Aug. 4, 1964 J. S. ASHWORTH 3,143,585

ELECTRIC ACCUMULATORS OF THE LEAD-ACID TYPE

Filed May 12, 1961 2 Sheets-Sheet 1

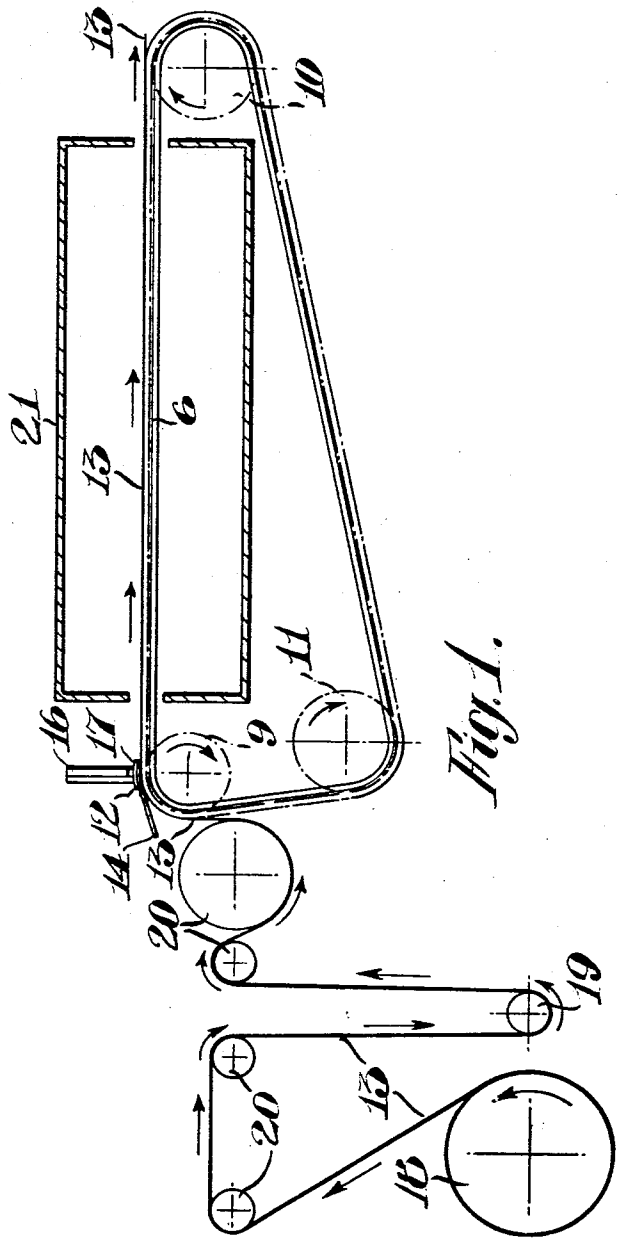

Fig. 1.

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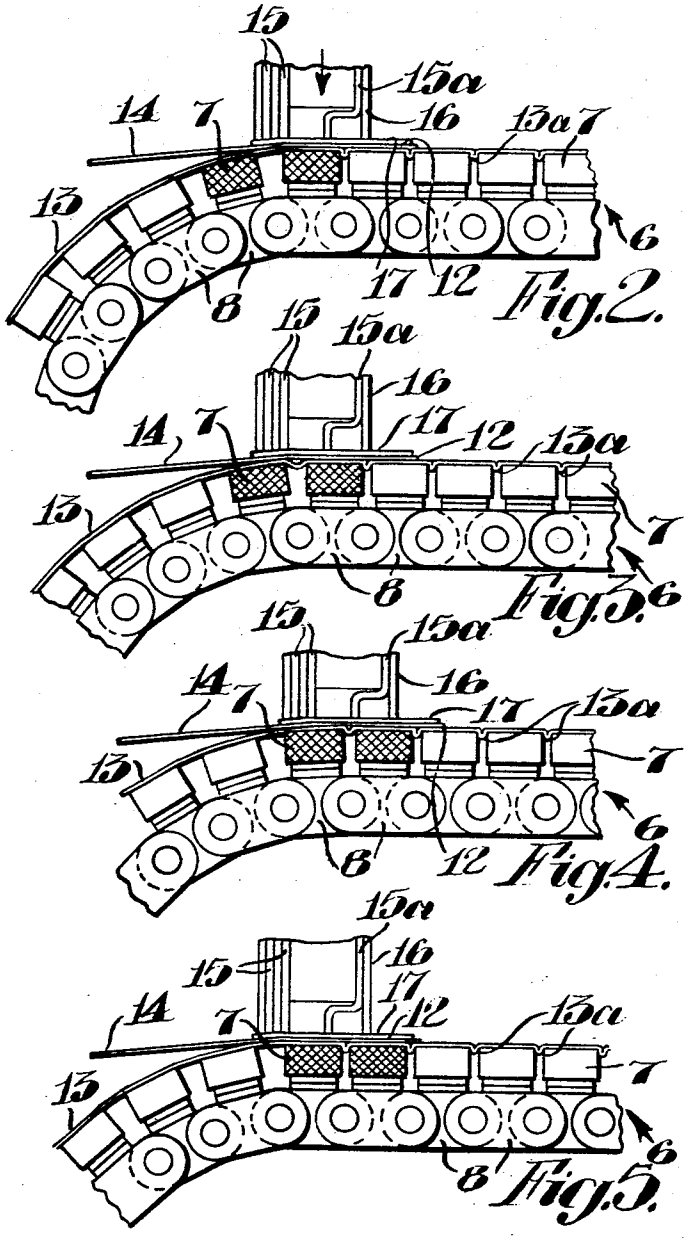
Filed May 12, 1961 2 Sheets-Sheet 2



United States Patent Office 3,143,585 Patented Aug. 4, 1964

3,143,585

ELECTRIC ACCUMULATORS OF THE LEAD-ACID TYPE

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Filed May 12, 1961, Ser. No. 109,631
Claims priority, application Great Britain May 17, 1960
5 Claims. (Cl. 264—285)

This invention relates to ribbed separators for use between the plates of electric accumulators of the lead-acid type. It is particularly concerned with an improved method and apparatus for the manufacture of separators of felted fibrous material, comprising for example cotton linters or a mixture thereof with wood pulp or with other natural or synthetic fibres. Such a material may be provided in sheet form and impregnated with a suitable resin which at a later stage may be cured to impart to the formed separators the required strength and rigidity.

In British Patent No. 824,025 there is described a method of producing ribbed felted fibrous separators by crimping in which the resin impregnated sheet material is passed between laths on an endless conveyor supported by a wheel or wheels and a wheel or drum having peripheral ribs which extend in parallel relationship across its face, the laths being relatively widely spaced where the peripheral ribs force the sheet material into the gaps between the laths, the latter and the conveyor then travelling in a straight line which causes the gaps between the laths to decrease so that the sheet material in the gaps is tightly trapped, squeezed and made into solid ribs with the opposite walls of the ribs adhering together.

The ribbed material, while still travelling on the conveyor in a straight line with the ribs squeezed between the laths, is then passed through a curing oven to cure the resin in the material and bind the ribs permanently into solid form.

It has been found in practice in the production of separators by the above method that there is a tendency for the individual web portions between adjacent pairs of ribs to become slightly bowed. This is due to the actual extent of contact between the periphery of the said wheel or drum and the sheet material being relatively short, and to the fact that the sheet material is not held firmly against the supporting laths during the formation of the ribs and while the gaps between the laths are decreasing. In order to ensure that the finished separators shall be sufficiently flat over their whole extent to be acceptable for use, it has been found desirable to introduce a further step in their manufacture whereby the said web portions are subjected to a straightening operation.

The above prior method is also limited in its range of usefulness in that it is not possible easily and conveniently to adapt the rib-forming wheel or drum in order to produce a range of separators in which the heights of the ribs may vary considerably between different types.

An object of the present invention is to provide an improved alternative method for the manufacture of such ribbed felted fibrous separators. The invention further includes the provision of apparatus for carrying out the said improved method.

According to the present invention there is provided a method of producing ribbed separators for electric accumulators of the lead-acid type comprising passing resin impregnated sheet material between a stationary member having a smooth surface and spaced laths carried on an endless conveyor, the material being introduced therebetween at a point where the laths are supported by an element selected from the group consisting of a wheel, drum and the like and over and around which element the conveyor passes and where the laths are relatively widely spaced, and subjecting the said member to pressure whereby the material is held firmly against the supporting faces of the laths without moving relatively thereto, the spaces between the laths decreasing as the laths enter a straight run portion of the conveyor whereby the excess sheet material between the laths folds itself into the decreasing gaps where it is tightly trapped and squeezed between adjacent laths to form solid ribs, pressure being maintained on the sheet material through the said member over a distance along the straight run portion embracing at least the trailing edge of one lath when the next following lath is fully entered on the said straight run portion.

According to a further aspect of the invention, there is provided apparatus for producing ribbed separators for electric accumulators of the lead-acid type comprising a lath type endless conveyor running over an element selected from the group consisting of a wheel, drum and the like in which the said element provides support for the laths of the conveyor as they travel around and over it, a stationary member located over the conveyor to overlie at least a portion of the supported part of the conveyor where the laths are relatively widely spaced and extending along a straight run portion of the conveyor a sufficient distance to embrace at least the trailing edge of one lath when the next following lath is fully entered on the said straight run portion and means exerting pressure on the said member, the said stationary member having a smooth surface beneath which the laths pass whereby material fed on to the conveyor between it and the member will be held firmly against the supporting faces of the laths without moving relatively thereto, due to the pressure exerted through the said member, while sliding freely along the said smooth surface.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic sectional view of apparatus for carrying out the method of producing ribbed separators according to the invention, and

FIGURES 2 to 5 are fragmentary sectional views of a portion of the apparatus illustrating successive stages in the formation of a rib in the separator forming material.

Referring to the drawings, a lath type endless conveyor 6 comprises transverse laths 7 secured at their ends to the links of chains 8 driven by sprocket wheels (not shown), the said laths being supported where the chains 8 pass around the wheels by drums 9, 10 and 11 extending between the wheels. In such a conveyor the laths 7 are brought relatively close together when travelling over a straight run portion of the conveyor but are spaced more widely when the conveyor passes around the supporting drums 9, 10 or 11.

An elongated strip 12 extending over the width of the sheet material 13 from which the separators are to be made is supported above the conveyor where it passes around the supporting drum 9. The undersurface of the strip 12 adjacent the upper faces of the laths 7 is polished. The strip 12 overlies a portion of the straight run of the conveyor 6 and also extends back over at least a portion of that part of the conveyor where it passes around the supporting drum 9. The strip 12 curves slightly to follow part of the curve of the conveyor 6 around the drum 9, the extent of this curved portion depending on factors to be explained in more detail hereinafter. Beyond the curved portion, the strip has an extension 14 in the form of a further straight portion, which leaves the track of the conveyor to provide a lead-in for material 13 entering between the strip and the conveyor.

Spring loaded pressure plates **15** carried on a transverse supporting member **16** bear down on the elongated strip **12**, the plates acting through a pressure pad **17** resting on the strip. One of the pressure plates **15***a* adjacent one side of the supporting member **16** is cranked beneath the member to provide a more even distribution of the pressure applied to the pad **17**. The pad **17** follows the curved form of the strip **12**, and the pressure plates **15** are adjustable along the length of the pad **17** to vary the location of the area of maximum effective pressure as transmitted through to the elongated strip **12**.

In order to carry out the invention, the fibrous sheet material **13** is first impregnated with an aqueous solution of phenolformaldehyde resin and is passed through an oven where it is dried but under conditions which do not allow the resin to cure. The material is then collected in the form of large rolls, one of these rolls **18** being represented in FIGURE 1 of the drawings.

From the roll **18**, the material **13** is fed over a tensioning roller **19** and suitable guide rollers **20** on to the conveyor **6** where it then passes beneath the polished surface of the strip **12**. As the material **13** passes below the pressure pad **17** and in particular comes within the area of the maximum effective pressure, depending on the position of the pressure plates **15**, it is pressed firmly by the strip **12** against the supporting faces of the laths **7**. Thus while still sliding freely along and beneath the strip **12**, the material **13** is held flat against the laths **7** and is prevented from moving longitudinally relatively thereto. In particular, the material **13** is held firmly against the trailing edge of one lath and against the leading edge of the next following lath, and the amount of material spanning the gap between the two laths is maintained constant. Thus as the laths **7** of the conveyor pass around the supporting drum **9** and begin to close up as they approach the straight run portion, the excess material **13** between adjacent pairs of laths **7** folds itself into the decreasing gaps until it becomes eventually trapped and squeezed to form solid ribs **13***a*. Furthermore the intermediate web portions of the sheet material **13** between successive ribs **13***a* are held flat against the supporting laths **7** all the time the rib formation is taking place, and once the material **13** is travelling along the straight run portion of the conveyor the said web portions are maintained flat due to the formed ribs **13***a* still being tightly gripped between adjacent laths **7**.

It will be appreciated that it is essential for the pressure exerted through the strip on to the material to be effective at least over an extent which will still embrace the trailing edge of one lath when the following lath is fully entered on the straight run portion. In other words, pressure must be maintained on the material **13** to hold it firmly against the supporting laths **7** on either side of the rib **13***a* until the rib is completely formed, following which the closed-up laths **7** hold the material against any possibility of subsequent movement. While the foregoing represents the minimum essential requirement, in practice and as shown in the drawings there is provided a strip **12** and pressure pad **17** which extend a distance along the straight run portion of the conveyor **6** approximately equivalent to the space occupied in the straight run portion by two adjacent laths **7**. The conveyor **6** then continues on the straight run and travels through a suitably heated oven **21** (FIGURE 1) where the ribbed sheet is cured sufficiently to set the ribs **13***a* and maintain the intermediate web portions in their flat condition. Reaching the supporting drum **10** at the far end of this straight run portion, the laths **7** open out as the conveyor **6** passes therearound thereby releasing the ribbed sheet so that it can be led off the conveyor. The material **13** is then fed through a second oven (not shown) under conditions which fully cure the resin, so that the ribs **13***a* are rendered permanently solid, and is finally carried to a guillotine where it is cut into suitable lengths for use as separators.

Using the method and apparatus of the present invention it is very simple to vary the height of the formed ribs **13***a* as will now be explained. It will be appreciated that the height of the formed ribs depends on the precise extent of the gap between adjacent laths **7** which exists at the time the conveyor **6** enters the area of pressure as transmitted through the elongated strip **12**, that is at the time the material **13** is first effectively held against both the trailing edge of one lath **7** and the leading edge of the next following lath. Accordingly by varying the extent of the area of effective pressure in relation to the curved path of the conveyor around the sprocket wheels, i.e., between the positions where the gaps between the laths are at their maximum and minimum, the amount of material **13** held between the edges of adjacent laths **7** can be varied and hence the height of the subsequently formed rib **13***a* will also be varied. The foregoing may be accomplished either by varying the extent of the curved part of the strip **12** which follows the contours of the conveyor, so that the material **13** is held firmly against the laths **7** relatively sooner or later in its path of travel, or by varying the position at which the pressure first becomes effective as transmitted through the pressure pad **17**. The second method is simpler and is more convenient for rapid changes. Thus the position of the pressure plates **15** is varied along the length of the strip **12**.

What I claim is:

1. In a method of producing ribbed separators for electric accumulators of the lead acid type wherein a resin-impregnated sheet material is conveyed on spaced laths on an endless conveyor and ribs are formed in said sheet material as the laths pass along an element defining a curvilinear path and the distance between adjacent laths is decreased, the improvement which comprises:

providing a stationary member having a smooth planar surface facing the laths on said endless conveyor;

introducing said sheet material between said stationary member and said laths, at a point where the laths are supported by an element defining a curvilinear path, over and around which element the conveyor passes and along which the laths are relatively widely spaced from one another;

holding said sheet material firmly against the supporting faces of said laths without moving relatively thereto, by applying presure to said stationary member, the spaces between said laths decreasing as the laths enter a straight run portion of the conveyor whereby the stationary member causes the excess sheet material between the laths to fold itself into decreasing gaps and to be tightly trapped and squeezed between adjacent laths to form solid ribs; and

maintaining presure on said sheet material, by means of the smooth planar face of said stationary member, said pressure being maintained over a distance along the straight run portion of said lath conveyor, and embracing at least the trailing edge of one lath when the next following lath is fully entered onto the said straight run portion.

2. A method according to claim 1, comprising advancing the material-carrying conveyor through a primary heating zone to cure the ribbed material sufficiently to set the ribs and maintain the intermediate web portions in a flat condition.

3. Apparatus for producing ribbed separators for electric accumulators of the lead-acid type comprising a lath type endless conveyor running over an element defining a curvilinear path in which the said element provides support for the laths of the conveyor as they travel around and over it, a stationary member located over the conveyor to overlie at least a portion of the supported part of the conveyor where the laths are relatively widely spaced and extending along a straight run portion of the

conveyor a sufficient distance to embrace at least the trailing edge of one lath when the next following lath is fully entered on the said straight run portion and means comprising spring loaded pressure plates which act through a pressure pad resting on the stationary member for exerting pressure on the said member, the said stationary member having a smooth planar surface beneath which the laths pass whereby material fed on to the conveyor between it and the member will be held firmly against the supporting faces of the laths without moving relatively thereto, due to the pressure exerted through the said member, while sliding freely along the said smooth surface.

4. Apparatus according to claim 3, in which the stationary member comprises an elongated strip which extends over at least the width of the sheet material and overlies and follows the contours of at least a portion of

the straight run of the conveyor and also at least a portion of that part of the conveyor which passes round the supporting element.

5. Apparatus according to claim 4, in which the underside of the strip is polished.

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