United States Patent

[11] 3,615,276

[72] Inventor **Fred G. Singleton**
Pittsburgh, Pa.

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[73] Assignee **H. H. Robertson Company**
Pittsburgh, Pa.

[54] **PROTECTED METAL ARTICLE**
5 Claims, 4 Drawing Figs.

[52] U.S. Cl. **29/195,** 29/473.1, 161/93
[51] **Int. Cl.** **B32b 15/14**
[50] **Field of Search** 29/195; 161/93

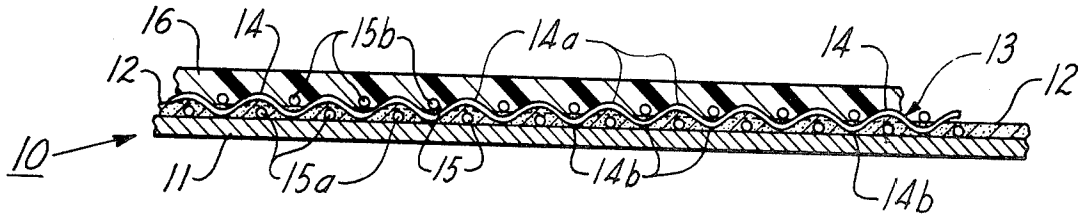
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Primary Examiner—L. Dewayne Rutledge
Assistant Examiner—E. L. Weise
Attorney—Harry B. Keck

ABSTRACT: A protected metal article consisting of a core of sheet steel coated sequentially with a protective metal consisting essentially of zinc; a fibrous glass cloth impressed into the protective metal and a weather-resistant outer coating applied to the fibrous glass cloth. The fibrous glass cloth may comprise either a glass fiber thread woven fabric or a bonded mat formed from randomly oriented continuous glass fiber filaments. The article is prepared by applying a molten protective metal coating consisting essentially of zinc to a steel sheet and, while the coating is in its molten condition, impressing a fibrous glass cloth into the protective metal and fusing the protective metal whereby the fibrous glass cloth is partially embedded within the protective metal.



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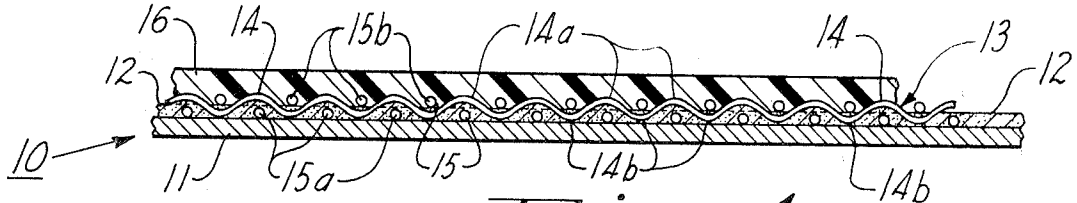


Fig. 1

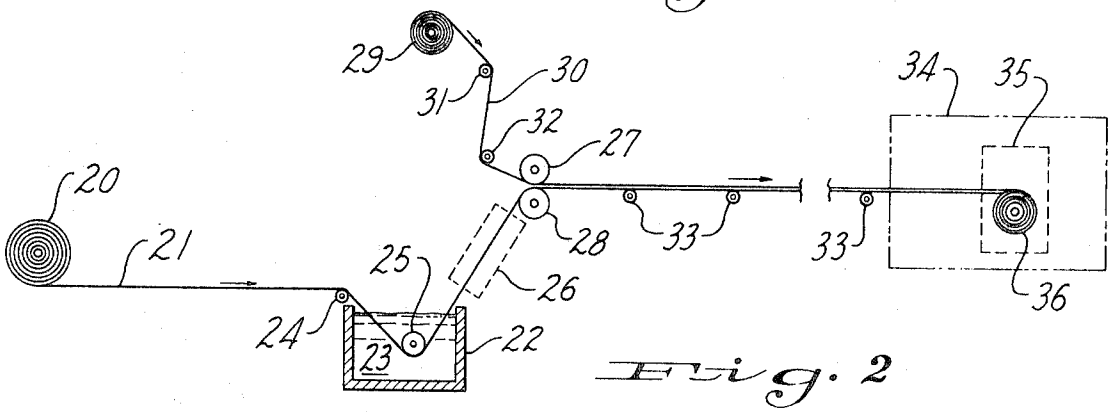


Fig. 2

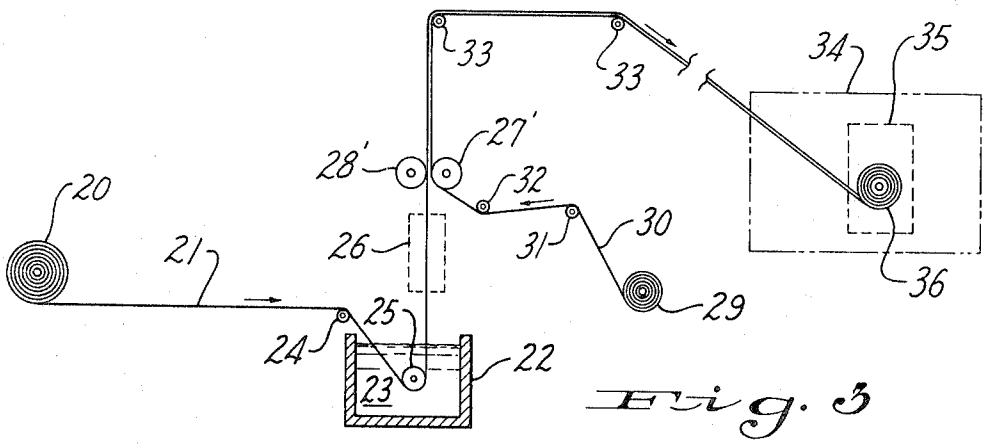


Fig. 3

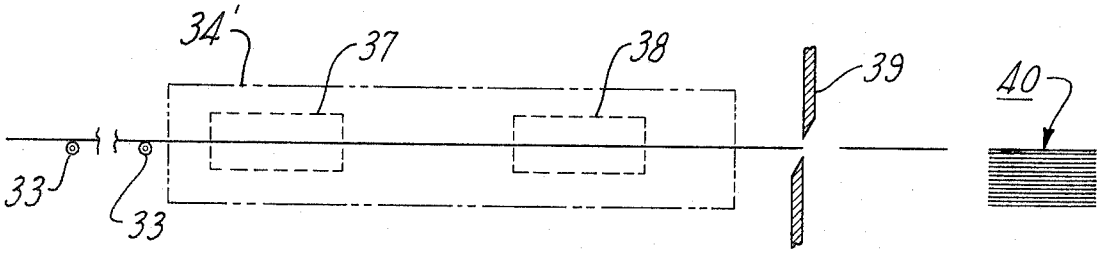


Fig. 4

INVENTOR.
FRED G. SINGLETON
BY
Harry B. Keck
ATTORNEY

PROTECTED METAL ARTICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to protected metal articles and more particularly to protected steel sheets adapted especially for use in building construction.

2. Description of the Prior Art

Enormous quantities of protected metal have been produced in the past by impressing asbestos fiber felt into a molten zinc-containing coating on a steel sheet, U.S. Pat. No. 2,073,334. Subsequently, the asbestos felt coated sheet is dipped into an asphaltic impregnant and thereafter a weather-resistant coating is applied to the asphalt impregnated asbestos felt which is itself mechanically bonded to the steel core by its partial embedment in the coating of zinc-containing material. Since the original development of this protected metal sheet which is sold throughout the world under the registered trademark GALBESTOS, substantial improvements have been made in the fabrication facilities and techniques and composition of the weather-resistant coating materials.

GALBESTOS walls and roofs have already demonstrated life expectancies greater than thirty years; many of the original installations are still in active use. The protected metal sheets are sometimes corrugated or otherwise profiled to produce building roofing and sheathing panels. See U.S. Pat. No. 3,150,465. The sheets occasionally are rolled to produce tubular products, such as round ventilator housings. SUMMARY OF THE INVENTION

According to the present invention, a protected metal sheet can be produced by embedment of a fibrous glass cloth into a molten protective metal coating consisting essentially of zinc which is adhered directly to a steel core. The resulting article consists of a steel core which has adhered to at least one surface a metal protective coating essentially of zinc. Impressed into the metal protective coating is a fibrous glass cloth which is retained in the metal protective coating by partial embedment. The fibrous glass cloth may be either

a. glass fiber thread woven fabric having essentially uniformly shaped interstices between the warp and wool threads and including from about 25 to 50 threads per inch as warp threads and from about 25 to 50 threads per inch as woof threads; or

b. a continuous filament glass fiber bonded mat fabricated from glass filaments which are retained in a random orientation by a suitable binder of starch, resin or the like.

If desired, an outer weather-resistant coating, preferably pigmented to a desired color, may be applied to the surface of the protected metal sheet having the fibrous glass cloth partially embedded therein. If the weather-resistant coating is extremely thin, e.g., 1 mil or thereabout, the texture of the fibrous glass cloth will be visually discernible in the protected metal surface. If heavier weather-resistant coatings are employed, e.g., about 5 mils and thicker, then the interstices of the fibrous glass cloth will be filled as valleys and the fibrous glass cloth configuration will not be visually discernible in the final product.

By treating the present article with a zinc-phosphate conversion treatment prior to application of the outer weather-resistant coating, a significantly improved bond of glass to metal can be achieved. It has been discovered that a chromate conversion treatment applied to the surface does not improve the adhesion of the glass to metal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional illustration of a protected metal sheet fabricated in accordance with the present invention;

FIG. 2 is a schematic illustration of typical apparatus adapted to produce the present protected metal sheets on a continuous basis;

FIG. 3 is a schematic illustration similar to FIG. 2 illustrating an alternative embodiment of typical apparatus adapted to produce the present protected metal sheet in a continuous strip form; and

FIG. 4 is a schematic illustration of alternative terminal apparatus which may be substituted in FIGS. 2 or 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, the present protected metal sheet includes a core sheet 11 which is ordinarily carbon steel having a thickness from about 28 gauge through about 10 gauge. Thicknesses from about 26 gauge to about 18 gauge are preferred.

Directly bonded to one surface of the steel core 11 is a suitable film 12 of a protective metal material, consisting essentially of zinc metal. The zinc metal is adhered to the steel core 11 in the manner of a galvanized coating. Embedded within the protective metal coating 12 over substantially the entire surface there is a fibrous glass cloth identified by the numeral 13. When the fibrous glass cloth is a glass fiber thread woven fabric, the cloth presents warp threads 14 and woof threads 15.

The view of FIG. 1 is taken along a single-warp thread 14 which exposes to view the weaving undulations including crests 14*a* and valleys 14*b*. In this view, the woof threads 15 include threads 15*a* which pass beneath the wrap crests 14*a* and include threads 15*b* which pass above the valleys 14*b*. It will be observed that the underneath woof thread segments 15*a* and the valley portions 14*b* of the warp threads are embedded within the protective metal coating 12 whereas the warp crests 14*a* and the woof thread portions 15*b* are outboard from the protective metal coating 12 and are not embedded therein. This desired partial embedment of the glass fiber thread woven fabric 13 is achieved by careful control of the amount of protective metal which is applied as the coating 12.

When a continuous filament bonded mat is selected as the fibrous glass cloth, the filaments cross over and under one another and create interstices which resemble those of the warp and woof threads of FIG. 1. Each filament is partially embedded in the protective metal and secured by the partial embedment.

An outer weather-resistant coating 16 is applied over the fibrous glass cloth 13. As seen in FIG. 1, the weather-resistant outer coating 16 is relatively thick and as a result, the configuration of the fibrous glass cloth 13 is not discernible when the exposed surface of the coating 16 is inspected.

The weather-resistant outer coating 16 may be an alkyd resin, a urethane coating, a polyvinyl chloride or polyvinyl fluoride resin, a silicone-modified polyester resin, paints, lacquers or the like. Preferably, the weather-resistant outer coating 16 will retain sufficient ductility to permit the bending and/or rolling of the sheet 10 after the coating 16 has been applied to the outer surface.

As shown in FIG. 2, the present protected metal sheet can be fabricated in a continuous strip form from a coil 20 of strip steel having a thickness of 28 gauge to 10 gauge and a width from about 1.5 feet to about 5 feet. A strip 21 of the steel is uncoiled and delivered into a vat 22 containing an inventory 23 of molten protective metal consisting essentially of zinc.

The molten metal inventory 23 may contain aluminum or lead in small quantities, if desired. Other molten metals may accumulate within the vat 23 as impurities in insignificant amounts.

The strip 21 preferably is subjected to cleaning, oxide removal and grease removal washings prior to entry into the vat 22 over an idler roller 24. Customarily, a holddown roller 25 is provided within the vat 22 to maintain the strip 21 under the surface of the inventory 23 for a desired period of time to allow the strip 21 to develop a molten-metal coating of acceptable thickness. As the strip 21 exits from the vat 22, it passes through a heating zone 26 which provides extrinsic heat to the molten-metal-coated strip to prevent the premature solidification of the molten coating on the outer surfaces of the strip. The molten-metal-coated strip is delivered between a pair of bonding rolls 27, 28 which have their axes in vertical alignment and are pressed together at the nip by a substantial pressure. Pressures of the order of 40,000 pounds are contem-

plated. The bonding rolls **27, 28** preferably are fabricated from tool steel and serve to extract the residual heat from the molten protective metal and to cause the molten metal to be chilled and fused as it passes into and through the nip of the rolls.

A reel **29** of fibrous glass cloth is provided adjacent to the bonding rolls **27, 28**. A sheet **30** of the cloth is drawn from the reel **29** over idler rollers **31, 32** and is fed into the nip between the rolls **27, 28** along with the molten-metal-coated steel strip. The sheet **30** is pressed into the molten metal coating at the same instant that the metal coating is being chilled by its initial contact at the hip between the rolls **27, 28** whereby the metal-coating fuses with the fabric sheet **30** partially embedded therein.

The underside of the strip **21** is preferably not coated with the fibrous glass cloth and is preferably coated with a relatively thin film of the protective metal to provide some corrosion resistance for the surface of the steel sheet. Coating thickness control on the underside of the sheet may be achieved by impingement of flames, steam, heated gases, against the surface, or by mechanical wiping or rolling of the under surface while the protective metal coating is in a molten condition.

From the nip between the bonding rolls **27, 28**, the product sheet is delivered over suitable idler rollers **33** to a terminal apparatus **34** including a recoiling device **35** where the continuous strip is formed into coils **36** of suitable length for subsequent coating.

If desired, as shown in FIG. **4**, the resulting protected metal sheet may be introduced into alternative terminal apparatus **34'** where the sheets are coated immediately by passing through a suitable zinc phosphate conversion coating system indicated schematically at **37** and thereafter through a suitable coating system indicated schematically at **38**. The resulting coated sheet is cut to length in a suitable guillotine **39** and the cut lengths of coated product are accumulated in a stack **40**.

THe embodiment illustrated in FIG. **3** employs corresponding numerals and includes essentially the same components illustrated in FIG. **2**. In FIG. **3**, the bonding rolls **27'28'** are presented in horizontal axial alignment where as the bonding rolls **27, 28** of FIG. **2** are presented with vertical axial alignment.

GENERAL COMMENTS

THe protected metal articles according to the present invention achieve a high degree of corrosion protection without requiring an asphaltic or bituminous coating of the type previously required in protected metal sheets. The fibrous glass cloth provides an excellent surface for the adhesion of a weather-resistant outer coating.

EXAMPLES

A number of specimens of metal sheets were prepared from 22 gauge steel coated with molten zinc metal. 1. glass thread woven fabric 40X40 threads per inch

2. glass thread woven fabric 40X32 threads per inch

3. continuous filament glass fiber bonded mat having thickness of 10 mils bonded with an adhesive material:

a. starch

b. polyester resin

c. acrylic resin

d. epoxy resin.

In each instance, the fibrous glass cloth successfully bonded to the molten zinc coating with the filaments or thread being partially embedded within the metal. Multiple identical specimens of the glass fiber thread woven fabric embedded sheets were obtained. Several were dipped in a zinc-phosphate conversion bath; others were dipped in a chromate conversion bath; others were untreated. The glass fabric was much more difficult to remove from the sheets which had received the zinc-phosphate conversion treatment. The glass fabric was attached about equally to the untreated sheets and to the sheets which had been chromate conversion treated.

Outer weather-resistant coatings of alkyd resins and of silicone-modified polyesters adhered well to all specimens.

The continuous glass fiber mats described in this specification should be distinguished from the chopped glass fiber mats which are widely employed in manufacturing glass-fiber-reinforced plastic laminates. Such chopped glass fiber mats can be applied to a molten zinc coating, but the resulting product is unacceptable as a protected metal sheet.

I claim:

1. A protected metal sheet comprising:

a steel core;

a protective metal coating over at least one surface of the said core, said coating consisting essentially of zinc;

a fibrous glass cloth impressed into the said protective metal coating, and secured thereto by partial embedment in the said protective metal, said cloth having essentially uniformly distributed interstices between the fibrous glass components of the said cloth.

2. The protected metal sheet of claim **1** including a weatherproof coating applied over the said fibrous glass cloth.

3. A protected metal sheet of claim **1** wherein the said fibrous glass cloth is glass fiber thread woven fabric containing from 25 to 50 threads per inch as woof threads.

4. The protected metal sheet of claim **1** wherein the said fibrous glass cloth is a mat formed from continuous glass fibers.

5. The protected metal sheet of claim **4**, wherein the said continuous glass fibers are bonded in the said mat by an adhesive material.