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Bowser et al.

[11] **3,886,013**

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[54] **PIVOTED ARM DEVICE FOR ASSEMBLY OF MULTIPLE GLAZED UNITS**

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[73] Assignee: **PPG Industries, Inc.,** Pittsburgh, Pa.

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[52] **U.S. Cl.** **156/109;** 156/201; 156/202; 156/292; 156/468; 156/577

[51] **Int. Cl.** **B32b 31/04;** E06b 3/66

[58] **Field of Search** 156/109, 201, 202, 292, 156/391, 459, 468, 486, 553, 574, 577

[56] **References Cited**

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2,269,621	1/1942	Davis et al.	156/468
2,549,136	4/1951	Simpson et al.	156/468
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3,669,785	6/1972	Bowser et al.	156/109
3,733,237	5/1973	Wolff	156/109

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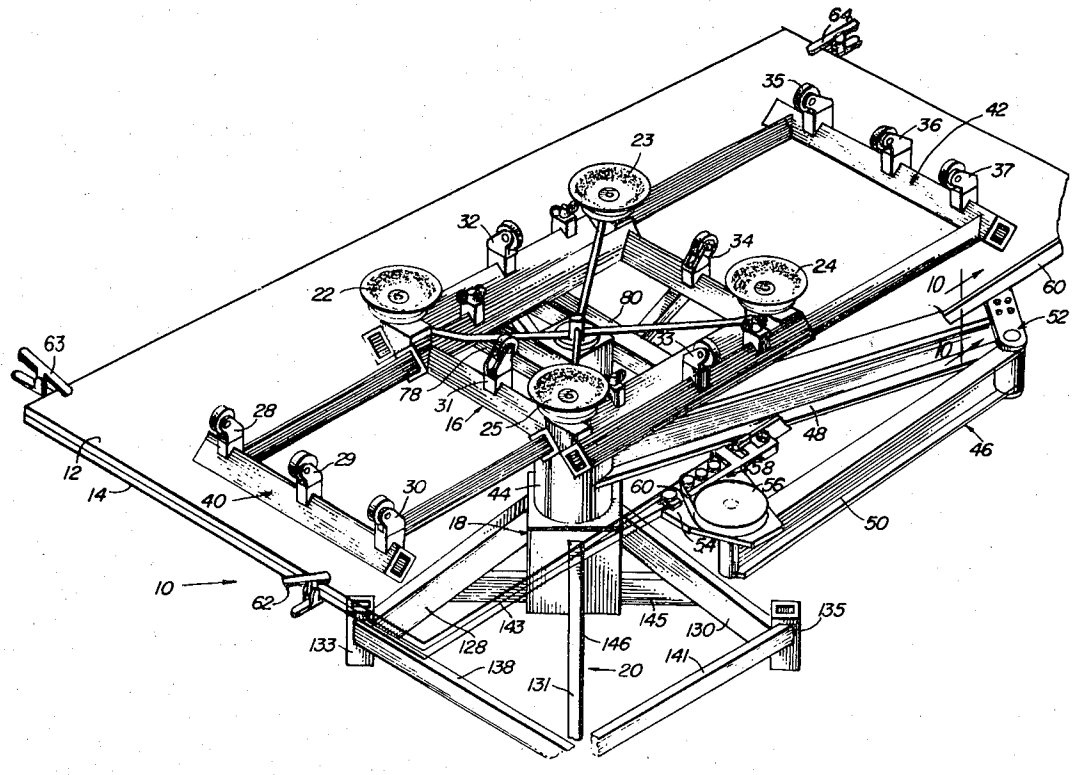
Primary Examiner—Daniel J. Fritsch
Attorney, Agent, or Firm—Thomas F. Shanahan

[57] **ABSTRACT**

An improved multiple glazed window unit and an improved method and apparatus for fabricating hermetically sealed glazing units are disclosed. The glazing units comprise a pair of spaced glass sheets separated at their marginal edges by a flexible spacer and surrounded about the perimeter by a sealant and a cover of flexible or non-rigid tape. The flexible cover tape and sealant are preassembled with the spacer into a unitary composite strip. During fabrication of a unit, the portions of the cover tape overlying the spacer are longitudinally recessed or indented relative to the lateral portions of the tape which overlie the glass sheet edges. In accordance with the preferred apparatus of this invention, the composite strip is installed by an apparatus which comprises a table for supporting the glass sheets, means for securing the glass on the table, means for holding the sheets together, means for installing the spacer, sealant and cover tape strip, and support means including a pivoted arm for supporting the inserter apparatus adjacent the edges of the glass for movement therealong.

1 Claim, 10 Drawing Figures



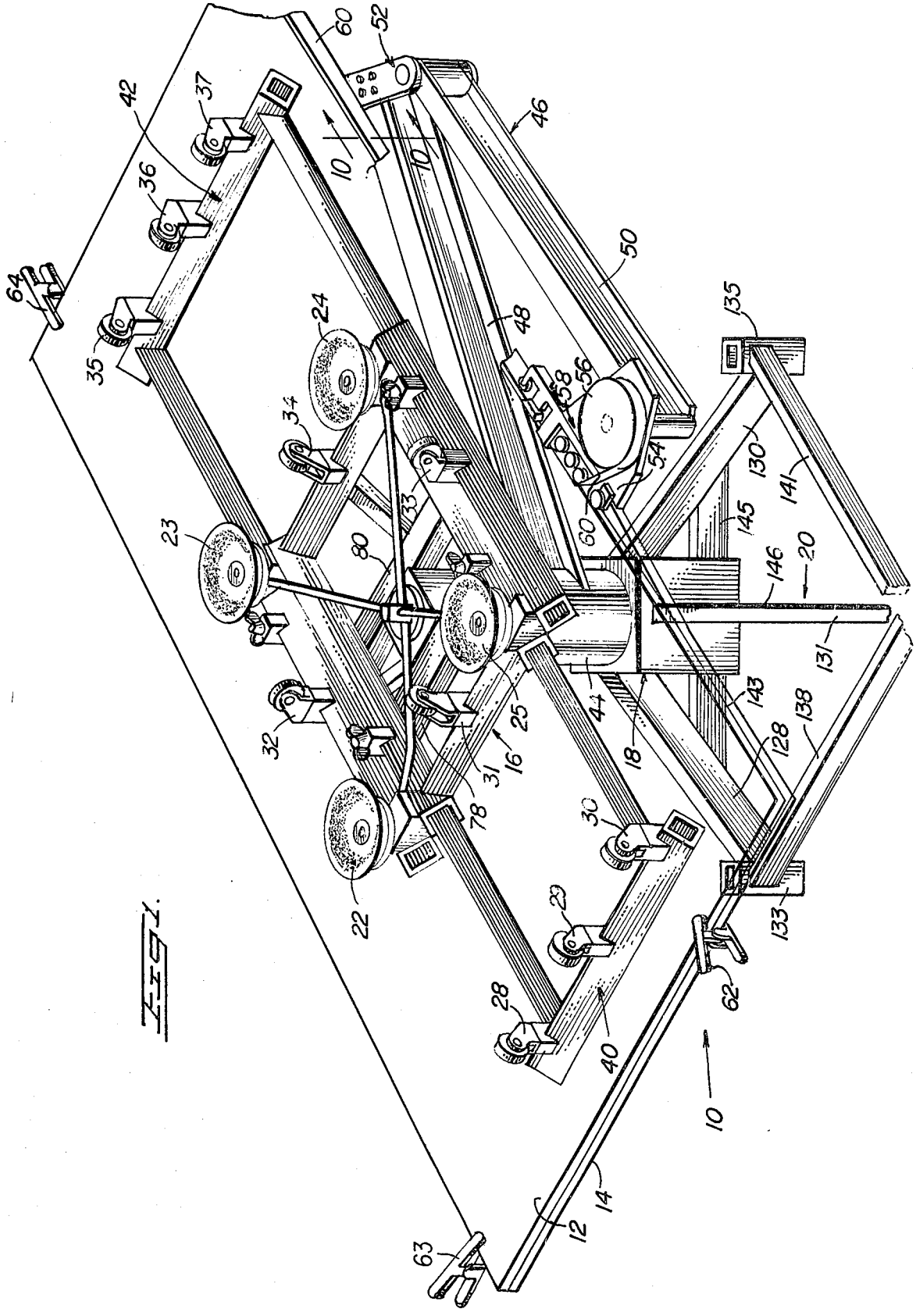

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FIG 1.

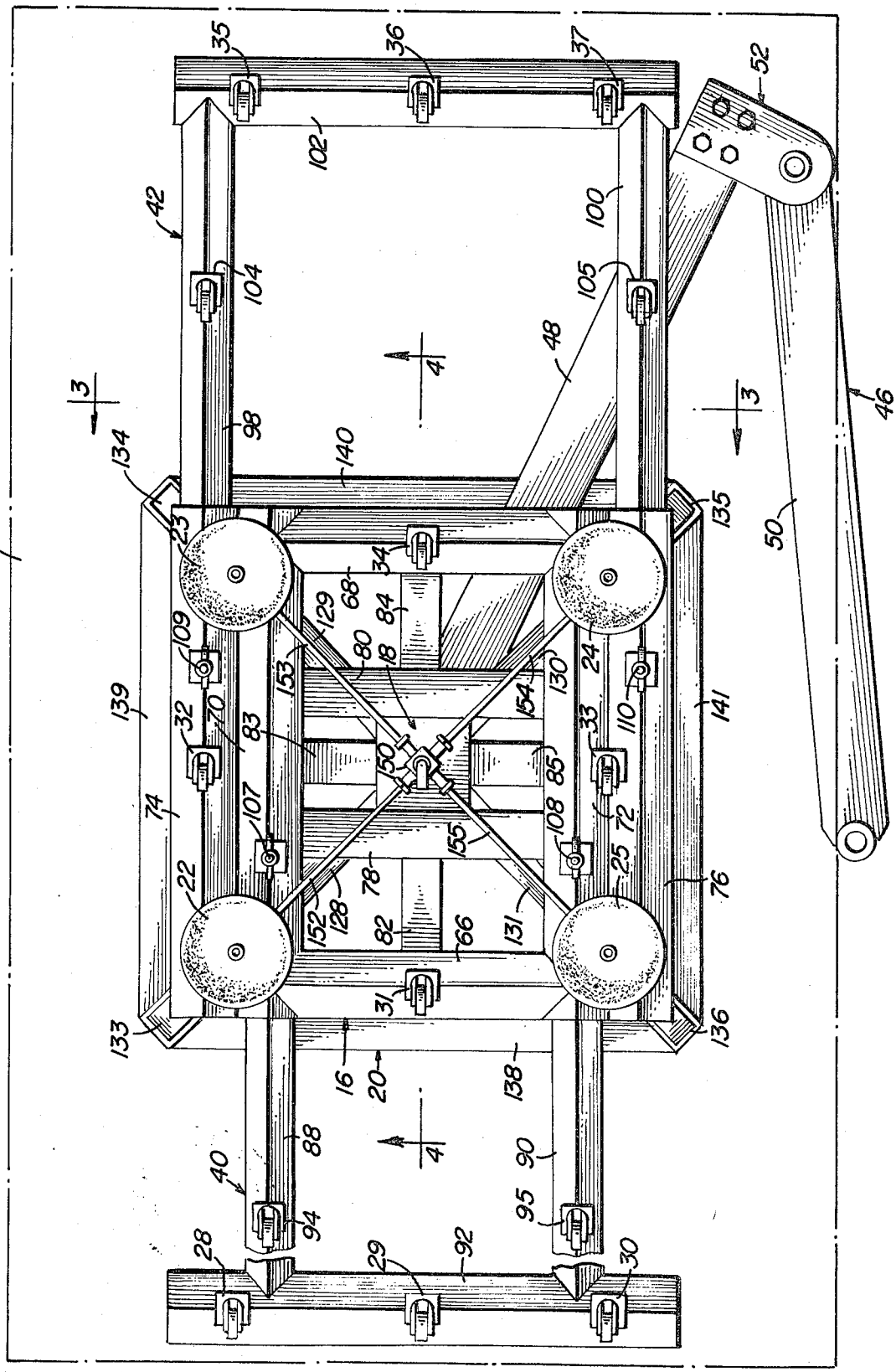
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FIG 2.

Fig 3.

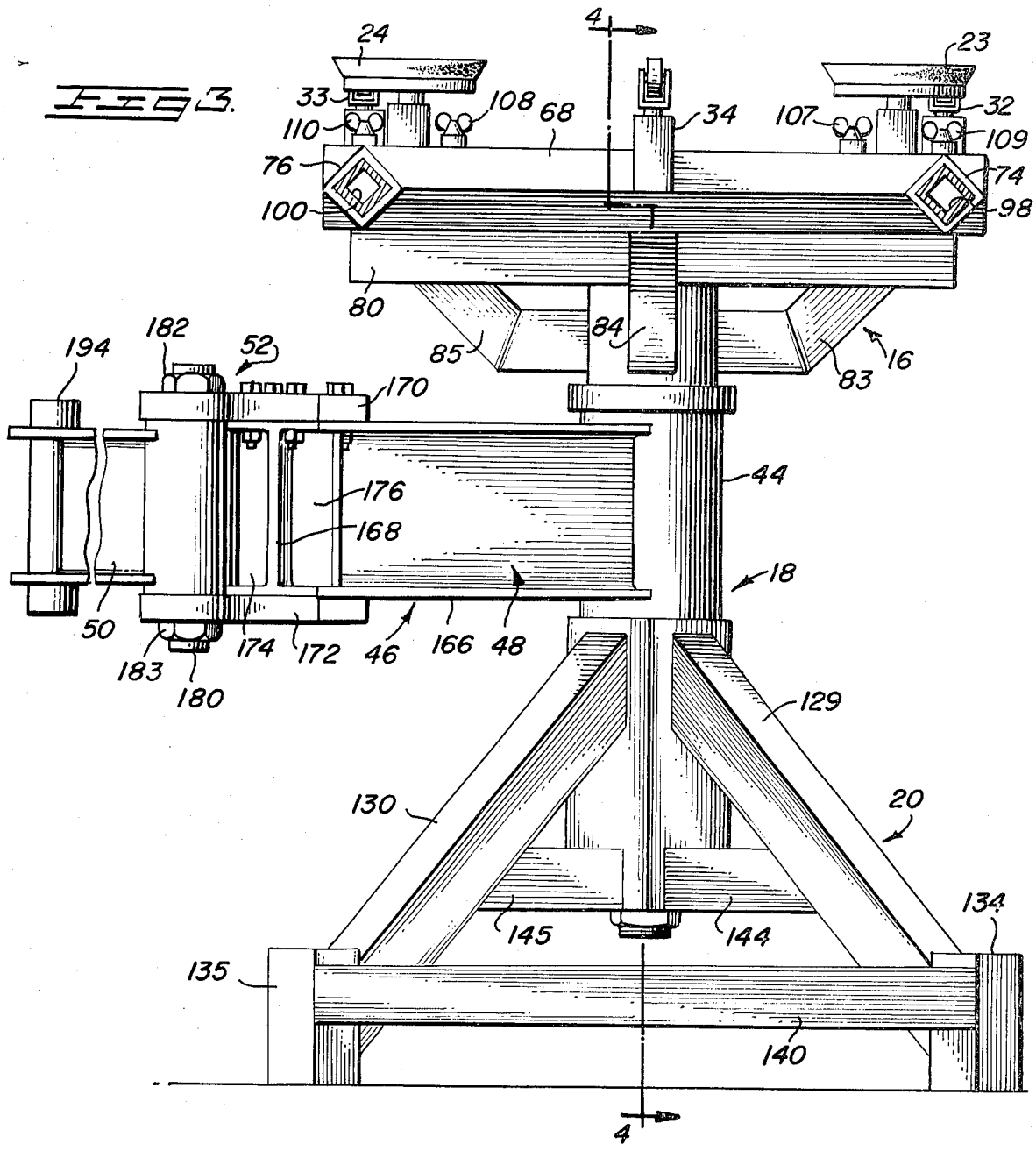
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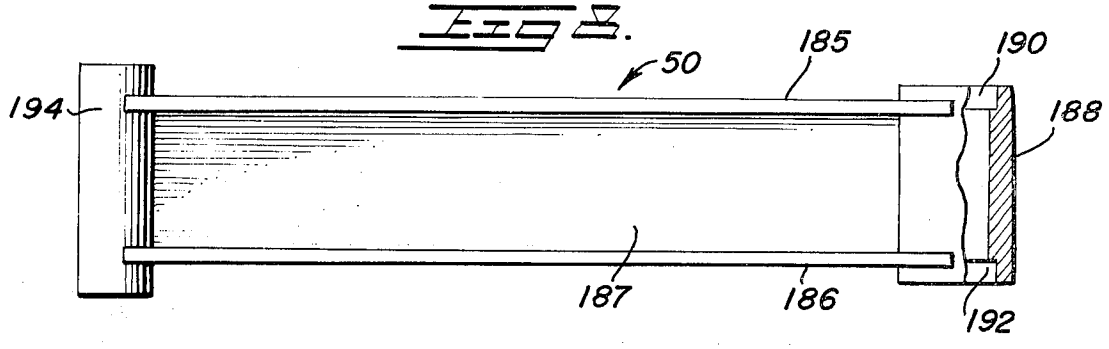
Fig 8.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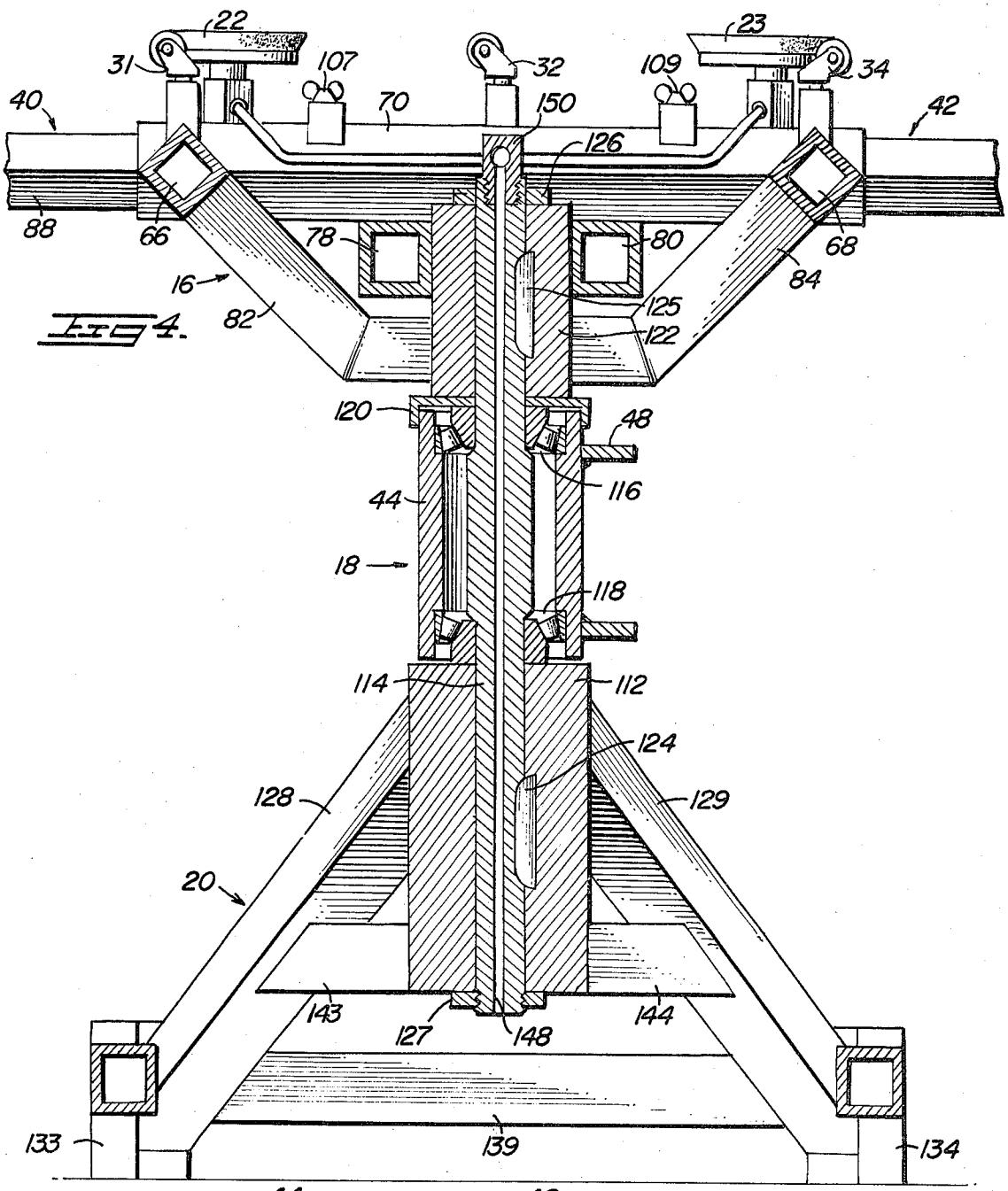

Fig 4.

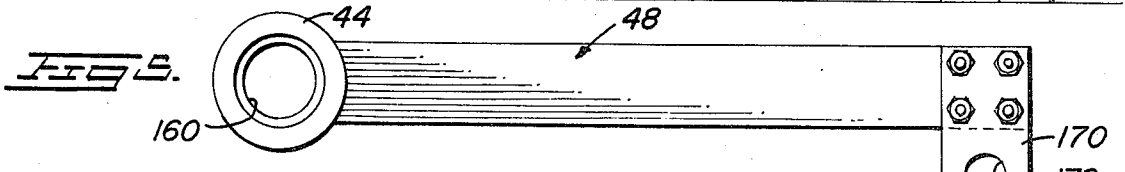

Fig 5.

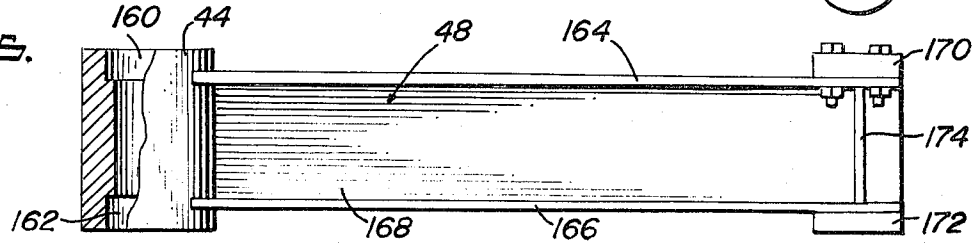

Fig 6.

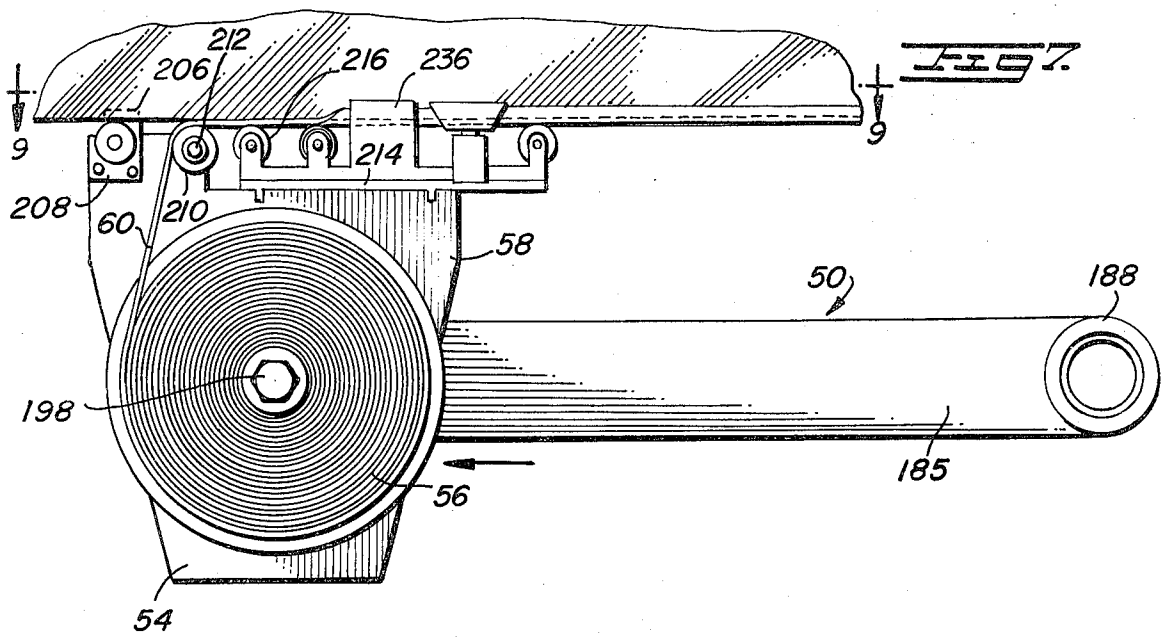

Fig 7.

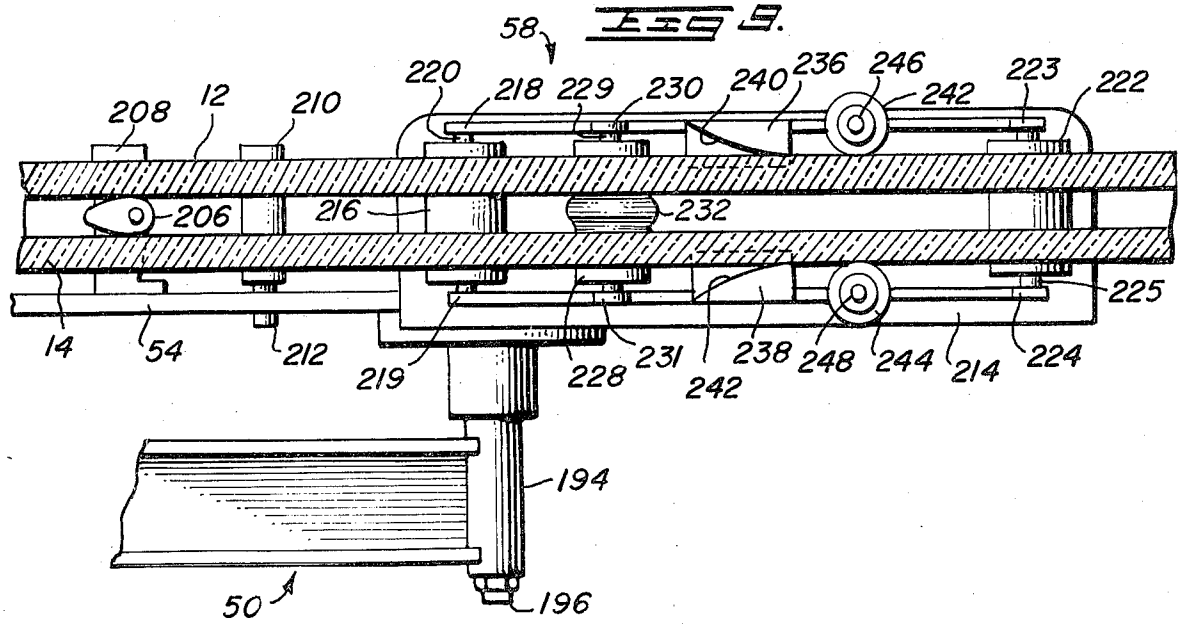

Fig 9.

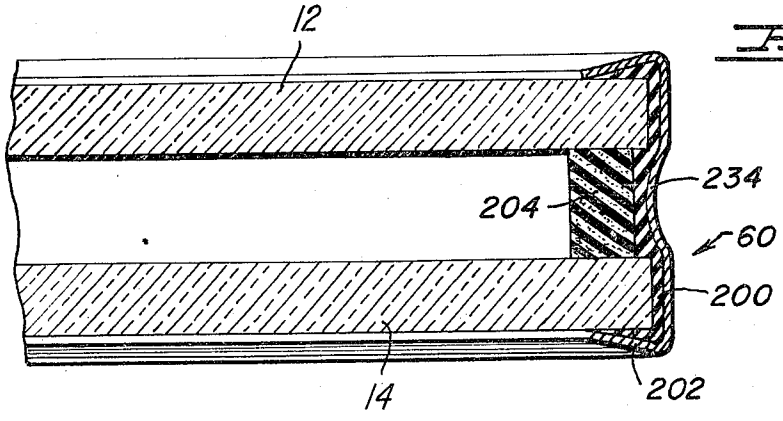

Fig 10.

PIVOTED ARM DEVICE FOR ASSEMBLY OF MULTIPLE GLAZED UNITS

BACKGROUND OF THE INVENTION

The present invention relates, in general, to hermetically sealed multiple glazed window units, and more particularly to an improved method and apparatus for fabricating such units.

In the manufacture of multiple glazed window units, which generally consist of two or more sheets of glass spaced from one another to provide an insulating air space between the sheets, it has been found that the glass sheets can be spaced at their marginal edges by a flexible organic spacer element and surrounded about the perimeter by a deformable sealant covered with a flexible or non-rigid tape. This composite spacer, sealer and cover tape element comprises an elongated strip of mastic sealant material having a flexible cover tape or the like adhered to one surface and a resilient organic spacer-dehydrator adhered to the opposite surface. Such composite strips have been used in place of the metallic spacers previously used in multiple glazed window units, are known in the art, and are described in more detail in copending application Ser. No. 325,464 of George H. Bowser, filed Jan. 22, 1973 and entitled "Dehydrator Element", and in copending application Ser. No. 232,411 of George H. Bowser, filed Mar. 7, 1972 and entitled "Multiple Glazed Unit",now U.S. Pat. No. 3,791,910, both of which are assigned to the assignee of the present application. In addition, U.S. Pat. No. 3,669,785 to Bowser et al. discloses a suitable packaging arrangement for composite hermetic sealant, spacer-dehydrator elements of this type.

As described in the aforementioned applications and patent, and as further described in U.S. Pat. No. 3,733,237 to Bernhard B. Wolff, also assigned to the assignee of the present application, the window units are assembled by supporting in a horizontal, opposed, spaced relationship a pair of cleaned glass sheets that have been precut to substantially the same size. Temporary spacers are placed between the sheets around the marginal edges thereof to provide the desired distance between them, and a 45° cut or mitre is made at a free end of the flexible spacer-dehydrator composite strip. The strip is applied manually to the glass by inserting the spacer-dehydrator portion of the strip between the contiguous peripheral marginal edge portions of the glass sheets, while removing the temporary spacers, with the lateral edges of the wider sealant portion being manually pressed against the edge surfaces of the sheets. At square corners a tool is used to remove a notch from the spacer-dehydrator portion of the strip, and at the final joint a cut is made through the composite element to provide a second 45° mitred surface which matches the surface produced by the initial cut. Thereafter, a finishing tool is used to press the spacer-dehydrator portion of the strip between the edges of the glass sheets. This tool also presses and folds the lateral edge surfaces of the sealant and cover tape against the edges of the glass sheets and over its upper and lower marginal surface portions, causing the sealant to flow out and provide the desired hermetic seal. For this purpose, the finishing tool is provided with a rotatable, laterally adjustable, nylon pressing and indenting roll, which has an annular, semi-cylindrical indenting rib to produce a longitudinally extending recess in the tape in the area of the spacer-dehydrator portion. In addition,

the finishing tool includes a pair of laterally adjustable folding slides which serve to fold the lateral edges of the flexible tape and sealant over the marginal surface portions of the glass sheets. The apparatus also includes an opposed pair of conically shaped pressing rolls which cooperate with the folding slides to press the folded tape and sealant to the final desired shape and appearance.

Although the prior art methods and apparatus for assembling window units described above generally produce a satisfactory unit, nevertheless some difficulties have been encountered in obtaining uniform high-quality results.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved method and apparatus for inserting and finishing a spacer-dehydrator and sealant composite strip between and around the peripheral edges of two adjacent aligned glass sheets to form in a single step a multiple glazed window unit.

It is a further object of the present invention to provide a method and apparatus for manufacturing multiple glazed window units which includes improved means for securing the glass sheets in proper alignment and then in a single operation inserting and finishing a composite spacer-dehydrator element.

It is another object of the present invention to provide in an apparatus for manufacturing multiple glazed window units a supporting means for moveably positioning an assembly tool adjacent the edges of the glass sheets to permit a single step assembly of the window units.

It is a further object of the present invention to provide a moveable support platform adapted to carry a supply of spacer-dehydrator composite strip for insertion between the edges of glass sheets and to further carry an assembly tool for installing and finishing the composite element to form a hermetically sealed multiple glazed window unit.

Briefly, and in accordance with the present invention, an assembly table is provided which is adjustable to define a horizontal work surface on which is supported two horizontal sheets of glass, one on top of the other. The peripheral edges of the two sheets are aligned, the bottom sheet is held in position on the table by means of vacuum cups, and at one corner the two sheets are separated by a single temporary spacer element which defines the distance, or air space thickness, that is to be between the two sheets. The remaining three corners of the glass sheets are clamped together to maintain proper alignment while the composite strip is applied between and to the edges of the two sheets.

A suitable assembly tool and a supply of the composite strip material are carried on a platform which is carried by a moveable support such as an articulated arm pivotally attached to the table so that the platform is moveable around the periphery of the glass sheets. In assembling the window unit, the leading edge of the strip is inserted between the sheets at the location of the temporary spacer. A spacer wedge located at the leading end of the assembly tool also is inserted between the sheets and serves to open the glass to the desired spacing as the tool is moved along the edges of the glass. The assembly tool includes a feed roller, which leads the composite strip from the supply roll to the

edge of the glass sheets so that the dehydrator-spacer element is fed into the space between the sheets provided by the guide wedge. A leading guide roll on the tool presses the sealer and cover tape portion of the composite strip against the edge of the glass, and a pressing and indenting roll urges the composite element into the space between the glass sheets and produces an elongated indentation around the periphery of the window unit. To finish the edge seal, the assembly tool also incorporates a pair of opposed folding slides, one located adjacent and above the marginal surface of the upper glass sheet and the other located adjacent and below the lower surface of the bottom glass sheet, which slides serve to fold the lateral edges of the flexible tape onto the corresponding marginal edges of the glass. Adjacent the folding slides are corresponding upper and lower conical pressing rolls which press the edges of the tape firmly in place and preferably provide a sloping chamfer to the edge portions of the folded over tape and sealant to provide a finished appearance. A final guide roller is provided to insure that the various elements of the inserter and finisher tool are maintained in their proper position with respect to the edges of the glass sheets during the foregoing operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional objects, features and advantages of the invention will become more apparent from a consideration of the following detailed description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a perspective view of the assembly apparatus of the present invention, showing an assembly table carrying sheets of glass, and a pivoted arm carrying an assembly tool;

FIG. **2** is a top plan view of the apparatus of FIG. **1**, with the assembly tool and its support platform removed;

FIG. **3** is an end view in partial section taken along lines **3**—**3** of FIG. **2**;

FIG. **4** is a partial sectional side view taken along lines **4**—**4** of FIG. **3**;

FIGS. **5** and **6** are top and side views, respectively, of the inner portion of the pivoted arm of FIG. **1**;

FIGS. **7** and **8** are top and side views, respectively, of the outer portion of the pivoted arm of FIG. **1**, with FIG. **7** also showing in top plan view the assembly tool of FIG. **1**;

FIG. **9** is an end view of the assembly tool viewed from lines **9**—**9** of FIG. **7** and showing its relationship to the glass plates; and

FIG. **10** is a cross-section view of the edge of the assembled window unit, taken along line **10**—**10** of FIG. **1**.

DESCRIPTION OF A PREFERRED EMBODIMENT

Turning now to a more detailed consideration of the apparatus of the present invention, there is illustrated in FIG. **1** an assembly table **10** adapted to receive and support upper and lower glass sheets **12** and **14** which are to be used in the fabrication of a hermetically sealed glazing unit. The assembly table incorporates a top frame portion generally indicated at **16**, a vertical support post portion generally indicated at **18**, and a lower frame portion generally indicated at **20** which comprises the support legs for the assembly table.

Securing means such as vacuum cups **22** through **25** are carried by the top frame portion and are operable to hold the lower glass sheet **14** in position on the table. To facilitate handling of the glass, a plurality of casters **28** through **37** are mounted on the assembly table to define a work surface and to provide the contact point between the table and the glass. The casters are mounted on suitable swivels and include rollers to allow the glass to be moved into position on the work surface, while the vacuum cups may be activated to secure the lower sheet once it is properly aligned. To accommodate various sizes of glass, the top frame portion **16** incorporates a pair of extension frames **40** and **42** which telescope into the main frame portion **16** and may be extended outwardly to accommodate large sheets of glass.

Connected to the vertical support post **18** by means of a suitable bearing sleeve **44** is a tool support device such as the articulated support arm **46** which is comprised of a primary or pivot arm **48** connected at one end to the bearing sleeve for rotation about the vertical support post and a secondary arm **50** pivotally connected to the other end of the primary arm at an elbow joint **52.** Pivotally attached to the outermost end of the articulated arm is a support platform **54** on which is carried the supply of composite strip material in the form of a reel or roll **56.** Also secured to the support platform is the assembly tool generally indicated at **58** for inserting and finishing the composite strip **60.**

As generally illustrated in FIG. **1,** during assembly of the window units, the top and bottom sheets **12** and **14** are secured in alignment by a plurality of spring clamps **62, 63** and **64** and the two sheets are in turn held in position on the assembly table by the vacuum cups **22** through **25.** The assembly tool **58** may then be drawn along the edges of the glass, forcing the sheets of glass apart and inserting and finishing the composite strip in a single action so that the unit can be completed in a single pass around the perimeter of the glass sheets.

A preferred embodiment of the structure of the assembly table **10** is illustrated in greater detail in FIGS. **2, 3** and **4,** wherein common elements are identified by the same number. As illustrated the top frame portion **16** of the assembly table comprises a pair of spaced transverse frame members, or tubes, **66** and **68** secured at their ends to a first pair of longitudinally extending frame members or tubes **70** and **72,** the tubes **66, 68,** 70 and **72** forming a rectangular framework for the table. The frame members may be square in cross-section, as seen in FIG. **4,** and at least tubes **70** and **72** have hollow centers to accommodate one of the extension frames to be described. Secured to the outer edges of tubes **70** and **72,** respectively, is a second pair of longitudinally extending frame members **74** and **76,** which serve as supports for the other of the extension frames. The longitudinal frame members are supported on and secured as by welding to the outer ends of a pair of cross-beams **78** and **80** which are in turn welded or otherwise affixed to the vertical support post **18.** Additional support for the top frame is provided by four support arms **82, 83, 84** and **85,** which are secured at their lower, or inner, ends to the vertical support post **18** and at their outer, or upper, ends to the horizontal frame members **66, 74, 68** and **76,** respectively. The various tubular frame members preferably are of aluminum or other suitable metal.

The extension frames **40** and **42** are adapted to be adjustably supported on the horizontal rectangular framework of the top portion **16** and serve to provide extensions of that framework so as to define a horizontal support surface of adjustable size for receiving glass sheets of various dimensions. As illustrated in FIG. **2**, the extension frame **40** comprises a pair of longitudinal extension arms **88** and **90** and a transverse support bar **92**, all constructed of aluminum or like tubing having a square cross-section. The outer dimensions of the extension arms **88** and **90** are slightly smaller than the inner dimensions of the longitudinally extending frame members **70** and **72** and are adapted to be telescoped into the frame members for longitudinal adjustment of the location of the support bar **92**. If desired, additional casters **94** and **95** may be located on the extension arms or provide support for the glass sheets when the extension arms **88** and **90** are extended. In similar manner, the extension frame **42** comprises a pair of longitudinal extension arms **98** and **100** secured at their outer ends to a transverse support bar **102**. The extension arms **98** and **100** are dimensioned to telescope into the outer pair of longitudinally extending frame members **74** and **76**. Again, provision may be made for additional casters **104** and **105** for use when the extension frame **42** is extended, and, as will be seen in FIGS. **3** and **4**, the vacuum cups **22** through **25** and the casters **28** through **37**, **94**, **95**, **104** and **105** extend equal distances above the top frame portion **16** to define a horizontal plane, which is the support surface on which the glass sheets rest.

Wing bolts **107** through **110** are provided in the frame members **70**, **72**, **74** and **76**, respectively, to secure the extensions **40** and **42** in the top frame portion **16**. The wing bolts extend through suitable threaded apertures in their respective frame members and abut the telescopic extension arms to secure them against undesired longitudinal movement.

The vertical support post **18**, as best illlustrated in FIG. **4**, comprises a base element **112**, to which the lower frame portion **20** is secured, and a main pivot shaft **114** extending through and supported by the base element. The bearing sleeve **44** is located on shaft **114** immediately above the base element **112** and includes upper and lower bearings **116** and **118** by means of which the sleeve is supported on and may be rotated about shaft **114**. The lower end of the bearing sleeve rests on the upper surface of base element **112**, while the upper end of the bearing sleeve is closed by a sealer cup **120** which prevents grease from being forced out of the bearings. Mounted on shaft **114** immediately above the bearing sleeve is an upper support member **122** to which the top frame portion of the assembly table is secured. The main pivot shaft **114** is keyed to the base element **112** and to the upper support member **122** by means of keys **124** and **125**, respectively, so that the top frame portion remains aligned with the lower frame portion. It will be noted that the support assembly **18** is secured together by means of self-locking bearing nuts **126** and **127** at the top and bottom of the shaft.

The lower frame portion **20** of the assembly table comprises four legs **128** through **131** secured at their upper ends to the base element **112**, and extending outwardly and downwardly to corresponding support feet **133** through **136**. The feet are tied together by means of stringers **138** through **141**, while the legs are tied to the base element **112** by means of the tie bars **143** through **146**. If desired, the support feet **133** through **136** may be provided with threaded extension feet for adjusting the table in the event it is placed on an uneven floor surface so that the work surface defined by the top frame portion can be maintained horizontal.

In order to secure a sheet of glass to the assembly table, a vacuum must be drawn on the vacuum cups **22** through **25**. This is accomplished in the present embodiment by way of an axially drilled passageway **148** extending through the main pivot shaft **114**. The passageway may be internally tapped at the lower end to receive a suitable vacuum fitting leading to a vacuum pump (not shown) while the upper end of the shaft is internally threaded to receive a fourway fitting **150** to which four vacuum lines **152** through **155** are connected. These vacuum lines lead from a common vacuum chamber within fitting **150** to the vacuum cups **22** through **25**, respectively, whereby a vacuum may be drawn in each of the cups by the vacuum pump connected to the lower end of pivot shaft **114**.

As illustrated in FIG. **3** and in further detail in FIGS. **5** through **8**, the articulated support arm **46** comprises a primary or pivot arm **48** secured to and supported by the bearing sleeve **44**. The sleeve is adapted to be positioned around the pivot shaft **114** and includes upper and lower annular channels **160** and **162**, which are adapted to receive the upper and lower bearing assemblies **116** and **118**, whereby the primary arm may be pivotally supported on the pivot shaft. The primary arm preferably is an aluminum I-beam having upper and lower flanges **164** and **166** (see FIG. **6**) and a central web portion **168**, as is conventional.

At the outer end of the primary arm, that is, at the end opposite to its connection to bearing sleeve **44**, a pair of upper and lower pivot plates **170** and **172** are bolted, welded, or otherwise secured to the upper and lower flanges **164** and **166**, respectively. It is preferred that at least one of the plates be removeably secured to the primary arm to facilitate assembly of the elbow joint **52**; thus, the plate **170** is shown as being bolted to flange **164**, while plate **172** is shown as being welded to flange **166**. A pair of bracing plates **174** and **176** are secured on opposite sides of web **168** between the upper and lower flanges (see FIG. **3**) to provide additional strength. The pivot plates **170** and **172** extend at right angles to the primary arm **48** and are provided at their outer ends with suitable apertures, such as the opening **178** in the end plate **170** (FIG. **5**), which are adapted to receive a pivot shaft **180** which is secured between the plates by means of self-locking bearing nuts **182** and **183**.

The secondary arm **50** may also be constructed in the form of an I-beam having an upper flange portion **185**, a lower flange **186**, and a central web portion **187**. At its right-hand end, as viewed in FIGS. **7** and **8**, the secondary arm is secured to a bearing sleeve **188** which is adapted to be pivotally mounted on shaft **180** by means of suitable bearings mounted in the upper and lower annular channels **190** and **192**, respectively. The pivot plates, pivot shaft, and bearing sleeve **188** form the pivoted elbow joint **52** for the articulated support arm **46**, with the two bearing sleeve mountings **44** and **188** providing free movement for the arm in a horizontal plane around the assembly table.

The outermost end of the secondary arm carries a tubular sleeve **194** adapted to receive a pivot shaft **196**

on which is mounted the assembly tool support platform **54** (see FIGS. 7 and 9). The upper surface of platform **54** carries a supply of the composite strip material that is to be used to space and seal the glass sheets. The composite strip may be in the form of a package or roll **56** secured to the platform by a bolt and washer arrangement **198** to permit the strip material **60** to be payed out as the assembly tool is moved along the edge of the glass.

As illustrated in FIG. **10**, the composite strip is comprised of an elongated, flowable, moisture-resistant, deformable sealant ribbon **200** to one side of which is symmetrically adhered a wider, flexible cover tape **202**. A narrower, flexible spacer-dehydrator element **204** is symmetrically adhered to the opposite surface of the sealer ribbon and it is this spacer element that is inserted between the peripheral marginal edge portions of the glass sheets **12** and **14** while the sealant and cover tape are pressed against the periperhal edges and outer marginal surfaces of the sheets to hermetically seal the space between the two glass sheets. The tape **202** may be composed of any flexible material, although a moisture-resistant material is preferred, and in a particular embodiment the tape may be a strip of five to six mil aluminum foil. However, a strip of flexible, moisture-resistant plastic may be used, if desired.

Adhesive, moisture-resistant, deformable sealants suitable for use as the sealant **200** include materials that are capable of cold flow at room temperature. Such materials may be pre-cured, as disclosed in U.S. Pat. No. 2,974,377, as well as thermosetting and/or room temperature curable, disclosed in U.S. Pat. Nos. 3,076,777 and 3,320,333. Room temperature curable materials that cold flow to form a seal and cure to form a resilient structural bond are particularly desirable for use as an edge-packing or hermetic sealant in the construction of multiple glazed units, and one such sealant material is fully disclosed in the aforementioned U.S. application Ser. No. 232,411 assigned to the assignee of the present invention.

The spacer-dehydrator **204** is a flexible or resilient member, one preferred composition of which is fully disclosed in U.S. application Ser. No. 325,464 assigned to the assignee of this invention, and may be comprised of the powdered molecular sieve material dispersed in a matrix of thermoplastic moisture-vapor transmittable, styrene-butadiene rubber disclosed in U.S. Pat. No. 3,265,765, or other suitable materials.

Also secured to the upper surface of support platform **54** is the assembly tool generally indicated at **58** in FIGS. 1 and 7 and illustrated in greater detail in FIG. **9**. The latter figure is a view of the assembly tool taken along lines **9—9** of FIG. 7 and thus is seen through a portion of the glass sheets **12** and **14**, thereby illustrating the relationship of the assembly tool to the glass. FIG. 9 illustrates the tool with the composite strip material removed, so that the elements will be more clearly visible. The assembly tool illustrated herein is in part a version of the tool illustrated and described in U.S. Pat. No. 3,733,237 to Bernhard B. Wolff, but simplified to illustrate its major features and functions. It will be understood that in a preferred assembly apparatus, the more complex tool illustrated in the aforesaid patent may beneficially be utilized by inserting it on the support platform.

At the leading edge of the assembly tool, on the left as viewed in FIG. **9**, is mounted a spacer wedge **206**, which comprises a vertically mounted plate generally oblong in shape and adapted to spread apart the two sheets of glass to a distance sufficient to permit the easy insertion of the spacer portion of the composite strip. The spacer wedge **206** is mounted on the platform by means of spacer plate **208** which may be adjustable to properly position the wedge. As illustrated in FIG. **9**, the upper and lower edges of the wedge are tapered to provide a reduced dimension at its leading edge to facilitate insertion of the wedge when starting an assembly operation. The upper and lower edges bear against the inner surfaces of the glass sheets, holding the sheets apart so that the composite strip **60** may be fed into position on the glass. The strip **60** is fed from the supply roll **56** which is rotatably mounted on the platform **54** as by means of a shaft **212** and suitable bearings (not shown). The feeder roller is mounted adjacent the spacer wedge and is positioned at the forward edge of the plate so that as the strip material **60** is payed out from the supply roll **56**, the feeder roller will press the spacer-dehydrator element **204** into the opening between the sheets of glass and will at the same time press the sealer ribbon **200** against the peripheral edges of the top and bottom sheets.

Secured to a mounting plate **214**, which is in turn carried by support plate **54**, are the elements of the assembly tool which correspond to the hand-held tool illustrated in U.S. Pat. No. 3,733,237. Adjacent the feeder roller **210** is a leading guide roller **216** which is rotatably secured to the mounting plate by upper and lower mounting brackets **218** and **219** and a vertical mounting shaft **220**. A trailing guide roller **222** is similarly secured to the mounting plate **214** by upper and lower mounting brackets **223** and **224** and vertical shaft **225**. The two guide rollers are located to contact the outer surface of the composite strip after it is in place, and cooperate to maintain the proper spacing between the assembly tool and the glass sheets, as well as serving to press the composite strip against the glass to produce the required seal.

Following the leading guide roll **216** is a pressing and indenting roller **228** which is mounted for rotation on a shaft **229** supported in upper and lower mounting brackets **230** and **231**. The pressing and indenting roller preferably is adjustably mounted to insure that it will be centered on the two sheets of glass and it is this roller which serves to firmly press the sealant ribbon against the glass. The rotatable pressing roller **228** is provided with an annular, semi-cylindrical, indenting rib **232** which projects beyond the cylindrical pressing surface of the roller, so that as the roller moves along the composite strip after the strip has been positioned on the glass, the cover tape and sealant are pressed against the peripheral edges of the glass while the indenting rib produces a longitudinal indentation, or recess, **234**, in the surface of the strip material. This indentation has been found to prevent unsightly bulging of the flexible spacer in the use of the window units, as explained in the aforesaid U.S. Pat. No. 3,733,237.

Following the pressing and indenting roller **228** is a pair of opposed folding slides **236** and **238**, attached to the mounting plate **214**, and positioned adjacent the upper and lower marginal surfaces of glass plates **12** and **14**, respectively. The folding slides are provided with suitably generated curvilinear surfaces of opposite hand which serve to gradually fold the lateral edge portions of the sealant ribbon **200** and flexible cover tape

202 over onto the upper and lower marginal surface portions of the outwardly facing surfaces of glass sheets 12 and 14 as the tool moves toward the left as viewed in FIG. 9. Thus, the upper folding slide 236 is provided with a curvilinear surface 240 which contacts and folds through a 90° fold that portion of the composite strip which extends above the top surface of glass sheet 12 after the spacer element has been placed between the two sheets. Similarly, the curvilinear surface 242 of the lower folding slide 238 folds through 90° the portion of the composite strip extending below the bottom surface of glass sheet 14. The two folding slides preferably are adjustably mounted by means not shown to permit adjustment for accommodation of various spacings and thicknesses of glass sheets.

Next following the folding slides 236 and 238 is a pair of opposed conical pressing rolls 242 and 244, which press the folded over portion of the composite strip against the outer marginal surfaces of the glass sheets to provide a final sloping chamfer to the edge portions of the tape and sealant, thereby providing the finished appearance illustrated in FIG. 10. The rolls 242 and 244 are mounted for rotation about shafts 246 and 248, respectively, which are in turn journalled in the mounting plate 214. Again, suitable adjusting and biasing means may be provided for the rollers, as illustrated in the aforementioned U.S. Pat. No. 3,733,237 to insure that the rollers will provide the appropriate finishing pressure to the composite strip material.

The apparatus of the present invention as described above provides a simplified method of assembling multiple glazed window units wherein a spacer-sealant composite strip may be inserted and pressed into position between two adjacent sheets of glass in a single pass around the unit. As has been indicated, the two sheets of glass which are to be assembled into a window unit are positioned on the assembly table illustrated in FIG. 1 and the lower sheet is secured on the work surface by a plurality of vacuum cups. The upper sheet is then aligned with the bottom sheet, and the two are secured together by four spring-loaded A-clamps, three of which are illustrated at 62, 63 and 64. The three illustrated clamps serve to hold the adjacent sheets of glass tightly together, while the fourth clamp (not shown) holds the two sheets of glass against a temporary spacer element which provides a starting point for the insertion of the composite strip. Each of clamps 62, 63 and 64 are positioned in such a way as to allow the assembly tool to complete one side of the window unit and turn the corner for the next adjacent side before the clamp is removed.

After the glass has been positioned and secured, the articulated arm is then pivoted to position the support platform 54 and the assembly tool 58 adjacent the starting corner. The spacer wedge is inserted between the sheets of glass and the leading end of the composite strip is threaded between the spacer wedge 206 and the feeder roll 210. For a spacer element having dimensions of approximately ¼ inch by ¼ inch, the leading end or leading edge of the composite strip is then positioned about ⅜ inch from the starting corner and manually pressed into place with the spacer element between the sheets. The assembly tool is then manually moved along the first side of the window unit, as illustrated in FIG. 1, the assembly tool serving to spread apart the sheets, insert the spacer element of the composite strip, press the sealant and cover tape against the edges of the glass sheets and finish the composite strip by folding its edges over and pressing them against the top and bottom marginal surfaces of the glass sheets. This operation is continued until the second corner is reached.

To turn the corner, the assembly tool is advanced so that the spacing wedge runs out from between the glass sheets and at least the feed roll has passed beyond the corner. This leaves a mark on the sealant, and the composite material is then pulled back slightly, a perpendicular cut is made through the spacer approximately ⅛ inch short of the mark, a second perpendicular cut is made about ⅜ inch beyond the mark and the ½ inch of spacer element is removed from the composite strip. The strip is then formed around the corner, thus leaving for expansion purposes about a ⅛ inch space between the first leg of the spacer element and the second leg of the spacer element and about a ⅛ inch space between the edge of the glass sheets and the leading end or leading edge of the second leg of the spacer element. Then the foil and mastic are folded over the upper and lower marginal surface portions of the glass sheets about the corners thereof and the assembly tool is then run completely off the first side of the window unit, completing that side.

The assembly tool is turned 90° on the pivot shaft 196, spring clamp 62 is removed, the spacer wedge is inserted between the edges of the glass sheets on the second side of the window unit and the inserting and finishing operation is continued on the second side as previously described. Upon completion of the second side, the spacer element of composite strip is marked and cut and the third side is assembled. This operation is continued around all four sides of the window unit.

At the fourth corner, the composite strip is completely severed about 1 inch beyond the corner; a perpendicular cut is made through the spacer element about ⅛ inch back of the mark produced on the sealant by the feed roll passing the corner; the 1 ⅛ inch section of spacer element is removed; the trailing end of the fourth leg of the spacer element is pressed into place; if necessary, air is injected into the unit through the approximately ⅛ inch space between the fourth and first legs of the spacer element unitl the glass sheets are parallel; the foil and mastic are pressed around the corner and folded over the upper and lower marginal surface portions of the glass sheets and the assembly tool is then completely run off of the fourth side of the window unit, completing the unit. Thus, the unit is completely assembled in a single pass, reducing the time required to assemble the window. The articulated arm and the support platform hold the assembly tool in proper relationship to the horizontal level of the glass sheets, thereby facilitating the operation and further insuring a high-quality window unit.

Although the present invention has been described in terms of a preferred embodiment, it will be apparent to those of ordinary skill in the art that numerous variations and modifications can be made without departing from the invention. Thus, for example, if it is desired to insure that a specified minimum pressure be applied against the composite strip as it is being assembled, a biasing tension spring may be attached between the primary and secondary arms 48 and 50 to pull the arms together toward a closed position. In addition, numerous variations may be made in the construction of the assembly table and the specific arrangement of its vari-

ous parts and components, in the tool supporting means, and in the details of the assembly tool. Although the tool supporting means is shown as an articulated arm, it will be understood that a telescoping arm could be used, or that the primary or secondary portions of the articulated arm could be made telescopic to compensate for various sizes of glass sheets. Further, it may be found desirable to mount handle posts or other gripping means on the assembly tool or on its support platform to facilitate its handling. In addition, under certain circumstances, it may be found desirable to eliminate one or both of the guiding rollers **216** and **222**, particularly if adequate guiding of the assembly tool is provided by other components of the tool. However, such changes are considered to be within the true spirit and scope of the present invention as described in the following claims.

We claim:

1. A method for assembling window units by inserting a spacer portion of a composite strip between the contiguous peripheral edges of two sheets of glass, pressing a sealant portion of the composite strip against said peripheral edges, folding the lateral edges of said strip over the outside marginal surfaces of said sheets and finishing said lateral edges in a single operation whereby a window unit is assembled in a single pass, the steps of:

securing a first sheet of glass to a horizontal work surface;

securing a second sheet on and in alignment with said first sheet;

pivotally mounting a tool support arm for motion in a plane parallel to the space between said first and second sheets;

pivotally securing to the free end of said pivotally mounted tool support arm an assembly tool comprising spacer wedge means, feed roll and inserter means and finishing means;

inserting said spacer wedge means between said sheets of glass to separate said sheets a distance sufficient to permit insertion of said spacer portion of said composite strip;

advancing said assembly tool around the peripheral edges of said sheets while feeding said composite strip to said feed roll and inserter means and sequentially pressing said spacer portion of said composite strip by said inserter means into the space between said sheets formed by said spacer wedge, folding the lateral edge portions of said composite strip over the outside marginal surfaces of said glass sheets, and finishing said folded lateral edge portions to space and hermetically seal said window unit in a single operation.

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