0037] As indicated previously, since such gas treatment unit uses catalytic coatings on relatively fragile support materials the fact that the treatment unit is not stressed by the weight of the final portion of the exhaust system additionally the shock absorbing and vibration-absorbing capabilities of the installation are advantageous.

[0038] Also, since the exhaust treatment unit is not mounted under the normal engine compartment cover, this leaves space available under the normal engine compartment cover for the mounting of other exhaust gas treatment units which may be required such as particulate filters and also allows existing vehicle engine installations to be easily upgraded to include improved exhaust gas treatment by mounting the gas treatment unit external to the engine compartment.

[0039] The exhaust system of the present invention is applicable to a wide range of exhaust gas treatment configurations in which the exhaust gas treatment unit may include one or more of the following units namely, an oxidation catalyser, an NOx catalyser and an NOx, HC or NH_3 absorber or diesel particulate filters. Also, although in the embodiment described above, urea injection is used this is not essential and the present invention is applicable to systems which do not inject urea into the exhaust system.

1-12. (canceled)

13. An exhaust for an internal combustion engine for a vehicle, the system including an exhaust gas treatment unit having an inlet and an outlet and a final portion of the exhaust system which receives the exhaust gases from the treatment unit, the system having a cage which surrounds the exhaust gas treatment unit and has a support means for attachment to a chassis of the vehicle and an outlet to which the outlet of the treatment unit is connected, the final portion of the exhaust system being connected with and supported from the cage outlet to relieve the treatment unit from supporting the weight of the final portion of the exhaust system.

14. A system according to claim **13** in which the cage has an upper portion with the cage outlet and a lower portion with the support means, the upper and lower portion being detachably interconnected to give access to the treatment unit for servicing/replacement.

15. A system according to claim **14** in which the upper and lower portions of the cage are provided with generally vertically extending fingers which extend towards each other and whose adjacent ends are interconnected to support the upper portion of the cage from the lower portion.

16. A system according to claim **14** in which the upper and lower cage portions are of a cast metal construction.

17. A system according to claim **15** in which the gaps between the fingers of the upper and lower portions of the cage are covered by heat shields to prevent accidental contact with the exhaust gas treatment unit.

18. A system according to claim **13** in which he exhaust gas treatment unit includes one or more of the following components namely an oxidation catalyser, a NOx catalyser and/or NOx, HC, NH_3 absorber arranged in series.

19. A system according to claim **18** in which the exhaust gas treatment unit includes a NOx sensor.

20. A system according to claim **19** in which the upper portion of the cage includes an access cover for the NOx sensor on the treatment unit.

21. A system according to claim **13** in which the gas treatment unit is secured to the cage via a vibration mount.

22. An exhaust system according to claim **13** in which the top of the cage for the treatment unit is located below the top of a cover over the associated engine to reduce impact on visibility from the cab.

23. An exhaust system for a vehicle having a cab and an internal combustion engine located in an engine compartment, the system including an exhaust gas treatment unit located outside the engine compartment and having an inlet which receives exhaust gases from the engine and an outlet which passes treated gases into a final portion of the exhaust system, the treatment unit extending generally vertically with the outlet generally vertically above the inlet and adjacent a corner post of the cab of the vehicle to reduce impact on the visibility from the cab.

* * * * *