Dec. 21, 1965 G. W. McNELLY 3,224,088

PROCESS FOR PRODUCING MULTI-LAYER METALLIC MATERIAL

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Fig. 1.

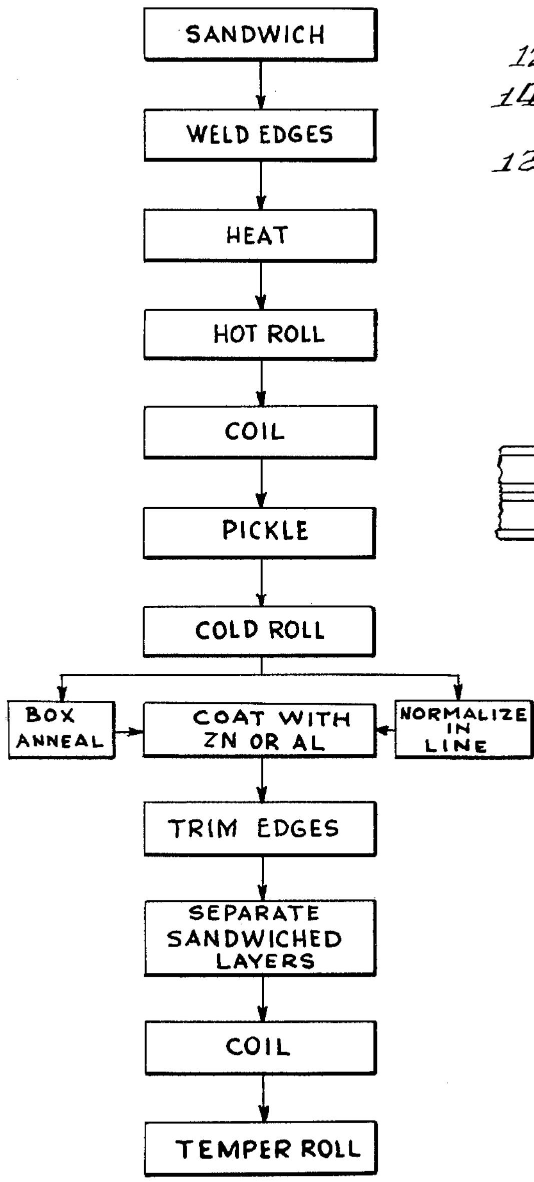


Fig. 2.

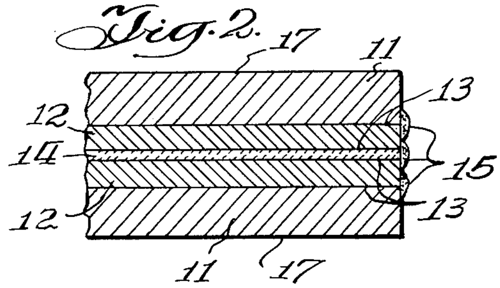


Fig. 3.

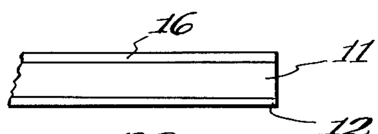
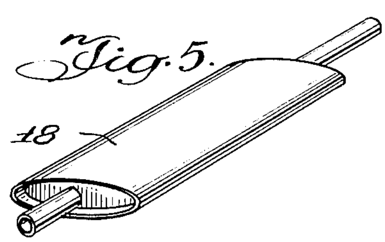


Fig. 4.

Fig. 5.



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PROCESS FOR PRODUCING MULTI-LAYER METALLIC MATERIAL

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The present invention relates generally to a process for producing multi-layer ferrous base flat material, and more particularly to a process for producing material of this general type for use in the walls of a fluid-confining chamber exposed to severe corrosive conditions on one side and to relatively less severe but still corrosive conditions on the other side.

A typical example of an article for which such material is intended is an automobile muffler, which has walls the inside of which are exposed to the severe corrosion caused by hot exhaust gases and the outside of which are exposed to the relatively less severe but still corrosive conditions of salty spray from streets salted in icy weather. For fluid confining chambers exposed to these corrosion conditions the present invention provides a multi-layer ferrous base flat material comprising a center layer of carbon steel, a first exterior layer of stainless steel, and a second exterior layer, opposite said first exterior layer, composed of a metal selected from the group consisting essentially of aluminum, zinc, and base alloys of each; the combined thickness of the two exterior layers being about one-tenth of the thickness of the low carbon steel center layer. When utilized in muffler walls or the like the first exterior layer, of stainless steel, is disposed on the inside where the most severe corrosive conditions are present, while the second exterior layer, of zinc, aluminum, etc., is on the outside where less severe but still corrosive conditions are present.

The present invention relates to a process for producing simultaneously two relatively continuous strips of the subject material in a manner to be described subsequently in detail.

Other features and advantages of the present invention are inherent in the material and process claimed and disclosed, or will become apparent to those skilled in the art from the following detailed description in conjunction with the accompanying drawings wherein:

FIGURE 1 is a flow diagram illustrating the individual steps of a typical embodiment of a process practiced in accordance with the present invention;

FIGURE 2 is a fragmentary schematic cross-sectional representation illustrating the appearance, at an initial stage of the subject process, of what ultimately becomes the subject material;

FIGURE 3 is a schematic representation, during a subsequent stage of the process, of what ultimately becomes the subject material;

FIGURE 4 is a schematic representation of one embodiment of the subject material, as finished; and

FIGURE 5 is a perspective view of an automobile muffler having walls constructed from one embodiment of the subject material.

Referring initially to FIGURE 4, the subject material constitutes essentially a multi-layered flat ferrous base material comprising, in the illustrated embodiment, a center layer 11 of carbon steel, a first exterior layer 12 of stainless steel, and a second exterior layer 16 of a metal selected from the group consisting essentially of zinc, aluminum, or base alloys of each. The carbon steel central layer has a typical composition as follows:

	Wt. percent
C ....up to..	1.0
Mn	0.6
P	.04
S ....max...	.05

Although the carbon content of the central layer is indicated as being of a relatively wide range, it is important that at least one surface portion of the central layer, adjacent the first exterior layer of stainless steel, have a low carbon content, e.g., about 0.03 wt. percent. This is to prevent the formation of a brittle interface between the central layer and the layer of stainless upon welding these two layers together during processing, said processing to be described subsequently. If the carbon content at the interface is too high, the embrittling effect will render the weld unsatisfactory.

A low carbon content at the surface in the range desired (e.g., up to about 0.08 wt. percent) may be obtained by providing a center layer of this composition, by providing a center layer of higher composition and decarburizing it to obtain the desired carbon content at one surface, by providing a center layer of higher composition having one surface clad with pure iron, etc.

The subject material is produced by a process the first step of which is to make a "sandwich" consisting of two inner layers of stainless steel 12, separated by an anti-weld compound 14, such as a mixture of aluminum oxide and lacquer spread like paint thinly and evenly over one of the two contacting surfaces, and two outer layers of carbon steel 11. The contacting surfaces of the low carbon and stainless layers are clean, so that no flux is necessary.

After a sandwich has been assembled as illustrated diagrammatically in FIGURE 2, the edges 13 of the several layers of the sandwich are welded continuously along the periphery of the sandwich, as at 15 in FIGURE 2, to prevent the entry of foreign material into the interstices between the several layers of material making up the sandwich. Continuous welding of the edges of the several layers also prevents lateral movement of one of the layers relative to the others during the subsequent processing operations to which the sandwich is subjected.

FIGURE 1 illustrates the steps in one embodiment of the subject process, said process including heating the sandwich to a temperature between about 2000° F. and 2400° F., and then subjecting the heated sandwich to hot rolling. This reduces the thickness of the sandwich and causes a fusion of stainless steel layers 12 to the adjacent carbon steel layers 11. At the same time, the anti-weld compound 14 between the two superimposed layers of stainless steel 12 prevents the welding of these two layers together. The welding of stainless steel to carbon steel by the sandwich method, as described above, is conventional and well-known in the art, and accordingly need not be described in greater detail.

Following the fusion operation described above, the sandwich is subjected to conventional coiling and pickling operations. After pickling, the sandwich, with its edge portions still welded shut to prevent the entry of foreign material, is subjected to a cold rolling operation to further reduce the thickness of the sandwich as well as the thickness of each of the individual layers making up the sandwich. This additional reduction in thickness is, of course, optional, depending upon the thickness desired for the final product.

Before the cold-worked sandwich is coated, it should be subjected to a heat treatment such as box annealing or an in-line normalizing treatment to improve the cold drawing qualities of the strip.

The next step is to coat the two exposed surfaces **17** of the sandwich, one on each of the carbon steel layers **11**, with a corrosion resistant metal such as zinc or aluminum. In a typical embodiment this may be accomplished by dipping, i.e., by passing the sandwich through a molten bath of the metal or alloy which constitutes the coating **16** (e.g., zinc, aluminum or base alloys of each).

After the coating step the sandwich is trimmed at the continuously sealed periphery thereof to remove the welded edge portions and enable the sandwich to be separated into two halves, each half consisting of a center layer of carbon steel **11**, a first exterior layer of stainless steel **12** and a second exterior layer of coating metal **16** (FIGURE 4). It is essential that the welded edge portions be retained until the coating step is concluded. This is to prevent entrance of foreign material, such as molten coating metal, into the interstice between the two non-welded layers of stainless steel **12**.

Each of the separated halves of the sandwich is then wound in a respective coil which may, if desired, be subjected to a subsequent temper roll of a conventional nature, well known to those skilled in the art.

In a typical end product, the multi-layer material includes a center layer **11** of carbon steel having a thickness of about 0.18 inch, a first exterior layer **12** of stainless steel having a thickness of about 0.015 inch, and a second exterior layer **16** constituting a coating of zinc or aluminum, a typical zinc layer being about ½ ounce of zinc per square foot, and a typical aluminum coating being about ¼ ounce aluminum per square foot. A typical thickness for layer **16** is about 0.001 inch and the combined thickness of the two layers **12** and **16** is about one-tenth of that of the center layer **11**.

A multi-layer ferrous base flat material of this nature will exhibit excellent resistance to severe corrosive conditions along one side (that covered with stainless steel) and excellent resistance to less severe but still corrosive conditions on the second side (that coated with, e.g., zinc). A typical application of this material would be in a wall of an article such as an automobile muffler **18** (FIGURE 5).

There has thus been described a material intended for use in the walls of a fluid-confining chamber, one side of which is subjected to severe corrosion conditions and the other side of which is subjected to less severe but still relatively corrosive conditions. There has also been described a process for producing two relatively continuous strips of the subject material simultaneously.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A process for producing a multi-layer, corrosion-resistant flat metallic material, said process comprising:

sandwiching a pair of stainless steel slabs between a pair of carbon steel slabs with a weld-preventing compound separating said stainless steel slabs;

said carbon steel slabs and said stainless steel slabs having clean contacting surfaces;

welding the edges of said sandwich continuously to prevent movement of one of the sandwiched slabs relative to another and to prevent entry of foreign material between any of the slabs until the weld is removed;

then hot rolling said sandwich to weld each of the stainless steel slabs to a respective one of said carbon steel slabs and to produce an elongated strip-like sandwich of reduced thickness capable of coiling;

pickling said strip-like sandwich;

cold rolling said sandwich after pickling;

heat treating said sandwich after cold rolling to improve its workability;

coating both exterior flat surfaces of said sandwich with a molten metal selected from the group consisting essentially of zinc, aluminum and base alloys of each, by dipping said sandwich in said molten material;

removing the continuously welded edge portions of said sandwich after said coating step to enable separation of the two sandwich halves;

and separating said sandwich into two halves, each comprising a center layer of carbon steel and integral exterior layers of said coating metal and stainless steel respectively.

2. A process for producing a multi-layer, corrosion-resistant flat metallic material, said process comprising:

sandwiching a pair of stainless steel slabs between a pair of carbon steel slabs with a weld-preventing compound separating said stainless steel slabs;

sealing said sandwich continuously along the periphery thereof to prevent entry of foreign material between any of the slabs until the seal is removed;

then welding each of the stainless steel slabs to a respective one of said carbon steel slabs by hot rolling;

then coating both exterior flat surfaces of said sandwich with a molten metal selected from the group consisting essentially of zinc, aluminum and base alloys of each, by dipping said sandwich in said molten metal;

then removing the continuously sealed periphery of said sandwich after said coating step to enable separation of the two sandwich halves;

and then separating said sandwich into two halves, each comprising a center layer of carbon steel and integral exterior layers of said coating metal and stainless steel respectively.

3. A process as recited in claim **2**, wherein said stainless steel slabs are sandwiched between carbon steel slabs containing less than 0.08 wt. percent carbon at their contacting surfaces.

4. A process as recited in claim **1**, wherein said stainless steel slabs are sandwiched between carbon steel slabs containing less than 0.08 wt. percent carbon at their contacting surfaces.

5. A process for producing a multi-layer, flat metallic material, said process comprising:

sandwiching a first pair of metallic slabs of a first composition between a second pair of metallic slabs of a second composition with a weld-preventing compound separating said first pair of slabs;

sealing said sandwich continuously along the periphery thereof to prevent entry of foreign material between any of the slabs until the seal is removed;

then welding each of the first pair of slabs to a respective one of said second pair of slabs by hot rolling;

then coating both exterior flat surfaces of said sandwich with a molten metal of a third composition, by dipping said sandwich in said molten metal;

then removing the continuously sealed periphery of said sandwich after said coating step to enable separation of the two sandwich halves;

and then separating said sandwich into two halves, each comprising a center layer of said second composition and integral opposite exterior layers of said first composition and said third composition respectively.

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