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(54) INTERCELL CONNECTORS FOR ELECTRIC STORAGE BATTERIES

(71) We, SOCIEDAD ESPANOLA DEL ACUMULADOR TUDOR S.A., a Spanish Company of 49, Gaztambide, Madrid, Spain, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to intercell connectors in multicell electric storage batteries of the type in which the plates of neighbouring cells are connected by a substantially straight intercell connector bar passing through an opening in the upper part of an intercell partition.

As compared with intercell connectors which pass over the tops of the partitions, connections of the type referred to have the advantage that the connection can be more direct, thereby saving material and in addition reducing the internal resistance of the cell as well as economising space. At the same time care must be taken in the sealing of the joint between the partition and the bar since the joint may be near or even below the liquid level.

Various arrangements have been proposed or adopted for sealing intercell connectors of the type specified and an object of the present invention is to provide a simple and convenient arrangement, more particularly, although not exclusively, suitable for use with casings formed of a plastics material such as polypropylene.

According to the present invention a mould for sealing an intercell connection in a multicell electric storage battery comprises a body which has in the bottom a first groove to straddle the upper part of an intercell partition and a second groove at right angles to the first to straddle an intercell connector bar passing through an aperture or notch in the partition, and closures which are carried by the body and which will lie one on each side of the par-

tion and with the body afford a marginal portion fitting against the face of the partition and defining a cavity surrounding the intercell connector in the region of the partition, in which the closures form the bottom of the cavity and are movable substantially horizontally from a closed position in which they extend under the bar, to an open position in which the bar and the moulded seal can move down relatively to and out of the mould.

The use of a removable mould results in economy since a single mould can be used for a large number of batteries.

Preferably the body forms one side wall of the cavity and on the opposite side of the bar provides guides for the closure permitting it to move substantially horizontally between its closed and open positions. The cavity may be closed at the top except for an injection nozzle through which sealing material can be injected under pressure.

In a preferred arrangement the body is adapted to form the side of the cavity between the connector bar and the side of the casing nearer to it, the closure being adapted to be withdrawn away from the said wall.

The closure may also afford the end wall of the cavity under the connector bar.

The invention may be employed with a precast connector bar, the plates of opposite polarity of neighbouring cells being mechanically and electrically connected together before being inserted in the casing, in which case the bar will be received in an open-topped notch. Alternatively, the bar may be preformed and inserted through a hole in the partition before being burnt, welded or otherwise secured to the lugs of the plates. Again the bar may be cast in situ so as to extend through a hole in the partition as set forth in British Patent Specification No. 49775/74 Serial 90

No. 1485454.

Particularly when the bar is cast in situ it may be difficult to ensure that its section is precisely rectangular and in particular the upper surface of a cast bar, due to surface tension, may be a convex curve or meniscus. This may be filed flat to enable it to mate and form a close fit with the mould, but in order to avoid the necessity for this in one form of the present invention the closure has a cutter portion arranged to gouge or broach a groove in the upper or lower surface of the bar so as to close the cavity throughout the width of the bar.

Moreover, there is a possibility that slight variations in the width of the bar may occur and it may therefore be desirable to arrange the closure and an opposed part of the body to bite into the sides of the bar to close the cavity throughout the height of the bar.

The mould may include a common operating member for simultaneously moving both closures between their open and closed positions.

The invention also embraces a method of sealing an intercell connection in a multicell electric storage battery which includes placing in the neighbouring cells plates connected by an intercell connector bar passing through an opening in the upper part of an intercell partition, sliding the closures of the mould to their open position, fitting the mould over the intercell connector bar and the partition so as to define a cavity round the opening sliding the closures horizontally to a closed position in which they extend under the bar to close the bottom of the cavity, introducing into the mould a plastics material which is compatible with the partition so as to seal the gap between the margins of the opening and the connector bar, when the sealing material has set removing the mould by sliding the closures horizontally to their open position, and moving the bar and seal downwards relatively to, and out of, the mould.

As a further safeguard the method may also include the step of compressing the bar longitudinally, after moulding the seal, to cause it to expand within the sealing material.

In one form of the invention in which the opening in the intercell partition is in the form of an open-topped notch through the lower part of which the intercell connector passes, the cavity of the mould extends up to the level of the top of the partition so as to fill the upper part of the notch above the bar with the sealing material.

The invention may be put into practice in various ways but two specific em-

bodiments will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic perspective view of an intercell connector bar extending through a notch in a partition prior to the moulding operation,

Figures 2 to 5 illustrate one form of mould comprising a body and a closure, and in particular

Figure 2 is an elevation of one half of the mould as seen from the partition, with the closure in the open position, and Figure 3 is a similar view with the closure in the closed position,

Figure 4 is a plan view of the closure, and

Figure 5 is an under-plan view of the mould,

Figures 6 to 10 illustrate a second embodiment in which the mould comprises a body and closure which cuts a groove in the connector bar, in particular

Figures 6 and 7 are elevations similar to Figures 2 and 3 showing half of the second form of mould with the closure respectively in the open and in the closed position,

Figure 8 is a sectional elevation on the line 8-8 of Figure 9,

Figure 9 is an under-plan view, and

Figure 10 is a perspective.

The invention will be described as applied to an intercell connector for a multicell electric storage battery having a casing formed of polypropylene.

The casing is of conventional form including intercell partitions 10 extending between side wall 11 and is provided with a lid also having partitions 12 extending between side walls 13.

As shown in Figure 1 each intercell partition 10 is formed with a generally rectangular notch 15 in its upper edge at a point where the intercell connector is to pass through it. The intercell connector comprises a straight bar 16 of rectangular section. The section may vary slightly from a precise rectangle as referred to below and in addition the bar may well taper away from the intercell partition so as to provide both the maximum strength and the maximum current carrying capacity at its middle portion where it passes through the partition. Thus the middle portion of the bar carries the current from the maximum number of plates from one cell to its neighbour.

The plates and separators for all the cells of the battery are assembled together in a jig and connected together by their intercell connectors, then lowered into the casing so that the intercell connectors are received in the notches of the partitions as indicated diagrammatically in Figure 1.

A mould is then placed over each notch.

The embodiment shown in Figures 2 to 5 provides an arrangement in which the application of the mould to the partition is facilitated in that the mould is formed as a single unit, in two halves which are rigidly secured together so that the mould fits astride the partition with one half on each side. Moreover each half comprises a body portion 31 which provides guides for a closure 32 which is movable relatively to the body between an open position shown in Figure 2 in which the mould can be applied to the partition and will pass over the intercell connector bar, and a closed position shown in Figure 3 in which the closure is advanced to close in the underside of the bar.

Each half of the body of the mould comprises a generally rectangular block or stout plate 33 having in the bottom a slot or notch 34 open at the bottom to fit over the connector bar. Adjacent the notch is a recess 35, also open at the bottom forming the top and sides of a mould cavity. Thus the thickness of the plate is reduced to form the recess 35, the face of the recess being parallel to and spaced from the face of the partition. The top of the recess communicates with half of an inlet passage 36 through which a fluid plastics material can be injected.

It will be appreciated that the recess forms a cavity round the top and sides of the connector bar but the cavity would be open at the bottom and under the bar so that the sealing material would not be confined.

Accordingly in accordance with the invention there is provided (on each side of the partition) a closure in the form of a plate 40 of L-section carried by a rod 41 forming a bolt having welded to its outer end a boss 42 engaging a fork 43 at the end of a lever 44 by which the closure can be slid from the open position of Figure 2 to the closed position of Figure 3.

As viewed in Figures 2 and 3 the plate 40 of the closure is of stepped form having an upper step 45 which as shown in Figure 3 fits under the connector bar and is of reduced thickness so as to be spaced from the face of the partition and to be flush with the face of the recess 35, and a lower step 46 which projects beyond the upper step and in thickness extends from the plane of the partition to the plane of the face of the recess.

Thus in the closed position of the closure, shown in Figure 3, the lower step forms the bottom of the moulding cavity extending from the plane of the face of the partition to the plane of the recess 35 while the upper step forms the face of the cavity opposed to the surface of the parti-

tion under the intercell connector.

The operation of this embodiment will in general be clear from the above description of its construction. Thus the mould is in a single unit which can be lowered into position astride the partition, and astride the connector bar, with the closure withdrawn as shown in Figure 2. The closure is then advanced to the closed position of Figure 3 forming a cavity on each side of the partition which completely surrounds the intercell connector and extends over the margins of the notch in the intercell partition whilst being closed on all sides except for the inlet passage 36 for the sealing material. The latter is then injected and when it has had time to solidify the closure is withdrawn by means of the lever 44 to the position of Figure 2 and the mould lifted off the intercell partition (or the battery lowered from it).

Preferably the mould extends up to or slightly above the top of the partition, and is filled to that level, so that the top of the moulded sealing material forms a continuation of the upper edge of the partition.

The lid can then be heat sealed to the casing in known manner, the top of the moulded sealing material being simultaneously heat sealed to the adjacent portion of the partition 12 of the lid so as to provide added sealing and reinforcement at the same time.

It will be noted that in the embodiment of Figures 2 to 5 the closure forms the whole of the bottom of the mould so that no part of the body needs to be retracted laterally in order that the mould may be applied to and removed from the intercell connector. This asymmetrical arrangement has the advantage that it can be applied to batteries in which the space between the intercell connector and the adjacent side wall is restricted, provided that an adequate space is available between the two intercell connectors of a cell, or any other obstruction that may exist between them. Thus in the arrangement shown in Figures 2 to 5 the portion of the mould to the left of the intercell connector as viewed in Figures 2 and 3 is comparatively narrow and can be arranged to fit between the intercell connector and the adjacent side wall of the container, whilst the lever 44 and associated parts are accommodated in the space between the two intercell connectors, which is generally very much greater.

The invention is particularly applicable where the intercell connector is cast in situ about the lugs of the plates, or indeed may be formed wholly or partly by melting the material of the lugs. Particularly in such cases there is the possibility that the dimensions of the section of the intercell

connector bar may vary somewhat. In particular if the bar is cast in an open topped mould its upper surface is liable to exhibit a convex curve or meniscus. With the arrangements shown in Figures 2 to 5 it may be desirable to file off such a meniscus before the sealing mould is applied, in order to obtain a water tight fit with the mould. Alternatively the bar may be cast with a top on the casting mould at the point where the sealing mould will engage it, but this renders the casting less simple.

Figures 6 to 10 show an embodiment in which this is overcome by forming the closure with a cutter which broaches or gouges a groove in the upper surface of the bar as it is advanced to its closed position.

As in the arrangement of Figures 2 to 5 the mould comprises two halves rigidly bolted together and mounted astride the partition with one half extending down on each side of it.

The upper part of each half of the mould comprises a substantial block from which depends a stout plate 52. The plate 52 has in it a notch 53 near one end which will be between the intercell connector and the nearest side wall to it, and extends a considerable distance in the opposite direction. In its face presented to the partition (and to the viewer in Figures 6 and 7) the plate 52 has in it a shallow recess 54 extending for its whole length so that almost the whole of its surface, as indicated in Figure 8, is spaced from and parallel to the surface of the intercell partition with the exception of a narrow rib 55 extending along its lower edge and contacting the partition.

Mounted to slide in the recess 54 is a closure 56 in the form of a generally flat plate of the stepped form shown in Figures 6 and 7. At its right hand end as viewed in Figures 6 and 7 the closure 56 has an up-standing lug 57 carrying a pin 58. As shown in Figures 9 and 6 the outer end of the plate 52 is provided with a shallow flat groove 59 in which can slide an operating bar 60 having in it an oblique slot 61 into which the pin 58 projects. Thus as the operating bar 60 is moved up or down the oblique slot acts as a cam on the pin to move the closure between the open position of Figure 6 and the closed position of Figure 7.

Over the majority of its area the closure plate 56 has a thickness corresponding to the depth of the recess 54 in which it is received so as to occupy the whole space between the bottom of that recess and the face of the intercell partition.

At its forward end, however, it is provided with a portion 62 of reduced

thickness. This comprises a foot 63 arranged to extend under the intercell connector in the closed position of Figure 7. Below the foot the plate is again of its full thickness so as to provide a toe 64 at the end of a rib 65 which bears against the intercell partition so as to close the bottom of the mould. The toe 64 enters a groove or hole 66 in the body of the plate when the closure reaches its closed position of Figure 7.

Above the foot the leading end of the closure has a comparatively narrow vertical area 67 of reduced thickness so as to be spaced from the intercell partition to provide a side of the cavity around the one side (the right as viewed in Figures 6 and 7) of the intercell connector. Above this again is a top area 68 terminating at its left hand end in what may be termed a beak 69 having a sharp cutting edge to broach or gouge a shallow groove in the upper surface of the intercell connector bar. The beak is also received in a corresponding recess 70 in the body portion of the mould.

The operation of the embodiment shown in Figures 6 to 10 is very similar to that of Figures 2 to 5. The arrangement of Figures 6 to 10 is particularly adapted to quantity production and in a specific embodiment a group of moulds is assembled to seal all the intercell connectors of a battery simultaneously. In this case the moulds are preferably held stationary whilst each battery in turn is advanced beneath them on a conveyor and then raised on a lift so as to bring all the intercell partitions and connector bars up into register with the moulds which are then located astride the partitions and connector bars. The operating bars 60 are then actuated to close the closures of the moulds, and at the same time the beak of each closure broaches or gouges a shallow groove corresponding approximately to the depth of the meniscus formed across the top of the connector bar when it is cast in situ, so as to close the moulding cavity throughout the width of the bar.

In addition the operating mechanism and the closure and other parts of the mould are so dimensioned that opposed faces of the mould will bite into the sides of the connector bar to allow for any variations in the horizontal width of the connector bar, and close the cavity throughout the height of the bar.

Alternatively or in addition the toe of the closure may be formed with a cutting edge to broach or gouge a groove in the underside of the connector bar, again to ensure satisfactory sealing. In particular if the connector bars are cast in situ with the battery in an inverted position it may be

desirable to provide the foot with a cutting edge, whereas this may be unnecessary on the beak and indeed the beak may be omitted.

5 For the rest the operation is similar to that of Figures 2 to 5, the sealing material being injected after the closure has been moved to the closed position of Figure 7, thereafter allowed to cool, after which the
10 closure is returned to the open position of Figure 6 and the battery lowered away from the moulds.

It will be appreciated that the invention is not limited to the details of the embodiments described, which may be modified in many ways, whilst features described in connection with one modification may also be applied to others. Thus for example both the modifications of Figures
15 2 to 5 and of Figures 6 to 10 may be used either by lowering the mould on to a stationary battery or by raising the battery into engagement with a stationary mould. Again the moulds may be connected
20 together to seal a complete battery simultaneously, or individual moulds may be applied separately to the various connectors or again a single mould may be applied successively to one connector after another.
25 The methods described provide a convenient way of forming an effective seal, completely surrounding the intercell connector bar, to prevent leakage of electrolyte between adjacent cells. In some cases the
30 sealing material may be chosen to shrink more than the bar. As a further safeguard, or in particularly difficult conditions, the bar may be compressed longitudinally, after formation of the seal, to cause it to
35 expand within the sealing material and cause the latter to grip the bar more firmly and further improve the seal.

WHAT WE CLAIM IS:—

1. A mould for sealing an intercell connection in a multicell electric storage battery, comprising a body which has in the bottom a first groove to straddle the upper part of an intercell partition and a second groove at right angles to the first to
45 straddle an intercell connector bar passing through an aperture or notch in the partition, and closures which are carried by the body and which will lie one on each side of the partition and with the body afford a
50 marginal portion fitting against the face of the partition and defining a cavity surrounding the intercell connector in the region of the partition, in which the closures form the bottom of the cavity and each
55 closure is movable substantially horizontally from a closed position in which it extends under the bar, to an open position in which the bar and the moulded seal can move down relatively to and out of the mould.

65 2. A mould as claimed in Claim 1 in

which the body forms one side wall of the cavity and on the opposite side of the bar provides guides for the closure permitting it to move substantially horizontally between its closed and open positions.

3. A mould as claimed in Claim 1 or Claim 2 in which the cavity is closed at the top except for an injection nozzle through which sealing material can be injected under pressure.

4. A mould as claimed in Claim 2 or Claim 3 in which the body is adapted to form the side of the cavity between the connector bar and the side of the casing nearer to it, the closure being adapted to be withdrawn away from the side wall.

5. A mould as claimed in Claim 4 in which each closure also affords the end wall of the cavity under the connector bar.

6. A mould as claimed in Claim 4 or Claim 5 in which the closure has a cutter portion arranged to gouge or broach a groove in the upper or lower surface of the bar so as to close the cavity throughout the width of the bar.

7. A mould as claimed in any one of Claims 4 to 6 in which the closure and an opposed part of the body are arranged to bite into the sides of the bar to close the cavity throughout the height of the bar.

8. A mould as claimed in any one of the preceding Claims including a common operating member for simultaneously moving both closures between their open and closed positions.

9. A mould for sealing an intercell connection in a multicell electric storage battery as specifically described herein with reference to Figures 2 to 5 or Figures 6 to 10 of the accompanying drawings.

10. A method of sealing an intercell connection in a multicell electric storage battery using a mould as claimed in any one of the preceding Claims, which includes placing in the neighbouring cells plates connected by an intercell connector bar passing through an opening in the upper part of an intercell partition, sliding the closures of the mould to their open position, fitting the mould over the intercell connector bar and the partition so as to define a cavity round the opening sliding the closures horizontally to a closed position in which they extend under the bar to close the bottom of the cavity, introducing into the mould a plastics material which is compatible with the partition so as to seal the gap between the margins of the opening and the connector bar, when the sealing material has set removing the mould by sliding the closures horizontally to their open position, and moving the bar and seal downwards relatively to, and out of, the mould.

11. A method as claimed in Claim 10



desirable to provide the foot with a cutting edge, whereas this may be unnecessary on the beak and indeed the beak may be omitted.

5 For the rest the operation is similar to that of Figures 2 to 5, the sealing material being injected after the closure has been moved to the closed position of Figure 7, thereafter allowed to cool, after which the
10 closure is returned to the open position of Figure 6 and the battery lowered away from the moulds.

It will be appreciated that the invention is not limited to the details of the embodiments described, which may be modified in many ways, whilst features described in connection with one modification may also be applied to others. Thus for
15 example both the modifications of Figures 2 to 5 and of Figures 6 to 10 may be used either by lowering the mould on to a stationary battery or by raising the battery into engagement with a stationary mould. Again the moulds may be connected
20 together to seal a complete battery simultaneously, or individual moulds may be applied separately to the various connectors or again a single mould may be applied successively to one connector after another.

30 The methods described provide a convenient way of forming an effective seal, completely surrounding the intercell connector bar, to prevent leakage of electrolyte between adjacent cells. In some cases the sealing material may be chosen to shrink
35 more than the bar. As a further safeguard, or in particularly difficult conditions, the bar may be compressed longitudinally, after formation of the seal, to cause it to expand within the sealing material and
40 cause the latter to grip the bar more firmly and further improve the seal.

WHAT WE CLAIM IS:—

1. A mould for sealing an intercell connection in a multicell electric storage battery, comprising a body which has in the bottom a first groove to straddle the upper part of an intercell partition and a second groove at right angles to the first to
50 straddle an intercell connector bar passing through an aperture or notch in the partition, and closures which are carried by the body and which will lie one on each side of the partition and with the body afford a
55 marginal portion fitting against the face of the partition and defining a cavity surrounding the intercell connector in the region of the partition, in which the closures form the bottom of the cavity and each
60 closure is movable substantially horizontally from a closed position in which it extends under the bar, to an open position in which the bar and the moulded seal can move down relatively to and out of the mould.

65 2. A mould as claimed in Claim 1 in

which the body forms one side wall of the cavity and on the opposite side of the bar provides guides for the closure permitting it to move substantially horizontally between its closed and open positions.

3. A mould as claimed in Claim 1 or Claim 2 in which the cavity is closed at the top except for an injection nozzle through which sealing material can be injected under pressure.

4. A mould as claimed in Claim 2 or Claim 3 in which the body is adapted to form the side of the cavity between the connector bar and the side of the casing nearer to it, the closure being adapted to be withdrawn away from the side wall.

5. A mould as claimed in Claim 4 in which each closure also affords the end wall of the cavity under the connector bar.

6. A mould as claimed in Claim 4 or Claim 5 in which the closure has a cutter portion arranged to gouge or broach a groove in the upper or lower surface of the bar so as to close the cavity throughout the width of the bar.

7. A mould as claimed in any one of Claims 4 to 6 in which the closure and an opposed part of the body are arranged to bite into the sides of the bar to close the cavity throughout the height of the bar.

8. A mould as claimed in any one of the preceding Claims including a common operating member for simultaneously moving both closures between their open and closed positions.

9. A mould for sealing an intercell connection in a multicell electric storage battery as specifically described herein with reference to Figures 2 to 5 or Figures 6 to 10 of the accompanying drawings.

10. A method of sealing an intercell connection in a multicell electric storage battery using a mould as claimed in any one of the preceding Claims, which includes placing in the neighbouring cells plates connected by an intercell connector bar passing through an opening in the upper part of an intercell partition, sliding the closures of the mould to their open position, fitting the mould over the intercell connector bar and the partition so as to define a cavity round the opening sliding the closures horizontally to a closed position in which they extend under the bar to close the bottom of the cavity, introducing into the mould a plastics material which is compatible with the partition so as to seal the gap between the margins of the opening and the connector bar, when the sealing material has set removing the mould by sliding the closures horizontally to their open position, and moving the bar and seal downwards relatively to, and out of, the mould.

11. A method as claimed in Claim 10

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in which the closure has a cutter portion arranged to gouge or broach a groove in the upper or lower surface of the bar so as to close the cavity throughout the width of the bar.

12. A method as claimed in Claim 10 or Claim 11 in which the closure and an opposed part of the body are arranged to bite in to the sides of the bar to close the cavity throughout the height of the bar.

13. A method as claimed in any one of Claims 10 to 12 which includes compressing the bar longitudinally, after moulding the seal, to cause it to expand within the sealing material.

14. A method as claimed in any one of the Claims 10 to 13 in which the opening in the inter-cell partition is in the form of an open-topped notch through the lower part of which the inter-cell connector

passes, and the cavity of the mould extends up to the level of the top of the partition so as to fill the upper part of the notch above the bar with the sealing material.

15. A method as claimed in Claim 14 in which the thickness of the cavity over an area extending beyond the sides of the notch exceeds that of the partition whilst it has marginal portions fitting against the face of the partition to enclose the cavity.

16. A method of sealing an intercell connection in a multicell electric storage battery as specifically described herein with reference to Figures 2 to 5 or Figures 6 to 10 of the accompanying drawings.

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