Feb. 28, 1939. G. A. KINGSLEY 2,148,948

MUFFLER

Filed April 5, 1935

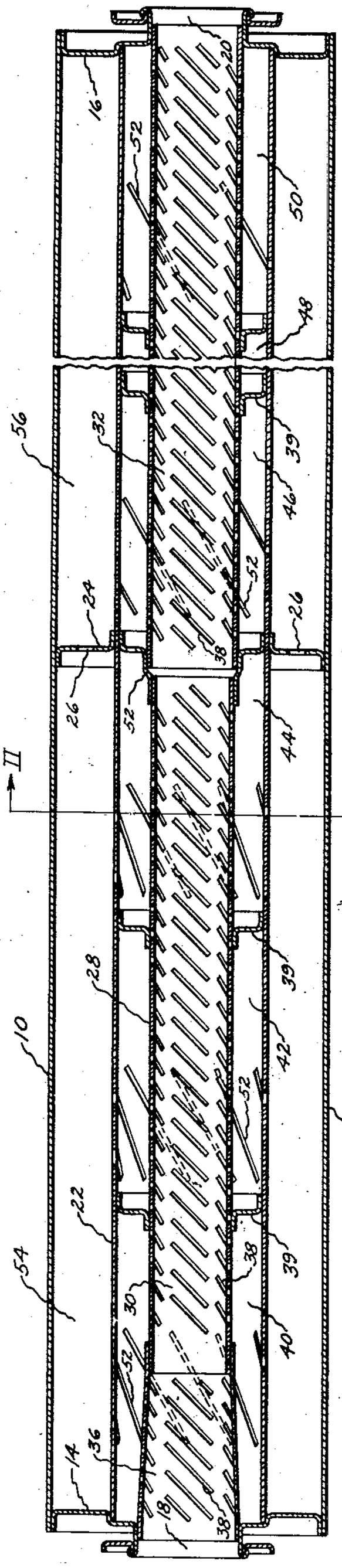

Fig. 1

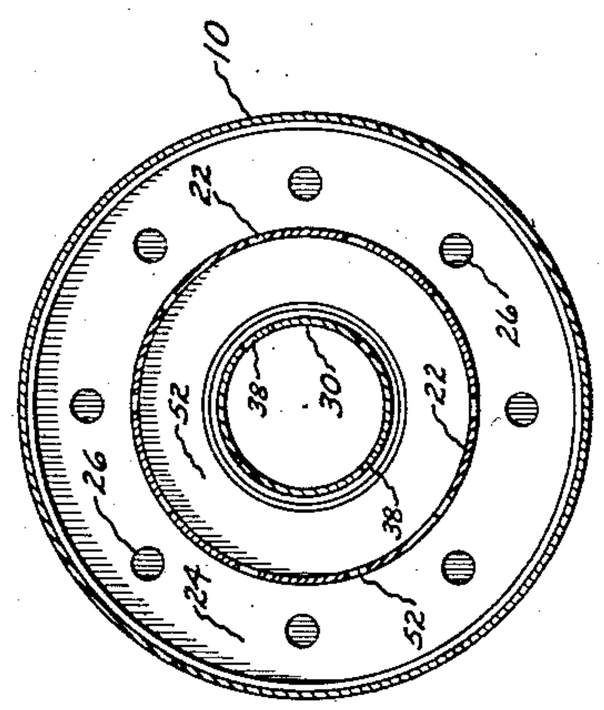

Fig. 2

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MUFFLER

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12 Claims. (Cl. 181—48)

The invention relates generally to mufflers, and has particular reference to mufflers for the suppression of the noise of the discharge of exhaust gases of internal combustion engines without the creation of excessive back pressure.

In the design of muffler constructions for internal combustion engines of automotive vehicles, it is not sufficient to consider only the suppression of the noise of the exhaust gases. Frequently, in automotive vehicles at definite engine speeds, the numerous vibrations result from the operation become "in tune" and by a purely additional effect objectional noise "periods" are experienced by occupants of the vehicle compartment. It has been found that the magnitude and occurrence of these "periods" may be materially reduced or even eliminated through the regulation of the pitch or frequency of the muffler to place it out-of-phase with the frequency of other sources of sound wave emanation. Thus it is important that the muffler design not only be effective in sound suppression arising in the exhaust system, but it is highly desirable that it be such as to permit control of its pitch or frequency as to throw it out of phase with other sources of sound wave emanation associated with the vehicle.

An object of the invention is to provide a muffler of the straight through acoustic labyrinth type capable of converting the gas flow from pulsating low velocity pressure to a more even flow high velocity pressure without seriously increasing the static pressure of the entire system measured at the engine manifold.

An object of the invention is to provide a straight through muffler in which the frequency or tone of the muffler may be readily changed in production without seriously affecting the back pressure of the system measured at the manifold.

A further object is to provide a straight through muffler of an acoustic labyrinth type in which improved sound wave cancellation effect result.

Other objects and advantages residing in the arrangement, construction and combination of parts as will be set forth and appear from the description to follow when considered in connection with the accompanying drawing wherein

Fig. 1 is a broken longitudinal cross-sectional view taken upon the vertical center line of the muffler construction, and

Fig. 2 is a cross-section taken on line II—II of Fig. 1.

When generally considered, the muffler of the present invention embodies a construction in which the major portion of the gas flow has a substantially free unobstructed passage. Preferably adjacent the inlet end of the muffler, a major portion of the gas flow is restricted to increase its velocity while the remainder of the flow is bypassed at a lower velocity. This divided gas flow is collected adjacent the outlet end of the muffler in a common conduit for discharge. Acoustic filters communicate and embrace the straight through conduit and act to vary the sound wave lengths to increase the wave cancellation. Although the invention is illustrated in connection with a straight through muffler, the principle of the present invention may be applied to modified types of straight through mufflers as should be readily appreciated by those skilled in the art.

Referring specifically to the drawing, a muffler 10 of the straight through type comprising an outer cylinder shell 12 having headers 14 and 16 at opposite ends define an inlet 18 and an outlet 20, respectively. An intermediate shell 22 is shown supported at opposite ends by the heads 14 and 16 and intermediate its ends by the annular partition 24 which is preferably perforated as at 26. The shell 22 as disclosed is of uniform diameter throughout its length; however, such construction may not be always desired or found to be necessary. Supported within the shell 22 is a straight through conduit 28 which in the preferred form of the invention consists in a section 30 of less cross-section area than the inlet 18 or the exhaust pipe leading to the inlet 18, a section 32 of substantially the diameter of the outlet 20 and the tail pipe of the exhaust system, and a tapered or restricting connector 36 which communicates the end 34 of the section 30 with the inlet 18. Perforations 38 are provided throughout the length of the conduit 28 including the connector 36 which preferably take the form of elongated slots angularly disposed to the direction of gas flow. The advantages of these perforations over those conventionally employed in muffler constructions is fully discussed in my Patent No. 2,088,296, issued July 27, 1937.

As illustrated, the section 30 of the central tube 28 is of uniform diameter throughout its length, namely, from its point of communication with the connector 36 to its point of communication with the section 32 of enlarged diameter. However, as will be readily appreciated, the connector 36 may be eliminated and the section 30 extended to the inlet 18 and made conical or tapered throughout its entire length or for only a part thereof. Also step-down and step-up tube construction between the inlet 18 and the section 32 or outlet 20 are fully anticipated and fall within

the scope of the present invention. With such an arrangement, the central tube **28** might be made up of more than two sections of different diameter.

Partition **39** supports the sections **30** and **32** and defines acoustic filter or resonator chambers **40**, **42**, **44**, **46**, **48** and **50** spaced longitudinally of the muffler. Suitable perforations **52** are provided in the walls of the tube **22** which constitute the outer walls of the chambers just mentioned. As shown, the perforations **52** take the form of angularly disposed elongated slots. In the preferred form of the invention, the perforated area in the acoustic filter chambers are varied from one end of the muffler to the other. For example, ten slots are provided in each of chambers **40**, **42** and **44**, six, four and three slots in chambers **46**, **48** and **50**, respectively. Because of the differences in cross-section area between the connector **36** and the sections **30** and **32**, the volume of the chamber **40** will be less than that of the chambers **42** and **44** and the volume of the chambers **46**, **48** and **50** will be the least of all the chamber. This difference in volume between the chamber acts to vary the length of sound waves which allows some chance for the sound waves in the muffler to cancel each other.

The diameter of the section **30** may be varied to change the frequency or tone of the muffler without seriously effecting the back pressure measured at the engine manifold. Changes in the diameter of the section **30** for such purposes may be readily made in production as it is only necessary to change to partitions **39**, connectors **36**, and connector partitions **52** having corresponding inner diameters. This is of particular advantage as different model vehicles and changes in engine and/or body design may require mufflers of different frequency tone to obviate noise "periods."

Another possible way of varying the frequency or tune of the muffler construction herein disclosed resides in the addition or substitution of circular holes or the like in the section **30**, adjacent the conical connector **36**. As fully treated in my aforesaid application, angularly disposed slots in the straight through tube give a much lower frequency note and makes it possible to use smaller diameter tubes at the front end of the muffler, as the section **30**, than could possibly be used with conventional circular or louver type perforations. By adding circular holes which may actually cause a "whistling" by themselves, the muffler note as a whole is raised a few octaves higher which would be sufficient, for example, to place the muffler frequency or note out of phase with a similar note from some other source of the vehicle. It is to be understood that the high frequency of the "whistle" created by the circular holes is reduced by the filtering chambers and the only effect is to slightly raise the muffler frequency or note.

In operation of the embodiment of the invention illustrated, pulsating exhaust gases from the engine enter the inlet **18**. As the connector **36** is tapered or restricted at the inner end, there is a tendency for a portion of the gas flow to be accelerated through the restricted section **30**. The slots in the connector **36** permit a portion of the gas flow to pass into the chamber **40**, hence into the outer chamber **54**, through the aperture **26** into the outer chamber **56**, and hence into the section **32** by passing through the chambers **46**, **48** and **50**. It is also possible for some of the gas flow through the perforations of the connector **36** to be drawn back into the main flow through the section **30** from the chamber **40** or from the chamber **54** through the chambers **42** and **44**. It will be appreciated that the gas circuits resulting from the flow through the perforations of the connector **36** into the chamber **54** will have a lower velocity than the flow through the restricted section **30**. In practice it has been found that at low engine speeds the velocity of the exhaust gases is not sufficient to bring acoustic filters of the general type herein disclosed into efficient operation. By accelerating at least a portion of the gas flow in the manner just described, the muffling efficient at low engine speeds is materially increased. Also the differential velocity of the gas circuits or streams in the muffler results in increased sound wave cancellation or each gas stream has its own frequency. Possible objectionable increase in back pressure measured at the engine manifold that might result from the restricting action of the connector **36** and section **30** is avoided by the perforation **38** which permits a radial flow of gas throughout the length of both the connector **36** and the section **30**. That portion of the gas flow by-passed into the chamber **54**, through the perforation **26**, and into the chamber **56**, passes through the chambers **46**, **48** and **50**, to be collected in the section **32** and discharged through the outlet **20**. The section **32** constitutes a collecting chamber for the straight through and by-passed gas streams and its cross-sectional area in most cases will at least approximate or be greater than that of the outlet **20**. Also, a collecting chamber in addition to the section **32** or its equivalent may be used within the scope of the invention.

The essence of the present invention is considered to reside in a muffler structure generally of the straight through type in which by restriction, by-passage, and acoustic filtering of the exhaust gases, increased sound wave cancellation results, pulsations are reduced to a steady flow, and objectional back-pressure is not created. Obviously, the muffler structure for carrying out the principles herein enumerated may be varied materially within the scope of the invention. In view of this fact it is not desired to limit the invention to the specific structure shown but to include as a part of the invention all changes in form and construction as will readily occur to those skilled in the art and come within the scope of the appended claims.

What I claim as new and desire to protect by Letters Patent is:

1. In a muffler for the exhaust gases of an internal combustion engine, an inlet, a straight conduit section in substantial alignment with said inlet for conducting the major portion of the gas flow through the muffler, the cross-sectional area of said conduit section at a point spaced from said inlet being reduced with reference to the area of said inlet, a section of said conduit approximating the diameter of said inlet at one end and the diameter of said reduced area at the other functioning to conduct the major portion of gas flow from said inlet into the reduced section of said conduit, and openings defined in said last conduit section for by-passing a portion of the gas flow.

2. In a muffler for the exhaust gases of an internal combustion engine, an inlet, a straight conduit section of uniform diameter for conducting the major portion of the gas flow through the muffler, said conduit being of less cross-sectional area than said inlet, a section of said con-

duit approximating the diameter of said inlet at one end and the diameter of said reduced area at the other functioning to conduct the major portion of gas flow from said inlet into the reduced section of said conduit, and openings defined in said last conduit section for by-passing a portion of the gas flow.

3. In a muffler for the exhaust gases of an internal combustion engine, an inlet, a straight conduit section of uniform diameter in substantial alignment with said inlet for conducting the major portion of the gas flow through the muffler, said conduit being of less cross-sectional area than said inlet, a tapered connector communicating said inlet and said conduit, and openings defined in said connector for by-passing a portion of the gas.

4. In a muffler for the exhaust gases of an internal combustion engine, an outer shell having an inlet and an outlet, a straight through passageway communicating said inlet and outlet, said passageway including a tapered section, a section of reduced cross-sectional area with reference to said inlet, and a second section approximating in cross-sectional area that of said outlet, said tapered section communicating said inlet and one end of said reduced section, said second section communicating the other end of said reduced section and said outlet, means forward of said reduced section for by-passing a portion of the gas flow around said reduced section to said outlet, and acoustic filter chambers embracing and communicating with said passageway.

5. In a muffler for the exhaust gases of an internal combustion engine, an outer shell having an inlet and outlet, a straight through passageway communicating said inlet and outlet, said passageway including a tapered section, a section of reduced cross-sectional area with reference to said inlet, and a second section approximating in cross-sectional area that of said outlet, said tapered section communicating said inlet and one end of said reduced section, said second section communicating the other end of said reduced section and said outlet, means forward of said reduced section for by-passing a portion of the gas flow around said reduced section to said outlet, acoustic filter chambers embracing and communicating with said passageway, said chambers having different volume.

6. In a muffler for the exhaust gases of an internal combustion engine, an outer shell having an inlet and an outlet, a straight through passageway communicating said inlet and outlet, said passageway including a tapered section, a section of reduced cross-sectional area with reference to said inlet, and a second section approximating in cross-sectional area that of said outlet, said tapered section communicating said inlet and one end of said reduced section, said second section communicating the other end of said reduced section and said outlet, means forward of said reduced section for by-passing a portion of the gas flow around said reduced section to said outlet, acoustic filter chambers embracing and communicating with said passageway, and perforations communicating said chambers with the interior of said shell outside of said chambers.

7. In a muffler for the exhaust gases of an internal combustion engine, an outer shell having an inlet and an outlet, a straight through passageway communicating said inlet and outlet, said passageway including a tapered section, a section of reduced cross-sectional area with reference to said inlet, and a second section approximating in cross-sectional area that of said outlet, said tapered section communicating said inlet and one end of said reduced section, said second section communicating the other end of said reduced section and said outlet, means forward of said reduced section for by-passing a portion of the gas flow around said reduced section to said outlet, acoustic filter chambers embracing and communicating with said passageway, perforations communicating said chambers with the interior of said shell outside of said chambers, the perforated area of said chambers being greatest adjacent the inlet end and being reduced toward the outlet end of the muffler.

8. In a muffler for the exhaust gases of an internal combustion engine, an outer shell having an inlet and an outlet, a central straight through conduit communicating said inlet and outlet, said central conduit being perforated throughout substantially its entire length and including a reduced section adjacent the inlet and of less cross-sectional area than said inlet and an enlarged section adjacent the outlet end of a cross-sectional area at least approximating that of the outlet, and a tapered section between said inlet and said reduced section, an intermediate shell, means dividing said shell into a plurality of acoustic filter chambers embracing said central conduit and spaced longitudinally of the outer shell, perforations in said intermediate shell to enable gases to be by-passed from said central conduit longitudinally of said outer shell through a chamber defined by said outer and intermediate shells, the restricting action of said tapered and reduced sections accelerating a portion of the gas flow through the central conduit and by-passing a portion of the gas flow out into said last chamber.

9. In a muffler for the exhaust gases of an internal combustion engine, an outer elongated shell having an inlet and an outlet at opposite ends, an intermediate shell spaced from said outer shell to define a longitudinally extending chamber, a central straight through conduit supported within said intermediate shell in spaced relation, parts spaced longitudinally of said central conduit dividing the space between said central conduit and intermediate shell into a plurality of acoustic filter chambers, perforations in said central conduit and intermediate shell communicating the interior of said central conduit with said first chamber through said acoustic filter chambers, said central conduit being proportioned adjacent the inlet end to accelerate a major portion of the gas flow through said central conduit, a portion of the gas flow being by-passed through said perforations to and from said first chamber.

10. In a muffler for the exhaust gases of an internal combustion engine, an inlet, a conduit of less cross-sectional area than said inlet communicating with said inlet and constituting a straight through passageway for a major portion of the gas flow through at least a substantial portion of the length of the muffler, the portion of said conduit adjacent said inlet end being tapered to accelerate a portion of the gas flow through said conduit, and perforations in said tapered portion to by-pass a portion of the gas flow to obviate the creation of objectionable back pressure.

11. In a muffler for the exhaust gases of an internal combustion engine of the straight through type, an outer shell having an inlet and an outlet, a straight through central conduit

communicating said inlet and outlet, acoustic filter chambers embracing said central conduit and communicating with and spaced longitudinally thereof, said central conduit being proportioned to accelerate a portion of the gas flow passing therethrough to increase the efficiency of said acoustic filter chambers at low engine speed, and means for by-passing a portion of the gas flow adjacent the inlet end to obviate the creation of objectionable back pressure.

12. In a muffler of the straight through type, an outer shell having an inlet and an outlet, a central straight through conduit communicating said inlet and outlet, acoustic filter chambers embracing said central conduit and communicating with and spaced longitudinally thereof, said chambers being of different volume, said central conduit being proportioned adjacent the inlet end to direct a portion of the gas flow through said central conduit at an increased velocity and to by-pass to said outlet another portion of the gas flow at a lower velocity, the differential velocity of the gas flows and the differential volume of said acoustic filter chambers acting to increase the sound wave cancellation effect of the muffler.

GEORGE A. KINGSLEY.