Dec. 25, 1962 F. E. DEREMER 3,070,187

SOUND-ATTENUATING SYSTEM AND APPARATUS FOR GAS STREAMS

Filed May 18, 1959 2 Sheets-Sheet 1

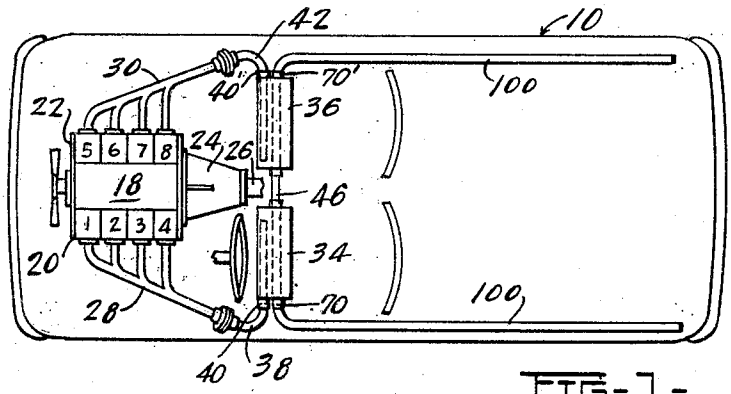


FIG-1-

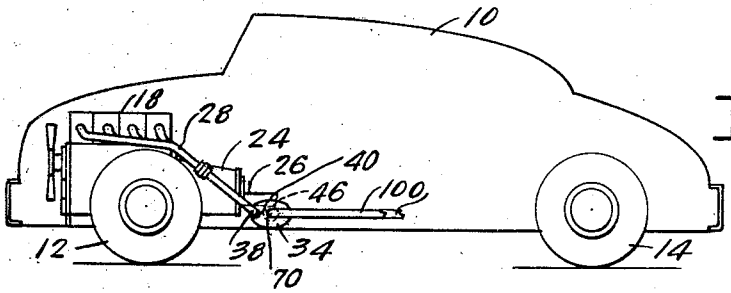


FIG-2-

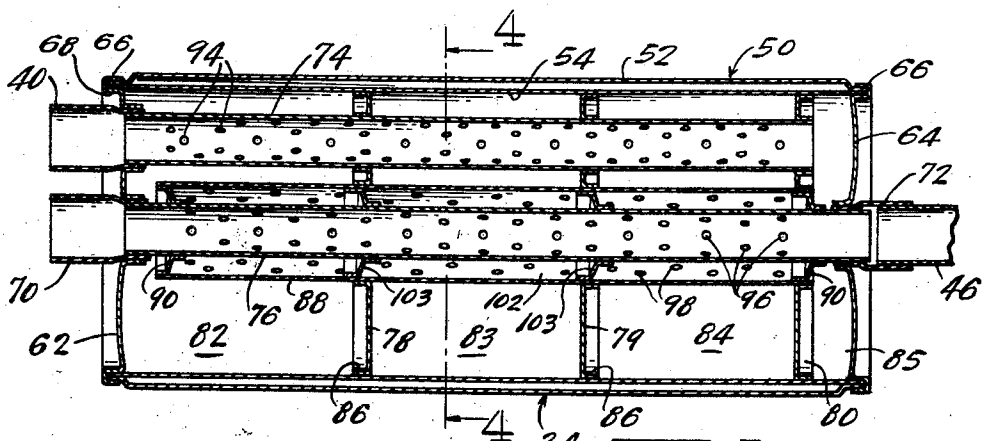


FIG-3-

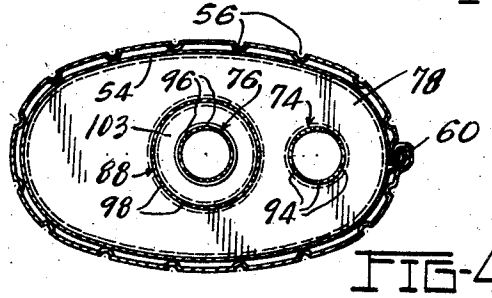


FIG-4-

INVENTOR:
FLOYD E. DEREMER.

BY Harry O. Ernsberger
ATTY.

Dec. 25, 1962 F. E. DEREMER 3,070,187

SOUND-ATTENUATING SYSTEM AND APPARATUS FOR GAS STREAMS

Filed May 18, 1959 2 Sheets-Sheet 2

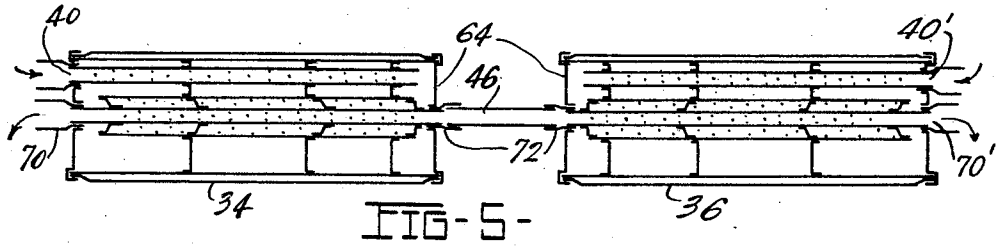


FIG-5-

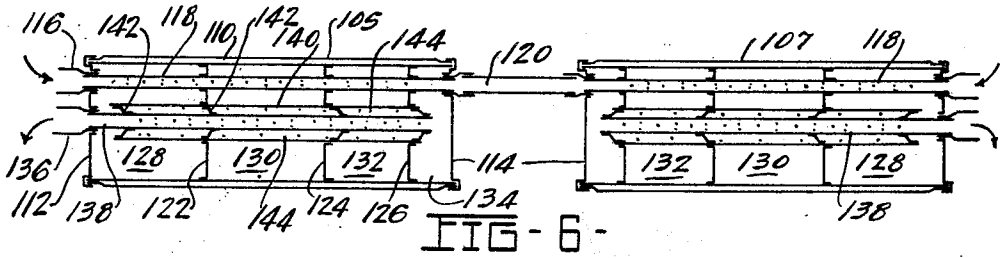


FIG-6-

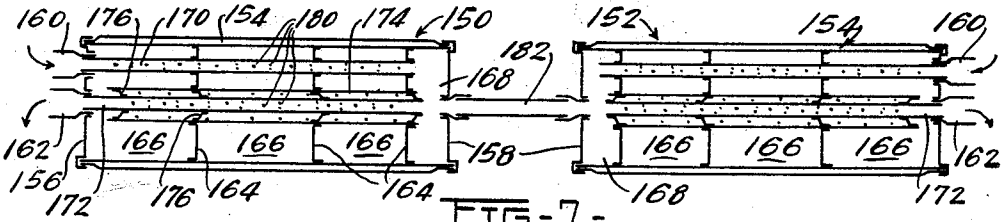


FIG-7-

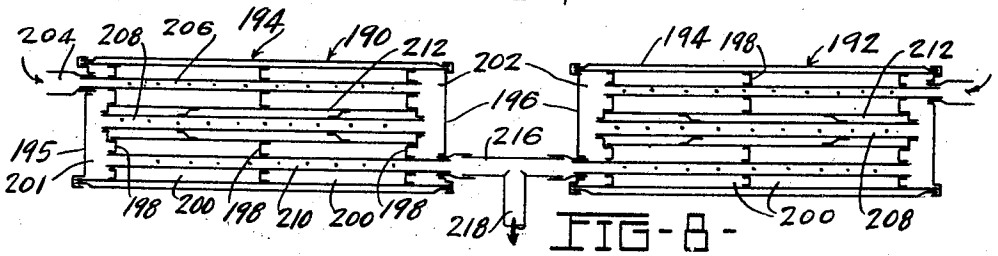


FIG-8-

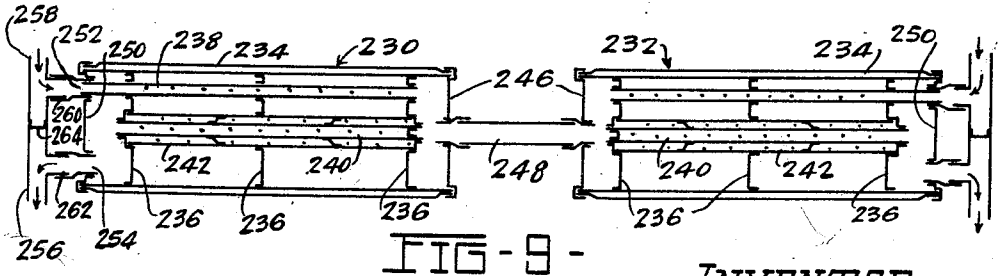


FIG-9-

INVENTOR:
FLOYD E. DEREMER.

BY
Harry O. Ernsberger
ATTY.

United States Patent Office 3,070,187 Patented Dec. 25, 1962

3,070,187

SOUND-ATTENUATING SYSTEM AND APPARATUS FOR GAS STREAMS

Floyd E. Deremer, Livonia, Mich., assignor to Oldberg Manufacturing Company, Grand Haven, Mich., a corporation of Michigan

Filed May 18, 1959, Ser. No. 813,771
6 Claims. (Cl. 181—55)

This invention relates to sound-attenuating system and apparatus especially for use with dual exhaust gas streams from an internal combustion engine of the character employed in automotive vehicles, the system and apparatus functioning to attenuate sound waves entrained in the gas streams and to further equalization of irregular pressure impulses in the exhaust gas streams.

Eight cylinder engines of the internal combustion type embodying two parallel banks of four cylinders in each bank have come into extensive use for powering automotive vehicles, each bank of cylinders being equipped with an individual exhaust manifold which heretofore have been joined for conveying exhaust gas streams from both banks through a single muffler or sound-attenuating means. In other types of installations, dual exhaust gas duct arrangements are provided and each gas stream is conveyed independently of the other through one or more sound-attenuating mufflers in order to attenuate sound waves entrained in the exhaust gas streams.

The trend of automotive construction is toward a lowering of the chassis frame and such design poses difficulties in the positioning of sound-attenuating means or mufflers beneath the body due to the necessary presence of transversely extending frame struts or bracing members of the vehicle frame. Thus in exhaust systems of vehicles where high sound-attenuating efficiency is desired, two or more mufflers have been placed in series relation lengthwise of the vehicle for each exhaust gas stream. In this type of installation, the presence of frame cross members prevents the use of a single muffler or sound-attenuating means of a length sufficient to obtain proper sound-attenuation over a desired sound wave range.

In multi-cylinder engine constructions comprising two banks of cylinders wherein the pistons are connected to a single crankshaft, the firing order of ignition in the cylinders in each bank do not occur at regular intervals. In an eight cylinder engine having two banks of cylinders, successive firing of two cylinders occurs in each bank, the remaining cylinders firing alternately. During a complete cycle of firing of the eight cylinders, two successive exhaust impulses occur in the exhaust manifold for each of the banks of cylinders. These irregular pressure impulses in each exhaust manifold establish nonrhythmic pulsations in the gas stream which are audibly exemplified by a distinct throbbing in each exhaust duct arrangement.

The present invention embraces a system and apparatus involving the positioning of sound-attenuating instrumentalities amidship and extending transversely of the vehicle and connected together by a pressure balancing or equalizing passage or tube whereby improved sound-attenuation is attained, particularly improved attenuation of the sound waves set up by irregular exhaust or pressure impulses in dual exhaust gas streams.

An object of the invention is the provision of a system or method of flowing exhaust gas streams from two manifolds into sound-attenuating chambers disposed transversely of a vehicle and connected by a pressure equalizing or gas exchange tube or passage in a manner whereby pressure impulses occurring at irregular intervals are dissipated in the interconnected chambers whereby the

sound waves of the irregular impulses are effectively attenuated or their audible effect minimized or rendered unobjectionable.

Another object of the invention resides in the provision of a combination of sound-attenuating units or mufflers disposed amidship and extending transversely of a vehicle and interconnected by a balancing tube whereby effective sound-attenuation is attained and wherein the installation does not interfere with the frame members of the vehicle so as to provide for maximum roadway clearance.

A further object of the invention resides in the provision of dual sound-attenuating chambers or units arranged in series relation disposed transversely of a vehicle and interconnected by a passage whereby pressure impulses in the gases from engine exhaust manifolds are blended or balanced whereby objectionable audible throbbing in the exhaust gas streams is substantially eliminated.

Another object is the provision of an apparatus or system involving multiple transversely extending and axially or longitudinally aligned muffler or sound-attenuating units connected at their adjacent end regions by tubular means whereby pressures of irregular impulses in the streams are substantially neutralized or equalized and the sound waves of the irregular impulses substantially attenuated.

Another object of the invention is the provision of multiple sound-attenuating units each embodying sound-attenuating and resonator chambers adapted to receive multiple streams of exhaust gases from an internal combustion engine, the units being interconnected by a balancing tube providing for pressure balancing and blending of the gases of the streams and improved sound-attenuation.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a schematic plan view of a vehicle embodying an exhaust system of the invention utilized with a multi-cylinder engine having dual banks of cylinders in parallel relation with sound-attenuating units arranged transversely and amidship of the vehicle;

FIGURE 2 is a schematic elevational view of the arrangement portrayed in FIGURE 1;

FIGURE 3 is an enlarged longitudinal sectional view through one form of sound-attenuating and gas blending unit of the multiple unit system of the invention;

FIGURE 4 is a transverse sectional view through the attenuating unit illustrated in FIGURE 3, the view being taken substantially on the line 4—4 of FIGURE 3;

FIGURE 5 is a schematic longitudinal sectional view drawn to a reduced scale illustrating the interior arrangements in the multiple units or mufflers illustrated in FIGURES 1 through 4;

FIGURE 6 is a schematic longitudinal sectional view drawn to a reduced scale illustrating a modified form of attenuating unit and interconnection between the units;

FIGURE 7 is a schematic sectional view drawn to a reduced scale illustrating the system embodying another form of sound-attenuating and impulse-equalizing interconnected units;

FIGURE 8 is a schematic longitudinal sectional view drawn to a reduced scale illustrating dual sound-attenuating units with a combined connecting passage and gas outlet means between the units, and

FIGURE 9 is a schematic sectional view drawn to a reduced scale illustrating a modified form of exhaust inlet and outlet passage means for each of the sound-attenuating units of a system.

While the forms of apparatus of the system of the invention disclosed herein have particular utility with dual exhaust gas streams of an internal combustion engine utilized as a power unit for an automotive vehicle, it is to be understood that the system and apparatus may be utilized wherever it is desired to attenuate sound waves entrained in the streams and equalize or neutralize irregular pressure impulses.

The illustrations of system and apparatus of the invention for blending exhaust gas streams are shown in connection with an eight cylinder engine having two banks or blocks of four cylinders each, but it is to be understood that the system and apparatus may be utilized in connection with exhaust gas streams of engines having a different number of cylinders. With particular reference to FIGURE 1, the outline of a top plan of a vehicle body is illustrated at **10**, the body being supported upon a suitable frame or chassis structure (not shown), the vehicle being equipped with pairs of front and rear road wheels designated respectively **12** and **14**.

Cradled in the forward region of the chassis frame and supported thereby is an internal combustion engine **18** of the eight cylinder type fashioned with two parallel banks or blocks of cylinders designated respectively **20** and **22**, each bank being inclusive of four cylinders. The engine is connected through suitable power transmission mechanism contained in a housing **24** and a drive shaft construction **26** to the rear wheels **14** of the vehicle for driving the same in a conventional manner.

The bank of cylinders **20** is equipped with an exhaust manifold **28** having four branches in communication with the exhaust ports of the four cylinders in the engine block **20** through which exhaust gases from the cylinders are delivered into the manifold **28**. The bank of cylinders **22** is equipped with a similar manifold **30**. In eight cylinder engines comprising dual blocks of four cylinders each, several firing orders may be utilized, but in all firing orders two cylinders in each block are fired consecutively while the remaining cylinders in both blocks are fired alternately. One typical firing order of cylinders of an eight cylinder engine, with reference to the cylinder numbering shown in FIGURE 1 is **1, 5, 4, 8, 6, 3, 7** and **2**.

Thus the successive firing of two cylinders in a block during engine operation produces or sets up successive pressure impulses in the gas streams in each of the manifolds **28** and **30**. The successive pressure impulses in one manifold occur at a different period of time than the successive dual impulses in the other manifold. Hence the pressure impulses in both exhaust gas streams delivered from the manifolds **28** and **30** are irregular and, when the gas streams are directed respectively through individual sound-attenuating means or mufflers, objectionable audible throbbing or pulsing sound are present.

In the present invention, the dual gas streams from the manifolds are fed into interconnected sound-attenuating and gas blending units wherein the irregular audible pressure waves are reduced or substantially attenuated and the pressure impulses substantially equalized through the medium of the interconnection between the sound-attenuating units. In the arrangement or system of the present invention, the interconnected sound-attenuating mufflers or units are arranged in alignment and extend transversely of the vehicle.

The transversely disposed units are shaped and the interconnection therebetween disposed so that the units may be mounted amidships of the vehicle adjacent the rear of the housing containing the power transmission mechanism, the individual units being mounted at opposite sides of the power transmission housing so as to provide maximum clearance above the roadway with the

interconnection between the units disposed adjacent and close to the power transmission mechanism housing. This type of mounting for dual sound-attenuating units is advantageous in that the units extend lengthwise transversely of the vehicle without interference with the transverse frame struts or connecting members of the vehicle frame construction.

FIGURES 1 and 2 are illustrative of the transverse positioning of the dual sound-attenuating and pressure equalizing units, FIGURES 3 and 4 illustrating a detailed form of one of the units and FIGURE 5 a semi-diagrammatic sectional view of the dual unit installation of FIGURES 1 and 2. The arrangement shown in FIGURES 1, 2 and 5 includes substantially identical units **34** and **36**, which are of the same construction, one of the units **34** being illustrated in detail in FIGURES 3 and 4.

The exhaust manifold **28** is connected by means of an exhaust-conveying tube or elbow **38** into the inlet **40** of the unit **34** while the exhaust gas stream from the manifold **30** is conveyed by means of a tube or elbow **42** with the inlet **44** of the unit **36**. The units **34** and **36** are connected together by means of a pressure equalizing or balancing tube **46** which, as shown in FIGURE 2, is disposed adjacent and beneath the drive shaft arrangement **26** at the rear of the power transmission housing **24** of the vehicle.

The sound-attenuating mufflers or units **34** and **36**, as illustrated, are of identical construction and one of the units **34** is illustrated in detail in FIGURES 3 and 4. A description of one unit will suffice for both. As shown in FIGURES 2 and 4, each sound-attenuating unit is preferably of oval ellipsoidal in cross-section as this configuration enables maximum clearance between the roadway and the sound-attenuating unit or muffler. Each of the units **34** and **36** is inclusive of a sheet metal shell construction **50** of generally oval or ellipsoidal shape as shown in FIGURE 4.

In the embodiment illustrated the shell is double walled, comprising an outer layer or shell **52** and an inner layer or shell **54**, the outer layer being formed with spaced longitudinally extending ridges **56** which engage the inner layer **54** so as to space the layers apart providing longitudinally extending isolated regions or zones providing air chambers adapted to cushion vibrations and reduce shell noise. The inner and outer metal layers are joined by a seam **60** formed by overlapping regions of the layers bent upon themselves as shown in FIGURE 4.

Each of the attenuating units **34** and **36** is provided with end closures or heads **62** and **64**, the peripheral regions of the end heads **62** and **64** being flanged as at **66** embracing the juxtaposed ends of the outer and inner layers **52** and **54** whereby the end heads are securely fastened to the shell construction providing sealed joints. The space between the inner and outer shell members **52** and **54** may accommodate a layer of asbestos or other heat resistant material having sound damping characteristics, the layer serving as heat insulation.

If desired, the shell construction **50** may be a single sheet of metal formed to tubular shape or a sheet of metal wrapped upon itself to form a multiple layer shell. In the shell construction shown in FIGURE 3, the ends of both layers **52** and **54** are brought into contiguous relation to receive the flanged regions of the end heads **62** and **64**. Each of the end heads is formed with a ledge **68** which snugly fits within the end region of the inner shell and the flange **66** spun into the position shown in FIGURE 3.

Each of the units **34** and **36** is inclusive of gas passage means disposed within the shell, the walls of the gas passage means being formed with small openings providing acoustic couplings for sound-attenuating purposes and for facilitating transverse or cross flow of gases within the shell construction. As particularly shown in FIGURE 3, the end closure **62** is provided with an opening

accommodating the gas inlet coupling or tube 40 and a second coupling or tube 70 providing a gas outlet.

The end head 64 of each of the units 34 and 36 is provided with a central opening accommodating a tubular coupling 72, the couplings being connected by means of a balancing tube or tubular means 46 as shown in FIGURE 5. In the embodiment illustrated in FIGURES 1 and 2, the inlet coupling 40 of each unit is connected with an adjacent exhaust tube or elbow 38 and 42. As shown in FIGURE 3, each of the sound-attenuating and gas blending units includes gas passage tubes 74 and 76, the gas passage tube or means 74 being in communication with the coupling member 40 and receives exhaust gases from the adjacent manifold. The second gas passage tube or means 76 is in communication with the couplings 70 and 72.

There is provided interiorly of each of the units 34 and 36, one or more partitions or transversely extending walls which divide the interior into two or more compartments or chambers. As shown in FIGURE 3, there are three transversely disposed, longitudinally spaced walls or baffles 78, 79 and 80 providing sound-attenuating and gas transfer chambers 82, 83 and 84. The baffle 80 and the end head 64 provide a low frequency resonator chamber 85. Each of the transversely extending walls 78, 79 and 80 is of oval shape and is provided with a peripheral flange 86 of oval shape engaging the interior surface of the inner shell 54.

Surrounding the tube or gas passage means 76 is a second tube or tubular member 88 of larger diameter which is substantially concentric with the tube 76 and is held in this position by annular members 90, the members having flanged portions which respectively engage the outer surface of the tube 76 and the inner surface of the end regions of the tube 88. The walls or baffles 78, 79 and 80 are provided with openings to accommodate the tubes 74 and 88. The walls of the gas passage tubes 74 and 76 are provided with a large number of comparatively small openings 94 and 96, and the tube 88 provided with a substantial number of comparatively small openings 98.

The openings in the tubes 74, 76 and 88 form acoustic couplings with the adjacent regions within the shell for attenuating sound waves and for facilitating transverse or cross flow of exhaust gases from the inlet tube 74 through the adjacent chambers 82, 83 and 84 and through the openings 96 and 98 into the tube 76, the latter conveying the gases either through the balancing tube 46 to the other attenuating unit or through the outlet coupling 70 and exhaust pipe 100 to the rear of the vehicle, this arrangement being schematically illustrated in FIGURE 1.

Very little transfer of exhaust gases occurs in the connecting or balancing tube 46, this tube serving primarily as a pressure balancing means whereby uneven pressure impulses in the exhaust gas streams are effectively equalized or neutralized. The annular space 102 provided between the tubes 76 and 88 is partitioned by annular members 103, the compartments forming attenuating chambers for sound waves in the high frequency range.

The operation and functioning of the system and apparatus illustrated in FIGURES 1 through 5 are as follows: The exhaust gas streams in the exhaust manifolds 28 and 30 are delivered into the inlet couplings 40 and 40' at the outer ends of the units 34 and 36 whereby the exhaust gases from the respective manifolds are discharged or delivered into the tubes or gas passage means 74, the gases flowing transversely through the openings 94. One end of the tube 74 opens into the resonator or chamber 85 which serves to attenuate low frequency sound waves.

The compartments or spaces 102 between the tubes 76 and 88 form or provide high frequency sound wave attenuating means. The gases from the tube 74 flow transversely through openings 94 in the tube 74, openings 98 in the tubular member 88 and openings 96 in the tube 76, the exhaust gases being then discharged through the outlet coupling 70 of unit 34 and outlet coupling 70' of unit 36 into the exhaust pipes 100 for discharge rearwardly of the vehicle.

When successive pressure impulses occur in one of the manifolds by reason of the particular firing order of the cylinders, the pressure balancing tube 46 serves to assist in the equalization, neutralization or balancing of differential pressures in the intercoupled units 34 and 36 to smooth out the gas flow and promote improved attenuation of sound waves set up by the irregularity of pressure impulses in both sound-attenuating units 34 and 36.

It is found that by delivering exhaust gases into the outermost ends of transversely aligned sound-attenuating units, coupled by balancing tube 46, that sound waves in the objectionable audible wave range are satisfactorily attenuated without necessitating the use of additional sound-attenuating means. It is to be understood however that if desired, additional sound-attenuating means may be incorporated with the exhaust pipes 100.

While the arrangement as shown in FIGURES 1 through 5 illustrates the coupling members 40 as the exhaust gas inlet, it is to be understood that the couplings 40 may be connected with the exhaust manifolds 28 and 30 and utilized as the gas inlets into the units 34 and 36. The couplings 40, in such an arrangement would be utilized as gas discharge outlets and same would be connected with the exhaust pipes 100 for conveying exhaust gases to the rear of the vehicle.

With the above described arrangement of mufflers or sound-attenuating units disposed transversely of and amidship of the vehicle at the rear of the transmission housing 24, an exhaust gas system is provided which does not interfere with the vehicle frame struts or members providing improved sound-attenuation and gas pressure or impulse balancing means which improves the flow of exhaust gases through the units and minimizes the audible throbbing resulting from irregular pressure impulses in the exhaust gas streams.

FIGURE 6 is illustrative of a modified sound-attenuating and pressure impulse balancing system. In this arrangement the sound-attenuating units 105 and 107 are of identical construction, each unit comprising a dual wall shell 110 provided with end heads 112 and 114 which are joined to the shell in the manner shown described in connection with the form of unit illustrated in FIGURE 3. In the arrangement shown in FIGURE 6, the end head 112 of each unit is provided with an inlet coupling 116 which is in communication with a gas passage tube 118, the latter extending through an opening in the end head 114.

A balancing tube 120 is in communication with the tube 118 in each of the sound-attenuating units to facilitate the balancing or neutralization of pressure impulses in the exhaust gas streams delivered into the units 105 and 107. The inlet couplings 116 are connected respectively with the engine exhaust manifolds in the manner illustrated in FIGURE 1. Partitions 122, 124 and 126 extend transversely within each sound-attenuating unit and with the end heads form gas passage and sound-attenuating chambers 128, 130, 132 and 134.

The end head 112 is provided with an outlet coupling 136 in communication with a gas passage means or tube 138 which extends through the partitions and is surrounded by a tube 140. The annular space between the tubes 138 and 140 is subdivided into lengthwise arranged compartments by means of annular spacers 142 providing high frequency sound-attenuating chambers or regions 144.

The tubes 118, 138 and 140 have their wall regions provided with a large number of comparatively small openings or orifices which facilities transverse flow of exhaust gases and eventual discharge through the outlet

136 in each unit. The openings in the walls of the gas passage tubes and the tube 140 form acoustic couplings with the adjacent chambers or compartments for attenuating sound waves. The gas passage means 138 opens into the resonator chamber 134 which serves to attenuate sound waves in the low frequency range.

In the arrangement shown in FIGURE 6, the inlet gas passage means in each of the units 105 and 107 are in alignment and communicate with each other through the medium of the connecting means or pressure balancing tube 120. The pressure balancing tube 120 facilitates the equalization of unequal or irregular pressure impulses in the individual exhaust gas streams so as to improve the attenuation or damping of the sound waves established by pressure impulses and to facilitate smoothing out the irregular pressure impulses in the exhaust streams.

FIGURE 7 illustrates a modified form of dual unit system for attenuating sound waves and balancing neutralizing irregular pressure impulses in dual gas streams. In this form, the system includes substantially identical sound-attenuating units or mufflers 150 and 152, the double wall shell construction 154 of each unit being substantially the same as that shown in FIGURE 3. Each of the units is provided with end heads or end closures 156 and 158, the outer end closures 156 being provided with openings accommodating an inlet coupling 160 and an outlet coupling 162, the heads being flanged and sealed to the peripheral end regions of the shell 154.

Partitions 164 extend transversely within the shell and form gas transfer and sound-attenuating compartments 166 and a low frequency resonator chamber 168, the end closure 158 forming a wall of the resonator chamber. The inlet couplings 160 is in communication with an inlet gas passage means or tube 170 and the outlet coupling 162 is in communication with a second gas passage tube or means 172.

The tube 172 is surrounded by a tube 174 of larger diameter, the annular regions surrounding the tube 172 between adjacent spacers 176 forming high frequency sound-attenuating compartments or chambers. The walls of the tubes 170, 172 and 174 are provided with a large number of comparatively small openings 180 to facilitate transverse flow of gases through the chambers 166 to the discharge tube 172 and discharge outlet 162. The openings 180 provide acoustic coupling means for attenuating sound waves in the high frequency range.

The adjacent end heads or closures 158 are formed with openings to accommodate or receive a connecting tube 182 which provides means for equalizing unequal pressures or pressure impulses in the attenuating units 150 and 152 resulting from irregular pressure impulses in the exhaust gas streams. In this form, the pressure balancing tube 182 opens into the low frequency resonator chambers 168 in each unit, and, as illustrated, the tube 182 is aligned with and spaced lengthwise from the gas passage tubes 172. The chambers 168 facilitate substantially unimpeded transfer of gases from the ends of the gas passage tubes 170 to the balancing tube 182 to facilitate equalization of pressure impulses in the gas streams.

FIGURE 8 illustrates a modified form of gas pressure blending and sound-attenuating system of the invention. In this arrangement the system is inclusive of substantially identical sound-attenuating and gas blending units or mufflers 190 and 192, the shell construction 194 being preferably of the double wall arrangement of the character illustrated in the form of the invention shown in FIGURE 3. Each of the sound-attenuating units is provided with an end head or end closures 195 and 196 which are secured to the muffler shell 194 in the same manner illustrated in FIGURE 3.

In the muffler arrangement shown in FIGURE 8, each muffler unit includes transversely extending partitions 198 subdividing the interior into gas transfer compartments 200 and resonator chambers 201 and 202, the end closures 195 and 196 forming walls of resonator chambers.

Each of the muffler units includes an inlet coupling 204 which is in communication with a first gas passage means or tube 206 which extends through openings in the partitions 198 and opens into the resonator chamber 202. Each unit includes a second gas passage tube 208 and a third gas passage tube 210.

A tubular member 212 surrounds the second gas passage tube 208 and the regions between the tube 208 and the tubular member 212 provide chambers for the attenuation of high frequency sound waves. The walls of all the gas passage tubes within each muffler and between the end partitions 198 are formed with a large number of comparatively small openings to facilitate transverse flow of gas through the compartments 200. The openings in the walls of the tubes form acoustic couplings with the adjacent regions in order to attenuate sound waves of the gas streams.

It should be noted that the regions or wall portions of the tubes 206 and 210 projecting respectively through the low frequency sound-attenuating chambers 201 and 202 are unperforated, a factor which compels traverse of the gases through longer paths in the muffler units. The end heads 196 of the muffler units of FIGURE 8 are connected by means of a balancing tube 216 for equalizing unequal pressure impulses in the exhaust gas streams.

In this form of the invention, a gas discharge outlet 218 is connected with the balancing tube 216 and through which the gases from both muffler units are discharged througuh a common outlet passage 218. The balancing tube 216 and the gas discharge tube or passage 218 should be of sufficient cross-sectional area to accommodate the volume of gases from both units 190 and 192 with a minimum of back pressure.

FIGURE 9 illustrates a pressure impulse balancing and sound-attenuating system for dual streams of exhaust gases from an internal combustion engine, each muffler of the unit embodying a combined gas inlet and outlet construction. The sound-attenuating units 230 and 232 include shell constructions 234, end heads 246 and 250 and interior components comprising transversely extending partitions 236, a first gas passage tube 238, a second gas passage tube 240 and a tubular member 242 surrounding the second gas passage tube.

These components are of the same construction and arrangement as the corresponding components illustrated in the sound-attenuating units 150 and 152 of FIGURE 7. The adjacent end heads or closures 246 are provided with openings to accommodate a connecting or pressure balancing tube 248 which corresponds in function with the balancing tube 182 shown in FIGURE 7. Each of the outer end heads 250 of the sound-attenuating units is provided with an inlet opening 252 and an outlet opening 254.

A fitting 256 is fashioned of tubular components to provide a combined inlet and outlet construction or unit to accommodate delivery of the streams of exhaust gases into the units 230 and 232 and accommodate the discharge of gases from both units. Each fitting 256 comprises a tubular portion 258 extending lengthwise of the vehicle and normal to the longitudinal axes of the sound-attenuating units. Joined by welding or other means to the tubular member 258 is a tubular gas inlet member 260 and a tubular gas outlet member 262.

Disposed within the tubular member 258, intermediate the connections of tubular members 260 and 262 therewith, is an abutment or plug 264 which is sealed within the tubular member 258 and compels delivery of exhaust gases from an exhaust manifold through the inlet opening 252 into the sound-attenuating unit. The portion of the tubular member 258 rearward of the outlet passage 262 may be connected with an exhaust

pipe for conveying the discharged exhaust gases rearwardly of the vehicle.

Thus the fittings **256**, associated with each of the sound-attenuating units **230** and **232**, provide a simple, yet effective, means for conveying the exhaust gases into and away from the attenuating units. It is to be understood htat the fitting arrangement **256** may be utilized with the forms of the invention illustrated in FIGURES 1 through 7.

The balancing tubes connecting the sound-attenuating units in all forms of the invention discolsed may be disposed amidship of the vehicle and adjacent the drive shaft construction **26** as shown in FIGURE 2 to obtain maximum clearance between the mufflers or sound-attenuators and the roadway. The balancing tubes may be bent downwardly at their central regions to obtain further additional clearance for the muffler constructions. The primary function of the balancing tube in all forms of the invention is to further the equalization or balancing of gas pressures or pressure impulses in the sound-attenuating units.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. An exhaust system for an internal combustion engine having dual exhaust manifolds including a pair of sound attenuating mufflers disposed in longitudinally aligned spaced relation, each of said mufflers being formed with gas inlet means and gas outlet means, pipes connecting the manifolds with the inlet means respectively, gas passage tubes in each of the mufflers disposed in parallel transversely spaced relation, transversely arranged walls in each of said mufflers forming compartments in the mufflers, the walls of the gas passage tubes being formed with a plurality of comparatively small openings, said openings forming acoustic couplings with the compartments for attenuating sound waves and accommodating transverse flow of exhaust gases through the compartments, and a single duct of lesser cross sectional area than that of either muffler connecting the spaced mufflers providing pressure balancing means between the mufflers.

2. An exhaust system for an internal combusion engine having dual exhaust manifolds including a pair of elongated mufflers disposed in longitudinally aligned spaced relation, each of said mufflers being formed with gas inlet means and gas outlet means, pipes connecting the respective manifolds with the inlet means, gas passage means in the mufflers including a tube in each muffler in registration with the inlet means, a second gas passage tube in each of said mufflers in registration with the outlet means, transversely arranged baffle means disposed in each of said mufflers forming compartments in the mufflers, the walls of the gas passage tubes being formed with a plurality of comparatively small openings, said openings forming acoustic couplings with the compartments for attenuating sound waves and accommodating transverse flow of exhaust gases in the compartments, and a single duct of lesser cross section than that of either of the mufflers connecting the spaced mufflers providing pressure balancing means between the mufflers.

3. Apparatus for attenuating sound waves of gas streams including, in combination, a pair of sound wave attenuating units arranged in longitudinally spaced aligned relation, each of said units comprising an elongated hollow shell and closures secured to the ends of the shell, each of the outer end closures of the units being provided with a gas inlet and a gas outlet, a pair of tubular gas passage means in each shell, one of said tubular gas passage means being in registration with the gas inlet and the other in registration with the gas outlet, each of the adjacent end closures of the units having an opening formed therein, a single connecting tube extending through the openings in the adjacent end closures establishing gas passage means between the units, the walls of the tubular gas passage means in each of the units being formed with a plurality of comparatively small openings forming acoustic couplings and providing for transverse flow of gases within each unit from one tubular means to the other.

4. Apparatus for attenuating sound waves of gas streams including, in combination, a pair of sound wave attenuating units arranged in spaced longitudinally aligned relation, each of said units comprising an elongated hollow shell and closures secured to the ends of the shell, each of the outer closures of the units being provided with a gas inlet and a gas outlet, gas passage tubes disposed in each shell, one of said gas passage tubes being in registration with the gas inlet and the other in registration with the gas outlet, the walls of the gas passage tubes having open areas formed therein, each of the inner end closures of the units having an opening formed therein, and a single connecting tube extending through the openings in the inner end closures establishing gas passage means between the units.

5. Sound attenuating apparatus for use with dual exhaust gas streams from an internal combustion engine of a vehicle including, in combination, a pair of sound attenuating units adapted to be disposed in aligned relation transversely of the vehicle, each of said units comprising an elongated hollow shell and closures at the ends of the shell, sound attenuating means contained within each of said units, the adjacent ends of the units being in spaced relation, openings formed in the adjacent end closures, a pressure equalizing tube registering with the openings establishing communication between the units, each of the opposite end closures of the units being provided with exhaust gas inlet and outlet openings, a tubular fitting disposed adjacent each of the opposite end closures including a tubular portion arranged normal to the axis of the adjacent unit, a pair of tubes joined with the tubular portion and extending in directions normal to the tubular portion and into the inlet and outlet openings in an end closure, and means in the tubular portion influencing the gases to flow into the adjacent unit through one of the tubes and away from the unit through the other of said tubes.

6. Sound attenuating apparatus for use with dual exhaust gas streams from an internal combustion engine of a vehicle including, in combination, a pair of sound attenuating units adapted to be disposed in aligned relation transversely of the vehicle, each of said units comprising an elongated hollow shell and closures at the ends of the shell, sound attenuating means contained within each of said units, the adjacent ends of the units being in spaced relation, a pressure equalizing tube connecting adjacent ends of the units establishing communication between the units, the outermost end closures of the units being provided with exhaust gas inlet and outlet openings, a tubular fitting disposed adjacent each of the outermost end closures including a tubular portion arranged normal to the axis of the adjacent unit, each of said fittings having a pair of tubes joined with the tubular portion and extending in directions normal to the tubular portion and into the inlet and outlet openings in an outermost end closure, and a wall in said tubular portion disposed between the regions of connection of the tubes with the tubular portion.

References Cited in the file of this patent

UNITED STATES PATENTS

2,078,420	Sheldrick	Apr. 27, 1937
2,356,782	Muller	Aug. 29, 1944

(Other references on following page)

11

UNITED STATES PATENTS

2,573,474	Marx	Oct. 30, 1951
2,614,647	Bryant	Oct. 21, 1952
2,658,580	Trembley	Nov. 10, 1953
2,692,025	Maxim	Oct. 19, 1954
2,990,028	Powers	June 27, 1961

12

FOREIGN PATENTS

187,171	Great Britain	Oct. 19, 1922
124,337	Austria	Sept. 10, 1931
506,100	Belgium	Oct. 15, 1951
1,021,641	Germany	Dec. 27, 1957
1,185,476	France	Feb. 16, 1959