(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 085 198 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.03.2001 Bulletin 2001/12

(51) Int. Cl.[7]: **F02M 35/12**

(21) Application number: **00119166.7**

(22) Date of filing: **05.09.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **14.09.1999 US 153722 P**

(71) Applicant:
SIEMENS CANADA LIMITED
Tilbury, Ontario N0P 2LO (CA)

(72) Inventor: **McLean, Ian R**
Chatham, Ontario N7M 3V6 (CA)

(74) Representative:
Allen, Derek et al
Siemens Shared Services Limited,
Intellectual Property Department,
Siemens House,
Oldbury
Bracknell, Berkshire RG12 8FZ (GB)

(54) Actively controlled induction noise using a multipole inlet

(57) An active noise attenuation assembly for an air induction system of an internal combustion engine is located in an air inlet duct leading to the engine. A fairing body is concentrically mounted within the duct and defines an annular space with the duct through which air travels. A loudspeaker is mounted on the fairing body facing outwardly from the duct. A controller generates an electrical signal amplified and phase shifted from a noise field emanating from the engine. The signal is applied to the loudspeaker for broadcasting a sound field phase shifted from the noise field for attenuating the noise field. A transition housing forms a first plurality of channels and a second plurality of channels. The housing mates to the outlet opening of the inlet duct. The first plurality of channels communicates with the loudspeaker and the second plurality of channels communicates with the annular space. The channels terminate at an end opposite the duct in a checkered pattern.

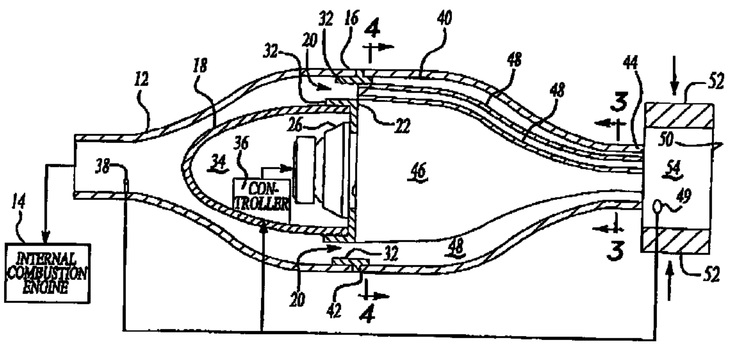

Fig-1

EP 1 085 198 A2

Description

BACKGROUND OF THE INVENTION

[0001] This application claims priority to provisional patent application 60/153,722, which was filed 14 September 1999. The subject invention relates to an improvement in noise reduction capabilities of an air induction system for an internal combustion engine.

[0002] Active noise attenuation has been used to reduce engine noise emitted through an air induction system from the combustion chambers of internal combustion engines. One such example is pending United States Patent Application Number 08/872,506 "Active Noise Attenuation." Noise attenuation assemblies of this type are affixed inside an air inlet duct leading to the engine's combustion chambers. The inlet duct includes an open end into which air is drawn for feeding the combustion chambers. The assembly includes a loud speaker mounted upon an internal housing. The internal housing forms an annular space with the inlet duct through which air travels.

[0003] A controller generates an electrical signal from input generated from a primary microphone that measures a noise field emanating from the engine. The electrical signal is amplified and phase shifted from the noise field and the signal is applied to the loudspeaker for broadcasting a sound field phase shifted 180° from the noise field.

[0004] To generate a sound field strong enough to attenuate the noise field from the engine, the speaker needed is large relative to the amount of space available inside the assembly. Further, it is desirable to reduce vehicle mass and thus reduce the mass of components such as the speaker be reduced to amounts a low as is practicable to perform the requisite functions is a desirable goal. Therefore, it would be desirable to provide apparatus that can reduce the strength of the noise field, and enable the use of smaller, lighter, and less powerful speaker.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0005] The present invention discloses an active noise attenuation assembly for an air induction system of an internal combustion engine. The assembly includes an air inlet duct leading to the engine having an open end into which air is drawn. A fairing body is concentrically mounted within the air inlet duct and defines an annular space with the inlet duct. Air travels through the annular space to the combustion chambers of the engine.

[0006] A loudspeaker is mounted on the fairing body and faces outwardly from the air inlet duct. A controller generates an electrical signal that is amplified and phase shifted from a noise field emanating from the engine. The electrical signal is applied to the loudspeaker for broadcasting a sound field phase shifted from the noise field 180° for attenuating the noise field.

[0007] The assembly includes a transition housing mated to the open end of the inlet duct. The housing forms a first plurality of channels that communicate with the loudspeaker. A second plurality of channels communicates with the annular space. The channels form a checkered pattern at the inlet end of the housing.

[0008] The checkered arrangement of the channels at the inlet end of the housing facilitates the transfer of particulate matter between the first and second plurality of channels. Because the sound fields are out of phase, particulate matter is pushed and pulled between the first and second plurality of channels at the inlet end of the housing. The transfer of the particulate matter between the channels dampens the noise field reducing the output requirements of the loudspeaker for attenuating the noise field. Reduced output requirements allows for the reduction in the size and power of the loudspeaker improving with the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 is a side sectional view of the subject invention;
Figure 2 is an end view of the frame shown in Figure 1;
Figure 3 is a sectional view along line 3-3 in Figure 1 showing the channels at the inlet end of the transition housing of the subject invention; and
Figure 4 is a sectional view along line 4-4 in Figure 1 showing channels at the outlet end of the transition housing of the subject invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring to the Figures 1, an active noise attenuation assembly is generally shown at 10. The assembly 10 includes an air inlet duct 12, which leads to an internal combustion engine 14. Air is channeled through the duct 12 into internal combustion chambers (not shown) within the engine 14 as is known in the art of internal combustion engines. The duct 12 includes an open end 16 into which air is drawn. The duct 12 is widest at the open end 16 and narrows as it approaches the engine 14.

[0011] A fairing body 18 is concentrically mounted within the air inlet duct 12 and defines an annular space 20 with the inlet duct 12 through which the air travels. The fairing body 18 is hollow and generally contoured to the shape of the duct 12. As best shown in Figure 2, the duct 12 includes a frame 22 for affixing the fairing body

18 to the duct 12. The frame 22 includes equally spaced radial bars 24 so as to allow maximum air flow through the annular space 20.

[0012] Referring again to Figures 1, a loudspeaker 26 is mounted on the fairing body 18 facing outwardly from the air inlet duct 12. The frame 22 includes spaced apertures 28 (Figure 2) for receiving fasteners to mount the loudspeaker 26 to the fairing body 18. The fairing body 18 is affixed to an inner ring 30 of the frame 22 by a series of tabs 32. The loudspeaker 26 is arranged to broadcast in an opposite direction of the air flow. The loudspeaker 26 forms a closed chamber 34 with the fairing body 18. A controller 36 is secured inside the chamber 34 to the fairing body 18.

[0013] The controller 36 generates an electrical signal amplified and phase shifted (preferably 180°, although other shifts are within the scope of this invention) from a noise field emanating from the engine 14. The noise field travels from the combustion chambers of the engine through the duct 12 in the opposite direction of the air flow. The controller 36 drives the loudspeaker 26 by applying the signal to the loudspeaker 26. Therefore, the loudspeaker 26 broadcasts a sound field that is phase shifted from the noise field. Phase shifting the sound field from the noise field attenuates the noise field generated by the engine 14 as is known in the art of active noise control. Again an 180° Shift is most preferred, but shifts approximately equal to 180°, but shifts approximately equal to 180° are also capable of performing a good deal of benefits of this invention.

[0014] The noise field is detected by a primary microphone 38. The primary microphone 38 signals the controller 36 with the measured noise field from which the controller 36 determines the phase of the noise field. The primary microphone 38 is affixed to the duct 12 in a location determined to measure the noise field prior to being attenuated by the loudspeaker 26. Thus, the optimum location is between the fairing body 18 and the engine 14.

[0015] A transition housing 40 is mated to the duct 12. The transition housing 40 includes an outlet end 42 and an inlet end 44. The outlet end 42 is mated to the open end 16 of the inlet duct 12. As best shown in Figures 3 and 4, the housing forms a first plurality of channels 46 and a second plurality of channels 48. The channels terminate at the inlet end 44 in a checkered pattern (Figure 3). In the preferred embodiment, the transition housing 40 includes eighteen of the first channels 46 and eighteen of the second channels 48. The first plurality of channels 46 communicates with the loudspeaker 26. The second plurality of channels 48 communicates with the annular space 20. As best shown in Figure 4, the housing 40 includes a mating ring 41 having slots 43 communicating with the second plurality of channels 48. Air enters the second plurality of channels 48 and passes through the slots 43 into the annular space 20. The noise field emanates through the annular space 20 into the second plurality of channels 48 against the flow of air. As is clear from Figure 4, the second channels 48 extend radially inwardly from the outer slots 43. Thus, the ends of the second channels 48 are spaced inwardly from an outer surface.

[0016] The loudspeaker 26 broadcasts the sound field through the first plurality channels 46 phase shifted from the noise field emanating from the engine 14 through the second plurality of channels 48. The sound field emanating from the loudspeaker 26 through the first plurality of channels 46 attenuates the sound field emanating from the engine 14 through the second plurality channels 48 at the inlet end 44. Locally attenuating the noise field in this manner prevents the noise field from traveling far away from the source.

[0017] The checkered arrangement of the first and second plurality channels 46, 48 facilitates the transfer of particulate matter between the first and second channels 46, 48 because each of the first channels 46 is adjacent at least two of the second channels 48. The high amount of adjacent area between the first plurality of channels 46 and second plurality of channels 48 increases the potential for particulate transfer between the channels 46, 48. Additionally, the 180° phase shift between the noise field and the sound field increases the amount of particulate matter transferred between the first and second plurality of channels 46, 48. The strength of the noise field is significantly dampened by the transfer of particulate matter into the second plurality of channels. Thus, the size and power requirements of the loudspeaker 26 necessary to attenuate the noise field are significantly reduced. As can be appreciated from the schematic arrangement of the second channels 48 in Figure 1, some of the second channels 48 are spaced inwardly from an outer surface. Figures 3 and 4 show the preferred arrangement of the first and second channels 46, 48.

[0018] An error microphone 49 is positioned adjacent the outlet end 42 for detecting unattenuated noise. The error microphone 49 senses both the noise field and the sound field and signals the controller 36 to adjust the phase of the sound field to improve the attenuating properties of the sound field.

[0019] As shown in Figure 1, a filter cell 50 is affixed at the inlet end 44 of the transition housing 40 for filtering air entering the inlet end 44. The filter cell 50 includes filter media 52 through which the air is drawn into a central cavity 54. The error microphone 49 is located in or near the cavity 54. The noise field is attenuated in the cavity 54 before it can leave the filter cell 50 through the media 52.

[0020] The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

[0021] Many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, wherein reference numerals are merely for convenience and are not to be in any way limiting, the invention may be practiced otherwise than as specifically described.

Claims

1. An active noise attenuation assembly for an air induction system of an internal combustion engine comprising:

an air inlet duct leading to the engine having an open end into which air is drawn;
a fairing body mounted within said air inlet duct defining a space with said inlet duct through which air travels;
a loud speaker mounted on said fairing body facing outwardly from said air inlet duct;
a controller for generating an electrical signal amplified and phase shifted from a noise field emanating from the engine and applying the signal to said loudspeaker for broadcasting a sound field phase shifted from the noise field thereby attenuating the noise field; and
a transition housing mated to said open end of said inlet duct forming a first plurality of channels communicating with said loudspeaker and a second plurality of channels forming a ring around said fairing body for communicating with said annular space, said second plurality of channels terminating at a location spaced radially inward from an outer surface.

2. An assembly as set forth in claim 1 wherein said speaker broadcasts said sound field through said first plurality of channels phase shifted from the noise field emanating from the engine through said second plurality of channels.

3. An assembly as set forth in claim 2 wherein said sound field emanating from said speaker through said first plurality of channels attenuates the noise field emanating from the engine through said second plurality of channels.

4. An assembly as set forth in claim 3 wherein the strength of the noise field emanating from the engine through said second plurality of channels is dampened by transfer of particulate matter between adjacent of said first and said second channels.

5. An assembly as set forth in claim 1 wherein said air inlet duct includes a primary microphone for detecting the phase of the noise field emanating from the engine and for signaling the controller.

6. An assembly as set forth in claim 5 including an error microphone for measuring both the noise field and the sound field and signaling said controller to adjust the phase of said sound field to improve attenuation the noise field.

7. An assembly as set forth in 1 wherein said fairing body forms a closed chamber with said speaker.

8. An assembly as set forth in claim 7 wherein said controller is disposed within said chamber formed by said fairing body and said speaker.

9. An assembly as set forth in claim 1 wherein two of said ends of said second channels are adjacent to the majority of ends of said first channels.

10. An assembly as set forth in claim 9 wherein said ends of said first and second channels are arranged in a checkered pattern.

11. A method of attenuating noise emanating from an internal combustion engine and travelling through an air inlet end of an air induction assembly comprises the steps of:

providing a loudspeaker mounted within said assembly facing outwardly of said assembly;
detecting the noise field emanating from the engine for determining the phase of the noise wave;
broadcasting a sound from said speaker out of phase of the noise field for attenuating the noise field; and
separating the sound field broadcast from the speaker into a first plurality of channels and separating the noise field emanating from the engine into a second plurality of channels, whereby said channels terminate in a pattern orienting each of said first plurality of channels adjacent to at least one of said second plurality of channels.

12. An assembly as set forth in claim 10 further including the step of dampening the noise field emanating from the engine by passing particulate matter between adjacent of said checkered first and second channels.

13. A method as set forth in claim 11 further including the step of measuring both the noise field and the sound field and adjusting the phase of the sound field to improve attenuation of the noise field.

14. An active noise attenuation assembly for an air induction system of an internal combustion engine, said assembly comprising:

an air inlet duct leading to the engine having an open end into which air is drawn;

a fairing body mounted within said air inlet duct defining a space with said inlet duct through which air travels;

a loud speaker mounted on said fairing body facing outwardly from said air inlet duct;
a controller for generating an electrical signal amplified and phase shifted from a noise field emanating from the engine and applying the signal to said loudspeaker for broadcasting a sound field phase shifted from the noise field thereby attenuating the noise field; and
a transition housing mated to said open end of said inlet duct forming a first plurality of channels communicating with said loudspeaker and a second plurality of channels communicating with said annular space wherein said channels terminate in a checkered pattern.

15. An assembly as set forth in claim 14 wherein said speaker broadcasts said sound field through said first plurality of channels phase shifted from the noise field emanating from the engine through said second plurality of channels.

16. An assembly as set forth in claim 15 wherein said sound field emanating from said speaker through said first plurality of channels attenuates the noise field emanating from the engine through said second plurality of channels.

17. An assembly as set forth in claim 16 wherein the strength of the noise field emanating from the engine through said second plurality of channels is dampened by transfer of particulate matter between adjacent of said first and said second channels.

18. An assembly as set forth in claim 14 wherein said air inlet duct includes a primary microphone for detecting the phase of the noise field emanating from the engine and for signaling the controller.

19. An assembly as set forth in claim 18 including an error microphone for measuring both the noise field and the sound field and signaling said controller to adjust the phase of said sound field to improve attenuation the noise field.

20. An assembly as set forth in 14 wherein said fairing body forms a closed chamber with said speaker.

21. An assembly as set forth in claim 20 wherein said controller is disposed within said chamber formed by said fairing body and said speaker.

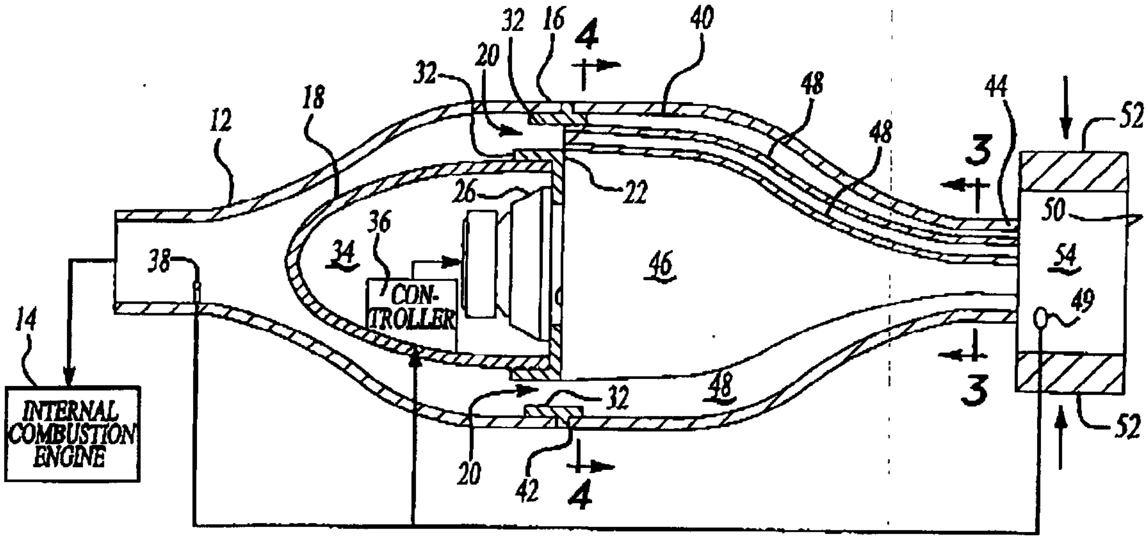
32
16
4
40
20
32
18
12
48
44
52
48
3
22
26
36
50
34
46
54
38
CON-
TROLLER
49
14
3
32
48
52
INTERNAL
COMBUSTION
ENGINE
20
42
4

Fig-1

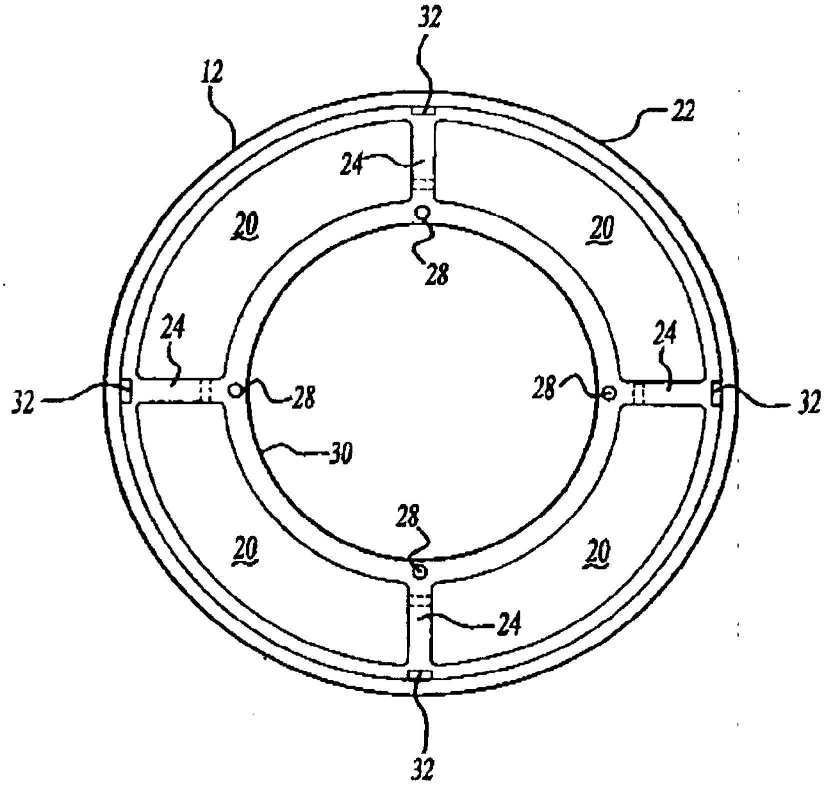
32
12
22
24
20
20
28
24
24
32
28
28
32
30
28
20
20
24
32

Fig-2

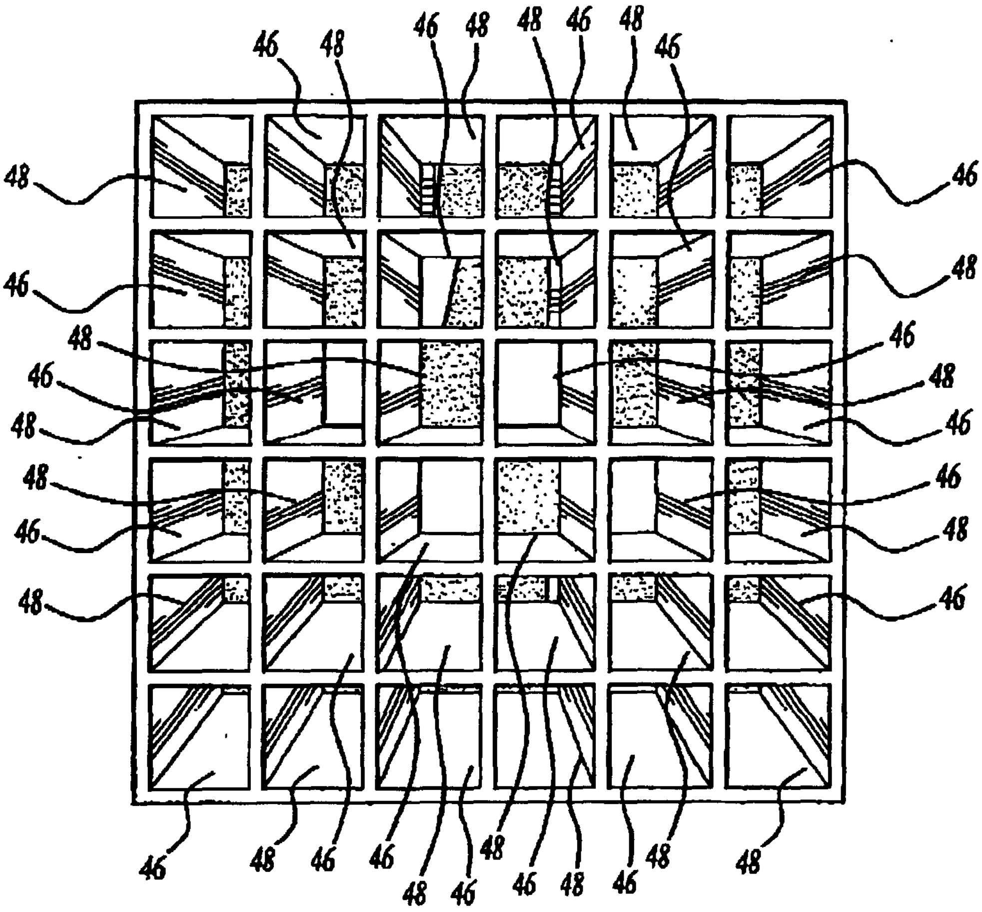
46
48
46
48
48
46
48
46
48
46
48
46
48
46
48
46
48
46
48
46
48
46
46
48
46
46
48
46
46
48
46
48
46
48

Fig-3

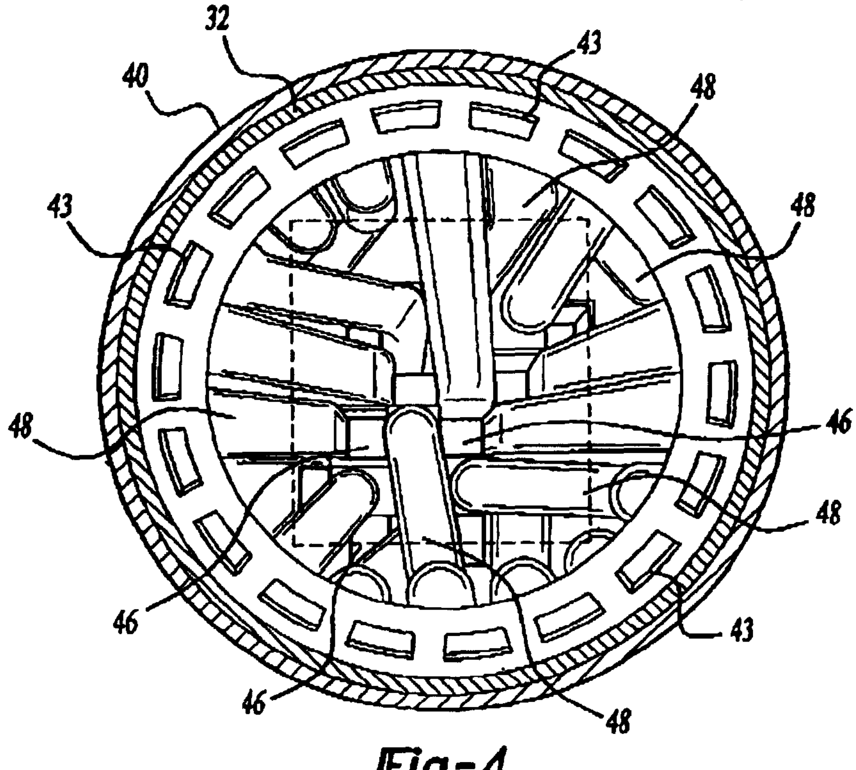
32
40
43
48
43
48
48
46
48
46
43
46
48

Fig-4