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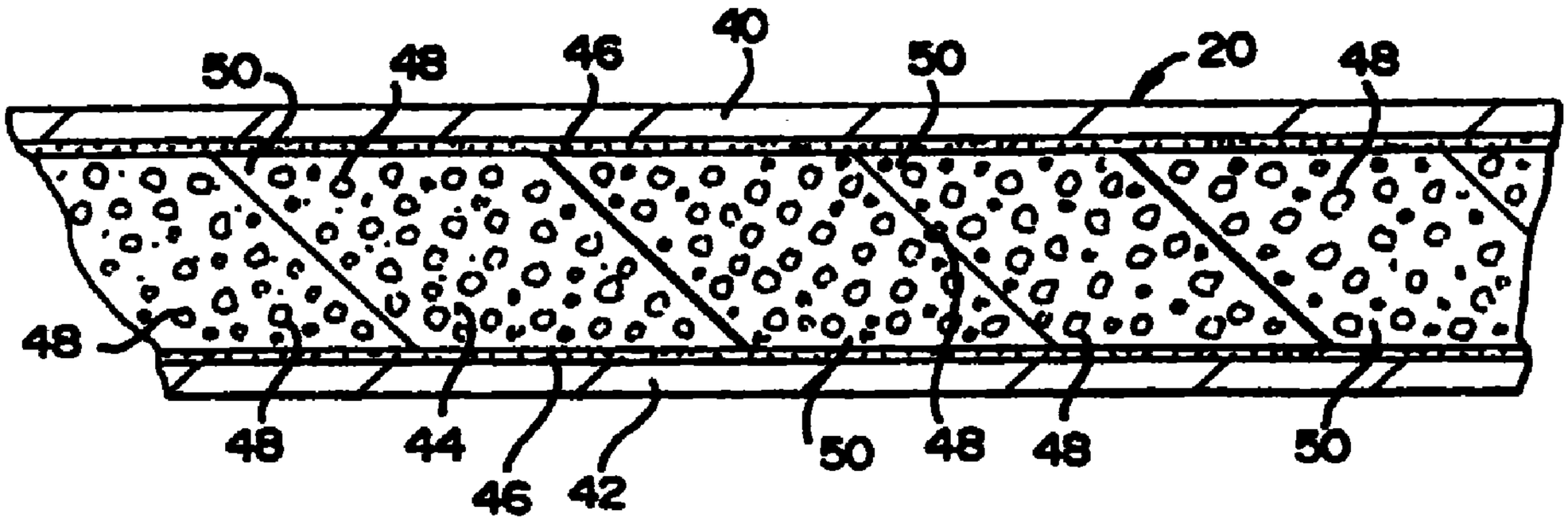
(54) **PLAQUE COMPOSITE A AME ALVEOLAIRE POUR PAROIS ET PORTES DE SEMI-REMORQUES**

(54) **FOAMED CORE COMPOSITE PLATE FOR USE IN TRAILER WALLS AND DOORS**



(57) L'invention concerne une nouvelle plaque composite (20) utilisée pour former une paroi (28, 30) ou une porte (32) d'un véhicule, comme un semi-remorque (22) ou un fourgon. Chaque plaque composite (20) utilisée dans le semi-remorque (22) est formée de deux couches de recouvrement métalliques (40, 42), par exemple en aluminium ou en acier, entre lesquelles est placé un élément formant âme de plastique thermique alvéolaire (44). Les couches de recouvrement (40, 42) sont liées à l'élément formant âme (44) par un adhésif flexible connu (46). L'élément formant âme (44) est élastique, et peut être fabriqué à partir d'un plastique

(57) A novel composite plate (20) is used to form a wall (28, 30) or a door (32) of a vehicle, such as a trailer (22) or van. Each composite plate (20) used in the trailer (22) is formed from a pair of metal skins (40, 42), such as aluminum or steel, having a foamed thermal plastic core member (44) sandwiched therebetween. The skins (40, 42) are bonded to the core member (44) by a known flexible adhesive (46). The foamed thermal plastic core member (44) is resilient and may be made from foamed high density or foamed low density thermal plastic. The foaming of the core member (44) in the present invention reduces the weight of the composite plate (20) versus

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thermique alvéolaire de faible densité ou de forte densité. Le moussage de l'élément formant âme (44) selon la présente invention réduit le poids de la plaque composite (20) par rapport aux plaques composites formant âmes plastiques solides de l'art antérieur. Le moussage assure également une meilleure résistance à l'arrachement de la plaque composite (20) par rapport à ces plaques composites de l'art antérieur. En outre, le moussage de l'élément formant âme plastique thermique (44) selon la présente invention réduit la contrainte de cisaillage de la couche de liaison entre l'âme et la couche de revêtement, ce qui réduit le risque de décollement des couches de revêtement métalliques (40, 42) par rapport à l'élément formant âme (44) lors des changements de température, qui a toujours posé un problème avec les plaques composites formant âmes solides.

prior art solid plastic core composite plates and provides for an increase in the peel strength of the composite plate (20) versus prior art solid plastic core composite plates. Furthermore, foaming of the thermal plastic core member (44) in the present invention reduces the shear stress of the skin to core bond layer so as to reduce the potential of delamination of the metal skins (40, 42) from the thermal plastic core member (44) under changing temperatures which has been found to be a problem with solid core composite plates.

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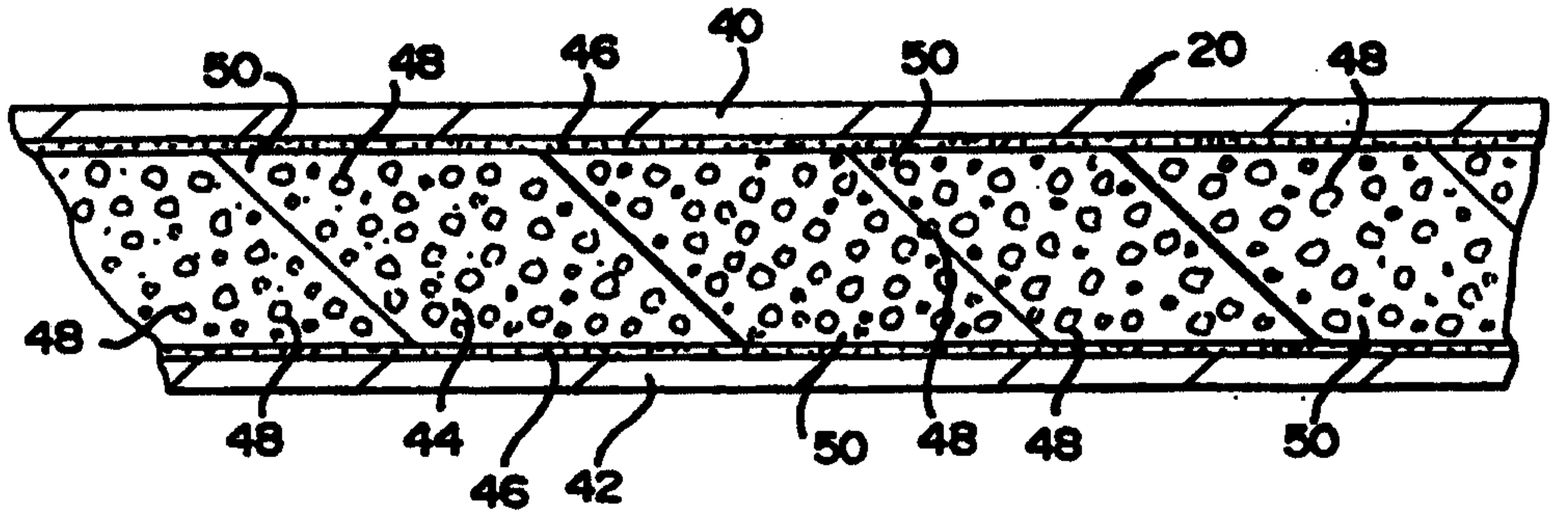
(54) Title: FOAMED CORE COMPOSITE PLATE FOR USE IN TRAILER WALLS AND DOORS



(57) Abstract

A novel composite plate (20) is used to form a wall (28, 30) or a door (32) of a vehicle, such as a trailer (22) or van. Each composite plate (20) used in the trailer (22) is formed from a pair of metal skins (40, 42), such as aluminum or steel, having a foamed thermal plastic core member (44) sandwiched therebetween. The skins (40, 42) are bonded to the core member (44) by a known flexible adhesive (46). The foamed thermal plastic core member (44) is resilient and may be made from foamed high density or foamed low density thermal plastic. The foaming of the core member (44) in the present invention reduces the weight of the composite plate (20) versus prior art solid plastic core composite plates and provides for an increase in the peel strength of the composite plate (20) versus prior art solid plastic core composite plates. Furthermore, foaming of the thermal plastic core member (44) in the present invention reduces the shear stress of the skin to core bond layer so as to reduce the potential of delamination of the metal skins (40, 42) from the thermal plastic core member (44) under changing temperatures which has been found to be a problem with solid core composite plates.

FOAMED CORE COMPOSITE PLATE FOR USE IN TRAILER WALLS AND DOORS

BACKGROUND OF THE INVENTION

This invention is generally directed to a novel composite plate for a trailer wall construction or a trailer door construction. More particularly, the invention contemplates a novel composite plate that has a foamed thermal plastic core which provides a variety of advantages over prior art solid core composite plates.

Composite plates having solid plastic cores for use in forming trailer walls or doors are known in the art. Such composite plates are formed from a pair of metal skins, formed of aluminum or steel, having a solid plastic core member, formed of polyethylene or polypropylene, sandwiched therebetween. The use of a solid plastic core member in a composite plate has worked reliably in the prior art, however, several disadvantages have been found.

Solid core composite plates tend to have low peel strength. That is, the metal skins peel away from the plastic core with small force. Furthermore, with the prior art solid core member, a high shear stress is obtained as the plastic core material changes temperature and if the shear stress gets too high, then the metal skins can delaminate from the solid plastic core member.

The present invention provides a novel composite plate having a foamed thermal plastic core member that is used in a trailer wall construction or a trailer door construction which overcomes the disadvantages of using a prior art solid plastic core member in a composite plate. Other features and advantages will become apparent upon a reading of the objects and description taken in combination with a study of the drawings.

OBJECTS AND SUMMARY OF THE INVENTION

A general object of the present invention is to provide a novel composite plate having a foamed thermal plastic core member which forms a wall or a door of a vehicle, such as a trailer.

An object of the present invention is to provide a novel composite plate for a trailer wall or door construction having a foamed thermal plastic core member which reduces the weight of the plate versus prior art solid core composite plates.

Another object of the present invention is to provide a novel composite plate for a trailer wall or door construction having a foamed thermal plastic core member which increases the peel strength of the plate versus prior art solid core composite plates.

A further object of the present invention is to provide a composite plate for a trailer wall or door construction which reduces the shear stress of the skin to core bond layer so as to reduce the potential of delamination of the metal skins from the thermal plastic core member under changing temperatures.

Briefly, and in accordance with the foregoing, the present invention discloses a novel composite plate which is used to form a wall or a door of a vehicle, such as a trailer or van. Each composite plate used in the trailer is formed from a pair of metal skins, such as aluminum or steel, having a foamed thermal plastic core member sandwiched therebetween. The skins are bonded to the core member by a known flexible adhesive layer. The foamed thermal plastic core member is resilient and may be made from foamed high density thermal plastic, such as polyethylene or polypropylene, or foamed low density thermal plastic, such as polyethylene or polypropylene, or other foamed thermal plastic.

To make the foamed core member used in the present invention, foaming beads or pellets are first mixed with thermal plastic resin beads or pellets by means of an auger in a mixing chamber. The foaming pellets have a gas therein. The mixed pellets are subjected to heat in a hot die chamber and the foaming pellets burst and produce carbon dioxide or nitrogen to foam the mixture. The mixture is extruded into

a layer by an extruder to form the foamed core member. Thereafter, a layer of flexible adhesive is preferably applied to the inner surface of the skins by suitable means, the layer of flexible adhesive can be applied to the opposite sides of the foamed thermal plastic core member by like suitable means, an adhesive film can be co-extruded on both sides of the core member and laminated to the core member immediately, or the surfaces of the core member can be treated to become the adhesive bonding layer such that the skins can be directly bonded thereto. Thereafter, the metal skins are adhered to the core member by means of the flexible adhesive layer under pressure. This process may be continuous. It is envisioned that other means of foaming the core member may be provided such as by injecting nitrogen into a heating chamber in which the thermal plastic resin pellets are being heated and are in a molten state and thereafter extruding the foamed core material into a core member, or by using both the nitrogen producing beads or pellets and the direct injection of nitrogen gas into a heating chamber in which the thermal plastic resin pellets and the nitrogen producing pellets are being heated.

BRIEF DESCRIPTION OF THE DRAWINGS

The organization and manner of the structure and operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings, wherein like reference numerals identify like elements in which:

FIGURE 1 is a perspective view of a trailer having a plurality of composite plates which incorporate the features of the invention and which form the walls and the rear doors thereof;

FIGURE 2 is a cross-sectional view of one of the plates of FIGURE 1; and

FIGURE 3 is a schematic view of an apparatus for forming one of the plates of FIGURES 1 and 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

While the invention may be susceptible to embodiment in different forms, there is shown in the drawings, and herein will be described in detail, a specific embodiment with the understanding that the present disclosure is to be considered an exemplification of the principles of the invention, and is not intended to limit the invention to that as illustrated and described herein.

The present invention discloses a novel composite plate 20 for use in a wall or door construction of a vehicle, such as a trailer 22, as shown in FIGURE 1, van or the like. The trailer 22 is generally comprised of a floor 24, a roof 26, a front wall 28, a pair of opposite side walls 30 (only one of which is shown), rear cargo doors 32, a landing gear 34, and an undercarriage assembly 36. As shown in FIGURE 1, the trailer 22 is connected to a tractor 38 by conventional means, such as a fifth wheel.

Each side wall 30 and the front wall 28 of the trailer 22 is formed from a plurality of the novel composite plates 20 of the present invention which are fastened together by suitable means such as by riveting. Preferably, each composite plate 20 is rectangular having a height greater than its width. The composite plates 20 can be relatively equal in size or the width and thickness of each plate 20 may vary. When composite plates 20 are used in the construction of the side walls 30 and the front wall 28, each composite plate 20 is connected to the floor 24 and extends upwardly therefrom and is attached to upper and lower rails of the trailer 20 by suitable joining members, such as bolts or rivets. When composite plates 20 are used in the construction of the rear doors 32, outer composite plates 20 are connected to the respective side walls 30 of the trailer 22 by hinges. When closed the doors 32 extend upwardly from the floor 24. Alternatively, each side wall 30 and the front wall 28 of the trailer 22 may be formed from one such continuous plate 20.

Attention is directed to FIGURE 2 which shows a cross-section of one of the novel composite plates 20 used in the construction of the trailer walls 28, 30 and/or doors 32. The composite plate 20 includes a pair of metal sheets or skins 40, 42 which are bonded to a foamed thermal plastic core member 44, described more fully

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herein, which is sandwiched therebetween by a thin adhesive layer 46 (such thickness of the adhesive layer has been exaggerated in the drawings for clarity in understanding the invention). The skins 40, 42 are bonded to the foamed thermal plastic core member 44 by means of a known flexible adhesive bonding film 46. Skin 40 forms an inner surface of the trailer 22 and skin 42 forms an outer surface of the trailer 22.

The metal skins 40, 42 used in the composite plate 20 of the present invention are preferably formed of aluminum or full hard, high strength, high tension, galvanized steel. Preferably, the each of the skins 40, 42 are formed from galvanized steel and preferably, the inner skin 40 is over nineteen thousandths of an inch in thickness and the outer skin 42 is over nineteen thousandths of an inch in thickness.

The core member 44 is formed from a foamed thermal plastic, preferably foamed high density polyethylene (HDPE) or high density polypropylene, which makes the core member 44 resilient. That is, the core member 44 can flex without breaking. As shown in FIGURE 2, the core member 44 includes a plurality of air bubbles 48 interspersed with the thermal plastic material 50. It has been found that molecular integrity of the core member 44 is not lost by the foaming of the core member 44 and peel strength is increased versus prior art composite plates which use a solid core member. That is, it takes a greater force to peel the metal skins 40, 42 from the foamed thermal plastic core member 44 than in prior art solid core composite plates. This is described more fully herein. The foaming of the core member 44 lowers the density of the thermal plastic and improves the strength to weight ratio thereof. Alternatively, the core member 44 may be made from foamed low density thermal plastic, such as foamed low density polyethylene or low density polypropylene. Low density thermal plastic will foam and produce a resilient core member, however, the resulting composite plate is not as stiff as when foamed high density thermal plastic is used in the composite plate. When foamed high density thermal plastic is used as the core member in the composite plate, the composite plate is approximately twice as stiff as when a foamed low density thermal plastic is used as the core member in the composite plate.

The core member 44 preferably has a thickness of one half of an inch or less. The core member 44 used in the present invention is thinner than prior art solid cores which are mush thicker, typically three quarters of an inch to four inches.

The foaming of the core member 44 reduces the weight of the composite plate 22 versus prior art solid core composite plates. Because the core member 44 is foamed in the present invention and is not solid as in prior art composite plates, the amount of plastic resin used in formation of the core member 44 is reduced by up to 50% versus prior art solid core composite plates.

As mentioned herein, the foaming of the thermal plastic core member 44 also increases the peel strength of the resulting composite plate 20. When the composite plate 22 is subjected to peel forces, that is, the skins 40, 42 are grasped opposite of each other and the skins 40, 42 are peeled away from the core member 44, the entire core member 44 flexes because the foamed core material is resilient and the peel force is along the length of the core member 44. Because the core member 44 is resilient and flexes, this allows for more of the core member 44 to be loaded during application of peel forces. In the prior art, solid core members are provided in composite plates and therefore, the peel strength is low; especially compared to the present invention because the solid core composite plate are not as resilient. When a solid core member is used in a composite plate as is used in the prior art, to peel a skin from the core member, peel force only is applied at a narrow line of the skin to crack the skin away from the solid core member.

In the present invention, peel strength was measured by means of a peel test. The metal skins 40, 42 were grasped opposite of each other and the force required to peel the skins 40, 42 from the core member 44 was measured. It was found that an increase in peel strength is obtained with the resilient foamed core member 44 of the present invention versus a solid core member as used in the prior art. This means that in the present invention, the skins 40, 42 are less likely to delaminate from the resilient core member 44 upon impact or because of abuse.

In prior art solid core composite plates, a high shear stress is obtained between

the metal skins and the solid plastic core member as the composite plate temperature changes. If shear stress gets too high, then the metal skins can delaminate from the core member. The plastic core member expands or contracts fastener than the metal skins, however, the metal skins will restrict this expansion when they are bonded to the core member, but high shear stresses result at the adhesive face. In the present invention, because the core material 44 is foamed, lower shear stresses of the skin to core bond layer result as temperature is changed because the foamed core member can be compressed or expanded because of the cell structure so as to reduce the potential of delamination of the metal skins 40, 42 from the thermal plastic core member 44. Thus, the foamed thermal plastic core member 44 will still expand or contract faster than the metal skins 40, 42, however, the foamed thermal plastic core member 44 compresses or expands thereby neutralizing this faster expansion or contraction such that the foamed thermal plastic core member 44 expands or contracts at approximately the same rate as the metal skins 40, 42 and lower shear stresses result at the adhesive face.

To make the foamed core member 44 used in the present invention, as shown in FIGURE 3, foaming beads or pellets 52 are first mixed with thermal plastic resin beads or pellets 54 by means of an auger 56 in a mixing chamber 58. The foaming pellets 52 have a gas therein. The mixed pellets 54, 56 are subjected to heat in a hot die chamber 60 and the foaming pellets 56 burst and produce carbon dioxide or nitrogen to foam the mixture. The mixture is extruded into a layer by an extruder 62 to form the foamed core member 44. Thereafter, a layer of flexible adhesive 46 is preferably applied to the inner surface of the skins 40, 42 by suitable means 64, as shown, the layer of flexible adhesive 46 can be applied to the opposite sides of the foamed thermal plastic core member 44 by like suitable means, an adhesive layer of film 46 can be co-extruded on both sides of the core member 44 and laminated to the core member 44 immediately, or the outer surfaces of the core member 44 can be treated to become the adhesive bonding layer 46 such that the skins 40, 42 can be directly bonded thereto. Thereafter, the metal skins 40, 42 are adhered to the core

member 44 by means of the flexible adhesive layer 46 under pressure. It is to be noted that the more gas that is used during the heating step, the more reduction in core material is ultimately achieved. This process may be continuous.

It is envisioned that other means of foaming the core member 44 may be provided such as by injecting nitrogen into a heating chamber in which the thermal plastic resin pellets 54 are being heated and are in a molten state (without the foaming pellets 52 being mixed therewith) and thereafter extruding the foamed core material into a core member 44, or by using both the foaming pellets 52 and the direct injection of nitrogen gas into a heating chamber (shown via conduit 61 shown in phantom lines in FIG. 3) in which both the thermal plastic resin pellets 54 and the foaming pellets 52 are being heated.

While a preferred embodiment of the present invention is shown and described, it is envisioned that those skilled in the art may devise various modifications of the present invention without departing from the spirit and scope of the appended claims.

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THE INVENTION CLAIMED IS:

1. A trailer (22) comprising: a floor (24) and at least one upstanding member (28, 30, 32) extending upwardly from said floor (24), said upstanding member (28, 30, 32) including a pair of skins (40, 42) having a foamed thermal plastic core member (44) sandwiched therebetween.

2. A trailer (22) as defined in claim 1, wherein said foamed thermal plastic core member (44) is resilient.

3. A trailer (22) as defined in claim 1, wherein said foamed thermal plastic core member (44) is made from foamed high density thermal plastic.

4. A trailer (22) as defined in claim 3, wherein said foamed high density thermal plastic is foamed high density polyethylene or high density polypropylene.

5. A trailer (22) as defined in claim 1, wherein said foamed plastic core member (44) is made from foamed low density thermal plastic.

6. A trailer (22) as defined in claim 5, wherein said foamed low density thermal plastic is foamed low density polyethylene or low density polypropylene.

7. A trailer (22) as defined in claim 1, wherein said upstanding member (28, 30, 32) is a side wall (30), a front wall (28) or a door (32) of said trailer (22).

8. A trailer (22) as defined in claim 1, wherein said skins (40, 42) are formed from metal.

9. A trailer (22) as defined in claim 1, wherein said skins (40, 42) are bonded to

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said core member (44) by a flexible adhesive (46).

10. A trailer (22) as defined in claim 1, wherein said thermal plastic core member (44) has a thickness of one half of an inch or less.

11. A method of forming a wall (28, 30) or a door (32) of a trailer (22) comprising the steps of: mixing thermal plastic resin pellets (54) and gas pellets (52) together; applying heat to said mixed pellets (52, 54); extruding said heated mixture into a core member (44); and bonding skins (40, 42) to opposite sides of said core member (44).

12. A method as defined in claim 11, further including the step of applying a flexible adhesive (46) to inner surfaces of said skins (40, 42) or to opposite sides of said core member (44) prior to bonding said skins (40, 42) to said opposite sides of said core member (44).

13. A method of forming a wall (28, 30) or a door (32) of a trailer (22) comprising the steps of: applying heat to thermal plastic resin pellets (54) in a heating chamber (60); injecting nitrogen into said heating chamber (60), thereby forming a foamed mixture; extruding said foamed mixture from said heating chamber (60) into a core member (44); and bonding skins (40, 42) to opposite sides of said core member (44).

14. A method as defined in claim 13, further including the step of applying a flexible adhesive (46) to inner surfaces of said skins (40, 42) or to opposite sides of said core member (44) prior to bonding said skins (40, 42) to said opposite sides of said core member (44).

15. A method of forming a wall (28, 30) or a door (32) of a trailer (22) comprising the steps of: mixing thermal plastic resin pellets (54) and gas pellets (52) together; applying heat to said mixed pellets (52, 54) in a heating chamber (60); injecting

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nitrogen into said heating chamber (60), thereby forming a foamed mixture; extruding said foamed mixture from said heating chamber (60) into a core member (44); and bonding skins (40, 42) to opposite sides of said core member (44).

16. A method as defined in claim 15, further including the step of applying a flexible adhesive (46) to inner surfaces of said skins (40, 42) or to opposite sides of said core member (44) prior to bonding said skins (40, 42) to said opposite sides of said core member (44).

17. A plate (20) capable of use in forming a wall (28, 30) or a door (32) of a trailer (22) comprising: a member (20) including a pair of skins (40, 42) having a foamed thermal plastic core member (44) sandwiched therebetween.

18. A plate (20) as defined in claim 17, wherein said foamed thermal plastic core member (44) is made from foamed high density thermal plastic.

19. A plate(20) as defined in claim 18, wherein said foamed high density thermal plastic is foamed high density polyethylene or high density polypropylene.

20. A plate (20) as defined in claim 19, wherein said foamed thermal plastic core member (44) is made from foamed low density thermal plastic.

21. A plate (20) as defined in claim 20, wherein said foamed low density thermal plastic is foamed low density polyethylene or low density polypropylene.

22. A plate (20) as defined in claim 17, wherein said skins (40, 42) are formed from metal.

23. A plate (20) as defined in claim 17, wherein said skins (40, 42) are bonded to

said core member (44) by a flexible adhesive.

24. A plate (20) as defined in claim 17, wherein said thermal plastic core member (44) has a thickness of one half of an inch or less.

FIG. 1

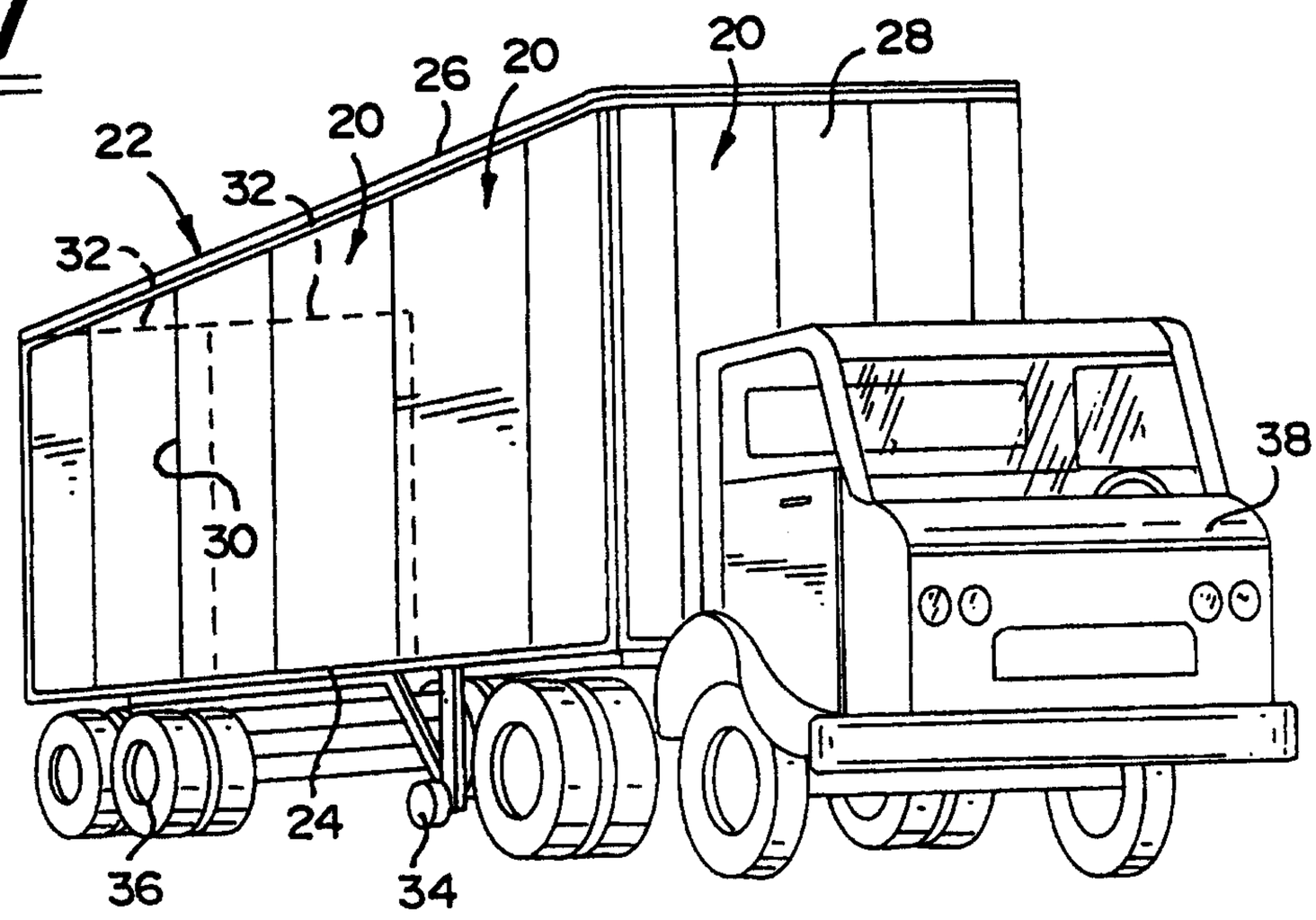

FIG. 2

FIG. 3