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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : F01N	A2	(11) International Publication Number: **WO 00/50742**
		(43) International Publication Date: 31 August 2000 (31.08.00)

(21) International Application Number: PCT/US00/04397

(22) International Filing Date: 22 February 2000 (22.02.00)

(30) Priority Data:
60/121,503 23 February 1999 (23.02.99) US

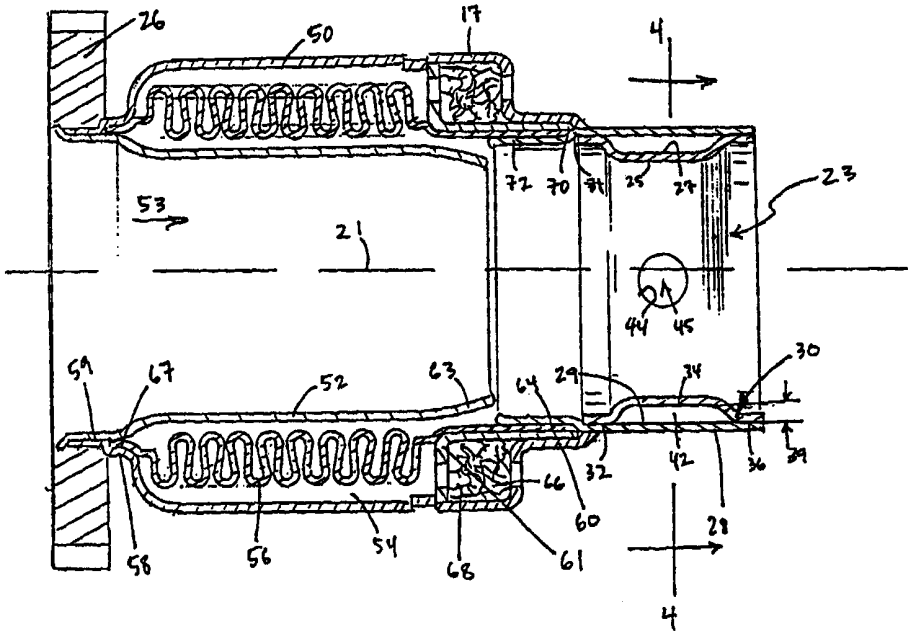
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(81) Designated States: BR, CA, MX, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: RESONATOR



(57) Abstract

An exhaust system (10) includes an exhaust manifold (14) coupled to an engine (12), a decoupler (16) including an inlet coupled to exhaust manifold (14), an outlet extension (28) coupled to an outlet of decoupler (16), and various downstream components such as a catalytic converter (20), exhaust pipe (18), bottle resonator (22), and muffler (24). A resonator shell (30) is positioned to lie in outlet extension (28) to define a resonator chamber (42) in communication with airborne noise frequencies associated with exhaust gas passing through outlet extension (28).

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RESONATOR

Background and Summary of the Invention

The present invention relates to a noise attenuation device, and particularly to a resonator for use in an internal combustion exhaust system for dampening air-borne noise frequencies of engine exhaust.

Internal combustion engine exhaust is noisy and must be quieted in some manner to satisfy users, e.g., automobile owners. Internal combustion exhaust includes both air-borne noise frequencies and vibration frequencies. Vibration frequencies are typically removed from exhaust systems by mechanical dampening devices, such as decouplers or exhaust system flex tubes. Airborne noise frequencies are typically removed by mufflers and resonators. A resonator is generally smaller than a muffler and is used for narrow band tuning of air-borne noise frequencies.

According to the present invention, a resonator is provided to eliminate certain air-borne frequencies in an internal combustion exhaust system. The resonator includes a resonator shell which fits within a pipe or tube of the exhaust system. The resonator shell includes an inlet end and an outlet end coupled to the pipe or tube. The resonator shell has an intermediate portion that is spaced apart from the pipe or tube to define a resonator chamber between the resonator shell and the pipe or tube. The intermediate portion of the resonator shell is also formed to include at least one aperture to allow air-borne frequencies from the exhaust system to travel into the resonator chamber where the air-borne frequencies are dampened.

In a preferred embodiment, the resonator shell is placed in the outlet extension of a mechanical dampening device, such as an exhaust system decoupler or flex tube. The mechanical dampening device is provided in the exhaust system to remove vibrational frequencies. The outlet extension couples the mechanical dampening device to the remainder of the exhaust system. The outlet end of the resonator shell is welded to the inner surface of the outlet extension and the inlet end of the resonator shell is press-fitted against the inner surface of the outlet extension. The intermediate portion of the resonator shell is spaced apart from the inner surface of the outlet extension to create a resonator chamber for dampening air-borne frequencies.

In preferred embodiments, the outlet extension is upstream of the catalytic converter. Providing a resonator in the outlet extension reduces air-borne frequencies before the air-borne frequencies reach the catalytic converter.

Additional features and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description exemplifying the best mode of carrying out the invention as presently perceived.

Brief Description of the Drawings

The detailed description particularly refers to the accompanying figures in which:

Fig. 1 is a perspective view of a portion of a motor vehicle including a typical exhaust system and an engine, the exhaust system including an exhaust manifold coupled to the engine, a decoupler coupled to the exhaust manifold, an outlet extension coupled to the decoupler, a catalytic converter, a bottle resonator, a muffler, and several sections of exhaust pipe;

Fig. 2 is an exploded perspective view of a decoupler, an outlet extension, and a resonator shell;

Fig. 3 is a sectional view taken along line 3-3 of Fig. 2 (after assembly of the components shown in Fig. 2) showing the resonator shell positioned to lie within the outlet extension and a resonator chamber defined between the resonator shell and the outlet extension;

Fig. 4 is a sectional view taken along line 4-4 of Fig. 3 showing the resonator shell positioned to lie within the outlet extension and the resonator chamber extending about the circumference of the resonator shell;

Fig. 5 is a side elevational view, with portions cut away, of a resonator shell positioned to lie within a pipe or tube; and

Fig. 6 is a side elevational view, with portions cut away, of a resonator shell positioned to lie within the outlet extension, where the outlet extension is coupled to an exhaust system flex tube.

Detailed Description of the Drawings

In an exhaust system 10 shown in Fig. 1, exhaust gases produced by an engine 12 pass through exhaust system 10 to exit a motor vehicle through a tail pipe.

Exhaust system 10 includes an exhaust manifold 14 coupled to engine 12, a decoupler 16, and an outlet extension 28 coupling decoupler 16 to the rest of exhaust system 10. Exhaust system 10 further includes sections of exhaust pipe 18, a catalytic converter 20, a bottle resonator 22, and a muffler 24. Other combinations of exhaust system components can be used.

Decoupler or mechanical dampener 16, shown in Fig. 2, includes a first end 15, a second end 17, a wall or mounting plate 26, and a longitudinal axis 21. Outlet extension 28 has an inner surface 29 facing toward longitudinal axis 21.

Exhaust system 10 also includes a resonator shell 30 as shown in Fig. 2. Resonator shell 30 includes an outer shell surface 27 facing away from longitudinal axis 21 and an inner shell surface 25 facing toward longitudinal axis 21 and defining an interior passageway 23. Resonator shell 30 further includes a flared inlet end 38, a flared outlet end 40, and an intermediate portion 34 positioned to lie between inlet and outlet ends 38, 40. Inlet end 38 has an inlet leading edge 31 and an inlet trailing edge 33. Similarly, outlet end 40 has an outlet leading edge 35 and an outlet trailing edge 37. Between inlet leading edge 31 and inlet trailing edge 33 and between outlet leading edge 35 and outlet trailing edge 37 are inlet and outlet engagement surfaces 32, 36, respectively.

Resonator shell 30 is sized so that inlet and outlet engagement surfaces 32, 36 abut inner surface 29 of outlet extension 28 as shown in Fig. 3. In the illustrated embodiment, outlet engagement surface 36 is coupled to inner surface 29 of outlet extension 28 by welding, inlet engagement surface 32 is press fitted against inner surface 29 of outlet extension 28, and intermediate portion 34 is spaced apart from inner surface 29 of outlet extension 28 by a distance 39, thereby creating a resonator chamber 42 between resonator shell 30 and outlet extension 28 (as shown in Figs. 3 and 4). Other coupling arrangements of engagement surfaces 32, 36 are operable, such as welding both engagement surfaces to inner surface 29 or press fitting both engagement surfaces against inner surface 29.

An aperture 44 is formed in intermediate portion 34 to define a passageway 45 between interior passageway 23 and resonator chamber 42. Passageway 45 allows air-borne noise frequencies to pass from interior passageway 23 of resonator shell 30 to resonator chamber 42 where the air-borne noise frequencies are dampened.

Decoupler 16 further includes an outer housing 50, an inner housing 52 positioned to lie within outer housing 50, a vibration dampener 56, a vibration dampener support 61, and wire mesh packing 68. The outer housing 50 includes spaced-apart first and second outer housing ends 58, 60 and inner housing 52 includes first and second inner housing ends 59, 63. The first inner and outer housing ends 59, 58 are connected to wall or mounting plate 26. The second outer housing end 60 is connected to vibration dampener support 61 and outlet extension 28.

Vibration dampener 56 is positioned to lie within a chamber 54 defined between outer housing 50 and inner housing 52. Vibration dampener 56 includes a first end 67 connected to inner and outer housings 50, 52 and a second end 64 connected to vibrations dampener support 61 and outlet extension 28.

A chamber 66 is defined between second end 60 of outer housing 50 and vibration dampener support 61. Wire mesh packing 68 is positioned to lie in chamber 66. The decoupler can include other arrangements of components for dampening vibration.

As shown in Fig. 3, outlet extension 28 includes a crimp 70 and a crimped portion 72. Crimped portion 72 of outlet extension 28 is received within second end 17 so that crimp 70 and crimped portion 72 both abut second end 64 of vibration dampener 56. Resonator shell 30 is positioned to lie within outlet extension 28 so that inlet and outlet engagement surfaces 32, 36 abut inner surface 29 of outlet extension 28 and so that inlet leading edge 31 abuts crimp 70. Intermediate portion 34 remains spaced apart from inner surface 29 of outlet extension 28 by a distance 39 to create resonator chamber 42.

During operation of engine 12, exhaust gases travel through inner housing 52 in direction 53. From there, the exhaust gases travel through outlet extension 28, into catalytic converter 20, and through the remainder of exhaust system 10. These exhaust gases typically contain air-borne noise frequencies which set up a vibration where catalytic converter 20 and outlet extension 28 join. The insertion of resonator shell 30 within outlet extension 28 creates resonator chamber 42 which dampens air-borne frequencies before the frequencies reach catalytic converter 20.

Resonator shell 30 is placed within exhaust system 10 at outlet extension 28, as shown in Fig. 3. Resonator shell 30 is positioned to lie within outlet extension 28 where it can eliminate air-borne frequencies which set up a vibration at the inlet of catalytic converter 20 and create noise. However, the resonator shell 30 may be positioned within an exhaust pipe 18 at any point along the exhaust system. For

example, Fig. 5 shows the resonator 30 positioned within a section of exhaust pipe 18. Further, Fig. 3 shows resonator shell 30 placed within exhaust system 10, including decoupler 16. However, resonator shell 30 may be placed within exhaust system 10, including other mechanical dampening devices, such as a flex tube 80 as shown in Fig. 6.

In conventional exhaust systems, exhaust gas-borne engine noise radiates through the catalytic converter shell and heat shield. Noise also radiates from the decoupler bellows. In accordance with the invention, exhaust gas flow is tuned acoustically to disallow (i.e., "tune out") offending noise frequency bands upstream of the converter. In addition, the system is configured to block exhaust gas flow to the inside of the decoupler's bellows. A Helmholtz tuning chamber is placed at the outlet of the decoupler by inserting a sized tube into the outlet tube of the decoupler assembly. The volume required by the Helmholtz tuning chamber is relatively small since the offending frequencies are relatively high. A wire mesh pack is used for the backflow inhibitor at the decoupler's outlet just upstream of the Helmholtz tuning chamber. This tuning chamber operates, for example, to tune out high frequency noise which is prone to radiate from oval catalytic converters in four-cylinder internal combustion engine applications.

Although this invention has been described in detail, variations and modifications exist within the scope and spirit of the invention as described and as defined in the following claims.

CLAIMS

1. A resonator assembly in an internal combustion engine exhaust system including an exhaust manifold, the resonator assembly comprising

a mechanical dampener including a first end adapted to couple to an exhaust manifold, a second end spaced apart from the first end, an outer housing, an inner housing positioned to lie in the outer housing to define a chamber between the outer housing and the inner housing, and a vibration dampener positioned to lie in the chamber,

an outlet extension coupled to the second end of the mechanical dampener, the outlet extension including a longitudinal axis and an inner surface facing toward the longitudinal axis and defining an interior passageway, and

a resonator shell positioned to lie in the outlet extension, the resonator shell including inlet and outlet ends and an intermediate portion extending between the inlet and outlet ends, the inlet and outlet ends being positioned to lie adjacent to the inner surface of the outlet extension, the intermediate portion being spaced apart from the inner surface of the outlet extension to form a resonator chamber, and the intermediate portion being formed to include an aperture to define a passageway into the resonator chamber.

2. The resonator assembly of claim 1, wherein the resonator shell includes a flared outlet end terminating in an outlet engagement surface having an outlet leading edge and an outlet trailing edge.

3. The resonator assembly of claim 2, wherein the outlet engagement surface is welded to the inner surface of the outlet extension.

4. The resonator assembly of claim 3, wherein a catalytic converter is connected to the outlet extension.

5. The resonator assembly of claim 4, wherein a wire mesh packing is positioned to lie between the outer housing and the inner housing.

6. The resonator assembly of claim 5, wherein the resonator chamber is a Helmholtz chamber.

7. The resonator assembly of claim 1, wherein the resonator chamber is a Helmholtz chamber.

8. A resonator assembly in an internal combustion engine exhaust system including an exhaust manifold, the resonator assembly comprising

a mechanical dampener including a first end adapted to couple to an exhaust manifold, a second end spaced apart from the first end, an outer housing, an inner housing, the inner housing being positioned to lie in the outer housing to define a chamber between the outer housing and the inner housing, and a vibration dampener positioned to lie in the chamber,

an exhaust pipe coupled to the second end of the mechanical dampener, the exhaust pipe including a longitudinal axis and an inner surface facing toward the longitudinal axis and defining an interior passageway, and

a resonator shell positioned to lie in the exhaust pipe, the resonator shell including inlet and outlet ends and an intermediate portion extending between the inlet and outlet ends, the inlet and outlet ends being positioned to lie adjacent to the inner surface of the exhaust pipe, the intermediate portion being spaced apart from the inner surface of the exhaust pipe to form a resonator chamber, and the intermediate portion being formed to include an aperture to define a passageway into the resonator chamber.

9. The resonator assembly of claim 8, wherein the resonator shell includes a flared outlet end terminating in an outlet engagement surface having an outlet leading edge and an outlet trailing edge.

10. The resonator assembly of claim 9, wherein the outlet engagement surface is welded to the inner surface of the exhaust pipe.

11. The resonator assembly of claim 10, wherein a catalytic converter is connected to the exhaust pipe.

12. The resonator assembly of claim 11, wherein the resonator chamber is a Helmholtz chamber.

13. The resonator assembly of claim 8, wherein the resonator chamber is a Helmholtz chamber.

14. A resonator assembly in an internal combustion engine exhaust system, the resonator assembly comprising

a mechanical dampener,

a catalytic converter,

an exhaust pipe having first and second ends, the first end being coupled to the mechanical dampener and the second end being coupled to the catalytic converter, and

a resonator shell positioned to lie in the exhaust pipe and configured to define a chamber between the resonator shell and the exhaust pipe.

15. The resonator assembly of claim 14, wherein the resonator shell includes a flared outlet end terminating in an outlet engagement surface having an outlet leading edge and an outlet trailing edge.

16. The resonator assembly of claim 15, wherein the outlet engagement surface is welded to the inner surface of the exhaust pipe.

17. The resonator assembly of claim 16, wherein the resonator shell is a Helmholtz resonator.

18. The resonator assembly of claim 14, wherein the resonator shell is a Helmholtz resonator.

19. A resonator assembly for use in an internal combustion exhaust system, the resonator assembly comprising

a tube including an inner surface and

a resonator shell including inlet and outlet ends positioned to lie adjacent the inner surface of the outlet extension and an intermediate portion spaced apart from the inner surface of the tube to form a resonator chamber, the intermediate portion being formed to include an aperture.

20. The resonator assembly of claim 19, wherein the resonator shell includes a flared outlet end terminating in an outlet engagement surface having an outlet leading edge and an outlet trailing edge.

21. The resonator assembly of claim 20, wherein the outlet engagement surface is welded to the inner surface of the tube.

22. The resonator assembly of claim 21, wherein the resonator chamber is a Helmholtz chamber.

23. The resonator assembly of claim 19, wherein the resonator chamber is a Helmholtz chamber.

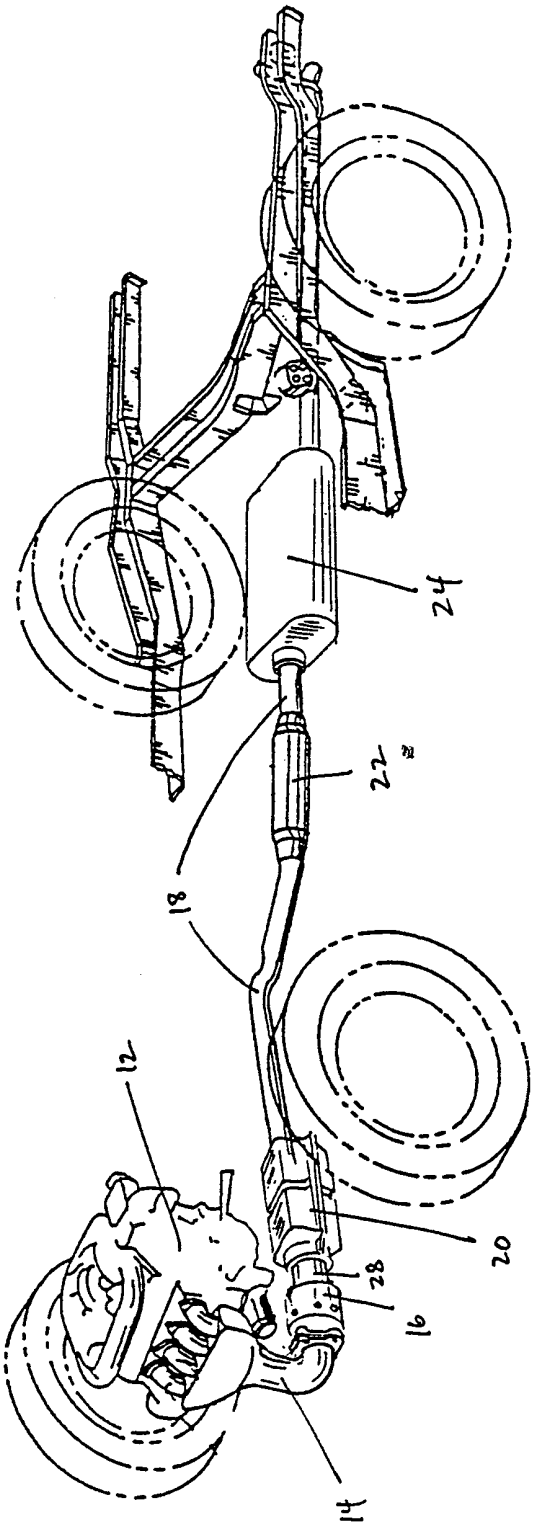


FIG. 1

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FIG. 2

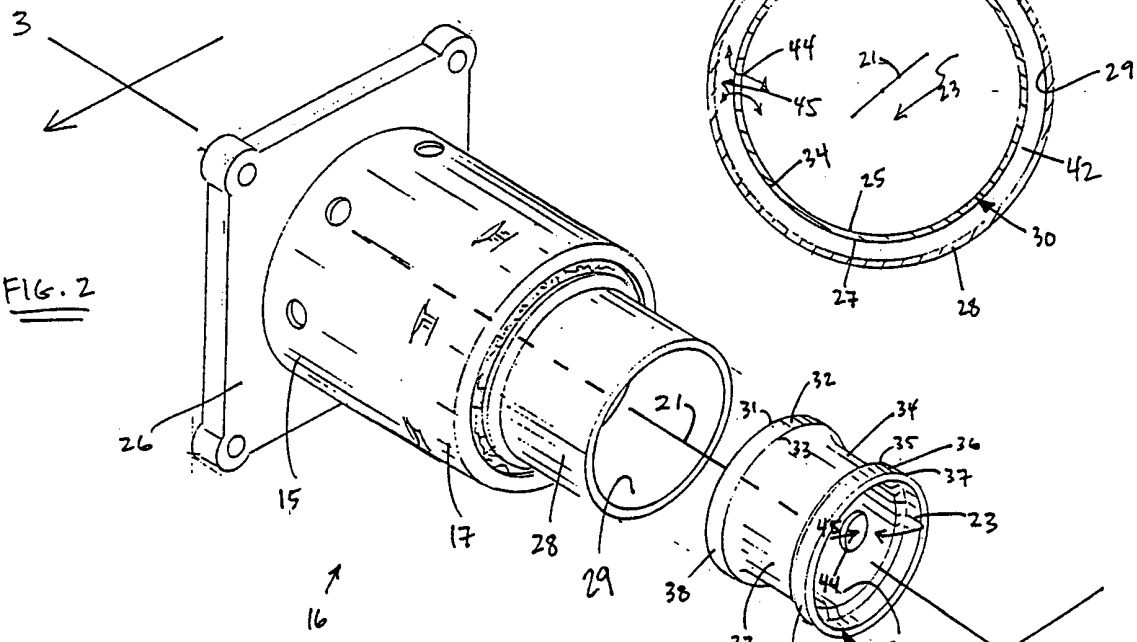


FIG. 4

FIG. 3

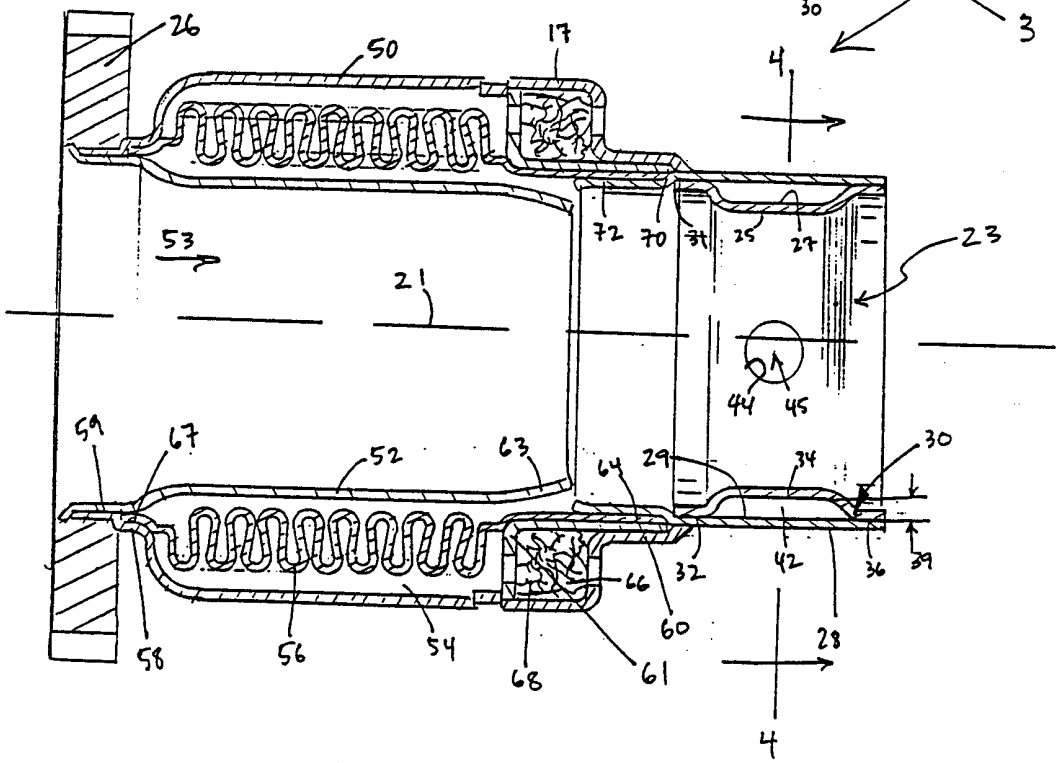


FIG. 5

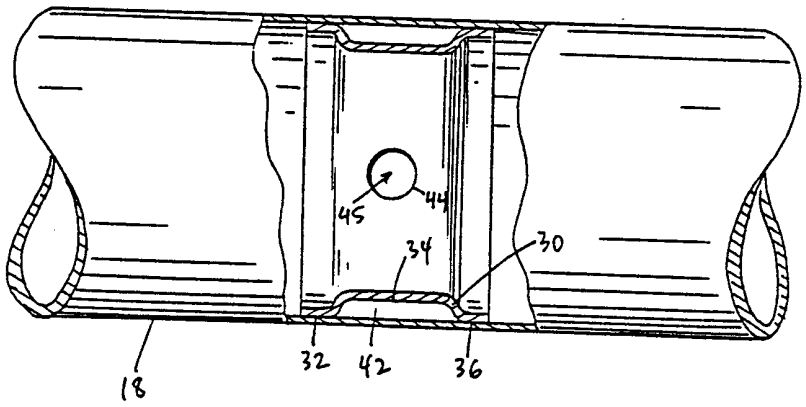


FIG. 6

