Sept. 27, 1966 H. E. KENNEDY 3,274,679

PROCESS FOR FABRICATING PROTECTED METAL SHEETS

Filed Dec. 19, 1963

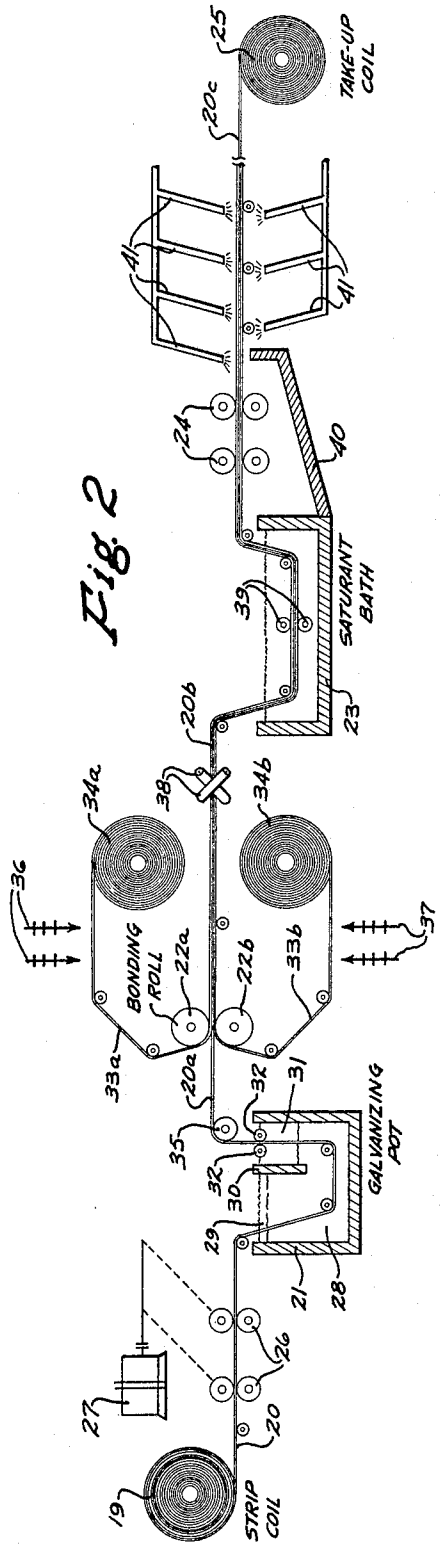



Fig. 2

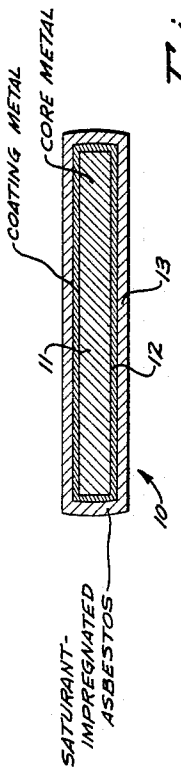



Fig. 1

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United States Patent Office 3,274,679 Patented Sept. 27, 1966



3,274,679

# PROCESS FOR FABRICATING PROTECTED METAL SHEETS

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Filed Dec. 19, 1963, Ser. No. 331,719
4 Claims. (Cl. 29—473.1)

This invention relates to an improved process for making protected metal sheets, and more particularly to a process for producing protected metal from continuous strips of core metal in coil form.

The production of protected metal is described in U.S. patents of Alden W. Coffman, 2,073,334, 2,631,641 and 2,764,808 inter alia.

The object of this invention is to provide an improved method for fabricating long lengths of uniform protected metal building sheets in an efficient manner whereby the resulting strip can be readily coiled and uncoiled.

In the accompanying drawings:

FIGURE 1 is a cross-sectional view of a typical protected metal building sheet described in the aforementioned U.S. Patents 2,073,334, 2,631,641, and 2,764,808;

FIGURE 2 is a schematic illustration of apparatus similar to that shown in the aforementioned U.S. Patents 2,631,641 and 2,764,808 for preparing protected metal sheets in long coiled strips.

*Protected metal sheets*

A protected metal sheet **10** is shown in FIGURE 1, comprising a metal sheet core **11**, a coating of adhesive non-corrodible metal **12** and an outer fibrous wrap **13**. The metal core **11** is formed from iron or steel, from about 14 gauge to about 28 gauge thickness, preferably from about 18 gauge to about 26 gauge thickness. Either cold-rolled or hot-rolled steel sheets are suitable. The non-corrodible adhesive metal coating **12** is preferably zinc, although various zinc alloys are acceptable as well as tin, cadmium, lead or other non-corrodible metals or alloys. The adhesive coating **12** becomes alloyed with the metal core **11** during the fabrication of the protected metal sheet **10**.

The adhesive metal coating **12** is affixed to the metal core **11** usually by a hot dip process wherein a film of molten adhesive coating metal is applied directly to the entire outer surface of the metal core. While the adhesive coating remains molten, the fibrous wrap **13** is pressed into the molten adhesive coating whereby the fibers of the wraps become mechanically keyed or anchored to the resulting protected metal sheet **10**. The foregoing processing technology is described in the aforementioned U.S. Patent 2,073,334. Subsequently the fibrous wraps **13** are impregnated with a resinous or bituminous saturant which provides weather-resistant properties for the resulting laminated building sheet.

The prior art methods for producing continuous protected metal strip have provided for chilling of the product saturant-coated strip prior to coiling in order to promote congealing of the usually tacky saturant prior to the coiling of the strip.

The present invention, contrary to the prior art suggestions, maintains the saturant-coated strip at a high temperature level prior to the coiling operation with the totally unexpected result that the coiled strip, after "aging" for several days, is

(1) Virtually free of wrap-to-wrap adhesion;

(2) Virtually free of separations of the saturant-impregnated fibrous wrap **13** from the steel core **11**;

(3) Presents highly uniform saturant impregnation, i.e., does not exhibit any saturant-free white-spots or light-spots.



The typical generalized processing apparatus for fabricating protected metal sheets will be described briefly in connection with FIGURE 2.

Typical processing apparatus is presented in FIGURE 2 wherein a coil **19** of metal core sheet **20** is positioned in uncoiling attitude at the entry point of a sequential processing system. The coil **19** preferably comprises a sheet **20** of cold-rolled steel or hot-rolled steel having a thickness from about 18 gauge through about 26 gauge. The metal core sheet **20** is delivered sequentially through a galvanizing pot **21**, a pair of vertically aligned bonding rolls **22***a*, **22***b*, a saturant impregnating bath **23**, saturant squeeze rolls **24** and a final take-up coil **25**.

Drive means such as sheet-engaging rollers **26** are provided for the metal core sheet **20** between the coil **19** and the galvanizing pot **21**. The rollers **26** may be driven in synchronism by a suitable motive power source such as an electric motor **27**.

The galvanizing bath **21** comprises preferably a container having an inventory of molten heating metal such as lead **28**, a supernatant layer of molten flux **29** on one side of a vertical baffle **30** and a supernatant layer of the molten adhesive metal **31** on the other side of the vertical baffle **30**. A pair of exit rolls **32** is partly immersed in the molten adhesive metal **30** to regulate the thickness of adhering molten metal on the metal core sheet **20***a*.

After the metal core sheet **20** leaves the galvanizing pot **21** it is coated with a molten adhesive metal and is identified by the numeral **20***a*. After the coated metal core sheet **20***a* passes through the nip of the bonding rolls **22***a*, **22***b*, it is coated with fibrous wraps in the form of asbestos paper **33***a*, **33***b* provided from paper coils **34***a*, **34***b* and is identified by the numeral **20***b*. After the fibrous coated metal core **20***b* has become impregnated with weather-resistant saturant, it is identified by the numeral **20***c*.

Emerging from the galvanizing bath **21**, the coated metal core sheet **20***a* turns over a guide roll **35** which is mounted within a few feet of the exit rolls **32**. Beyond the guide roll means **35**, the metal core sheet is maintained hot enough to prevent fusion of the molten adhesive metal coating. The coated metal core sheet **20***a* with its molten metal coating, passes directly unsupported from the guide roll **35** to the bonding rolls **22***a*, **22***b*. Sheets of asbestos paper **33***a*, **33***b* are withdrawn continuously from the coils **34***a*, **34***b*, respectively. The combustible content of the asbestos paper sheets is burned by impingement with flames identified by the arrows **36**, **37**. The sheets of residual incombustible asbestos paper peripherally engage the bonding rolls **22***a*, **22***b* respectively and, as the asbestos passes through the nip of the bonding rolls, the molten adhesive metal coating is substantially concurrently fused and pressed into the interstices of the asbestos sheets to provide a mechanical keying or anchoring of the asbestos paper to the metal core sheet as a fibrous wrap. The resulting laminated sheet structure is identified by the numeral **20***b*.

Any excess asbestos paper at the side edges of the laminated sheet **20***b* is removed by means of trimming devices such as abrasive edge trimmer wheels **38** or spirally grooved steel burrs.

The protected metal sheet **20***b* is subsequently impregnated with a suitable resinous or bituminous saturant, preferably a high flash point asphalt, contained in a molten bath **23**. The impregnated protected metal sheet passes through a pair of grooved impregnating rolls **39** and thence through one or more pair of smooth-surfaced squeeze rolls **24**. Excess impregnant is collected in a tray **40** beneath the rolls **24** and returned to the molten bath **23**. The coated, smooth-surfaced protected metal sheets **20***c* heretofore have been cooled by passing through water sprays **41**.

The resultant impregnated protected metal **20***c* is turned into a coil **25** as shown in FIGURE 2 for aging prior to further processing.

The further processing might comprise applying outer coatings of resins, asphalts and the like. The final sheets are cut to desired lengths and rolled or bent into desirable architectural shapes.

*Processing conditions*

The temperature of the molten metal galvanizing pot **21** is usually maintained between 800 and 950° F. when the coating metal is zinc. The molten lead inventory **28** serves to heat the metal core strip **20** to the bath temperature so that adequate zinc adhesion will occur without excessive alloying phenomenon. The metal coating of the strip **20***a* is maintained in a molten condition until the strip passes through the bonding rolls **22***a*, **22***b*. The asbestos-bonded metal strip **20***b* enters into the saturant bath **23** at a temperature between about 500 and 650° F., which is preferably about 100° F. above the temperature of the saturant bath. Since the saturant preferably is a high flash point asphalt, the saturant bath temperature is maintained at 350 to 500° F., preferably about 420 to 450° F. The saturant-impregnated protected metal strip **20***c* is thence directed through the squeeze rolls **24** to remove excess saturant and thence directly to the take-up coil **25**.

Between the squeeze rolls **24** and the take-up coil **25**, the protected metal strip **20***c* loses some of its heat content through radiation to the surroundings. The preferred temperature at the take-up coil, according to the present invention, is from 250° to about 400° F., and preferably about 270 to 320° F.

*Prior art*

Protected metal sheets heretofore have been commercially manufactured solely as individual sheets as described in U.S. Patent 2,073,334. In the processing of indivindual sheets, water sprays were directed against the product coated sheets at the final squeeze roll **24** and subsequently thereafter until the relatively cooled sheets were lifted and stacked in piles for further use.

When continuous metal-coated sheets were initially fabricated, the use of cooling water was, of course, continued with the water being supplied through the sprays **41**. It was considered essential that the asphalt saturant be cooled to minimize its sticking tendencies prior to recoiling the continuous sheet in the take-up coil **25**. With the water sprays **41** directed against the upper and bottom surfaces of the continuous sheet of protected metal, the temperature at the take-up coil **25** was about 190–200° F.

The initial coils of continuous metal sheets could not be successively uncoiled because of the delaminating of the sheets. The fibrous asbestos wraps cohered; fibrous chunks of the asbestos coating were actually torn out of the asbestos wrap material. The failure was in the asbestos wrapping itself, through internal delamination; there was no failure of the asbestos-to-metal-core bond which is the result of the concurrent compression and fusion of the molten metal into the asbestos wraps.

In an effort to offset the delamination problems, it was concluded that the asphalt saturant should be further chilled prior to recoiling of the product sheets in order to guarantee that the saturant would be below a temperature at which it is tacky. Accordingly, an ice-and-water bath was interposed between the squeeze rolls **24** and the take-up coil **25** to provide the needed chilling capacity.

Actual temperature measurements indicated that a temperature of 100° to 110° F. could be achieved through the ice-and-water bath. Accordingly protected metal was coiled at about 100–110° F. These chilled coils presented greater uncoiling problems than any coils theretofore manufactured. The wrap-to-wrap cohesion was excessive. Great areas of the asbestos felt from one wrap were cohered to areas of fibrous asbestos felt of the next wrap. In addition, there were white spots and light spots on the coiled strip where the asphalt failed to penetrate toward the metal core.



*This invention*

Subsequently the continuous protected metal strips were fabricated according to this invention by eliminating all cooling water and avoiding deliberate cooling efforts between the squeeze rolls **24** and the take-up coil **25**. The actual surface temperature measurement at the take-up coils was 270–290° F. The saturant-impregnated strip appeared to have moist spots of excess saturant as it approached the take-up coil after the final squeeze roll. Nevertheless the coiling proceeded smoothly and the resulting coils were stored at ambient room temperature on blocks to allow air circulation around the coils. After about four days, the temperature of the coils equalized with the room temperature and uncoiling of the coils was accomplished without difficulty. There was no noticeable wrap-to-wrap cohesion. The saturant uniformity was excellent, i.e., there were no white spots or light spots where the saturant failed to penetrate toward the metal core.

Hereinabove, it has been stated that the metal core sheet **11** may have a thickness from about 14 through 28 gauge. It should be apparent that the different thickness materials will dissipate their heat content at different rates in transit between the squeeze rolls **24** and the take-up coil **25**. The recoiling temperature may be regulated by controlling the distance between the take-up coil **25** and the squeeze rolls **24** according to the gauge of the core sheets.

The difference in core metal gauge also may have an effect on the required "aging" period for the coils. The nature of the changes occurring during the so-called "aging" period are not clearly understood. It has been found, for example, that uncoiling of the protect metal coils which are still hot is undesirable in that the wraps of fibrous coating material tend to stick together and delaminate in a manner similar to that described. As a rule, to determine a suitable aging period, it has been found that sufficient "aging" has occurred when the coil temperature is about equalized with ambient room temperature. This usually requires about four days where 22-gauge cold-rolled steel is used as core metal. Other gauge thicknesses may require more-or-less than four days to achieve substantial coil temperature equalization with the surroundings.

The unexpected discovery which constitutes the present invention is the fact that avoiding deliberate cooling of the protected metal strip between the squeeze rolls and the take-up coil will permit production of a uniform coiled product which can be readily uncoiled.

A further unexpected discovery, not heretofore appreciated is that the coiled protected metal as described must be "aged" for at least several days until the coil temperature substantially equalizes with ambient room temperature before uncoiling is attempted.

*Further embodiment*

A still further refinement of this invention involves the application of added processing heat energy into the moving strip of freshly-made protected metal. That is, in addition to avoiding the deliberate cooling of the freshly made strip of protected metal, extrinsic heat can be applied to the strip after application of the asphalt saturant. Electrical heating elements incorporated into the final squeeze rolls, for example, have been utilized to raise the temperature of the rolls to about 450° F. (*Note:* Where the saturant bath **23** is maintained at 420–450° F., the temperature of the squeeze rolls **24** will be about 400° F. as a result of their conductive heat absorption through continuing peripheral engagement with the moving strip of freshly-made protected metal.) The subsequent recoiling of the heated moving strip without further deliberate cooling resulted in especially good coiled protected metal products.

The application of added heat to the moving strip conveniently is accomplished conductively by passing the sheet between rolls such as smooth-surface squeeze rolls which are deliberately heated with hot liquids, steam, hot gases or by electrical means. Alternatively, added heat may be introduced into the moving strip through radiant energy such as infra-red radiation, through induction heating, through electrical resistance heating, through corrective heating by heated gases or vapors, et cetera.

Heated rolls about 10 to 100° F. above the temperature of the moving strip are preferred.

I claim:

**1.** In the process of producing a protected metal sheet from a coil of metal core sheet including the sequential steps of:

metal-coating the metal core sheet;

applying a substantially asbestos felt sheet to said metal coating while said coating is at least partially molten, thereby bonding said substantially asbestos felt sheet to said metal sheet;

impregnating the said asbestos felt sheet with a high flash point asphalt saturant in molten condition; and

recoiling the resulting protected metal sheet;

the improvement comprising: recoiling the said resulting protected metal sheet at a temperature between 250° and 400° F.

**2.** In the process of producing a protected metal sheet from a coil of metal core sheet including the sequential steps of:

metal-coating the metal core sheet;

applying a substantially asbestos felt sheet to said metal coating while said coating is at least partially molten, thereby bonding said substantially asbestos felt sheet to said metal sheet;

impregnating the said asbestos felt sheet with a high flash point asphalt in molten condition; and

recoiling the resulting protected metal sheet;

the improvement comprising: recoiling the said resulting protected metal sheet at a temperature between 250° and 400° F., and aging the protected metal sheet coil until its temperature is substantially equalized with ambient temperature.

**3.** In the process of producing a protected metal sheet from a coil of metal core sheet including the sequential steps of:

metal-coating the metal core sheet;

applying a substantially asbestos felt sheet to said metal coating while said coating is at least partially molten, thereby bonding said substantially asbestos felt sheet to said metal sheet;

impregnating the said asbestos felt sheet with a high flash point asphalt in molten condition; and

recoiling the resulting protected metal sheet;

the improvement comprising: heating the asphalt-impregnated, fibrous-bonded, metal-coated core sheet to a temperature between 280° to 400° F. prior to recoiling and thereafter carrying out the said recoiling between 250° and 400° F.

**4.** In the process of producing a protected metal sheet from a coil of metal core sheet including the sequential steps of:

metal-coating the metal core sheet;

applying a substantially asbestos felt sheet to said metal coating while said coating is at least partially molten, thereby bonding said substantially asbestos felt sheet to said metal sheet;

impregnating the said asbestos felt sheet with a high flash point asphalt in molten condition; and

recoiling the resulting protected metal sheet;

the improvement comprising: passing the saturant-impregnated, fibrous-bonded, metal-coated core sheet between a pair of rolls in peripheral engagement therewith, maintaining the temperature of the said rolls from 10 to 100° F. above the temperature of the saturant engaged therewith, and thereafter carrying out the said recoiling between 250° and 400° F.



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