

明 細 書

合成樹脂製中空ボードの融着方法およびその方法により得られる中空ボード

技 術 分 野

本発明は、対向する平行な２枚のシートを多数のリップをそれらの間に介在させて一体に成形した熱可塑性合成樹脂製中空ボードの融着方法およびその方法により得られた中空ボードに関する。

背 景 技 術

対向する平行な２枚のシートの間に両シートを一体的に連結する多数のリップを介在させた熱可塑性合成樹脂製中空ボードは、箱などの包装具、仕切り、壁などの建築材、その他の用途に用いられている。この種の合成樹脂製中空ボードは、そのリップの方向に押出し成形することによって製造されるものであって、通常、ポリプロピレン、ポリエチレンなどの熱可塑性樹脂により構成されており、従来から用いられている段ボール材に比べて強度および耐久性において優れているために、多用されるようになってきている。

ところで、従来のこの種中空ボードは、リップに平行をなす側縁およびリップに直交する端縁が外部に対して開口しているため、ボードの中空内部にごみや雑菌等の異物が入り易く、また、この中空内部の汚れが洗浄が事実上出来ないという欠点があり、このため衛生基準の厳しい食品や医療品、化粧品などの包装箱の材料には使用できなかった。

また、この種の中空ボードを包装材として使用する場合には、板面に溝や凹面を形成したり、折り込み線や開口部を形成するための加工の必要が生ずる。これらの加工には従来からプレス加工や熱板を圧接して加工することが行われているが、プレス加工による折り込み線は、折り目が浅く反発力が強すぎるため、箱に

組立てる際や、組立てた後にさまざまな不都合が生ずる。また、プレス加工による打ち抜き開口部の形成は開口部縁辺が開放してしまうため、中空内部にゴミなどの不純物が入り込んでしまう。さらに、熱板を使用する上記の加工は熱板の側面で圧接部両側の両面シートを融してしまうため、ボードに多数の孔があいてしまうという問題があった。

一方、中空ボード同士、あるいは中空ボードとフレーム等の他の部品を接合する手段としては、従来から、ステープラー止め、リベット止め、粘着テープ止め、接着剤による接合等を使用する方法が用いられている。これらの接合方法は、紙質段ボールに用いられてきた方法であって、合成樹脂製中空ボードの接合に用いて問題がない場合もある。

しかしながら、合成樹脂製中空ボードは、紙質段ボールを用いては荷重面で耐えられないような重量物用容器等に用いたり、高い気密性や水密性が要求される場合に用いたりするので、粘着テープや接着剤による接合では、上記用途に対して信頼性が欠けるという問題がある。また、ステープラー止め、リベット止め等は特に気密性や水密性の点で問題がある。

一方、前述のように、熱板を用いて合成樹脂製中空ボードを熔融させて接合する方法の場合でも、中空ボードに溝や凹面を形成したり、折り込み線や開口部を形成したりする場合と同様に、ボード表面に多数の孔や圧痕が残るという問題があるうえに、接合される2枚の中空ボードの接合面や、接合される中空ボードと他の合成樹脂部品の接合面における溶着が十分にしかも仕上がり良く行われず、接合個所が場合によって焼き切れる等の不都合が生じる。

本発明は、従来技術の上述の問題点を解消するためになされたもので、その主目的は、中空ボードの対向するシート同士、2枚の中空ボード同士、および中空ボードと他の部品を確実にかつ仕上がりよく接合することができる熱可塑性合成樹脂製ボードの融着方法を提供することにある。

本発明の他の目的は、中空ボードの縁辺等を確実に融着して閉じ、中空ボードの内部を外部に対して閉塞することができる熱可塑性合成樹脂製ボードの融着方法を提供することにある。

本発明のさらに他の目的は、中空ボードの板面に溝、凹面、折り込み線、開口部等を確実にかつ仕上がりよく、しかも加工によりボードに反発力を発生させることなく形成することができる熱可塑性合成樹脂製ボードの融着方法を提供することにある。

また、本発明の目的は、上記の方法により得られた熱可塑性合成樹脂製ボードおよびその製品を提供することにある。

発明の開示

本発明の一形態によれば、平行をなす第1シートおよび第2シートと、これらシート間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボードを用意し、一方のシートの面に超音波融着装置の超音波発振部を、また他方のシートの面に超音波融着装置の受座部を位置させ、発振部と受座部を互いに接近させて第1シートと第2シートを接触させ、発振部から受座部へ向かって超音波を発振させ、超音波によって、一方のシートと他方のシートに超音波振動による摩擦熱を発生させ、両シートを前記発振部と受座部の間で押圧しながら融着することからなる熱可塑性合成樹脂製ボードの融着方法が提供される。

本発明の他の形態によれば、平行をなす第1シートおよび第2シートと、これらシート間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、これらの第1および第2のボードを重ね合せ、第1ボードの面に超音波融着装置の超音波発振部を、また第2ボードの面に超音波融着装置の受座部を、線に沿って対向するように位置させ、発振部と受座部を互い

に接近させて第1のボードと第2のボードを接触させ、前記超音波発振部の発振によって第1のボードと第2のボードに超音波振動による摩擦熱を発生させ、両ボードを前記線に沿って融着することからなる熱可塑性合成樹脂製ボードの融着方法が提供される。

また、本発明のさらに他の形態によれば、平行をなす第1シートおよび第2シートと、これらシートの間一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボード、および熱可塑性合成樹脂製部品を用意し、これらボードと部品を重ね合せ、前記ボードの面と部品の面に超音波融着装置の超音波発振部と受座部それぞれを位置させ、超音波発振部と受座部の間に前記ボードと部品を挟んだ状態で、前記超音波発振部を発振させて、ボードと部品の接触部に超音波振動による摩擦熱を発生させ、両者を互いに融着することからなる熱可塑性合成樹脂からなるボードと部品の融着方法が提供される。

本発明のさらに他の形態によれば、平行をなす第1シートおよび第2シートと、これらシートの間一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、これらの第1および第2のボードの端縁を面と面が接するように重ね合せ、両端縁の重ね合せ部分の一侧に、超音波融着装置の超音波発振部を、また他側に超音波融着装置の受座部を位置させ、前記超音波発振部から受座部へ向かって超音波を発振させ、この超音波によって、第1および第2のボードの端縁の互いに接する面部分に超音波振動による摩擦熱を発生させて両面部分を可塑状態にしてこれら両面部分を融合し、互いに接する前記面部分における第1シートおよび第2シートをその厚さの方向に、前記受座部と発振部の間で押圧して第1および第2のボードを接合することからなる熱可塑性合成樹脂製ボードの融着方法が提供される。

本発明の他の形態によれば、平行をなす第1シートおよび第2シートと、これ

らシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボードを用意し、このボードの一方の縁辺と他方の縁辺とを互いに接するように重ね合せ、両縁辺の重ね合せ部分の一側に、超音波融着装置の超音波発振部を、また他側に超音波融着装置の受座部を位置させ、発振部から受座部へ向かって超音波を発振させ、この超音波によって、ボードの前記両縁辺の互いに接する面部分に超音波振動による摩擦熱を発生させて両面部分を可塑状態にしてこれら両面部分を融合し、互いに接する前記面部分におけるボードの両縁辺をその厚さ方向に、前記受座部と発振部の間で押圧してそれらの合計厚さをボードの厚さにまで減少させることからなる熱可塑性合成樹脂製ボードの融着方法が提供される。

本発明の他の形態によれば、平行をなす第1シートおよび第2シートと、これらのシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボードを用意し、このボードの端縁を層をなすように折り返し、この層を超音波融着装置の超音波発振部と受座部との間に挟み、前記超音波発振部を発振させてボードの層に超音波振動による摩擦熱を発生させて層を一体的に融着し、厚さの増大した縁辺を形成することからなる熱可塑性合成樹脂製ボードの融着方法が提供される。

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可塑性合成樹脂製ボードの融着方法が提供される。

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し、前記ボードの側縁と前記部品とを突き合せ、突き合せ部の一面側に超音波融着装置の超音波発振部を、他面側に受座部を当接させ、前記発振部を発振させて、ボードと部品の突き合せ部に超音波振動による摩擦熱を発生させ、両者を互いに融着することからなる熱可塑性合成樹脂からなるボードと部品の融着方法が提供される。

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本発明の他の形態によれば、平行をなす第1シートおよび第2シートと、これらシート間に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボード、および熱可塑性合成樹脂製付属部品とからなり、前記ボードと前記部品が互いに接触状態にあり、これらが接触部分で超音波融着されている熱可塑性合成樹脂製ボード製品が提供される。

本発明で用いる超音波融着は、加熱融着と異なり、ボードを構成する材料に内

部振動を生起させ、これによりボードは内部発熱をする。特に、互いに押しつけられているボードのシート同士には摩擦発熱が生じ易くしたがって熔融し易い。このため、融着は内側から起こる。したがって、ボードの外側シートの面は融着の影響を受けにくく、きれいに保たれる。また、ボードは内部において融着しているので、接合強度は大で、また融着の範囲の制御がし易いので、例えば線に沿う融着を正確に行うことができる。なお、ボード内部のウェブは超音波の伝播を行うに有効で、このウェブのために特にボードのシート面同士の融着が効果的に行われる。

これに対し、加熱融着はボードの外側から行われるのでボードの表面に悪影響が及び易く、ボードの内部での確実な融着が常年实现されるとは言えず、また熱の影響が融着部に隣接する領域へ及びやすく、設計通りの融着を行うのが困難な場合が多い。

図面の簡単な説明

図1は本発明で用いる熱可塑性合成樹脂製中空ボードの断面図である。

図2は図1の中空ボードの一部切除斜視図である。

図3は、中空ボードの端縁部を目塞ぎのために融着する方法の最初の段階を示す断面図である。

図4は、図3に示す融着方法を完了した状態を示す断面図である。

図5は、図4に示すように端縁を目塞ぎされた中空ボードの一部切除斜視図である。

図6は図4の中空ボードの断面図である。

図7は、中空ボードの中間部分を線状に融着する方法を説明する断面図である。

図8は、中空ボードの第1、第2シートを面状に融着する方法を説明する断面図である。

図9は、図7および図8に示す方法で融着された中空ボードの断面図である。

図10は、中空ボードの中間部を両側から線状に融着する例を示す斜視図である。

図11は、中空ボードに開口部および切欠き部を形成して融着する例を示す平面図である。

図12は図11のXII-XII線断面図である。

図13は、2枚の中空ボードを線状に融着する例を示す斜視図である。

図14は中空ボードと他の部分を融着する例を示す斜視図である。

図15は、2枚の中空ボードをそれらの側縁部で融着する前の状態を示す断面図である。

図16は図15の段階に続く段階を示す断面図である。

図17は図16に続く最終段階を示す断面図である。

図18は、最終的に融着された2枚の中空ボードの融着部を示す断面図である。

図19は、1枚の中空ボードの両側縁を接合して筒状にしたものとする図である。

図20は、1枚の中空ボードを四角筒状にしてその両側縁を接合したものとする図である。

図21は、連続状に融着された中空ボードと枠材の接合の例を示す斜視図である。

図22は、中空ボードによる箱の組み立ての仕方をする展開図である。

図23は、中空ボードによる箱の組み立ての他の仕方をする展開図である。

図24は中空ボードの縁部の補強部の形成前の状態を示す断面図である。

図25は中空ボードの縁部の補強部の融着後の状態を示す断面図である。

図26は、1対の中空ボードの側縁の突合せ融着方法を示す断面図である。

図27は、3枚の中空ボードの突合せ融着方法を示す断面図である。

図28は、2枚の中空ボードの角度をなす融着方法を示す断面図である。

図29は、中空ボードの側縁への他の部品の融着方法を示す断面図である。

図30は、縁部材を示す部分斜視図である。

図31は、図30の縁部材を折り曲げる場合に必要な切欠き部を示す斜視図である。

図32は、縁部材に形成する他の切欠き部を示す斜視図である。

図33は、図31の切欠き部をもつ縁部材を折り曲げて中空ボードに施した状態を示す斜視図である。

図34は、図32の切欠き部をもつ縁部材を折り曲げて中空ボードに施した状態を示す斜視図である。

図35は、取手の斜視図である。

図36は、図35の取手を中空ボードに融着した状態を示す断面図である。

図37は、カードホルダの斜視図である。

図38は、カードホルダを中空ボードに融着した状態を示す断面図である。

図39は、透明板を中空ボードに融着した状態を示す図である。

図40は、透明板を中空ボードに融着した他の例を示す図である。

図41は、図40の断面図である。

発明を実施するための最良の形態

本発明による実施の形態を、図面を参照して以下に説明する。

図1および図2は、本発明が関係する熱可塑性合成樹脂製ボードの断面図および一部切除斜視図をそれぞれ示す。これらの図において、Bは熱可塑性合成樹脂製中空ボードを全体的に示す。この中空ボードBは、第1シート2aおよび第2シート2bを有し、これらのシート2a、2bは互いに平行をなして対向している。そして、これらシート2a、2bはそれらに直交する方向の多数の平行ウェブ3によって一体的に結合され、ウェブ3の間には中空空間4が形成されている。シート2a、2bおよびウェブ3は、熱可塑性樹脂、例えばポリプロピレン、ポ

リエチレンなどの樹脂を、図1に示す断面形状の押出ダイを通して押出すことにより一体成形される。

以上のようにして構成される中空ボードBは、図1に示すように、ウェブ3の方向に平行をなす側縁が符号5で示すように外部に対し開放されるとともに、ウェブ3の長手方向両端の側で中空空間4が外部に対し開放されることになる。したがって、中空ボードBの内部にごみや雑菌等の異物が入り易く、またその内部が汚れても洗浄が事実上できないという問題がある。

本発明の一実施形態ではこの問題を解決することができる。このためには、例えば図3に示すように、中空ボードBのウェブ長手方向端部側において、中空ボードBの端縁に沿って第1シート2aおよび第2シートBを互いに近寄せて接合し、中空空間4を外部に対し閉塞する。接合のために、本発明では超音波融着装置が用いられる。超音波融着装置の原理自体は公知であり、超音波融着装置は、電力を超音波振動に変換するため一方向性ピエゾエレクトリック効果を利用する変換器と増幅器を備えている。超音波振動は超音波ホーンから融着すべき物体に伝えられ、超音波振動は物体内部に分子内振動を生起させて発熱させる。

本発明による一融着方法によれば、図3に示すように、中空ボードBの端縁に沿って（紙面に直交する方向に）、超音波融着装置の超音波ホーン、すなわち超音波発振部6を、中空ボードBの第1シート2aの外面に位置させる。超音波発振部6は第1シート2aの端縁に沿って線状に延びるように構成されている。一方、超音波融着装置の受座部7は、第2シート2bの端縁に沿って線状（帯状）に延びるように構成され、平坦な受面を有している。受座部7上に中空ボードBの端縁を載置した後、発振部6から超音波を受座部7へ向かって発振させ、しかも発振部6を下方へ矢印Aで示すように下降させ、中空ボードBの端縁部を受座部7と発振部6との間で押圧する。

以上のようにすることによって、発振部6から出た超音波は第1シート2aか

ら特にウェブ4を伝わって下方へ進んで第2シート2bに達し、第1シート2a、ウェブ3および第2シート2bに分子内振動を生起させ内部から発熱させ、これらを溶融させる。そして、これらの部分は発熱により溶融させられつつ発振部6と受座部7の間で圧縮を受けるので、ウェブ3が軟化した状態で第1シート2aが第2シート2bへ近付くように移動し、最終的には図4に示す状態が得られる。すなわち、第1シート2aの端縁寄り部分は第2シート2bの端縁寄り部分に接触して、両者の先端縁同士が融着により接合される。そして、発振部6の先端縁の断面形状、例えば図示のうよな片側が最も突出した凹入弧状の斜面の形に対応するように第1シート2aの端縁部が成形される。各ウェブ4の先端部も溶融して第1シート2aの端縁部の成形形状に対応するような形をとる。上述の融着作業に際し、超音波は発振部6と受座部7の間の領域にしか作用しないので、溶融する部分は限られ、他の領域には溶融が起きることはない。

以上に述べたようにして、中空ボードBの他方の端縁にも融着を生起させることによって、図5および図6に示すように中空ボードBの両端縁に目塞ぎ部8を形成させることができる。目塞ぎ部8の断面形状は発振部6と受座部7の形状によって適当な形状となるようにすることができる。

以上のように目塞ぎ部8を形成することにより、中空ボードBの端縁からは中空空間4にごみなどの異物が入ることがなくなり、中空空間4内に空気が封入された状態になるので、ボードの断熱性や剛性が増すことになる。なお、上述の融着作業は、中空ボードBのウェブ3に平行をなす側縁に沿っても必要により施すことができる。

以上に述べたと類似の融着作業は、中空ボードBの端縁から離れた中間部分にも施すことができる。その例を図7に示す。この例では、超音波発振部6Aは中央先端部9が最も突出し両側に斜面をもつ形状をなしている。受座部7Aはさきに述べた受座部7と基本的に異なることなく平坦な受面を有している。このよう

な構成をもつ受座部7 A上に中空ボードBの中間部分を載置し、発振部6 Aから超音波を発振しつつ発振部6 Aを受座部7 Aへ向けて移動させて行くと、前述の場合と同様に、発振部と受座部の間の中空ボード部分の溶融が起り、第1シート2 aとウェブ3は溶融して、図7に鎖線で示すように第1シート2 aはほぼV字状に凹入して第2シート2 bに接合される。

このようなV字状凹入部は図9に符号10で示される。このような加工によって、中空ボードBには圧接ライン11が形成され、この圧接ライン11の部分の凹入部10は、発振部6 Aの形の選定により曲線状にも形成することが可能である。凹入部10は他部品の取付嵌合部として、また文字、模様、マーキングなどの表示手段として利用することができる。

図8に示す例は、前記線状凹入部10に代って面状凹入部を形成する方法である。この例では、超音波発振部6 Bの端面は平坦面をなしており、受座部7 Bも発振部の平坦面に応じた面積の平坦な受面をもっている。そして、発振部6 Bから超音波を発振させつつ発振部6 Bを受座部7 Bへ向かって移動させて行くと、両者の間の中空ボード部分が溶融し、最終的にはウェブ3が溶けるとともに、第1、第2シート2 a、2 bが面接触状態で溶融し合い、図9に示すように面状凹入部12が形成される。この面状凹入部12は取手部として、また、模様、マーキング等として利用することができる。

図10は、中空ボードBのウェブ3に直交する方向に折り込み溝線14を形成した例を示す。この折り込み溝線14は、図7に示す発振部6 Aと、この発振部と類似の形状をもつ受座部を中空ボードBの両面のシートにそれぞれ作用させることにより形成することができる。このような方法により、中空ボードBの第1、第2シート2 a、2 bのいずれにも、図9の線状凹入部10と同様な線状凹入部が形成されてそれらの底部が接合される。このような折り込み溝線14を設けることにより、中空ボードBはその溝線に沿って折ることができるようになる。な

お、折り込み溝性はウェブ3に平行をなす方向でも、または斜め方向でも形成することができる。

この折り込み溝線を形成すると、両シート2a, 2bが直接融着して重合するため、溝線に沿う折り込みの際の中空ボードの反発力が少なくなり、また溝線の部分をヒンジとして用いた時のヒンジの疲労強度が増大する。なお、図7に示す線状凹入部10もヒンジ等の折り込み溝線として使用することができるが、図10のように両シートの側から線状凹入部を形成するのが折り込み溝線としては望ましい。

第1シート2aと第2シート2bの融着は、図11および図12に示す態様でも行うことができる。図11に示すように、中空ボードBの開口部16または切欠き部17を形成し、次いで開口部16の縁辺または切欠き部17の縁部に沿うような形状の超音波発振部および受座部の間に、開口部縁辺または切欠き部縁部を挟んで超音波を発振させることにより、開口部縁辺または切欠き部縁部が融着する。これによって、開口部16の場合には図12に示すように縁辺18を目塞ぎされた開口16が形成される。

以上に述べた例では、同じ中空ボードBの対向するシート2a, 2b同士を融着しているが、図13に示す例では、2枚の中空ボードB1, B2が線に沿って接合される。2枚の中空ボードの接合は、両ボードを重ね合せ、一方の中空ボードB1の第1シート2aに当接するように超音波発振部を位置させ、他方の中空ボードB2の第2シート2bに当接するように受座部を位置させ、発振部から超音波を発振させつつ発振部を受座部に向かって相対的に移動させ、発振部と受座部の間にある両中空ボードの領域に内部から熱を発生させて両者を融着させる。この融着を直線に沿って生起させるように、発振部と受座部を線状に構成する。かくして、図13に示すように両中空ボードB1, B2は線状接合部20により接合される。このような線状接合部20をもつ中空ボードB1, B2は、箱内部

の仕切りやハニカム構造体の構成要素として使用することができる。

図14に示す例では、中空ボードBと他の熱可塑性合成樹脂部品22とが線状接合部23に沿って接合される。この接合も、中空ボードBと部品22とを重ね、それらの一側から超音波発振部を当て、他側から受座部を当てて、超音波を発振することにより行うことができる。部品22は例えば箱の補強枠である。

図15から図18は、2枚の中空ボードB1、B2の側縁同士を重ねて融着する方法を示している。融着される中空ボードB1、B2は、まず図15に示すように側縁同士が所定の幅Wで重なるように、超音波融着装置の超音波発振部6Cと受座部7Cの間に挿入される。次いで、発振部6Cを受座部7Cへ向かって相対的に移動させながら超音波発振させる。発振部6Cおよび受座部7Cは、中空ボードB1の第1シート2aおよび中空ボードB2の第2シート2bの面にそれぞれ面接触させうる平坦な端面を有する。これらの端面は、前記重合幅Wに相当する幅Wを有している。発振部6Cの移動によって、図16に示すように両中空ボードB1、B2は発振部6Cと受座部7Cの間に挟まれる。

発振部6Cは図16の位置から図17の位置へ向かってさらに前進する。この間、次のような現象が起きる。すなわち、発振部6Cでの超音波発振によって超音波は中空ボードB1の第1シート2aからウェブ3を伝わって第2シート2bへ、次いで中空ボードB2の第1シート2aからウェブ3を伝わって第2シート2bへ伝播し、これらのシートおよびウェブの分子内に超音波振動を生起させ、これにより内部発熱を起こす。分子内振動による摩擦効果は、互いに面接触している中空ボードB1の第2シート2bと中空ボードB2の第1シート2aとの間に特に激しく起こり、両中空ボードB1、B2の面接触部の領域は発熱により最もよく溶融する。

この溶融により、図16から図17の状態へ至る間に両中空ボードB1、B2が接触する境界部がまず溶融して一体化されつつ、最終的に両中空ボードB1、

B 2の幅Wの重合部は、各中空ボードB 1またはB 2の厚さに等しいかそれ以下の厚さにまで圧縮される。図17から明らかなように、両中空ボードB 1, B 2の中間領域30が最も溶融が起った領域であり、表面領域ではシート2a, 2bの形はくずれておらず、両中空ボードB 1, B 2は一枚のボードであるが如く、きれいに連続する。超音波照射を完了すると、溶融個所は比較的短時間で常温に戻り、両中空ボードB 1, B 2は、最終的に図18に示される状態になる。中間の融着部31は分子同化によって固結化し、両中空ボードB 1, B 2は完全に一体的に大きな強度で接合されている。なお、両中空ボードB 1, B 2の接合部の厚さは、発振部6Cと受座部7Cの間における圧縮の度合いによって変えることができ、各中空ボードの厚さより少し薄い程度にまで厚さを減らすことが可能である。

上記の例では、2枚の異なる中空ボードの端縁同士を重ねて融着しているが、同じ1枚の中空ボードの2つの端縁同士を重ねて融着することも可能である。図19に示す例では1枚の中空ボードBを円筒状に丸め、その両端縁を重ねて融着し、接合部32を形成している。

また、図20に示す例では、1枚の中空ボードBを四角筒状に折り曲げ、その両端縁を重ねて融着し、接合部33を形成している。図19および図20の例における中空ボードは容器の側壁を構成するためのものである。

容器を構成するには、例えば図19に示す円筒側壁に円形の底部材が接合される。また、図20に示す四角筒の側壁に四角形の底部材を接合すれば直方体容器が構成される。

直方体容器を構成するには、図22に示すような展開形状をもつ中空ボードB3を用いることができる。中空ボードB3は、底ボード34と4枚の側壁ボード35, 36, 37, 38を折り込み線40, 41, 42, 43を介して接続することにより構成される。折り込み線は、例えば図9に示す凹入部10のような

構成、または図10に示す折り込み溝線14のような構成をもつものとすることができる。各側壁ボード35, 36, 37, 38の側辺には重ね合せ代45が設けられ、これらの重ね合せ代45は容器を組み立てる時に、互いに重ねられ、図15ないし図17に示した融着工程により接合され、その重ね合せた厚さは前述のような圧縮によって例えば1枚の中空ボードの厚さに相当するように低減される。

以上のようにして組み立てた容器の側壁の上端縁には、必要によって図21に示すような逆U字状断面の枠体50を被せて、前述したような方法で側壁に融着することができる。図21の場合には、図18に示すように融着部31により接合した2枚の中空ボードB1, B2により構成される側壁の縁部に枠体50を被せて融着している。

図23は直方体状容器を構成する他の例を示す。この場合には、底ボード34と4枚の側壁ボード35, 36, 37, 38が別体で構成され、底ボード34の4辺には重ね合せ代52が設けられ、側壁ボード35, 36, 37, 38の底部にも重ね合せ代51が設けられる点で図22に示される場合と異なっている。底ボード34と各側壁ボード35, 36, 37, 38の重ね合せ代52, 51を重ね合せて図15ないし図17に示した方法で融着すると、図22に示すものと同じ展開形状の素材が得られる。この素材を図22について説明した方法で組立てれば、直方体形状の容器が得られる。

図24および図25は中空ボードBの端縁を補強する手段を示している。この手段によれば、中空ボードBの端縁を図24に示すように適宜の幅寸法で二重または三重以上の層55となるように折り込み、これらの層55の両側に、超音波融着装置の超音波発振部6Dと受座部7Dを位置させ、図15ないし図17に示したと同じ融着方法で層55を圧縮しつつ融着する。これによって、厚さが少くなった強靱剛性部56が一体的に形成される。

図26には、2枚の中空ボードB1、B2をそれらの側縁を突き合せて融着する方法が示されている。この方法では、左側の中空ボードB1の右側縁と右側の中空ボードB2の左側縁とが、超音波融着装置の超音波発振部6Eと受座部7Eの間に突き合せ状態で挿入され、発振部6Eを下降させ受座部7E上で両中空ボードB1、B2の突き合せ部を押圧した状態で発振部6Eから超音波を発振させる。発振部6Eと受座部7Eはいずれも平坦な端面をもっていて両中空ボードの面に面圧接するようになっている。

この超音波発振によって、両中空ボードの突き合せ部は振動により内部で発熱し、融合作用が起きて突き合せ部は同化し、発振作用の終了によって溶融個所60は固結して両中空ボードは1枚の中空ボードになる。

図27に示す融着方法では、左右1対の突き合せ中空ボードB1、B2に加えて、第3の中空ボードB3が中空ボードB1、B2の面に対して直交する方向に図において下方から突き合せられる。そして、受座部としては左右1対の受座部7F、7Fが用いられて第3の中空ボードB3を左右から挟んで位置決めするとともに、左右の中空ボードB1、B2を下方から支持するようになっている。この例でも、発振部6Fから発振された超音波が3枚の中空ボードB1、B2、B3の突き合せ部に発熱による溶融を生起させて突き合せ部を融着する。溶融個所は符号61で示されている。なお、受座部7F、7Fに付した矢印は、受座部に発振部6Fからの力に抗して作用させる力の方向を示す。また、第3の中空ボードB3は左右の中空ボードB1、B2の面に直交するものとして説明したが、第3の中空ボードB3の向きは中空ボードB1、B2の面に対し90°以外の角度をなしていてもよい。図28に示す融着方法は、図27に示す方向において、左右1対の中空ボードB1、B2の代りに1枚の連続する中空ボードBを用いた点が異なるだけであり、融着の原理は図27の場合とまったく同じである。溶融個所は符号62で示されている。なお、図27および図28の方法において、中空ボードB3は

他の任意の熱可塑性合成樹脂部品に代えて融着作業を行うことができる。

図29は、中空ボードBの側縁部に他の熱可塑性合成樹脂部品65を融着する例を示す。部品65は中空ボードBの第1シート2aの面に接する平板状突出部66を有しており、この突出部66の外面に超音波融着装置の超音波発振部6Gを接触させる。また、中空ボードBの第2シート2bの面と部品65の面の一部に当接するように受座部7Gを位置させる。溶融個所は符号67により示している。なお、超音波発振により生じる突出部66が平板状でない部品65を用いる場合には、突出部66の側に受座部を位置させ、中空ボードBの第2シート2bの側に発振部を位置させるのが望ましい。

図30は、中空ボードで構成した箱の開口縁部に融着される縁部材70を示している。この縁部材70はポリプロピレン、ポリエチレン、ポリカーボネート等の熱可塑性合成樹脂の押出し材であって、主体部71と主体部からL字状に突出する張出し部72とを有し、主体部71と張出し部72の間には溝73が形成されている。また、主体部71の溝73側の面には押出し方向にビード74が形成されている。ビード74をもつ主体部71の部分は張出し部72より図において下方へ延びている。

この縁部材70を中空ボードの端縁に施すには、前記溝73を中空ボードの端縁にはめる。主体部71は中空ボードの外面に位置するようにする。そして、図29に示したと類似の態様で、発振部および受座部を当接させる。例えば、主体部71のビード74と反対側の面に発振部を当接させる。発振部からの超音波の発振により中空ボードとの融着を行う場合、ビードは溶融面積の増大にあずかり、効果的な融着を可能にする。

縁部材70を四角形の箱状容器の側壁の上縁に施すには、縁部材70を3カ所で直角に折り曲げ、両端部を突き合せて四角形の枠状にしなければならない。このためには、張出し部72に図31で示すような切欠き部75を形成する。切欠

き部75は、張出し部72の上側部72aを直角三角形形状に切欠いた部分と、垂下部72bを三角形形状切欠きの底辺の長さに相当する幅で切欠いた部分とにより構成される。また、縁部材70は切欠き部75の三角形の頂点76に相当する位置に折り曲げ線77が形成される。

図32は図31の縁部材70の変形例としての縁部材70Aを示す。この縁部材70Aが縁部材70と相違する点は、切欠き部75Aの形状のみである。この変形例では、図31の張出し部72の上側部72aの三角形形状切欠きに代って単なる線状切込み78が形成されている。そして、折り曲げ線77は線状切込み78の位置に形成されている。

図33は、図31に示す縁部材70を、箱の側壁をなす中空パネルBの角部の上縁に施した状態を示す。図31の縁部材70を切欠き部75の方向に角度をなして折り曲げ線77に沿って折り曲げると、三角形形状切欠き部分の両縁辺が図33に線80で示すように当接し、また三角形の底辺の長さに相当する幅だけ離れていた切欠き部75の両縁部が線81で示すように当接する。そして、縁部材70を中空パネルBに融着すると、融着部は符号82で示すように形成される。

図32に示す縁部材70Aも同様の態様で図34に示すように中空パネルBに融着により接合される。ただし、この縁部材70Aの場合は、図32で線80をなして突合せられた上側部分72aが図34に符号84で示すように重ね合わされることになる。

図35は中空ボードで形成された容器に取り付ける取手の一例を示す。取手86は環状本体87とその周りに張出すフランジ88とを有し、内側に開口89をもっている。なお、取手86は下辺を除いた逆U字形状をなしていてもよい。取手86は熱可塑性合成樹脂で形成される。この取手86は図36に示すようにして中空ボードBに融着により固定される。すなわち、中空ボードBに取手86の本体87の大きさに相当する開口を形成し、この開口内に環状本体87を挿入

して中空ボードBの一面から図示のように突出させ、中空ボードBの他面にはフランジ88を当接させる。そして、フランジ88の外面に超音波融着装置の超音波発振装置を位置させ、反対側に受座部を位置させ、圧縮力を加えつつ超音波を発振させる。これによって、前述の融着の場合と同様に溶融部90が生じて、取手86は中空ボードBに融着される。そして、フランジ88は中空ボードBの厚さの一部となる。なお、取手86が逆U字状をなす場合には、取手が欠けている部分に対応する中空ボード開口縁辺の第1、第2シートを互いに融着して目塞ぎを行う。

図37はカードホルダ91を示す。カードホルダ91は一辺が開放されたU字状をなす本体92とその外周のフランジ93とから一体的に構成される。本体92はフランジ93から偏位した面に設けられており、表示用カードを保持する部分である。カードホルダ91も熱可塑性合成樹脂製で、図38に示すように中空ボードBの表面側にフランジ93を当接させて超音波融着される。超音波発振部はフランジ93の面に当接される。94は溶融部分を示している。表示用カード95は図38に示すように保持される。

図39は、中空ボードよりなる容器の内部を透視できるようにするための透明板を中空ボードに取り付ける例を示している。この例では中空ボードBに適当な大きさの例えば四角形の開口96を予め形成し、この開口96よりやや大きい寸法の熱可塑性合成樹脂製透明板95で開口96を覆い、次いで透明板95の縁辺の中空ボードとの重合部分に、超音波融着装置の超音波発振部を当て、反対側に受座部を当接させて押圧力を加えつつ超音波発振を行い、重合部分を符号97で示すように帯状に融着する。

図40および図41は、透明板95Aを中空ボードBの開口96Aに取り付ける他の態様を示す。この態様では、開口96Aは透明板95Aより寸法が小さく形成されている。この態様では、開口96Aの縁辺の近傍のウェブ3の一部を切

除して、第1シート2aと第2シート2bを開口縁辺近傍で互いに離れる方向に広げられるようにしておき、第1、第2シートを幾分か離して透明板95Aの縁辺部を図41に示すように両シートの上に挿入して保持させる。次いで、透明板95Aと開口96Aの縁辺部の重合部分を帯状部97Aに沿って超音波融着することにより、透明板95Aは中空ボードBの開口部分に接合される。

産業上の利用可能性

本発明の方法により融着された熱可塑性合成樹脂製ボードは、接合の品質が高く、種々の接合の可能性を与えるので、包装材や建築材としてきわめて多様な用途に用いることができる。

請 求 の 範 囲

1. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボードを用意し、一方のシートの面に超音波融着装置の超音波発振部を、また他方のシートの面に超音波融着装置の受座部を位置させ、発振部と受座部を互いに接近させて第1シートと第2シートを接触させ、発振部から受座部へ向かって超音波を発振させ、超音波によって、一方のシートと他方のシートに超音波振動による摩擦熱を発生させ、両シートを前記発振部と受座部の間で押圧しながら融着することからなる熱可塑性合成樹脂製ボードの融着方法。

2. 前記第1シートおよび第2シートの端縁部に沿って超音波融着装置の超音波発振部と受座部を位置させて、合成樹脂製ボードの縁辺部を連続的に融着して塞ぐことからなる請求項1記載の熱可塑性合成樹脂製ボードの融着方法。

3. 前記第1シートおよび第2シートの端縁部から離れた位置で、超音波融着装置の超音波発振部と受座部を線に沿って位置させ、第1シートおよび第2シートを前記線に沿って連続的に融着することからなる請求項1記載の熱可塑性合成樹脂製ボードの融着方法。

4. 前記第1シートおよび第2シートの外側に、超音波融着装置の超音波発振部と受座部を、ほぼ同じ面積を占めるように対向状に位置させ、第1シートおよび第2シートを前記面積の部分において面接触状態で融着することからなる請求項1記載の熱可塑性合成樹脂製ボードの融着方法。

5. 前記第1シートおよび第2シートの対向位置にそれぞれ対応する開口を形成し、これら開口の縁辺に沿って超音波融着装置の超音波発振部と受座部を位置させ、前記両開口の縁辺に沿って第1シートおよび第2シートを連続的に融着することからなる請求項1記載の熱可塑性合成樹脂製ボードの融着方法。



6. 前記第1シートおよび第2シートの対向位置にそれぞれ対応する切欠きを形成し、これら切欠きの縁辺に沿って、超音波融着装置の超音波発振部と受座部を位置させ、前記両切欠きの縁辺に沿って第1シートおよび第2シートを連続的に融着することからなる請求項1記載の熱可塑性合成樹脂製ボードの融着方法。

7. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、これらの第1および第2のボードを重ね合せ、第1ボードの面に超音波融着装置の超音波発振部を、また第2ボードの面に超音波融着装置の受座部を、線に沿って対向するように位置させ、発振部と受座部を互いに接近させて第1のボードと第2のボードを接触させ、前記超音波発振部の発振によって第1のボードと第2のボードに超音波振動による摩擦熱を発生させ、両ボードを前記線に沿って融着することからなる熱可塑性合成樹脂製ボードの融着方法。

8. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボード、および熱可塑性合成樹脂製部品を用意し、これらボードと部品を重ね合せ、前記ボードの面と部品の面に超音波融着装置の超音波発振部と受座部それぞれを位置させ、超音波発振部と受座部の間に前記ボードと部品を挟んだ状態で、前記超音波発振部を発振させて、ボードと部品の接触部に超音波振動による摩擦熱を発生させ、両者を互いに融着することからなる熱可塑性合成樹脂からなるボードと部品の融着方法。

9. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、これらの第1および第2のボードの端縁を面と面が接するように重ね合せ、



両端縁の重ね合せ部分の一側に、超音波融着装置の超音波発振部を、また他側に超音波融着装置の受座部を位置させ、前記超音波発振部から受座部へ向かって超音波を発振させ、この超音波によって、第1および第2のボードの端縁の互いに接する面部分に超音波振動による摩擦熱を発生させて両面部分を可塑状態にしてこれら両面部分を融合し、互いに接する前記面部分における第1シートおよび第2シートをその厚さの方向に、前記受座部と発振部の間で押圧して、第1および第2のボードを接合することからなる熱可塑性合成樹脂製ボードの融着方法。

10. 第1のボードおよび第2のボードの互いに重ね合せられた両端縁部分を超音波発振部と受座部の間で押圧して厚さを減少させることを含む請求項9記載の熱可塑性合成樹脂製ボードの融着方法。

11. 第1のボードおよび第2のボードの互いに重ね合せられた両端縁部分の合計厚さを、各ボードの厚さに等しい厚さにまで減少させることを含む請求項10記載の熱可塑性合成樹脂製ボードの融着方法。

12. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボードを用意し、このボードの一方の縁辺と他方の縁辺とを互いに接するように重ね合せ、両縁辺の重ね合せ部分の一側に、超音波融着装置の超音波発振部を、また他側に超音波融着装置の受座部を位置させ、発振部から受座部へ向かって超音波を発振させ、この超音波によって、ボードの前記両縁辺の互いに接する面部分に超音波振動による摩擦熱を発生させて両面部分を可塑状態にしてこれら両面部分を融合し、互いに接する前記面部分におけるボードの両縁辺をその厚さ方向に、前記受座部と発振部の間で押圧してそれらの合計厚さをボードの厚さにまで減少させることからなる熱可塑性合成樹脂製ボードの融着方法。

13. 平行をなす第1シートおよび第2シートと、これらのシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性



性合成樹脂製ボードを用意し、このボードの端縁を層をなすように折り返し、この層を超音波融着装置の超音波発振部と受座部との間に挟み、前記超音波発振部を発振させてボードの層に超音波振動による摩擦熱を発生させて層を一体的に融着し、厚さの増大した縁辺を形成することからなる熱可塑性合成樹脂製ボードの融着方法。

14. 前記層を融着しながら圧縮して厚さを減少させることからなる請求項13記載の熱可塑性合成樹脂製ボードの融着方法。

15. 平行をなす第1シートおよび第2シートと、これらシートの間で一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、これらの第1および第2のボードの側縁を突き合せ、両ボードの突き合せ部における一方の面に超音波融着装置の超音波発振部を、他方の面に超音波融着装置の受座部を両ボードに直交する方向に対向状に位置させ、前記超音波発振部の発振によって、両ボードの突き合せ面に摩擦熱を発生させ、両ボードを突き合せ面で融着して連続したボードにすることからなる熱可塑性合成樹脂製ボードの融着方法。

16. 平行をなす第1シートおよび第2シートと、これらシートの間で一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2および第3の熱可塑性合成樹脂製ボードを用意し、前記第1および第2のボードの側縁を突き合せ、この突き合せ部に、前記第3のボードの側縁を第3のボードが第1、第2ボードの面に対し角度をなすように突き合せ、第1、第2ボードの突き合せ部の第3ボードと反対の面に超音波融着装置の超音波発振部を当接させ、第3のボードが第1、第2ボードに当接する領域の両側に超音波融着装置の受座部を当接させ、前記発振部の発振によって、第1、第2、第3のボードの突き合せ部に摩擦熱を発生させ、こ



これらのボードを突き合せ部で融着することからなる熱可塑性合成樹脂製ボードの融着方法。

17. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる第1の熱可塑性合成樹脂製ボード、および同じ構成の第2の熱可塑性合成樹脂製ボードを用意し、第1のボードの一面に第2のボードの側縁を突き合せ状に当接させて、第2のボードが第1のボードに対し角度をなすようにし、突き合せ部における第1ボードの他面に、超音波融着装置の超音波発振部を当接させ、突き合せ部における第2ボードの両側に超音波融着装置の受座部を位置させて第1、第2ボードの面に当接させ、前記発振部の発振によって第1、第2ボードの突き合せ部に摩擦熱を発生させ、これらボードを突き合せ部で融着することからなる熱可塑性合成樹脂製ボードの融着方法。

18. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボード、および熱可塑性合成樹脂部品を用意し、前記ボードの側縁と前記部品とを突き合せ、この突き合せ部の一面側に超音波融着装置の超音波発振部を、他面側に受座部を当接させ、前記発振部を発振させて、ボードと部品の突き合せ部に超音波振動による摩擦熱を発生させ、両者を互いに融着することからなる熱可塑性合成樹脂からなるボードと部品の融着方法。

19. 平行をなす第1シートおよび第2シートと、これらシートの間に一体的に介在して両シート間に多数の中空空間を形成する平行なウェブとからなり、これらのウェブを横切る線または面において第1シートおよび第2シートが互いに超音波融着されている熱可塑性合成樹脂製ボード。

20. 前記線はボードの端縁に沿っている請求項19記載の熱可塑性合成樹脂製ボード。



21. 第1シートが第2シートへ向かって凹入した状態で第2シートに超音波融着されている請求項19記載の熱可塑性合成樹脂製ボード。

22. 第1シートと第2シートが互いに凹入した状態で超音波融着されている請求項19記載の熱可塑性合成樹脂製ボード。

23. 平行をなす第1シートおよび第2シートと、これらシートの間になんらかの介在して両シート間に多数の中空空間を形成する平行なウェブとからなる第1の熱可塑性合成樹脂製ボードと、第1のボードと同じ構成の第2の熱可塑性合成樹脂製ボードとからなり、これらの第1、第2のボードがその側縁部分で互いに面接触状態で重合されており、この重合された部分で第1、第2ボードの互いに面接触状態にあるシートを含む領域が超音波融着されており、重合された部分の厚さが第1、第2ボードのそれぞれの厚さにほぼ近い厚さとなっている熱可塑性合成樹脂製ボード製品。

24. 平行をなす第1シートおよび第2シートと、これらシートの間になんらかの介在して両シート間に多数の中空空間を形成する平行なウェブとからなる第1の熱可塑性合成樹脂製ボードと、第1のボードと同じ構成の第2の熱可塑性合成樹脂製ボードとからなり、これら第1、第2のボードがその側縁部分で互いに突き合せられ、この突き合せ部分で両ボードが超音波融着されている熱可塑性合成樹脂製ボード製品。

25. 平行をなす第1シートおよび第2シートと、これらシートの間になんらかの介在して両シート間に多数の中空空間を形成するウェブとからなる熱可塑性合成樹脂製ボード、および熱可塑性合成樹脂製付属部品からなり、前記ボードと前記部品が互いに接触状態にあり、これらが接触部分で超音波融着されている熱可塑性合成樹脂製ボード製品。



1/16

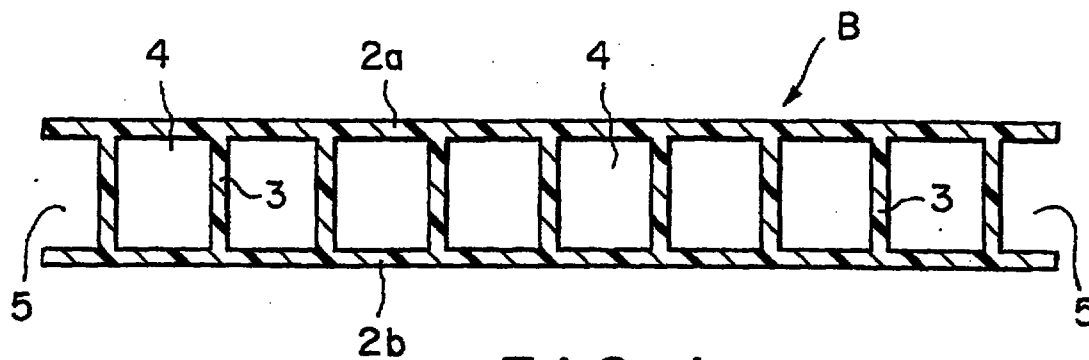


FIG. 1

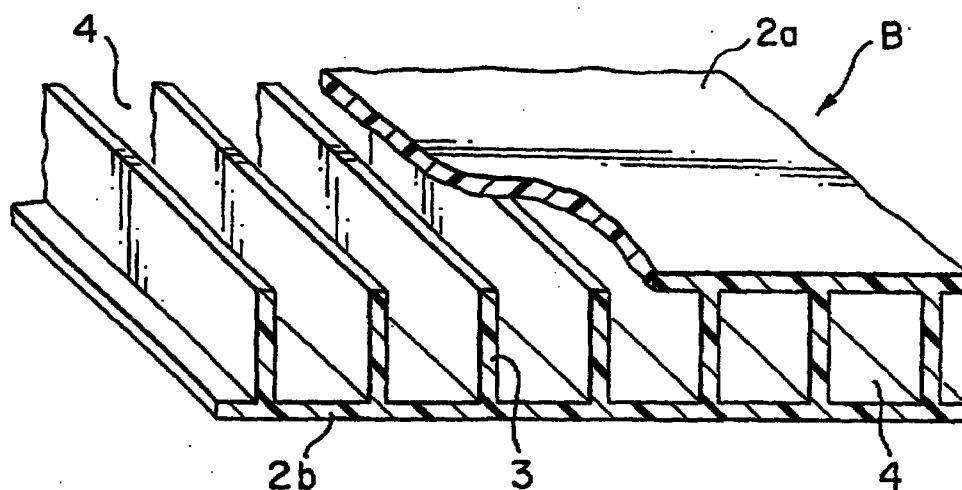


FIG. 2

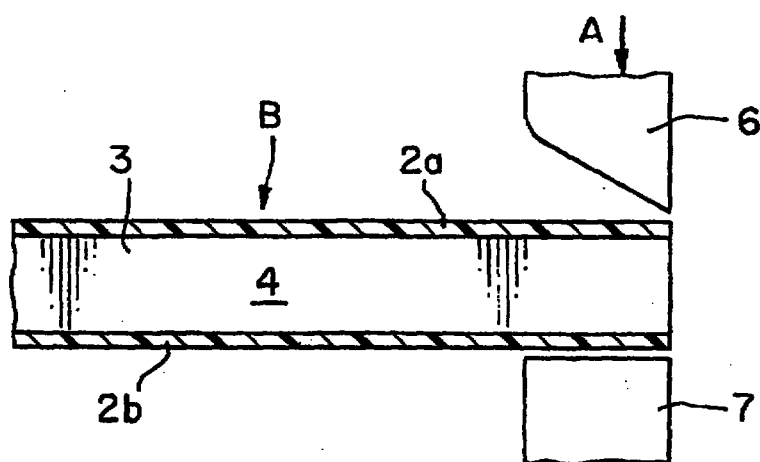


FIG. 3

2/16

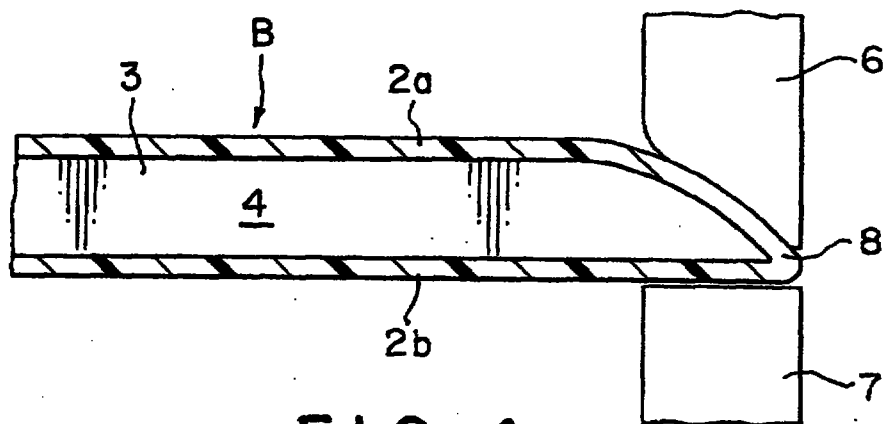


FIG. 4

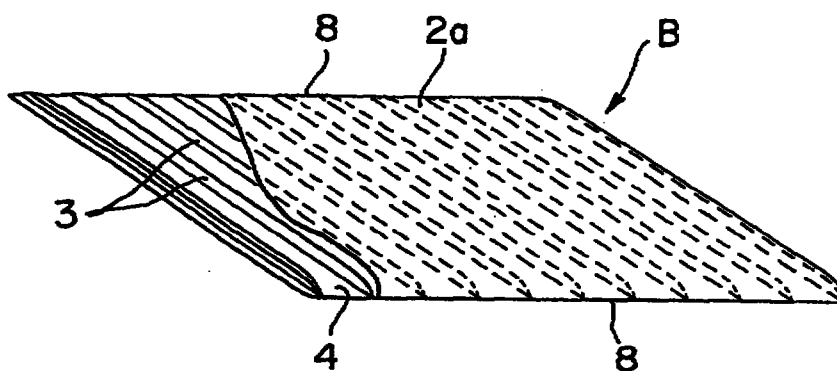


FIG. 5

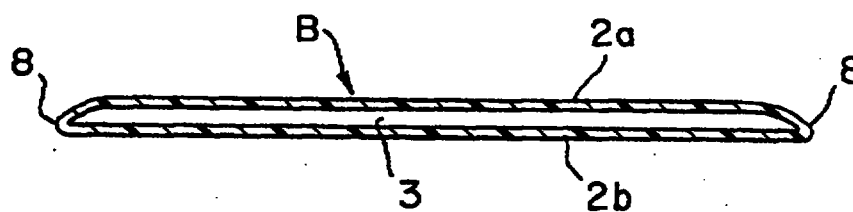


FIG. 6

3/16

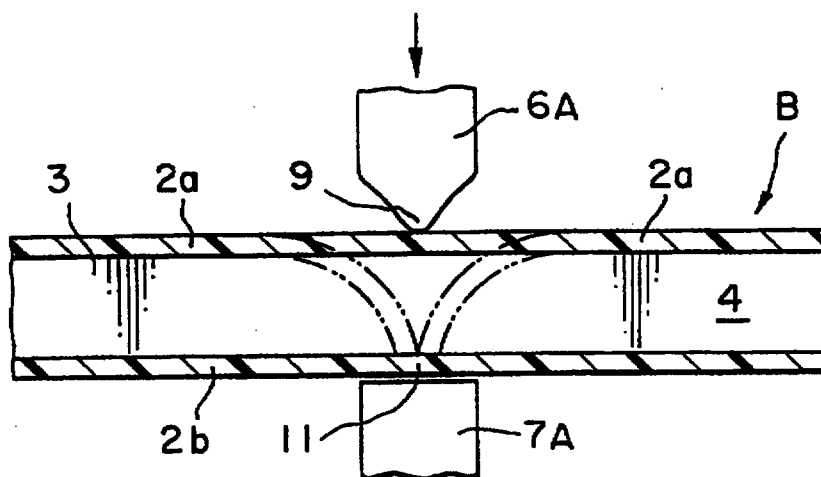


FIG. 7

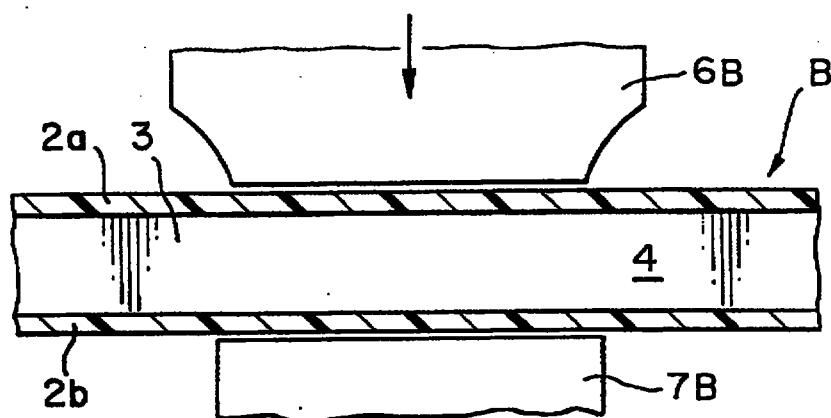


FIG. 8

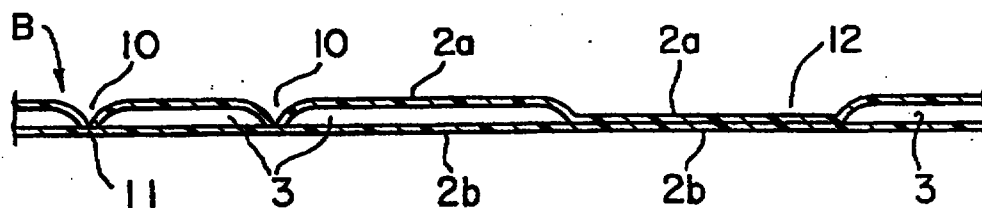


FIG. 9

4/16

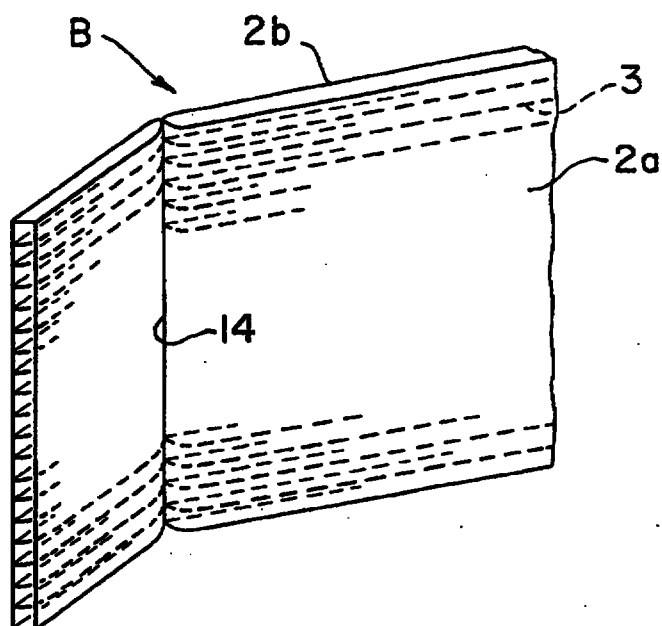


FIG. 10

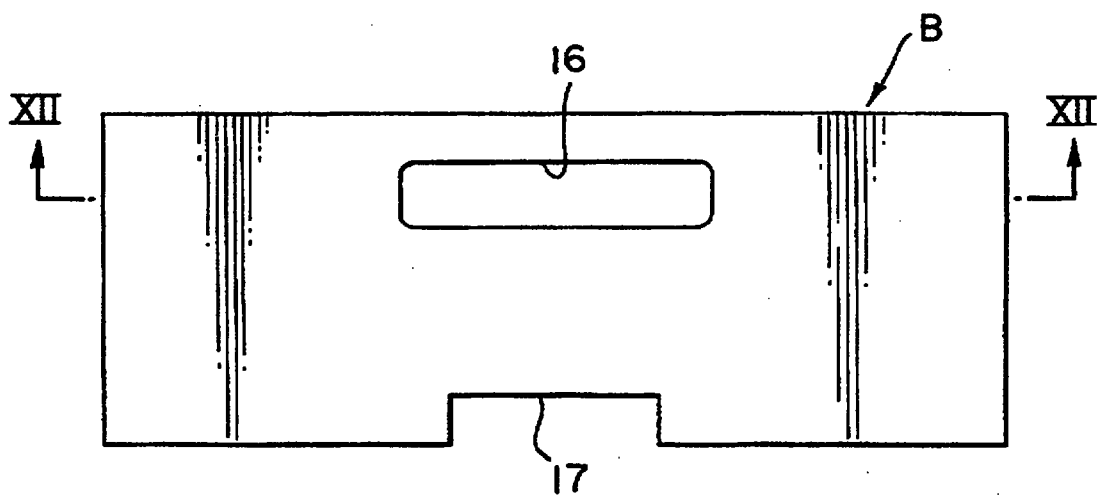


FIG. 11

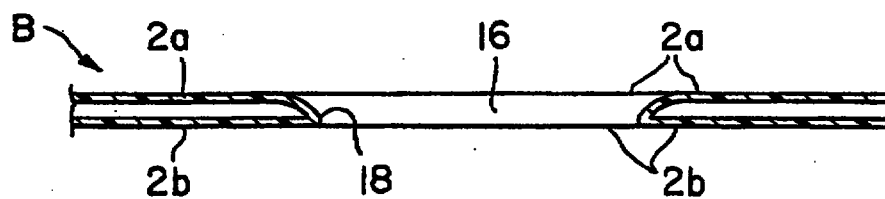


FIG. 12

5 / 16

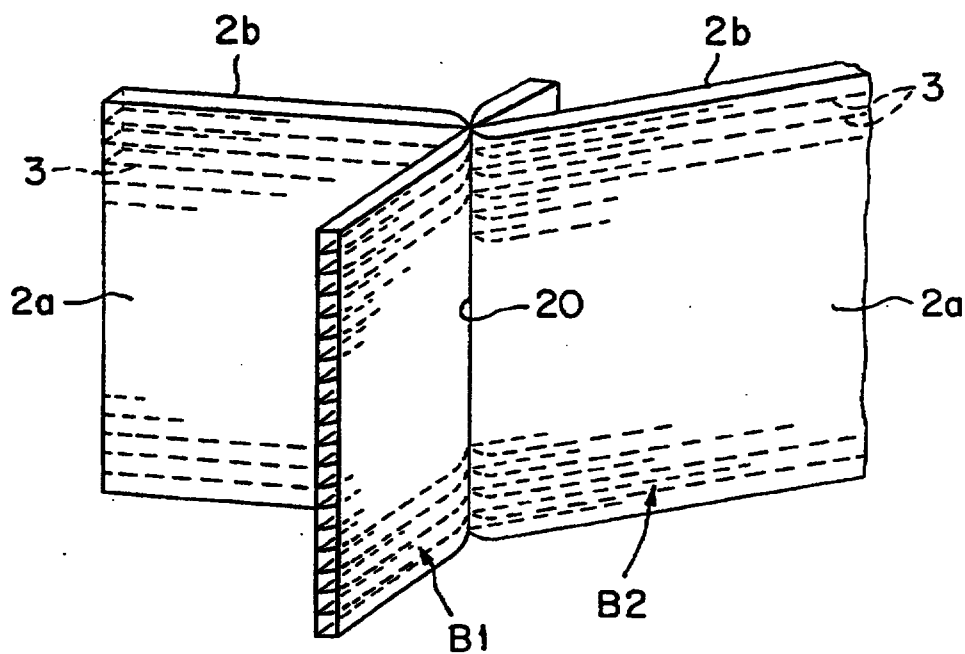


FIG. 13

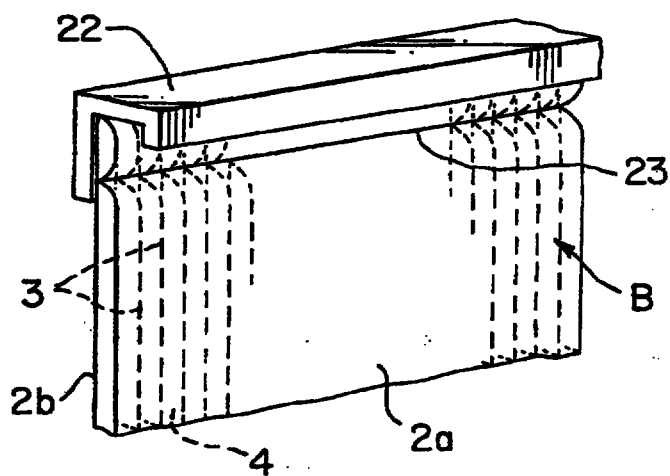


FIG. 14

6 / 16

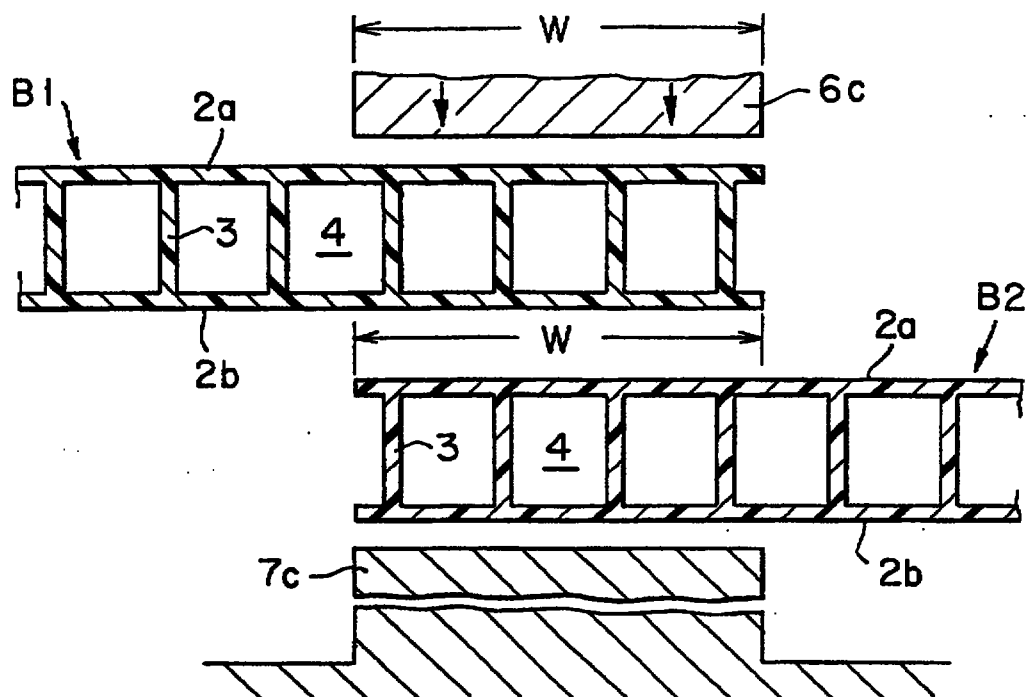


FIG. 15

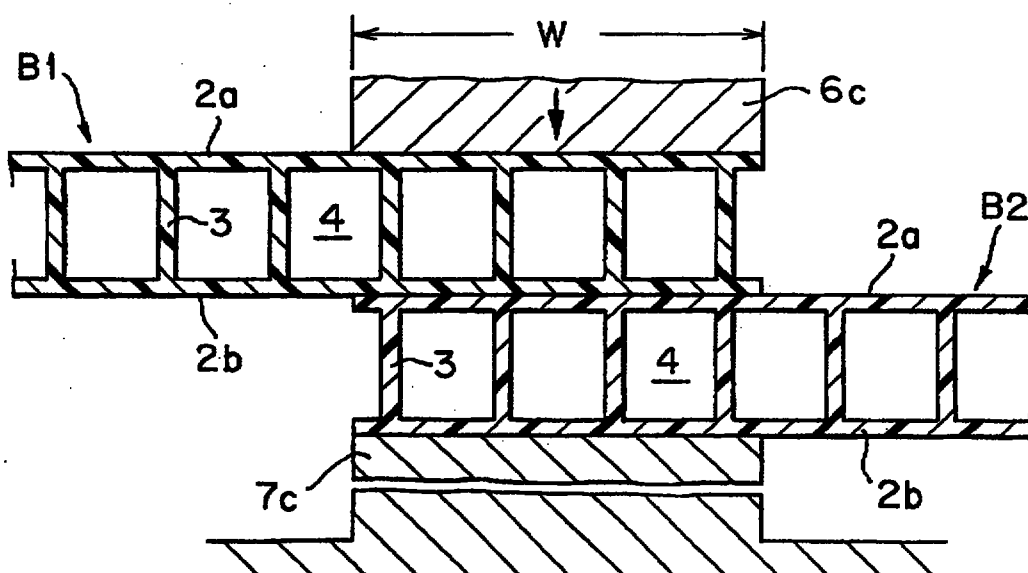


FIG. 16

7/16

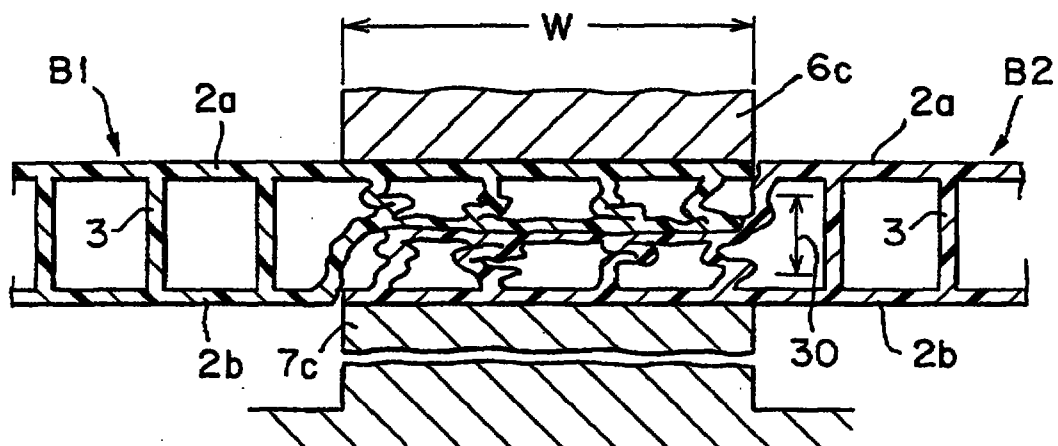


FIG. 17

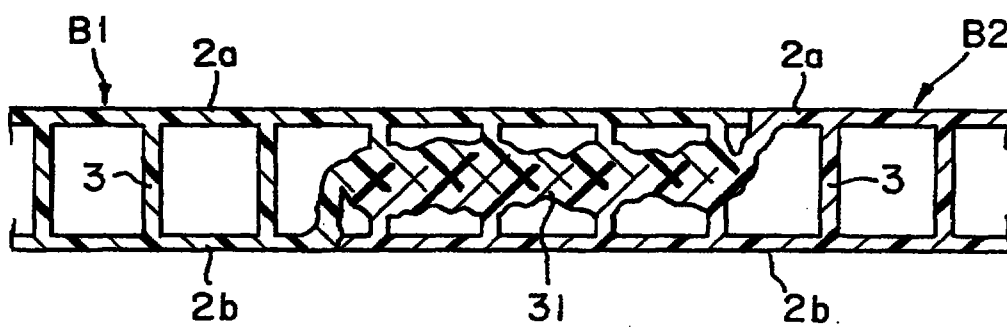


FIG. 18

8/16

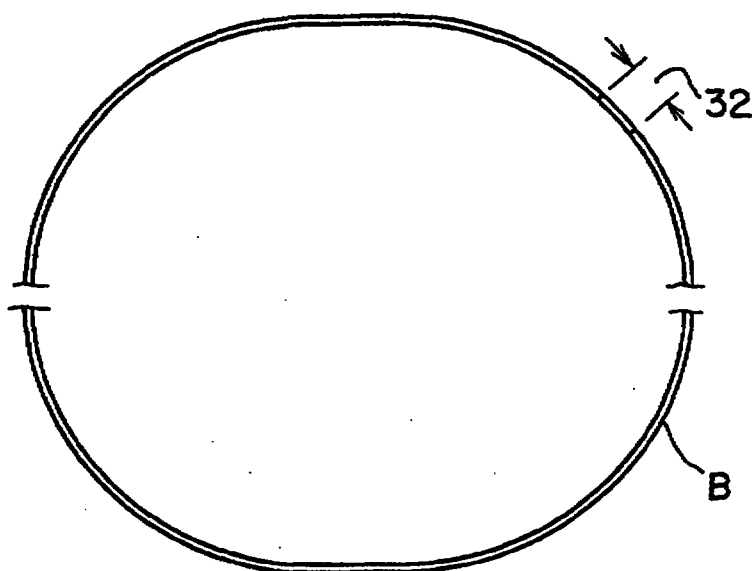


FIG. 19

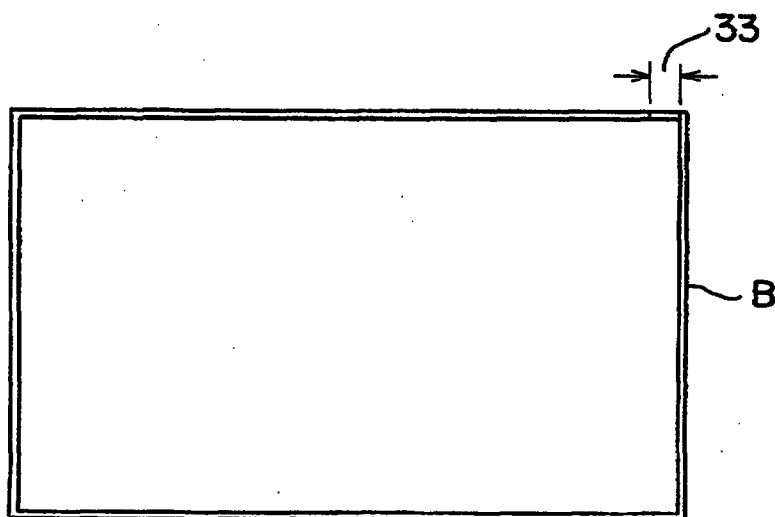


FIG. 20

9/16

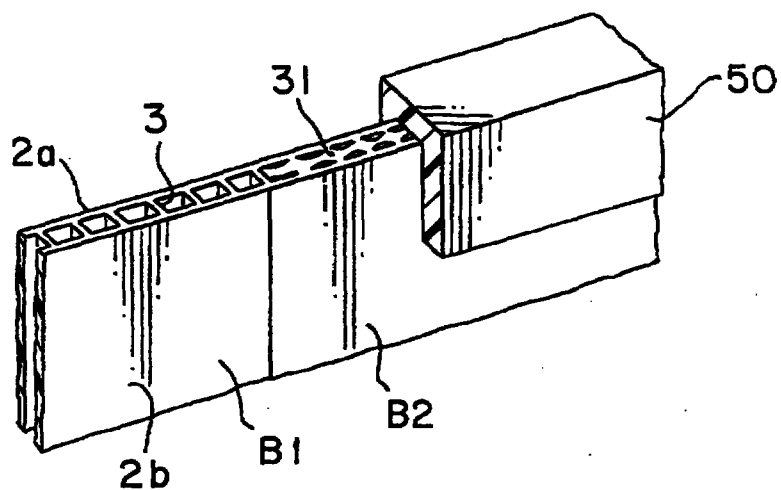


FIG. 21

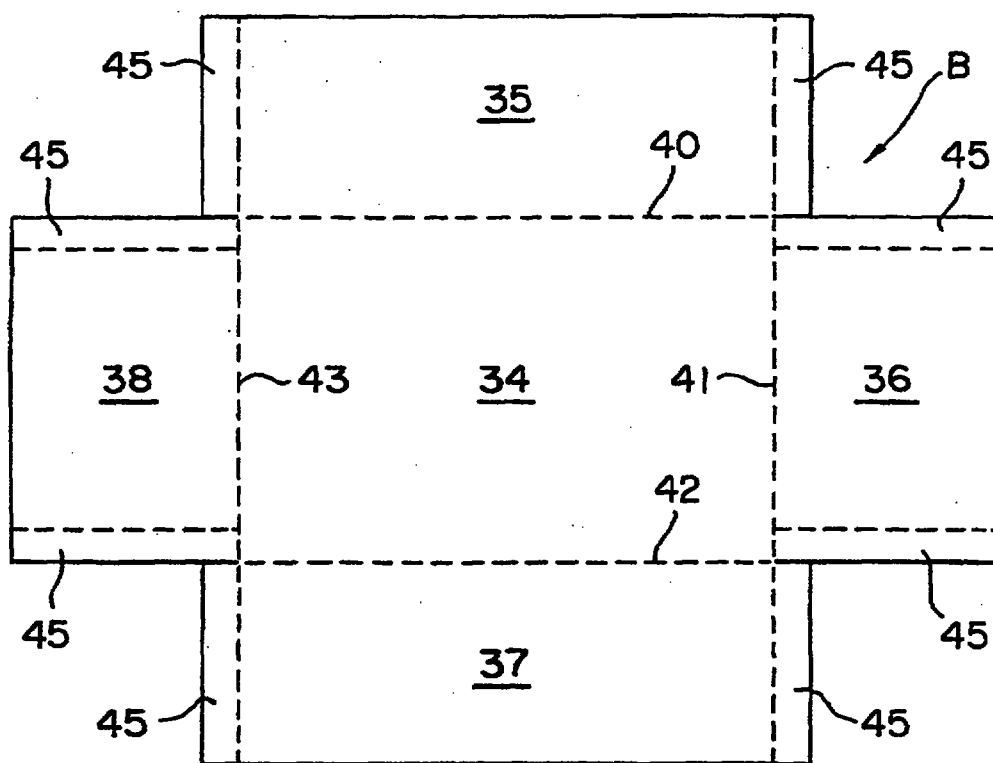


FIG. 22

10/16

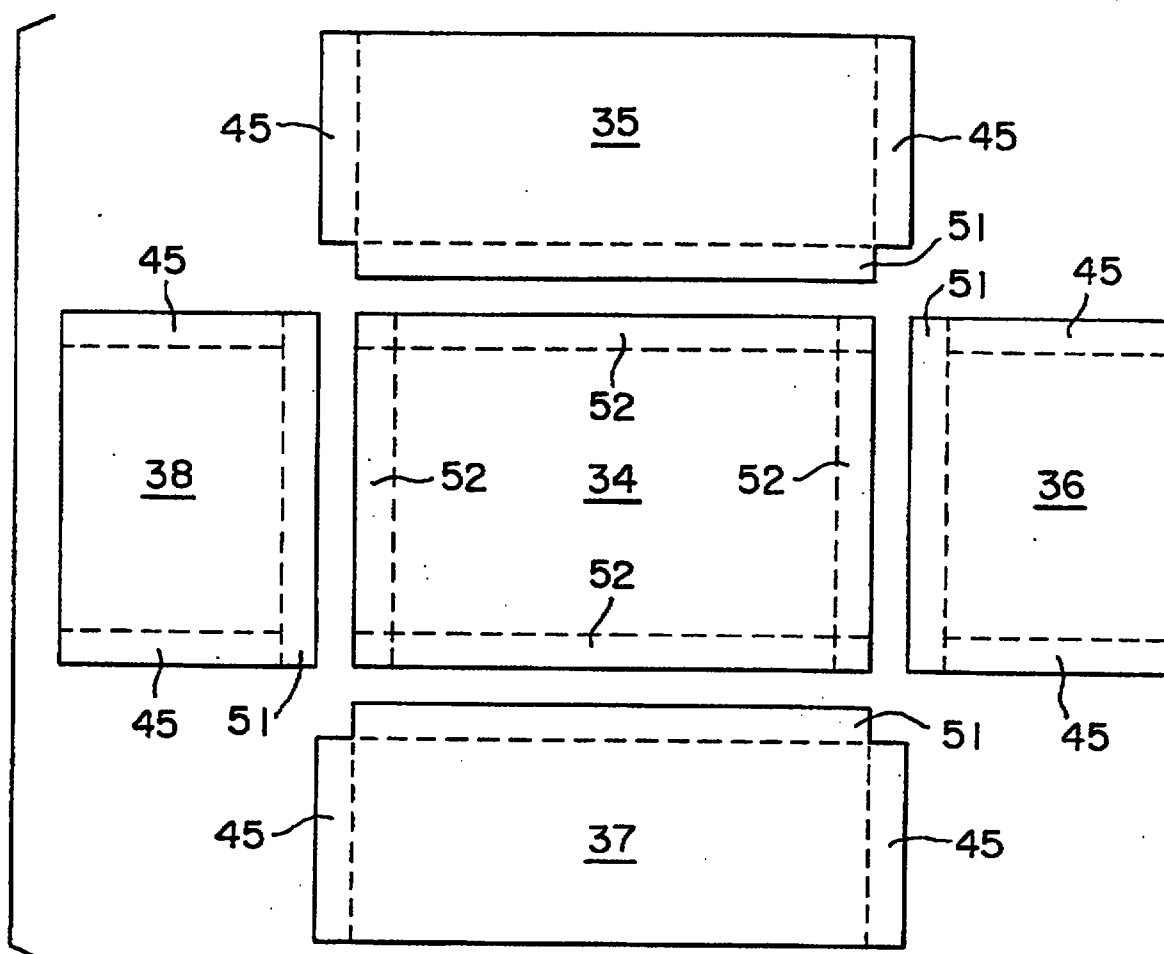


FIG. 23

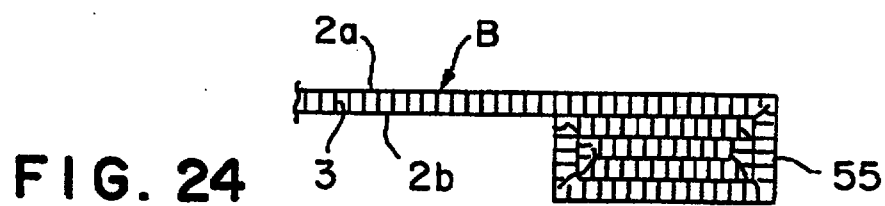


FIG. 24

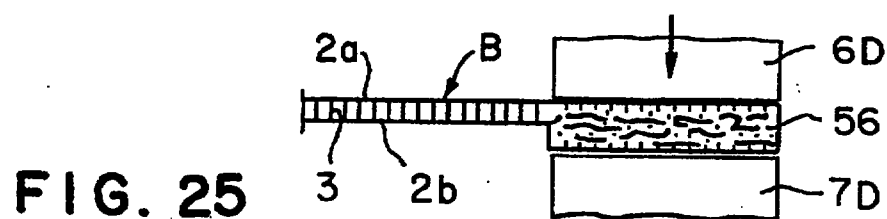


FIG. 25

11/16

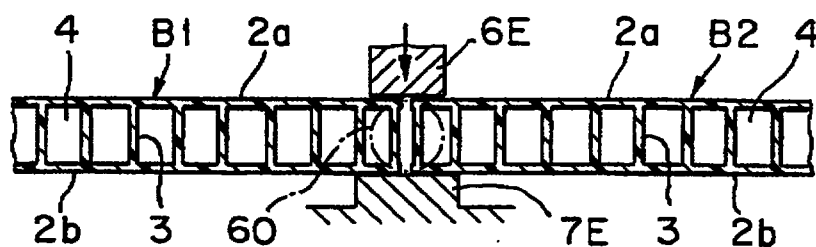


FIG. 26

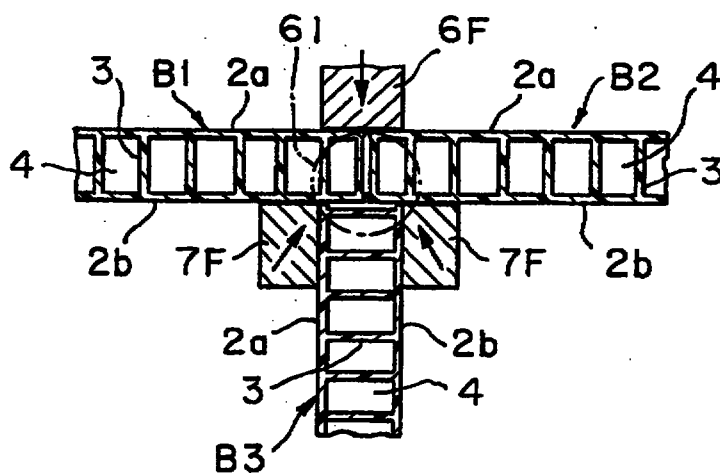


FIG. 27

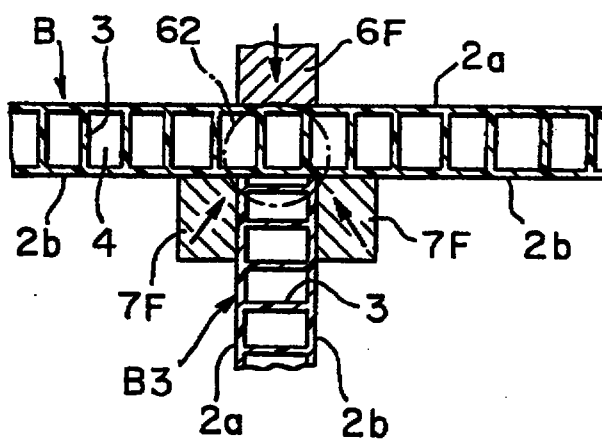


FIG. 28

12/16

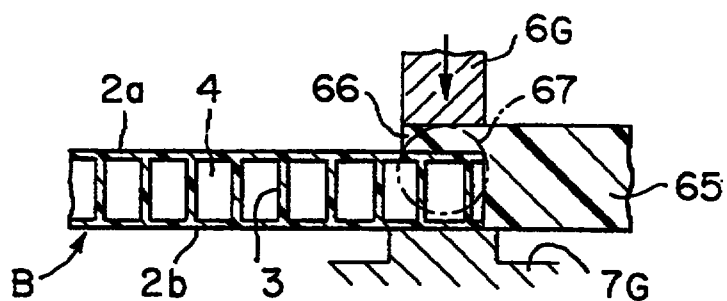


FIG. 29

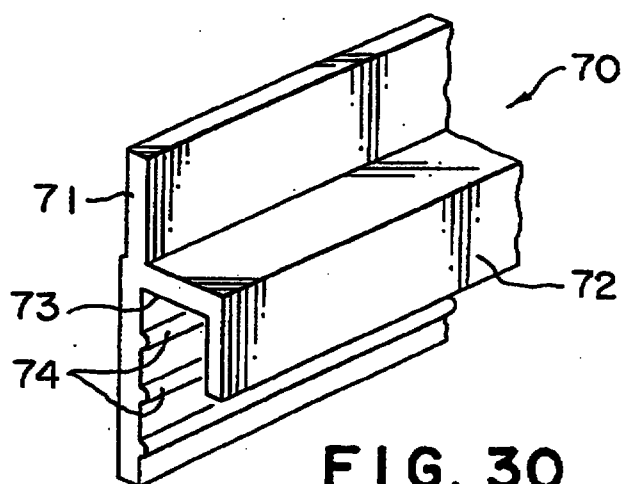


FIG. 30

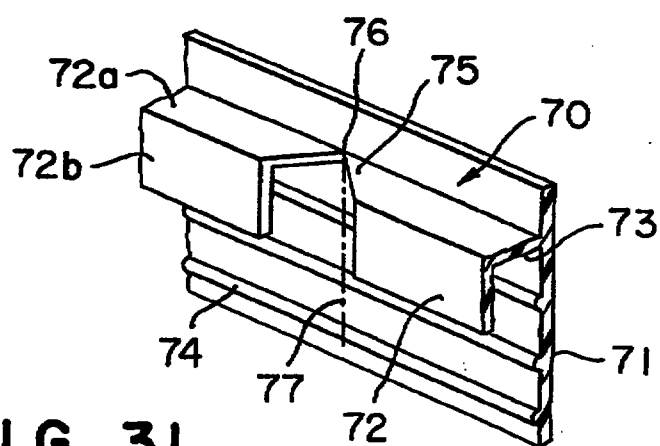


FIG. 31

13/16

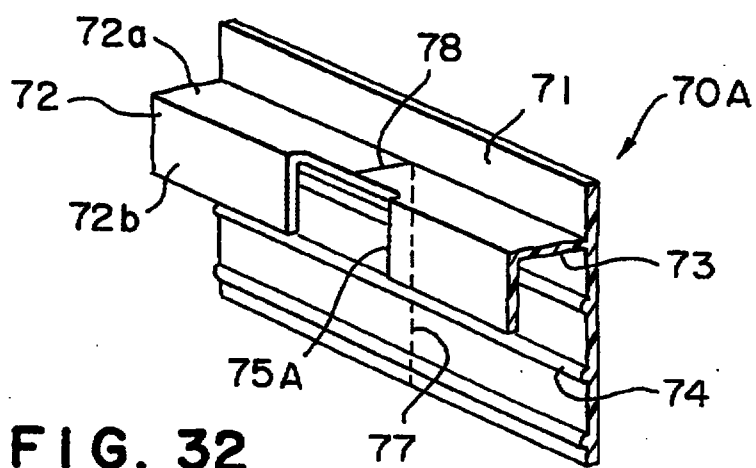


FIG. 32

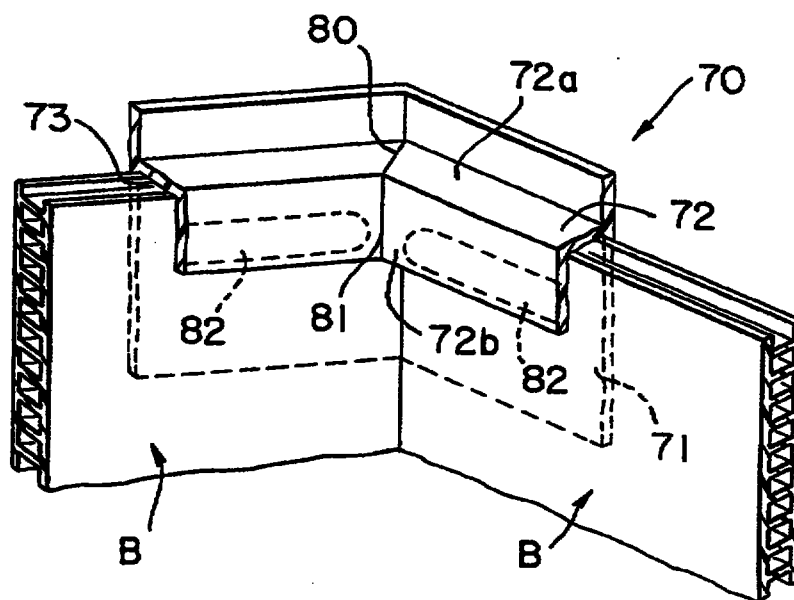


FIG. 33

14 / 16

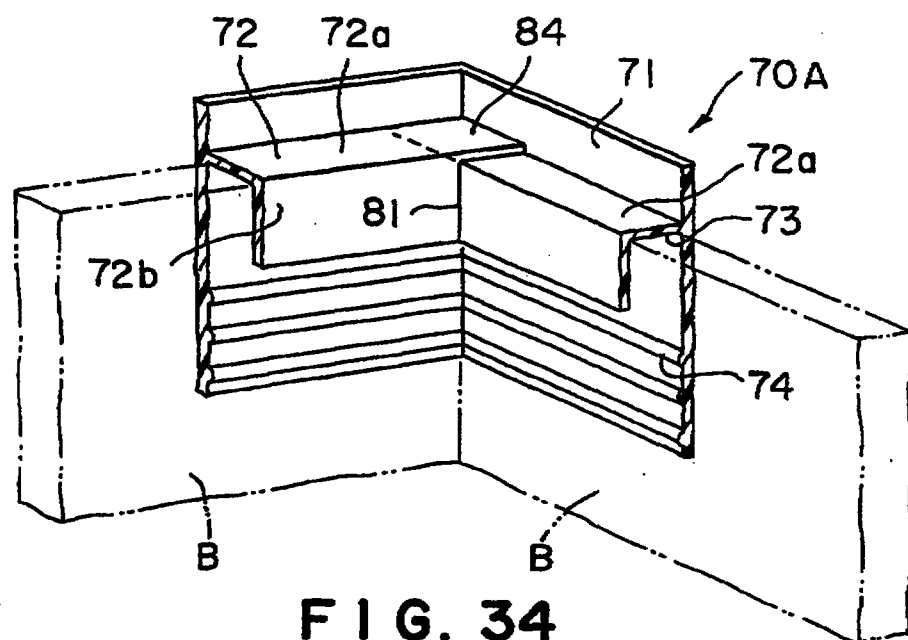


FIG. 34

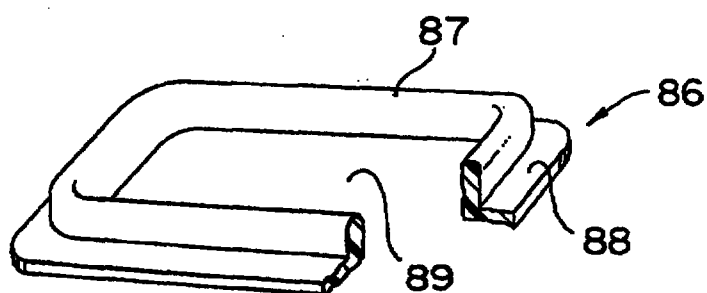


FIG. 35

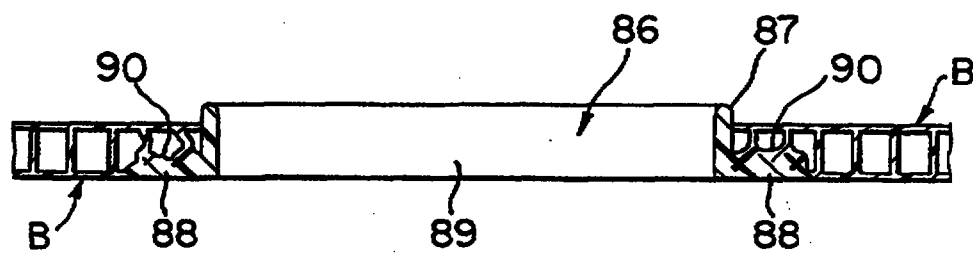


FIG. 36

15/16

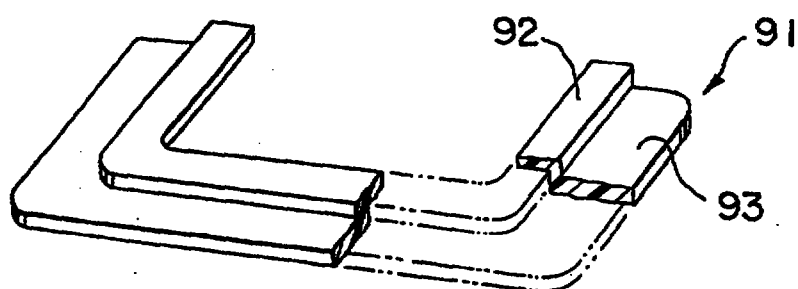


FIG. 37

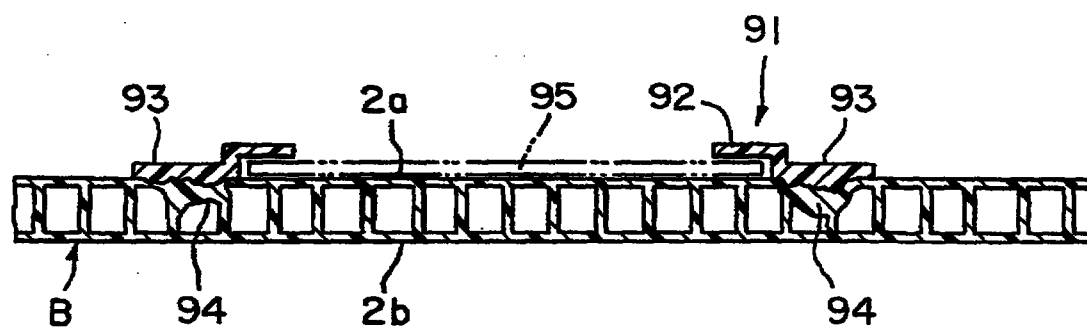


FIG. 38

16/16

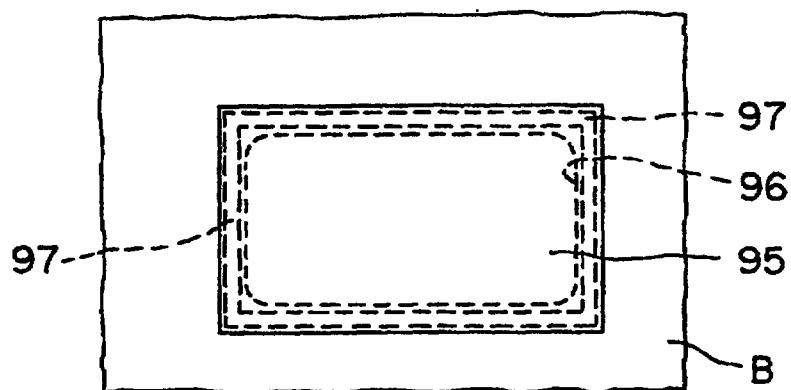


FIG. 39

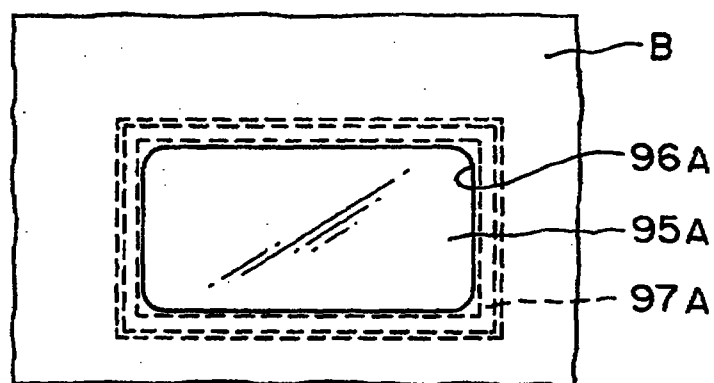


FIG. 40

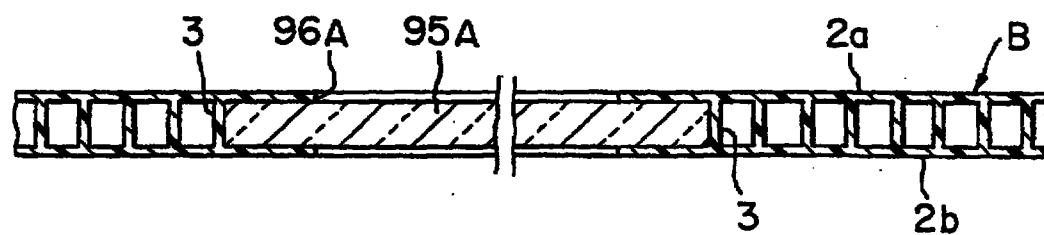


FIG. 41

SPECIFICATION

SYNTHETIC RESIN PANEL WELDING METHOD AND
HOLLOW PANEL STRUCTURES FABRICATED BY THE METHOD

5

TECHNICAL FIELD

The present invention relates to a method of welding together hollow thermoplastic synthetic resin panels each formed by integrally joining together two parallel sheets by a plurality of ribs, and a hollow panel structure fabricated by the same method.

BACKGROUND ART

Hollow thermoplastic synthetic resin panels having two parallel sheets and a plurality of ribs integrally connecting together the two sheets are used for forming packages, such as boxes, architectural materials, such as partition members and walls, and the like. The hollow thermoplastic synthetic resin panel for such purposes are produced by extruding a material in the direction of extension of the ribs. Generally, the material is a thermoplastic resin such as a polypropylene resin or a polyethylene resin. The hollow thermoplastic synthetic resin panel has become prevalently used owing to its excellent strength and durability as compared with those of corrugated cardboards,

Since the side edges parallel to the ribs of the conventional hollow panel of this kind, and the end edges of the same hollow panel perpendicular to the ribs are open to the outside, the interior of the spaces of the hollow panel are liable to be contaminated with foreign matters including dust and unwanted bacteria, and the cleaning of the interiors of the hollows is practically impossible. Accordingly, the conventional hollow panel could not have been used for forming boxes for containing food, medical and pharmaceutical products, cosmetics, etc. which must meet severe sanitary standards.

When using hollow panels of this kind as a packaging

material, the hollow panels need to be subjected to processes to form grooves and/or recesses in the surface thereof, and to form folding grooves and openings in the hollow panels. Such processes use press working including
5 hot-plate press working. However, since folding grooves formed by press working are shallow and portions of the hollow panels corresponding to the folding grooves are excessively resilient, various troubles arise during and after assembling the hollow panels to form boxes. If an
10 opening is formed in the hollow panel by press working, the interior of the hollows are opened on the edge of the opening and hence the interior of the hollows are contaminated with foreign matters including dust. When a hot plate is used for press working, the surface of the hot
15 plate melts portions on the opposite sides of a pressed part of the opposite sheets of the hollow panel and many pores are formed in the hollow panel.

Hollow panels are joined together or a hollow panel is joined to another part, such as a frame, by methods
20 respectively using staples, rivets, an adhesive tape and an adhesive. These methods have been employed in joining together corrugated cardboards made of paper and, in some cases, these methods are applicable to joining together hollow synthetic resin panels without entailing any
25 problem.

Hollow thermoplastic synthetic resin panels are used for forming a package for containing a heavy article that applies a large load that cannot be borne by a corrugated cardboard or fiberboard to the package or a highly
30 air-tight or liquid-tight package. Therefore, a package formed by welding together hollow thermoplastic synthetic resin panels with adhesive tapes or an adhesive is not perfectly reliable when used for such purposes. Stapling and riveting have difficulty in carrying out air-tight or
35 liquid-tight welding.

A method of welding together hollow thermoplastic synthetic resin panels with a hot plate, similarly to the

method of forming grooves and/or recesses in hollow thermoplastic synthetic resin panels and forming folding grooves and openings in the hollow thermoplastic synthetic resin panel, has problems in that many holes and impressions are formed in the surface of the hollow thermoplastic synthetic resin panel, and in that two hollow thermoplastic synthetic resin panels, or a hollow thermoplastic synthetic resin panel and a thermoplastic synthetic resin part are not welded firmly together with satisfactory appearance and, in a worst case, the welded portions of the hollow thermoplastic synthetic resin panel are burnt off.

The present invention has been made to solve those problems in the prior art and it is therefore an object of the present invention to provide a hollow thermoplastic synthetic resin panel welding method capable of firmly welding together the opposite sheets of a hollow thermoplastic synthetic resin panel, two hollow thermoplastic synthetic resin panels or a hollow thermoplastic synthetic resin panel and another part with satisfactory appearance.

Another object of the present invention is to provide a thermoplastic synthetic resin panel welding method capable of surely closing the edges or the line of a hollow thermoplastic synthetic resin panel by fusion to seal the interior of the hollow thermoplastic synthetic resin panel.

Still another object of the present invention is to provide a thermoplastic synthetic resin panel welding method capable of surely forming grooves, recesses, folding grooves, openings and such in a hollow thermoplastic synthetic resin panel without inducing resilience in portions of the hollow thermoplastic synthetic resin panel corresponding to the grooves, the recesses, the folding grooves, the openings and such.

A further object of the present invention is to provide a hollow thermoplastic synthetic resin panel

processed by the foregoing method and a hollow panel structure fabricated by processing hollow thermoplastic synthetic resin panels by the foregoing method.

DISCLOSURE OF THE INVENTION

5 According to an aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing a hollow thermoplastic synthetic resin panel having a first sheet, a second sheet
10 parallel to the first sheet, and ribs integrally joining the first and second sheets; placing an ultrasonic welding machine with an ultrasonic welding head thereof and a work support means thereof disposed adjacent the first and second sheets, respectively; moving the ultrasonic welding
15 head and the work support means toward each other to bring the ultrasonic welding head and the work support means into contact with the first and second sheets, respectively; generating ultrasonic waves between the ultrasonic welding
20 head and the work support means to generate frictional heat by the ultrasonic vibration of the first and second sheets; and compressing the first and second sheets between the ultrasonic welding head and the work support means to weld
 together the first and second sheets.

 According to another aspect of the present invention, a thermoplastic synthetic resin panel welding method
25 comprises the steps of preparing a first hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a second hollow thermoplastic synthetic resin
30 panel of the same construction as that of the first hollow thermoplastic synthetic resin panel; placing the first and second hollow thermoplastic synthetic resin panels one on top of the other; placing an ultrasonic welding machine
 with an ultrasonic welding head thereof disposed on a
35 surface of the first hollow thermoplastic synthetic resin panel and a work support means thereof disposed on a surface of the second hollow thermoplastic synthetic resin

panel opposite to each other with respect to a line; moving the ultrasonic welding head and the work support means toward each other to bring the first and second hollow thermoplastic synthetic resin panels into contact with each other; driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in the first and second hollow thermoplastic synthetic resin panels so that portions of the first and second hollow thermoplastic synthetic resin panels along the line are fused and welded together.

According to another aspect of the present invention, a method of welding together a hollow thermoplastic synthetic resin panel and a thermoplastic synthetic resin part comprises the steps of preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a thermoplastic synthetic resin member; putting the hollow thermoplastic synthetic resin panel and the member one on top of the other; placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on a surface of the hollow thermoplastic synthetic resin panel and a work support means of the ultrasonic welding machine disposed on a surface of the member so that the hollow thermoplastic synthetic resin panel and the member are held between the ultrasonic welding head and the work support means; driving the ultrasonic welding head to generate frictional heat in portions of the hollow thermoplastic synthetic resin panel and the member in contact with each other by ultrasonic vibration so that the hollow thermoplastic synthetic resin panel and the member are welded together.

According to still another aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing a first hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs

defining a plurality of spaces between the first and second sheets, and a second hollow thermoplastic synthetic resin panel of the same construction as that of the first hollow thermoplastic synthetic resin panel; placing the first and second hollow thermoplastic synthetic resin panels so that end portions thereof overlap each other to form an overlapping section; placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and with a work support means thereof disposed on the other side of the same; driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in the surfaces of the overlapping end portions of the first and second hollow thermoplastic synthetic resin panels in contact with each other so that the surfaces of the overlapping end portions of the first and second hollow thermoplastic synthetic resin panels in contact with each other are softened and welded together; and compressing the first and second sheets of the overlapping portions of the first and second hollow thermoplastic synthetic resin panels in the direction of their thickness by the ultrasonic welding head and the work support means to weld together the first and second hollow thermoplastic synthetic resin panels.

According to a further aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets; placing opposite edge portions of the hollow thermoplastic synthetic resin panel one on top of the other to form an overlapping section; placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and with a work support means thereof disposed on the other side of the overlapping section; driving the ultrasonic welding head to generate ultrasonic waves that propagate from the ultrasonic welding

head toward the work support means so that frictional heat is generated in the surfaces of the overlapping edge portions by ultrasonic vibration and the surfaces of the overlapping edge edge portions are softened and welded together; and compressing the overlapping edge portions of the hollow thermoplastic synthetic resin panel between the ultrasonic welding head and the work support means in the direction of the thickness of the overlapping edge portions to reduce the thickness of the overlapping section to a thickness substantially equal to the thickness of the hollow thermoplastic synthetic resin panel.

According to a still further aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets; folding an end portion of the hollow thermoplastic synthetic resin panel in layers; holding the layers of the hollow thermoplastic synthetic resin panel between an ultrasonic welding head and work support means of an ultrasonic welding machine; driving the ultrasonic welding head to generate frictional heat in the layers of the hollow thermoplastic synthetic resin panel by ultrasonic vibration so that the layers of the hollow thermoplastic synthetic resin panel are welded together to form an edge portion of a thickness greater than that of the hollow thermoplastic synthetic resin panel.

According to another aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing a first hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joined to the first and second sheets and defining a plurality of spaces between the first and second sheets, and a second hollow thermoplastic synthetic resin panel of the same construction as that of the first hollow

thermoplastic synthetic resin panel; disposing the first and second hollow thermoplastic synthetic resin panels with side edges thereof pressed against each other to form a butting section; placing an ultrasonic welding machine with
5 an ultrasonic welding head thereof and a work support means thereof disposed opposite to each other with respect to the direction of thickness of the butting section on the opposite sides of the butting section, respectively; driving the ultrasonic welding head to generate frictional
10 heat in the end surfaces of the hollow thermoplastic synthetic resin panels butting on each other by ultrasonic vibration so that the end surfaces of the hollow thermoplastic synthetic resin panels butting each other are fused and welded together to connect the first and second
15 hollow thermoplastic synthetic resin panels together in a single hollow thermoplastic synthetic resin panel.

According to still another aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing first, second and
20 third hollow thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets;
25 placing the first and second hollow thermoplastic synthetic resin panels to form an edge-to-edge junction; placing the third hollow thermoplastic synthetic resin panel at an angle to the surfaces of the first and second hollow thermoplastic synthetic resin panels so that a side edge of
30 the third panel butts on the edge-to-edge junction of the first and second hollow thermoplastic synthetic resin panels; placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with the edge-to-edge junction of the first and second hollow
35 thermoplastic synthetic resin panels on a side opposite the side on which the third hollow thermoplastic synthetic resin panel butts on the edge-to-edge junction of the first

and second hollow thermoplastic synthetic resin panels, and with a work support means of the ultrasonic welding machine in contact with portions of the first, second and third hollow thermoplastic synthetic resin panels in the edge-to-edge junction of the first, second and third hollow thermoplastic synthetic resin panels; driving the ultrasonic welding head to generate frictional heat in portions of the first, second and third hollow thermoplastic synthetic resin panels in the junction of the first, second and third hollow thermoplastic synthetic resin panels so that portions of the first, second and third hollow thermoplastic synthetic resin panels in the junction are fused and welded together.

According to a further aspect of the present invention, a thermoplastic synthetic resin panel welding method comprises the steps of preparing first and second hollow thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; placing the second hollow thermoplastic synthetic resin panel at an angle to one surface of the first hollow thermoplastic synthetic resin panel with a side edge of the second panel butting on the surface of the first hollow thermoplastic synthetic resin panel; placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of the other surface of the first hollow thermoplastic synthetic resin panel corresponding to the junction of the first and second hollow thermoplastic synthetic resin panels, and with a work support means of the ultrasonic welding machine in contact with portions of the surface of the first hollow thermoplastic synthetic resin panel on the opposite sides of the second hollow thermoplastic synthetic resin panel and with portions of the opposite surfaces of the second hollow thermoplastic synthetic resin panel; driving the ultrasonic welding head

to generate frictional heat in portions of the first and second hollow thermoplastic synthetic resin panels corresponding to the junction so that those positions are fused and welded together.

5 According to a still further aspect of the present invention, a method of welding together a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining
10 a plurality of spaces between the first and second sheets, and a thermoplastic resin member, comprises the steps of preparing the hollow thermoplastic synthetic resin panel and the thermoplastic synthetic resin member; placing the hollow thermoplastic synthetic resin panel with a side edge
15 thereof butting on the thermoplastic synthetic resin member; placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of one surface of the hollow thermoplastic synthetic resin panel adjacent the joint of the hollow thermoplastic
20 synthetic resin panel and the thermoplastic synthetic resin member and a work support means of the ultrasonic welding machine in contact with a portion of the other surface of the hollow thermoplastic synthetic resin panel adjacent the joint of the hollow thermoplastic synthetic resin panel and
25 the thermoplastic synthetic resin member; driving the ultrasonic welding head to generate frictional heat in portions of the hollow thermoplastic synthetic resin panel and the thermoplastic synthetic resin member around the joint so that those portions are fused and welded together.

30 According to an aspect of the present invention, a hollow panel structure comprises first and second hollow thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs
35 integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, wherein the first and second hollow thermoplastic synthetic

resin panels are disposed with side edge portions thereof overlapping each other to form an overlapping section, portions of the first and second hollow thermoplastic synthetic resin panels in the overlapping section are
5 welded together by ultrasonic welding, and the thickness of the overlapping section is substantially equal to the thickness of the first and second hollow thermoplastic synthetic resin panels.

According to a further aspect of the present invention,
10 a hollow panel structure comprises first and second hollow thermoplastic synthetic resin panels of the same construction consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining
15 a plurality of spaces between the first and second sheets; wherein the first and second hollow thermoplastic synthetic resin panels are disposed with side edges thereof butting against each other, and the side edges are welded together by ultrasonic welding.

According to a still further aspect of the present invention, a hollow panel structure comprises a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second
20 sheets and defining a plurality of spaces between the first and second sheets, and a thermoplastic synthetic resin member; wherein the hollow thermoplastic synthetic resin panel and the thermoplastic synthetic resin member are put in contact with each other, and portions of the hollow
25 thermoplastic synthetic resin panel and the thermoplastic synthetic resin member in contact with each other are welded together by ultrasonic welding.

The present invention employs an ultrasonic welding process instead of a heat bonding process which applies
35 heat to portions of components to be welded together. An ultrasonic welding process employed in the present invention makes the material forming the hollow

thermoplastic synthetic resin panel vibrate to generate heat in the hollow thermoplastic synthetic resin panel instead of applying heat to the hollow thermoplastic synthetic resin panel. Frictional heat is easily generated in portions of the sheets of hollow thermoplastic synthetic resin panels pressed against each other and hence those portions are easily fused. Accordingly, welding starts from the interior of those portions and the external surfaces of the sheets are hardly affected by welding and are kept clean. Since the internal portions of the components of the hollow thermoplastic synthetic resin panel are welded, the junctions has a high weld strength. Since the range of welding can easily be controlled, the components can be welded together accurately, for example, along a line. Ultrasonic waves can effectively propagate through the ribs of the hollow thermoplastic synthetic resin panel, and the sheets of the hollow thermoplastic synthetic resin panels can effectively be welded together owing to the agency of the ribs.

The heat bonding process heats portions of components to be welded together by applying heat to those positions from the outside. Therefore, the surfaces of the hollow thermoplastic synthetic resin panel are liable to be affected adversely by the heat, the inner portion of the components of the hollow thermoplastic synthetic resin panel are not necessarily be welded with reliability, portions of the components around the welded portions are liable to be affected by heat and, in most cases, it is difficult to weld the components exactly as designed.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a hollow thermoplastic synthetic resin panel to which the present invention is applied;

Fig. 2 is a partly cutaway perspective view of the hollow thermoplastic synthetic resin panel of Fig. 1;

Fig. 3 is a side view of the hollow thermoplastic synthetic resin panel in an initial stage of a method of

closing openings in an end edge of the hollow thermoplastic synthetic resin panel;

Fig. 4 is a side view of the hollow thermoplastic synthetic resin panel in a final stage of the method of closing openings in an end edge of the hollow thermoplastic synthetic resin panel;

Fig. 5 is a partly cutaway perspective view of a hollow thermoplastic synthetic resin panel having end edges closed as shown in Fig. 4;

Fig. 6 is a sectional view of the hollow thermoplastic synthetic resin panel of Fig. 4;

Fig. 7 is sectional view of a hollow thermoplastic synthetic resin panel, explaining a method of welding portions of the hollow thermoplastic synthetic resin panel along lines;

Fig. 8 is a sectional view of a hollow thermoplastic synthetic resin panel, explaining a method of two-dimensionally welding together portions of the first and the second sheets of the hollow thermoplastic synthetic resin panel;

Fig. 9 is sectional view of a hollow thermoplastic synthetic resin panel having welded portions formed by the methods illustrated in Figs. 7 and 8;

Fig. 10 is a perspective view of a hollow thermoplastic synthetic resin panel having a linearly welded portion;

Fig. 11 is a plan view of a hollow thermoplastic synthetic resin panel provided with an opening and a recess demarcated by welded portions;

Fig. 12 is a sectional view taken on line XII-XII in Fig. 11;

Fig. 13 is a perspective view of two hollow thermoplastic synthetic resin panels welded together along a line;

Fig. 14 is a perspective view of a hollow thermoplastic synthetic resin panel welded to a member;

Fig. 15 is sectional view of two hollow thermoplastic synthetic resin panels in an initial stage of a welding

process for welding together the respective side edge portions of the hollow thermoplastic synthetic resin panels;

5 Fig. 16 is a sectional view of the two hollow thermoplastic synthetic resin panels in a stage subsequent to the initial stage of the welding process shown in Fig. 15;

10 Fig. 17 is a sectional view of the two completely welded hollow thermoplastic synthetic resin panels in the final stage of the welding process subsequent to the stage shown in Fig. 16;

15 Fig. 18 is sectional view of a welded portion of a structure formed by welding together the two hollow thermoplastic synthetic resin panels by the welding process illustrated in Figs. 15, 16 and 17;

Fig. 19 is an end view of a circular tube formed by welding together the opposite side ends of a single hollow thermoplastic synthetic resin panel;

20 Fig. 20 is an end view of a rectangular tube formed by welding together the opposite side ends of a single hollow thermoplastic synthetic resin panel;

25 Fig. 21 is a perspective view of a hollow panel structure formed by successively connecting hollow thermoplastic synthetic resin panels, and a frame member combined with the hollow panel structure;

Fig. 22 is a development of a hollow thermoplastic synthetic resin panel box;

Fig. 23 is a development of another hollow thermoplastic synthetic resin panel box;

30 Fig. 24 is a sectional view of a reinforced edge portion of a hollow thermoplastic synthetic resin panel before completion;

35 Fig. 25 is a sectional view of the reinforced edge portion of the hollow thermoplastic synthetic resin panel of Fig. 24 after completion;

Fig. 26 a sectional view of two hollow thermoplastic synthetic resin panels, explaining a method of butt welding

the two hollow thermoplastic synthetic resin panels;

Fig. 27 is a sectional view of three hollow thermoplastic synthetic resin panels, explaining a method of butt welding the three hollow thermoplastic synthetic resin panels;

Fig. 28 is a sectional view of two hollow thermoplastic synthetic resin panels, explaining a method of welding the two hollow thermoplastic synthetic resin panels at an angle;

Fig. 29 is sectional view, explaining a method of welding a part to one side edge portion of a hollow thermoplastic synthetic resin panel;

Fig. 30 is a fragmentary perspective view of an edge member;

Fig. 31 is a perspective view of the edge member of Fig. 30 provided with a notch necessary for bending the same;

Fig. 32 is a perspective view of an edge member provided with another notch necessary for bending the same;

Fig. 33 is a perspective view of the edge member of Fig. 31 bent and attached to a hollow thermoplastic synthetic resin panel;

Fig. 34 is a perspective view of the edge member of Fig. 32 bent and attached to a hollow thermoplastic synthetic resin panel;

Fig. 35 is a perspective view of a grip;

Fig. 36 is a sectional view of a hollow thermoplastic synthetic resin panel to which the grip of Fig. 35 is welded;

Fig. 37 is a perspective view of a card holder;

Fig. 38 is a sectional view of a hollow thermoplastic synthetic resin panel and the card holder welded to the hollow thermoplastic synthetic resin panel;

Fig. 39 is a plan view of a hollow thermoplastic synthetic resin panel to which a transparent plate is welded;

Fig. 40 is a plan view of another hollow thermoplastic

synthetic resin panel to which a transparent plate is welded; and

Fig. 41 is a sectional view of the hollow thermoplastic synthetic resin panel of Fig. 40.

5

BEST MODE FOR CARRYING OUT THE INVENTION

Preferred embodiments of the present invention will be described hereinafter with reference to the accompanying drawings.

Referring to Figs. 1 and 2 showing a hollow
10 thermoplastic synthetic resin panel B relevant to the present invention in a sectional view and a partly cutaway perspective view, respectively, the hollow thermoplastic synthetic resin panel has a first sheet 2a, a second sheet 2b extended opposite to and in parallel to the first sheet
15 2a, and a plurality of parallel ribs 3 integrally joining the sheets 2a and 2b. A plurality of hollow spaces 4 are formed between adjacent ribs 3. The sheets 2a and 2b and the ribs 3 are formed in an integral structure by extruding a thermoplastic resin, such as a polypropylene resin or a
20 polyethylene resin, through an extrusion die.

In the hollow thermoplastic synthetic resin panel B thus formed, the side edges 5 parallel to the ribs 3 are open to the outside as shown in Fig. 1, and the spaces 4 are open in the longitudinal end edges as shown in Fig. 2.
25 Therefore, the interior of the hollow thermoplastic synthetic resin panel B is liable to be contaminated with foreign matters including dust and unwanted bacteria and, once contaminated, it is practically impossible to wash the interior of the hollow thermoplastic synthetic resin panel
30 B.

A thermoplastic synthetic resin panel welding method in a preferred embodiment according to the present invention solves such a problem. For example, the open ends of the spaces 4 opening in the longitudinal end edges of the
35 hollow thermoplastic synthetic resin panel B are closed by welding together the longitudinal end portions of the first sheet 2a and the second sheet 2b as shown in Figs. 3 and 4.

The present invention employs an ultrasonic welding machine, the principle of which is generally known, for welding together the longitudinal end portions of the first sheet 2a and the second sheet 2b. The ultrasonic welding machine is provided with a transducer which uses a unidirectional piezoelectric effect for converting electric power into ultrasonic vibration, and an amplifier. Ultrasonic vibration is exerted through an ultrasonic horn on a workpiece to generate heat in the workpiece by stimulating atomic movement in molecules of the material forming the workpiece.

Fig. 3 shows an ultrasonic welding machine which carries out a thermoplastic synthetic resin panel welding method in accordance with the present invention. The ultrasonic welding machine has an ultrasonic welding head 6, i.e., an ultrasonic horn, and a work support block 7 having a flat support surface. The ultrasonic welding head 6 is extended along an end edge of the outer surface of the first sheet 2a of the hollow thermoplastic synthetic resin panel B (perpendicularly to the sheet of Fig. 3), and the work support block 7 is disposed with its support surface extended along an end edge of the outer surface of the second sheet 2b of the hollow thermoplastic synthetic resin panel B so as to correspond to the ultrasonic welding head 6. The end edge of the hollow thermoplastic synthetic resin panel B is placed on the work support block 7, the ultrasonic welding head 6 is actuated to generate ultrasonic waves, and the ultrasonic welding head 6 is moved in the direction of the arrow A (Fig. 3) toward the work support block 7 to compress the end edge portion of the hollow thermoplastic synthetic resin panel B between the ultrasonic welding head 6 and the work support block 7. The ultrasonic waves generated by the ultrasonic welding head 6 are transmitted through the first sheet 2a and the ribs 4 to the second sheet 2b. Then, heat is generated in the first sheet 2a, the second sheet 2b and the ribs 3 by intramolecular vibration and the first sheet 2a, the second

sheet 2b and the ribs 3 are fused and welded together. Since those fused portions of the first sheet 2a, the second sheet 2b and the ribs 3 are compressed between the ultrasonic welding head 6 and the work support block 7, the first sheet 2a is pressed toward the second sheet 2b as the ribs 3 are softened and, finally, the end edge of the first sheet 2a is joined to the end edge of the second sheet 2b as shown in Fig. 4. The end edge portion of the first sheet 2a is bent toward the end edge portion of the second sheet 2b and the respective end edges of the first sheet 2a and the second sheet 2b are welded together. The ultrasonic welding head 6 has a concave, curved shape with the outer edge portion protruding to the largest extent as shown in Fig. 4, and the end edge portion of the first sheet 2a is bent in a curve conforming to the concave, curved shape of the ultrasonic welding head 6. The end portions of the ribs 4 are melted into a shape conforming the curved shape of the end edge portion of the first sheet 2a. Since the ultrasonic waves are effective only in a region between the ultrasonic welding head 6 and the work support block 7, only portions of the hollow thermoplastic synthetic resin panel B in this region are melted and the rest of the same are not melted.

The other end edge of the hollow thermoplastic synthetic resin panel B is closed also by welding to form closed end edges or seams 8 in the hollow thermoplastic synthetic resin panel B as shown in Figs. 5 and 6. The closed end seams 8 can be formed in a desired shape by properly determining the shapes of the ultrasonic welding head 6 and the work support block 7.

When the end seams 8 are thus formed, the space 4 of the hollow thermoplastic synthetic resin panel B are not contaminated with foreign matters including dust, and air is sealed in the spaces 4. Consequently, the heat insulating performance and the rigidity of the hollow thermoplastic synthetic resin panel B are enhanced. If necessary, the side edges of the hollow thermoplastic

synthetic resin panel B parallel to the ribs 3 may be closed by welding.

Welding work similar to that mentioned above can be practiced for portions of the hollow thermoplastic synthetic resin panel B other than the edge portions. When forming a hollow panel structure shown in Fig. 7, an ultrasonic welding head 6A is formed in a tapered cross section and has a middle nose 9. and a work support block 7A is basically the same as the foregoing work support block 7 and has a flat support surface. A desired portion of the hollow thermoplastic synthetic resin panel B is placed on the work support block 7A, the ultrasonic welding head 6A is driven to generate ultrasonic waves and the ultrasonic welding head 6A is moved toward the work support block 7A. Consequently, the desired portion of the hollow thermoplastic synthetic resin panel B is softened and partly melted and the first sheet 2a is curved and welded to the second sheet 2b to form a linear groove 10 having a substantially V-shaped cross section as indicated by alternate long and two short dashes lines in Fig. 7.

Thus, a weld line 11 is formed in the bottom of the V-shaped linear groove 10 in the hollow thermoplastic synthetic resin panel B. The shape of the linear groove 10 is dependent on the shape of the ultrasonic welding head 6A. A member may be attached to the panel B by fitting the member in the linear groove 10 or the groove 10 may be formed in characters, patterns or marks.

A thermoplastic synthetic resin panel welding method shown in Fig. 8 forms a recess 12 having a flat bottom surface instead of the linear groove 10. An ultrasonic welding head 6B having a flat end surface and a work support block 7B having a flat support surface corresponding to the flat end surface of the ultrasonic welding head 6B are employed. The ultrasonic welding head 6B is driven to generate ultrasonic waves and is moved toward the work support block 7B. Consequently, a portion of the hollow thermoplastic synthetic resin panel B

corresponding to the flat end surface of the ultrasonic welding head 6B is softened, portions of the ribs 3 corresponding to the ultrasonic welding head 6B are melted, and a portion of the first sheet 2a corresponding to the ultrasonic welding head 6B is welded to the second sheet 2b to form the recess 12 as shown in Fig. 9. The recess 12 may be a gripping recess, pattern or marks.

Fig. 10 shows a hollow panel structure obtained by forming a folding line 14 perpendicular to ribs 3 in a hollow thermoplastic synthetic resin panel B. This folding line 14 can be formed by compressing a portion of the hollow thermoplastic synthetic resin panel B between an ultrasonic welding head similar to the ultrasonic welding head 6A shown in Fig. 7, and a work support block of a shape similar to that of the ultrasonic welding head. In this hollow panel structure, corresponding portions of the first sheet 2a and the second sheet 2b are curved in linear grooves similar to the linear groove 10 of Fig. 9 and the bottoms of the linear grooves are joined to each other to form the folding line 14. The hollow thermoplastic synthetic resin panel B can be folded along the folding line 14. The folding line 14 can be formed in parallel to or at an inclination to the ribs 3.

Since corresponding portions of the sheets 2a and 2b on the folding line 14 are directly welded together, the resilience of the hollow thermoplastic synthetic resin panel B against bending along the folding line 14 is low and, when used as a hinge, the folding line 14 has an increased fatigue strength. Although the linear groove 10 having a V-shaped cross section as shown in Fig. 7 may be used as a folding line, it is desirable that the folding line be formed by forming linear grooves having a common bottom in the opposite surfaces of the hollow thermoplastic synthetic resin panel B.

The first sheet 2a and the second sheet 2b can be welded together in a manner as shown in Figs. 11 and 12. An opening 16 or a recess 17 is formed in the hollow

thermoplastic synthetic resin panel B as shown in Fig. 11, the edges of the opening 16 or the recess 17 are held between an ultrasonic welding head and a work support block having the shape of the opening 16 or the recess 17, and then ultrasonic waves are generated by the ultrasonic welding head. Consequently, portions of the sheets 2a and 2b corresponding to the edges of the opening 16 or the recess 17 are welded together. Thus, the edges 18 of the opening 16 are closed or seamed as shown in Fig. 12.

10 In the foregoing hollow panel structures, the sheets 2a and 2b of a hollow thermoplastic synthetic resin panel B are welded together. A hollow panel structure shown in Fig. 13 is formed by welding together a first hollow thermoplastic synthetic resin panel B1 and a second hollow thermoplastic synthetic resin panel B2 along a weld line 20. When welding together the two hollow thermoplastic synthetic resin panel B1 and B2 along the weld line 20, the two hollow thermoplastic synthetic resin panel B1 and B2 are put one on top of the other, an ultrasonic welding head is brought into contact with the first sheet 2a of the first hollow thermoplastic synthetic resin panel B1, a work support block is brought into contact with the second sheet 2b of the second hollow thermoplastic synthetic resin panel B2, the ultrasonic welding head is driven to generate ultrasonic waves and moved toward the work support block. Consequently, heat is generated in portions of the hollow thermoplastic synthetic resin panels B1 and B2 between the ultrasonic welding head and the work support block and the hollow thermoplastic synthetic resin panels B1 and B2 are welded together. The ultrasonic welding head and the work support block are formed in linear shapes to form the straight weld line 20 as shown in Fig. 13. The hollow panel structure thus formed by welding together the hollow thermoplastic synthetic resin panels B1 and B2 and having the straight weld line 20 is used as a partition member for dividing the interior of a box into separate spaces or a component member of a honeycomb structure.

Fig. 14 shows a hollow panel structure formed by combining a hollow thermoplastic synthetic resin panel B and a thermoplastic synthetic resin member 22. The hollow thermoplastic synthetic resin panel B is welded along a weld line 23 to the thermoplastic synthetic resin member 22 by ultrasonic welding as mentioned above. The thermoplastic synthetic resin member 22 is, for example, a member of a frame for reinforcing a box.

Figs. 15 to 18 show different phases of a thermoplastic synthetic resin panel welding method for welding together side edge portions of a first hollow thermoplastic synthetic resin panel B1 and a second hollow thermoplastic synthetic resin panel B2. As shown in Fig. 15, the hollow thermoplastic synthetic resin panel B1 and B2 are disposed between an ultrasonic welding head 6C and a work support block 7C of an ultrasonic welding machine so that side edge portions of a width W of the hollow thermoplastic synthetic resin panel B1 and B2 overlap each other. Then, the ultrasonic welding head 6C is driven to generate ultrasonic waves and moved toward the work support block 7C. The ultrasonic welding head 6C and the work support block 7C have flat working surfaces having a width W equal to the width W of the overlapping portions of the hollow thermoplastic synthetic resin panels B1 and B2 and capable of being brought into close contact with the first sheet 2a of the first hollow thermoplastic synthetic resin panel B1 and the second sheet 2b of the second hollow thermoplastic synthetic resin panel B2, respectively. When the ultrasonic welding head 6C is thus moved toward the work support block 7C, the overlapping portions of the hollow thermoplastic synthetic resin panels B1 and B2 are held between the ultrasonic welding head 6C and the work support block 7C as shown in Fig. 16.

As the ultrasonic welding head 6C is advanced further from a position shown in Fig. 16 to a position shown in Fig. 17, ultrasonic waves generated by the ultrasonic welding head 6C are propagated through the first sheet 2a,

the ribs 3 and the second sheet 2b of the hollow thermoplastic synthetic resin panel B1, and the first sheet 2a and the ribs 3 of the second hollow thermoplastic synthetic resin panel B2 to the second sheet 2b of the second hollow thermoplastic synthetic resin panel B2, so that heat is generated in the overlapping portions of the hollow thermoplastic synthetic resin panels B1 and B2 by intramolecular ultrasonic vibrations generated in the materials forming the hollow thermoplastic synthetic resin panels B1 and B2. The frictional effect of the intramolecular ultrasonic vibrations is remarkable particularly in the interface between the second sheet 2b of the first panel B1 and the first sheet 2a of the second panel B2, and hence portions of the panels B1 and B2 around the interface are heated most intensely and melted.

Consequently, the portions of the hollow thermoplastic synthetic resin panels B1 and B2 around the interface are fused and welded together as the ultrasonic welding head 6C advances from the position shown in Fig. 16 to the position shown in Fig. 17 and, finally, the overlapping portions of the width W of the hollow thermoplastic synthetic resin panels B1 and B2 are compressed to a thickness equal to or less than the thickness of the panel B1 or B2. As best shown in Fig. 17, portions of the panels B1 and B2 in an intermediate region 30 are melted most intensely, the first sheet 2a of the first hollow thermoplastic synthetic resin panel B1 and the second sheet 2b of the second hollow thermoplastic synthetic resin panel B2 are not deformed, and the two panels B1 and B2 are joined together in a single hollow panel structure. The temperature of the molten portions returns to an ordinary temperature in a relatively short time after the ultrasonic vibrations have been stopped. Thus, the hollow thermoplastic synthetic resin panels B1 and B2 are joined together in a single hollow panel structure as shown in Fig. 18. Portions of the panels B1 and B2 in the intermediate region 30 are fused and solidified in a welded joint 31 and the panels B1

and B2 are joined firmly together. The thickness of the joint of the panels B1 and B2 can be adjusted by properly adjusting the final distance between the ultrasonic welding head 6C and the work support block 7C, and the joint can be
5 formed in a thickness slightly smaller than the thickness of each hollow thermoplastic synthetic resin panel.

While in the above stated structure, two different panels are welded, a single panel can be welded together to form a hollow panel structure shown in Fig. 19. In this
10 case the opposite end edge portions of a single hollow thermoplastic synthetic resin panel B are welded together. The hollow thermoplastic synthetic resin panel B is rolled in a tubular shape so that the opposite end edge portions thereof overlap each other, and the overlapping end edge
15 portions are welded to form a joint 32.

When forming a hollow panel structure shown in Fig. 20, a hollow thermoplastic synthetic resin panel B is folded into a rectangular tube so that the opposite end edge portions thereof overlap each other, and then the
20 overlapping end edge portions are welded together to form a joint 33. The hollow panel structures shown in Figs. 19 and 20 are used as side walls of containers.

A circular bottom is bonded to the hollow panel structure shown in Fig. 19 having the shape of a circular
25 tube to form a container having the shape of a circular cylinder. A rectangular bottom is bonded to the hollow panel structure shown in Fig. 20 having the shape of a rectangular tube to form a container having the shape of a rectangular prism.

30 A container having the shape of a rectangular prism can be formed by folding a hollow thermoplastic synthetic resin panel B3 as shown in Fig. 22. The hollow thermoplastic synthetic resin panel B3 has a bottom section 34, four side sections 35, 36, 37 and 38, and folding lines 40, 41, 42
35 and 43, which may be similar to the linear groove 10 shown in Fig. 9 or the folding line 14 shown in Fig. 10. The side sections 35, 36, 37 and 38 are provided with bonding

tabs 45. When forming a container by folding the hollow thermoplastic synthetic resin panel B3, the corresponding bonding tabs 45 are superposed and welded together by the welding procedure previously described with reference to Figs. 15 to 17 to form joints of a thickness corresponding to that of the hollow thermoplastic synthetic resin panel B3.

When necessary, frame members 50 having a cross section resembling an inverted letter U as shown in Fig. 21 may be put on the upper edges of the side walls of the container thus formed and the frame members 50 may be welded to the side walls by the previously described method. In Fig. 21, a frame member 50 is put on and welded to an edge of the hollow panel structure formed by connecting two hollow thermoplastic synthetic resin panel B1 and B2 as shown in Fig. 18.

Fig. 23 shows separate component hollow thermoplastic synthetic resin panels for forming a container having the shape of a rectangular prism. This container is formed by assembling one bottom panel 34 and four side panels 35, 36, 37 and 38. The bottom panel 34 is provided on its four sides with bonding tabs 52, the side panels 35, 36, 37 and 38 are provided on their bottom sides with bonding tabs 51. The bonding tabs 51 of the side panels 35, 36, 37 and 38, and the bonding tabs 52 of the bottom panel 34 are superposed, respectively, and the bonding tabs 51 and 52 are welded together by the welding procedure previously described with reference to Figs. 15 to 17 to obtain a blank panel of a shape as shown in Fig. 22. Then, the blank panel is folded and bonding tabs 45 of the side panels 35, 36, 37 and 38 are welded together by the same method as that previously described with reference to Fig. 22 to obtain a container having a rectangular prism.

Figs. 24 and 25 illustrates a method of reinforcing an end edge of a hollow thermoplastic synthetic resin panel B. As shown in Fig. 24, an edge portion of the hollow thermoplastic synthetic resin panel B is folded in two,

three or more layers in a layered structure 55 of an appropriate width, the ultrasonic welding head 6D and the work support block 7D of an ultrasonic welding machine is applied to the opposite surfaces of the layered structure 55, and the layered structure 55 is compressed and welded by the welding procedure previously described with reference to Figs. 15 to 17 to form a strong, reinforced edge portion 56 of a thickness smaller than that of the layered structure 55 integrally with the hollow thermoplastic synthetic resin panel B.

Fig. 26 illustrates a hollow panel structure formed by butt-welding two hollow thermoplastic synthetic resin panels B1 and B2. The right side edge portion of the left panel B1 and the left side edge portion of the right panel B2 are disposed edge to edge between the ultrasonic welding head 6E and the work support block 7E of an ultrasonic welding machine, the ultrasonic welding head 6E is driven to generate ultrasonic waves while the same is moved toward the work support block 7E to compress the joint 60 of the side edge portions. Both the ultrasonic welding head 6E and the work support block 7E have flat working surfaces capable of being brought into close contact with the surfaces of the hollow thermoplastic synthetic resin panels B1 and B2.

Heat is generated in the joint 60 by the ultrasonic vibrations of the joint 60, the side edge portions are melted and welded. The melted joint 60 solidifies after the ultrasonic vibration of the ultrasonic welding head 6E has been stopped and the two hollow thermoplastic synthetic resin panels B1 and B2 are joined together in a single hollow thermoplastic synthetic resin panel.

Fig. 27 illustrates a hollow panel structure formed by butt-welding first and second hollow thermoplastic synthetic resin panels B1 and B2, and butt-welding a third hollow thermoplastic synthetic resin panel B3 to the joint of the first and the second hollow thermoplastic synthetic resin panels B1 and B2 perpendicularly to the second sheets

2b of the first and the second panels B1 and B2. A pair of work support blocks 7F are disposed so as to hold the third panel B3 therebetween and to support the first hollow thermoplastic synthetic resin panel B1 and the second hollow thermoplastic synthetic resin panel B2. An ultrasonic welding head 6F pressed against the first sheets 2a of the panels B1 and B2 is driven to generate ultrasonic waves to generate heat in the joint 61 of the panels B1, B2 and B3, so that the joint 61 is melted and welded. The work support blocks 7F are biased in the direction of the arrows to compress the joint 61 between the ultrasonic welding head 6F and the work support blocks 7F. The third hollow thermoplastic synthetic resin panel B3 may be inclined at an angle other than 90° to the second sheets 2b of the panels B1 and B2. Fig. 28 illustrates a hollow panel structure formed by welding together a single hollow thermoplastic synthetic resin panel B, instead of the two hollow thermoplastic synthetic resin panels B1 and B2 shown in Fig. 27, and a hollow thermoplastic synthetic resin panel B3. The hollow panel structure illustrated in Fig. 28 is entirely the same in principle as that illustrated in Fig. 27. A joint 62 is formed in the hollow panel structure shown in Fig. 28. In Figs. 27 and 28, an optional hollow thermoplastic synthetic resin member may be welded to the hollow thermoplastic synthetic resin panels B1 and B2 or the hollow thermoplastic synthetic resin panel B instead of the third hollow thermoplastic synthetic resin panel B3.

Fig. 29 illustrates a hollow panel structure formed by welding a thermoplastic synthetic resin member 65 to a side edge of a hollow thermoplastic synthetic resin panel B. The thermoplastic synthetic resin part 65 has a projection 66 having the shape of a flat plate and set in contact with the first sheet 2a of the hollow thermoplastic synthetic resin panel B. The ultrasonic welding head 6G of an ultrasonic welding machine is pressed against the projection 66, and the work support block 7G of the

ultrasonic welding machine is pressed against the second sheet 2b of the hollow thermoplastic synthetic resin panel B and a portion of the thermoplastic synthetic resin member 65. A welded joint 67 is formed. If the projection 66 of the thermoplastic synthetic resin member 65 does not have a shape resembling a flat plate, it is desirable to place the ultrasonic welding head in contact with the second sheet 2b of the hollow thermoplastic synthetic resin panel B and to place the work support block in contact with the projection 66.

Fig. 30 shows an edge trimming member 70 for trimming an edge of an open end of a box formed by processing a hollow thermoplastic synthetic resin panel. The edge trimming member 70 is formed by extruding a thermoplastic synthetic resin, such as a polypropylene resin, a polyethylene resin or a polycarbonate resin, and has a base 71, and a clipping lug 72 having a cross section resembling the inverted letter L and projecting from the base 71 so as to define a groove 73. Longitudinal ridges 74 are formed on the inner surface of the base 71 facing the clipping lug 72. The vertical size, as viewed in Fig. 30, of a portion provided with the ridges 74 of the base 71 is greater than that of the clipping lug 72.

The edge of the hollow thermoplastic synthetic resin panel is fitted in the groove 73 of the edge trimming member 70 so that the base 71 is in contact with the outer surface of the hollow thermoplastic synthetic resin panel. An ultrasonic welding head and a work support block are applied to the assembly of the hollow thermoplastic synthetic resin panel and the edge trimming member 70 in a manner as shown in Fig. 29. For example, the ultrasonic welding head is applied to the outer surface of the base 71 at a position corresponding to the ridges 74. The ridges 74 increases the area of a melted portion for effective welding.

When applying the edge trimming member 70 to the upper edges of the side walls of a box having the shape of a

rectangular prism, the edge trimming member 70 needs to be bent at right angles at three positions, and the opposite ends of the edge trimming member 70 needs to be butted to form a rectangular frame. Notches 75 are formed in the clipping lug 72 as shown in Fig. 31. Each notch 75 is formed by removing a triangular portion having the shape of a rectangular equilateral triangle from an upper wall 72a of the clipping lug 72, and a rectangular portion having the shape of a rectangle and a width equal to the length of the base of the triangular portion from a side 72b of the clipping lug 72. The edge trimming member 70 is bent along a folding line 77 passing the apex 76 of the triangular space of the notch 75.

Fig. 32 shows an edge trimming member 70A in a modification of the edge trimming member 70 of Fig. 31. The edge trimming member 70A is provided with a notch 75A of a shape different from that of the notch 75 of the edge trimming member 70. The edge trimming member 70A is provided with a slit 78 in the upper wall 72a of the clipping lug 72 instead of the triangular space of the edge trimming member 70. A folding line 77 is formed at a position corresponding to the slit 78.

Fig. 33 shows hollow thermoplastic synthetic resin panels B forming side walls of a box, and the edge trimming member 70 of Fig. 31 attached to the upper edges of the hollow thermoplastic synthetic resin panels B. When the edge trimming member 70 is bent along the folding line 77 toward the notch 75, edges of the upper wall 72a defining the oblique sides of the triangular space are joined together in a line 81. When the edge trimming member 70 is welded to the hollow thermoplastic synthetic resin panels B, welded joints 82 are formed.

Similarly, the edge trimming member 70A of Fig. 32 is welded to hollow thermoplastic synthetic resin panels B as shown in Fig. 34. In the edge trimming member 70A, adjacent portions 84 of the upper wall 72a on the opposite sides of the slit 78 overlap each other as shown in Fig.

34.

Fig. 35 shows a grip 86 to be attached to a container formed by assembling hollow thermoplastic synthetic resin panels. The grip 86 has a ring 87 and a flange 88 spreading out from the ring 87. The ring 87 define an opening 89. The grip 86 may be formed in the shape of an inverted letter U. The grip 86 is made of a thermoplastic synthetic resin. As shown in Fig. 36, the grip 86 is welded to a hollow thermoplastic synthetic resin panel B. An opening corresponding to the ring 87 of the grip 86 is formed in the hollow thermoplastic synthetic resin panel B, the ring 87 is fitted in the opening so that the ring 87 project from one surface of the hollow thermoplastic synthetic resin panel B and the flange 88 is in close contact with the other surface of the hollow thermoplastic synthetic resin panel B. The ultrasonic welding head of an ultrasonic welding machine is applied to the outer surface of the flange 88, and the work support block of the ultrasonic welding machine is applied to a portion of the hollow thermoplastic synthetic resin panel B corresponding to the flange 88, and then flange 88 and the corresponding portion of the hollow thermoplastic synthetic resin panel B are compressed and ultrasonic waves are applied to the same to form a welded joint 90. The flange 88 is incorporated into the hollow thermoplastic synthetic resin panel B so as to form a portion of the latter. If the grip 86 has the shape of an inverted letter U, portions of the first and the second sheet of the hollow thermoplastic synthetic resin panel B forming an edge of the opening corresponding to the open side of the grip 86 are welded together to close or seam the open edge of the hollow thermoplastic synthetic resin panel B.

Referring to Fig. 37, a card holder 91 has a frame 92 of a shape resembling the letter U, and a flange 93 formed integrally with and extending outward from the frame 92. The frame 92 is raised from the flange 93 so as to define a space for receiving the periphery of a card 95 therein as

shown in Fig. 38. The card holder 91 is made of a thermoplastic synthetic resin. As shown in Fig. 38, the flange is attached to the outer surface of a hollow thermoplastic synthetic resin panel B by ultrasonic welding. The ultrasonic welding head of an ultrasonic welding machine is applied to the flange 93 and a welded joint 94 is formed to weld the flange 93 of the card holder 91 to the hollow thermoplastic synthetic resin panel B.

Referring to Fig. 39, a transparent plate 95 of a thermoplastic synthetic resin is attached to a hollow thermoplastic synthetic resin panel B to enable the observation of the interior of a container formed by folding the hollow thermoplastic synthetic resin panel B. A rectangular opening 96 of a predetermined size is formed in the hollow thermoplastic synthetic resin panel B, the transparent plate 95 of a size slightly greater than that of the opening 96 is put on the hollow thermoplastic synthetic resin panel B so as to cover the opening 96, the ultrasonic welding head of an ultrasonic welding machine is applied to the periphery of the transparent plate 95, the work support block of the ultrasonic welding machine is applied to the hollow thermoplastic synthetic resin panel B so as to correspond to the ultrasonic welding head, the periphery of the transparent plate 95 and the corresponding portion of the hollow thermoplastic synthetic resin panel B are compressed between the ultrasonic welding head and the work support block, and the ultrasonic welding head is driven to form a welded joint 97.

Figs. 40 and 41 shows another transparent plate 95A attached to a hollow thermoplastic synthetic resin panel B so as to cover an opening 96A formed in the hollow thermoplastic synthetic resin panel B. Portions of the ribs 3 of the hollow thermoplastic synthetic resin panel B around the opening 96A are removed so that portions of the first sheet 2a and the second sheet 2b of the hollow thermoplastic synthetic resin panel B around the opening 96A can be warped away from each other, the periphery of

the transparent plate 95A is inserted in a space between the first sheet 2a and the second sheet 2b as shown in Fig. 41. Then, the periphery of the transparent plate 95A is welded to edge portions of the first sheet 2a and the
5 second sheet 2b around the opening 95A by ultrasonic welding to form a welded joint 97A.

INDUSTRIAL APPLICABILITY

The thermoplastic synthetic resin panel welding methods of the present invention are capable of forming various
10 types of bonds of high quality in hollow panel structures formed by processing hollow thermoplastic synthetic resin panels, and the hollow panel structures fabricated by the thermoplastic synthetic resin panel welding methods of the present invention are applicable to versatile uses as
15 building materials and packaging materials.

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CLAIMS

1. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel having a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and the second sheet;

placing an ultrasonic welding machine with an ultrasonic welding head thereof and a work support means thereof disposed adjacent the first and second sheets, respectively;

moving the ultrasonic welding head and the work support means toward each other to bring the ultrasonic welding head and the work support means into contact with the first and the second sheet, respectively;

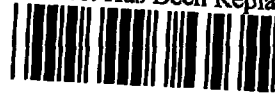
generating ultrasonic waves between the ultrasonic welding head and the work support means to generate internal frictional heat by ultrasonic vibration of the first and second sheets; and

compressing the first and the second sheet between the ultrasonic welding head and the work support means to weld together the first and second sheets.

2. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along end edges of the first and second sheets to melt and seam edges of the synthetic resin board continuously.

3. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along a line spaced from the end edges of the first and second sheets, and portions of the first and second sheets corresponding to the line are welded together continuously.





4. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine have working surfaces of substantially the same area, respectively, the ultrasonic welding head and the work support block are disposed opposite to each other on the outer side of the first sheet and on the outer side of the second sheet, respectively, and two-dimensional portions of the first and second sheets corresponding to the ultrasonic welding head and the work support means are welded together.

5. The thermoplastic synthetic resin panel welding method according to claim 1, wherein an opening is formed in the thermoplastic synthetic resin panel, the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along the edge of the opening, and edge portions of a first and a second sheet of the thermoplastic synthetic resin panel along the edge of the opening are welded together continuously.

6. The thermoplastic synthetic resin panel welding method according to claim 1, wherein recesses are formed in corresponding portions of the first and the second sheets, respectively, the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along the edges of the recesses, respectively, and the edges of the first and second sheets defining the edges of the recesses are welded together continuously.

7. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a second thermoplastic synthetic resin panel of the same





construction as that of the first thermoplastic synthetic resin panel;

placing the first and the second thermoplastic synthetic resin panels one on top of the other;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on a surface of the first thermoplastic synthetic resin panel and a work support means thereof disposed on a surface of the second thermoplastic synthetic resin panel opposite to each other with respect to a line;

moving the ultrasonic welding head and the work support means toward each other to bring the first and second thermoplastic synthetic resin panels into contact with each other;

driving the ultrasonic welding head to generate frictional heat in the first and second thermoplastic synthetic resin panels by ultrasonic vibration so that portions of the first and second thermoplastic synthetic resin panels corresponding to the line are fused and welded together.

8. A method of welding together a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a thermoplastic synthetic resin member, said method comprising the steps of:

preparing the thermoplastic synthetic resin panel, and the thermoplastic synthetic resin member;

putting the hollow thermoplastic synthetic resin panel and the member one on top of the other;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on a surface of the thermoplastic synthetic resin panel and a work support means thereof disposed on a surface of the thermoplastic synthetic resin member so that the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member





are held between the ultrasonic welding head and the work support means; and

driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member in contact with each other so that the thermoplastic synthetic resin panel and the member are welded together.

9. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and the second sheet, and a second thermoplastic synthetic resin panel of the same construction as that of the first hollow thermoplastic synthetic resin panel;

placing the first and second thermoplastic synthetic resin panels so that end portions thereof overlap each other and the surfaces of the overlapping end portions are in close contact with each other to form an overlapping section;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and a work support means thereof disposed on the other side of the same;

driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in the surfaces of the overlapping end portions of the first and second thermoplastic synthetic resin panels in contact with each other so that the surfaces of the overlapping end portions of the first and second thermoplastic synthetic resin panels are softened and welded together; and

compressing the first and second sheets of the overlapping portions of the first and second hollow thermoplastic synthetic resin panels in the direction of





their thickness by the ultrasonic welding head and the work support means to weld together the first and second thermoplastic synthetic resin panels.

10. The thermoplastic synthetic resin panel welding method according to claim 9, wherein the overlapping end portions of the first and second thermoplastic synthetic resin panels in the overlapping section are compressed between the ultrasonic welding head and the work support means to reduce the thickness of the overlapping section.

11. The thermoplastic synthetic resin panel welding method according to claim 10, wherein the thickness of the overlapping section in which the end portions of the first and second thermoplastic synthetic resin panels overlap each other is reduced to a thickness substantially equal to that of each of the first and second thermoplastic synthetic resin panels.

12. A hollow thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets;

placing opposite edge portions of the thermoplastic synthetic resin panel one on top of the other to form an overlapping section;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and a work support means thereof disposed on the other side of the overlapping section;

driving the ultrasonic welding head to generate ultrasonic waves that propagate from the ultrasonic welding head toward the work support means so that frictional heat is generated in the surfaces of the overlapping edge portions by ultrasonic vibration and the surfaces of the





overlapping edge portions are softened and welded together;
and

compressing the overlapping edge portions of the thermoplastic synthetic resin panel between the ultrasonic welding head and the work support means in the direction of the thickness of the overlapping edge portions to reduce the thickness of the overlapping section to a thickness substantially equal to the thickness of the thermoplastic synthetic resin panel.

13. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets;

folding an end portion of the thermoplastic synthetic resin panel in layers;

holding the layers of the hollow thermoplastic synthetic resin panel between an ultrasonic welding head and an work support block of an ultrasonic welding machine;

driving the ultrasonic welding head to generate frictional heat in the layers of the thermoplastic synthetic resin panel by ultrasonic vibrations so that the layers of the thermoplastic synthetic resin panel are welded together to form an edge portion of a thickness greater than that of the thermoplastic synthetic resin panel.

14. The hollow thermoplastic synthetic resin panel welding method according to claim 13, wherein the layers are compressed to reduce the thickness thereof while the layers are being welded.

15. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel





consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and the second sheets, and a second thermoplastic synthetic resin panel of the same construction as that of the first thermoplastic synthetic resin panel;

disposing the first and second hollow thermoplastic synthetic resin panels with side edges thereof pressed against each other to form a butting section;

placing an ultrasonic welding machine with an ultrasonic welding head thereof and a work support means thereof disposed opposite to each other with respect to a direction perpendicular to the thickness of the butting section on the opposite sides of the butting section, respectively;

driving the ultrasonic welding head to generate frictional heat in the end surfaces of the thermoplastic synthetic resin panels butting on each other by ultrasonic vibration so that the end surfaces of the thermoplastic synthetic resin panels butting each other are fused and welded together to connect the first and the second thermoplastic synthetic resin panels in a single thermoplastic synthetic resin panel.

16. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing first, second and third thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet and ribs integrally joining the first and the second sheet and defining a plurality of spaces between the first and second sheets;

placing the first and second thermoplastic synthetic resin panels so as to form an edge-to-edge junction;

placing the third thermoplastic synthetic resin panel at an angle to the surfaces of the first and second thermoplastic synthetic resin panels so that its side edge





butts on the edge-to-edge junction of the first and the second thermoplastic synthetic resin panels;

placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with the edge-to-edge junction of the first and second thermoplastic synthetic resin panels on a side opposite the side on which the third thermoplastic synthetic resin panel butts on the edge-to-edge junction of the first and second thermoplastic synthetic resin panels, and with a work support means of the ultrasonic welding machine in contact with a region around the junction of the first, second and third thermoplastic synthetic resin panels;

driving the ultrasonic welding head to generate frictional heat in the junction of the first, second and third thermoplastic synthetic resin panels so that the portions of the first, second and third thermoplastic synthetic resin panels in the junction are fused and welded together.

17. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing first and second thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets;

placing the second thermoplastic synthetic resin panel at an angle to one surface of the first thermoplastic synthetic resin panel with a side edge of the second panel butting on the surface of the first thermoplastic synthetic resin panel;

placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of the other surface of the first thermoplastic synthetic resin panel corresponding to the junction of the first and second thermoplastic synthetic resin panels, and with a



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work support means of the ultrasonic welding machine in contact with portions of the surface of the first thermoplastic synthetic resin panel on the opposite sides of the second thermoplastic synthetic resin panel and with portions of the opposite surfaces of the second thermoplastic synthetic resin panel;

driving the ultrasonic welding head to generate frictional heat in portions of the first and second thermoplastic synthetic resin panels corresponding to the junction so that those positions are fused and welded together.

18. A method of welding together a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, and a thermoplastic resin member, said method comprising the steps of:

preparing the thermoplastic synthetic resin panel, and the thermoplastic synthetic resin member;

placing the thermoplastic synthetic resin panel with a side edge thereof butting on the thermoplastic synthetic resin member;

placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of one surface of the thermoplastic synthetic resin member adjacent the joint of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member and with a work support means of the ultrasonic welding machine in contact with a portion of the other surface of the thermoplastic synthetic resin panel adjacent the joint of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member;

driving the ultrasonic welding head to generate frictional heat in portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member





around the joint so that those portions are fused and welded together.

19. A thermoplastic synthetic resin panel structure comprising a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, wherein portions of the first and second sheets along a line or a plane extending across the ribs are welded together by ultrasonic welding.

20. The thermoplastic synthetic resin panel structure according to claim 19, wherein the line extends along an end edge of the thermoplastic synthetic resin panel.

21. The thermoplastic synthetic resin panel structure according to claim 19, wherein a portion of the first sheet extending along the line is depressed toward the second sheet and welded to the second sheet by ultrasonic welding.

22. The thermoplastic synthetic resin panel structure according to claim 19, wherein portions of the first and the second sheet extending along the line are depressed toward each other and welded together by ultrasonic welding.

23. A thermoplastic synthetic resin panel structure comprising first and second thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining spaces between the first and second sheets; wherein the first and the second thermoplastic synthetic resin panel are disposed so that the side edge portions thereof overlap





each other to form an overlapping section, portions of the first and second thermoplastic synthetic resin panels in the overlapping section are welded together by ultrasonic welding, and the overlapping section has a thickness substantially equal to a thickness of each of the first and second thermoplastic synthetic resin panels.

24. A thermoplastic synthetic resin panel structure comprising first and second hollow thermoplastic synthetic resin panels of the same construction consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; wherein the first and second thermoplastic synthetic resin panels are disposed so that side edges thereof butt on each other, and the side edges of the first and second thermoplastic synthetic resin panels are welded together by ultrasonic welding.

25. The thermoplastic synthetic resin panel structure comprising:

a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; and

a thermoplastic synthetic resin member;

wherein the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member are put in contact with each other, and portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member in contact with each other are welded together by ultrasonic welding.



ABSTRACT

Portions of a thermoplastic synthetic resin panel (B) formed by extrusion and integrally having a first sheet (2a), a second sheet (2b) parallel to the first sheet (2a), and a plurality of ribs (3) integrally joining the first and second sheets (2a, 2b) are welded together by ultrasonic welding by applying an ultrasonic welding head (6) and a work support block (7) of an ultrasonic welding machine to the first sheet (2a) and the second sheet (2b), respectively, and compressing the portions of the thermoplastic synthetic resin panel (B) between the ultrasonic welding head (6) and the work support block (7). When welding together two thermoplastic synthetic resin panels (B1, B2), at least portions of the panels (B1, B2) are put one on top of the other to form an overlapping section, an head (6C) and a work support block (7C) are applied to the opposite surfaces of the overlapping section, respectively, and the head (6C) is driven to generate ultrasonic waves, compressing the overlapping section between the ultrasonic welding head (6C) and the work support block (7C). The overlapping section vibrates, generates frictional heat therein, and is welded under compression.

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DATE OF RECEIPT <u>13 FEB 1999</u>	

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CLAIMS



1. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel having a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and the second sheet;

placing an ultrasonic welding machine with an ultrasonic welding head thereof and a work support means thereof disposed adjacent the first and second sheets, respectively;

moving the ultrasonic welding head and the work support means toward each other to bring the ultrasonic welding head and the work support means into contact with the first and the second sheet, respectively;

generating ultrasonic waves between the ultrasonic welding head and the work support means to generate internal frictional heat by ultrasonic vibration of the first and second sheets; and

compressing the first and the second sheet between the ultrasonic welding head and the work support means to weld together the first and second sheets.

2. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along end edges of the first and second sheets to melt and seam edges of the synthetic resin board continuously.

3. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along a line spaced from the end edges of the first and second sheets, and portions of the first and second sheets corresponding to the line are welded together continuously.



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Date: 13 FEB 1999



4. The thermoplastic synthetic resin panel welding method according to claim 1, wherein the ultrasonic welding head and the work support means of the ultrasonic welding machine have working surfaces of substantially the same area, respectively, the ultrasonic welding head and the work support block are disposed opposite to each other on the outer side of the first sheet and on the outer side of the second sheet, respectively, and two-dimensional portions of the first and second sheets corresponding to the ultrasonic welding head and the work support means are welded together.

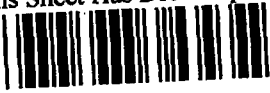
5. The thermoplastic synthetic resin panel welding method according to claim 1, wherein an opening is formed in the thermoplastic synthetic resin panel, the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along the edge of the opening, and edge portions of a first and a second sheet of the thermoplastic synthetic resin panel along the edge of the opening are welded together continuously.

6. The thermoplastic synthetic resin panel welding method according to claim 1, wherein recesses are formed in corresponding portions of the first and the second sheets, respectively, the ultrasonic welding head and the work support means of the ultrasonic welding machine are disposed along the edges of the recesses, respectively, and the edges of the first and second sheets defining the edges of the recesses are welded together continuously.

7. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a second thermoplastic synthetic resin panel of the same





construction as that of the first thermoplastic synthetic resin panel;

placing the first and the second thermoplastic synthetic resin panels one on top of the other;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on a surface of the first thermoplastic synthetic resin panel and a work support means thereof disposed on a surface of the second thermoplastic synthetic resin panel opposite to each other with respect to a line;

moving the ultrasonic welding head and the work support means toward each other to bring the first and second thermoplastic synthetic resin panels into contact with each other;

driving the ultrasonic welding head to generate frictional heat in the first and second thermoplastic synthetic resin panels by ultrasonic vibration so that portions of the first and second thermoplastic synthetic resin panels corresponding to the line are fused and welded together.

8. A method of welding together a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets, and a thermoplastic synthetic resin member, said method comprising the steps of:

preparing the thermoplastic synthetic resin panel, and the thermoplastic synthetic resin member;

putting the hollow thermoplastic synthetic resin panel and the member one on top of the other;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on a surface of the thermoplastic synthetic resin panel and a work support means thereof disposed on a surface of the thermoplastic synthetic resin member so that the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member





are held between the ultrasonic welding head and the work support means; and

driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member in contact with each other so that the thermoplastic synthetic resin panel and the member are welded together.

9. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and the second sheet, and a second thermoplastic synthetic resin panel of the same construction as that of the first hollow thermoplastic synthetic resin panel;

placing the first and second thermoplastic synthetic resin panels so that end portions thereof overlap each other and the surfaces of the overlapping end portions are in close contact with each other to form an overlapping section;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and a work support means thereof disposed on the other side of the same;

driving the ultrasonic welding head to generate frictional heat by ultrasonic vibration in the surfaces of the overlapping end portions of the first and second thermoplastic synthetic resin panels in contact with each other so that the surfaces of the overlapping end portions of the first and second thermoplastic synthetic resin panels are softened and welded together; and

compressing the first and second sheets of the overlapping portions of the first and second hollow thermoplastic synthetic resin panels in the direction of





- 37 -

their thickness by the ultrasonic welding head and the work support means to weld together the first and second thermoplastic synthetic resin panels.

10. The thermoplastic synthetic resin panel welding method according to claim 9, wherein the overlapping end portions of the first and second thermoplastic synthetic resin panels in the overlapping section are compressed between the ultrasonic welding head and the work support means to reduce the thickness of the overlapping section.

11. The thermoplastic synthetic resin panel welding method according to claim 10, wherein the thickness of the overlapping section in which the end portions of the first and second thermoplastic synthetic resin panels overlap each other is reduced to a thickness substantially equal to that of each of the first and second thermoplastic synthetic resin panels.

12. A hollow thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets;

placing opposite edge portions of the thermoplastic synthetic resin panel one on top of the other to form an overlapping section;

placing an ultrasonic welding machine with an ultrasonic welding head thereof disposed on one side of the overlapping section and a work support means thereof disposed on the other side of the overlapping section;

driving the ultrasonic welding head to generate ultrasonic waves that propagate from the ultrasonic welding head toward the work support means so that frictional heat is generated in the surfaces of the overlapping edge portions by ultrasonic vibration and the surfaces of the

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Date: 13 FEB 1999



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- 38 -

~~overlapping edge portions are softened and welded together;~~
and

~~compressing the overlapping edge portions of the thermoplastic synthetic resin panel between the ultrasonic welding head and the work support means in the direction of the thickness of the overlapping edge portions to reduce the thickness of the overlapping section to a thickness substantially equal to the thickness of the thermoplastic synthetic resin panel.~~

13. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets;

folding an end portion of the thermoplastic synthetic resin panel in layers;

holding the layers of the hollow thermoplastic synthetic resin panel between an ultrasonic welding head and an work support block of an ultrasonic welding machine;

driving the ultrasonic welding head to generate frictional heat in the layers of the thermoplastic synthetic resin panel by ultrasonic vibrations so that the layers of the thermoplastic synthetic resin panel are welded together to form an edge portion of a thickness greater than that of the thermoplastic synthetic resin panel.

14. The hollow thermoplastic synthetic resin panel welding method according to claim 13, wherein the layers are compressed to reduce the thickness thereof while the layers are being welded.

15. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel



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Date: 13 FEB 1999

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DATE OF RECEIPT 13 FEB 1999

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- ☐ Description : paged to paged
☒ Claim(s) : paged 41 to paged 52
☐ Drawing(s) : paged to paged
☐ Abstract : paged to paged

- 41

work support means of the ultrasonic welding machine in contact with portions of the surface of the first thermoplastic synthetic resin panel on the opposite sides of the second thermoplastic synthetic resin panel and with portions of the opposite surfaces of the second thermoplastic synthetic resin panel;

driving the ultrasonic welding head to generate frictional heat in portions of the first and second thermoplastic synthetic resin panels corresponding to the junction so that those positions are fused and welded together.

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~~18. A method of welding together a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, and a thermoplastic resin member, said method comprising the steps of:~~

~~preparing the thermoplastic synthetic resin panel, and the thermoplastic synthetic resin member;~~

~~placing the thermoplastic synthetic resin panel with a side edge thereof butting on the thermoplastic synthetic resin member;~~

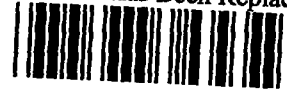
~~placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of one surface of the thermoplastic synthetic resin member adjacent the joint of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member and with a work support means of the ultrasonic welding machine in contact with a portion of the other surface of the thermoplastic synthetic resin panel adjacent the joint of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member;~~

~~driving the ultrasonic welding head to generate frictional heat in portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member~~

This is the replacement sheet



Date: 13 FEB 1999



- 42 -

~~around the joint so that these portions are fused and welded together.~~

19. A thermoplastic synthetic resin panel structure comprising a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, wherein portions of the first and second sheets along a line or a plane extending across the ribs are welded together by ultrasonic welding.

20. The thermoplastic synthetic resin panel structure according to claim 19, wherein the line extends along an end edge of the thermoplastic synthetic resin panel.

21. The thermoplastic synthetic resin panel structure according to claim 19, wherein a portion of the first sheet extending along the line is depressed toward the second sheet and welded to the second sheet by ultrasonic welding.

22. The thermoplastic synthetic resin panel structure according to claim 19, wherein portions of the first and the second sheet extending along the line are depressed toward each other and welded together by ultrasonic welding.

~~23. A thermoplastic synthetic resin panel structure comprising first and second thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining spaces between the first and second sheets; wherein the first and the second thermoplastic synthetic resin panel are disposed so that the side edge portions thereof overlap~~

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13 FEB 1999

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~~each other to form an overlapping section, portions of the first and second thermoplastic synthetic resin panels in the overlapping section are welded together by ultrasonic welding, and the overlapping section has a thickness substantially equal to a thickness of each of the first and second thermoplastic synthetic resin panels~~

24. A thermoplastic synthetic resin panel structure comprising first and second hollow thermoplastic synthetic resin panels of the same construction consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; wherein the first and second thermoplastic synthetic resin panels are disposed so that side edges thereof butt on each other, and the side edges of the first and second thermoplastic synthetic resin panels are welded together by ultrasonic welding.

~~25. The thermoplastic synthetic resin panel structure comprising:~~

~~a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; and~~

~~a thermoplastic synthetic resin member;~~

~~wherein the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member are put in contact with each other, and portions of the thermoplastic synthetic resin panel and the thermoplastic synthetic resin member in contact with each other are welded together by ultrasonic welding.~~





26. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said first and second sheets having respective end edges in parallel opposing relation and extending in a second direction crossing said first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said end edge of the first sheet (2a) and with said sloping surface portion thereof disposed inwardly of said end edge of the first sheet (2a);

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) adjacent and along the end edge of the second sheet;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support

This is the replacement sheet



Date: 13 FEB 1999



block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said end edge of the first sheet;

causing said protruding outer edge portion of the welding head to move the end edge of the first sheet toward and against the end edge of the second sheet;

causing said sloping surface portion of the welding head to move an end region of the first sheet adjacent said end edge thereof toward an end region adjacent the end edge of the second sheet, to thereby shape said end region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent the end edges of the first and second sheets to conform in shape to the sloping surface portion; and

thus joining the end edge of the first sheet to the end edge of the second sheet in a manner to form a closed end seam (8) of a converging cross-sectional shape along said end edges. (FIGS.3-6)

27. The thermoplastic synthetic resin panel welding method according to claim 26, wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam (8) is given a convex curved shape on the side of the first sheet (2a). (FIGS.3-6)

28. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and





-46-

second sheets to integrally join the first and second sheets and extending in parallel in a first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a middle nose (9) and a pair of side sloping surface portions contiguously provided on both sides of said middle nose; placing said ultrasonic welding head (6) with said end surface thereof disposed in opposition to the first sheet (2a) and with the middle nose thereof extending in a second direction crossing said first direction;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with said second sheet (2b) and in confronting relation with said end surface of the welding head;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block;

causing said middle nose (9) of the welding head to move a linear region of the first sheet along the middle nose toward and against the second sheet;

causing said sloping surface portions of the welding head to move opposite adjoining regions on both sides of said linear region of the first sheet toward the second sheet, to



This is the replacement sheet

Date: 13 FEB 1999



-47-

thereby shape said opposite adjoining regions of the first sheet to conform in shape to the sloping surface portions;

concurrently causing said sloping surface portions of the welding head to shape portions of said ribs between the welding head and the work support block to conform in shape to the sloping surface portions; and

thus joining said linear region of the first sheet to the second sheet in a manner to form a linear groove (10) in the first sheet. (FIGS.7 and 9)

29. The thermoplastic synthetic resin panel welding method according to claim 28, wherein each of said sloping surface portions of the welding head (6) has a concave curved shape so that said linear groove (10) is given side surfaces each of a convex curved shape. (FIGS.7 and 9)

30. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a middle nose (9) and a pair of side sloping surface portions contiguously provided on both sides of said middle nose, said work support surface of the work support block (7) having the same configuration as said end surface of the welding head;

placing said ultrasonic welding head (6) with said end surface thereof disposed in opposition to the first sheet (2a) and with the middle nose thereof extending in a second direction across said first direction;



This is the replacement sheet

Date: 13 FEB 1999



placing said work support block (7) with said work support surface thereof disposed in opposition to the second sheet (2b) and in confronting relation with said end surface of the welding head ;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet

in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the work support surface of said work support block;

causing the middle noze (9) of the welding head to move a linear region of the first sheet along the middle nose toward and against the second sheet;

causing said sloping surface portions of the welding head to move opposite adjoining regions on both sides of said linear region of the first sheet toward the second sheet, to thereby shape said opposite adjoining regions of the first sheet to conform in shape to the sloping surface portions of the welding head;

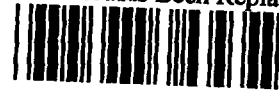
causing the middle noze of the work support block to move a linear region of the second sheet along the middle nose toward and against the first sheet;

causing the sloping surface portions of the work support block to move opposite adjoining regions on both sides of said linear region of the second sheet toward the first sheet, to thereby shape said opposite adjoining regions of the second sheet to conform in shape to the sloping surface portions of the work support block;

concurrently causing the sloping surface portions of the



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welding head and the sloping surface portions of the work support block to shape portions of said ribs between the welding head and work support block to conform in shape to the sloping surface portions of the welding head and the work support block; and

thus joining said linear regions of the first and second sheets to each other in a manner to form a linear folding line (14). (FIG.10)

31. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said synthetic resin panel (B) having an opening (16) therethrough, said opening having a first edge of the first sheet and a second edge of the second sheet;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

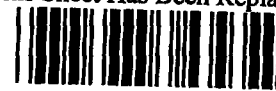
placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said



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13 FEB 1999

Date:



first edge of the opening (16) and with said sloping surface portion thereof disposed inwardly of said first edge;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) along said second edge of the opening;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said first edge of the opening;

causing said protruding outer edge portion of the welding head to move the first edge of the opening toward and against the second edge of the opening;

causing said sloping surface portion of the welding head to move a region of the first sheet adjacent said first edge toward a region of the second sheet adjacent said second edge, to thereby shape said region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent said first and second edges of the opening to conform in shape to the sloping surface portion; and

thus joining the first and second edges of the opening in a manner to form a closed end seam of a converging cross-sectional shape along said edges. (FIGS. 11 and 12)





32. The thermoplastic synthetic resin panel welding method according to claim 31, wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam is given a convex curved shape on the side of the first sheet (2a). (FIGS. 11 and 12)

33. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said synthetic resin panel (B) having a recess (17) therethrough, said recess having a first edge of the first sheet and a second edge of the second sheet;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said first edge of the recess (17) and with said sloping surface portion thereof disposed inwardly of said first edge;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) along said second edge of the opening;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to





said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said first edge of the recess;

causing said protruding outer edge portion of the welding head to move the first edge of the recess toward and against the second edge of the recess;

causing said sloping surface portion of the welding head to move a region of the first sheet adjacent said first edge toward a region of the second sheet adjacent said second edge, to thereby shape said region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent said first and second edges of the recess to conform in shape to the sloping surface portion; and

thus joining the first and second edges of the recess in a manner to form a closed end seam of a converging cross-sectional shape along said edges. (FIGS. 11 and 12)

34. The thermoplastic synthetic resin panel welding method according to claim 33, wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam is given a convex curved shape on the side of the first sheet (2a). (FIGS. 11 and 12)



01 JUL 1999

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- 42 -

~~around the joint so that these portions are fused and welded together.~~

19. A thermoplastic synthetic resin panel structure comprising a thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets, wherein portions of the first and second sheets along a line or a plane extending across the ribs are welded together by ultrasonic welding.

20. The thermoplastic synthetic resin panel structure according to claim 19, wherein the line extends along an end edge of the thermoplastic synthetic resin panel.

21. The thermoplastic synthetic resin panel structure according to claim 19, wherein a portion of the first sheet extending along the line is depressed toward the second sheet and welded to the second sheet by ultrasonic welding.

22. The thermoplastic synthetic resin panel structure according to claim 19, wherein portions of the first and the second sheet extending along the line are depressed toward each other and welded together by ultrasonic welding.

~~23. A thermoplastic synthetic resin panel structure comprising first and second thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining spaces between the first and second sheets; wherein the first and the second thermoplastic synthetic resin panel are disposed so that the side edge portions thereof overlap.~~

AMENDED SHEET

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REPLACEMENT SHEET

01 JUL 1999

- 53 -

35. A thermoplastic synthetic resin panel structure comprising a thermoplastic synthetic resin panel which includes a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs extending in parallel between, and integrally joining the first and second sheets to define a plurality of spaces between the sheets, wherein portions of the first and second sheets along a line extending across the ribs are welded together by ultrasonic welding in such a manner that at least one of the sheets are shaped in a region adjacent said line to gradually approach the other toward said line.

36. The thermoplastic synthetic resin panel structure according to claim 35, wherein said one of the sheets are shaped to approach the other in a curve.

37. The thermoplastic synthetic resin panel structure according to claim 35, wherein said line extends along an end edge of the thermoplastic synthetic resin panel.

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AMENDED SHEET

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REPLACEMENT SHEETS SG	
☐	Description : paged to paged
☒	Claim(s) : paged 33 to paged 44
☐	Drawing(s) : paged to paged
☐	Abstract : paged to paged
DATE OF RECEIPT 05 OCT 2000	

33

CLAIMS

1. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel consisting of a first sheet, a second sheet parallel to the first sheet, and ribs defining a plurality of spaces between the first and second sheets;

folding an end portion of the thermoplastic synthetic resin panel in layers;

holding the layers of the follow thermoplastic synthetic resin panel between an ultrasonic welding head and a work support block of an ultrasonic welding machine;

driving the ultrasonic welding head to generate frictional heat in the layers of the thermoplastic synthetic resin panel by ultrasonic vibrations so that the layers of the thermoplastic synthetic resin panel are welded together to form an edge portion of a thickness greater than that of the thermoplastic synthetic resin panel.

2. The hollow thermoplastic synthetic resin panel welding method according to claim 1, wherein the layers are compressed to reduce the thickness thereof while the layers are being welded.

3. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a first thermoplastic synthetic resin panel, consisting of a first sheet, a second sheet parallel to the first sheet, the ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and the second sheets, and a second thermoplastic synthetic resin panel of the same construction as that of the first thermoplastic synthetic resin panel;

disposing the first and second hollow thermoplastic synthetic resin panels with side edges thereof pressed against each other to form a butting section;



AMENDED SHEET

- 5 OCT 2000

placing an ultrasonic welding machine with an ultrasonic welding head thereof and a work support means thereof disposed opposite to each other with respect to a direction perpendicular to the thickness of the butting section on the opposite sides of the butting section, respectively;

driving the ultrasonic welding head to generate frictional heat in the end surfaces of the thermoplastic synthetic resin panels butting on each other by ultrasonic vibration so that the end surfaces of the thermoplastic synthetic resin panels butting each other are fused and welded together to connect the first and the second thermoplastic synthetic resin panels in a single thermoplastic synthetic resin panel.

4. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing first, second and third thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet and ribs integrally joining the first and the second sheet and defining a plurality of spaces between the first and the second sheets;

placing the first and second thermoplastic synthetic resin panels so as to form an edge-to-edge junction;

placing the third thermoplastic synthetic resin panel at an angle to the surfaces of the first and second thermoplastic synthetic resin panels so that its side edge butts on the edge-to-edge junction of the first and the second thermoplastic synthetic resin panels;

placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with the edge-to-edge junction of the first and second thermoplastic synthetic resin panels on a side opposite the side on which the third thermoplastic synthetic resin panel butts on the edge-to-edge junction of the first and second thermoplastic synthetic resin panels, and with a work support means of the ultrasonic welding machine in contact with a region around the junction of the first, second and third thermoplastic synthetic resin panels;

driving the ultrasonic welding head to generate frictional heat in the junction of the first, second and third



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AMENDED SHEET

- 5 OCT 2000

thermoplastic synthetic resin panels so that the portions of the first, second and third thermoplastic synthetic resin panels in the junction are fused and welded together.

5. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing first and second thermoplastic synthetic resin panels of the same construction each consisting of a first sheet, a second sheet parallel to the first sheet, and ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets;

placing the second thermoplastic synthetic resin panel at an angle to one surface of the first thermoplastic synthetic resin panel with a side edge of the second panel butting on the surface of the first thermoplastic synthetic resin panel;

placing an ultrasonic welding machine with an ultrasonic welding head thereof in contact with a portion of the other surface of the first thermoplastic synthetic resin panel corresponding to the junction of the first and second thermoplastic synthetic resin panels, and with a work support means of the ultrasonic welding machine in contact with portions of the surface of the first thermoplastic synthetic resin panel on the opposite sides of the second thermoplastic synthetic resin panel and with portions of the opposite surfaces of the second thermoplastic synthetic resin panel;

driving the ultrasonic welding head to generate frictional heat in portions of the first and second thermoplastic synthetic resin panels corresponding to the junction so that those positions are fused and welded together.

6. A thermoplastic synthetic resin panel structure comprising first and second hollow thermoplastic synthetic resin panels of the same construction consisting of a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs integrally joining the first and second sheets and defining a plurality of spaces between the first and second sheets; wherein the first and second thermoplastic synthetic resin panels are disposed so that side edges thereof butt on each other, and the



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AMENDED SHEET

- 5 OCT 2000

side edges of the first and second thermoplastic synthetic resin panels are welded together by ultrasonic welding.

7. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said first and second sheets having respective end edges in parallel opposing relation and extending in a second direction crossing said first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said end edge of the first sheet (2a) and with said sloping surface portion thereof disposed inwardly of said end edge of the first sheet (2a);

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) adjacent and along the end edge of the second sheet;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in



AMENDED SHEET

5 OCT 2000

portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said end edge of the first sheet;

causing said protruding outer edge portion of the welding head to move the end edge of the first sheet toward and against the end edge of the second sheet;

causing said sloping surface portion of the welding head to move an end region of the first sheet adjacent said end edge thereof toward an end region adjacent the end edge of the second sheet, to thereby shape said end region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent the end edges of the first and second sheets to conform in shape to the sloping surface portion; and

thus joining the end edge of the first sheet to the end edge of the second sheet in a manner to form a closed end seam (8) of a converging cross-sectional shape along said end edges (FIGS. 3-6).

8. The thermoplastic synthetic resin panel welding method according to claim 7 wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam (8) is given a convex curved shape on the side of the first sheet (2a). (FIGS. 3-6)

9. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head



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AMENDED SHEET

- 5 OCT 2000

(6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a middle nose (9) and a pair of side sloping surface portions contiguously provided on both sides of said middle nose; placing said ultrasonic welding head (6) with said end surface thereof disposed in opposition to the first sheet (2a) and with the middle nose thereof extending in a second direction crossing said first direction;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with said second sheet (2b) and in confronting relation with said end surface of the welding head;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block;

causing said middle nose (9) of the welding head to move a linear region of the first sheet along the middle nose toward and against the second sheet;

causing said sloping surface portions of the welding head to move opposite adjoining regions on both sides of said linear region of the first sheet toward the second sheet, to thereby shape said opposite adjoining regions of the first sheet to conform in shape to the sloping surface portions;

concurrently causing said sloping surface portions of the welding head to shape portions of said ribs between the welding head and the work support block to conform in shape to the sloping surface portions; and



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AMENDED SHEET

- 5 OCT 2000

thus joining said linear region of the first sheet to the second sheet in a manner to form a linear groove (10) in the first sheet. (FIGS. 7 and 9)

10. The thermoplastic synthetic resin panel welding method according to claim 9 wherein each of said sloping surface portions of the welding head (6) has a concave curved shape so that said linear groove (10) is given side surfaces each of a convex curved shape. (FIGS. 7 and 9)

11. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a middle nose (9) and a pair of side sloping surface portions contiguously provided on both sides of said middle nose, said work support surface of the work support block (7) having the same configuration as said end surface of the welding head;

placing said ultrasonic welding head (6) with said end surface thereof disposed in opposition to the first sheet (2a) and with the middle nose thereof extending in a second direction across said first direction;

placing said work support block (7) with said work support surface thereof disposed in opposition to the second sheet (2b) and in confronting relation with said end surface of the welding head;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;



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AMENDED SHEET

- 5 OCT 2000

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the work support surface of said work support block;

causing the middle nose(9) of the welding head to move a linear region of the first sheet along the middle nose toward and against the second sheet;

causing said sloping surface portions of the welding head to move opposite adjoining regions on both sides of said linear region of the first sheet toward the second sheet, to thereby shape said opposite adjoining regions of the first sheet to conform in shape to the sloping surface portions of the welding head;

causing the middle nose of the work support block to move a linear region of the second sheet along the middle nose toward and against the first sheet;

causing the sloping surface portions of the work support block to move opposite adjoining regions on both sides of said linear region of the second sheet toward the first sheet, to thereby shape said opposite adjoining regions of the second sheet to conform in shape to the sloping surface portions of the work support block;

concurrently causing the sloping surface portions of the welding head and the sloping surface portions of the work support block to shape portions of said ribs between the welding head and work support block to conform in shape to the sloping surface portions of the welding head and the work support block; and

thus joining said linear regions of the first and second sheets to each other in a manner to form a linear folding line (14). (FIG. 10)

12. A thermoplastic synthetic resin panel welding method



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AMENDED SHEET

- 5 OCT 2000

comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said synthetic resin panel (B) having an opening (16) therethrough, said opening having a first edge of the first sheet and a second edge of the second sheet;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said first edge of the opening (16) and with said sloping surface portion thereof disposed inwardly of said first edge;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) along said second edge of the opening;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

compressing the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said first



AMENDED SHEET

5 OCT 2000

edge of the opening;

causing said protruding outer edge portion of the welding head to move the first edge of the opening toward and against the second edge of the opening;

causing said sloping surface portion of the welding head to move a region of the first sheet adjacent said first edge toward a region of the second sheet adjacent said second edge, to thereby shape said region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent said first and second edges of the opening to conform in shape to the sloping surface portion; and

thus joining the first and second edges of the opening in a manner to form a closed end seam of a converging cross-sectional shape along said edges. (FIGS. 11 and 12)

13. The thermoplastic synthetic resin panel welding method according to claim 31, wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam is given a convex curved shape on the side of the first sheet (2a). (FIGS. 11 and 12)

14. A thermoplastic synthetic resin panel welding method comprising the steps of:

preparing a hollow thermoplastic synthetic resin panel (B) having a first sheet (2a), a second sheet (2b) parallel to the first sheet, and ribs (4) interposed between the first and second sheets to integrally join the first and second sheets and extending in parallel in a first direction, said synthetic resin panel (B) having a recess (17) therethrough, said recess having a first edge of the first sheet and a second edge of the second sheet;

providing an ultrasonic welding machine with an ultrasonic welding head (6) and a work support block (7), said welding head (6) having an end surface and said work support block (7) having a flat work support surface cooperable with said end surface of the welding head (6), said end surface of the welding head



AMENDED SHEET

5 OCT 2000

having a protruding outer edge portion and a sloping surface portion contiguously provided adjacent said outer edge portion;

placing said ultrasonic welding head (6) with said outer edge portion thereof disposed in opposition to and along said first edge of the recess (17) and with said sloping surface portion thereof disposed inwardly of said first edge;

placing said work support block (7) with said flat work support surface thereof disposed in a face-to-face relation with a portion of said second sheet (2b) along said second edge of the opening;

moving said welding head (6) and said work support block (7) toward each other to bring the welding head and the work support block into contact with the first and second sheets, respectively;

generating ultrasonic waves from said welding head (6) to said work support block (7) through said first sheet (2a), said ribs (4) and said second sheet (2b) to said work support block (7) to generate internal frictional heat by ultrasonic vibration so as to melt the first sheet, the ribs and the second sheet in portions thereof in which ultrasonic waves are generated;

comprising the first and second sheets between the end surface of said welding head (6) and the flat work support surface of said work support block with said protruding outer edge portion of the welding head abutting against said first edge of the recess;

causing said protruding outer edge portion of the welding head to move the first edge of the recess toward and against the second edge of the recess;

causing said sloping surface portion of the welding head to move a region of the first sheet adjacent said first edge toward a region of the second sheet adjacent said second edge, to thereby shape said region of the first sheet to conform in shape to the sloping surface portion;

concurrently causing said sloping surface portion of the welding head to shape portions of said ribs adjacent said first and second edges of the recess to conform in shape to the sloping surface portion; and

thus joining the first and second edges of the recess in a

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5 OCT 2000

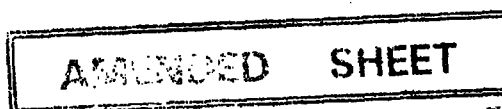
manner to form a closed end seam of a converging cross-sectional shape along said edges. (FIGS. 11 and 12)

15. The thermoplastic synthetic resin panel welding method according to claim 14, wherein said sloping surface portion of the welding head (6) has a concave curved shape so that said closed end seam is given a convex curved shape on the side of the first sheet (2a). (FIGS. 11 and 12)

16. A thermoplastic synthetic resin panel structure comprising a thermoplastic synthetic resin panel which includes a first sheet, a second sheet parallel to the first sheet, and a plurality of ribs extending in parallel between, and integrally joining the first and second sheets to define a plurality of spaces between the sheets, wherein portions of the first and second sheets along a line extending across the ribs are welded together by ultrasonic welding in such a manner that at least one of the sheets are shaped in a region adjacent said line to gradually approach the other toward said line.

17. The thermoplastic synthetic resin panel structure accordingly to claim 16, wherein said one of the sheets are shaped to approach the other in a curve.

18. The thermoplastic synthetic resin panel structure according to claim 16, wherein said line extends along an end edge of the thermoplastic synthetic resin panel.



25 OCT 2000



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特許協力条約に基づいて公開された国際出願

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(21) 国際出願番号 PCT/JP96/03318 (22) 国際出願日 1996年11月12日(12.11.96) (30) 優先権データ 特願平7/319488 1995年11月14日(14.11.95) JP 特願平7/331012 1995年11月27日(27.11.95) JP 特願平7/349698 1995年12月21日(21.12.95) JP (71) 出願人 (米国を除くすべての指定国について) 岸本産業株式会社(KISHIMOTO SANGYO CO., LTD.)(JP/JP) 〒541 大阪府大阪市中央区伏見町三丁目3番7号 Osaka, (JP) 株式会社 ユニテク(UNITEK CO., LTD.)(JP/JP) 〒335 埼玉県戸田市新柏南二丁目13番25号 Saitama, (JP) (72) 発明者：および (75) 発明者／出願人 (米国についてのみ) 齋藤 健(SAITOH, Tsuyoshi)(JP/JP) 〒336 埼玉県浦和市領家一丁目16番16号 Saitama, (JP) 萩原健次郎(HAGIWARA, Kenjiro)(JP/JP) 〒189 東京都東大和市向原四丁目6番20号 Tokyo, (JP) 佐々木恒(SASAKI, Hisashi)(JP/JP) 〒333 埼玉県川口市戸塚鉄町13-3 Saitama, (JP)		(74) 代理人 弁理士 佐藤一雄, 外(SATO, Kazuo et al.) 〒100 東京都千代田区丸の内三丁目2番3号 富士ビル323号 協和特許法律事務所 Tokyo, (JP) (81) 指定国 CN, KR, SG, US, 欧州特許 (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). 添付公開書類 国際調査報告書
(54)Title: METHOD OF FUSING HOLLOW BOARD OF SYNTHETIC RESIN AND HOLLOW BOARD OBTAINED BY SAME (54)発明の名称 合成樹脂製中空ボードの融着方法およびその方法により得られる中空ボード (57) Abstract An ultrasonic fusion apparatus is used for joining of a unitary thermoplastic resin extruded board (B), in which a first sheet (2a) and a second sheet (2b) are connected to each other through a multiplicity of parallel webs (3). In order to fuse the first sheet (2a) and the second sheet (2b) to each other in a linear or surface-like manner, an ultrasonic oscillation unit (6) of the ultrasonic fusion apparatus is made to abut against a surface of the first sheet (2a), and a seat portion (7) is made to abut against a surface of the second sheet (2b), so that the board (B) is pressed between the oscillation unit (6) and the seat portion (7). In order to join boards (B1, B2) to each other, both boards are made to at least partially overlap each other, ultrasonic waves are generated while an oscillation unit (6C) and a seat portion (7C) press both sides of both boards. Ultrasonic waves cause internal oscillation in the boards, and friction due to the oscillation generates heat from inside, so that fusion is effected by the fusing and the pressing forces.		

(57) 要約

第1シート(2a)および第2シート(2b)を平行をなす多数のウェブ(3)を介して連結した熱可塑性樹脂一体押出しボード(B)を接合するために、超音波融着装置が用いられる。第1シート(2a)および第2シート(2b)を線状または面状に互いに融着するには、第1シート(2a)の面に超音波融着装置の超音波発振部(6)が当接され、第2シート(2b)の面に受座部(7)が当接されてボード(B)は発振部(6)と受座部(7)の間で押圧される。ボード(B1, B2)同士を接合するには、両ボードを少くとも部分的に重合させて、両ボードの両側から発振部(6C)と受座部(7C)を押圧しながら超音波を発振させる。超音波はボードに内部振動を生起させ、振動による摩擦により内部から発熱が生じ、溶融と押圧力によって融着がなされる。

情報としての用途のみ

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