

DESCRIPTION

PROCESS TO CREATE AN ELECTROMAGNETICALLY-SCREENING SEAL

TECHNICAL FIELD

The present invention concerns the field of screening. It deals with a process to create an electromagnetically-screening seal that comprises a substrate with a sealing bead fixed tightly to a substrate consisting of an elastic, electrically conductive sealing material. In the process, a hardening, elastic and electrically-conductive sealing material is adhered as a paste in a predetermined geometric pattern to the substrate and then hardened.

Such a process in which the sealing material is applied to the bearing substrate by screen printing is e.g. found in EP A2 0 241 192.

STATE OF THE ART

It has been prior art for a long time to use elastic, electrically conductive seals for sealing electromagnetically-screened multi-component housing, etc. The seals securely close the gaps between the housing parts and provide a good electrical contact between the (electrically-screening) housing parts. Such seals consist of tubes made of wire mesh or metallic fleeces, or frequently an elastomer mixed with conductive fillers (carbon particles, copper or silver particles, metallically-coated spheres, silver-coated particles, etc.). The elastomer is used in an unhardened state to form a corresponding sealing bead or strip. The formed bead is then hardened (by heat, radiation, humidity, etc.).

In US A 4 659,869, a screening seal is described where a sealing element made of a conductive elastomer is extruded in the form of a tube and then connected to an elongated clamping strip made of metal. This type of seal is very involved to manufacture due to the clamping strip. In addition, it can only be used for limited instances because there must be a straight, strip-like edge of sheet metal on the housing on which to clamp the clamping bead. In particular, this technique cannot be used to create an annular closed seal with complicated dimensions.

Another type of screening seal is described in the initially-cited EP A2 0 241 192. A flat substrate in the form of an annular strip is printed on one or both sides by screen printing with one or more sealing beads made of an electrically-conductive elastomer. Silk screen printing makes it easy to create different seal shapes in contrast to the above-cited case. The use of silk screen printing also has disadvantages, however. Each seal shape must be created in correspondingly shaped screen. Although this does not provide a limitation for large-scale series production, small-scale series are not economical due to the frequently changing shapes. Furthermore, silk screen printing can only create seal beads that have a uniform, essentially rectangular cross-section. Variations of the height or cross-section are nearly impossible with silk screen printing. Finally, it is impossible to change the composition of the seal material in relation to the site to e.g. adjust the reaction to pressure, etc. of the seal bead.

Another sealing technique for screening seals that is not limited as above has been suggested by the applicant in an earlier patent application (EP A1 0 629 114). In this sealing technique, the seal bead is

applied directly to a surface of the housing to be sealed. The sealant is applied as a pasty, electrically-conductive elastomer by an applicator with a nozzle in the form of a bead. The applicator follows the shape of the seal like a robot that is controlled along several axes. With this technique (termed „form-in-place“), the sealing bead is hardened on the sealing surface as shaped by and applied by the nozzle. Suitable sealing materials for this process are e.g. disclosed in EP A1 0 643 551 and EP A1 0 643 552.

The form-in-place technique is very flexible to use, can be economically used for large-scale and small-scale series, and can easily create seals for very small housings with complicated shapes. Additionally by controlling the supply of the sealing material to the nozzle, the composition and cross-section of the sealing bead can be easily varied in relation to the site. Finally, it is easy to create complicated cross-sections of the sealing bead and hence special characteristics of the seal by applying several parallel individual beads either sequentially or with multiple nozzles.

With the form-in-place technique, at least the housing part (or the printed circuit board) that has the surface to which the seal is applied must be at the site of manufacture for the seal bead to be applied. However, it would be desirable to use the indisputable advantages of the form-in-place technique for those instances in which the parts to be sealed are not at the site of manufacture.

DESCRIPTION OF THE INVENTION

The problem of the invention is to present a process to manufacture a screening seal that has the flexibility

of the form-in-place process, and to create a seal that can be stored and transported apart from the part to be sealed and used away from the site of manufacture.

The problem is solved by a process of the initially-cited type whereby a sealing material is applied in the form of a sealing bead onto the substrate by an applicator (that can follow a given shape) from a nozzle, and the sealant is hardened as a sealing bead. By creating the sealing bead on a separate substrate that forms the complete seal together with the sealing bead, the two processes of creating the seal and installing the seal can be separated from each other. The seal is given the necessary mechanical stability from the substrate that can be stored and transported separately and installed at a later time on the sealing surface. The substrate can be flexibly adapted to the different requirements.

A first preferred embodiment of the process according to the invention is characterized in that the sealing bead consists of several individual beads, and either the individual beads of the sealant are applied from a nozzle sequentially to the substrate, or the individual beads of the sealant are simultaneously applied to the substrate from several nozzles. Very different cross-sections can be advantageously created that have correspondingly different characteristics.

A second preferred embodiment of the process according to the invention is characterized in that the sealing material is applied to a substrate sheet, and then areas of the substrate sheet with the sealing bead are cut out to form the seal. By limiting the substrate to the areas covered by the sealing bead, the seal takes less space.

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In another preferred embodiment, a flexible film is used as the substrate that is either electrically insulating (especially made of a plastic); or the substrate is an electrically conductive, especially metal film or plastic film metallized on one or both sides; or the substrate is a fabric, grate or net that either is electrically insulating (especially of plastic), or electrically conductive, especially a metal fabric, grate or net. The substrate can be a single-layer or multilayer plate of metal and/or plastic or a nonwoven fabric. The substrates in the form of films, fabrics, grates, nets and nonwovens can be easily adapted to difficult shapes. The substrates in the form of plates are characterized by greater shape retention.

Another preferred embodiment of the process according to the invention is characterized in that a substrate is used that has cut-outs in the area of the sealing bead through which the sealing bead can contact the surface on which rests the seal with the substrate. Such perforated substrates like perforated plates, coarse fabrics, nets, grates, etc. allow a direct electrical connection to be provided by the sealing bead with the top and bottom sealing surface.

Other embodiments are found in the dependent claims.

SHORT EXPLANATION OF THE FIGURES

The invention will be further explained in the following with reference to exemplary embodiments in connection with the drawings. Shown are:

Fig. 1 Perspective view of an example of a substrate sheet for the process according to the invention;



- Fig. 2 The application of the sealing bead to the substrate from Fig. 1 according to a preferred exemplary embodiment of the invention;
- Fig. 3 The finished sealing bead applied using the procedure in Fig. 2;
- Fig. 4 Examples of removing the substrate areas from the sheet of substrate that are covered with the sealing bead from Fig. 3;
- Fig. 5 The seal ready for use created by the steps represented in Fig. 2-4;
- Fig. 6 The use of the seal from Fig. 5 to provide an EMI seal of an exemplary housing consisting of a top and bottom part;
- Fig. 7 A top view of a seal created by the process according to the invention with a grid-shaped substrate with net lines are parallel to the seal bead;
- Fig. 8 A top view of a seal manufactured by the process of the invention with a grid-like substrate, whereby the net lines are at an angle to the sealing bead;
- Fig. 9a, b A side view of the seal comparable with Fig. 7 in which the sealing bead is in an unpressed state (Fig. 9a) above the substrate and only contacts the bottom surface through the substrate when pressed (Fig. 9b); and



Fig. 10 A seal comparable to Fig. 9 in which the sealing bead provides contact through the substrate even when no pressure is applied.

WAYS TO IMPLEMENT THE INVENTION

The process according to the invention is based on a thin, preferably flat substrate 10 as shown in Fig. 1. The substrate 10 can have one or more cut-outs 21 (the significance of which will be discussed below) at predetermined sites. Whereas Fig. 1 only shows an example of a cut-out 21, it is easily conceivable to place cut-outs throughout the entire substrate 10 surface as is e.g. the case with a perforated plate or film.

The substrate 10 can be designed to be flexible or rigid depending on the application. Furthermore, an electrically conductive or nonconductive substrate can be used. If the substrate is flexible, films, fabrics, grids, nets or nonwovens can be used that either consist of metal (metal films or fabrics, grids or nets or mats) or one or more metallized plastics. If the substrate is rigid, plates (single-layer metal plates, or single or multilayer plates of plastic, or a metal/plastic sandwich) can be used.

To create the seal, the substrate 10 sheet from Fig. 2 is placed on a suitable, stable base 11 and sufficiently fixed. Using an applicator 12 that can be moved relative to the base 11 or the substrate 10 on it along several axes, an elastic, electrically-conductive, unhardened, pasty sealing material is applied on the substrate 10 under pressure from a nozzle 13 in the form of a sealing bead 14. The applicator 12 automatically follows geometric patterns that corresponds to the path of the subsequent seal.



The relative movement of the applicator 12 in relation to the base 11 or substrate 10 can be such that the base 11 is held and the applicator 12 is moved above, or the applicator 12 can be held and the base 11 is moved with the substrate 10 below the applicator 12. Possible applicators 12 are e.g. a device that is described in European patent application EP A1 0 629 114 by the applicant. A possible sealing material for the sealing bead is preferably an elastomer mixed with an electrically-conductive filler as e.g. the composition described in EP A1 0 643 551 and EP A1 0 643 552. The hardening that causes the bead to permanently adhere to the substrate 10 can be carried out in many ways, especially by heat or the effect of humidity.

When application is finished, the state arises that is shown in Fig. 3 in which the substrate 10 is covered with a complete (open or closed, annular, meandering, labyrinthine, etc.) sealing bead 14. In another (optional) step, the area of the substrate 10 covered by the sealing bead 14 is stamped out of the substrate 10 sheet or e.g. cut out with a laser beam or a high-pressure water jet to produce a finished seal 15 that consists of the (cut out) substrate 10 and the tightly-adhering sealing bead 14. It is also possible to conversely first cut out from the sheet the areas that are to bear the sealing bead, and then apply the sealing material to form the seal on the cut out areas.

It can be particularly advantageous when the cut-out substrate 10 is continuous at a site where the sealing bead has an interruption 16 because of the purpose for which it is used. This makes it easier and safer to handle the seal even at the loose ends of the sealing bead 14. The finished seal 15 can then be removed from



the base 11, and it is ready to be transported in the form in Fig. 5, to be stored or to be directly used.

Fig. 6 shows an exemplary use of the invention on an electrically-screening housing 17 that consists of a top housing part 18 and a bottom housing part 19 and an interior 20 to be screened. The seal 15 illustrated in Fig. 5 whose cut-out edge is preferably adapted to the sealing surface of the housing 17 is e.g. placed loosely or glued on the sealing surface of the bottom housing part 19. It can be adjusted or mechanically fixed by providing holes (24, 25 in Fig. 7) in the substrate 10 (as described below in relation to Fig. 7) that can be used to shove the substrate 10 on corresponding posts or pins on the bottom sealing surface. The top housing part 18 that has a corresponding sealing surface is then placed on the seal 15, the sealing bead 14 is pressed, and the housing 17 becomes electromagnetically sealed. At the cut-out 21, the sealing bead 14 is pressed through the cut-out 21 onto the sealing surface of the bottom housing part directly below the substrate 10 so that the sealing bead provides an electrical contact in the area of the cut-out 21 with both housing parts 18, 19 (through contacting). This is particularly important when an insulating film or plate is used as the substrate 10, and the top and bottom parts are to be electrically connected. The through contact between the top and bottom parts is particularly easy to obtain over a wide surface when a wide-mesh fabric, grate or net (of plastic or metal) is used as a substrate for the seal as in Fig. 7-10. In the exemplary embodiment in Fig. 7, the seal 21 is formed by a sealing bead 22 that is applied to a grid-like substrate 23. The sealing bead 22 is parallel to the grid lines. If the grid lines in the lengthwise direction do not expand, the parallel orientation restricts the stretching of



the sealing bead 22 and hence protects it from overstretching.

In the substrate 23, there are e.g. two circular (e.g. stamped or cut) openings 24 and 25 surrounded by the sealing bead 22. During installation, the seal 21 can be shoved on corresponding posts or pins on the bottom housing part or on the bottom sealing surface that simultaneously makes it easier to join the housing parts. The automatically adjusts the seal 21 relative to the housing. When the posts or pins are correspondingly shaped, the seal 21 can be mechanically fixed on the bottom sealing surface.

Another example of the seal according to the invention is shown in Fig. 8. The seal 26 comprises a closed sealing bead 27 that is also applied to a grid-like substrate 28. In this case, the grid lines are angled in relation to the sealing bead 27. If the grid lines can bend with this orientation, the substrate 28 and the sealing bead can be stretched in the lengthwise direction of the bead. This makes it easier to adapt the seal 26 to different shapes.

When using grid-shaped substrates, whether or not the finished sealing bead can penetrate the substrate and make contact largely depends on the thickness of the substrate (thickness of the strings or grid wire), the mesh width, and the sealant viscosity when it is applied. Fig. 9a shows a side view of an instance in which the sealing bead 29 is largely above the grid-like substrate 30 after the bead hardens (when not subjected to pressure). The bead does not extend through the substrate 30. Only when it is used (Fig. 9b), the (elastic) sealing bead 29 is pressed between the two sealing surfaces 31 and 32 and passes through the substrate 30 to the bottom sealing surface 32 and

hence closes the gap between the top and bottom sealing surface 31 and 32.

If the mesh width of the substrate is larger or the viscosity of the sealant is less when it is applied, a seal results as in Fig. 10 in which the sealing bead 33 extends downward through the mesh of the grid-shaped substrate 34 even when no pressure is applied. In this manner, the disturbing influence of a nonconducting substrate (plastic weave or grid) on the screening properties can be reduced to a minimum.

Overall, the process according to the invention produces a screening seal that is distinguished by the following advantages:

- Simple and economical manufacture,
- Flexible to use even with complicated and involved shapes,
- Any substrate (base material) can be selected within wide limits, and it can be optimized to the respective application,
- The finished seal is easy and safe to handle,
- The seal can be manufactured apart from the housing.

REFERENCE NUMBER LIST

10	Substrate
11	Base
12	Applicator
13	Nozzle
14	Sealing bead
15	Seal
16	Space
17	Housing
18	Top housing part
19	Bottom housing part
20	Interior (housing)

21, 26 Seal
22, 27 Sealing bead
23, 28 Substrate (grid or net)
24, 25 Opening
29, 33 Sealing bead
30, 34 Substrate (grid or net)
31, 32 Sealing surface



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CLAIMS

1. A process to manufacture an electromagnetically screening seal (15, 21, 26) whereby the seal (15, 21, 26) comprises a substrate (10, 23, 28, 30, 34) with a sealing bead (14, 22, 27, 29, 33) fixed tightly to the substrate (10, 23, 28, 30, 34) consisting of an elastic, electrically conductive sealing material; in the process, a hardening, elastic, and electrically-conductive sealing material is adhered as a paste in a predetermined geometric pattern to the substrate (10, 23, 28, 30, 34) and then hardened, characterized in that the sealing material is applied in the form of a sealing bead (14, 22, 27, 29, 33) from a nozzle (13) to the substrate (10, 23, 28, 30, 34) with an applicator (12) that can move relative to the substrate (10, 23, 28, 30, 34) and follow the given shape, and the sealant is hardened as a sealing bead (14, 22, 27, 29, 33).
2. A process according to claim 1, characterized in that the sealant (14, 22, 27, 29, 33) is composed of several individual beads.
3. A process according to claim 2, characterized in that the individual beads of the sealant (14, 22, 27, 29, 33) are applied sequentially from a nozzle to the substrate (10, 23, 28, 30, 34).
4. A process according to claim 2, characterized in that the individual bead of the sealant (14, 22, 27, 29, 33) are applied from several nozzles simultaneously to the substrate (10, 23, 28, 30, 34).

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5. A process according to one of claims 1-4, characterized in that an elastomer mixed with an electrically conductive filler is used as the sealant.
6. A process according to one of claims 1-5, characterized in that the sealant is applied to a sheet of substrate (10, 23, 28, 30, 34), and the areas covered with the sealant bead (14, 22, 27, 29, 33) are removed from the sheet of substrate (10, 23, 28, 30, 34), and these areas form the seal (15, 21, 26).
7. A process according to claim 6, characterized in that the areas covered with the sealant bead (14, 22, 27, 29, 33) are removed from the sheet of substrate (10, 23, 28, 30, 34) by stamping.
8. A process according to claim 6, characterized in that the areas covered with the sealant bead (14, 22, 27, 29, 33) are removed from the sheet of substrate (10, 23, 28, 30, 34) by cutting, especially by a laser or water jet.
9. A process according to one of claims 1-5, characterized in that the areas that will later bear the sealing bead (14, 22, 27, 29, 33) are removed from the sheet of substrate (10, 23, 28, 30, 34), and the sealant is applied to the cut-out areas to form the seal (15, 21, 26).
10. A process according to one of claims 1-9, characterized in that a flexible film is used as the substrate (10).

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11. A process according to claim 10, characterized in that the film is electrically insulating and especially consists of a plastic.
12. A process according to claim 10, characterized in that the film is electrically conductive, and is especially a metal film or a plastic film metallized on one or both sides.
13. A process according to one or claims 1-9, characterized in that a fabric, grid or net is used as the substrate (23, 28, 30, 34).
14. A process according to claim 13, characterized in that the fabric, grid or net is electrically insulating and especially consists of a plastic.
15. A process according to claim 14, characterized in that the fabric, grid or net is electrically conductive and is especially a metal fabric, grid or net.
16. A process according to one of claims 1-9, characterized in that a one or multi-layer plate of metal and/or plastic is used as the substrate (10).
17. A process according to one of claim 1-9, characterized in that a nonwoven is used as the substrate (10).
18. A process according to one of claim 1-17, characterized in that a substrate (10) is used that has holes in the area of the sealing bead (14) through which the sealing bead (14) can contact the surface on which lies the seal (15) with the substrate.

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19. A process according to one of claims 1-18, characterized in that there are openings (24, 25) in the substrate (23) to adjust and/or fix the seal (21) to a sealing surface.

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