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(54) **Method of forming weathertight seal.**

(57) A method of forming a weathertight seal between surfaces which move in relation to each other during the time required for the seal to be applied and cured is disclosed. The seal is formed from a preformed silicone gasket which is bonded in place with a silicone adhesive. The silicone adhesive bonds rapidly and cures because it is either a pressure sensitive adhesive, a two part adhesive which cures rapidly, or is a moisture-curable adhesive which cures rapidly because it is a thin layer in contact with a silicone elastomer, said elastomer being permeable to moisture.

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Description

METHOD OF FORMING WEATHERTIGHT SEAL

This invention is related to forming and bonding seals between surfaces which move in relation to each other, such as panels in a building.

There are in current use a variety of methods of sealing seams or joints in buildings and highways that are based upon silicone sealants. A common method makes use of a backer rod to fill the joint and shape the bottom of the seal, then extruding a silicone sealant into the joint to fill it from side to side over the top of the backer rod. The sealant is then tooled to aid in shaping the top of the seal and to aid in forcing the sealant into contact with the sides of the joint. The sealant then cures over time to an elastomer which is bonded to the surface it was in contact with at the time it cured.

United States Patent Number 3,119,204, issued January 28, 1964, to Williams, discloses a molded sealing device which positions the panels to be sealed, seals the joint and acts as a backer rod in forming the yieldable caulking compound inserted in the joint. He does not specify the material used other than an elastomer such as rubber, synthetic rubber, synthetic plastic, or the like having elastic deformable properties.

United States Patent Number 3,292,330, issued December 20, 1966 to Tennison, discloses an elongated strip of resilient rubber like material which is adhered to the walls of the space to be sealed with an adhesive.

United States Patent Number 3,581,450, issued June 1, 1971, to Patry discloses an expansion joint cover in which corrugated metal strips are imbedded in the edges of a flexible impregnated strip of fabric. The cover is attached to the substrate as by nailing through the metal strips.

A pavement expansion joint is shown in United States Patent Number 3,829,228, issued August 13, 1974, to Miyazaki et al. in which a prefabricated expansion joint seal is used.

A sealing means for breaches in architectural barriers is shown in United States Patent Number 4,237,667, issued December 9, 1980, to Pallucci et al. an expansion seal which is constructed of reinforced silicone rubber sheet stock material. The sheet stock material is attached to the surface by means of clamps and a layer of adhesive such as silicone adhesive.

Canadian Patent Number 1,138,715, issued January 4, 1983, teaches a framed dual glazed window unit, especially for use in high temperature environments. Panes of glass are separated by a gasket of silicone material, the combination being enclosed in a frame comprising a U-shaped channel of silicone material. The panes of glass, gasket and frame are bonded together with a silicone sealant material.

German Offenlegungsschrift DE 31 31 677 AI, published February 24, 1983, teaches adhesive joints for wall parts, especially for insulating glass panes. A prior construction having a spacer between the panes and a surrounding space filled with an adhesive to hold the individual panes together is

modified by the insertion of a profiled strip into the adhesive to serve as a strength bridge between the parts to be joined. The thin layer of adhesive remaining between the profiled strip and the wall parts cures in a relatively short period of time. A preferred material in an adhesive of uncured silicone rubber and a profiled strip material of an at least partially vulcanized silicone rubber with essentially the same chemical base is as the uncured silicone rubber of the adhesive.

United States Patent Number 4,516,876, issued May 14, 1985, to Wicks discloses a precast concrete expansion joint that includes an elastomeric strip bonded to the sides of a groove.

None of these methods are directed to the problem of sealing joints that move during the placement and/or cure of the sealant means.

This invention relates to a method of sealing joints that are subject to movement during the placement and cure of the sealant. The method makes use of a preformed silicone elastomeric gasket shaped to extend from a first surface to be sealed to a second surface to be sealed, in combination with a thin layer of silicone adhesive between each surface to be sealed and the preformed silicone elastomeric gasket. The silicone adhesive quickly cures because only a thin layer is used to bond the gasket to the surfaces. The preformed gasket is shaped so as to compress or extend without excessive strain upon the bonded joint.

It is an object of this invention to describe a method of forming a weathertight seal between surfaces which are subject to movement during the period required for cure of the adhesive or sealant used to form or bond the seal in place.

Figure 1 is a cross-section of a silicone gasket bonded between two blocks to seal the space between the blocks.

Figure 2 is a cross-section of a silicone gasket formed to create a minimum strain on the bonded joint between two blocks.

Figure 3 is a cross-section of a metal roof expansion joint covered with a preformed silicone elastomeric gasket bonded to the roof.

Figure 4 is a cross-section of a glass plate bonded to a metal mullion.

Figure 5 is a cross-section of a split mullion having a glass plate bonded to each piece.

A method of forming a weathertight seal between surfaces which move in relation to each other comprising (A) placing a preformed silicone elastomeric gasket between the surfaces to be sealed, said gasket having silicone adhesive applied to the gasket surfaces which contact the surfaces to be sealed, or silicone adhesive being applied to the surfaces to be sealed which contact the gasket surfaces, in those areas in which there is contact between the surfaces to be sealed and the gasket surfaces, and (B) allowing the adhesive to cure to a permanent bond, to give a quickly curing, weather-tight seal which does not leak when subjected to

movement of the surfaces in either a compressive or expansive direction.

One of the most common methods of sealing a gap between surfaces, at the present time, is the use of a sealant composition which is extruded into place to fill the gap to be sealed. After the gap is filled, the sealant is generally tooled to force it in contact with the sides of the gap so that it can adhere. The sealant is then allowed to cure in most cases. The cured sealant is of an elastomeric nature so that it can expand and contract as the gap itself expands and contracts, due to changes in temperature, shrinkage of the materials making up the surfaces, vibrations and movements of the building itself, as due to settling, or even such things as seismic movements. In order for the gap to remain sealed during all such movements, it is necessary that the sealant adhere to the sides of the gap so that during periods of expansion of the gap, the sealant is also expanded. If there is no adhesion between the sealant and the gap surfaces, a space will form when the gap expands due to movement or shrinkage of the gap walls.

In cases where the size of the gap to be sealed is varying at a rapid rate, such as when night falls and the gap to be sealed has been in the full sun, it is difficult to get a proper seal; because the size of the gap is changing while the sealant is curing. If the gap widens after the sealant starts to cure, but before the sealant had developed adhesion to the surface, a space will form between the sealant and the surface. As the sealant continues to cure, the adhesion between the sealant and the surface is lost at that point. The method of this invention is designed to be useful in situations such as this where the size of the gap to be sealed is changing during the period normally required for a sealant to cure, a time which is normally in the order of several hours at best.

The invention will be illustrated by reference to the drawings. Figure 1 is a cross-section of a gap between two pieces of material, for example, the expansion joint in a cement block building or the joint between two cement panels in a curtain-wall building construction. The surfaces 1 and 2 form the gap to be sealed. A preformed silicone elastomeric gasket 3 is selected that will fill the gap to be sealed so that the gasket is compressed slightly during insertion into the gap so that the gasket is held in place by friction with the walls of the gap. The gasket is held in place by a silicone adhesive 4 between each surface and the gasket.

The silicone adhesive 4 can be either a pressure sensitive adhesive, a curing adhesive or a combination. The silicone adhesive 4 must have sufficient adhesion to both the surfaces 1 and 2 and to the gasket 3 that when the gap expands due to shrinkage of the pieces having surfaces 1 and 2, the gasket 3 is stretched out to maintain a weather-tight seal between the surfaces without a loss of adhesion.

When a silicone pressure sensitive adhesive is used, the adhesive would be applied to the edges of the gasket just before placement in the gap. At the time of application, the adhesive is a solvent solution and after application gives the edges of the gasket to

which it is applied a slippery surface, allowing the gasket to be forced into the gap. Because the gasket is a silicone elastomer, the solvent quickly passes through the gasket and the adhesive develops a bond to the surfaces and the gasket and also develops a strength and elongation itself. This rapid development of adhesion and internal strength and elongation of the adhesive allows the gasket to be stretched and the adhesion preserved if the gap then widens due to thermal or mechanical stresses.

When a curing silicone adhesive is used, the adhesive can be either a one or two part adhesive. When a two part adhesive is used, the two parts are mixed and applied to the gasket or to the surfaces to be sealed or to both, then the gasket is forced into place. The two part adhesive is chosen to have a short cure time after mixing so that the gasket is bonded to the surfaces before the surfaces have an opportunity to move away from the gasket, causing a loss of adhesion because the adhesive is not yet cured or bonded.

When a one part curing silicone adhesive is used, it is preferred that the adhesive be cured by reaction to water vapor in the air. Because the gasket being used is silicone elastomer, the gasket is very permeable to moisture vapor and the entire area of the adhesive is exposed to moisture through the gasket in a short period of time. Because only a thin layer of adhesive is used, the entire adhesive layer cures in a short period of time because the moisture does not have to penetrate and react with a large amount of material as is true when a conventional sealant is used to fill and seal a gap between panels.

A preferred one part silicone adhesive is any of the common silicone sealant materials that are used as sealants and caulks. The type of cure system or the exact sealant chosen depends upon the surfaces to be sealed. An adhesive is chosen which will provide a strong bond to the material making up the surfaces to be sealed. The choice of the proper type of sealant for different types of substrates is well known in the art.

The preformed silicone elastomeric gasket 3 can be an extruded shape made from a heat curable silicone rubber, for example, as well as from a moisture curable silicone sealant or from a two part room temperature curable sealant or rubber. In any case, the material is extruded or shaped to the desired size and cured. The cured gasket is then used in this invention because the cured silicone rubber will allow the quick curing of the adhesive layer. The cured gasket is designed to exert little strain upon the curing or cured seal. Where the preformed elastomeric silicone gasket is a simple rectangle, as in Figure 1, the silicone rubber or sealant is chosen to have a low modulus of elasticity so that when the surfaces 1 and 2 move relative to each other, the strain on the bonded surfaces is not excessive.

Figure 2 is a cross section of of a silicone gasket formed to create a minimum strain on the bonded joint between two blocks. The blocks, having surfaces 21 and 22, create a gap which is sealed by the pleated gasket 23. A preferred form of gasket 23 is a molded silicone rubber having a fabric layer

reinforcement in the rubber. The size and number of pleats in the gasket can be varied to change the amount of expansion and contraction the gasket can accommodate while placing only a minimum of strain on the adhesively bonded joints. The adhesive 24 can be any of the types mentioned above. This construction is particularly adaptable to the use of a pressure sensitive adhesive in that the adhesive can be applied to the gasket surfaces and allowed to dry and develop its pressure sensitive characteristics. The gasket is then installed by forcing the pressure sensitive adhesive coated surface into place against the wall of the gap to form a seal across the gap. Because the pressure sensitive adhesive gives rapid bonding to the surface, the gasket can bond to the surfaces rapidly so that if the surfaces are moving during sealing or shortly thereafter, it is still possible to get a good bond which is not destroyed by the fact that the surfaces move.

Figure 3 is a cross-section of a metal roof expansion joint covered with a preformed silicone elastomeric seal bonded to the roof with silicone adhesive. The separate metal panels 31 and 32 are subject to movement as from thermal expansion and contraction due to exposure to the sun and then shade from clouds or night. On a hot summer day, with clouds passing by, the panels can expand and contract at a relatively rapid rate. If the panels were attempted to be sealed with a conventional sealant, applied as a bead between the two surfaces, the moving surfaces could very easily destroy the integrity of the seal while it was curing due to the movement of the two surfaces relative to each other during the cure period. In this type of application, a preferred method would consist of applying a silicone adhesive, preferably a moisture curable silicone adhesive or sealant bead upon the flange of the preformed silicone gasket in the location shown, then placing the gasket over the joint and pressing the gasket flange firmly into contact with the panels. The silicone adhesive flows out to form a thin layer of adhesive between the panel and the gasket. Because of the porosity of the silicone gasket to moisture vapor, the thin layer of moisture curable silicone adhesive quickly cures to give a bond between the gasket and the panels. The shape of the gasket and the quick cure maintains a weathertight seal even though the panels move relative to each other at a relatively rapid rate.

Figure 4 is a cross-section of a glass plate bonded to a metal mullion, as in the construction of a curtain wall building. The glass plate 45 is held in contact with the mullion 41 through the preformed silicone gasket 43 and the adhesive layers 44. A preferred method of constructing this joint extrudes a bead of silicone adhesive, preferably a moisture curable silicone adhesive, onto the surface of the mullion, then the preformed silicone elastomeric gasket 43 is pressed over the bead of adhesive to form a thin layer of adhesive bonding the gasket to the mullion. A bead of silicone adhesive is then applied to the exposed surface of the gasket, and the glass plate 45 is forced into contact with the adhesive bead to form a thin layer of adhesive, bonding the glass plate to the gasket. If necessary, temporary holders are

attached to the mullion spacer to hold the glass in place as the adhesive cures. Because the adhesive is present in a thin layer and because the silicone gasket is silicone and is permeable to gases, the adhesive layer quickly cures to form a bond between the mullion and the glass. This bond is formed even though the glass may move relative to the mullion because the layer of adhesive is thin and cures at a rapid rate. The elasticity of the gasket 43 also allows movement between the glass plate and mullion without applying large stresses to the adhesive joint. The area of the gasket bonded to the mullion and to the glass is determined by the design strength required to hold the glass plate in place. The thickness of the silicone rubber gasket is determined by the useful elongation of the gasket material and the amount of relative movement expected between the metal mullion and the glass plate due to the temperature changes, building movements and wind loads.

Figure 5 is a cross-section of a split mullion having a glass plate bonded to each piece. This is a variation of the application shown in Figure 4. This variation is particularly adopted to use in the shop prefabrication of panels for use in curtain wall construction. Four split mullions are arranged in a rectangle in a shop on a horizontal surface so as to form a rectangle to enclose the glass plate. A bead of silicone adhesive is applied to the mullion, the gasket 53 is forced into place, forming a thin adhesive layer 54, then a bead of adhesive is applied to the gasket and the glass plate 55 is forced into place, forming the other thin layer of adhesive 54. In this application, the method is particularly useful, not because of movement of the surfaces during cure, but because the rapid cure of the adhesive, due to the thin layer and the porosity of the silicone gasket, allows the assembly to be removed from the assembly area in a short period of time and allows application of the assembly to the building without a lengthy time for curing of the adhesive. Conventional construction of this type, using a spacer and an area of sealant to bond the glass plate in place provide sufficient thickness and area to allow for all the necessary movement and loads, requires a cure period of from 14 to 21 days before the assembly can be applied to the building. In a large application, such as a skyscraper, this requires a large area for the storage and inventory of the assemblies during the cure period. With the instant method, the assembly needs only to cure for a period such as two days before it is placed on the building.

In an application such as this, where experience has shown that a silicone sealant has the required physical properties to function in the application, it is preferred to manufacture the preformed silicone gasket using the silicone sealant as the material of choice. The sealant is placed in a form the desired size and allowed to cure, then is removed from the form to give the preformed silicone gasket. The same silicone sealant is then used as the silicone adhesive in the construction of the assembly as discussed above. The cured product is essentially the same as that obtained in the previous method, except the assembly cures to a useful unit in a short

period of time as the long period of time required for the preformed gasket to cure is not part of the assembly cure time.

After the split mullion assemblies are cured, they are placed on the building and fastened into place, as by bolting or riveting. The space between the mullion halves is then sealed in the conventional manner as shown at 57. The seals 56 are formed of conventional sealant either in the shop or after assembly on the building.

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Claims

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1. A method of forming a weathertight seal between surfaces which move in relation to each other comprising

(A) placing a preformed silicone elastomeric gasket between the surfaces to be sealed, said gasket having silicone adhesive applied to the gasket surfaces which contact the surfaces to be sealed, or silicone adhesive being applied to the surfaces to be sealed which contact the gasket surfaces, in those areas in which there is contact between the surfaces to be sealed and the gasket surfaces, and

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(B) allowing the adhesive to cure to a permanent bond, to give a quickly curing, weathertight seal which does not leak when subjected to movement of the surfaces in either a compressive or expansive direction.

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2. The method of claim 1 in which the preformed silicone elastomeric gasket is shaped so as to compress or extend without excessive strain on the bonded seal.

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3. The method of claim 1 in which the silicone adhesive is a moisture curable silicone sealant.

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4. The method of claim 1 in which the silicone adhesive is a two-part silicone adhesive which cures at room temperature upon mixing of the two parts.

5. The method of claim 1 in which the preformed silicone elastomeric gasket is manufactured from a moisture curable silicone sealant.

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6. The method of claim 1 in which the preformed silicone elastomeric gasket is manufactured from a heat curable silicone rubber.

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7. The method of claim 5 in which the heat curable silicone rubber is reinforced with fabric.

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Fig. 1

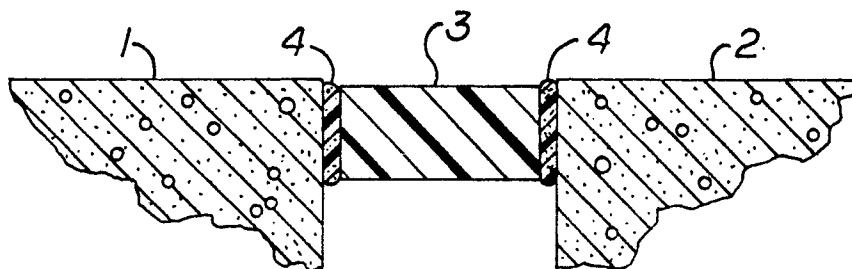


Fig. 2

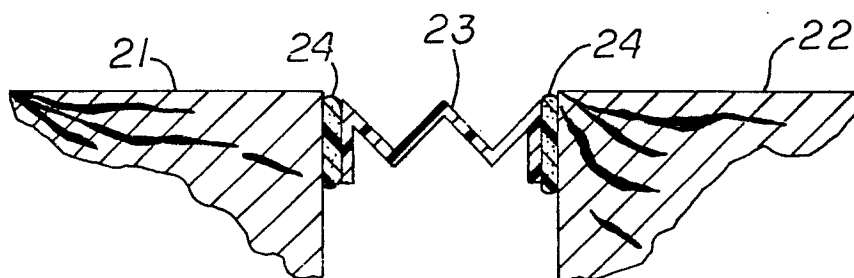


Fig. 3

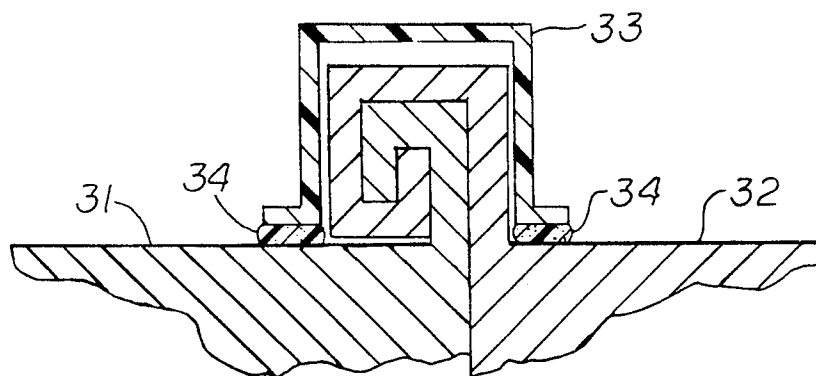


Fig. 4

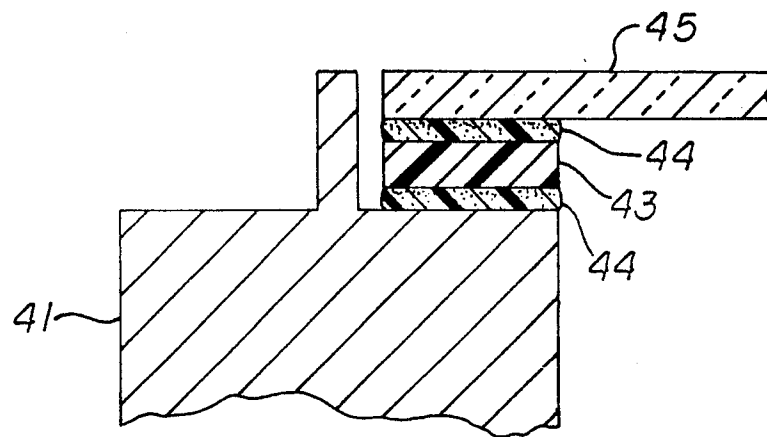


Fig. 5

