March 2, 1937. G. A. KINGSLEY 2,072,372

EXHAUST SYSTEM FOR AUTOMOTIVE ENGINES

Filed Feb. 23, 1934 2 Sheets-Sheet 1

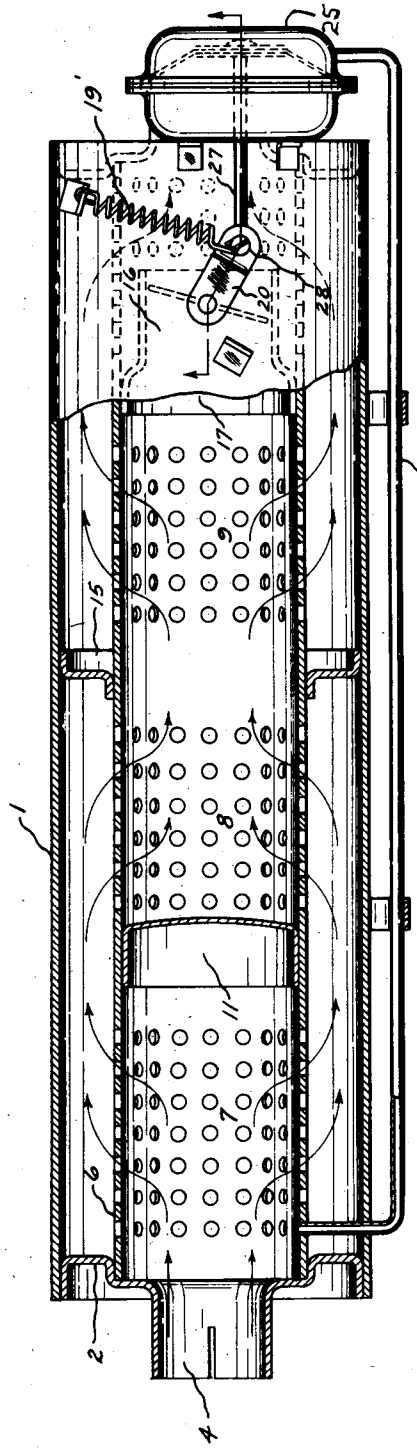

Fig. 1

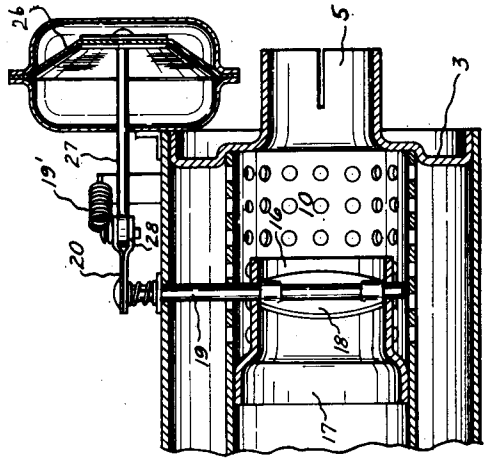

Fig. 2

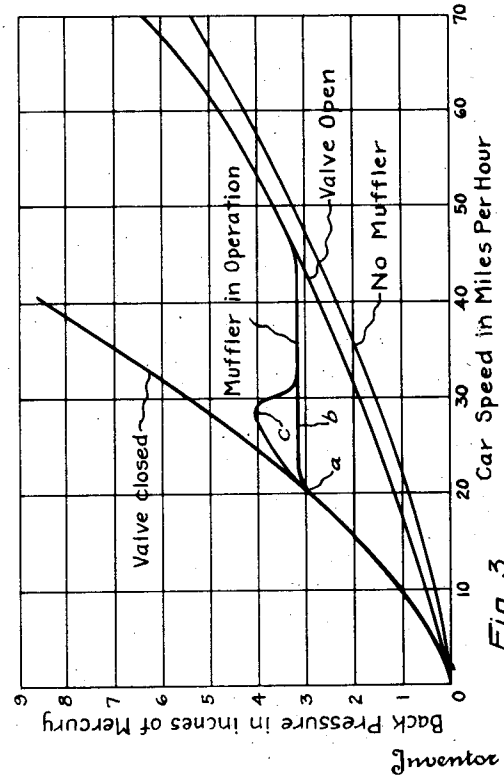

Fig. 3

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EXHAUST SYSTEM FOR AUTOMOTIVE ENGINES

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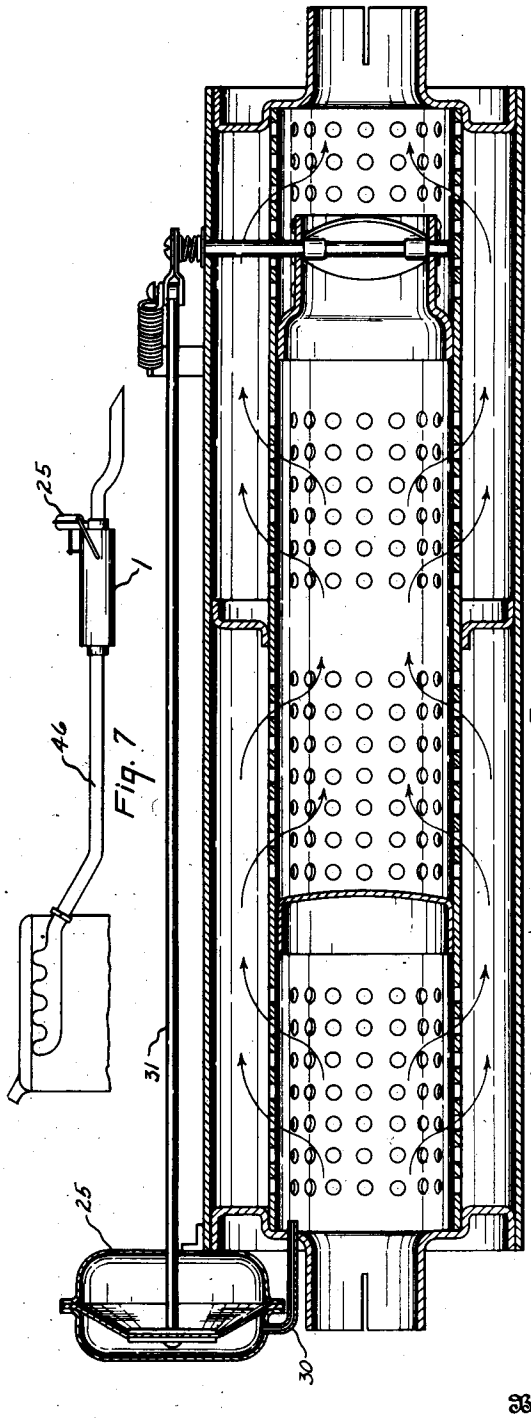

Fig. 7

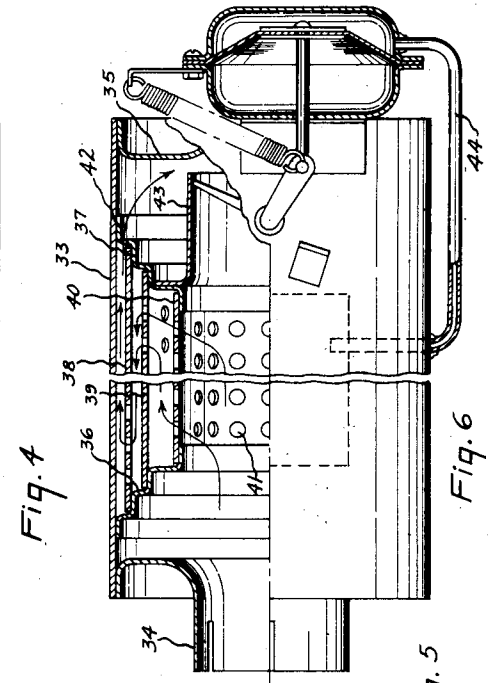

Fig. 4

Fig. 6

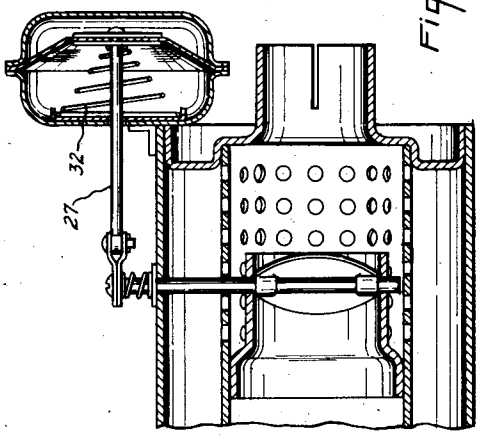

Fig. 5

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UNITED STATES PATENT OFFICE

2,072,372

EXHAUST SYSTEM FOR AUTOMOTIVE ENGINES

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Application February 23, 1934, Serial No. 712,451

13 Claims. (Cl. 181—38)

This invention relates to muffler construction for internal combustion engines and more particularly to muffler constructions in which means are provided to prevent the accumulation of back pressure resulting in excessive reduction of engine efficiency particularly at high speeds.

In the design of muffler constructions for internal combustion engines used in automotive vehicles, innumerable factors must be taken into consideration. Under normal driving conditions the engine is operative over a wide range of speeds resulting in corresponding variations in the frequency of tones to be muffled. Muffler constructions which will successfully muffle the low frequency tones at low engine speed usually produce objectionable back pressure at high engine speed. Also, when the muffler is constructed to avoid the building up of objectionable back pressure at high engine speed, it will be found that the muffling capacity is not adequate for the low frequency tones at low engine speed. Moreover, it is not uncommon in particular vehicle engines and body designs to experience at certain well defined explosive frequencies an "exhaust period" or state of resonance because of inadequate muffling capacity at these particular engine speeds. It is fully realized that commercial mufflers have been developed heretofore which will satisfactorily muffle both high and low frequency tones without the creation of objectionable back pressures. However, the construction of such mufflers has been complicated and cumbrous and relatively expensive.

Heretofore mufflers have been provided with automatically operable by-pass mechanism for releasing or regulating the back pressure in the exhaust system. Such mufflers, however, have been commercially unsatisfactory for the reason that in their operation the by-pass mechanism in its cycle of operation from closed to opened position necessarily required a proportionate increase in back pressure in the exhaust system. Furthermore, all prior constructions in their action are dependent not only on the static pressure in the exhaust system but also on the dynamic pressure due to the velocity of the gases. This results in chattering and objectionable vibration of the by-pass mechanism producing excess wear and hinders efficiency and quiet operation.

The usual exhaust conduct and tail piece for conducting the exhaust gases to the rear of the automotive vehicle are usually proportioned to sufficiently constrict the gases at high engine speed to build up adequate back pressure to satisfactorily muffle the high frequency tones without the assistance of the inserted muffler. Only at low engine speed does it become necessary to change the direction of the flow of the gases, filter, expand and otherwise treat the same in the inserted muffler in order to take out the low frequency tones. In constructions of the type exemplified by the Gaskins Patent No. 1,512,210 an unbalanced by-pass valve is provided for relieving excessive back pressure. The opening of this valve is opposed by the direct action of a spring with the result that the more the valve opens the proportionately greater the force required to open it. For this reason the inserted muffler throughout the entire range of operation of the valve, from full closed to full open, functions to produce objectionable back pressure in the exhaust system. It becomes one of the objects of the present invention to provide an exhaust system having a relatively simple, inexpensive muffler inserted therein capable of adequately muffling the low frequency tones at low engine speed; there being back pressure releasing mechanism for partially or entirely negativing the muffling action of the inserted muffler and for regulating the back pressure in the exhaust system to muffle high frequency tones at high engine speed.

Another object of the invention is to provide an exhaust system having an automatically acting pressure responsive valve to release excessive back pressure, which will not chatter in its operation.

Another object of the invention is to provide an exhaust system having automatically acting by-pass mechanism responsive only to variations in static pressure.

A further object of the invention is to provide an exhaust system in which the back pressure may be increased at one engine speed and then reduced at a higher engine speed to overcome "exhaust period" and states of resonance.

A still further object of the invention is to provide an exhaust system having a back pressure releasing valve, the opening of which is disproportionate to the back pressure and engine speed.

A still further object of the invention is to provide a by-pass mechanism in which the static pressure within the exhaust system is directed against an exteriorly located diaphragm.

These and other objects will be apparent from the following specification when taken with the accompanying drawings in which,

Fig. 1 is a plan view broken away to show a partial horizontal section through one modification,

Fig. 2 is a partial vertical section through one end of the same modification,

Fig. 3 is a chart showing comparative back pressure with and without the back pressure regulating mechanism of my invention,

Fig. 4 is a horizontal section through another modification,

Fig. 5 is a partial horizontal section of another modification,

Fig. 6 is a horizontal section through still another modification, and

Fig. 7 is a diagrammatic view of an exhaust system.

Referring to the drawings, 1 represents a cylindrical external muffler casing having a front head 2 and a rear head 3. The front head 2 has an inlet 4 and the rear head 3 has an outlet 5. Concentrically disposed within the casing 1 and between said heads is a cylinder 6 arranged so that the inlet 4 leads into it and the outlet 5 leads from it. The cylinder 6 has drilled or stamped therein four groups 7, 8, 9 and 10 of closely arranged holes. Within the cylinder 6 between group 7 and group 8 of said holes is fitted a baffle 11 to deflect gases entering the cylinder, through the holes of group 7 into the space between the cylinder 6 and the casing 1. An annular baffle 15 is placed between the cylinder 6 and the casing 1 to deflect the gases passing through the muffler back into the cylinder 6 through the holes of group 8. A restricted shortened cylinder 16 is concentrically disposed in the cylinder 6 and is secured thereto between the hole groups 9 and 10 by the bell 17 formed on one of its ends. The cylinder 16 houses a balanced butterfly valve 18 mounted on a shaft 19. The butterfly valve 18, when in closed position baffles the gases passing through the muffler back into the space between the cylinder 6 and the casing 1. From this space they are baffled by the rear head 3 back into the cylinder 6 and from there they pass through the outlet 5 into any suitable tail pipe to the atmosphere.

The butterfly valve 18 is normally held in closed position by the spring 19' acting on the lever 20. Upon an excessive exhaust pressure building up in the muffler, the pressure is transmitted by the conduit 21 to the diaphragm casing 25. Within the diaphragm casing 25 is disposed a diaphragm 26 having connected thereto for movement therewith a connecting rod 27. The free end of the connecting rod 27 is pivotally connected to the end of the lever to which the spring 19 is attached. Excessive back pressure passing through the conduit 21 to the diaphragm casing 25 fills out the diaphragm 26 which normally is held collapsed by the action of the spring 19' tending to straighten out the toggle 28 formed by the lever 20 and the connecting rod 27. Filling out of the diaphragm decreases the angle of toggle 28 and opens the butterfly valve 18. The angular relation between the spring 19' and the lever 20 of the toggle 28 is such that the effective lever arm of the lever 20 is shortened as the angle of the toggle 28 decreases and the pull of the spring increases. The relation between the respective parts may be designed to pre-load the diaphragm cracking the valve at the predetermined back pressure in the exhaust system with a substantially constant effective spring load being directed against movement of the diaphragm between full closed and full open position of the valve. Referring to the chart in Fig. 3, this arrangement would result in the valve being cracked at *a* upon the curve taken with the valve closed throughout the entire range and would maintain substantially a constant back pressure within the exhaust system as designated by the curve *b*. In the event it is found desirable to build the back pressure up in the exhaust system at a definite engine speed in order to overcome an "exhaust period" or state of resonance, the angular relation between the lever 20, the connecting rod 27, the valve 18 and the spring 19' may be designed so that the effective load of the spring 19' upon the diaphragm is greater during the initial opening of the valve 18 than during the remainder of its movement to full open position. That is, greater back pressure is required to open the valve than to hold it open and continue the movement to full open position. This is diagrammatically illustrated by the curve *c*. With this arrangement the back pressure may be permitted to build up at low engine speeds to increase the muffling capacity of the system; the back pressure being reduced during high engine speeds at which time it has the greatest effect upon the efficiency of the engine.

In the chart shown in Fig. 3, the curves were plotted from actual test run upon the conventional exhaust system, including an exhaust conduit extending from the engine manifold to the muffler proper with a suitable tail piece extending rearwardly from the muffler to the atmosphere. The curve designated "no muffler" depicts the back pressure in the exhaust system with the muffler proper removed therefrom. The curve designated "valve open" substantially paralleling that with no muffler in the system represents the increase of back pressure with the valve 18 open throughout the entire range. It is to be understood that the various curves shown in Fig. 3 and the particular operation of the exhaust system depicted thereby are merely by way of illustration and are not intended to limit the scope of the invention to any degree.

Fig. 4 discloses a modification of the invention. The difference between this modification and the embodiments disclosed in Fig. 1 is in the location of the diaphragm casing 25 which is attached to the muffler body at the inlet end of the muffler rather than at the outlet end. A short conduit 30 replaces the conduit 21 of Fig. 1 and a long connecting rod 31 replaces the short connecting rod 27. The operation is unchanged.

In the modification shown in Fig. 5 the spring 19' of Fig. 1 is replaced by a conical spring 32 coiled around the connecting rod 27. A spring of this character exerts substantially a constant load upon the diaphragm during its entire movement with the resulting constant back pressure in the system as shown by the curve *b* between full closed and full open position of the valve.

The modification of Fig. 6 is constructed to allow a straight through flow of gases when the pressure releasing valve is opened. An outside casing 33 is fitted with an inlet head 34 and an outlet head 35. Disposed within the casing 33 are supplementary heads 36 and 37 to which are connected concentric cylinders 38, 39 and 40. Stamped or drilled in the casing 40 are a plurality of holes 41. The front end of the cylinder 39 and the rear end of the cylinder 38 are provided with similar holes. A series of holes 42 are formed at the outer edge of the supplementary head 37 to permit escape of gases.

A somewhat restricted and shortened cylinder 43 is connected to the front end of the head 37 and within the cylinder 43 is disposed the balanced butterfly valve 18. The pressure responsive mechanism for operating the valve 18 is the same as that of Fig. 1. As a variation the pressure conduit 44 taps into the body of the muffler at the rear end thereof.

In Fig. 7 is diagrammatically shown an exhaust system for the engine 45 which is illustrated as

comprising an exhaust conduit 46 and tail piece 47 between which the muffler 1 is inserted.

It will be readily apparent that by locating the diaphragm casing exteriorly of the exhaust system it is not subjected to the high temperature of the exhaust, also by actuating the diaphragm solely by static pressure in the exhaust system and directing the pressure through a relatively small conduit 21, the actuation of the valve 18 is uniform and without chatter and is not effected by minor fluctuality in pressure.

Several modified types of muffler constructions have been illustrated in connection with my improved by-pass mechanism. From this it is to be understood that the invention is in no sense limited to any particular type of muffler construction for muffling the low frequency tone at low engine speed. As a matter of fact, my by-pass mechanism may be inserted at innumerable points in the exhaust system as in its broadest conception the invention resides in the release of back pressure at any point in the exhaust system through an automatic mechanism actuated solely by static pressure. For example, the by-pass mechanism might be located in the exhaust system forward of the muffler proper.

I claim:

1. In an exhaust system for internal combustion engines, means defining a passageway for conducting the exhaust gases from the engine to the atmosphere, said passageway being of such proportions as to constrict the flow of gases whereby a back pressure is created in the system substantially proportional to the speed of the engine over a certain range, means located in the system for regulating said back pressure, back pressure responsive means actuating said first means, and means resisting the activity of said pressure responsive means, the resistance of said last means being characterized by the fact that it is disproportionate to the speed of the engine over said range.

2. In an exhaust system for internal combustion engines, means defining a passageway for conducting the exhaust gases from the engine to the atmosphere, said passageway being of such proportion as to constrict the flow of gases whereby a back pressure is created in the system substantially proportional to the speed of the engine over a certain range, means located in the system for regulating said back pressure, and back pressure responsive means for actuating said first means, said last means being characterized by the fact that it requires a greater pressure during the first part of its cycle of operation than in the latter part whereby the back pressure is reduced below its maximum with said range.

3. In a muffler, the combination of a body, a balanced back pressure releasing valve associated with said body, means to operate said valve, said means including a diaphragm operably connected to said valve, and means to transmit the back pressure in said body to said diaphragm.

4. In a muffler, the combination of a body, a back pressure releasing valve associated with said body and fixed to a rotatable shaft, a lever rigidly fixed to said shaft, a casing communicating with said body, a diaphragm in said casing, a connecting rod attached at one end of said diaphragm for movement therewith and pivotally connected at the other end to said lever to form a toggle therewith, and means tending to hold said diaphragm in collapsed position and said valve in closed position.

5. In an exhaust system for internal combustion engines, the combination of a muffler, a balanced back pressure releasing valve associated therewith and static pressure responsive means to operate said valve.

6. In an exhaust system for internal combustion engines, the combination of a muffler, a balanced back pressure valve associated therewith, a casing, pressure responsive means in said casing, an operative connection between said pressure responsive means and said valve, and means for conducting the static pressure of the system to said casing.

7. In a muffling system for internal combustion engines, means including a pressure releasing valve to baffle exhaust gases in their passage from an engine to the atmosphere and means responsive to the static pressure but non-responsive to the dynamic pressure of the system to control said valve.

8. In a muffler, the combination of a body, a balanced back pressure releasing valve associated with said body and means responsive to the static pressure but non-responsive to the dynamic pressure in said body to operate said valve.

9. In a muffling system for internal combustion engines, a muffler, a back pressure releasing valve associated therewith fixed on a rotatable shaft, a lever connected at one end to said shaft, a casing, pressure responsive means therein, a connecting rod attached at one end thereof to said pressure responsive means for movement therewith and at the other end thereof to said lever to form an angle therewith, means tending to prevent a decrease in the size of said angle and a conduit for conducting the back pressure of said system to said casing.

10. In an exhaust system for internal combustion engines, the combination of a muffler, a balanced back pressure releasing valve associated therewith, means responsive to a pressure within the system for opening said valve, and means resisting the opening of said valve, said means being characterized by the fact that the resistance exerted thereby is disproportionate to the speed of the engine.

11. In an exhaust system for internal combustion engines, a conduit for conducting the exhaust gases from the engine to the atmosphere, said conduit being proportioned to sufficiently modify the flow of gases to muffle tones of a high frequency range accompanying high speed operation of the engine, muffler means associated with said conduit for increasing the muffling capacity of the exhaust system to muffle tones of lower frequency range accompanying lower speed operation of the engine, regulating means for varying the muffling action of said muffler means, and control means for actuating said regulating means, said control means being actuated by and directly responsive to pressure within the system.

12. In an exhaust system for internal combustion engines, the combination as provided in claim 11 wherein the control means is responsive only to static pressures in the system.

13. In an exhaust system for internal combustion engines, the combination as provided in claim 11 wherein the control means is located exteriorly of the exhaust system.

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