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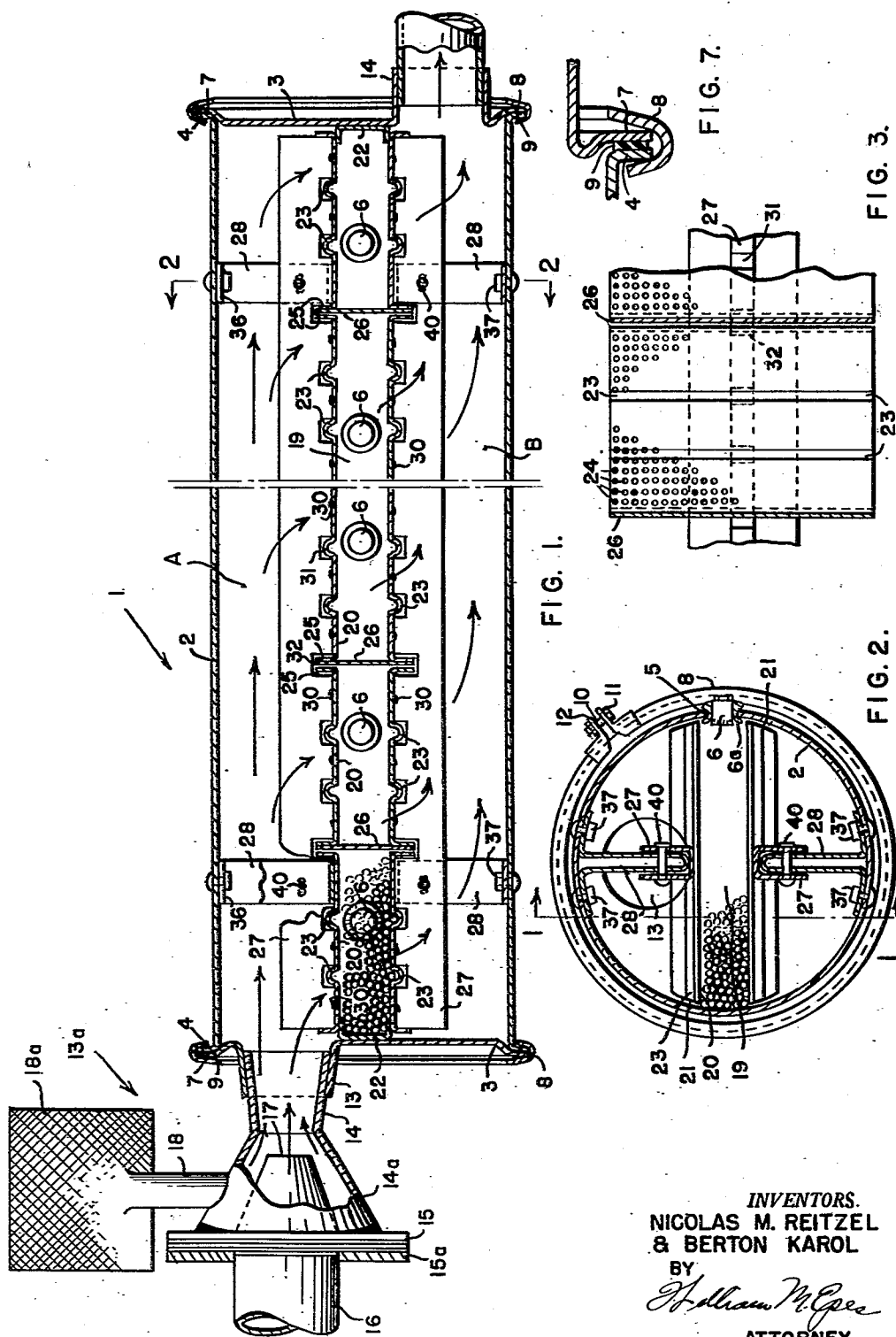
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2,795,488

CATALYTIC DEVICE

Filed Jan. 27, 1954

2 Sheets-Sheet 1



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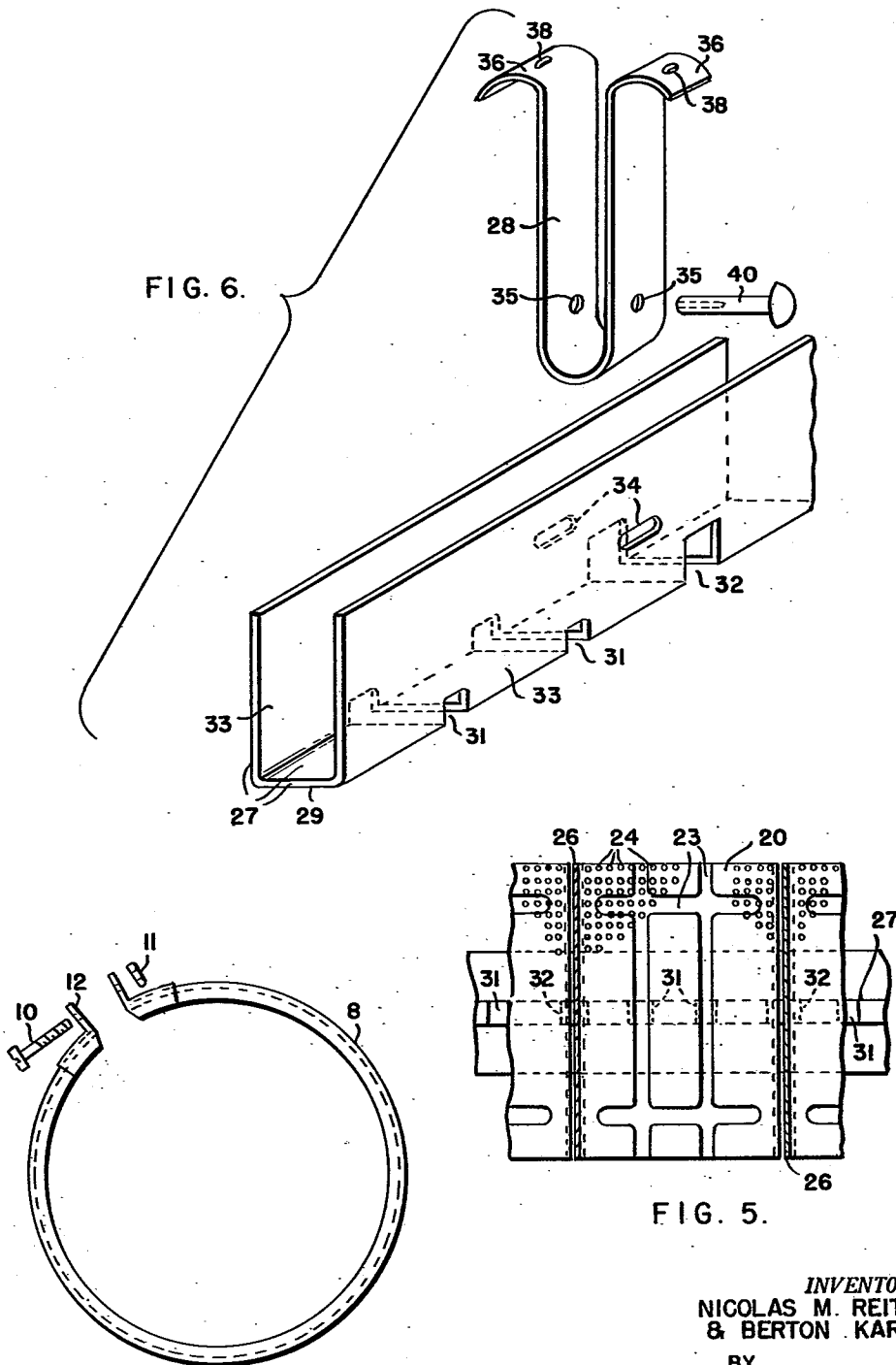
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CATALYTIC DEVICE

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Application January 27, 1954, Serial No. 406,442

9 Claims. (Cl. 23—288)

Our invention relates to catalytic apparatus of the general type disclosed in the copending application of Eugene J. Houdry, Serial Number 318,382 for Catalytic Apparatus, filed November 3, 1952. In many respects our invention provides improvements to the basic Houdry apparatus while other aspects of our invention are applicable to catalytic mufflers in general.

In the aforementioned Houdry application there is disclosed a catalytic apparatus for attachment to the exhaust manifold of an internal combustion engine for oxidizing toxic and obnoxious components of the exhaust gases therefrom. Generally speaking, this Houdry apparatus comprises a housing, closed at the ends by end plates, which contains a relatively thin bed of catalytic material which bed is confined between foraminous trays. The catalyst containing trays are mounted on beams carried in turn by the housing in such manner as to permit thermal expansion and contraction of the beams independently of the housing.

It is one of the objects of the present invention to provide an improved beam construction of the general type disclosed in the aforementioned Houdry application.

It is a further object of the present invention to provide an improved arrangement for the catalyst-containing foraminous trays which will afford improved efficiency in the operation of the muffler.

It is further object of the invention to provide an improved and more economical construction for the end plates affording easier access to the interior of the muffler.

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

Fig. 1 is a cross-sectional side view, with parts broken away, of an embodiment of the invention taken along the lines 1—1 of Fig. 2.

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

Fig. 3 is a fragmental plan view of a tray of a type usable in our apparatus.

Fig. 4 is a plan view of an end plate clamping member.

Fig. 5 is a view, similar to Fig. 3 showing a modified form of tray.

Fig. 6 is an exploded perspective view showing a mounting member, a portion of a beam, and a connecting pin.

Fig. 7 is a fragmentary sectional view showing details of the relationship between a housing shell and end plate of the preferred embodiment.

Referring to Fig. 1, our apparatus comprises a housing, indicated generally by reference numeral 1, catalyst containing means and mounting means for the catalyst containing means.

The housing is composed of a shell member 2, end plates 3 and clamping members 8, also shown in Fig. 4. The shell is preferably, but not necessarily, of cylindrical shape and is provided with a plurality of aligned openings 5 which are closed by plugs 6 as shown in Fig. 2. These openings permit recharging of the catalyst bed from the outside of the housing without disassembly

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thereof. In the preferred embodiment of our invention the plugs are provided in the form of expansible rivets which cooperate with gaskets 6a to seal the openings but any alternative type of plug, such as a threaded plug, may be employed. The edges of the shell are flared to provide radially extending flanges 4. The end plates 3 conform to the cross sectional shape of the shell and are provided with peripheral portions in the form of offset flanges 7 which abut the shell flanges 4. A U-shaped split clamping member 8 (Figs. 1 and 4) is provided for each end plate to straddle the end plate and shell flanges and hold them in airtight relationship which may be enhanced by the interposition of gasketing 9, as clearly shown in Fig. 7. An adjustable connection is provided to connect the two ends of the clamping member across the split portion thereof which in the embodiment shown comprises a machine screw 10 and nut 11 which cooperate with perforate ears 12 on the ends of the clamping member. Other adjustable connections might be provided in place of the screw and nut. The faces of the end plates are provided with inlet and outlet pipes 13 and 14 through which exhaust gases pass into and out of the apparatus. The inlet pipe 13 is preceded in the exhaust line by an air inspirator 13a operating on the venturi principle. As shown in the drawing the inspirator comprises a frustro-conical section 14 diverging as it approaches the end plate. Beyond the frustro-conical portion 14 a second frustro-conical portion 14a is provided which terminates in a flange 15 secured to a second flange 15a provided on exhaust pipe 16. The exhaust pipe terminates in a nozzle 17. An air inlet 18 provided with a filter 18a completes this inspirator structure.

The disclosed housing is simple to manufacture and requires virtually no expensive machining operations. The parts can be formed from standard gages of steel sheet and assembled with a minimum of effort. The interfitting flanges 4, 7 on the shell 2 and end plates 3 provide the necessary airtight relationship of these parts while permitting disassembly of the apparatus for repairs or servicing in a minimum of time.

The catalyst containing means of the disclosed embodiment of the invention comprises a pair of opposed foraminous trays which enclose a catalyst bed receiving space 19. Each of these trays is composed of a plurality of tray sections 20 described in detail below. The trays extend longitudinally and transversely of the housing a distance substantially equal to but less than the length and width of the housing. The clearance thus remaining, shown in Figs. 1 and 2 and indicated by reference numeral 21, between the edges of the trays and the internal walls of the housing is sufficient to permit the trays to thermally expand independently of the housing but this clearance is not so large as to permit catalyst particles from the bed to escape from the space between the trays. The sections on the ends of each of the trays overlap channel-shaped sealing members 22 which are welded or otherwise secured to the internal face of each end plate 3. Thus catalyst particles are restricted from escaping from the catalyst bed at its ends by the sides of these channel members 22 while the end tray sections are free to expand over the sides of these channels.

The tray sections 20 are preferably constructed of a relatively thin gage stainless steel plate, for example 22 U. S. gage (0.032" thick) and are perforated over their entire surfaces with small diameter holes 24, for example 0.062" in diameter, which are arranged in rows with approximately 74 holes per square inch of tray surface. For purposes of illustration, only a few of these holes are shown in Figs. 3 and 5. Stiffening ribs 23 (Figs. 1, 3 and 5) are formed in the trays preferably by a stamping operation which produces channels on one side of the tray and protrusions on the other side thereof as shown

in Fig. 1. These ribs may extend only transversely across the tray sections, as shown in Fig. 3, or transversely and longitudinally on the trays to form a waffle pattern, as shown in Fig. 5. The tray section edges which extend transversely are flanged, as at 25 in order to further stiffen these members.

The tray sections 20 are desirably of stainless steel or other high temperature alloy because of the fact that they must withstand operating temperatures in the range of 500° F. to 1800° F. Perforations are provided over the entire surface area of the trays for the purpose of permitting the passage of exhaust gases therethrough. The tray sections are desirably of thin gage material because it is important to minimize the use of relatively expensive stainless steel, because of weight considerations, and finally because of the fact that the formation of closely spaced perforations in stainless steel is economically feasible only with thin stock. The ribs 23 are provided because of the fact that such thin stock is inherently flexible and flexible trays in our device would be inadmissible since they would permit the escape of catalyst particles from the bed.

Divider plates 26, Figs. 1 and 2, are secured as by welding to the flanges of these trays, for the purpose of dividing the catalyst bed into a plurality of compartments. The utility of these dividers stems from the fact that in a compartmented catalyst bed, as opposed to an uncompartimented bed, the catalyst particles have less tendency to pack in one end of the bed if the apparatus is tilted from its horizontal position. The use of divider means to compartment the catalyst bed is more fully described in application Serial Number 438,423, filed June 22, 1954, by Eugene J. Houdry for Catalytic Exhaust Cleaner Purifier.

The mounting means for the trays comprises elongated channel shaped beams 27 affixed to the internal wall of the shell 2 by means of U-shaped beam supports or mounting members 28. The tray sections 20 are welded or otherwise secured to the underside of the base 29 of each beam, spot welds 30 being provided in the disclosed embodiment of our invention. The beams are notched as at 31 and 32, the notches extending across the base 29 of each beam and up the sides 33 thereof. These notches receive the protrusions formed by the ribs 23 and the end flanges 25 as shown in Fig. 1 so that the protrusions project away from, and not into, the catalyst bed. The importance of this feature will be discussed below. As will also be explained below the relationship of the notches to the rib protrusions and the flanges expedites the assembly of the tray sections to the beams.

The channel shaped beams of our invention can conveniently be formed by merely punching openings in a piece of flat sheet stock and subsequently bending the flat sheet into the desired channel shape. The openings for slots 34 (described below) and the notches 31, 32 can be punched in a single punching operation. Thereafter it is only necessary to bend the punched blank to form the finished notched and slotted beam. This is an important feature of our invention and affords many advantages over other types of construction, such as that shown in the aforementioned Houdry application, Serial Number 318,382, in that expensive machining operations are completely eliminated and the resulting structure is both strong and light in weight.

The U-shaped beam supports or mounting members 28, shown in Figs. 1, 2, and 6, extend within and between the sides of the channel-shaped beam and are connected thereto by means of a pin-slot or other lost motion connection. In the preferred embodiment of the invention each beam is supported by means of two such hangers with slots 34 being provided in the sides of the beams 27 and punched holes 35 being provided in the sides of the beam supports. A pin, in the form of a tubular rivet 40 extends through these slots and holes to hold the parts

in assembled relation whilst permitting longitudinal movement of the beam under the influence of thermal expansion. This pin, which is under a tensional force, tends to draw the sides 33 of the beam inwardly toward each other into a snug engagement with the supports 28 but the relationship of the parts is not so tight as to prevent thermal expansion and contraction of the parts independently of each other. It is understood that the number of beam supports provided for each beam is not critical. One elongated support would be sufficient to mount each beam or more than two supports might be provided for each beam.

The open ends of the U-shaped mounting members or beam supports are provided with oppositely extending flanges 36, Fig. 6, having surfaces shaped to conform to the internal surface of the housing. These flanges are rigidly secured to the shell member by bolting in the preferred embodiment of our invention. To this end a nut pocket 37 (Fig. 2) is welded to the underside of each flange 36 in alignment with a bolt receiving hole 38 in the flange. Alternatively the U-shaped supports might be directly welded to the shell member.

The U-shaped beam supports 28, like the channel shaped beams 27, can be conveniently formed by a series of inexpensive punching and bending steps.

Referring again to the catalyst containing trays it will be noted that they enclose between them a relatively thin bed of catalyst particles. In a catalytic apparatus of the type disclosed herein the thickness or depth of this catalytic bed is an important consideration from the standpoint particularly of not imposing a high back pressure on the internal combustion engine thus impairing this efficiency. This consideration calls for a relatively shallow bed of relatively extensive surface area. Because of the necessary shallowness of the bed, maintaining uniformity of bed thickness becomes an important consideration. Even relatively slight variations in bed thickness will lead to undesirable "channeling" of exhaust gases through the shallower portions and corresponding loss of efficiency in destroying obnoxious oxidizable components. With respect to this question of maintaining uniformity of bed thickness, the arrangement of the ribbed foraminous trays as disclosed herein is an important feature of the invention. It will be noted that the ribs project away from rather than into the catalyst bed and are accommodated by the notches 31 provided in the beams 27. Through this arrangement, constriction of the catalyst bed which would otherwise occur at the points where the ribs project into it, as disclosed in copending application Serial Number 318,382, is obviated. This constriction is particularly serious where the ribs are in alignment with one another.

An additional advantage of this arrangement of ribbed trays and notched beams is that the structural relationship between the ribs and the notches simplifies the assembly of the tray sections to the beams. This is evident from Fig. 1 where the ribs are shown protruding into the notches 31 and the flanges are shown in notches 32. To position a tray section on a beam preparatory to spot welding, it is only necessary to lay the tray on the beam, with the rib protrusions downward and align the tray section axially along the beam with the rib protrusions seated in the notches 31 and the flanges projecting into the notches 32. With the rib protrusions thus seated the end flanges 25 of adjacent trays will be properly spaced from each other in the notches 32 and the surface of the tray will be flush against the underside 29 of the beam 27. The spacing between adjacent flanges 25 must be held within relatively close dimensional tolerances since this spacing must be sufficiently wide to permit longitudinal expansion of the sections and sufficiently narrow to preclude the escape of catalyst particles from the bed. After the tray section is positioned on the beam the spot welds 30 can be made by well known practice.

In the operation of the device, exhaust gases from the

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internal combustion engine pass through the exhaust pipe 16 and are intermixed with fresh air by the inspirator 13a. The addition of fresh air to the gases is necessary in order to provide the necessary excess oxygen to assure substantially complete oxidation of the carbon monoxide and hydrocarbons contained in the exhaust. The mixture of exhaust gases and air then passes into the upper portion of the muffler designated by the letter A. From there the gases flow through the catalyst bed and into the lower zone B of the muffler from which they pass through the outlet pipe 14. While passing through the catalyst bed the hydrocarbons and carbon monoxide are oxidized to produce carbon dioxide and water vapor.

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 kind of catalyst. One type of catalyst which has been found to be particularly suitable, however, consists of pellets of activated alumina $\frac{1}{8}$ " to $\frac{1}{16}$ " in diameter, and of about the same length, impregnated with about 0.4% by weight of platinum. The platinum impregnation may be accomplished by immersing the pellets in a 1% solution of platinum chloride for about 10 minutes, draining, and then decomposing the platinum chloride by heat at about 1100° F. to leave the metallic platinum deposited on the alumina. Preferably the space between the foraminous trays is not filled to the limit of its capacity with catalytic particles. The space between the foraminous trays must not be packed tightly with catalyst particles since the tightly packed particles would tend to be crushed by each other as the catalytic bed is heated and the particles expand. On the other hand, the space between the trays must be filled sufficiently to avoid uneven bed depth due to shifting of the catalyst particles as the apparatus is tilted from a horizontal position. Such unevenness in the bed depth would have the undesirable result that exhaust gases would preferentially pass through the thinner bed portions and fail to be fully oxidized.

It is thus apparent that we have disclosed a catalytic muffler structure in which thermal expansion and contraction of the various parts is permitted and which also precludes the possibility of by-pass or "channelling" of exhaust gases around the catalytic bed. At the same time our device is amenable to economic and expeditious manufacturing processes. While we have disclosed the preferred embodiment of our invention, it may be practiced in other forms and adaptations which fall within the purview of the appended claims.

We 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 an elongated housing, catalyst containing means in said housing and rigid supporting means for said catalyst containing means, said rigid supporting means comprising elongated channel shaped beams extending longitudinally within said housing, said catalyst containing means being supported by the underside of the base of said beams, means mounting said channel shaped beams within said housing comprising members rigidly secured to said housing and extending within and between the sides of said channel shaped beams, and a connection between each of said members and its associated beam, said connection permitting expansion and contraction of each of said beams independently of said member and said housing.

2. 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 an elongated housing, catalyst containing means in said housing and rigid supporting means for said catalyst containing means, said rigid supporting means comprising elongated channel shaped beams extending longitudinally within said housing, said catalyst containing means being supported by the under-

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side of the base of said beams, U-shaped mounting members secured at their open ends to said housing, the closed end of each of said U-shaped mounting members extending within and between the sides of one of said channel shaped beams, and a pin-slot connection between each of said U-shaped members and its associated beam, said pin-slot connection permitting expansion and contraction of each of said beams independently of its associated mounting member and said housing.

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 an elongated housing, catalyst containing means in said housing, rigid supporting means for said catalyst containing means comprising elongated beams in said housing extending longitudinally thereof, said catalyst containing means comprising a plurality of foraminous trays extending longitudinally and laterally of said housing a distance substantially equal to the length and width of said housing, each of said trays being provided with transverse stiffening ribs forming protrusions on the surfaces of said trays, said trays being in opposed face-to-face relationship to define therebetween a space for receiving a relatively thin bed of catalyst particles, said beams being provided with notches on the tray supporting surfaces thereof, each of said trays being supported by one of said beams with the notches of said beams receiving the ribs of said trays whereby said ribs protrude into said notches and not into said catalyst bed whereby a substantially uniform velocity of gases through said catalyst bed is obtained throughout the area of said bed.

4. 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 an elongated housing, catalyst containing means in said housing, rigid supporting means for said catalyst containing means comprising elongated channel shaped beams in said housing extending longitudinally thereof, means mounting said channel shaped beams within said housing comprising members rigidly secured to said housing and extending within and between the sides of said channel shaped beams, a connection between each of said members and its associated beam, said connection permitting expansion and contraction of each of said beams independently of said member and said housing, said catalyst containing means comprising foraminous trays extending longitudinally and laterally of said housing a distance substantially equal to the length and width of said housing, each of said trays being provided with transverse stiffening ribs forming protrusions on one side of the tray and channels on the other side thereof, said trays being in opposed face-to-face relationship to define therebetween a space for receiving a relatively thin bed of catalyst particles, said channel shaped beams being provided with notches extending from the base of the beam along each side thereof, each of said trays being supported by the underside of the base of one of said beams with the notches of said channel-shaped beams receiving the ribs of said trays whereby said ribs protrude into said notches and not into said catalyst bed whereby a substantially uniform velocity of gases through said catalyst bed is obtained throughout the area of said bed.

5. 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, catalyst containing means in said housing, supporting means for said catalyst containing means, said catalyst containing means comprising foraminous trays extending longitudinally and laterally of said housing, said trays being in opposed face-to-face relationship to define therebetween a space for receiving a relatively thin bed of catalyst particles, said trays being provided with stiffening ribs pressed into said

trays and forming protrusions on one side of the tray and channels on the other side thereof, said ribs projecting away from and not into the space between said trays whereby a substantially uniform flow of gases through said thin catalyst bed is obtained throughout the area of said bed.

6. 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, catalyst containing means in said housing, supporting means for said catalyst containing means, said catalyst containing means comprising a plurality of foraminous trays extending longitudinally and laterally of said housing, each of said trays being provided with stiffening ribs pressed into said trays and forming protrusions on one side of the tray and channels on the other side thereof, said trays being in opposed face-to-face relationship to define therebetween a space for receiving a relatively thin bed of catalyst particles, the corresponding ribs of opposed trays being in alignment with one another, said ribs projecting away from, and not into, the space between said trays whereby a substantially uniform flow of gases is obtained throughout the area of said bed.

7. 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, catalyst containing means in said housing, rigid supporting means for said catalyst containing means, said rigid supporting means being carried by said housing in such manner as to permit expansion and contraction thereof independently of said housing, said catalyst containing means comprising foraminous trays divided into a plurality of sections extending longitudinally and laterally of said housing a distance substantially equal to the length and width thereof, each of said tray sections being provided with stiffening ribs pressed into said tray sections and forming protrusions on one side of the tray and channels on the other side thereof, said trays being in opposed face-to-face relationship to define therebetween a space for receiving a relatively thin bed of catalyst particles, the corresponding ribs of opposed tray sections being in alignment with one another, said ribs projecting away from, and not into, the space between said tray sections

whereby a substantially uniform flow of gases is obtained throughout the area of said bed.

8. 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, catalyst containing means in said housing, rigid supporting means for said catalyst containing means, said rigid supporting means being carried by said housing in such manner as to permit expansion and contraction thereof independently of said housing, said housing comprising an elongated open ended shell provided with flanges at the open ends thereof, end plates closing the open ends of said shell, said end plates being provided with peripheral portions complementary to and abutting said flanges, and clamping means clamping said end plates to said shell.

9. 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, catalyst containing means in said housing, rigid supporting means for said catalyst containing means, said rigid supporting means being carried by said housing in such manner as to permit expansion and contraction thereof independently of said housing, said housing comprising an elongated open ended shell provided with flanges at the open ends thereof, end plates closing the open ends of said shell, said end plates being provided with peripheral portions complementary to and abutting said flanges, clamping means clamping said end plates to said shell comprising split clamping members of U-shaped cross section disposed over the peripheral portions of said end plates and the flanges of said shell, and adjustable connecting means connecting the ends of said split clamping member across the split portion thereof.

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