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ENGINE MUFFLER

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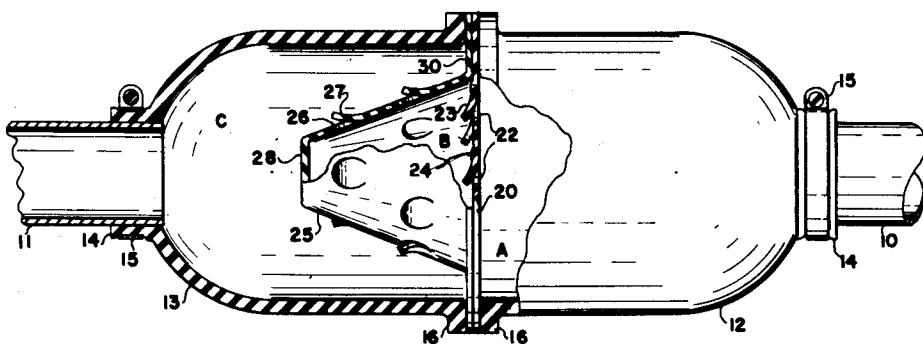


**Fig. 1**

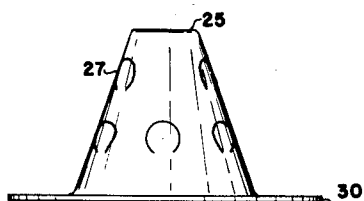


**Fig. 3**

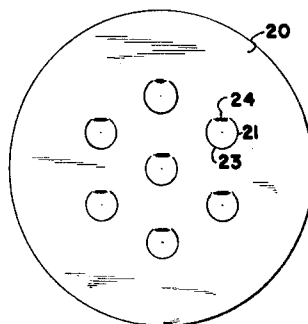


**Fig. 2**

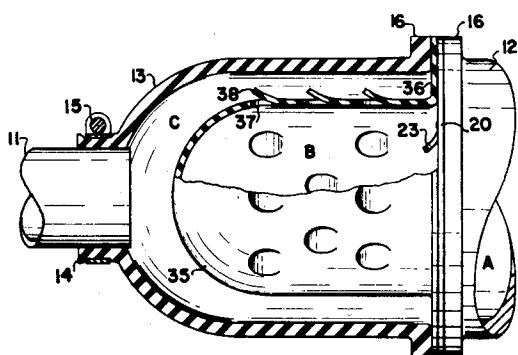


**Fig. 4**

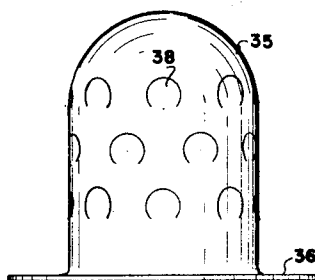


**Fig. 5**

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## ENGINE MUFFLER

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2 Claims. (Cl. 181—39)

This invention relates to improvements in exhaust mufflers and silencers for internal combustion engines.

In a piston type internal combustion engine, the exhaust gases are discharged from the engine cylinders, one after another, in a continuous series of loud explosions. The frequency of the explosions varies widely with variations in the engine speed, and the noise level varies more or less in accordance with the engine speed and load. Conventional mufflers are only partially effective in eliminating the noise nuisance because, as the silencing function is improved, the back pressure on the engine is increased to an objectionable degree, with the result of impairing the performance of the engine, particularly at high speeds when there is a high rate of gas flow through the muffler. Conventional mufflers cannot adjust themselves to different operating conditions of the engine, but must be designed to effect a compromise between the desired degree of silencing of the engine exhaust and an objectionably high back pressure condition. Conventional mufflers also have a relatively short life as a result of corrosion, particularly in marine use where the engine cooling water is discharged through the muffler.

The general object of the present invention, therefore, is to provide an improved exhaust muffler for internal combustion engines which is more effective in silencing the explosion noise level without imposing objectionable back pressure on the engine and which is not subject to corrosion.

Another object is to provide a muffler which automatically adjusts itself to the operating condition of the engine so as to function more effectively under different speed and load conditions.

Another object is to provide a muffler having a resilient outer shell and a plurality of resilient baffles which are readily yieldable and distortable to absorb a part of the energy of noise producing pressure waves and dissipate such energy silently before the exhaust gases are discharged to atmosphere.

Another object is to provide a muffler having an intermediate chamber equipped with resilient inlet and outlet valves for attenuating the explosion impulses from an engine.

Another object is to provide a muffler having a plurality of ported baffles equipped with clapper valves to control the flow of gases.

Another object is to provide an improved all rubber muffler having no metal parts.

The invention will be better understood and these and other objects will become apparent from the description of certain preferred embodiments illustrated on the accompanying drawing. Various changes may be made in the construction and arrangement of parts, however, and all such modifications within the scope of the appended claims are included in the invention.

In the drawings:

Figure 1 is an elevation view, with parts in section and other parts broken away, showing one form of muffler embodying the principles of the invention;

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Figure 2 is an elevation view of a baffle plate in the muffler of Figure 1;

Figure 3 is an elevation view of a baffle cone in the muffler of Figure 1;

Figure 4 is a fragmentary elevation view, with some parts in section and others broken away, showing a modified form of construction; and

Figure 5 is an elevation view of the baffle cylinder in Figure 4.

In Figure 1, the numeral 10 designates an engine exhaust pipe, as, for example, in connection with an engine in a boat. The numeral 11 designates a tail pipe which, in the case of a marine installation, may project through the transom of the boat either above or below the water level. The muffler is connected between the engine exhaust pipe 10 and tail pipe 11, and, in addition to the exhaust gases from the engine, the muffler must also convey the engine cooling water which is introduced into exhaust pipe 10 ahead of the muffler. In the usual small boat installation, the muffler is disposed horizontally as shown in Figure 1.

The muffler comprises two identical molded rubber shell members 12 and 13, neoprene being a suitable type of rubber for the present purpose. In Figure 1, the shell members are cylindrical in cross section, but they may be flattened into an elliptical shape, if desired, in order to fit the space requirements beneath a deck or other confining structure. In any event, each shell member is equipped with a cylindrical neck 14 to fit the exhaust pipe or tail pipe, so that such neck may be secured thereon by a clamp 15 of the general nature of an ordinary hose clamp. On the other end of each shell member there is a peripheral outstanding integral flange 16. The space within shell 12 is designated as chamber A and the space within shell 13 is designated as chamber C.

The numeral 20 designates a circular rubber baffle plate having the same diameter as shell flanges 16. Baffle plate 20 is cut at 21 with a sharp arcuate die to form a plurality of circular ports 22 with clapper valves 23. The die does not cut out a complete circle, and so leaves a connecting portion 24 at one side of the circular port forming a hinge for the valve. Valves 23 are preferably hinged at their top edges to facilitate the discharge of cooling water, and the hinge portions 24 are thickened by relieving the mold at these points to impart additional strength in the bending section.

Numeral 25 designates a molded rubber baffle cone having similar ports 26 equipped with clapper valves 27. In the present embodiment, the cone is truncated and has a solid end wall 28 without any port. Molded integrally with the base of the cone is a base flange 30 having the same diameter as baffle plate 20 and flanges 16. The space within cone 25 forms an intermediate chamber B.

The baffle plate 20 and baffle cone 25 are assembled and cemented or vulcanized between the flanges 16 of the two shell members 12 and 13 as shown in Figure 1. Baffle plate 20 faces the engine exhaust pipe 10, and baffle cone 25 projects in a downstream direction into shell 13 which is connected with the tail pipe 11. The natural resilience of the rubber normally holds clapper valves 23 and 27 closed, and, if desired, these valves may be constructed to close the ports 22 and 26 against the entrance of sea water in cases where the tail pipe 11 is submerged. Valves 23 and 27 ordinarily need not be water-tight, however, since exhaust pipe 10 usually rises to a height considerably above water level before it connects with the engine.

When the engine is started, the pressure and flow of exhaust gases push the valves 23 and 27 open slightly, as shown in Figure 1 which is illustrative of a running

condition under light load at moderate speed. When the engine is idling, the valves 23 and 27 may pulsate under the impact of each explosion wave entering the muffler, opening to allow the explosion wave to pass through, and then closing after it has passed. At higher speed, the explosion waves come in such quick succession as to prevent closing of the valves 23 and 27, but, nevertheless, they are free to pulsate with variations in pressure so that the ports are never open wider than necessary to permit the pressure waves to pass through without undue restriction and imposition of back pressure in exhaust pipe 10.

A considerable portion of the explosion energy in the exhaust gas is absorbed silently in chamber A by the resilience of the first shell 12, this shell being observed to dilate and contract in a pulsating movement in rhythm with the engine explosions. Baffle plate 20, constituting a ported wall or diaphragm at the end of chamber A likewise pulsates and absorbs energy from the pressure waves in chamber 12. After the pressure waves in shell 12 have lost a portion of their energy through work done on the resilient shell and baffle plate 20, the waves are broken up in passing through ports 22, and the action is repeated in chamber B within cone 25. This cone also pulsates and absorbs energy from the explosion waves, and the waves are further broken up and the gases discharged more gradually through ports 26 into chamber C in shell 13. Shell 13 also pulsates and absorbs more energy from the explosion waves, allowing them to escape into tail pipe 11 in a greatly attenuated, almost steady flow without objectionable explosion noise. The thickness of rubber in the shell walls and baffles 20 and 25 provides in the aggregate a sufficient mass of resilient material appropriately disposed and arranged to absorb the explosion energy efficiently and silently.

Figure 4 shows a modified form of construction for larger engines. In this case, the central chamber B is formed by a domed cylindrical rubber baffle member 35 having a peripheral base flange 36 whereby the baffle member may be secured between the two shell members 12 and 13, as before. The cylindrical wall of baffle 35 has space for a larger number of ports 37 which are normally closed by clapper valves 38, these valves being shown in Figure 4 in the partially open position they would assume while the engine is running. When cylindrical baffle 35 is used, the plate baffle 20 may be provided with a larger number of ports 22 and clapper valves 23 to accommodate the higher rate of gas flow without producing back pressure. Preferably, there are no ports in the hemispherical end of baffle 35 whereby each advancing pressure wave is required to change direction several times in passing through chambers B and C.

The chambers A, B and C in both embodiments constitute a series of expansion chambers wherein each pressure wave is gradually reduced substantially to atmospheric pressure before being released to atmosphere. The clapper valves provide individual resilient baffles at each port which are more effective than open ports in reducing the pressure gradually and which, at the same time, do not produce as much back pressure on the

engine as the rigid labyrinth type of baffle arrangement in conventional mufflers.

Not only does the rubber material of the muffler reduce the noise level of the exhaust explosions by absorbing energy from the explosions and breaking them up into small gas flows, but it also inhibits the propagation of objectionable sound from the muffler shell itself. Whereas a metal muffler shell acts as a sounding board to amplify and transmit sound, a rubber shell has sound deadening acoustic properties which still further enhance the silencing effect. In a marine installation, the inclusion of cooling water with the exhaust gases, instead of shortening the life of the muffler as in the case of metal mufflers, actually extends the life of the present muffler by preventing the attainment of temperatures above 212° F. which might be injurious to the rubber over a period of time.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A muffler for an internal combustion engine comprising a pair of peripherally flanged rubber end shells, a flat transverse rubber baffle plate secured between the flanges of said two shells, a cup shaped rubber baffle member extending into one of said shells and having a peripheral rim flange secured between said shell flanges, ports in said baffle plate and the side wall of said baffle member, and clapper valves in said ports integral with said plate and said member, said valves being hinged on the upper sides of the ports in said baffle plate and on the upstream sides of the ports in said baffle member.

2. An all rubber muffler for an internal combustion exhaust comprising a pair of cylindrical rubber end shells, each shell having a peripheral flange on one end and a reduced neck on the other end for connection with an exhaust pipe, a flat transverse rubber baffle plate secured between the flanges of said two shells, a cup-shaped rubber baffle member extending into one of said shells and having a peripheral rim flange secured between said shell flanges, said baffle member having a side wall facing the cylindrical wall of said one shell for a distance longitudinally of said one shell, a plurality of ports distributed over the area of said plate, and a plurality of ports in said side wall distributed longitudinally and circumferentially thereof, said end shells being resiliently expansible outwardly by the pressure of exhaust gases in the muffler except in said end flanges, said end flanges being restrained against outward expansion by said baffle plate.

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