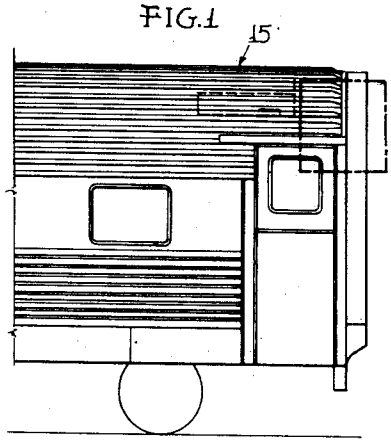
April 28, 1953 M. WATTER 2,636,968

SEALED SEAM ATTACHMENT OF CORRUGATED SHEET METAL

Filed July 23, 1948

2 SHEETS—SHEET 1

FIG. 1



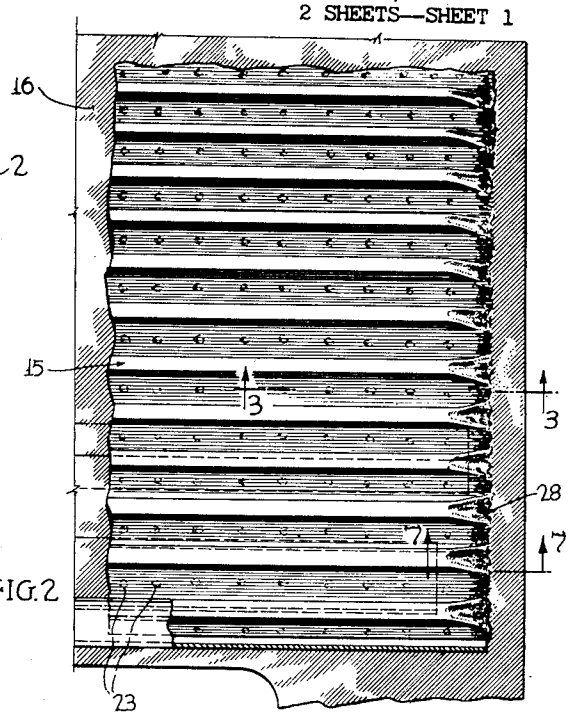


FIG. 2

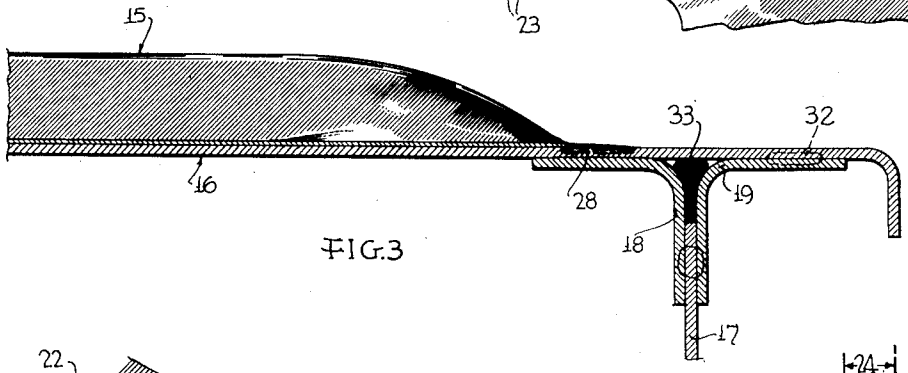


FIG. 3

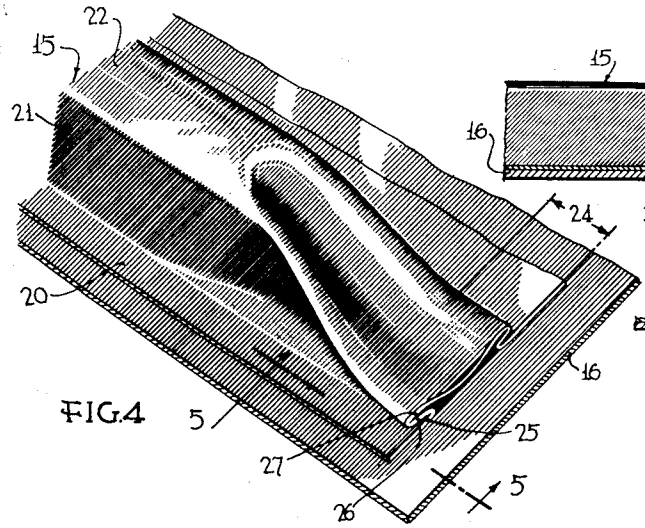


FIG. 4



FIG. 5

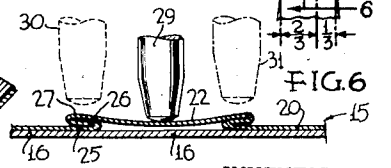


FIG. 6

INVENTOR.
Michael Watter
BY Maurice A. Creos
ATTORNEY

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SEALED SEAM ATTACHMENT OF CORRUGATED SHEET METAL

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2 SHEETS—SHEET 2

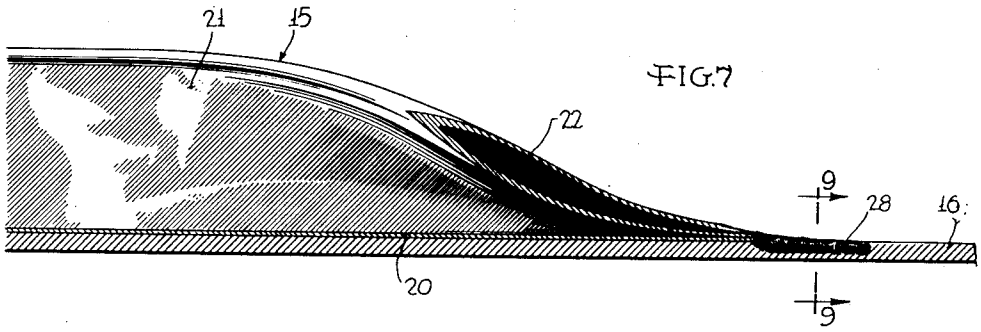


FIG. 7

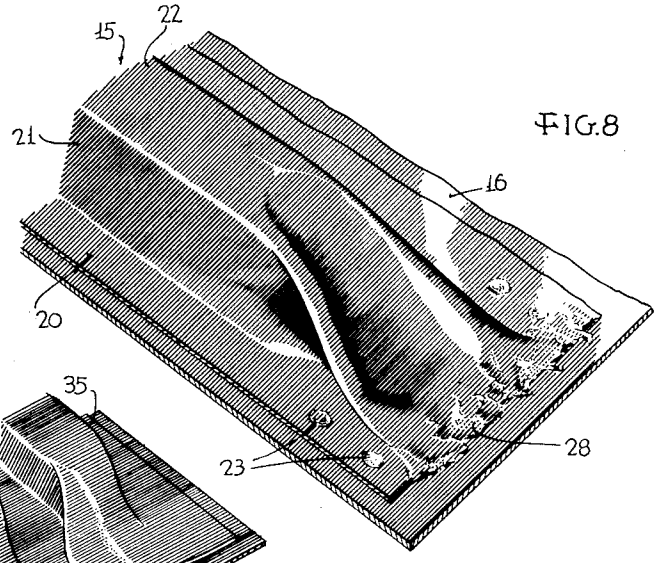


FIG. 8

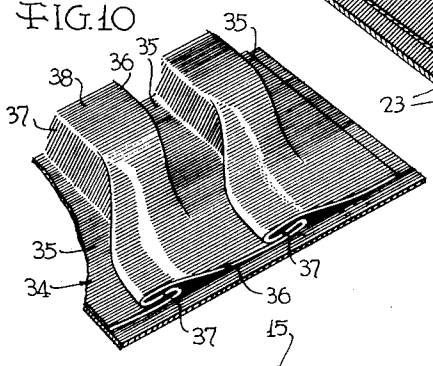


FIG. 10

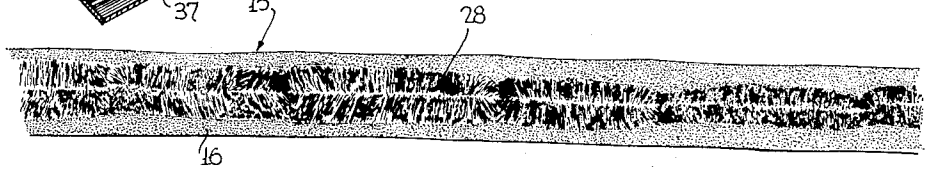


FIG. 9

INVENTOR.
Michael Watter

BY
Maurice L. Crews

ATTORNEY

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UNITED STATES PATENT OFFICE

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SEALED SEAM ATTACHMENT OF CORRUGATED SHEET METAL

Michael Watter, Philadelphia, Pa., assignor to The Budd Company, Philadelphia, Pa., a corporation of Pennsylvania

Application July 23, 1948, Serial No. 40,238

11 Claims. (Cl. 219—10)

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The invention relates principally to the structure and to the making of a sealed seam (i. e., fluid- and dust-proof) attachment of a corrugated sheet metal member to another metal member along a margin traversing the corrugations.

More specifically, the invention relates to sealed seam connections between an outer corrugated skin or sheathing and adjoining members of vehicle bodies, especially railway cars, highway trailers and the like.

An object of the invention is to obtain a connection or attachment of the indicated type which is truly fluid- and dust-tight, which is dependable and durable, which can be made conveniently on a production basis and which, above all, avoids the necessity of using solder, with its many drawbacks.

The objects and advantages of the invention are achieved through the attachment of the locally flattened corrugations to the underlying member by a continuous electric resistance seam weld which not only unites the directly contacting surfaces of the corrugated sheet and the underlying member but also unites the reversely bent, flattened wall portions of the corrugations with each other by a substantially homogeneous, continuous zone of fused metal.

The manner in which the above and further features, objects and advantages of the invention are achieved is fully disclosed in the attached drawing and the following detailed description.

In the drawing:

Figure 1 is a small-scale diagrammatic side elevation of the end region of a railway car having a corrugated metal roof sheathing;

Figure 2 is an enlarged fragmentary view of the region surrounded by the dot-and-dash line 2—2 of Figure 1;

Figure 3 is a fragmentary section, on a still larger scale, along line 3—3 of Figure 2;

Figure 4 is a fragmentary perspective view of one corrugation and the underlying structure prior to the establishment of the sealed seam;

Figure 5 is a fragmentary section along line 5—5 of Figure 4 and a diagrammatic side view of a spot welding electrode;

Figure 6 is a diagrammatic, partly sectional, view along line 6—6 of Figure 5 illustrating the sequence of certain initial welding operations;

Figure 7 is a fragmentary section taken along line 7—7 of Figure 2;

Figure 8 is a perspective diagrammatic view corresponding to Figure 4 showing the completed joint between the corrugated sheet and the underlying member;

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Figure 9 is a section along line 9—9 of Figure 7 through the completed sealed seam along its longitudinal extent; and

Figure 10 is a fragmentary perspective view corresponding to Figure 4 but illustrating a modification of the flattening of the corrugations.

The railway car body illustrated in the drawing has a roof skin or sheathing 15 of longitudinally corrugated sheet metal secured at its ends to a shear panel 16 of flat stock and an end wall panel 17 reinforced peripherally by angle-section rails 18 and 19 which support member 16. The corrugations or nodes of sheet 15 have bottom walls 20, side walls 21 and top walls 22. The bottom walls 20 are structurally connected by spaced spot welds 23 to the underlying structural member 16.

For obtaining a fluid-tight closure of the ends of the corrugations in the known construction described so far, it has been a practice to flatten the ends of the corrugations, as shown in Figure 4, and then close the remaining openings or passages by applying solder to the members 15 and 16 in a narrow region on both sides of the edge of the corrugated sheet. As indicated above, this soldering procedure has numerous serious drawbacks, inasmuch as it is expensive, on account of the high cost of the solder and the time required for its application, as it requires skilled, meticulous workmanship and as it impairs the appearance, especially when the structure consists of shiny metal, such as stainless steel.

In carrying out the invention, care is taken that a marginal strip 24 of a certain width, Figure 5, is flattened so that in this region wall portions of the corrugations are folded back upon each other in three layers, 25, 26 and 27, whereas the intervening portions of the bottom and top walls 20 and 22, Figure 6, remain single-layer. The extreme edge portion of the corrugated sheet is secured to the underlying member 16 by a continuous electric resistance weld 28 which fairs the edge of the corrugated sheet into the outer surface of member 16 and integrally connects the three layers 26, 25, 27 without leaving any passages transversely to the edge of the corrugated sheet. Thus, a sealed seam is formed, as shown in Figures 3, 7 and 8.

An effective method of obtaining the weld connection 28 comprises the following steps:

After the corrugated sheet 15 is flattened at 24 and structurally connected to the member 16 by welds 23, single spaced welds are first made along the edge of the corrugated sheet at about the centers of the flattened tops 22 of the nodes, as indicated by the position of the electrode 29

shown in full line, and in each triple-layer region 25, 26, 27, as indicated by the positions of the electrode shown in dotted and dot-and-dash lines 30, 31, respectively, in Figure 6. These three locations on each corrugation were found to be somewhat critical, and it was discovered that the seam could be made more easily, economically and safely by starting the welding at these three locations rather than making the continuous close-space spot or seam welding at once. The single weld operations forge the three layers 25, 26, 27 together and force the ends of the top walls into contact with the member 16.

Upon completion of the single welds at the margin, the corrugated sheet 15 is secured fluid-tightly to the underlying structure 16 by close-space spot welding, such as tangent welding, or by seam welding. This produces the continuous seam 28 and may also fair the edge of sheet 15 into member 16.

In making the welds, the electrodes are preferably placed on the very edge of corrugated sheet 15, so that about two-thirds of the contact surface of the electrodes are over the sheet, whereas the remaining one-third projects outwardly thereheyond, as illustrated in Figure 5. This location of the electrodes, coupled with a relatively high electrode pressure, facilitates the forging together of the three layers 25, 26 and 27 and the tapering of the entire edge of sheet 15, resulting in the continuous weld 28 and the merger or fairing of the surface of sheet 15 into the surface of member 16.

For reasons of simplicity and economy of procedure, the last welding step is carried out without regard to the welds previously made at the locations 29, 30, 31, instead of merely filling in the missing welds.

In a practical case illustrating the invention, good results were achieved for securing austenitic cold-rolled corrugated .02" gauge stainless steel to a .06" gauge member of the same material, in using an electrode pressure of about 2,000 pounds, a time for each single weld of 6 to 10 cycles of 60-cycle current, an electrode diameter of about ½" and a spacing between the welds giving about 25% overlap between adjacent weld nuggets.

After completion of the welding, a barbed structure is sometimes noted to have been formed by molten metal squeezed out beyond the edge of the sheet 15. If necessary or desirable, the weld region is subsequently smoothed and the loose barbs removed by appropriate means, such as a rotating wire brush. The final appearance is then as shown in Figure 8, but in many cases, the edge will be even more uniform and have a less irregular marginal line, depending on the proper adjustment of all factors involved and upon the skill exercised by the workman.

The finished composite structure 15, 16, together with other elements of the roof strucure, is placed on the rails 18, 19 of end wall 17 and is secured to rail 19 by welds 32. A caulking compound is placed at 33 between the rails 18, 19 to seal the connection between end wall and roof.

While the stresses between the roof skin 15, which, in the illustrated embodiment, constitutes a structural element of the body, and the member 16 are mostly transmitted by the welds 19, it is important that the seal have sufficient strength to avoid tearing out or cracking when subjected to a certain unavoidable amount of stress. This is the case with the seal formed by weld 28.

Figure 10 illustrates a novel way of flattening the ends of the corrugations preparatory to the establishment of the sealed seam. The sheet 34 has corrugations formed by bottom walls 35, side walls 36 and 37 and top walls 38. The ends of the corrugations are flattened toward one side by straightening out the adjoining bottom walls 35, side walls 36 and top walls 38 while folding the other side walls 37 between the top and bottom walls. The exact location of the creases is, of course, dictated by the shape and dimensions of the corrugations. Also for this formation it is advisable to make single welds at least in the three-layer regions and possibly in regions adjacent thereto, before completing the continuous seam.

The invention has particular advantages over seals obtained by such means as gas or arc welding in its application to cold-rolled austenitic high-tensile stainless steel. The weld timing and heat input of electric resistance welding, used in connection with the invention, can easily be regulated and kept at a minimum in accordance with known rules for avoiding deleterious changes of the physical and chemical properties of this type of material. Nor is there undue weakening of the cold-worked strength by the annealing incidental to the welding operation, because the extent of annealed zone is kept small. Similar considerations apply also to other metals having desirable qualities which may be affected by prolonged or intensive heating connected, for instance, with arc or gas welding.

The invention is not restricted to the illustrated and described embodiment, nor to all the details thereof, as indicated by the following enumeration of some examples of available variants. Obviously, electrode diameter, electrode pressure, weld spacing, etc., have to be adjusted to the natures and the gauges of the materials to be welded together. Furthermore, adjustments may be made so as to carry out the invention with available welding equipment. The result achieved in the three-layer regions by the initial welds may also be achieved by other means forging the layers together preparatory to the making of the continuous weld. There is a great latitude in regard to the spacing of successive welds. While an overlap of about 25% is suggested above, a wider spacing in which the weld nuggets just touch each other or are even slightly spaced without leaving a passage for fluid between them, is satisfactory. Not only the ends of a sheet, but also margins at cut-outs, openings and the like may be sealed off in the same manner. The invention may also be used for securing a corrugated sheet intermediate its ends to a member, such as to a margin of a partition wall, by flattening the corrugations in the attachment zone and then closing all passages in the longitudinal direction of the corrugations by a practically continuous resistance weld which obliterates in its zone the multi-layer structure and makes a homogeneous unit of all layers of the corrugated sheet and the underlying structure to which it is secured. The term "corrugation" is to be understood in a broad sense, and the invention is applicable to the attachment of hat-sections, sheets having widely spaced nodes or channels, or having for other reasons, multi-layer regions, which hitherto were deemed to prevent the formation of a continuous tight seam by means of resistance welding.

Protection is sought in the light of these explanations for basic features of the invention, in addition to protection for more specific illustrated and described features.

What is claimed is:

1. In a structure comprising a metal sheet provided with corrugations and overlappingly contacting another metal member, said corrugations being flattened in a localized elongated region extending transversely to the corrugations by having portions of the sheet folded in three layers reversely upon each other, and an elongated electric resistance weld in said region uninterruptedly connecting said sheet and member by their own substance at their interface, extending through said layers and filling all passages between sheet and member and between said layers, whereby a sealed seam is formed.

2. In a structure comprising a metal sheet provided with corrugations and overlappingly contacting another metal member, said corrugations being locally flattened along a margin of the sheet extending transversely to the corrugations, the flattening comprising portions of the sheet folded in three layers reversely upon each other, and a practically continuous electric resistance weld along said margin uninterruptedly connecting said sheet and member at their interface by fused parts of their own substance and extending through said layers in closing all passages between sheet and member and between said layers.

3. In a structure comprising a metal sheet provided with corrugations and overlappingly contacting another metal member, said corrugations being flattened in an elongated region extending along one margin of the sheet transversely to the corrugations by having portions of the sheet folded in three layers reversely upon each other, and an elongated electric resistance weld uninterruptedly connecting the margin of said sheet and said member at their interface, extending through said layers and filling, by fused parts of said metal members all passages between said margin of the sheet and said member and between said layers, the surface of the sheet at the margin being tapered and faired into the surface of said member.

4. In a fabricated structure, a sheet metal member provided with at least one channel-section formation and overlappingly contacting a surface of another metal member, said channel-section formation having a restricted region flattened by reverse three-layer folds of portions of the sheet member, said three-layer folds being reduced in aggregate thickness to the thickness of the adjoining portions of the sheet member along an elongated zone extending transversely to the channel-section, and a continuous electric resistance weld connecting in said zone the sheet member to said other member at their interface and extending through said three-layer folds thereby forming a sealed seam between the two members free of extraneously supplied sealing material.

5. Sealed seam between a margin of a metal sheet and the surface of an underlying metal member at a distance from the margins of the latter, comprising a continuous electric resistance weld connecting said sheet and member at their interface along the extreme limit of said margin and fairing the outer surface of the sheet into the adjoining surface of said member.

6. In a fabricated article, a sheet metal structure overlappingly contacting a surface of another metal member and having a multi-layer formation adjoined by a single-layer formation, said

multi-layer formation being reduced in aggregate thickness to the thickness of the adjoining single-layer formation in an elongated zone traversing both formations, and a continuous electric resistance weld providing a fused inclusion formed by the parent metal of said metal structure and member, said inclusion connecting in said zone the sheet metal structure to said member at their interface and extending through said multi-layer formation thereby forming a sealed seam between said structure and said member.

7. Method of making a fluid-tight connection between an edge of a corrugated metal sheet and a surface of another member, comprising the known step of flattening the corrugations along the margin to be sealed so that the side walls and adjoining wall portions of the corrugations are reversely bent upon each other in three overlapping layers, the step of securing by single spot welds the walls forming the uppermost layers along said edge to the underlying member at points adjacent the reversely bent portions and of securing by single spot welds the three layers to each other and to said member, and the step of forming a continuous electric resistance weld seam between said edge of the corrugated sheet and said member.

8. In a method of making a fluid-tight connection between the edge of a corrugated metal sheet and an underlying flat surface metal member by electric resistance welding, comprising the step of flattening the ends of the corrugations along the edge to be secured and of making the welds by an electrode placed on the edge of the corrugated sheet so that part of the contact surface of the electrode projects beyond such edge.

9. In a method according to claim 8, in which the part of the electrode contact surface located on the corrugated sheet is greater than the part which extends beyond the edge of the sheet.

10. In a method according to claim 8, in which about one-third of the electrode contact surface extends beyond the edge of the corrugated sheet.

11. Method of making a fluid-tight connection between the edge of a corrugated sheet and a surface of another member, comprising the step of flattening the corrugations along an elongated zone so that the side walls and adjoining wall portions of the corrugations are reversely bent upon each other in three overlapping layers, and the step of forming a continuous electric resistance weld seam in said zone between said corrugated sheet and said member in using an electrode pressure forging the three layers together and reducing their aggregate thickness to about the gauge of the sheet.

MICHAEL WATTER.

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