

Oct. 5, 1965

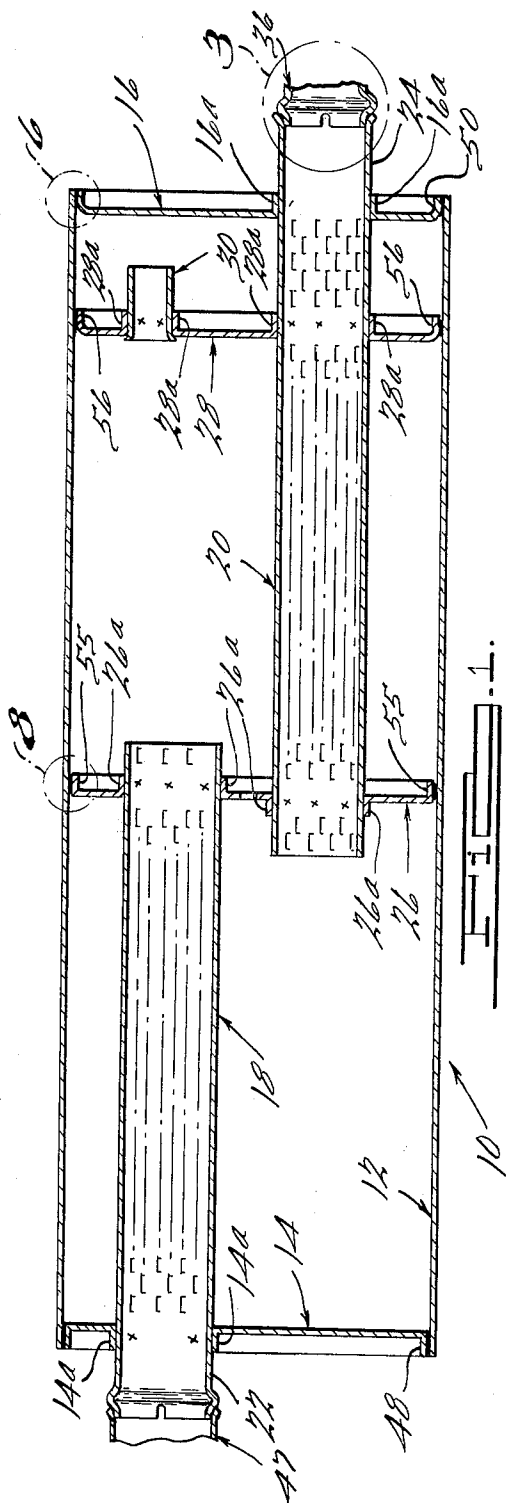
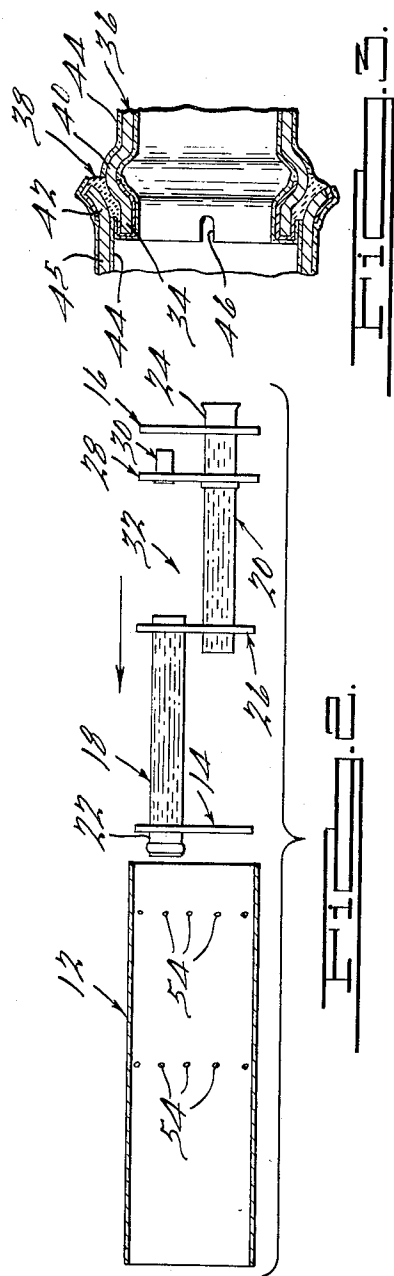
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CERAMIC COATED MUFFLER AND PROCESS

Filed Jan. 9, 1964

2 Sheets-Sheet 1



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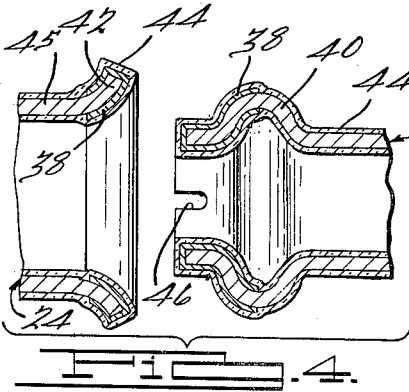
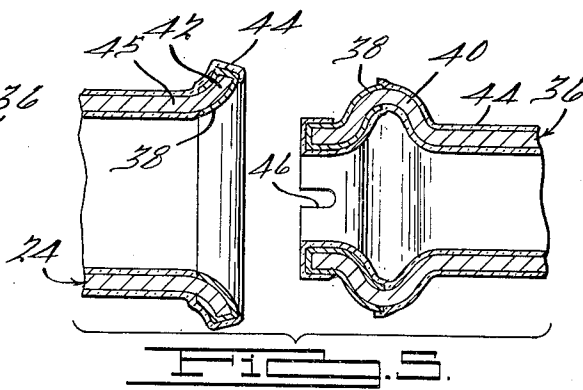
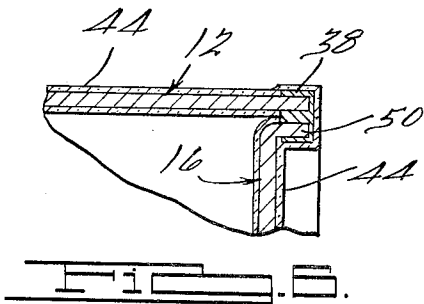
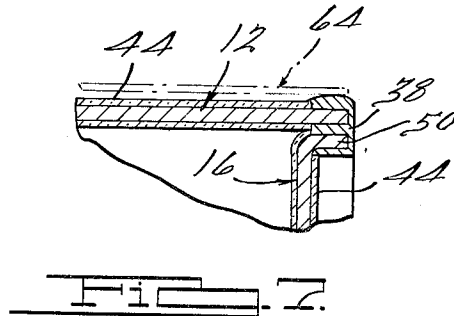
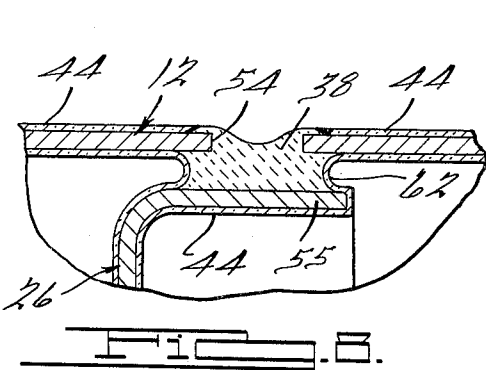
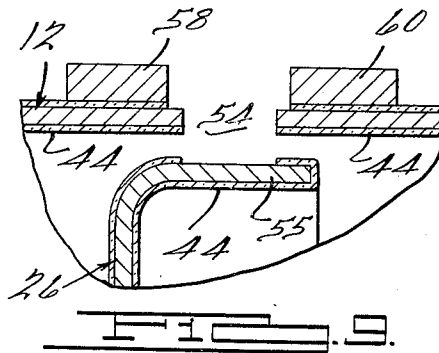
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CERAMIC COATED MUFFLER AND PROCESS

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2 Sheets-Sheet 2



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3,209,862

CERAMIC COATED MUFFLER AND PROCESS
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20 Claims. (Cl. 181-61)

This invention relates generally to exhaust mufflers for internal combustion engines, and more particularly, to a ceramic-coated muffler assembly adapted to be operatively associated with the exhaust system of an automotive vehicle.

Automotive muffler assemblies heretofore known, usually consist of an external housing or shell enclosing a plurality of gas baffles or partitions which form adjacent closed compartments within the shell. During normal engine operation, condensation together with exhaust products of combustion accumulate within these compartments to form highly corrosive acids which have an extremely deleterious effect on the muffler construction, and which frequently necessitates the replacement thereof at recurring intervals. In attempting to obviate the expense and inconvenience of replacing these muffler assemblies, it has been proposed to provide an acid resistant coating of a ceramic enamel on the surfaces thereof; however, in applying the art of ceramic enameling to muffler constructions, certain troublesome difficulties arise in achieving and maintaining 100% ceramic coverage of all surfaces of the muffler. In particular, because the outer edges of the partitions or baffles are joined to the muffler shell as by spotwelding, the ceramic material cannot enter and coat the edges of the partition or the muffler shell in these areas, thus enabling the corrosive media to penetrate such areas to attack and destroy these components.

Another difficulty is encountered due to the fact that the above partitions are spotwelded to the muffler shell, but are joined to their adjacent partitions by exhaust conduits or tubes extending longitudinally through the muffler. Upon rapid heating, these internal tubes expand at a slower rate than the external shell, the latter of which therefore tries to expand away from the partitions causing strains at the junctures of the partition and the shell which crack the ceramic coating thereby permitting the corrosive media to flow freely into the junctures and attack the shell and partitions.

Still another difficulty heretofore prevalent in ceramic-coated muffler assemblies relates to the ceramic coating on the muffler bushings which is indiscriminately chipped off as the bushings are clamped to the automobile tailpipe assembly. The exposed areas created by such chipping accordingly become highly susceptible to corrosive attack from both common road salt and the aforementioned corrosive media formed within the muffler assembly.

The present invention is accordingly directed towards a muffler assembly which is adapted to obviate the aforementioned and related objectionable features of ceramic-coated muffler units heretofore known and used. More specifically, the muffler assembly of the present invention is characterized by the provision of a precoating operation which places a layer of a corrosion-resistant material subjacent the protective ceramic coating on those portions of the muffler assembly which are particularly susceptible to the excessive stresses which lead to the aforementioned cracking and chipping of the ceramic coating. Besides rendering these areas of the muffler assembly entirely resistant to the corrosive effects of exhaust condensation, the precoating alloy acts as a means for rigidly joining the various components of muffler assembly. Therefore, it will be seen that the present invention discloses a muffler construction which is not only entirely impervious to the corrosive exhaust condensate retained therein, but also

to the mechanical stresses which the assembly is subjected during the normal operation thereof.

It is accordingly a primary object of the present invention to provide an improved ceramic-coated muffler assembly for the exhaust system of an automotive vehicle.

It is another object of the present invention to provide an improved muffler assembly with the service life equal to the full capabilities of flawless ceramic enameling on plain steel.

It is still another object of the present invention to provide a muffler assembly of the above character which is at least partially coated with a corrosion-resistant metallic alloy that is adapted to mechanically join various components of the muffler assembly together.

It is yet another object of the present invention to provide an improved muffler assembly of the above character which may be easily assembled and economically manufactured.

Other objects and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a longitudinal cross-sectional view of an exemplary embodiment of the present invention;

FIGURE 2 is an exploded assembly view of the structure illustrated in FIGURE 1;

FIGURE 3 is an enlarged fragmentary cross-sectional view of the structure within the circle 3 of FIGURE 1;

FIGURE 4 is an exploded assembly view of the structure illustrated in FIGURE 3;

FIGURE 5 is a view similar to FIGURE 4 and illustrates a step in the assembly of the structure illustrated in FIGURE 3;

FIGURE 6 is an enlarged fragmentary cross-sectional view of the structure illustrated within the circle 6 of FIGURE 1;

FIGURE 7 is a modification of the structure illustrated within the circle 6 of FIGURE 1;

FIGURE 8 is an enlarged fragmentary cross-sectional view of the structure within the circle 8 of FIGURE 1; and

FIGURE 9 is an exploded assembly view of the structure illustrated in FIGURE 8 and illustrates a step in the assembly thereof.

Referring now to the drawings, a muffler 10, the configuration of which is intended to be only exemplary insofar as muffler constructions are concerned, comprises an elongated oval-sectioned external housing or shell 12 which is closed at the opposite ends thereof by end walls in the form of inlet and outlet headers 14 and 16. A pair of exhaust conduits or flow tubes 18 and 20 extend longitudinally within the shell 12 and terminate on the exterior ends of the headers 14 and 16 in inlet and outlet bushings 22 and 24. The flow tubes 18 and 20 are supported within the shell 12 by the headers 14 and 16 and by a pair of transversely extending partitions 26 and 28. The partition 26 also supports a longitudinally extending resonator or tuning tube 30 which may, of course, be axially aligned with the flow tube 18 to provide certain desired acoustical effects. Each of the flow tubes 18 and 20 is perforated, preferably louvered, so that the pressure waves created by the exhaust gases passing therethrough may expand outwardly in the space surrounding the tubes.

The headers 14 and 16 are provided with annular flange portions 14a and 16a, and the partitions 26 and 28 are provided with similar flange portions 26a and 28a, which are adapted to be secured to a circumferential portion of the appropriate flow tubes 18, 20 and 30, as by the spotwelding x, thereby providing the subassembly illustrated in FIGURE 2, generally designated by the numeral 32.

Upon complete assembly of the subassembly 32 and fabrication of the shell 12, both of these units are entirely

coated with a ceramic enamel in a manner hereinafter to be described; however, in accordance with the principles of the present invention, prior to the ceramic enameling application, the headers 14 and 16, together with the bushings 22 and 24 and the shell 12 are partially coated with a metallic alloy which, upon the final assembly thereof, is adapted to bond these components together with strong, highly corrosion-resistant joints.

In general, this metallic alloy, which may be broadly considered a brazing alloy, is characterized by the following properties; an ability to resist acidic and non-acidic corrosion, an ability to form strong joints with plain steel, an ability to form an adequate bond with a ceramic enamel, and a melting point that is compatible with the preservation of the ceramic material when the various components are joined together. It may be noted that because the subject muffler units are to be most likely mass-produced, the economies of the alloy are a primary consideration in selecting the alloy constituents. For example, metals such as silicon and vanadium exhibit the desired corrosion-resistant properties, and titanium exhibits both the desired bonding characteristic and the corrosion-resistant characteristics. However, none of these metals are economically feasible for use on a large production basis. Similarly, alloys of silver and manganese exhibit the desired range of melting temperatures (approximately 1500-2000° F.) but their use is also limited from a cost standpoint.

Of the wide variety of elements and combination of elements available, a copper-chromium-manganese alloy has been found to exhibit the above desired properties while remaining economically feasible for a large production operation. More specifically, a 69% Cu-11% Cr-20% Mn alloy has been found to be especially preferable in that it provides a strong mechanical bond with both plain steel and the ceramic material. Also, the chromium additive renders the alloy corrosion-resistant under the most severe testing and operating conditions.

Another alloy which has been found to provide the aforementioned desired properties is a 85% Ag-15% Mn alloy; however, due to the relatively large percentage of silver used therein, the cost of such an alloy renders it economically unfeasible for the present application.

In general, after the precoat alloy has been applied to the appropriate areas of the shell 12, the headers 14 and 16, and the bushings 22 and 24, the subassembly 32 and the shell 12 are entirely coated with the ceramic enamel. The enameling process is well known in the art and broadly consists of a cleaning and pickling process which prepares the surfaces of the units for the enameling. Thereafter, the enamel is applied by a so-called wet process which involves the application of the ceramic slip by a dipping or spraying operation. The coated units are then dried and the bisque is fused to the components by a subsequent firing operation.

Upon completion of the entire ceramic enameling operation, preselected portions of the precoat alloy are re-exposed at the joint areas by masking and removing the ceramic coating overlying these areas by an abrasive blasting process. This step may be easily performed without significant removal of the precoat alloy due to the fact that the brittle ceramic coating reacts to the abrasive action at a much faster rate than the somewhat ductile precoat or brazing alloy. After removal of all of the necessary ceramic material at the joint areas, the subassembly 32 is inserted within the shell 12, as illustrated in FIGURE 2, and thereafter, the opposite ends of the completed assembly are dipped into a molten bath of the aforementioned brazing alloy and are subsequently allowed to cool, thereby rigidly securing the subassembly 28 and the shell 12 into a single integral muffler unit, which, by virtue of its ceramic coating and corrosion-resistant joints, is completely impervious to the deleterious attack of both internal and external corrosive mediums.

Referring now in detail to the actual construction of

the muffler 10, and more specifically to the steps to be followed in the construction illustrated in FIGURES 3 through 5, the outlet bushing 24 is shown in various pre-assembled and assembled conditions with its associated bushing section 34 of a conventional exhaust pipe 36. Initially, the outer ends of the bushing 24 and the bushing section 34 are dipped in molten bath of the precoat alloy (preferably 69 Cu-20 Mn-11 Cr) thereby placing a coating of the alloy, generally designated 38, over the entire joint area of each of these components. This coating should extend substantially over the enlarged annular shoulder 40 of the exhaust pipe 36, and it should extend over the enlarged annular flange portion 42 of the bushing 24 and at least as far as the uniform diameter section thereof, as seen at 45. After the precoating operation, the bushing 24 and the exhaust pipe 36 are completely coated with the ceramic material, generally designated 44, as by the method hereinbefore described. Thereafter, the flange portion 42 of the bushing 24 and the bushing section 34 are suitably masked (as by being placed in an appropriate masking fixture) and the ceramic material overlying the precoat alloy at the joint areas is removed by the aforementioned abrasive blasting process. The resulting exposed joint areas of the bushing 24 and bushing section 34 are illustrated in FIGURE 5.

Upon installation of the muffler unit 10, the muffler bushing 24 and the bushing section of the exhaust pipe 36 fit together in the conventional manner of piloting a dimple on the bushing 24 (not shown) into a corresponding slot 46 in the end of the exhaust pipe 36, thereby engaging the corresponding exposed areas of the precoat alloy of each of these members. Heat and braze filler metal are then applied to the joint area, for example, by an oxy-acetylene or heliarc torch, whereby the exposed precoat alloy on the respective members fuses together to form a strong, gas-tight and entirely corrosion-resistant joint, as seen in FIGURE 3.

It will be readily apparent the aforesaid procedure of operatively connecting the exhaust pipe 36 to the bushing 24 may be applied in an identical manner to join the exhaust pipe 47 (illustrated in FIGURE 1) to the inlet bushing 22.

Referring now to the shell-header joint areas, it will be seen in FIGURE 1 that the headers 14 and 16 are respectively provided with longitudinally extending peripheral flange sections 48 and 50. Prior to coating the shell 12 and the subassembly 28 with the ceramic enamel, these flange sections 48 and 50, together with the opposite ends of the shell 12, are dipped in the molten bath of the precoat alloy 38, thereby placing a coating of the material on these members in essentially the same manner as it was applied to the aforesaid bushings and exhaust pipes. As best seen in FIGURE 6, the precoat alloy should extend inward from the ends of each of the flange sections a distance of about one inch, and should cover the ends of the shell 12 a distance equal to at least the width of the flange sections 48 and 50.

Subsequent to this precoating operation, the subassembly 28 and the shell 12 are coated with the ceramic material 44 in accordance with the aforesaid procedure. The ends of the shell 12 and the flange sections 48 and 50 are then placed into a suitable masking fixture whereby the ceramic material overlying the precoating on the outer surface of the flange sections 48 and 50 and the inner periphery of the ends of the shell 12 is removed by the aforementioned abrasive blasting technique. Preferably, the ceramic material should be removed so as to expose on each of these members a peripheral strip of precoating approximately one-half an inch wide.

Upon completion of the abrasive blasting of the ceramic material at the header to shell joint areas, the subassembly 32 is inserted within the shell 12 such that the associated exposed joint areas of the shell 12 headers 14 and 16 are adjacently oriented. The headers 14 and 16 and the shell 12 may then be rigidly joined together by either of

two methods, the first and simplest of which consists of applying sufficient heat to the ends of the shell 12 to fuse the adjacent precoat 38 on the ends of the shell 12 and the flange sections 48 and 50, thereby providing a strong, gas-tight and corrosion-resistant joint, as seen in FIGURE 6. This heat may be applied in a manner similar to that which is applied in joining the bushings 22 and 24 to the exhaust pipes 36 and 48 (i.e., as by an electric arc or flame heat source).

An alternative and preferable method of joining the headers 14 and 16 to the opposite ends of the shell 12 includes the initial aforesaid step of abrasively removing the ceramic material 44 around the inner periphery of the ends of the shell 12, and around the outer periphery of the header flange sections 48 and 50. The headers 14 and 16 are then inserted in the opposite ends of the shell 12 and the flange sections 48 and 50 thereof are clinched to the respective ends of the shell 12. The opposite ends of the assembled shell and header unit are then dipped into a molten bath of the precoat alloy 38. This dipping procedure provides sufficient heat to fuse the adjacent joint areas of the shell 12 and the headers 14 and 16 while concurrently providing a supplemental dip-seal around the joint areas at each end of the shell 12, as seen in FIGURE 7. It may be noted that this operation, by virtue of being quick, inexpensive and providing a good seal and an extremely strong point, readily lends itself to mass-production techniques.

As illustrated in FIGURE 2, the shell 12 is provided with two transverse rows of peripherally spaced apertures, generally designated 54, which are adapted to longitudinally align or register with a pair of longitudinally extending peripheral flange sections 55 and 56 of the partitions 26 and 28 when the subassembly 32 is inserted into the shell 12.

Upon insertion of the ceramic-coated subassembly 32 into shell 12, the muffler unit 10 is placed in a suitable masking fixture (indicated by the masking sections 58 and 60 illustrated in FIGURE 9) such that the ceramic enamel 44 on the exterior surface of the shell 12 circumjacent each of the apertures 54, and the ceramic enamel on the partition's flange sections 55 and 56 which registers with the apertures 54, may be removed by abrasive blasting, thereby leaving each of the apertures in the condition illustrated in FIGURE 9. Thereafter, the partitions 26 and 28 are rigidly joined to the shell 12 by depositing a molten charge of the precoat alloy (69 Cu-11 Cr-20 Mn) in each of the apertures 54. In this operation, the alloy is preferably in rod form and is brazed into the apertures by a heliarc welding machine or similar type apparatus. As the precoat alloy 38 flows into the apertures 54, the ceramic enamel adjacent both the apertures 54 and the exposed areas of partition flange sections 55 and 56 acts as a flux for the melted alloy, and as a greater quantity of alloy is introduced into the apertures, the ceramic enamel becomes fused around each of the joint areas to further enhance the corrosion-resistant characteristics thereof, as seen at 62.

It will be noted that there is a peripheral gap between the partition flange portions 55 and 56 and the inner periphery of the shell 12 between each of the shell-partition joint areas. The size of this gap is designed to be compatible with the clearance allowances necessary for sliding the ceramic-coated subassembly 32 into the shell 12, and thus the size of the gap is not considered to be critical.

The number of apertures 54 provided in the shell 12, and accordingly the number of joint areas provided between each of the partitions 26 and 28 and the shell 12, may be varied in accordance with the desired "back fire strength" of the muffler unit 10; however, a preferred embodiment of the present invention is provided with approximately twelve such joints for each partition.

It may be desired to provide the muffler 10 with an external protective cover which would be coextensive with

the outer periphery of the muffler shell 12. Such covers, which usually consist of a thin layer of asbestos and a stainless steel or similar corrosion-resistant exterior jacket, function to improve the acoustical qualities of the muffler and also to provide a barrier to prevent stones and the like from impinging directly upon and chipping the ceramic enamel on the exterior surface of the shell 12. It has been found that the previously discussed precoat alloy material provides a strong bond with stainless steel and similar type materials which might be used for the jacket portion of a protective cover, and thus a cover of the aforesaid type, and herein designated by the numeral 64, may be conveniently secured to the exterior of the muffler unit 10 by merely fusing the ends of the external jacket to the ends of the shell 12, as representatively illustrated in FIGURE 7.

To facilitate correlating each of the various assembly and joining processes hereinbefore specifically disclosed, a brief resume of the final assembly of the muffler 10 will now be described.

Assuming that the subassembly 32 and the shell 12 are coming from the ceramic firing conveyor, they would each be unloaded at different stations where they are subjected to their respective preparatory operations. The subassembly 32 would be placed in a masking fixture and abrasively blasted to expose the precoat alloy around the headers 14 and 16, and around the bushings 22 and 24. Similar abrasive blasting would expose the precoat alloy on the ends of the shell 12 which registers with the peripheral flange sections of the headers 14 and 16. Thereafter, the subassembly 32 would be placed inside the shell 12 whereby the ends of the shell 12 and the headers 14 and 16 would be fused together, as previously described. The partially completed assembly would then be advanced to another masking fixture where the ceramic material would be removed from around the aperture 54 and from the underlying flange sections of the partitions 26 and 28. This would expose the bare steel preparatory to the brazing operation. Advancing to the next station, the operation of joining of the partitions 26 and 28 to the shell 12 would be accomplished by the aforesaid manner of using a heliarc welding device to melt the precoat alloy into the apertures 54.

If a cover is to be added to the muffler unit, the assembly would be advanced to another station where the cover would be applied and fused to the ends of the shell 12. The muffler unit is then completed and installation on an automotive vehicle would entail only the previously discussed brazing of the muffler bushings when they are engaged with the vehicle exhaust pipe assembly.

It will thus be seen that the hereinbefore described construction provides a muffler unit that is entirely impervious to attack by a corrosive media which might come in contact with either the interior or exterior surfaces thereof. Furthermore, by virtue of the aforesaid properties of the precoat alloy used herein, the various joints or connections of the described muffler components are adapted to be not only completely corrosion-resistant, but also extremely strong and long-lasting.

It will be further seen that the above construction allows the muffler unit 10 to be assembled in such a way that the entire unit is impervious to corrosive attack without any substantial change in the functional design thereof to accommodate the ceramic coating operation. Thus, by following the principles of the present invention, it is unnecessary to provide drainage holes or similar structural revisions which might possibly affect the acoustical qualities of the muffler construction. Furthermore, no subsequent closure of temporary access openings is required, and complete inspection of every component may be made prior to final assembly of the unit, thus insuring improved quality control.

While it will be apparent that the preferred embodiments herein illustrated are well calculated to fulfill the objects stated, it will be appreciated that the invention is

susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In an exhaust muffler construction,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
said headers and said shell having a corrosion-resistant
precoating material applied to at least a portion of
the mutually adjacent surfaces thereof, said precoat-
ing material serving to bond said headers and said
shell together, and
said shell and said headers having a thin layer of
ceramic material fused to the surfaces thereof except
for a portion of their surfaces covered by said pre-
coating material.
2. In an exhaust muffler construction,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
said headers having a corrosion-resistant precoating
material covering at least the outer peripheral por-
tions thereof,
said shell having a corrosion-resistant precoating mate-
rial covering at least a portion of the interior sur-
faces corresponding to the longitudinal position of
said headers in said shell, said precoating material
serving to bond said headers and said shell together,
and
said shell and said headers having a thin layer of
ceramic material fused to the surfaces thereof except
for a portion of their surfaces covered by said pre-
coating material.
3. In an exhaust muffler construction,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell
and each having a longitudinally extending peripheral
flange portion,
said flange portion of each of said headers having a
corrosion-resistant metallic bonding material cover-
ing at least the outermost surfaces thereof,
said shell having a corrosion-resistant metallic bonding
material covering at least the interior surfaces of the
opposite ends thereof,
said headers and said shell being fused together by said
bonding material, and
said shell and said headers having a thin layer of
ceramic material fused to the surfaces thereof except
for a portion of their surfaces covered by said bond-
ing material.
4. In an exhaust muffler construction,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
a plurality of gas flow tubes extending longitudinally
of said shell,
one of said flow tubes terminating in an inlet bushing
on the exterior side of said inlet header and another
of said flow tubes terminating in an outlet bushing
on the exterior side of said outlet header,
an exhaust pipe for communicating exhaust gases to
and from said inlet and outlet bushings,
said inlet and outlet bushings having a corrosion-resist-
ant precoating material applied to at least a portion
of the outer peripheral surfaces thereof, said precoat-
ing material serving to fuse said inlet and outlet
bushings to said exhaust pipe, and
said bushings having a thin layer of ceramic material
fused to the surfaces thereof except for a portion of
their surfaces covered by said precoating material.
5. In a combination in a muffler and exhaust pipe
assembly,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
a plurality of gas flow tubes extending longitudinally
of said shell,
one of said flow tubes terminating in an inlet bushing

- on the exterior side of said inlet header and another
of said flow tubes terminating in an outlet bushing
on the exterior side of said outlet header,
an exhaust pipe for communicating exhaust gases to
and from the muffler,
bushing means on said exhaust pipe adapted to engage
said inlet and outlet bushings,
said inlet and outlet bushings and said exhaust pipe
bushing means having a corrosion-resistant precoat-
ing material covering at least the outer peripheral
portions thereof, said precoating material serving to
fuse said inlet and outlet bushings to said exhaust
pipe, and
said inlet and outlet bushings and said exhaust pipe
bushing means having a thin layer of ceramic mate-
rial fused to the surfaces thereof except for a portion
of their surfaces covered by said precoating material.
6. In a combination in a muffler and exhaust pipe
assembly,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
a plurality of gas flow tubes extending longitudinally
of said shell,
one of said flow tubes terminating in an inlet bushing
on the exterior side of said inlet header and another
of said flow tubes terminating in an outlet bushing
on the exterior side of said outlet header,
exhaust pipe means operable to communicate gases to
and from the muffler,
bushing means on said exhaust pipe means adapted to
engage said inlet and outlet bushings,
said inlet and outlet bushings having a corrosion-resist-
ant metallic bonding material covering at least the
inner periphery of the ends thereof,
said bushing means having a corrosion-resistant metallic
bonding material covering at least the outer periphery
of the ends thereof,
said inlet and outlet bushings and said exhaust pipe
bushing means having a thin layer of ceramic mate-
rial fused to the surfaces thereof except for a portion
of their surfaces covered by said bonding material,
and
said bushings and said bushing means being rigidly
connected together by having their mutually adjacent
areas covered by said bonding material fused to-
gether.
7. In an exhaust muffler construction,
an elongated hollow shell,
inlet and outlet headers closing the ends of said shell,
a plurality of gas flow tubes extending longitudinally
within said shell,
one of said flow tubes terminating in an inlet bushing
on the exterior side of said inlet header and another
of said flow tubes terminating in an outlet bushing
on the exterior side of said outlet header,
an exhaust pipe for communicating exhaust gases to
and from said inlet and outlet bushings,
said inlet and outlet bushings having a corrosion-resist-
ant precoating material applied to at least a portion
of the outlet peripheral surfaces thereof,
said headers having a corrosion-resistant precoating
material covering at least the outer peripheral por-
tions thereof,
said shell having a corrosion-resistant precoating mate-
rial covering at least a portion of the interior surfaces
corresponding to the longitudinal position of said
headers in said shell, said precoating material serving
to fuse said headers and said shell together and to
fuse said inlet and outlet bushings to said exhaust
pipe, and
said shell, said inlet and outlet headers, and said inlet
and outlet bushings having a thin layer of ceramic
material fused to the surfaces thereof except for a
portion of their surfaces covered by said precoating
material.

8. In an exhaust muffler construction,
 an elongated hollow shell,
 inlet and outlet headers closing the ends of said shell,
 a plurality of transversely extending partitions longi-
 tudinally spaced in said shell,
 a plurality of gas flow tubes extending longitudinally
 within said shell,
 one of said flow tubes terminating in an inlet bushing
 on the exterior side of said inlet header and another
 of said flow tubes terminating in an outlet bushing
 on the exterior side of said outlet header,
 said headers having a corrosion-resistant metallic
 bonding material covering at least the outer periph-
 eral portions thereof,
 said shell having said corrosion-resistant metallic bond-
 ing material covering at least a portion of the in-
 terior surfaces corresponding to the longitudinal posi-
 tions of said headers in said shell,
 said shell having a plurality of longitudinally spaced
 apertures adapted to register with the outer periph-
 eral portions of said partitions,
 said shell further having a thin layer of ceramic ma-
 terial fused to the surfaces thereof except for an area
 circumjacent each of said apertures and a portion
 of its surface covered by said bonding material,
 said shell and said headers having their adjacent sur-
 faces covered by said bonding material fused to-
 gether in strong, gas-tight joints,
 said partitions having a thin layer of ceramic ma-
 terial fused to the surfaces thereof except for a plu-
 rality of points on the peripheral portions thereof
 which register with said apertures, and
 a brazed joint in each of said apertures comprising a
 deposit of said corrosion-resistant metallic bonding
 material rigidly connecting said peripheral portions
 of said partitions to said shell.

9. A muffler construction as set forth in claim 8 which
 includes a muffler cover which is coextensive with said
 shell and is rigidly connected thereto by said corrosion-
 resistant metallic bonding material on said end portions
 of said shell.

10. In an exhaust muffler construction, the steps which
 include,
 applying a corrosion-resistant precoating and bonding
 material to preselected surface areas of the muffler,
 fusing a ceramic material over the entire surface of
 said muffler,
 exposing a portion of said precoating and bonding ma-
 terial, and
 heating the adjacent of said exposed areas together to
 fuse said bonding material together whereby to pro-
 vide gas-tight and corrosion-resistant joints.

11. In an exhaust muffler construction, the steps which
 include,
 dipping preselected portions of the unassembled muffler
 into a molten bath of a corrosion-resistant metallic
 bonding material,
 fusing a ceramic material over the entire surface of
 said muffler,
 removing a portion of said ceramic material overlying
 the dipped portions of said muffler, and
 applying heat to the adjacent of the exposed areas of
 said bonding material to rigidly interconnect the
 muffler assembly with gas-tight and corrosion-re-
 sistant joints.

12. In an exhaust muffler construction, the steps which
 include,
 coating preselected areas of the muffler with a corro-
 sion-resistant metallic bonding material,
 fusing a ceramic material over the entire surface of
 said muffler,
 abrasively removing a portion of said ceramic material
 overlying the areas of said muffler coated by said
 bonding material, and
 dipping the exposed areas of said bonding material in

a molten bath of said bonding material to fuse the
 adjacent exposed areas of said muffler together.

13. The construction of a ceramic-coated muffler as-
 sembly which includes the steps of,
 fabricating the shell, flow tubes, partitions, and header
 components out of sheet metal,
 assembling said flow tubes, partitions and headers into
 a subassembly,
 coating preselected areas of said shell, flow tubes and
 partitions with a corrosion-resistant metallic bonding
 material,
 applying a ceramic material over the entire surfaces
 of said subassembly and said shell,
 firing said subassembly and said shell to fuse said
 ceramic material thereto,
 abrasively removing a portion of said ceramic material
 overlying the areas of said subassembly and said
 shell coated by said bonding material,
 inserting said subassembly into said shell to align the
 exposed areas of said bonding material, and
 applying heat to the adjacent of said exposed areas to
 fuse together said bonding material.

14. In the construction of an exhaust muffler assembly
 having inlet and outlet bushings adapted to be opera-
 tively connected with associated bushing means of an ex-
 haust pipe assembly, the steps which include,
 dipping at least the outer ends of said inlet and outlet
 bushings and said exhaust pipe bushing means into
 a molten bath of a corrosion-resistant metallic bond-
 ing material,
 entirely coating said inlet and outlet bushings and said
 bushing means with a thin layer of a ceramic ma-
 terial,
 abrasively removing an annular strip of said ceramic
 material overlying said bonding material on said
 bushings and said bushing means,
 engaging said bushing means with said inlet and outlet
 bushing, and
 applying heat to the exposed areas of said bonding
 material to fuse said bushings and bushing means
 together in rigid gas-tight joints.

15. In the assembly of an exhaust muffler shell with
 the inlet and outer headers therefor, the steps which in-
 clude,
 applying a corrosive-resistant metallic bonding material
 to at least the outer peripheral portions of said head-
 ers and to a portion of the interior surface of said
 shell,
 entirely coating said headers and said shell with a thin
 layer of a ceramic material,
 removing at least a portion of said ceramic material
 overlying said precoating material on said shell and
 said headers,
 assembling said headers in said shell, and
 applying heat to said areas of said bonding material
 not covered by said ceramic material to fuse said
 headers and said shell together.

16. The assembly as set forth in claim 15 wherein said
 heat applying step consists of dipping at least a portion
 of the assembled shell and headers into a molten bath of
 said bonding material.

17. In the assembly of an exhaust muffler shell and
 internal partitions therefor, the steps which include,
 forming the muffler shell with a plurality of longi-
 tudinally spaced apertures adapted to register with
 the outer periphery of said partitions,
 entirely coating said shell and said partitions with a
 thin layer of a ceramic material, fusing said ceramic
 material to said shell and said partitions,
 inserting said partitions into said shell,
 thereafter removing at least a portion of said ceramic
 material circumjacent said apertures, and
 brazing said shell and said partitions together by plac-
 ing a molten deposit of a corrosion-resistant metallic
 bonding material in each of said apertures.

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18. The assembly as set forth in claim 17 wherein the portion of said ceramic material on said outer periphery of said partitions that registers with said apertures is removed together with said ceramic material circum-

5 adjacent said apertures.
19. In the assembly of an exhaust muffler shell and internal partitions therefor, the steps which include, forming the muffler shell with a plurality of longitudinally spaced apertures adapted to register with the outer periphery of at least some of said partitions, dipping preselected portions of said muffler shell and at least some of said partitions into a molten bath of a corrosion-resistant metallic bonding material, entirely coating said shell and said partitions with a thin layer of a ceramic material, 10 removing a portion of said ceramic material circumjacent said apertures and overlying the dipped portions of said shell and said partitions, inserting said partitions into said shell, applying heat to a portion of the exposed areas of said bonding material to fuse said dipped portions to said shell, and 15 brazing said shell and the partitions which register with said apertures together by placing the molten deposit of said bonding material in each of said apertures. 20

20. In the construction of an exhaust muffler assembly having a muffler shell, inlet and outlet headers and internal partitions for said shell, and inlet and outlet bushings, the steps which include, 25 forming the muffler shell with a plurality of longitudinally spaced apertures adapted to register with the outer periphery of said partitions, applying a corrosive-resistant metallic bonding material to the outer peripheral portions of said headers and to a portion of the interior surface of said shell, 30

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applying said bonding material to the outer ends of said inlet and outlet bushings, entirely coating said shell, partitions, headers, and bushings with a thin layer of a ceramic material, abrasively removing a strip of said ceramic material overlying said bonding material on said shell, said headers, and said inlet and outlet bushings, assembling said shell, partitions, headers and bushings, abrasively removing a portion of said bonding material circumjacent said apertures and that portion of said ceramic material on said outer periphery of said partitions that registers with said apertures, applying heat to the exposed areas of said bonding material on said shell and said headers, and brazing said shell and said partitions together by placing a molten deposit of said bonding material in each of said apertures. 35

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