

# PATENT SPECIFICATION (11)

1 430 205



1 430 205

- (21) Application No. 43839/73 (22) Filed 18 Sept. 1973 (19)  
(31) Convention Application No. 569/72 (32) Filed 25 Sept. 1972 in  
(33) Australia (AU)  
(44) Complete Specification published 31 March 1976  
(51) INT. CL.<sup>8</sup> H01M 4/73 2/24 2/28  
(52) Index at acceptance  
H1B 1006 212 224 228 414 468 473 474

## (54) IMPROVED BATTERY CONSTRUCTION

(71) We, DUNLOP AUSTRALIA LIMITED, a Company incorporated under the laws of the State of Victoria, Commonwealth of Australia, of 108 Flinders Street, Melbourne, State of Victoria, Commonwealth of Australia, 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 a multi-cell secondary battery such as a lead acid battery.

One of the major disadvantages of current constructions of lead batteries is the high weight and cost of the cell plates formed of a lead alloy grid pasted with active material. Also because of the low mechanical strength of the lead alloys used in grids, a substantial amount of alloy is used so that the grids, and hence the completed battery, is heavy and bulky.

The formation of an effective and desirable connection between the plates within each cell, and between assemblies of plates in adjoining cells is difficult to achieve by high volume production methods. The current trend is to make the connection between adjoining cells through an opening in the cell wall but this has produced problems in achieving an effective seal between the connecting member and the cell wall.

The present invention seeks to provide a battery construction which will overcome or at least reduce many of the problems of production and disadvantages in construction of presently known multi-cell batteries.

According to the invention there is provided a multi-cell battery including a plurality of frames formed of a material as herein specified, each frame defining a plurality of active material support spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frames, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent support spaces secured in a sealing relationship to the corresponding elements in adjoining frames to

form partitions between adjacent cells of the battery.

More particularly there is provided a multi-cell battery including a plurality of frames formed of a material as herein specified, each frame defining a plurality of active material receiving spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frame, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent receiving spaces secured in a sealed relationship to the corresponding elements in adjoining frames to form partitions between adjacent cells of the battery, and individual masses of active battery material supported in each space of each frame so that each space forms a plate of the battery, the active battery material in respective spaces being selected so that adjacent spaces in each frame form plates of opposite polarity and adjacent spaces in adjoining frames form plates of opposite polarity.

The frames of the battery are formed from a mouldable material which is electrically insulating at the intended operating voltage of the battery, and is inert to the active materials of the battery and any material produced during operation of the battery. Throughout this specification and the appended claims a material as above defined is referred to as "a material as herein specified". Suitable thermoplastic materials for use in the construction of frames are high impact polystyrene, ABS, and polypropylene.

Conveniently each frame is of rectangular form having a continuous perimeter member and a number of division elements parallel to two opposite sides of the frame to define the plurality of receiving spaces, the perimeter member and division elements of adjacent frames inter-fitting so that the perimeter member forms two opposite walls, a top, and a bottom of the battery and the division elements form the plurality of cell partitions of the battery.

There is thus provided a plurality of side by side column-like spaces in the frame to receive active material to form battery plates. Each column-like space may be divided into smaller spaces by a plurality of transverse elements preferably of lesser thickness than the division elements to provide additional support for the active material.

Preferably, the thickness of the frames varies so that alternate active material receiving spaces are thinner. The thinner spaces are pasted with a material to form a negative plate and the thicker spaces with a material to form a positive plate. This variation in thickness also enables the frames to inter-fit or nest when assembled in side by side relation.

Electrically conductive elements may be embedded in the members of the frame during moulding thereof and extend into the space which receives the active material to provide electrical collectors, support for the active material, and if desired, the electrical connection between spaces of negative and positive active material.

When the frames are pasted with active material and assembled side by side, a separator of porous material is inserted between the positive and negative paste in adjoining frames.

A battery formed by an assembly of frames as previously described has a number of cells determined by the number of active material spaces in each frame. The adjacent active material spaces in each two adjoining frames being of opposite polarity form a basic cell having a nominal voltage of 2 volts in the case of a lead acid cell. Thus the voltage and capacity of the battery is determined by the number of active material spaces in each frame and the number of frames in the assembly respectively.

Although it is possible to electrically connect the basic cells in any desired arrangement, this construction of battery is highly suitable for connecting the basic cells formed by two adjoining frames in series, and connecting the terminals of each pair of adjoining frames in parallel. When this arrangement of cell connections is used, suitable connector members may be located in the frame during moulding thereof to electrically interconnect the cells in the finished assembly of frames. If the basic cells formed by two adjoining frames are to be connected in series, an intercell connector member is provided in each alternative division element of the frame, with the intercell connector members in each frame staggered with respect to the connector members in the adjoining frame.

Also terminal members may be located in the sides of the frames during moulding, the location and number of terminal members being determined by whether the cells

are to be series or parallel connected, and the number of cells formed by each two frames. If there is an even number of active material receiving spaces in each frame, a terminal member is provided at each end of each alternate frame. Where there is an odd number of active material receiving spaces in each frame, there is a terminal member at alternate ends of adjoining frames. The terminal members of individual frames are interconnected by welding to a connector strap or by other convenient means, and the battery main terminals are suitably connected to the straps.

As previously indicated, the perimeter and the division elements are sealed together, with or without the provision of interfitting elements on adjoining frames, so that the assembly of frames forms the top, bottom, two opposite walls and cell partitions of the battery case. The battery case may then be completed by bonding cover plates to the exposed face of the two end frames of the assembly. Also suitable covers are provided if the frames have terminal members projecting from the sides of the frames coupled by a connector strap.

The invention will be more readily understood from the following description of two embodiments of the invention with reference to the accompanying drawings wherein:

Figure 1 is a general perspective view, partly in section, of a lead acid battery incorporating the present invention;

Figure 2 is a side elevation of one frame and grid assembly suitable for use in a battery shown in Figure 1;

Figure 3 is an enlarged cross-sectional view along line 3—3 in Figure 2;

Figure 4 is an enlarged sectional view along the line 2—2 in Figure 2;

Figure 5 is a plan view of the assembly as shown in Figure 2; and

Figure 6 is a partial sectional view of an alternative construction of the frames.

Referring now to the drawings, the battery 10 comprises a housing 11 enclosing an assembly of frame members 12 arranged and bonded together so as to form in the finished battery a plurality of cells 14 separated one from the other by partition walls, such as 13, which are composed of the abutting vertical elements of the respective frame members 12.

Referring now to Figure 2, each frame member 12 comprises a perimeter member 15 having top and bottom elements 16 and 17 and opposite side elements 18 and 19. Extending between the top and bottom elements 16 and 17 are division elements 20, 20a which are parallel to the side elements 18 and 19. The frame and the vertical division elements together define three column-like spaces 22, 23 and 24 which will, in the

finished battery, be pasted with appropriate active battery material.

The top and bottom elements and the side and division elements are provided on one face with a continuous tongue (Figures 3 and 4) at right angles to the general plane of the frame, and on the opposite face a continuous groove 28, so that when a plurality of frames are assembled in side by side relationship as shown in Figure 13, the tongue on one frame inter-fits with the groove on the adjoining frame. The inter-fitting tongue and groove are adhered or otherwise secured together, with or without the use of additional sealing compound, so that the connection between the top and bottom elements, the side elements and division elements in respective adjoining frames will not permit the leakage of electrolyte between the cells in the finished battery. As assembly of a plurality of frames of this construction provides an open ended box-like structure with internal partitions, the sides and top and bottom of the box being formed by the inter-fitting top and side bottom elements and the internal partitions being formed by the inter-fitting division elements 20, 20a.

The frames also include a plurality of vertically spaced support elements 30 extending between the opposite side elements 18, 19 and integral with the division elements 20, 20a. In the frame shown in Figure 2 there are three support elements and these elements are of a thickness less than the thickness of the side and division elements and their respective tongues so that when a number of frames are assembled in a side by side relationship, the support elements in adjoining frames are spaced one from the other. The support elements 30 divide the space between the respective division elements so that the active battery material subsequently located between the division elements is given additional support and will not become dislodged during service.

In the preferred form, grid-like structures 26, 26a are provided to span part or all of the space between the respective division elements 20, 20a to provide even further support for the active battery material. The grids may be formed of the same material as the remainder of the frame and moulded as an integral part thereof, but preferably are made of an electrically conductive material, such as lead alloy, which is not adversely affected by the materials of the battery, and are embedded in the elements of the frame during the moulding of the frame.

In the embodiment shown in Figure 2 the grid 26 extends through the side element 18 of the frame and is embedded in, but does not extend through the adjacent division element 20. The portion of the grid 26 external of the frame provides a terminal for

electrically connecting the cells constituted by an assembly of frames. The grid 26a extends through the other division element 20a and is embedded in but does not extend through the side element 19. The grid 26a thus forms an intercell connector between plates formed by the material in the spaces 23 and 24. The grids 26 and 26a thus provide support for the active battery material, act as a current collector for the respective plates, and form intercell connectors and/or terminals as required in respect of cells formed by the assembly of frames in the finished battery.

During the pasting of the frames the area above the upper support element 30 in each frame is not pasted so that when the frames are assembled together electrolyte reservoirs 31 are formed as shown in Figure 1. Also during assembly, separator strips 32 are inserted between the plates in adjoining frames. The separators perform their normal function in a battery, and are made of conventional material.

In order to assist the gas, generated when the battery is in use, to escape from between the plates, vent strips 33 made of porous material extend vertically through the frames containing active material. The vent strip may be added to the frame prior or during the pasting operation, or may be located in the mould during moulding of the frame so that the vent strips are bonded to the support elements 30.

In order to form a battery such as is shown in Figure 1, a plurality of frames of the construction shown in Figure 2 are individually pasted with conventional active battery material; the construction of the frames being such that it permits the adjacent spaces 22, 23 and 24 to be pasted with active material of different polarity. Thus each frame forms a plurality of side by side plates of alternative positive and negative polarity. A number of these frames are then assembled together in a side by side relationship with each plate in each frame, adjacent a plate of opposite polarity in the adjoining frame. In assembling the frames, the tongues and grooves on adjoining frames interfit and are sealed together. The series of cells so formed by each two adjoining frames are electrically connected in series by the grids, such as 26a, provided in each alternate division element of each frame, and as each frame shown in Figure 2 has an odd number of plates there will be positive and negative terminal tags 37 formed by the portions of the grids, such as 26, external of the frames at alternate ends of adjoining frames as seen in Figure 5. The terminal tags 37 at opposite ends of the assembly of frames are then interconnected by welding or other convenient means to respective connector straps 35 and the battery

(13)

main terminals such as 36 are suitably connected to the straps.

Although the assembly of frames will form a top, bottom and two opposite side walls, the remaining two sides include exposed active material and two side plates 38 are secured to these two sides to complete the battery case. In some applications it is also desirable to provide cover plates 39 for the terminal tags and connector straps, and these cover plates may be secured to the side plates 38. The cover 40 is also provided with openings 41 which align with openings 42 formed in the top face of the assembly of frames, to enable the introduction of electrolyte to each cell of the battery.

It will be appreciated that by suitable adaptation of the construction of the frames, the cover plates and/or top cover may not be required.

Referring now to Figure 6, there is here shown a horizontal section through an assembly of complementary frames of a battery of the same basic construction as previously described, but wherein the individual frames are of an alternative construction. The side element 50 and division elements 51 are each of step shaped cross section arranged so that in assembly the step shaped sections interfit. In addition the stepped shape of the element results in the frame having alternate thick and thin active material receiving spaces. As more positive active material is required in a normal battery than negative active material, the thick area of the frame is pasted with positive active material and the thin area with negative active material.

The arrangement of the current collectors, intercell connectors, terminal tabs and separator strips is the same as previously described with reference to Figure 2 to 4. The frames are also provided with tongue and groove elements that interfit on assembly of the frames to locate and hold the frames, and provide a sealed joint between the cells in the finished battery.

Some of the advantages of the battery constructed in accordance with the above embodiment are:—

1. The reduction of battery weight and size by elimination of bulky lead alloy grids;
2. Elimination of forming intercell connections during assembly, with the avoidance of consequent sealing problems;
3. The possibility to eliminate a separate battery case;
4. Additional support for active material to eliminate shedding of active material;
5. Increased capacity per unit weight of battery.

WHAT WE CLAIM IS:—

1. A multi-cell battery including a plur-

ality of frames formed of a material as herein specified, each frame defining a plurality of active material support spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frame, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent support spaces secured in a sealed relationship to the corresponding elements in adjoining frames to form partitions between adjacent cells of the battery.

2. A multi-cell battery including a plurality of frames formed of a material as herein specified, each frame defining a plurality of active material support spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frame, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent support spaces secured in a sealed relationship to the corresponding elements in adjoining frames to form partitions between adjacent cells of the battery, and individual masses of active battery material supported in each space of each frame so that each space forms a plate of the battery, the active battery material in respective spaces being selected so that adjacent spaces in each frame form plates of opposite polarity and adjacent spaces in adjoining frames form plates of opposite polarity.

3. A battery as claimed in Claim 2 wherein a terminal member extends from the active material of a plate at one side of each frame through said side of the frame, and a connector member extends through each alternate division element of the frame counted from said one side to electrically connect the plates of opposite polarity separated by said division element.

4. A battery as claimed in Claim 2 wherein each frame is of rectangular form having a continuous perimeter member and a number of division elements parallel to two opposite sides of the frame to define the plurality of receiving spaces, the perimeter member and division elements of adjoining frames inter-fitting so that the perimeter member forms two opposite walls, a top, and a bottom of the battery and the division elements form the cell partitions of the battery.

5. A battery as claimed in Claim 2 wherein the frame members are adapted to interfit one with the other when assembled in the side by side relation.

6. A battery as claimed in Claim 2, 3



main terminals such as 36 are suitably connected to the straps.

Although the assembly of frames will form a top, bottom and two opposite side walls, the remaining two sides include exposed active material and two side plates 38 are secured to these two sides to complete the battery case. In some applications it is also desirable to provide cover plates 39 for the terminal tags and connector straps, and these cover plates may be secured to the side plates 38. The cover 40 is also provided with openings 41 which align with openings 42 formed in the top face of the assembly of frames, to enable the introduction of electrolyte to each cell of the battery.

It will be appreciated that by suitable adaptation of the construction of the frames, the cover plates and/or top cover may not be required.

Referring now to Figure 6, there is here shown a horizontal section through an assembly of complementary frames of a battery of the same basic construction as previously described, but wherein the individual frames are of an alternative construction. The side element 50 and division elements 51 are each of step shaped cross section arranged so that in assembly the step shaped sections interfit. In addition the stepped shape of the element results in the frame having alternate thick and thin active material receiving spaces. As more positive active material is required in a normal battery than negative active material, the thick area of the frame is pasted with positive active material and the thin area with negative active material.

The arrangement of the current collectors, intercell connectors, terminal tabs and separator strips is the same as previously described with reference to Figure 2 to 4. The frames are also provided with tongue and groove elements that interfit on assembly of the frames to locate and hold the frames, and provide a sealed joint between the cells in the finished battery.

Some of the advantages of the battery constructed in accordance with the above embodiment are:—

1. The reduction of battery weight and size by elimination of bulky lead alloy grids;
2. Elimination of forming intercell connections during assembly, with the avoidance of consequent sealing problems;
3. The possibility to eliminate a separate battery case;
4. Additional support for active material to eliminate shedding of active material;
5. Increased capacity per unit weight of battery.

#### WHAT WE CLAIM IS:—

1. A multi-cell battery including a plur-

ality of frames formed of a material as herein specified, each frame defining a plurality of active material support spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frame, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent support spaces secured in a sealed relationship to the corresponding elements in adjoining frames to form partitions between adjacent cells of the battery.

2. A multi-cell battery including a plurality of frames formed of a material as herein specified, each frame defining a plurality of active material support spaces arranged in side by side relationship across the width of the frame, each frame including elements forming divisions between adjacent support spaces of the frame, the frames being arranged in a side by side relationship in a direction normal to the width of each frame with the elements of each frame forming the divisions between adjacent support spaces secured in a sealed relationship to the corresponding elements in adjoining frames to form partitions between adjacent cells of the battery, and individual masses of active battery material supported in each space of each frame so that each space forms a plate of the battery, the active battery material in respective spaces being selected so that adjacent spaces in each frame form plates of opposite polarity and adjacent spaces in adjoining frames form plates of opposite polarity.

3. A battery as claimed in Claim 2 wherein a terminal member extends from the active material of a plate at one side of each frame through said side of the frame, and a connector member extends through each alternate division element of the frame counted from said one side to electrically connect the plates of opposite polarity separated by said division element.

4. A battery as claimed in Claim 2 wherein each frame is of rectangular form having a continuous perimeter member and a number of division elements parallel to two opposite sides of the frame to define the plurality of receiving spaces, the perimeter member and division elements of adjoining frames inter-fitting so that the perimeter member forms two opposite walls, a top, and a bottom of the battery and the division elements form the cell partitions of the battery.

5. A battery as claimed in Claim 2 wherein the frame members are adapted to interfit one with the other when assembled in the side by side relation.

6. A battery as claimed in Claim 2, 3



14

5

1,430,205

5

or 4 wherein each division element of each frame is formed with a laterally projecting tongue on one side and a groove on the opposite side, said tongue and groove extending the full length of the division element and being arranged so that when the frames are assembled in side by side relation, the tongues on one frame engage the grooves on the adjoining frame.

7. A multi-cell battery as claimed in Claims 2 or 6 wherein each pair of adjoining frames forms a number of single cell batteries equal to the number of division elements in a frame plus one, and said single cells are electrically connected in series by connector members extending through selected division elements.

8. A multi-cell battery as claimed in Claim 7 wherein terminal members are provided on selected frames so that the assemblies of series connected cells formed by each pair of frames may be electrically connected to battery terminals.

9. A multi-cell battery comprising a plurality of frames of a material as herein specified, each frame including a continuous perimeter member of rectangular shape and a number of division elements parallel to two opposite sides of the frame, said perimeter member and division elements defining a plurality of active material support spaces arranged in side by side relation across the width of the frame, the frames being arranged in side by side relation in a direction normal to the width of the frames, the peri-

meter member and division elements of each frame interfitting with the corresponding portion of the adjoining frame and being secured thereto in sealed relation to form two opposite side walls, a top, a bottom and a plurality of cell partitions of the battery, one of said sides of each frame having a metallic terminal member embedded therein and projecting externally of the frame and into the receiving space adjacent said side of the frame, metallic intercell connector members embedded in each alternate division element and extending into the receiving spaces on opposite sides of said division element, and individual masses of active battery material supported in each receiving space of each frame so that each space forms a plate of the battery, the active battery material in respective spaces being selected so that adjacent spaces in each frame form plates of opposite polarity and adjacent areas in adjoining frames form plates of opposite polarity, whereby each pair of frames forms a plurality of single cells electrically connected in series.

10. A multi-cell battery as herein described with reference to Figures 1 to 5 or 1 and 6.

STEVENS, HEWLETT & PERKINS,  
Chartered Patent Agents,  
5, Quality Court,  
Chancery Lane,  
London, W.C.2.  
Tel. 01-405 8393.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1976.  
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,  
from which copies may be obtained.