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[54] LARGE CALIBER GUN MUFFLER

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[51] Int. Cl.⁶ **F41A 21/30**

[52] U.S. Cl. **89/14.4; 181/223; 181/225**

[58] Field of Search **89/14.4; 181/223, 224, 181/225**

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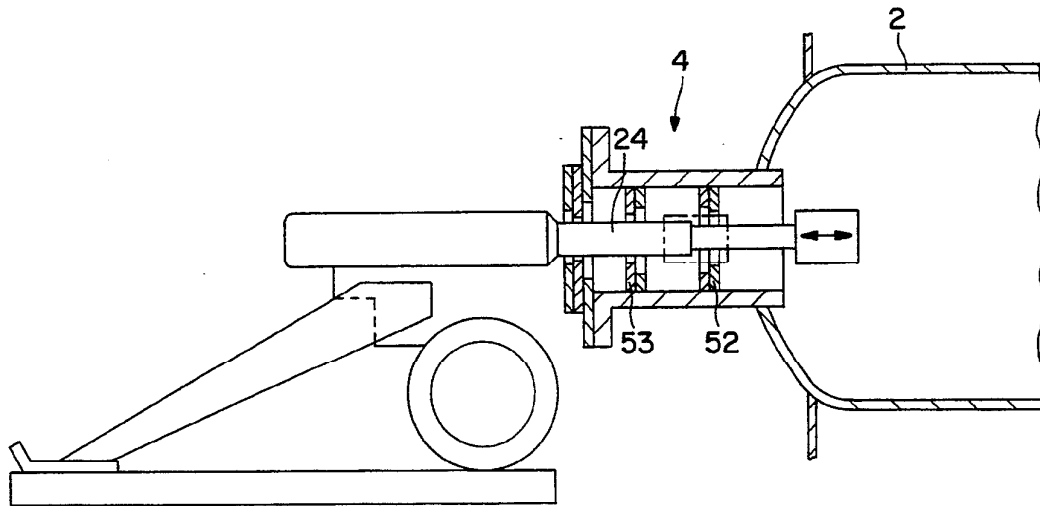
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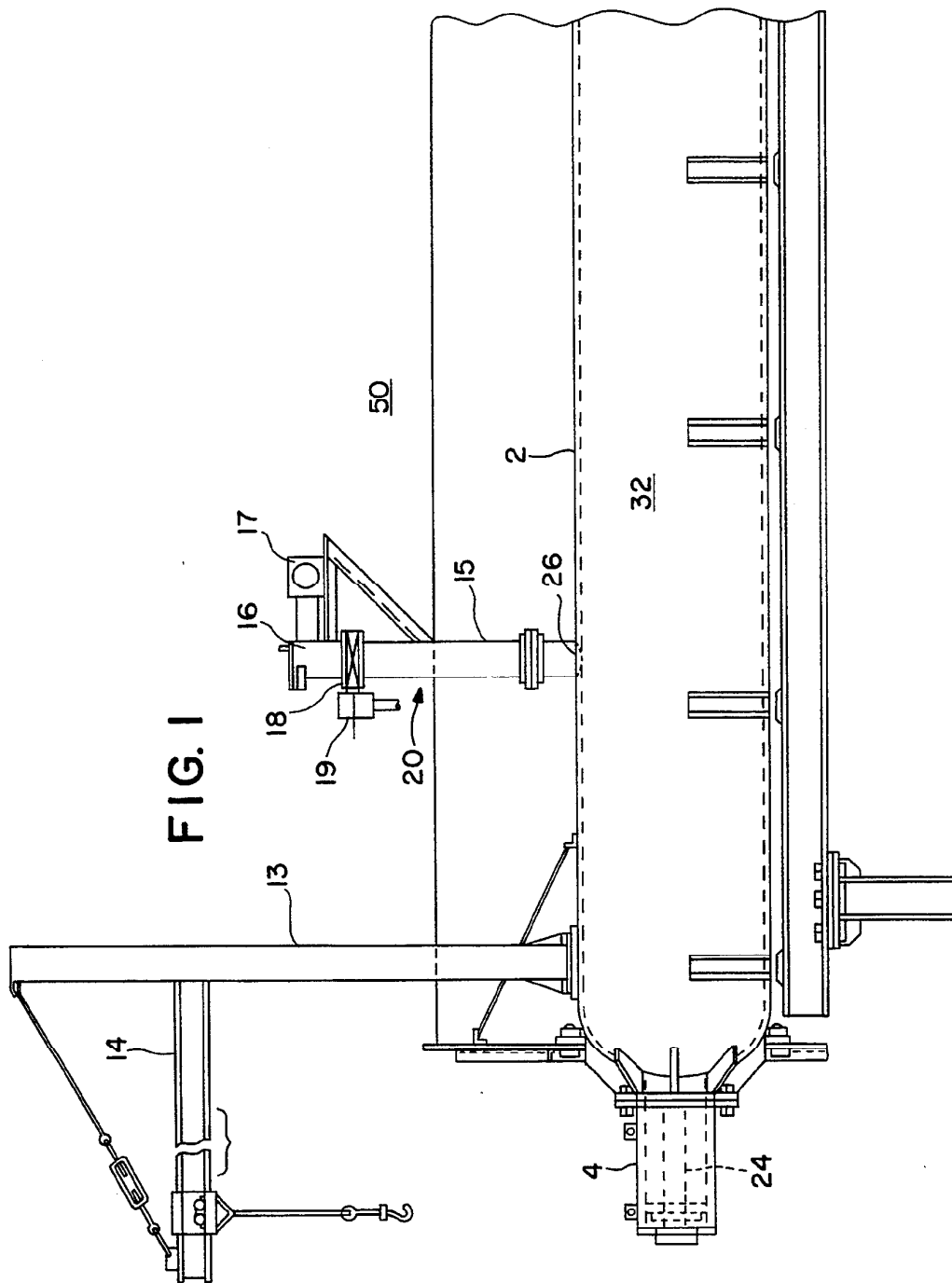
Primary Examiner—Stephen C. Bentley
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[57] ABSTRACT

A muffler for a large caliber gun having a gun tube includes a transition section fitted around the gun tube and engaging the gun tube for preventing the escape of residual combustion gases caused by a firing of the gun. Attached to the transition section is at least one pressure vessel which defines a pressure chamber for containing residual combustion gases and attenuating pressure waves. A vent stack is coupled to the pressure chamber at a port of the pressure chambers and an exhaust blower is disposed in the vent stack for removing residual combustion gases from the pressure chamber between firings. A valve, disposed in the vent stack between the pressure chamber and the exhaust blower, closes during firings of the gun and opens between firings for permitting the exhaust blower to remove residual combustion gases from the pressure chamber. At least one baffle and orifice assembly in the pressure chamber serves to attenuate pressure waves. Preferably, there are two pressure vessels, including a main pressure vessel and an extension pressure vessel, disposed in series with one another.

10 Claims, 6 Drawing Sheets





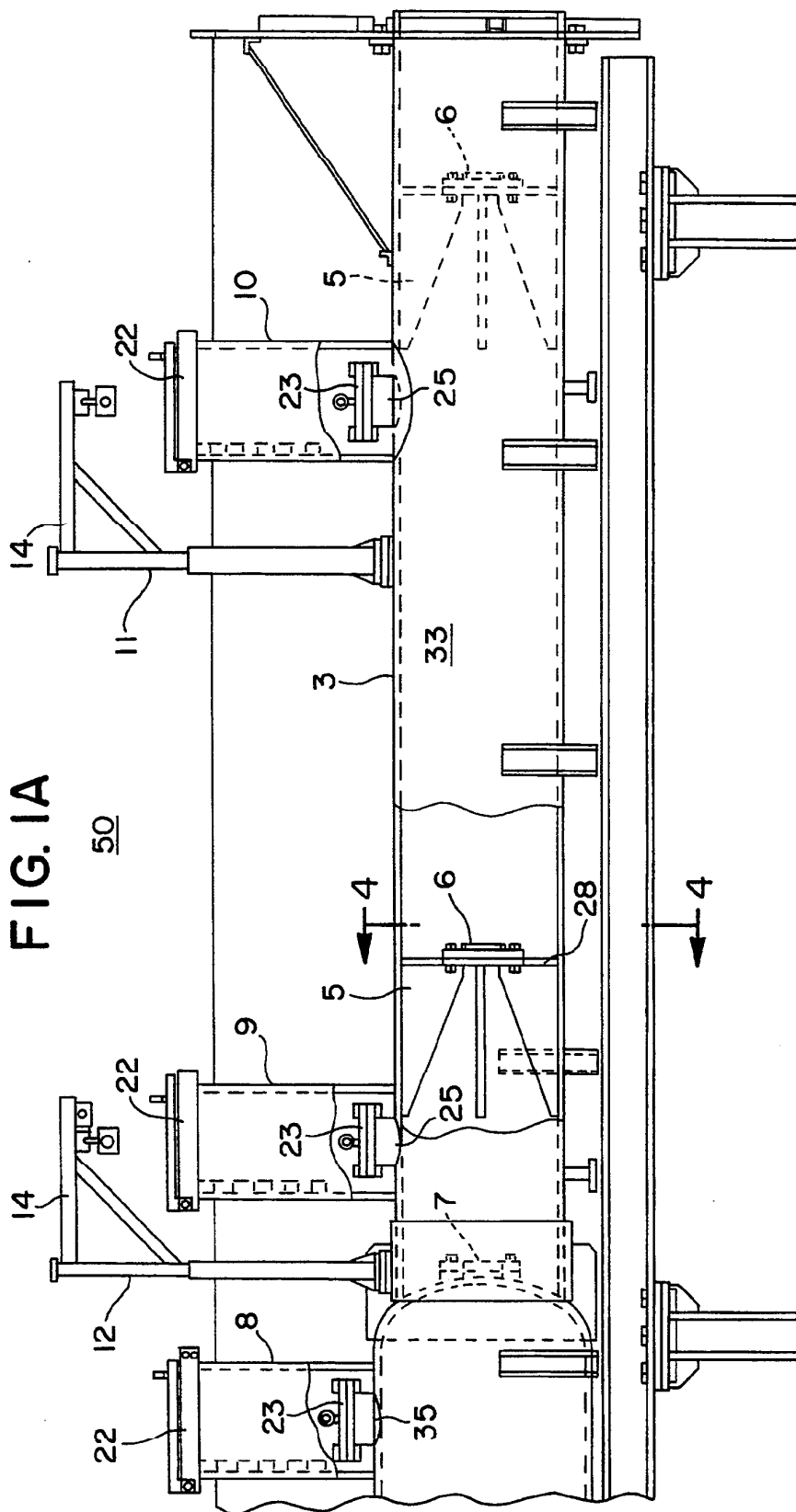


FIG. 1A

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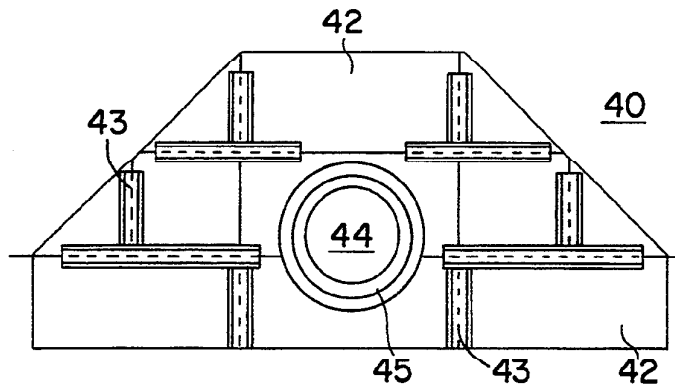


FIG. 2

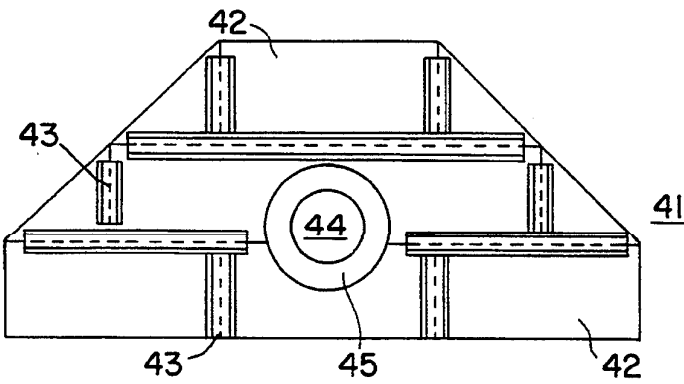


FIG. 3

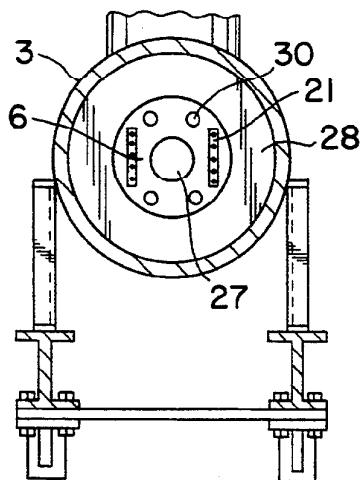


FIG. 4

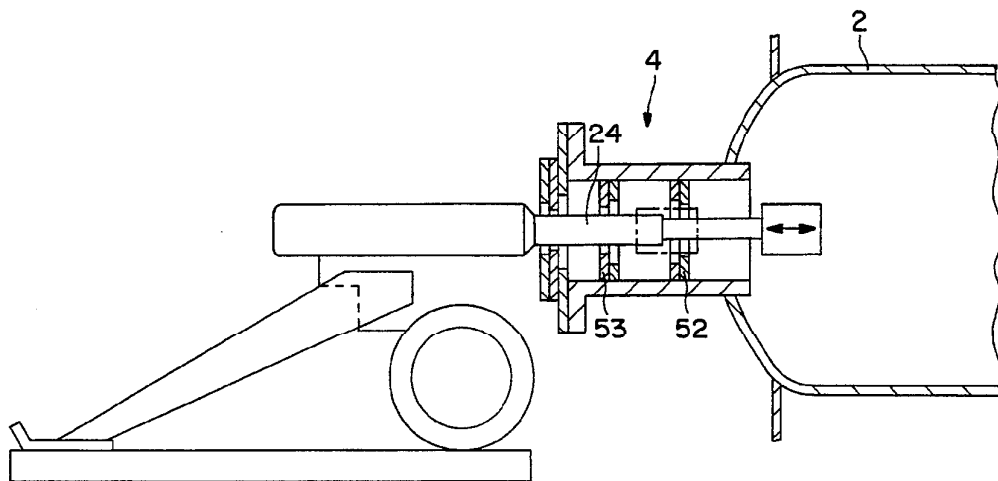


FIG. 5

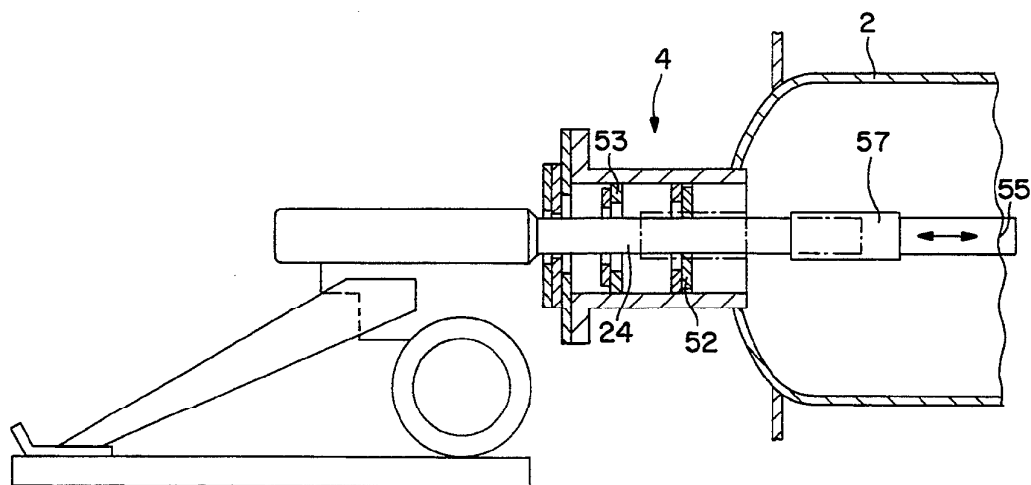


FIG. 6

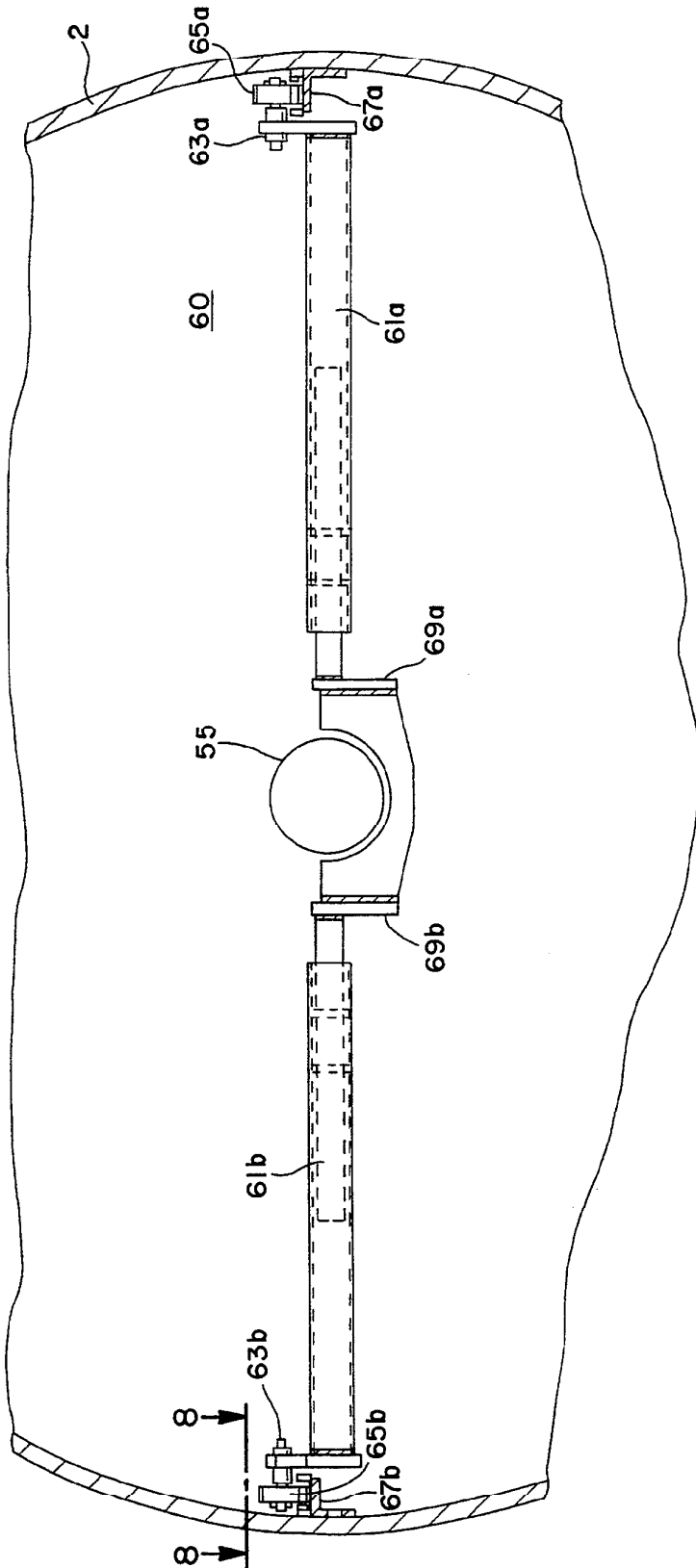


FIG. 7

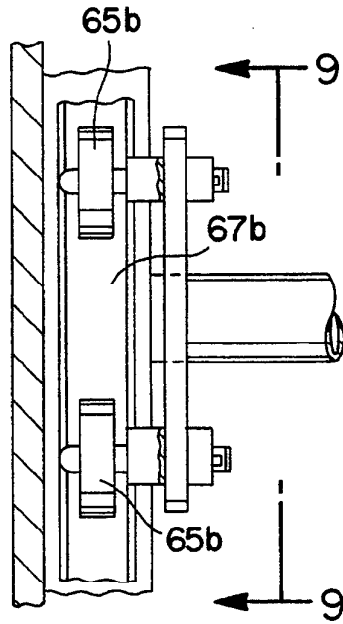


FIG. 8

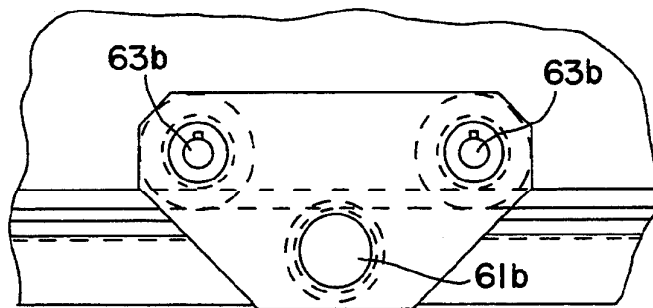


FIG. 9

LARGE CALIBER GUN MUFFLER

FIELD OF THE INVENTION

The present invention relates to a muffler for minimizing the noise generated by the firing of a large caliber gun.

BACKGROUND OF THE INVENTION

Due to the increased population in the world, the noise generated by the testing of large caliber weapon systems in communities located near testing facilities of such weapon systems is becoming an increasing problem. As a result of this concern in noise, there has been a need for a gun muffler to attenuate the generated noise level. Preferably, such a gun muffler should be able to rapidly and safely attenuate the noise generated by the firing of a large caliber gun.

SUMMARY OF THE INVENTION

The present invention is directed to a muffler for a large caliber gun having a gun tube. The muffler includes a transition section fitted around the gun tube and engaging the gun tube for preventing the escape of residual combustion gases caused by the firing of the gun. At least one pressure vessel is attached to the transition section and defines a pressure chamber for containing residual combustion gases and attenuating pressure waves caused by the firing of the gun. A vent stack is coupled to the pressure chamber at a port of the pressure chamber. Disposed in the vent stack is an exhaust blower, which serves to remove residual combustion gases from the pressure chamber between firings. In the vent stack between the pressure chamber and the exhaust blower is a valve. The valve closes during firings of the gun to prevent pressure waves caused by the firing from escaping directly to the atmosphere during firing. The valve is opened between firings for permitting the exhaust blower to remove residual combustion gases from the pressure chamber. Finally, at least one baffle and orifice assembly is disposed in the pressure chamber for attenuating pressure waves.

According to a preferred embodiment of the present invention, two pressure vessels, including a main pressure vessel and an extension pressure vessel, are disposed in series with and connected to the transition section. The main pressure vessel defines a main pressure chamber, and the extension pressure vessel defines an extension pressure chamber. The two pressure vessels may be generally cylindrical. In accordance with one embodiment of the invention, the main pressure chamber has a volume of about 4,000 cubic feet, and the extension pressure chamber has a volume of about 1,000 cubic feet.

According to a preferred embodiment of the invention, an orifice plate is disposed in the main pressure chamber near the connection of the main pressure vessel to the extension pressure vessel. This orifice plate serves to control static pressure in the main pressure chamber. Also, the baffle and orifice assemblies may include two energy-absorbing baffle and orifice assemblies, disposed in series in the extension pressure chamber. The valve disposed in the vent stack may be a butterfly valve.

According to another embodiment of the present invention, the main pressure vessel may include a second port, at which an access cover is mounted. Additionally, the extension pressure vessel may also include

an access port, at which another access cover could be mounted.

According to another embodiment of the present invention, a supplemental tube is placed in abutment against the gun tube during firing of the gun and extends longitudinally along the center axis of the pressure vessel. A supplemental tube transporter assembly transports the supplemental tube longitudinally along the pressure vessel. The assembly includes a first and a second pair of wheels which respectively engage and move along a first and a second track. The tracks extend parallel to one another and longitudinally along the inner surface of the pressure vessel. A first and second extendable arm, which are respectively coupled to the first and second pair of wheels, are selectively attached to the supplemental tube.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary longitudinal side elevational view of the left portion of a gun muffler of the present invention;

FIG. 1A is a fragmentary longitudinal side elevational view of the right portion of the gun muffler shown in FIG. 1;

FIG. 2 is an elevational view of the reinforced left-end plate of the gun muffler;

FIG. 3 is an elevational view of the reinforced right-end plate of the gun muffler;

FIG. 4 is a fragmentary transverse vertical sectional view, showing the orifice plate, taken along the line 4-4 of FIG. 1A;

FIG. 5 is a fragmentary side elevational view of a gun and gun muffler, partly in section;

FIG. 6 is a fragmentary side elevational view of a gun, having a longer tube than the gun shown in FIG. 5 and the gun muffler, partly in section;

FIG. 7 is an enlarged fragmentary transverse sectional view, showing a tube transporter in accordance with the present invention;

FIG. 8 is an enlarged fragmentary horizontal sectional view of a portion of the tube transporter of FIG. 7, taken along the line 8-8 of FIG. 7; and

FIG. 9 is a fragmentary vertical sectional view of the tube transporter of FIG. 7, taken along the line 9-9 of FIG. 8.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to a muffler for a large caliber gun having a gun tube. As used herein, a "large caliber gun" refers to a gun having the size of at least 155 mm. Although a muffler in accordance with the present invention could be made for smaller guns, for example, as low as 30 mm, it is normally not needed to muffle the noise generated from such smaller guns. With a gun muffler of the present invention, the noise level is attenuated by 30% at 100 yards from the firing of the gun and by 95% at 300 yards from firing of the gun.

Referring to FIGS. 1 and 1A, a gun muffler 50 in accordance with the present invention is shown. The gun muffler includes a transition section 4 which fits around the gun tube 24 and engages the gun tube for preventing the escape of residual combustion gases

caused by a firing of the gun. At least one pressure vessel is attached to transition section 4. As shown in FIGS. 1 and 1A, the pressure vessels include a main pressure vessel 2 defining a main pressure chamber 32 and an extension pressure vessel 3 defining an extension pressure chamber 33. Extension pressure vessel 3 is disposed in series with and connected to main pressure vessel 2. The two pressure vessels may be bolted together.

As shown, main pressure vessel 2 and extension pressure vessel 3 are generally cylindrical. In one embodiment, the main pressure vessel is about 4,000 cubic feet (9 feet in diameter and 64 feet long) and the extension pressure chamber is approximately 1,000 cubic feet.

Main pressure vessel 2 includes a port 26. A vent stack 20 is coupled to main pressure vessel 2 at port 26 and includes a lower vent stack 15 and an upper vent stack 16. Lower vent stack 15 is in permanent fluid communication with main pressure chamber 32 by way of port 26. Disposed in upper vent stack 16 is an exhaust blower 17. Exhaust blower 17 should be capable of rapidly creating a vacuum in main pressure chamber 32 and extension pressure chamber 33 for venting residual combustion gases from these chambers to the atmosphere by way of port 26. Blower 17 may be a squirrel-cage blower having drum type blowers or vanes.

Disposed in vent stack 20 is a valve 18, which separates upper vent stack 16 from lower vent stack 15. Accordingly, valve 18 is disposed between main pressure chamber 32 and exhaust blower 17. Valve 18 is actuated by actuator 19, which is air-operated. Valve 18 should be capable of withstanding high pressure, for example, pressure above 600 psi.

According to an embodiment of the invention, valve 18 is a butterfly valve having a twenty-four inch diameter through port and is capable of operating at 1,000 psig. Such a butterfly valve is commercially available from Jamesbury. Also, actuator 19 can be a pneumatic actuator which operates at 100 psig and is controlled by an electrically operated solenoid valve. Valve 18 is operated to be closed during firings of the gun and opened between firings of the gun.

At the end of main pressure vessel 2 which is coupled to extension pressure vessel 3 is an orifice plate 7. Orifice plate 7 is an annular disk defining a central circular hole through which the projectile passes. The size of the hole is dictated by the size of the projectile. Also, if the hole is too small, it is difficult to rapidly vent extension pressure chamber 33 through the hole and out through port 26 by way of exhaust blower 17. On the other hand, if the hole of orifice plate 7 is too large, the muffling of sound is not sufficient. It has been found that for a projectile of 155 mm, the orifice plate 7 should have a hole of about ten inches in diameter.

As shown in FIG. 1A, two baffle and orifice assemblies are disposed in series in extension pressure chamber 33. These energy-absorbing baffle and orifice assemblies each comprise a baffle 5 and an orifice plate 6. Baffles 5 are generally conical in shape, having a diameter which linearly decreases from the entry end of extension pressure chamber 3 to the exit end of extension pressure chamber 3. Baffle 5 abuts against orifice plate 6, which is also shown in FIG. 4. A retaining wall 28 is coupled to extension pressure chamber 3, and orifice plate 6 is mounted to retaining wall 28 by way of straps 21 and nuts and bolts 30. Similar to orifice plate 7, orifice plate 6 defines a central hole 27 through which a projectile passes. The diameter of hole 27 is defined by

similar functional requirements as the diameter of the hole of orifice plate 7.

Also shown in FIG. 1A are vent/access stacks 8, 9, 10. Vent/access stacks 8, 9, 10 include stack covers 22, which could be mounted by way of a hinge to the vent/access stacks. Each vent/access stack covers an access cover 23 which is mounted over an access port 25, 35. Access ports 25 are in communication with extension pressure chamber 33, and access port 35 is in communication with main pressure chamber 32. The purpose of these access stack assemblies is to permit personnel to enter into main pressure chamber 32 or extension pressure chamber 33 for maintenance or repair.

Because of the size and weight of the parts of vent/access stacks 8, 9, 10 cranes 11, 12, each having crane arms 14, are used to remove and replace stack covers 22 and access covers 23. Furthermore, crane 13, having crane arm 14, is used to remove and mount transition section 4.

FIGS. 2 and 3 show respectively the left-end plate 40 and right-end plate 41 of the present invention. Each end plate includes individual plates 42 which are connected to one another by connector beams 43. Each end plate defines a central hole 44. Preferably, each end plate includes removable annular disks 45 so that the diameter of central hole 44 can be changed to accommodate various sizes of guns.

Left-end plate 40 is placed vertically at the entry end of transition section 4. A gun tube is pushed through central hole 44 and into transition section 4. Preferably, the innermost removable annular disk 45 sealingly engages the gun tube.

Right-end plate 41 is placed on the exit end of extension pressure chamber 3. A supplemental tube is placed through central hole 44. Preferably, the innermost annular disk 45 sealingly engages the supplemental tube.

The purpose of left-end plate 40 and right-end plate 41 is to retain sand so that the main pressure vessel 2 and extension pressure vessel 3 can be entirely covered in sand during operation. By covering the muffler 50 in sand, the muffling effect is increased.

FIGS. 5 and 6 show transition section 4 in detailed cross section. FIG. 5 shows a gun having a shorter gun tube than the gun tube of FIG. 6. In either case, transition section 4 includes radially inward protruding flanges 52, 53 which serve as seals for engaging gun tube 24 for preventing residual combustion gases caused by the firing of the gun from escaping back through transition section 4. FIG. 6 also shows a supplemental tube 55 having an enlarged portion 57 which fits over gun tube 24. The projectile passes through gun tube 24 and through supplemental tube 55 through the entire muffler 50.

FIG. 7 shows a cross section of main pressure vessel 2 at a point through which supplemental tube 55 extends. A supplemental tube transporter assembly 60 is shown. Supplemental tube transporter assembly 60 includes a first extendable arm 61a and a second extendable arm 61b. At one end of each extendable arm is a coupling 63a,b respectively, for coupling each extendable arm to a respective pair of wheels 65a,b. As shown in FIG. 8, wheels 65a,b engage and move along respective tracks 67a,b, which extend parallel to one another and longitudinally along the inner surface of main pressure vessel 2. Such a transporter tube assembly 60 could also be disposed in extension pressure chamber 33. The supplemental tube transporter assembly 60 also includes flanges 69a,b respectively coupled to the ends of ex-

tendable arms 61a,b opposite the ends attached to the wheels. Flanges 69a,b are selectively attached to supplemental tube 55.

In operation, transporter tube assembly 60 is used to transport supplemental tube 55 from the exit end of extension pressure chamber 3 to a point so that it engages with a gun tube 24. This is done by first rolling wheels 65a,b along tracks 67a,b towards the exit end of the pressure vessel. Then, supplemental tube 55 is pushed through the exit hole of the extension pressure vessel 3 and into extension pressure chamber 33. Extendable arms 61a,b are extended so that flanges 69A, B are in engagement with supplemental tube 55. Then, the entire assembly 60 is moved towards the entry end of the pressure vessel.

After placing the supplemental tube in engagement with the gun tube and securing the transition section over the top of the gun tube, the gun is ready for firing. Initially, valve 18 is closed when the gun is fired. As a consequence of firing, combustion gases fill main pressure chamber 32 and extension pressure chamber 33. The pressure waves caused by the firing of the gun are attenuated by orifice plate 7 and the baffle and orifice plate assemblies disposed in series in extension pressure chamber 33. Thus, both pressure vessels serve to contain residual combustion gases and attenuate the pressure waves.

Immediately after firing and attenuation of the pressure waves, valve 18 is opened thereby permitting exhaust blower 17 to remove the residual combustion gases from the main pressure chamber. This process is repeated rapidly. As mentioned above, main pressure vessel 2 and extension pressure vessel 3 are preferably covered with sands which is contained by left-end plate 40 and right-end plate 41.

Although illustrated and described herein with reference to certain specific embodiments, the claims of the present invention are nevertheless not intended to be limited to the details illustrated and described. Rather, the claims are meant to cover various common modifications without departing from the spirit of the invention.

What is claimed:

1. A muffler for a large caliber gun having a gun tube, said muffler comprising:
 - a transition section fitted around the gun tube and engaging the gun tube for preventing the escape of residual combustion gases caused by a firing of the gun;
 - at least one pressure vessel, having a port, a first end attached to said transition section, and defining a pressure chamber for containing residual combustion gases and attenuating pressure waves;
 - a vent stack coupled to said pressure chamber at said port;
 - an exhaust blower, disposed in said vent stack, for removing residual combustion gases from said pressure chamber between firings;
 - valve means, disposed in said vent stack between said pressure chamber and said exhaust blower, for:
 - (a) closing during firings of the gun for preventing pressure waves caused by firing from escaping directly to the atmosphere during firing, and
 - (b) opening between firings for permitting said exhaust blower to remove residual combustion gases from said pressure chamber; and
 - at least one baffle and orifice assembly in said pressure chamber for attenuating pressure waves.

2. A muffler according to claim 1, wherein said at least one pressure vessel includes a main pressure vessel defining a main pressure chamber and an extension pressure vessel, disposed in series with and connected to said main pressure vessel, and defining an extension pressure chamber.

3. A muffler according to claim 2, wherein said main pressure vessel and said extension pressure vessel are generally cylindrical.

4. A muffler according to claim 3, wherein said main pressure chamber is about 4,000 cubic feet and said extension pressure chamber is about 1,000 cubic feet.

5. A muffler according to claim 2 further comprising an orifice plate, disposed within said main pressure chamber near the connection of said main pressure vessel to said extension pressure vessel, for controlling static pressure in said main pressure chamber.

6. A muffler according to claim 1, wherein said at least one baffle and orifice assembly includes a first energy-absorbing baffle and orifice assembly and a second energy-absorbing baffle and orifice assembly, disposed in series in said extension chamber.

7. A muffler according to claim 1, wherein said valve means is a butterfly valve.

8. A muffler for a large caliber gun having a gun tube, said muffler comprising:

- a transition section fitted around the gun tube and having a seal engaging the gun tube for preventing residual combustion gases caused by a firing of the gun from escaping;

- a main pressure vessel, having a port, a first end attached to said transition section and a second end, and defining a main pressure chamber for containing residual combustion gases and attenuating pressure waves;

- a vent stack coupled to said main pressure chamber at said first port;

- an exhaust blower, disposed in said vent stack, for removing residual combustion gases from said main pressure chamber between firings of the gun;

- a butterfly valve, disposed in said vent stack between said main pressure chamber and said exhaust blower, for:

- (a) closing during firings of the gun for preventing pressure waves caused by the firing of the gun from escaping directly to the atmosphere during the firing of the gun, and

- (b) opening between firings of the gun for permitting said exhaust blower to remove residual combustion gases from said main pressure chamber;

- an orifice plate, disposed within said main pressure chamber at the second end of said main pressure vessel, for controlling static pressure in said main pressure chamber;

- an extension pressure vessel coupled to said main pressure vessel at the second end of said main pressure vessel, defining an extension pressure chamber for containing residual combustion gases and attenuating pressure waves; and

- at least one baffle and orifice assembly in said extension pressure chamber for attenuating pressure waves.

9. A muffler for a large caliber gun having a gun tube and a breech, said muffler comprising:

- a transition section fitted around the gun tube and having a seal engaging the gun tube for preventing residual combustion gases caused by a firing of the gun from blowing back to the breech;

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a main pressure vessel, having a first port and a second port, and having a first end attached to said transition section and having a second end, and defining a main pressure chamber for containing residual combustion gases and attenuating pressure waves; 5

a vent stack coupled to said main pressure chamber at said first port;

an exhaust blower, disposed in said vent stack, for removing residual combustion gases from said main pressure chamber between firings of the gun; 10

a butterfly valve disposed in said vent stack between said main pressure chamber and said exhaust blower, for: 15

(a) closing during firings of the gun for preventing pressure waves caused by the firing of the gun from escaping directly to the atmosphere during the firing of the gun, and 20

(b) opening between firings of the gun for permitting said exhaust blower to remove residual combustion gases from said main pressure chamber;

an access cover mounted to said main pressure vessel at said second port; 25

an orifice plate, disposed within said main pressure chamber at the second end of said main pressure vessel, for controlling static pressure in said main pressure chamber; 30

an extension pressure vessel, coupled to said main pressure vessel at the second end of said main pressure vessel, and having an access port, and defining an extension pressure chamber for containing resid-

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ual combustion gases and attenuating pressure waves;

a first baffle and orifice assembly disposed at a first longitudinal position in said extension pressure chamber;

a second baffle and orifice assembly disposed at a second longitudinal position in said extension pressure chamber; and

a second access cover bolted to said extension pressure vessel and covering said access port of said extension pressure vessel.

10. A muffler according to claim 1 further comprising:

a first and a second track extending parallel to one another and longitudinally along the inner surface of said at least one pressure vessel;

a supplemental tube extending longitudinally along the center axis of said at least one pressure vessel for engaging said gun tube during firing of the gun; and

a supplemental tube transporter assembly, for transporting said supplemental tube longitudinally along said at least one pressure vessel, comprising:

(a) a first pair of wheels for engaging and moving along said first track,

(b) a second pair of wheels for engaging and moving along said second track,

(c) a first extendable arm, coupled to said first pair of wheels, for selectively attaching to said supplemental tube, and

(d) a second extendable arm, coupled to said second pair of wheels, for selectively attaching to said supplemental tube.

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