

Feb. 21, 1956

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2,735,504

PULSATION DAMPENER FOR GASEOUS STREAMS

Filed July 13, 1953

2 Sheets-Sheet 1

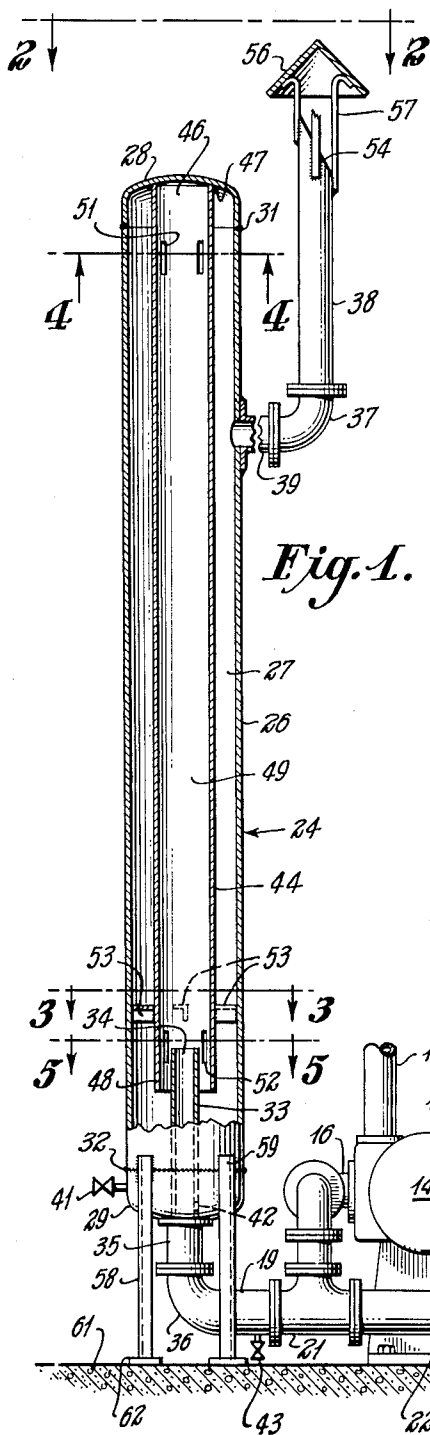


Fig. 1.

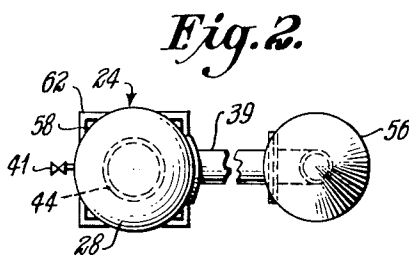


Fig. 2.

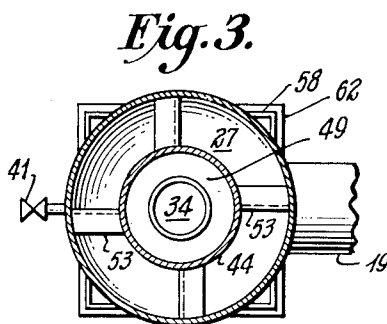


Fig. 3.

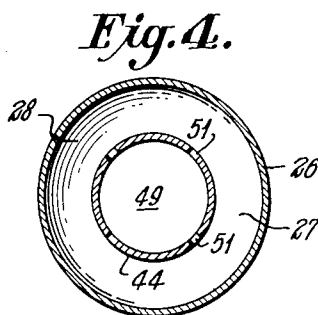


Fig. 4.

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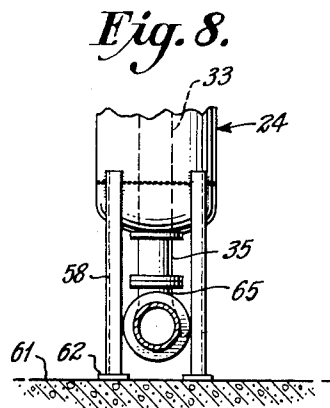
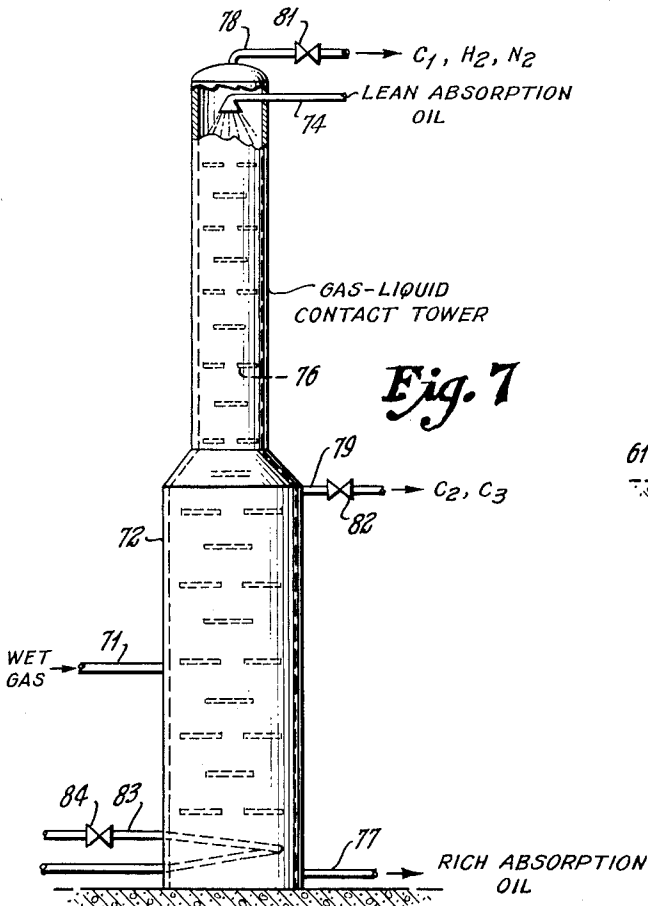
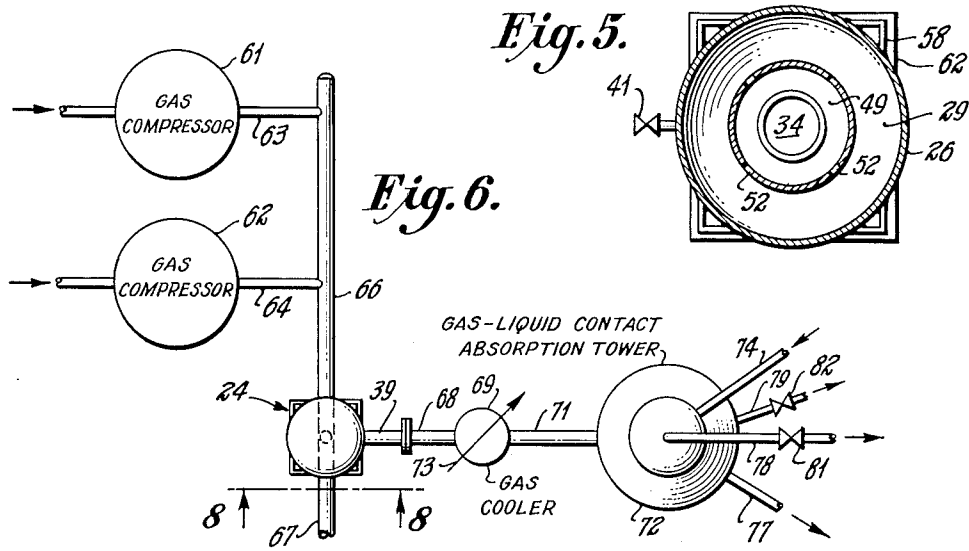
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PULSATION DAMPENER FOR GASEOUS STREAMS

Filed July 13, 1953

2 Sheets-Sheet 2



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PULSATION DAMPENER FOR GASEOUS STREAMS

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Application July 13, 1953, Serial No. 367,423

16 Claims. (Cl. 181—36)

This invention relates to apparatus for limiting or reducing the noise and/or vibration and/or fluctuations in pressure and/or like effects occurring in gaseous streams. In one aspect, it relates to apparatus for smoothing out the flow of exhaust gases coming from one or more internal combustion engines. In another aspect, it relates to apparatus for smoothing out the flow of gas coming from one or more gas compressors.

In the prior art whenever one or more compressors or internal combustion engines discharge into a conduit, this conduit and any apparatus connected thereto is subjected to considerable vibration, which may soon become of a destructive nature. At the same time undesirable noise is created and there may be pressure fluctuations in the gases in said conduit which are great enough to interfere with the proper operation of other apparatus to which said compressed gaseous stream is being supplied.

The present invention substantially eliminates or greatly reduces such pulsations and the resulting noise, vibration and pressure changes, by causing the pulsating stream of gas to be projected axially into the inlet end of a cylindrical internal chamber from which it passes to an outer chamber having a radial outlet conduit connected thereto at a point substantially less than half the length of said outer chamber from the end of said outer chamber opposite said inlet end of said inner chamber. This dampening action is further improved by the addition of one or more series of slots affording communication, between the inner and outer chambers, either adjacent to the inlet of the gases, or between the outlet and the other end of the chamber, or both, a distinct improvement being noted for the use of either set of slots, and further improvement being noticed when both sets of slots are present, the major improvement, however, being caused by the cylindrical partition forming said inner and outer chambers and having one end sealed to the end of said outer chamber opposite the inlet conduit, said partition being disposed with its other end extending toward the inlet end of said chamber to a point substantially beyond the end of an inlet conduit which extends a substantial distance into said outer chamber, said partition being spaced from said inlet conduit and from the walls of said chamber beyond the same to form two concentric pulsation receiving chambers.

One object of the present invention is to provide an improved pulsation dampener for gaseous streams.

Another object is to provide such a pulsation dampener in combination with an internal combustion engine exhaust connected to the inlet of the dampener and the outlet of the dampener connected to the atmosphere, or to apparatus for receiving the same.

Another object is to provide a pulsation dampener connected in the line between a gas compressor and a gas cooler and/or to other apparatus for treating or receiving compressed gas.

Other objects are to provide an improved pulsation dampener having a simple, rugged and fool-proof construction which is easily constructed and assembled and

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which is inexpensive but effective to dampen pulsations of gaseous streams.

Numerous other objects and advantages will be apparent to those skilled in the art upon reading the accompanying specifications, claims and drawings.

In the drawings:

Figure 1 is an elevational view with parts broken away to show details of construction of an internal combustion engine exhaust system including a pulsation dampener embodying the present invention.

Figure 2 is a plan view of the pulsation dampener shown in Figure 1, with the exhaust manifold line and other portions of Figure 1 disconnected.

Figure 3 is a cross-sectional view of a portion of Figure 1 taken along the line 3—3 looking in the direction indicated.

Figure 4 is a cross-sectional view of a portion of Figure 1 taken along the line 4—4 looking in the direction indicated.

Figure 5 is a cross-sectional view of a portion of Figure 1 taken along the line 5—5 looking in the direction indicated.

Figure 6 is a plan view, with portions broken away, of a gas compressor, gas cooler, and gas-liquid contact absorption tower in a system including in combination the pulsation dampener shown in Figure 1.

Figure 7 is an elevational view with portions broken away to show details of construction of the gas-liquid contact tower shown in Figure 6.

Figure 8 is a fragmentary elevational view of the lower portion of the pulsation dampener shown in Figure 6.

In Figure 1, one or more internal combustion engines generally designated as 11 and 12 may be provided with fuel inlets 13, cylinders 14 and exhaust outlet conduits 16. These engines 11 and 12 may do any type of useful work, such as drive belt 17 by means of driving wheels 18 driven by the conventional linkage of crank, connecting rod and piston (not shown). (The piston is reciprocated in cylinder 14 by the expanding combustion gases and the crank is connected to wheel 18.)

With such reciprocating internal combustion engines, or other types of combustion engines of the prior art, such as gas turbines (not shown) pulsating streams of gases are produced in exhaust conduit 16, which pulsating streams cause noise, vibration and fluctuations in pressure.

As shown in Figure 1, exhaust conduits 16 may be connected together into manifold line 19 by means of T's 21, pipe 22 and closure plate 23, and obviously any number of additional engines similar to 11 and 12 may be added by similar connections, provided the pulsation dampener generally designated as 24 is large enough to handle them. For example, dampener 24 may be designed to handle the exhaust from twelve engines and at the same time be effective for any lesser number of engines down to and including a single engine.

Pulsation dampener 24 comprises in combination an elongated cylindrical body 26 forming an enclosed chamber 27. The body 24 is preferably formed with hemispherical or ellipsoidal shaped ends 28 and 29 welded to the center section 26 at 31 and 32 respectively for ease of assembly.

Extending axially through head 29 into chamber 27 for a substantial distance along the axis of said chamber is an inlet conduit 33 having an opening discharge end 34. The other end of inlet conduit 33 is connected in communication with manifold line 19 by pipe 35 and elbow 36 to receive the pulsating stream of exhaust gases from engines 11 and 12. While it is preferred to have dampener 24 disposed with its axis in a vertical position as shown in Figure 1 to obtain the best results, valuable results can also be obtained with dampener 26 disposed

with its axis in a horizontal plane (not shown) in which case elbow 36 and 37 would be eliminated and pipes 19 and 35, and 38 and 39, respectively, connected directly together.

When dampener 24 is disposed with its axis in a horizontal plane it is then desirable to add a sediment drain valve 41, but in the vertical position shown in Figure 1, it is preferred to provide a drain hole 42 communicating with spaces 27 and 34 through pipe 33, and a further sediment valve 43 may be provided at a lower point in the exhaust system to remove sediment and condensate when desired.

Inlet conduit 33 extends into chamber 27 a substantial but minor distance along the axis of said chamber less than one half the length of said chamber, and said chamber is provided with an outlet conduit 39 connected in a radial direction at a point spaced from but substantially less than half the length of the chamber 27 from the end 28 opposite said inlet conduit 33. It is preferably spaced from 0.1 to 0.4 times the length of chamber 27 from the end 28, the optimum being about one fourth. A cylindrical partition 44 is disposed in chamber 27 with one end 46 sealed to the end 28 of chamber 27 opposite said inlet conduit 33, preferably by welding at 47. The other end 48 of partition 44 extends toward the other end 29 of chamber 27 to a point substantially beyond the end 34 of said inlet conduit 33 and is spaced from said inlet conduit and from the wall 26 of chamber 27 and lies between the same to form two concentric pulsation receiving chambers 49 and 27.

This form of construction as discussed up to this point is very effective in dampening pulsations. However, it has been found that by adding one, or both, of the series of slots 51 (best shown in Figure 1) and/or 52 (best shown in Figure 5) that the pulsation dampening efficiency is increased with each series of slots, and further increased when both series are employed.

In order to reduce vibration and make for ease of assembly, radial pipe guides or spacers 53 preferably in the form of angle irons as shown are preferably welded at their ends to pipe 44 and fits snugly but are not secured to pipe 26. In assembling the device pipe 44 may be welded at 47 to end 28 and spacing elements 53 are welded to pipe 44. Then pipe 44 may be lowered down through space 27 and end 28 welded to pipe 26 at 31.

The series of longitudinal slots 52, which are disposed angularly at equal angles in a transverse plane in pipe 44, are preferably disposed adjacent the end of the inlet conduit 33 when slots 51 are employed. A similar series of slots 51 disposed in a transverse plane in pipe 44 are preferably located between the outlet conduit 39 and the adjacent end 28 of the chamber when slots 51 are employed.

While the pulsations have been substantially dampened at the time the gases enter outlet conduit 39, and it could be discharged directly to the atmosphere at this point, it is often preferred to conduct them further to a convenient point of use, or of disposal such as through the roof of a building (not shown) by means of pipes 37 and 39. Pipe 38 may terminate in a plane transverse to its axis to provide a simple open ended pipe (not shown), or it may have its terminal end slanted as shown at 54. If pipe 38 discharges upwardly into the atmosphere, it may be preferred to cover the same by some type of roof or rain cap 56 which may be secured to pipe 38 by suitable supporting legs 57.

In order to support the weight of dampener 24, its lower end 29 may be supported by L-cross section legs 58 which may be welded to pipe 26 and end 29 by welds 59, and the legs 58 may be suitably supported on the foundation 61 by feet 62. Legs 58 can also be welded to the sides of pipe 26 when it is placed in a horizontal position (not shown) if such modifications are employed, by welding the same in a manner similar to that shown in Figure 1, and any welder skilled in the art can do so,

cutting out part of the side of legs 58 to fit the round sides of pipe 26 if desired, or just building up the weld to fit it sufficiently.

Figure 2 merely shows the upper portion of the pulsating dampener 24 and rain cap 56, and as all of the parts are the same as indicated by the numerals, no further exposition is necessary.

The same is true of Figures 3, 4 and 5 which are cross-sectional views of Figure 1 taken along the lines 3—3, 4—4, and 5—5 respectively as indicated.

Figure 6 is a plan view illustrating another preferred combination embodying the pulsating dampener 24. In Figure 6, the gases compressed by gas compressors 61 and 62, and other gas compressors if desired (not shown) is manifolded through lines 63 and 64 into manifold lines 66 and 67 which discharge into T 65 connected to pipe 35 as shown in Figure 8, from which it passes into the dampener 24 through inlet conduit 33 as shown in Figure 1.

After the pulsations have been dampened in dampener 24 in the manner described above, the compressed gases emerge through outlet conduit 39 and are then passed through line 68 through gas cooler 69 and line 71 through gas-liquid contact absorption tower 72.

Gas cooler 69 may be an atmospheric cooler comprising merely an extension of pipe 68, with or without radial fins (not shown) thereon, but it is preferred to have cooler 69 be an indirect heat exchange cooler between the gas from pipe 68 and water indicated by arrow 73 passing through cooler 69 in suitable cooling pipes or chambers (not shown because conventional).

The gas-liquid contact absorption tower 72 is more fully shown in Figure 7, where it will be noted that lean absorption oil is sprayed into the top of the tower through line 74 where it passes downwardly by trickling over plates 76 and is withdrawn by gravity, or a pump (not shown), through line 77 in the form of rich absorption oil. The so-called "wet gas" (which means gases containing hydrocarbons which would be liquid at atmospheric temperatures if they were alone) enters tower 72 through lines 71 and the lightest elements thereof are not absorbed but passed out the top of the tower through line 78. Intermediate unabsorbed gaseous materials pass out the center portion of the tower through line 79 whereas the heavier materials are absorbed in the absorption oil and pass out through line 77. As well known in such towers, the lean absorption oil may first absorb methane or ethane, only to have the same replaced by heavier hydrocarbons such as pentane, or hexane, as the oil proceeds down the column 72. While I have shown for purposes of illustration methane, hydrogen and nitrogen being removed through pipe 78, ethane and propane being removed through pipe 79, and everything heavier being removed through pipe 77, it is obvious that the process may be adjusted as to pressure, temperature, height of column and other conditions well understood in the prior art, to separate whatever desired weight of materials in the light stream 78, the intermediate stream 79, and the heavy stream 77, valves 81 and 82 being shown as one means of controlling the pressure and hot fluid heater 83 controlled by valve 84 being shown as one means by which the temperature may be controlled, the size of the column being decided at the time it is built to provide substantially the separation desired. The liquid or fluid circulated through heater 83 need not be hot, but may merely be warmer than the lower interior of tower 72.

Operation

In Figure 1, the exhaust gases emerging from the outlet 16 of motors 11 and 12 contain periodic pulsations or pressure waves which create noise, cause excessive and sometime destructive vibrations, and causes wide variations in pressure of the fluid at a given point during a given time. When these exhaust gases emerge through end 34 of inlet conduit 33, part of these gases pass

through pipe 49 and the surges therein are reflected from the head 28. At the same time some of the gases passes between pipes 33 and 48 and its surges are reflected from head 29 and pass upwardly in space 26 to be reflected from head 28 the second time. If the distance from opening 34 to head 28 and out in 48 to pipe 39 is different than the distance from end 34 to head 29 to 39, or as reflected from either 28 or 29 to 39, the various pulses and reflections thereof will arrive out of phase at the entrance to pipe 39, so that the gases passing through pipe 39 will be substantially free from surges and will be dampened to a substantial extent. This action is further improved by the addition of either or both series of holes 51 and 52 which provide further paths of different lengths leading directly or by reflecting from the ends 28 and 29, to pipe 39, which further smooth out any pulsations and effectively removes substantially all of the noise, vibrations, and variations in pressure from that point on. The dampened gases can be discharged directly to the atmosphere through 39, or may be passed through further pipe 37 and 38 to some use (not shown), on to the atmosphere.

Figure 6 is representative of an actual plant installation in a large refinery. In this example, the vibrations caused by the pulsation of gases from two 660 horsepower gas compressors was so serious that it was obvious that the gas cooler 69 would be destroyed in a relatively short time, and the variation in pressures were such that gas-liquid contact absorption tower 72 was blowing liquid overhead into line 78 and was therefore not operating properly. Upon installing pulsation dampener 24 as shown in Figure 6, the vibration of gas cooler 69 was substantially eliminated and the flow of gas was under steady pressure through tower 72 which eliminated the blowing of liquid into line 78. The amount of noise was also substantially reduced.

While certain apparatus has been shown in the drawings and described in the specifications for illustrative purposes, the invention is not limited thereto.

Having described my invention, I claim:

1. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point about one fourth the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane adjacent the end of said inlet conduit, and a similar series of slots disposed in a transverse plane between said outlet conduit and the adjacent end of said chamber, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

2. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of

an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point about one fourth the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane adjacent the end of said inlet conduit, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

3. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point about one fourth the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane between said outlet conduit and the adjacent end of said chamber, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

4. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point about one fourth the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the

end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

5. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point from 0.1 to 0.4 times the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane adjacent the end of said inlet conduit, and a similar series of slots disposed in a transverse plane between said outlet conduit and the adjacent end of said chamber, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

6. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point from 0.1 to 0.4 times the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane adjacent the end of said inlet conduit, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more

than three substantially different lengths to said outlet conduit.

7. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point from 0.1 to 0.4 times the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, said partition having a series of longitudinal slots disposed angularly in a transverse plane between said outlet conduit and the adjacent end of said chamber, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

8. A pulsation dampener for a substantially unexpanded pulsating gaseous stream consisting essentially of an elongated cylindrical body forming an enclosed chamber, an inlet conduit for said unexpanded pulsating gaseous stream extending into said chamber a substantial but minor distance less than half the length of said chamber along the axis of said chamber and disposed to discharge said substantially unexpanded pulsating gaseous stream directly into said chamber axially thereof, a single outlet conduit disposed to exhaust said gaseous stream from said chamber after the dampening of pulsations therein has been concluded connected to said chamber in a radial direction at a point from 0.1 to 0.4 times the length of the chamber from the end opposite said inlet conduit, and a cylindrical partition having one end thereof sealed to the end of said chamber opposite said inlet conduit, said partition being disposed with its other end extending toward the other end of said chamber to a point substantially beyond the end of said inlet conduit and spaced from said inlet conduit and from the wall of said chamber between the same to form two concentric pulsation receiving chambers, the wall of said body, and the wall of said partition at least throughout its major longitudinal extent, being imperforate whereby there is provided a central imperforate tube section into which the substantially unexpanded pulsating gaseous stream is discharged for expansion by paths of not more than three substantially different lengths to said outlet conduit.

9. In combination with the pulsation dampener of claim 1 an internal combustion engine exhaust connected to said inlet conduit and said outlet conduit connected to the atmosphere.

10. In combination with the pulsation dampener of claim 4 an internal combustion engine exhaust connected to said inlet conduit and said outlet conduit connected to the atmosphere.

11. In combination with the pulsation dampener of claim 5 an internal combustion engine exhaust connected to said inlet conduit and said outlet conduit connected to the atmosphere.

12. In combination with the pulsation dampener of claim 8 an internal combustion engine exhaust connected

to said inlet conduit and said outlet conduit connected to the atmosphere.

13. In combination with the pulsation dampener of claim 1 a gas compressor connected to said inlet conduit and a gas cooler and gas-liquid contact absorption tower connected in series to said outlet conduit. 5

14. In combination with the pulsation dampener of claim 4 a gas compressor connected to said inlet conduit and a gas cooler and gas-liquid contact absorption tower connected in series to said outlet conduit.

15. In combination with the pulsation dampener of claim 5 a gas compressor connected to said inlet conduit and a gas cooler and gas-liquid contact absorption tower connected in series to said outlet conduit.

16. In combination with the pulsation dampener of claim 8 a gas compressor connected to said inlet conduit and a gas cooler and gas-liquid contact absorption tower connected in series to said outlet conduit.

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