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DEVICE FOR CATALYTICALLY PURIFYING EXHAUST GASES

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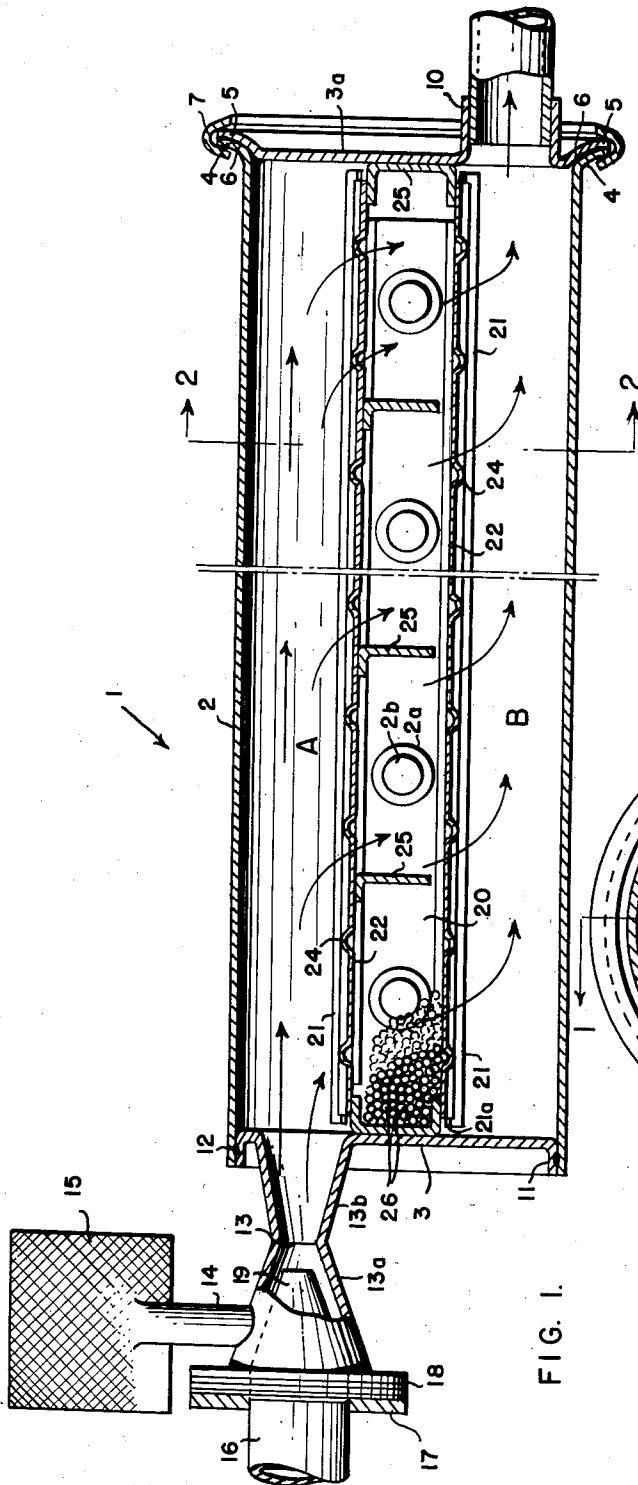


FIG. 1.

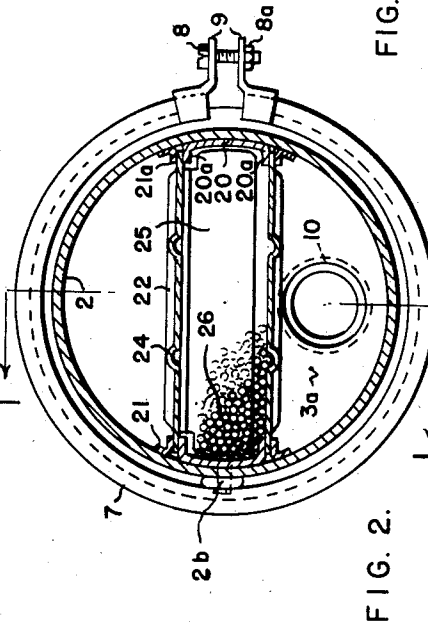


FIG. 2.

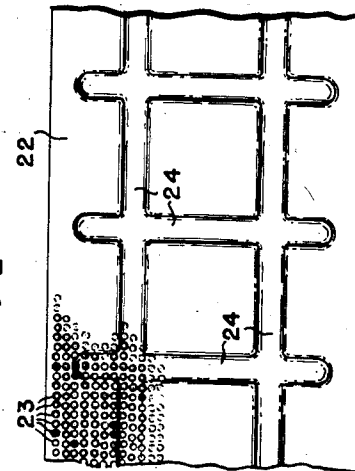


FIG. 3.

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**DEVICE FOR CATALYTICALLY PURIFYING
EXHAUST GASES****Eugene J. Houdry, Ardmore, Pa., assignor to Oxy-Catalyst, Inc., a corporation of Pennsylvania****Application February 4, 1954, Serial No. 408,175****4 Claims. (Cl. 23—288)**

This invention relates to catalytic apparatus of the type suitable for attachment to the exhaust outlet of an internal combustion engine for eliminating toxic and obnoxious components of the exhaust gases therefrom by catalytic oxidation.

An extremely vexatious problem in catalytic devices used for the purification of internal combustion engine exhaust gases is that connected with thermal expansion and contraction of the components of such devices. Catalytic mufflers, as they are commonly termed, purify exhaust gases by oxidizing the toxic and obnoxious components thereof such as carbon monoxide and hydrocarbons. The oxidation reactions which effect this purification take place within the muffler housing and are, of course, highly exothermic. The heat liberated by the reactions is dissipated in part through the metallic structural components of the muffler which, as a result, attain elevated temperatures while the device is in operation. Moreover such mufflers require a plurality of parts, for example, an external housing and a means within the housing to contain the bed of catalytic material, which attain elevated temperatures of varying magnitude while the catalytic operations proceed. Finally since in ordinary operation the speeds of internal combustion engines, and particularly automotive engines, is varied over wide ranges, the amount of heat liberated within the muffler per unit of time will also vary over wide ranges.

The cumulative effect of the above mentioned conditions is that in ordinary operation of the muffler its structural components will tend to expand and contract relative to each other at varying rates and to varying degrees. If provision is not made to permit such expansion and contraction, undesirable thermal stresses will be imposed upon the muffler which will cause warping and even failure of the parts.

In the copending application of Eugene J. Houdry, Serial Number 318,382, for Catalytic Apparatus, filed November 3, 1952, now Patent 2,776,875, there is disclosed one type of catalytic device which obviates the thermal expansion and contraction problem. In the apparatus there disclosed catalyst-containing trays are secured to a beam which is mounted within the muffler housing. The beam itself is carried by the housing in such manner that it may expand and contract independently of the housing thus precluding the possibility of thermal stresses between these two members. Also in the Houdry application Serial Number 318,382 the beam acts as a rigid support for the relatively thin gage catalyst-containing trays. By virtue of this rigid support afforded the trays the Houdry invention is particularly adapted to relatively large catalytic mufflers.

The present invention constitutes an alternative to the Houdry device in that it provides sufficiently rigid support for the catalyst-containing trays without recourse to an intermediate support such as a beam. Our device is particularly, but not exclusively, adapted to relatively small mufflers and provides a structure in which the parts are

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free to thermally expand and contract. Furthermore our device provides a structure which is highly efficient in purifying exhaust gases.

It is accordingly one of the objects of the present invention to provide a catalytic muffler in which catalyst-containing trays are carried directly by the muffler housing.

It is a further object of the present invention to provide a catalytic muffler which will accomplish substantially complete oxidation of the exhaust gases and in which bypass of the catalytic bed by the exhaust gases will be obviated.

It is a further object of the present invention to provide a catalytic muffler in which catalyst-containing trays mounted therein are free to expand and contract under the influence of extreme temperature variations independently of the housing of the apparatus.

Further objects of this invention will be apparent from the following description and from the annexed drawings in which:

Fig. 1 is a longitudinal sectional view of one embodiment of the invention taken along the lines 1—1 of Fig. 2.

Fig. 2 is a cross-sectional view taken along the lines 2—2 of Fig. 1.

Fig. 3 is a fragmentary plan view of a foraminous tray of the type usable with my invention.

Referring to Figs. 1 and 2, the preferred embodiment of the present invention comprises a housing 1 consisting of an elongated cylindrical shell 2, the open ends of which are closed by end plates 3, 3a. A series of aligned filling holes 2a provided in the shell member 2 permit charging of the device with catalytic particles. These openings are closed by removable plugs 2b such as threaded plugs or expansible rivet type plugs. The right hand end of the shell 2, as viewed in Fig. 1, is provided with a radially extending peripheral flange 4 which abuts a complementary offset peripheral flange 5 on end plate 3a. Gasketing 6 interposed between these flanges provides a substantially pressure tight relationship between the shell member 2 and end plate 3a. A removable U-shaped split clamping member 7 (Figs. 1 and 2) straddles the flanges 4 and 5 and clamps the end plate to the shell member. The split ends of this clamping member are connected by means of an adjustable connection 8, 8a (Fig. 2) in the form of a machine screw and nut which cooperate with perforate ears 9 on the split ends of the clamping member 7. End plate 3a is provided with an outlet 10 which conducts oxidized exhaust gases to the atmosphere. By virtue of the split clamping member, end plate 3a can be easily removed when it is necessary to disassemble the apparatus.

End plate 3, shown at the left hand side of Fig. 1, is provided with a reversed peripheral flange 11 which abuts the internal surface of shell member 2. This flange is welded or otherwise permanently secured to the shell member, a continuous seam weld 12 being provided in my embodiment of the invention.

An inlet 13 provided on the face of this end plate permits the entry of unoxidized exhaust gases into the catalytic apparatus. The inlet 13 is provided with a converging portion 13a and a diverging portion 13b. An air inlet 14 capped with an air filter 15 conducts fresh air from the atmosphere into the converging inlet portion 13a. The exhaust pipe 16 from the engine manifold terminates in a circular flange 17 which is secured, as by welding or bolting, to a flange 18 provided on the base of the diverging portion 13a of the inlet. A nozzle 19 is secured to flange 18 and projects within converging portion 13a of the inlet. Aligned bores in the flanges 17, 18 permit the passage of exhaust gases through the pipe 16, nozzle 19 and inlet portions 13a, 13b. The inlet portions 13a, 13b, nozzle 19 and air inlet 14 constitute

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an inspirator working on the venturi principle, the fresh air being drawn through the inlet 14 due to the momentum of the exhaust gases passing through the nozzle and into the shell member 2.

The interior of shell member 2 is provided with guideways defined by channel shaped members 20 and angle members 21 as shown in Fig. 2. The base of each channel member is secured, as by welding to the internal surface of shell member 2, parallel to the axis thereof. In the disclosed embodiment of the invention two channel members are mounted within the shell 2 in opposed relationship. The angle members 21 are secured as by welding to the internal surface of the shell member spaced from, but parallel to, the channel members. The guideways are thus defined by the sides 20a of the channel members and the sides 21a of the angle members. As is apparent from Fig. 2 the disclosed embodiment of the invention is provided with four guideways which are defined by two channel members 20 and four angle members 21.

As also shown in Fig. 2, the guideways are arranged in opposed sets with each set receiving the longitudinal edges of a foraminous tray 22. The edges of the trays are received in the guideways in a slidable relationship which is sufficiently tight to restrain the trays from rattling. The longitudinal edges of the trays do not contact the internal wall of the shell 2, as shown in Fig. 2, but are retained solely by the guideways. As best seen in Fig. 1 the trays extend longitudinally within housing 1 for a distance substantially equal to but less than the length of the housing. The trays are preferably formed of relatively thin stainless steel or other high temperature alloy and are perforated over their entire areas with small diameter holes (of which only a few are shown in Fig. 3 in the interest of clarity). Stiffening ribs 24 are pressed into the trays in order to enhance the rigidity of these members. These ribs, as shown in Fig. 1, form protrusions on one side of the tray and channels or depressions on the other side thereof. The trays are preferably mounted within shell member 2 with the protrusions of these ribs projecting away from each other, or in other words, with the protrusions of the ribs protruding away from rather than into the space between the trays.

Divider plates 25 mounted within the space between the opposed trays 22 divide this space into a plurality of compartments. In the embodiment shown these plates are secured to the upper tray 22 shown in Fig. 1 and extend into the space between the trays but do not contact the lower tray of Fig. 1. As shown in Fig. 2 these plates extend laterally within the housing a distance less than the width of the housing so that the edges of the plates 25 do not contact the channel members 20.

The divider plates 25 and their function are fully described in application Serial Number 438,423, filed by Eugene J. Houdry on June 22, 1954, for Catalytic Exhaust Purifier.

End plates 3 and 3a are provided with channel members 25 secured, as by welding or bolting, to their opposed faces. The sides of these channel members extend within the space between the opposed trays 22 and abut the opposed faces of these trays. This relationship permits the trays to expand longitudinally within the housing but at the same time provides a seal between the lateral edges of the trays 22 and the end plates 3, 3a.

In the operation of the device the space between the opposed trays 22 is substantially, but not completely, filled with particles of a catalytic substance as indicated by reference numeral 26, Figs. 1 and 2. The exhaust gases from an internal combustion engine are conducted from the manifold through pipe 16 and nozzle 19 where they are mixed with fresh air drawn in through air inlet 14. The mixture of fresh air and exhaust gases then passes through inlet 13 into the upper chamber, designated by the letter A of the apparatus and distribute

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themselves throughout this chamber. The gases then pass through the holes in foraminous trays 22, through the bed of catalytic particles and into the lower chamber, designated by the letter B, of the apparatus from whence they are exhausted to the atmosphere through outlet 10.

In passing through the bed of catalyst particles the gases undergo an exothermic reaction in which the highly obnoxious and toxic carbon monoxide and hydrocarbons are oxidized to produce an innocuous mixture of carbon dioxide, water vapor and the usual inert gases contained in the atmosphere. Since the raw manifold exhaust gas is mixed with free oxygen by the inspirator the reactions go to substantial completeness and the usual objectionable components of the exhaust gases are virtually entirely eliminated.

It is important that the catalyst bed extend throughout the entire area through which the exhaust gases must pass. Crevices between the borders of the catalyst bed and the internal wall of the shell would permit a substantial portion of the gases to escape oxidation thus impairing the efficiency of the device, particularly since such crevices would permit "channeling" of gases therethrough. The pressure drop across such a crevice would be relatively lower than the pressure drop across the bed of catalyst material which would cause a correspondingly higher percentage of the gases to flow through the crevice and thus escape the effect of the catalyst. As shown by the drawings the catalyst bed occupies the entire area bordered by the channel members 20, 25 and these members are in turn secured to the shell member 2. Any channeling of the gases is thus impossible and all exhaust gases passing through the apparatus are forced to flow through the bed of catalyst particles.

Any suitable oxidation catalyst, capable of operation at temperatures in the range of about 500° F. to 1800° F. may be employed. It is understood, of course, that the invention is not limited to any particular type of catalyst. One type of catalyst which has been found to be particularly suitable, however, consists of pellets of activated alumina approximately $\frac{1}{8}$ " or $\frac{1}{16}$ " in diameter, and of about the same length, impregnated with about 0.4% by weight of platinum.

The reactions fostered by my apparatus are, as noted above, exothermic which means that the gaseous mixture expelled from my apparatus contains considerably more sensible heat than the raw, unoxidized gases of the internal combustion engine exhaust. Furthermore, the parts of the apparatus, particularly the trays and the housing, are heated to extremely high temperatures as a result of the passage of these oxidized gases.

Some indication of the effect of these exothermic reactions can be appreciated from the following considerations. With the type of catalyst described above, the temperature of the catalytic bed may vary between extremes of 500° F. to 1800° F. The temperature of the exterior skin of the shell member 2 may vary between extremes of 250° F. to 750° F. The foraminous trays 22 and particularly the lower tray as viewed in Fig. 1, will operate at a temperature which will approach the temperature of the catalyst bed. As the engine speed is varied the volume of exhaust gases passing through the apparatus is correspondingly varied which means that varying quantities of heat will be liberated. For example, if the engine speed is increased the volume of gases passing through the catalytic bed will be increased and the trays will be rapidly heated causing them to abruptly expand. If the engine speed is decreased, the reverse effect will result and the trays will contract. The temperature of the gases in the upper zone A of the apparatus will usually be lower than the temperature of the gases in the lower zone B since the sensible heat of the gases in zone B, as compared with zone A, has been greatly increased as a result of the oxidation of carbon monoxide and hydrocarbons in the raw (unoxidized) exhaust gases.

The foregoing discussion emphasizes the need in cata-

lytic mufflers for structures capable of withstanding severe thermal gradients in their different components. Particularly, the trays must be mounted within the housing member in such manner that these trays are free to expand and contract independently of the housing. At the same time the relationship between the trays and the housing must be such that substantially all of the exhaust gases pass through the bed of catalyst particles contained between the opposed trays. For reasons explained above, the gases must not be permitted to channel through crevices such as might exist between the internal surface of the housing and the borders of the catalytic bed.

The instant invention provides a catalytic apparatus which is simple and economical to manufacture and which in addition possesses the qualities necessary to devices of this type. The tray members 22 of this invention, since they do not contact the interior surface of the housing are free to expand and contract as the temperature of the device is raised or lowered. The bed of catalyst particles extends over the entire area through which the exhaust gases must pass and the edges of this bed are sealed by channels 20 and members 25 so that no unoxidized gases will be expelled to the atmosphere.

While I have disclosed the preferred embodiment of the invention I contemplate the substitution of various equivalent structures as being within its scope. For example, the guideways might be provided as a plurality of ledges formed integrally with the housing by merely forming indentations running the entire length thereof. Alternatively each guideway might be provided in the form of a single channel member secured to the internal surface of the shell 2 and receiving the edges of trays 22 between its sides. I have disclosed two foraminous trays mounted within the housing and one bed of catalyst particles therebetween. However, it is within the scope of the invention to provide more than two trays in order to provide a plurality of beds of catalyst particles.

Other modifications within the scope of my invention will be apparent to those skilled in the art to which it appertains.

I claim:

1. Catalytic apparatus suitable for attachment to the exhaust outlet of an internal combustion engine for oxidizing toxic and obnoxious components of the exhaust gases therefrom comprising a housing, two pairs of guideways arranged opposite one another on the lateral internal walls of said housing, the guideways of each pair being spaced vertically from one another and each extending along substantially the entire length of said housing, a pair of flat foraminous trays carried by said guideways, each guideway providing a narrow U-shaped slot to slidably receive an edge of one of said trays, said pair of trays extending along substantially the entire length of said housing and being supported in parallel spaced-apart relationship in said U-shaped slots, the space enclosed between said trays and the walls of said

housing providing a container for receiving a layer of catalyst particles, the width of each tray being slightly less than the lateral distance between the bases of the U-shaped slots provided by oppositely arranged guideways supporting said tray, whereby said trays are free to expand and contract independently of said housing and said guideways in response to the high and variable temperature existing in the bed of catalyst particles during operation of said purifier.

2. Catalytic apparatus in accordance with claim 1 in which said flat foraminous trays are provided with intersecting longitudinal and lateral stiffening ribs.

3. Catalytic apparatus suitable for attachment to the exhaust outlet of an internal combustion engine for oxidizing toxic and obnoxious components of the exhaust gases therefrom comprising a housing, said housing comprising an elongated shell, the ends of said shell being closed by end plates, two pairs of guideways arranged opposite one another on the lateral internal walls of said shell, the guideways in each pair being spaced vertically from one another and each extending along substantially the entire length of said shell, a pair of flat foraminous trays carried by said guideways, each guideway providing a narrow U-shaped slot to slidably receive an edge of one of said trays, said pair of trays extending along substantially the entire length of said shell and being supported in parallel spaced-apart relationship in said U-shaped slots, U-shaped sealing members carried on and extending across the width of the internal face of each end plate, the legs of said U-shaped sealing members extending horizontally between and in snug face-to-face sliding relationship with the end portions of said spaced-apart flat foraminous trays, the space enclosed between said trays, the lateral walls of said shell, and said U-shaped sealing members providing a container for receiving a layer of catalyst particles, the width of each tray being slightly less than the lateral distance between the bases of the U-shaped slots provided by oppositely arranged guideways supporting said tray, whereby said trays are free to expand and contract independently of said shell, said guideways, and said sealing members in response to the high and variable temperatures existing in the bed of catalyst particles during operation of said purifier.

4. Catalytic apparatus in accordance with claim 3 in which said flat foraminous trays are provided with intersecting longitudinal and lateral stiffening ribs.

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