

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVED HEAT-INSULATING PANEL OR SHEET AND A METHOD OF AND APPARATUS FOR MAKING THE SAME

(71) We, HEATSHIELD RESEARCH AND DEVELOPMENT PTY. LIMITED, an Australian Company, of 62 Blunder Road, Oxley, Brisbane, Queensland, Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to an improved heat insulating panel or sheet and a method of and apparatus for making the same.

15 Sheet materials used for roofs, such as corrugated galvanized sheet steel and corrugated asbestos cement, though economical to make, transport and erect, are generally not good insulators against solar heat, and although roofs made of such materials may be additionally heat-insulated, this has hitherto been costly.

20 The main objects of the invention are to provide articles, including such roofing materials, but also including tiles, wall cladding, ducting for air conditioning and many others, which are of such improved character as to have good heat insulating qualities at little additional cost and without significant addition to bulk.

30 In one aspect, the invention resides in a method of producing a heat insulating article of sheet material including the steps of conveying a section of sheet material substantially horizontally, its surface to be positioned remote from a heat source uppermost, delivering continuously to the moving said surface superimposed laminations of a metal foil and a film of clear or transparent thermoplastic material such as polyethylene; and applying pressure and heat to the assembly of the section, foil and interposed film by conveying it under a weighted flexible sheet and past heating means to cause the film to adhere to the said surface and the foil whilst separating the surface and the foil from direct contact.

The invention in another aspect resides in a heat insulating article of sheet material produced according to this method; and in another aspect it resides in apparatus for carrying the method into effect and including a frame; a conveyor for conveying a section of sheet material substantially horizontally along the frame its surface to be positioned remote from a heat source uppermost; dispensing means on the frame adapted to deliver continuously to the moving said surface superimposed laminations of metal foil and clear or transparent thermoplastic film; a weighted flexible sheet secured to the frame and adapted to apply pressure to the assembly of foil, film and the section to compress the film between the foil and the said surface; and heating means adapted to apply heat to the assembly to cause the film to adhere to both the said surface and the foil whilst separating the two from direct contact.

In order that the invention may be readily understood and carried into practical effect, reference is now made to the accompanying drawings, wherein:—

FIG. 1 is a side elevation of the dispensing section of apparatus according to the invention,

FIG. 2 is a plan view of the apparatus shown in Fig. 1,

FIG. 3 is a side elevation of the bonding section of the apparatus,

FIG. 4 is a plan view, partly broken-away, of the bonding section shown in Fig. 3,

FIG. 5 is a partly broken-away sectional drawing, to enlarged scale, along line 5—5 in Fig. 4,

FIG. 6 is a detail drawing showing in plan part of a gas heating element of the bonding section, and

FIG. 7 is a side elevation of a bonding section of the apparatus according to an alternative embodiment of the invention.

The dispensing section shown in Figs. 1 and 2 includes a frame having a base 10 and two

side members 11 supported by pairs of standards 12. Transverse rollers 13 between the side members 11 are adapted to support corrugated galvanized steel 14 fed continuously forward, in the direction indicated by an arrow in Fig. 2, from a conventional roll-forming machine (not shown) used in the manufacture of such galvanized sheet steel.

A pair of arms 15 pivoted to the rear standards 12 carry co-axial shafts 16 for a removably mounted roll 17 of thin transparent polyethylene film, bearing upon a roll 18 of thin aluminium foil similarly mounted between a pair of intermediate standards 12, the pressure applied by the polyethylene roll 17 to the foil roll 18 being adjustable by means of weights 19 slidable on rods 20 extending from the arms 15.

The polyethylene and foil rolls 17 and 18 are counter-rotated in the directions indicated by arrows in Fig. 1 so that aluminium foil 18a superimposed on polyethylene film 17a is drawn forwardly over a splicing table 21 and between a pair of resiliently-surfaced pinch rollers 22 rotatably mounted between a pair of brackets 23, the upper pinch roller being vertically adjustable to vary the pressure on the superimposed foil and film.

Both the polyethylene roll 17 and the upper pinch roller 22 are adjustably braked frictionally, each having on its shaft at one side a drum 24 engaged by a loop of friction belt 25 supporting weights 26. In addition, an electrically operable brake 27 is associated with the shaft of the polyethylene roll 17 at the other side, for a purpose hereinafter explained.

From the pinch rollers 22, the superimposed foil and film are carried up and over a tension compensating roller 28, carried by arms 29 pivoted to the front standards 12 and supported by springs 30. The foil and film are then carried down and under a roller 31 between a pair of brackets 32 on the side members 11, and forwardly under a series of co-axial forming rollers 33 mounted adjacently on a shaft 34 carried by a pair of arms 35 pivoted to the side members 11, and which may be raised or lowered by handles 36. The forming rollers are adapted to press the superimposed foil 18a and polyethylene film 17a into corrugations of the galvanized steel. Before the apparatus is set into operation, the superimposed laminations of foil and polyethylene film may be guided into the corrugations of the galvanized steel, a number of rods being laid over the laminations to press them into the corrugations, before the forming rollers 33 are lowered into operative position. The foil and film, when thus corrugated, do not overlie the corrugated steel from side to side, but, as shown in Fig. 5, at one side the foil 18a protrudes for a short distance beyond the corresponding side of the corrugated steel, the polyethylene film for a somewhat lesser amount; and at the other side the foil extends to the position indi-

cated at 37, the polyethylene film extending somewhat further, to the position indicated at 38, so that a narrow side portion of the film beyond the foil is exposed at this side.

From the dispensing section, the corrugated sheet steel with the superimposed foil and film applied thereto is fed forwardly to the bonding section shown generally in Figs. 3 and 4. This has a frame including a base 39 and side members 40 are supported by uprights. The advancing corrugated steel is supported by a series of rollers 41, and also by a series of bearer bars 42, between the side members 40. The steel supported by the bars 42 is heated by a series of gas burners 43, each consisting of a manifold with series of jets 44 and 45, arranged in two parallel rows of corresponding jets, the jets 44 being of lesser diameter than the jets 45 to produce a flame which, viewed from the direction of advance of the steel, has a profile which substantially corresponds to the corrugations of the steel, which thus is substantially uniformly heated.

Each burner 43 receives gas under pressure from a gas pipe 46 through a manually controllable valve 47 and a solenoid valve 48.

The advancing corrugated steel, with the superimposed foil 18a and polyethylene film 17a, passes under a flexible sheet 49, which may be of glass cloth, and which extends beyond the portion heated by the burners. One side of the flexible sheet 49 is engaged by a clamp bar 50 suspended under a longitudinal channel 51 by cables 52 which pass up into the said channel, over pulley wheels 53, and to any suitable device (not shown) for tensioning the cables to lift the clamp bar 50 and the side of the sheet 49 secured thereto, to the position shown in broken outline in Fig. 5. Normally the clamp bar is lowered, as shown in Fig. 3 and in full outline in Fig. 5, and the flexible sheet 49 extends across the foil and polyethylene applied to the corrugated steel, and is substantially uniformly weighted by the application of a layer 54 of gravel. Owing to the heat applied to the undersurface of the steel by the burners 43, and the pressure applied by the weighted flexible sheet 49, the polyethylene film is sufficiently heated by conduction, and pressed sufficiently firmly and for a sufficient period between the galvanized steel and the foil, to adhere to both, so the foil is bonded to the galvanized steel by a thin but substantially uninterrupted lamination of transparent polyethylene. The narrow side section of the foil depending from one side of the galvanized steel sheet serves to insulate the flexible sheet, at that side, from the effect of the gas burners. To prevent adhesion between the narrow side strip of polyethylene exposed at the other side and the flexible sheet, this side portion of the flexible sheet is preferably coated with a material with very low coefficient of friction.

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thereto is advanced beyond the flexible sheet 49, the narrow side sections of foil and polyethylene film extending beyond the steel are cut away by an edge cutter wheel 55, driven from a flexible drive and urged into contact with the side edge of the steel by a spring 56.

The galvanized steel, with foil bonded thereto by the polyethylene film, is passed under a series of pressure rollers 57, generally similar to the forming rollers 33, rotatable on a shaft carried by a pair of arms 59 pivoted to the side members 40. The rollers 57 bear gravitationally into the corrugations and ensure that the bonding is effected thoroughly.

From the bonding section, the finished sheet is carried forward to be cut into appropriate lengths by a guillotine (not shown) of conventional type.

20 If, during the operation of the apparatus,
the roll former is stopped, the electric brake
27, which is connected in the circuit of the
roll former, is automatically applied a short
time after to stop rotation of the polyethylene
25 roll 17 and also of the foil roll 18 on which
it bears. During the short period the polyethy-
lene and foil are not being drawn forward by
the advancing steel sheet, the roller 28 carried
by the spring-loaded arms 29 will be lifted by
30 the springs 30. When the roll former starts
again, the brake 27 is automatically released,
and the tension re-applied to the polyethylene
and foil, owing to inertia of the rolls 19 and
18, causes the roller 28 to be drawn down
35 to prevent undue stress on the film and foil.
As the foil and film are fed in superimposed
manner, no additional brake is required for
the foil roll 18. Moreover, relatively fragile
foil may be controlled and tensioned through
40 the much more resilient polyethylene on which
it is superimposed.

With the stopping of the roll former, the burners 43 are automatically turned down by their solenoid valves 48 which are connected in the roll former circuit; and if the delay is more than a very brief one, the clamp bar 50 is automatically raised to the position shown in broken outline in Fig. 5 to carry the flexible sheet 49 clear of the narrow exposed side portion of polyethylene film before referred to, to avoid any possibility of the sheet adhering to this exposed and heated section of the film.

55 Panels of corrugated galvanized steel with heat insulating applied as described will be found to be very satisfactory in use. When used for roofing, they are fixed with the foil lowermost for insulating against solar heat. The clear or transparent polyethylene is a poor
60 conductor of heat, but is a good medium for the transmission of radiant heat, and so, when the galvanized steel is heated by the sun, heat radiated from its underside passes readily through the polyethylene layer to the upper
65 surface of the foil which, being a good reflector

of heat, causes the radiant heat to be reflected back. Furthermore, the undersurface of the foil will emit little radiant heat. The polyethylene film may be very thin, and satisfactory results have been achieved with a film of about .00075. in thickness. The film serves also as an electrolytic barrier between the galvanized steel and the foil, and assists in preventing oxidation of the surface of the galvanized steel near to the foil, which would decrease the insulating qualities of the panel.

In applying laminations of a transparent film and metal foil to articles other than corrugated sheet steel, the apparatus is appropriately modified. Thus, in applying the laminations to corrugated asbestos cement roofing panels, the dispensing section is modified, as shown in broken outline in Fig. 1, by substituting a conveyor 60 of endless-belt type for the rollers 13. The panels may be placed manually or mechanically upon the conveyor, by which they are carried forward, end to end, to have the laminations of polyethylene and foil applied thereto as before described. Weighted rollers 61 passing down on the panels assist in ensuring a positive feed by the conveyor. The panels are fed from the dispensing section to a bonding section shown in Fig. 7 which has a main frame including a base 62 above which side members 63 are supported by uprights 64, and the advancing panels are supported by transverse rollers 65 between these side members. The panels pass under a flexible sheet weighted by a layer of gravel as before described, but the means for lifting one side of the sheet may be omitted. Instead of heat being applied from below by gas burners, as before described, the heat is directed downwardly from electric or gas radiant heaters 66 supported above part of the main frame to heat the gravel and sheet weighted thereby, and thus, by conduction, to heat the foil and the film, this heating, with the applied pressure causing the foil to be bonded to the panels by the polyethylene film. The panels, after leaving the weighted flexible sheet, are acted on, as before described, by pressure rollers before being conveyed to any suitable apparatus (not shown) for severing the foil and film laminations between succeeding corrugated panels. In this case, the operation of the electrically operated brake 27 is linked to the operation of the conveyor.

With suitable modifications, the apparatus may be used for applying the superimposed foil and clear film to flat sheet galvanized steel or asbestos cement, the shaped forming and pressure rollers then being replaced by plain rollers; or to tiles, the forming and pressure rollers being appropriately modified; and to many other articles.

WHAT WE CLAIM IS:

1. A method of producing a heat insulating article of sheet material including the steps of conveying a section of sheet material substan-

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The galvanized steel, with foil bonded thereto by the polyethylene film, is passed under a series of pressure rollers 57, generally similar to the forming rollers 33, rotatable on a shaft carried by a pair of arms 59 pivoted to the side members 40. The rollers 57 bear gravitationally into the corrugations and ensure that the bonding is effected thoroughly.

From the bonding section, the finished sheet is carried forward to be cut into appropriate lengths by a guillotine (not shown) of conventional type.

If, during the operation of the apparatus, the roll former is stopped, the electric brake 27, which is connected in the circuit of the roll former, is automatically applied a short time after to stop rotation of the polyethylene roll 17 and also of the foil roll 18 on which it bears. During the short period the polyethylene and foil are not being drawn forward by the advancing steel sheet, the roller 28 carried by the spring-loaded arms 29 will be lifted by the springs 30. When the roll former starts again, the brake 27 is automatically released, and the tension re-applied to the polyethylene and foil, owing to inertia of the rolls 19 and 18, causes the roller 28 to be drawn down to prevent undue stress on the film and foil. As the foil and film are fed in superimposed manner, no additional brake is required for the foil roll 18. Moreover, relatively fragile foil may be controlled and tensioned through the much more resilient polyethylene on which it is superimposed.

With the stopping of the roll former, the burners 43 are automatically turned down by their solenoid valves 48 which are connected in the roll former circuit; and if the delay is more than a very brief one, the clamp bar 50 is automatically raised to the position shown in broken outline in Fig. 5 to carry the flexible sheet 49 clear of the narrow exposed side portion of polyethylene film before referred to, to avoid any possibility of the sheet adhering to this exposed and heated section of the film.

Panels of corrugated galvanized steel with heat insulating applied as described will be found to be very satisfactory in use. When used for roofing, they are fixed with the foil lowermost for insulating against solar heat. The clear or transparent polyethylene is a poor conductor of heat, but is a good medium for the transmission of radiant heat, and so, when the galvanized steel is heated by the sun, heat radiated from its underside passes readily through the polyethylene layer to the upper surface of the foil which, being a good reflector of heat, causes the radiant heat to be reflected back. Furthermore, the undersurface of the foil will emit little radiant heat. The polyethylene film may be very thin, and satisfactory results have been achieved with a film of about .00075. in thickness. The film serves also as an electrolytic barrier between the galvanized steel and the foil, and assists in preventing oxidation of the surface of the galvanized steel near to the foil, which would decrease the insulating qualities of the panel.

In applying laminations of a transparent film and metal foil to articles other than corrugated sheet steel, the apparatus is appropriately modified. Thus, in applying the laminations to corrugated asbestos cement roofing panels, the dispensing section is modified, as shown in broken outline in Fig. 1, by substituting a conveyor 60 of endless-belt type for the rollers 13. The panels may be placed manually or mechanically upon the conveyor, by which they are carried forward, end to end, to have the laminations of polyethylene and foil applied thereto as before described. Weighted rollers 61 passing down on the panels assist in ensuring a positive feed by the conveyor. The panels are fed from the dispensing section to a bonding section shown in Fig. 7 which has a main frame including a base 62 above which side members 63 are supported by uprights 64, and the advancing panels are supported by transverse rollers 65 between these side members. The panels pass under a flexible sheet weighted by a layer of gravel as before described, but the means for lifting one side of the sheet may be omitted. Instead of heat being applied from below by gas burners, as before described, the heat is directed downwardly from electric or gas radiant heaters 66 supported above part of the main frame to heat the gravel and sheet weighted thereby, and thus, by conduction, to heat the foil and the film, this heating, with the applied pressure causing the foil to be bonded to the panels by the polyethylene film. The panels, after leaving the weighted flexible sheet, are acted on, as before described, by pressure rollers before being conveyed to any suitable apparatus (not shown) for severing the foil and film laminations between succeeding corrugated panels. In this case, the operation of the electrically operated brake 27 is linked to the operation of the conveyor.

With suitable modifications, the apparatus may be used for applying the superimposed foil and clear film to flat sheet galvanized steel or asbestos cement, the shaped forming and pressure rollers then being replaced by plain rollers; or to tiles, the forming and pressure rollers being appropriately modified; and to many other articles.

WHAT WE CLAIM IS:

1. A method of producing a heat insulating article of sheet material including the steps of conveying a section of sheet material substan-

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5 tially horizontally, its surface to be positioned
remote from a heat source uppermost, deliver-
ing continuously to the moving said surface
superimposed laminations of a metal foil and
a film of clear or transparent thermoplastic
material; applying pressure and heat to the as-
sembly of the section, foil and interposed film
by conveying it under a weighted flexible sheet
and past heating means to cause the film to
10 adhere to the said surface and the foil while
separating both from direct contact.

2. A method according to Claim 1 wherein
the heating means is adapted to heat the article
to heat the film by conduction from the said
15 article.

3. A method according to Claim 1 wherein
the heating means is adapted to heat the
weighted flexible sheet, to heat the film by
conduction from the weighted flexible sheet
20 and foil.

4. A method according to any one of the
preceding claims wherein the thermoplastic
film is of polyethylene.

5. A method according to any one of the
preceding claims wherein the foil is of alumin-
25 ium.

6. A heat insulating article of sheet material
produced according to the method set out in
any one of the preceding claims.

30 7. Apparatus for producing a heat insulating
article of sheet material including a frame; a
conveyor for conveying a section of sheet ma-
terial substantially horizontally along the frame
its surface to be positioned remote from a heat
35 source uppermost; dispensing means on the
frame adapted to deliver continuously to the
moving said surface superimposed laminations
of metal foil and clear or transparent thermo-
plastic film; a weighted flexible sheet secured
40 to the frame and adapted to apply pressure
to the assembly of superimposed foil, film and
the section to compress the film between the
foil and the said surface; and heating means
adapted to apply heat to the said assembly
45 to cause the film to adhere to both the said
surface and the foil while separating the two
from direct contact.

8. Apparatus according to Claim 7 wherein
the dispensing means include means for rotat-
ably mounting a roll of thermoplastic film,
50 means for rotatably mounting a roll of metal
foil, means for urging the two rolls into con-
tact, and means for guiding foil and film
drawn from the two rolls in superimposed ar-
rangement to the surface of the sheet or panel.
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9. Apparatus according to Claim 8 wherein

the means for guiding the superimposed foil
and film include a spring-loaded roller over
which the foil and film may be passed and
adapted to yield to compensate for variations
60 in tension applied to the said foil and film.

10. Apparatus according to either of Claims
8 or 9 wherein the means for guiding the
superimposed foil and film include a forming
roller adapted to press the foil and film close
65 to the surface of the panel or sheet.

11. Apparatus according to any one of the
preceding claims wherein means are provided
for raising a side portion of the weighted flex-
ible member from a side portion of the super-
imposed foil and film laminations for the pur-
70 pose hereinbefore set out.

12. Apparatus according to any one of the
preceding claims wherein the heating means
consists of a heat radiator mounted on the
main frame and adapted to heat the weighted
flexible sheet to heat the film by conduction
75 through the foil.

13. Apparatus according to any one of
Claims 7 to 12 wherein the heating means con-
sists of heaters mounted on the frame and
adapted to heat the section to heat the film
80 by conduction.

14. Apparatus according to Claim 13 where-
in the heaters are a series of gas burners so
made and arranged as to be adapted to emit
flame which, viewed from the direction of
travel of the panel or sheet, is of similar profile
to the cross-sectional configuration of the sec-
90 tion.

15. Apparatus according to any one of
Claims 7 to 14 wherein means are provided
for cutting away any laminations of foil and
film protruding beyond a side edge of the sec-
95 tion.

16. A method of producing a heat insulating
article of sheet material substantially as herein
described.

17. Apparatus for producing a heat insulat-
ing article of sheet material substantially as
herein described with reference to the accom-
panying drawings. 100

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