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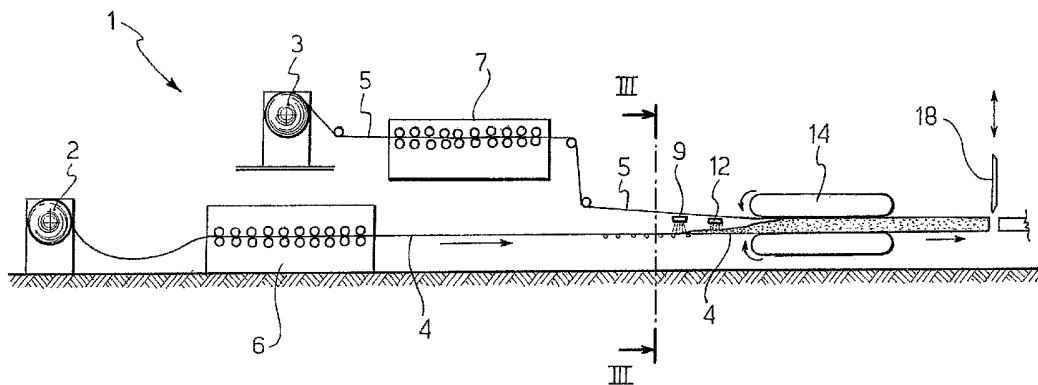
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(54) Title: INSULATING PANEL, PROCESS AND APPARATUS FOR MANUFACTURING THEREOF, WITH EXPANSIBLE
RESIN SPRAYING



(57) Abstract: There is disclosed an insulating panel and a method for continuous manufacturing thereof, wherein a polyurethane expansible resin of the quick-reaction type is sprayed on a strip (4); after the sprayed resin has expanded, another resin is poured in liquid condition, thereby obtaining the insulating core of the panels. The invention also concerns the apparatus for carrying out the method.

Insulating panel, process and apparatus for manufacturing thereof, with expansible resin spraying

The invention relates in general to the production of composite insulating panels.

As is known, these panels, which are also commonly known as "sandwich" panels, are widely used in the civil and industrial construction field to form walls, roofs, coverings, slabs, sectional doors, etc.; they are also used to construct cold-storage rooms, or containers intended for low temperatures.

The panels considered herein comprise basically two opposed faces between which there is an insulating core made of expanded resin, also commonly known as foam; the latter is generally a polyurethane foam but may also be phenolic foam or foam of another type.

The industrial production of these panels can be carried out in a continuous or discontinuous manner.

In the first case it is particularly useful for mass productions of panels with metal outer faces; to this purpose two sheet metal strips are made to advance one upon the other along the in line production plant, unrolling them from respective coils.

After an initial step of profiling of the strips, the resin is applied on the lower strip and then expands whilst the strips pass through a continuous press which keeps them apart by a distance equal to the thickness of the finished panel.

This continuous production process has been known since a long time and, for further information on this matter, reference should be made to existing publications and to the many patents of which the applicant for the present application is the proprietor.

On the other hand, the discontinuous production of the panels is more suitable for small series or for special panels; the latter may have outer faces made of metal or another material, such as for example plastic materials (polycarbonate or the like) or others (i.e. wood etc.).

The faces of the panels are prepared separately and then arranged in a mould where the polymer resin application and expansion take place, thereby forming the insulating foam.

It can be appreciated that this production process requires a longer time with respect to the continuous one, since there are unavoidably idle times when the faces must be accommodated in the mould and the finished panel removed therefrom.

However, beyond the different production methods seen above, what pointed out is that in order to produce quality panels, it is important that the expansion of the polymer resin takes place evenly; for this purpose, one of the conditions to be complied with is that there should be no bubbles of air or other gases in the vicinity of their outer faces because these may cause problems.

One of these problems is delamination of the panels, that is to say the detachment of their faces.

Indeed, as the temperature conditions vary between day and night or between summer and winter, the gas contained in the bubbles expands cyclically, leading to progressive fatigue of the foam and the propagation of the void regions inside it; in the long term, this situation leads to detachment of the face of the panel.

For this reason, a method for the continuous production of panels in which the liquid resin poured from a nozzle bar is spread uniformly on the surface of the strip by air jets is known from German patent application No. 197 41 523.

The effect of these air jets is to eliminate the gas bubbles from the mass of liquid resin, thus producing the desired result.

However, this method of application of the resin does not seem to be easy to implement because the impact of the air on the resin cannot be uniform over the entire width of the strip; the device described in the German patent application in fact has suitable devices for limiting the edge effects, that is to say, the accumulations of resin which form along the edges of the strip because of the non-uniformity of the effect of the air in this region.

Moreover, this known application method appears to depend significantly on the viscosity of the resin since the effect of the air thereon will clearly be different according to how liquid the resin is.

In other words, the known method may be difficult to implement according to the type of panels to be produced; thus, for example, it is not stated that it is effective

in the same manner both for the production of panels with polyurethane resins and for the production of panels with phenolic resins.

The same applies if the speed of advance of the sheet-metal strip to which the resin is applied is increased in order to increase panel production or if the quantity of resin applied is increased because it is desired to make thicker panels.

In the light of these remarks, the problem underlying the present invention is therefore that of providing a method for the continuous production of insulating panels in which the polymer resin is applied uniformly to at least one of the strips in a manner such as to prevent the formation of bubbles in the vicinity of the strips, also achieving improved adhesion between the foam and the surface of the strip.

The concept for the solution of this problem consists in the spray application of a first layer of resin onto the surface of the strip; the surface is in fact thus covered uniformly without lack of homogeneity which might give rise to bubbles.

Once the spray-applied layer has expanded, a second layer of liquid resin can be poured thereon, thus producing an insulating core of the desired thickness and density.

These and further characteristics of the invention are set out in the appended claims; they will become clearer from the following description of a non-limiting embodiment of the invention which is illustrated in the appended drawings, in which:

Figure 1 shows schematically apparatus for the continuous production of panels according to the invention,

Figure 2 shows a detail of the apparatus of Figure 1,

Figure 3 is a section taken on the line III-III of Figure 1,

Figure 4 is a perspective view of a panel formed in accordance with the invention, and

Figures 5 and 6 show a variant of the above-mentioned apparatus in views similar to those of Figures 2 and 3, respectively;

Figures 7 and 8 show a perspective view and a sectional view of a variant of the panel of the invention;

Figures 9 and 10 are a section and a perspective view of a manufacturing phase of the panel in fig. 7, 8;

Figure 11 is a variant of the manufacturing phase in fig. 9.

The first of these drawings shows an apparatus, generally indicated 1, for the continuous manufacturing of panels according to the invention, starting from two coils 2, 3 of metal strips 4 and 5.

In the apparatus 1 after the strips have been unrolled, they are processed by respective forming machines 6 and 7 to form therein the usual edges, ribs, profiling, etc., in known manner.

Downstream of the forming machines, the strips 4 and 5 advance close together up to the zone for the application of expansible resin; this operation is performed in two steps.

In particular, the first step is constituted by the spraying application of a quick-reaction resin by a head 9; for this purpose, the head 9 moves to and fro (as indicated by the arrows in Figure 3) along a cross-member 10 arranged above the strip 4 and is provided with a spray nozzle of a type known *per se* and not shown in the drawings. The speed of advance of the lower strip 4 is set in a manner such that the resin sprayed thereon expands (at least partially), forming a layer 13 which covers the strip 4 uniformly, before reaching a position below a second cross-member 11.

A pouring nozzle 12 of known type (which may be a single nozzle or a comb nozzle such as that of German published application No. 197 41 523) is movable to and fro along the second cross-member 11 and performs the second resin-application step, by pouring onto the expanded layer 13 a resin of the same type as that sprayed previously but in the liquid condition (the vertical broken line in Figure 3 indicates the pouring line).

The liquid resin then expands, filling the space between the strips 4 and 5 whilst they pass through a continuous press 14, also known *per se*.

Downstream of the continuous press, a semi-finished product 16 formed by the two strips 4 and 5 with the expanded sprayed layer 13 and an insulating core 17 of

foam of the second resin is thus obtained; the semi-finished product is then cut by a cutter 18, thereby obtaining finished panels 20 like that of Figure 4.

The production process described above solves the problem underlying the invention.

Indeed, the spray application distributes the resin uniformly over the entire surface of the strip 4, so that the resulting layer 13 is free of internal voids or bubbles.

This is due to the atomization of the resin supplied by the spray system, which enables the surface of the strip 4 to be covered with a thin film of small droplets similar to that of paints applied by the same method, wherein gas bubbles cannot build up.

In order to achieve a good spray application of the resin it will suffice to select the speed of movement of the head 9 along the cross-member 10 appropriately in dependence on various parameters such as, for example, the width of the strip, its speed of advance, the type of spray nozzle mounted on the head 9, the supply pressure of the nozzle, its distance from the strip, the type of resin applied, etc.

Moreover, since the resin is of the quick-reaction type, it produces a film 13 of foam on which the liquid resin can subsequently be applied in known manner; the interface between the two resins advantageously reduces the presence and/or the size of any voids in the mass of the second resin when it expands.

In contrast with the prior art referred to above, this production method is reliable, easy to implement and does not require complex adaptive modifications when the resin, the speed of the strip 4, or other production parameters are changed.

Indeed basically all polymer resins (polyurethane resins or the like), either of one-component and of two-component type, can be applied with the spray technique; this technique is well known and has been used since a long time, so that changes in the type of resin do not alter the efficacy of the production process of the invention.

Similarly, if the speed of advance of the strip is changed (for example, to increase panel production) it will suffice to move the spray head 9 with the cross-member 10 upstream slightly, so as to allow the quick-reaction resin to expand before it reaches the second nozzle bar 11.

Finally, as a further advantageous result achieved by the invention, it should be pointed out that it prevents the poor or inadequate adhesion of the foam to the face of the panel which sometimes occurs when liquid resin is deposited on the strip. Naturally, variants of the above-described embodiment of the invention are possible.

First of all, it should be pointed out that the type and shape of the panels may differ from that shown in Figure 4; as a consequence, there may be panels profiled on one or both faces, or even curved panels produced with moulds and methods developed by the applicant for the present application.

Moreover, the production process may include also heating steps carried out with ovens or lamps disposed along the path of the strips 4 and 5, as is already known in the panel manufacturing; for example, an oven or lamps may be arranged upstream of the resin-application zone, that is before the spray head 9 and the cross-member 10, in order to accelerate the expansion of the resin sprayed onto the lower strip 4.

With regard to the spraying of the resin, in addition to the nozzles described above, it should be pointed out that there may be various solutions in relation to the type and shape of the nozzles; as a consequence, the nozzles will be selected among the most suitable for the operative conditions existing, such as the size and shape of the panel (profiled, corrugated, flat, curved, etc.), the type of apparatus (continuous, discontinuous) by which it is produced, the resins used as insulation, etc.

A possible alternative to the spray head 9 movable along the cross-member 10 of the previous embodiment is shown in Figures 5 and 6 in which, for simplicity, the same numbering has been retained for the same elements.

As can be seen, in this embodiment instead of the head 9 there is a fixed nozzle bar 30 in which a plurality of nozzles spray the resin onto the strip 4, with jets which cover its surface uniformly.

Likewise, for the application of the liquid resin instead of the pouring nozzle 12 movable along the cross-member 11, in this variant a fixed bar 31 of pouring nozzles is provided (the vertical broken lines indicate the pouring lines).

Finally, it should be pointed out that the spraying of the resin may also be performed on the upper strip, as an alternative to or in combination with the spraying on the lower strip; there may consequently be methods and apparatus for the production of panels in accordance with the invention, wherein the spraying is carried out on only one of the strips (that is, only the upper strip or the lower strip) or on both strips.

The spraying of the expansible resin fits well also with the discontinuous manufacturing process of the panels, referred to at the beginning; several solutions are possible for carrying out this operation, which are mainly based upon the use of moulds.

For instance there can be used a spraying head like that of fig. 3 or a nozzle bar as in fig. 6; in both cases after the sprayed layer has expanded, liquid resin will be poured and the mould closed so as to let it expand thereby obtaining the desired thickness of the panel.

Likewise it has been seen before in the case of continuous production, also in the panels made in a discontinuous manner according to the invention it is prevented the formation of harmful empty spaces or air bubbles, between the insulating foam and the outer faces.

This result is rather important especially for the architectural panels, that is to say panels used for the façades of buildings as schematically shown in fig. 7; indeed, because of the particular purpose to which they are intended, it can be understood that their outer aspect is very important.

As can be seen from the drawings the peculiar feature of the architectural panels referred to as 40, is that they have outer faces 41 and 42 without fretting, ribbing or the like; they are therefore smooth and this renders critical the manufacturing process, because the presence of air bubbles between the outer faces and the foam of the insulating core 43, gives rise to surface defects which can disfigure the facade of the building where the panels are applied.

Furthermore, the lack of ribbings renders the outer faces of the panels less stiff and more deformable, so that actually they do not remain plane when there are defects in the core of insulating foam.

Another particular feature of the aforesaid panels is that they are generally mounted upon structures formed by pillars and beams 45, 46 by means of bolts 47, brackets 48 and similar; as a consequence their peripheral edges are shaped with long and thin appendices 49, to allow the coupling of the panels with the mounting elements.

However these appendices generate problems during the production of the panels, because the insulating foam does not always fill all the inside thereof; indeed these panels are made by preparing the faces in moulds and pouring the liquid resin thereon, but the viscosity of the latter does not allow to reach well all the inner zones of the appendices, so that inside them empty spaces can remain with all the problems involved and already stated before.

On the contrary, the spray application of a layer of resin upon one or both faces 41, 42 of the panel, allows to reach even the innermost zones of the appendices 49 thereby creating a thin layer 50 of expanded resin which fills all the spaces nearby the faces.

On this expanded layer 50 it can thus be poured the liquid resin, thereby obtaining the insulating core 42 of the panel in accordance with the desired thickness.

Also in this embodiment of the invention the sprayed resin is preferably of the rapid reaction type, because it has resulted that this allows to obtain better results. Furthermore, as mentioned above, the resin can be sprayed also on the other face 42 of the panel 40, thereby forming a layer (indicated with broken line in fig. 8) adjacent thereto which prevents the formation of air bubbles or empty spaces in the appendices.

Last, in the example shown schematically in fig. 9 and 10, for avoiding the undulations which can appear on the sheet metal of the faces, the discontinuous manufacturing process of the panels is carried out using a vacuum support plane or base 52 where it is laid the sheet metal of the face 41 of the panel 40.

This plane is provided inside with channels 54 through which air is sucked in a manner known per se, thereby obtaining a depression under the face 41 which keeps it adhering to the plane 52 and eliminates the aforesaid undulations.

The plane 52 is also horizontally movable (as indicated by the arrow in fig. 8 and 9) with respect to a nozzle bar 30 of the type already seen in the example of fig. 5 and 6: as a consequence the resin is sprayed on the face 41 by carrying out one or more passes.

Of course also in this case changes can be made; for instance porous support planes could be used, which do not require channels formed therein because the air can be sucked through them: to this purpose reference can be made to planes made of chipboards, plastic material with open cells or spongy material.

Pneumatic vacuum systems like that considered before can operate on all types of surfaces, either metallic, plastic or other, for keeping the planarity of the faces where the resin is sprayed.

Nevertheless it can be understood that they might be replaced by other systems, based for instance on the use of magnets in the case of sheet metal, or of suction caps or other similar holding means.

The first of these alternatives is shown in fig. 11 where the support plane 52 is provided with magnets incorporated therein, which apply an attractive force on the face 41 made of sheet metal; the magnets can be either of natural type or electromagnets and, as mentioned above, they might be replaced with suction caps or other equivalent holding means.

All of these variants fall within the scope of the following claims.

CLAIMS

1. Insulating panel characterised in that it comprises two opposed faces (4, 5; 41, 42), a layer (13; 50) of a first polymeric expanded resin sprayed on at least one of said faces, an insulating core (17; 43) made of a second polymeric expanded resin contiguous to said layer (13).
2. Panel according to claim 1, wherein the opposed faces (4, 5; 41, 42) are substantially smooth.
3. Panel according to claims 1 and 2, comprising peripheral appendices (49) along the edge, filled by said layer (50) of expanded resin applied by spraying.
4. Panel according to the preceding claims, wherein the faces (4, 5; 41, 42) are of sheet metal.
5. Method for the continuous production of insulating panels, comprising the steps of:
 - advancing an upper strip (5) and a lower strip (4) longitudinally in a substantially superimposed condition,
 - applying a substantially liquid expansible polymeric resin between the strips (4, 5), andcausing the resin to expand whilst the strips (4, 5) are kept spaced apart at a predetermined distance substantially equal to the thickness of the panels to be produced,
characterized in that it comprises a step of spraying an expansible polymeric resin onto at least one of the strips (4, 5).
6. Method according to Claim 5, wherein the substantially liquid resin is applied on a layer (13) formed by the sprayed and at least partially expanded resin.
7. Method according to claims 6 and 7, wherein the sprayed resin is of the quick-reaction type.
8. Method according to Claims from 5 to 7, wherein the strip onto which the quick-reaction expansible resin is sprayed, is the lower strip (4).
9. Method according to the preceding claims, wherein the strips (4, 5) are made of metal.

10. Method according to the preceding claims, wherein the resins applied are one-component or two-component polyurethane resins.

11. Apparatus for the production of panels according to the method of the preceding claims, characterized in that it comprises means (9, 10; 30) for spraying a first expansible polymer resin and means (11, 12; 31) for applying a second, substantially liquid, expansible polymer resin onto at least one of the strips (4).

12. Apparatus according to Claim 11, wherein the means (9, 10; 30) for spraying the first resin are arranged upstream of the means (11, 12; 31) for applying the second, substantially liquid resin.

13. Apparatus according to Claims 11 and 12, wherein the means for spraying the first resin comprise a spraying head (9) movable to and fro transversely relative to the advance direction of the strip (4) onto which the resin is sprayed.

14. Apparatus according to claims 11 and 12, wherein the means for spraying the first resin comprises a fixed nozzle bar (30), extending transversely to the advancing direction of the strip (4, 5) where the resin has to be sprayed.

15. Method for the discontinuous production of insulating panels according to claims 1 to 4, comprising the steps of:

- spraying on at least one of the faces (41, 42) a layer (50) of an expansible polymer resin;
- applying an expansible polymer resin in a substantially liquid condition;
- allowing the liquid resin to expand while keeping the faces (41, 42) in a mould, spaced apart at a predetermined distance substantially equal to the thickness of the panel to be produced.

16. Method according to claim 15, wherein the resin substantially liquid is applied on a layer (50) of resin sprayed and at least partially expanded.

17. Method according to claims 15 and 16, wherein the sprayed resin is of the quick-reaction type.

18. Method according to the claims from 15 to 17, wherein the expansible resins are one-component or two-component polyurethane resins.

19. Method according to the claims from 15 to 18, wherein the face (41) on which the resin is sprayed, is supported by a support plane (52) provided with means (54) for causing a depression under said face to avoid the presence of undulations on it.

20. Method according to the claims from 15 to 18, wherein the face (41) on which the resin is sprayed, is supported by a support plane (52) provided with means (64) of magnetic type acting under said face to avoid the presence of undulations on it.

21. Method according to claims 19 and 20, wherein the support plane (52) is movable with respect to the nozzles (30) for spraying the resin.

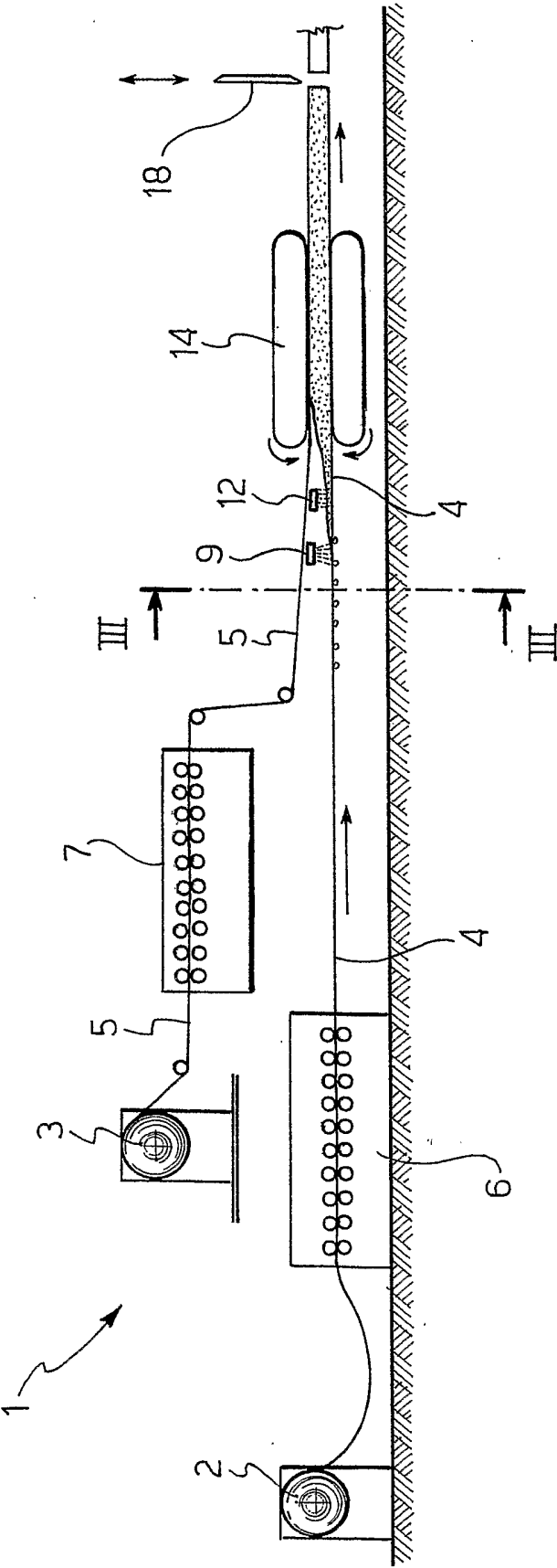


FIG. 1

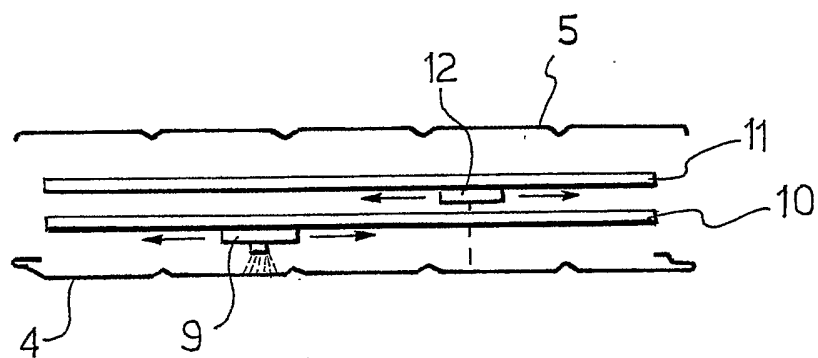
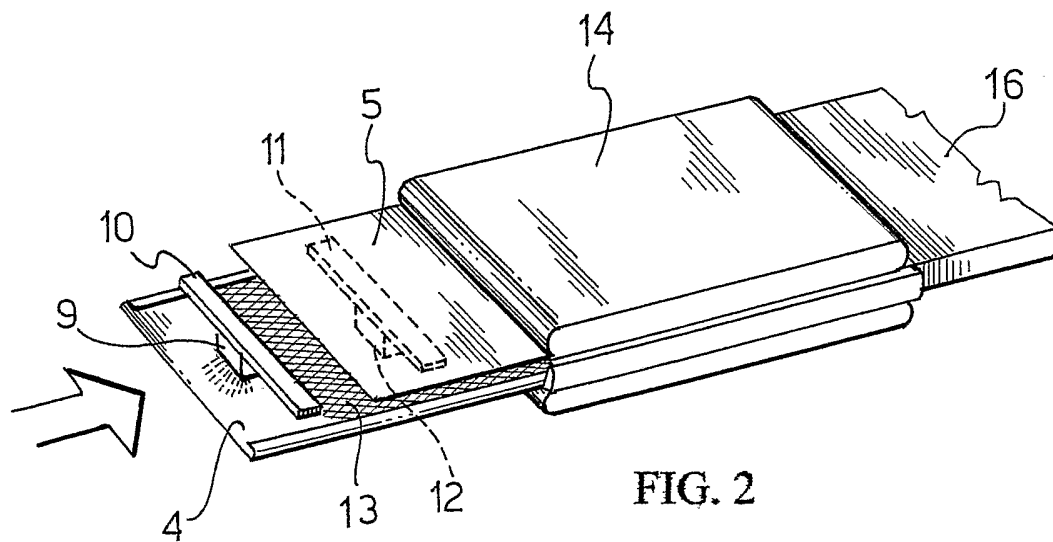
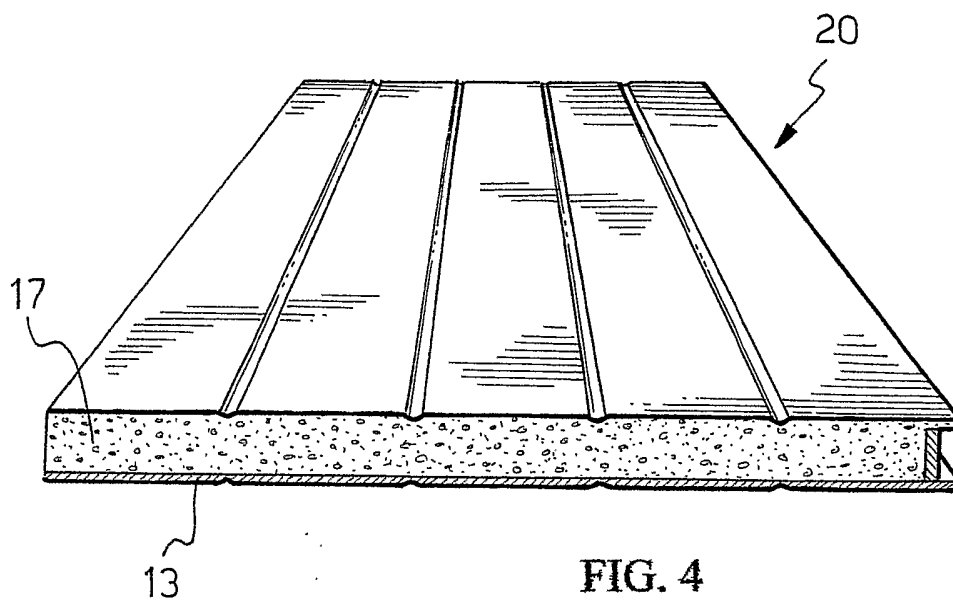


FIG. 3



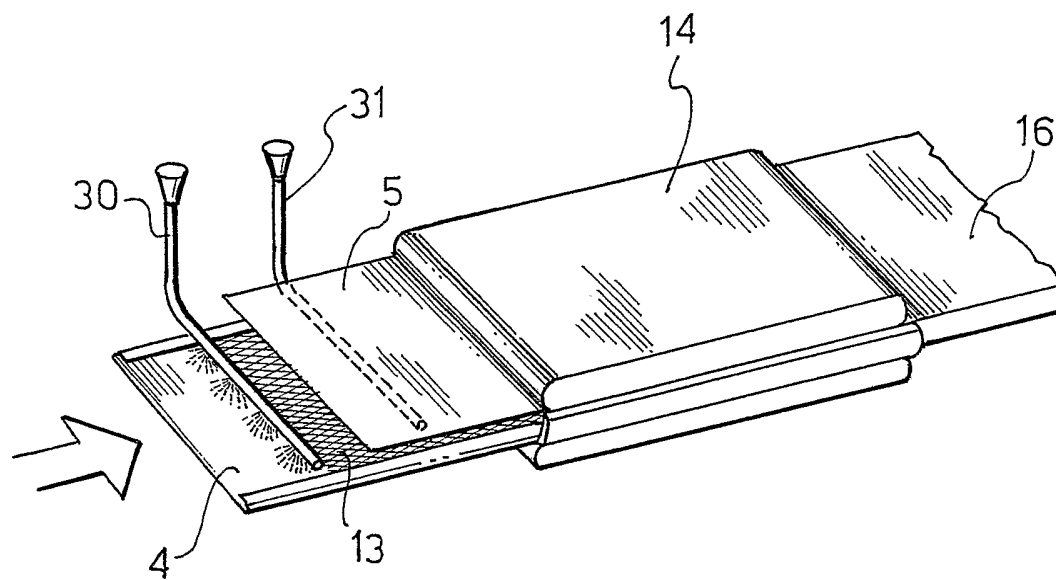


FIG. 5

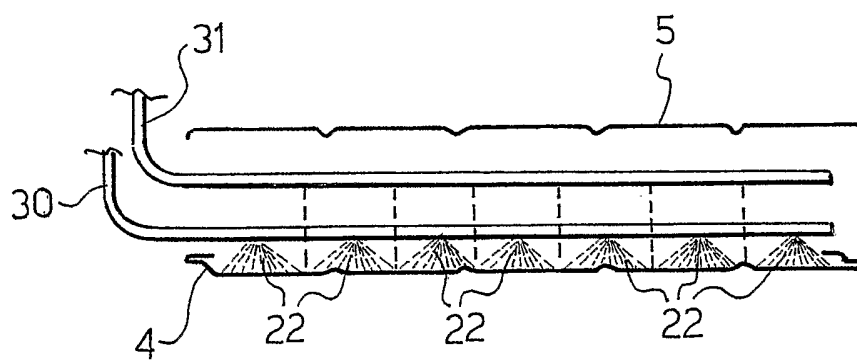


FIG. 6

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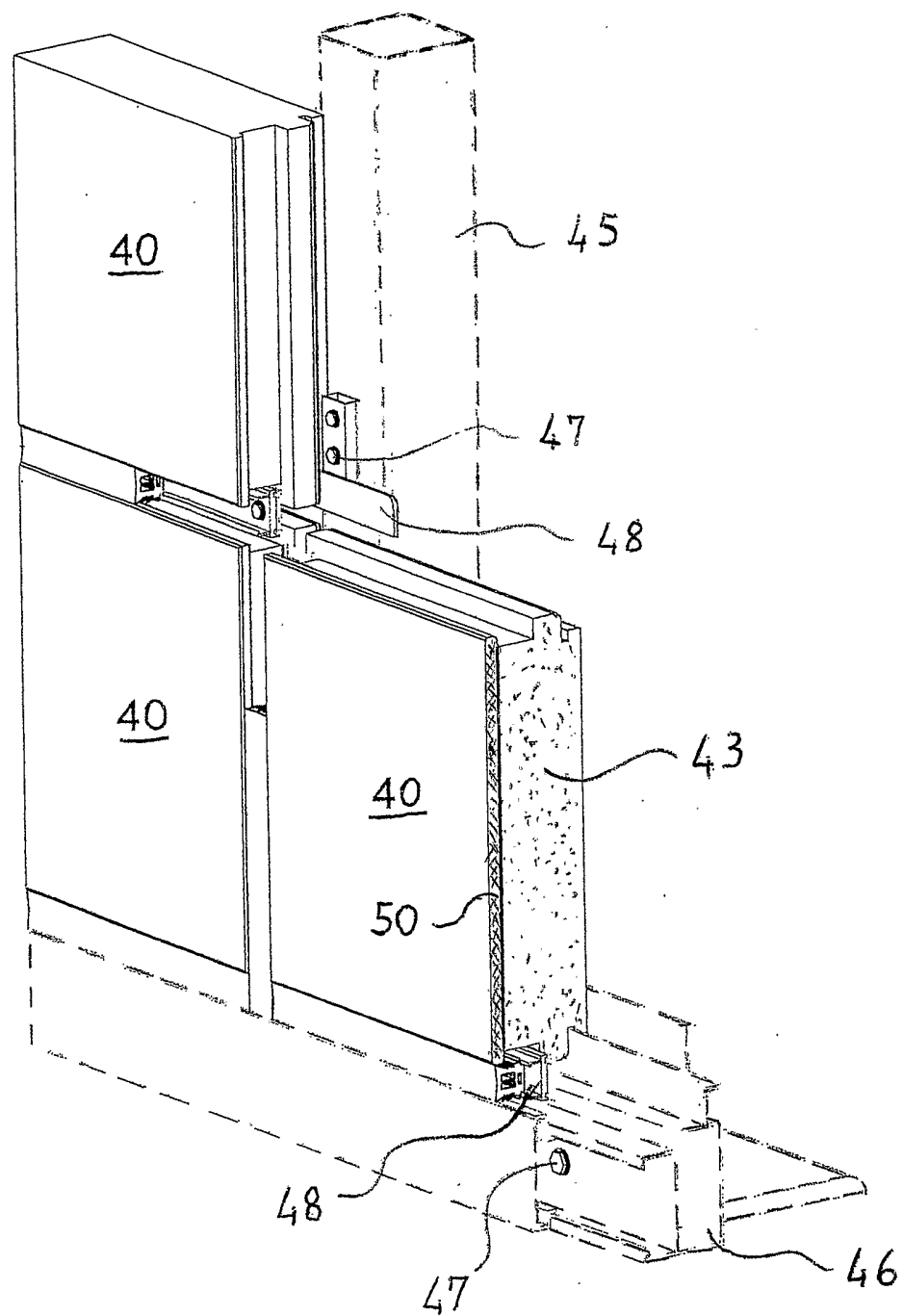


FIG. 7

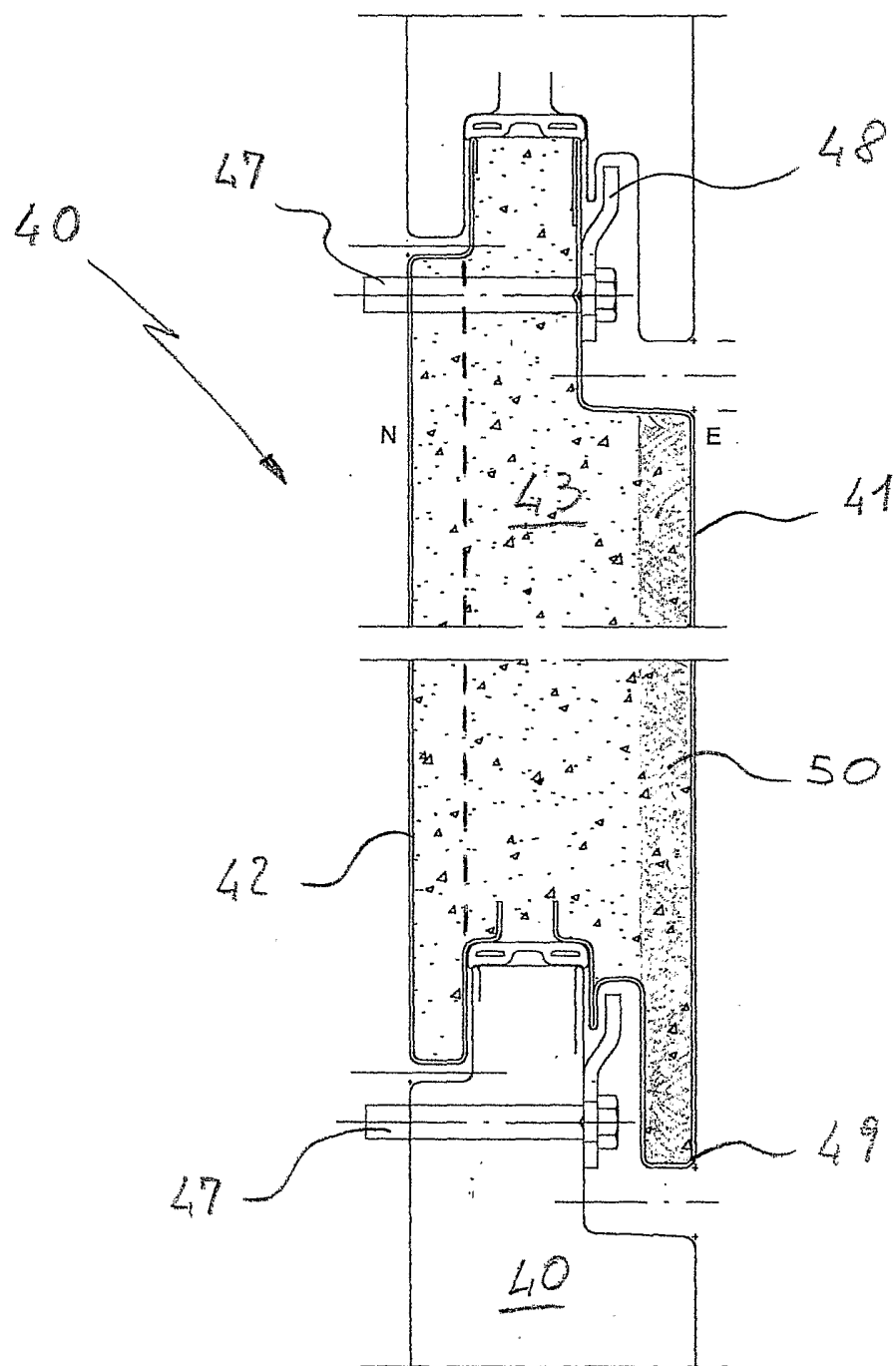


FIG. 8

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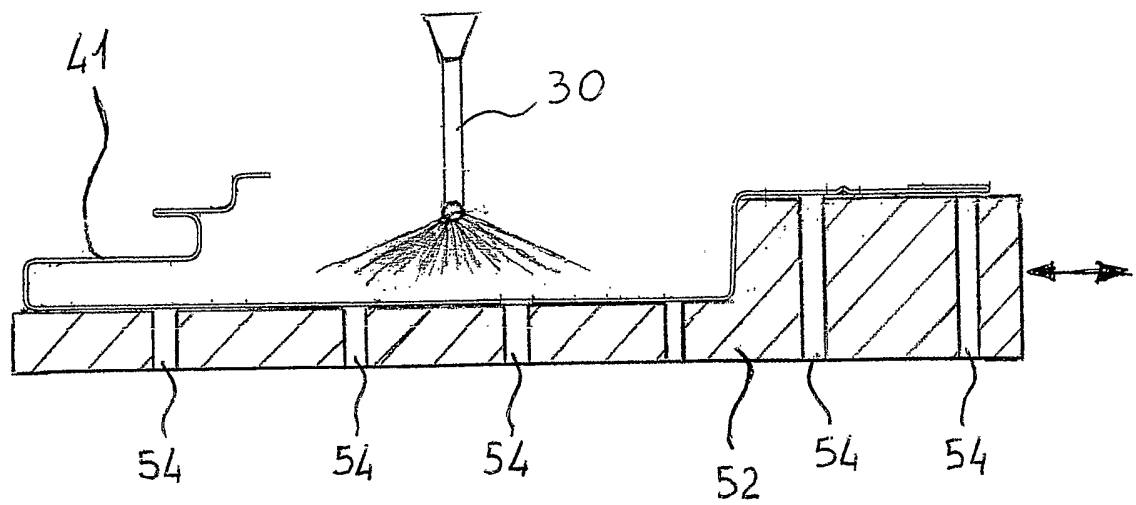


FIG. 9

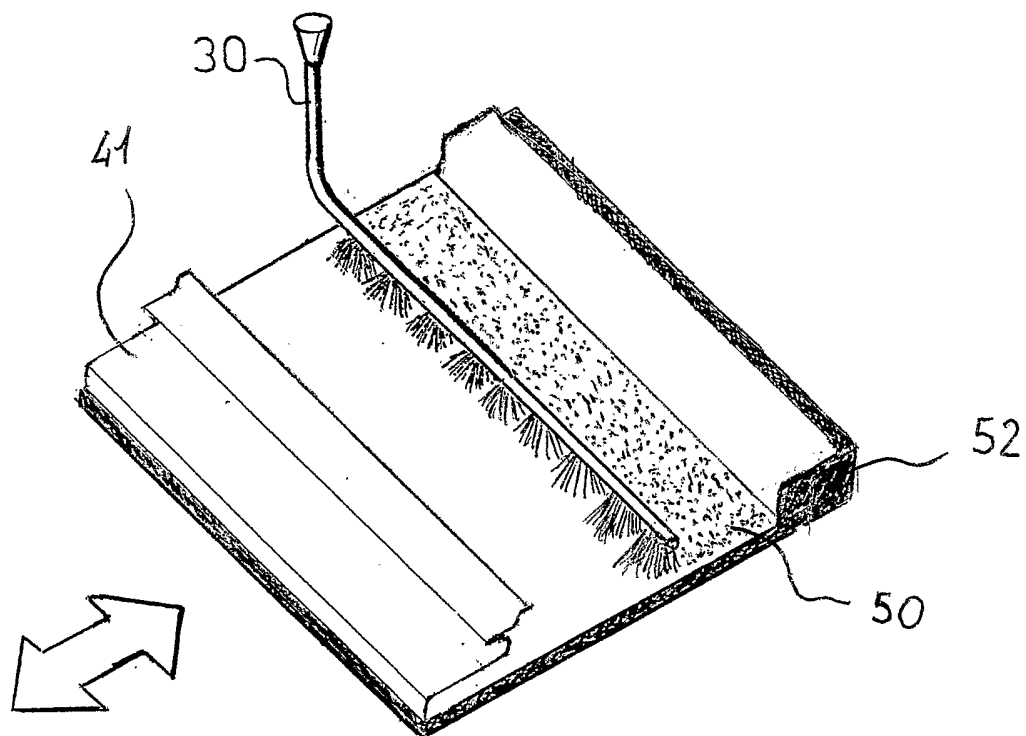


FIG. 10

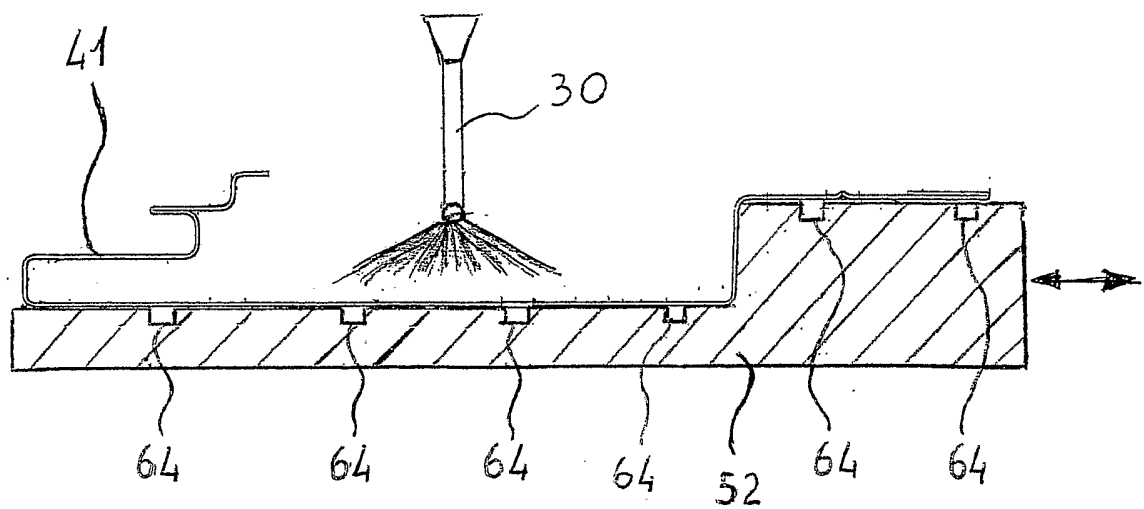


FIG.11