April 22, 1958 H. R. ORTEGA 2,832,015

RECTIFIER DEVICE

Filed Jan. 3, 1956

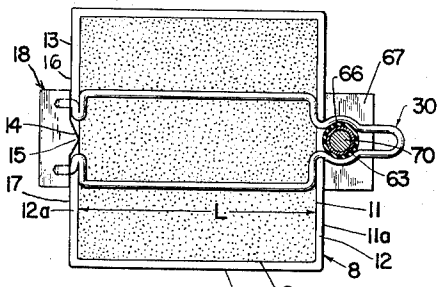

FIG. 2.

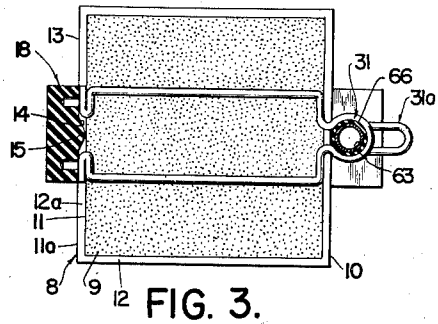

FIG. 3.

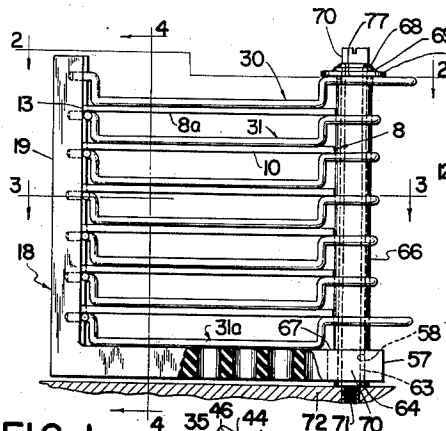

FIG. 1.

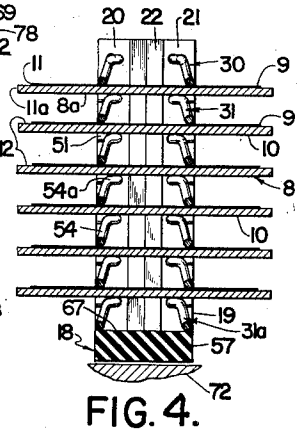

FIG. 4.

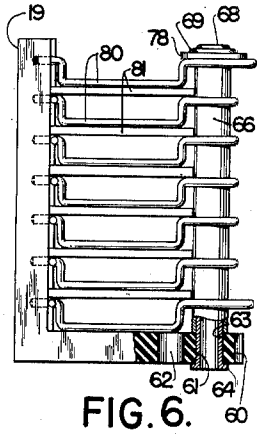

FIG. 6.

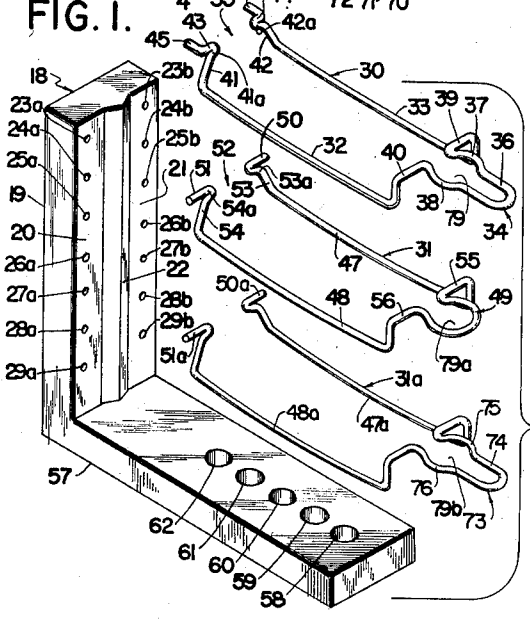

FIG. 5.

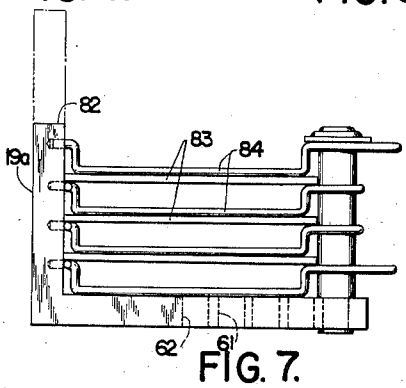

FIG. 7.

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RECTIFIER DEVICE

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18 Claims. (Cl. 317—234)

This invention relates to rectifier stacks of the dry cell type, such as of the selenium category.

In the formation of an assembly of dry cell rectifier plates, it is necessary to provide against a shifting of the cells relative to each other, as well as to avoid overheating. The shifting of one or more cells obviously causes a loss of efficiency; and this is also caused by overheating, which can also cause possible damage to the device. Various conventional expedients have been employed to avoid these conditions. To prevent a shifting of the cells, they are frequently provided with oppositely disposed cut-out portions coactively held together by a more or less complicated arrangement of holding posts or other securing means. Another common expedient is to employ cells provided with center holes through which extends a center post coactively associated with other clamping or holding components. In both of these assembly methods, there is a loss of various amounts of the active area of the cells, with a corresponding decrease of capacity. Even in the center hole type employing a central perforated disk as a spacer, it has been found that a considerable amount of area is lost within the periphery of the disk.

In the non-perforated type of cells, the common practice has been to employ spacer elements between the cells. Due to the fact that there is a relatively limited contact area between the spacers and the opposing surfaces of the plates, considerable heat is generated, thereby making it necessary to provide the spacers with fins, ribs, or other undulating elements to facilitate the dissipation of heat. Such constructions are difficult to fabricate and are generally expensive. Moreover, radiator fins or similar elements in this type of construction are often arranged to protrude outwardly from the insulating housing, to enhance the heat dissipating effect. This creates a short-circuit hazard, making it necessary to keep the device away from metallic conductors.

It is an important objective of my invention to provide an effective rectifier stack having none of the aforesaid shortcomings and disadvantages. It is particularly my objective, in certain aspects of the invention, to provide a simple construction which will obviate the danger of the shifting of non-perforated cells relative to each other, as well as to provide cells of this category with maximum effective area.

In conventional stack assembly devices of non-perforated cells where there is an excessively limited contact area between the spacers and the cells engaged, there is generated, as hereinabove indicated, intense heat in the regions of contact. It is within the contemplation of this invention to provide a novel form of spacer element providing a relatively large area of contact, whereby the danger of overheating is reduced to a minimum.

Because of the aforesaid limited area of contact between the spacers and the engaged cells in conventional structures, it has been found necessary to provide relatively great pressures between the spacers and the cells so as to assure firm contact therebetween. Such excessive pressures have frequently caused damage to active rectifier

surfaces, such as to the selenium crystal layers commonly used in dry cell rectifiers. With the novel form of spacer used in this invention, relatively large areas of contact are obtained with light and uniform engagement pressures along the regions of contact, obviating the need to employ pressures which might cause injury to the active rectifier material. Rectifier stacks made according to my invention accordingly are superior to the conventional rectifier stacks in that they have better electrical characteristics, less current leakage, more constant forward current, and a longer life.

It is also within the contemplation of this invention to provide a structure adapted to accommodate assemblies of different numbers of cells and of different sizes. For example, it is possible for the holder component of my invention to employ a single dry cell, or a stack of any number of cells up to the predetermined maximum limit of the device. It is also possible for the holder to accommodate cells of various lengths, within limits, so as to provide for rectifier stacks of different ranges of ratings.

It is a further object of this invention to provide spacer members that are light in weight, with effective spring action, and which are relatively simple to fabricate.

Another object of my invention is to provide a rectifier stack assembly of stable structure, of less bulk than is characteristic of many conventional devices, and of relatively low cost.

Other objects, features and advantages will appear from the drawings and the description hereinafter given.

In the drawings:

Fig. 1 is a side elevation of a stack of rectifier cells constructed, supported and arranged according to my invention, a fragment being sectioned for clarity.

Fig. 2 is a sectional plan view of Fig. 1 taken along line 2—2.

Fig. 3 is a section of Fig. 1 taken along line 3—3.

Fig. 4 is a vertical section of Fig. 1 taken along line 4—4.

Fig. 5 is a perspective view of the main holder component of my invention, showing three spacer members in disassembled relation.

Fig. 6 is a view substantially like Fig. 1, showing the holder adapted to rectifier cells and spacers of relatively short proportions, the base of the holder of Fig. 1 having been shortened and the bolt removed.

Fig. 7 is a view substantially like Fig. 1, the upright portion of the holder having been shortened from original proportions shown by dot-dash lines, this device operatively accommodating fewer cells than the structure of Fig. 1, the bolt shown in Fig. 1 having been removed.

In the particular form of my invention illustrated, a plurality of non-perforated rectifier cells 8 are employed, the upper surface of each of said cells containing a coating 9 comprising a layer of active material, such as selenium crystals with overlying layers of a barrier material and a low-melting point metallic electrode—the lower surface 10 being of the base material of the plate, such as aluminum. The coating 9 has a periphery 11 which is in close spaced relation to the periphery 11*a* of the cell thereby providing a narrow uncoated peripheral margin 12. Preferably at the middle of one edge 13 of the cell is a notched portion 14 contained entirely within the confines of the adjacent marginal portion 12*a*. In the specific embodiment illustrated, said notched portion is of shallow V-shaped configuration, the apex 15 being disposed outside of the coating 9. It is hence obvious that in this construction the notched portion 14 occupies the relatively narrow inactive marginal portion of the cell. Flanking the notched portion 14 of each cell are the two flat edges 16 and 17, these being aligned and in one plane.

The main holder component of my invention comprises a substantially L-shaped member 18 of electrical insulat-

ing material, and consisting of an upright portion 19 and a base 57. The upright portion contains two laterally spaced parallel flat walls 20 and 21 in one vertical plane, and flanking the protruding ridge 22 extending vertically from the top to the bottom of said upright portion 19. In the particular embodiment illustrated, said ridge 22 is of shallow V-shaped cross-section, proportioned for entry into the said shallow V-shaped notch 14 of said rectifier cells 8.

In the said walls 20 and 21 of the upright portion 19 are laterally spaced pairs of holes designated 23*a* and 23*b*, 24*a* and 24*b*, 25*a* and 25*b*, 26*a* and 26*b*, 27*a* and 27*b*, 28*a* and 28*b*, and 29*a* and 29*b*, the holes of each pair being in the same horizontal plane. Each pair of holes is adapted to accommodate a pair of terminals of spacer members hereinbelow described.

There are three types of spacer members, the uppermost member 30, the lowermost member 31*a*, and the other spacer members generally designated by the reference numeral 31. Each of the spacer members is of generally U-shaped configuration with a closed looped portion at one end having a section proportioned for embracing engagement with an insulating post (to be hereinafter described), with a pair of longitudinal arms for engagement with the upper active coating of an underlying rectifier cell, and with an open terminal portion having a pair of terminal sections for engagement with the said upright portion of the holder, as will more clearly hereinafter appear. The arrangement is such that each rectifier cell is positioned between an upper and a lower spacer and maintained in proper immovable position relative to the other cells and the entire structure, whereby the opposing surface of the cells may effectively serve as electrodes for the current passing through the rectifier stack.

Referring specifically to the spacer member 30, which is positioned at the top of the stack, it comprises two substantially parallel arms 32 and 33 slightly bowed downwardly, said spacer member having a closed end generally designated 34 and an open end generally designated 35. The closed end contains an elongated looped portion 36 adapted to receive a conductor suitably secured thereto (as by soldering) and two outwardly oppositely curved arcuate portions 37 and 38, the said closed end 34 being disposed at a level above that of the arms 32 and 33. Joining said arms 32 and 33 to the closed end 34 are the two connecting sections 39 and 40 (shown of bent configuration). At the open end 35 of the spacer member are two generally upwardly extending sections 41 and 42 carrying, respectively, the horizontal bearing portions 43 and 44, the latter two being in one horizontal plane and preferably in the same vertical plane, and being positioned for bearing contact with the said flat walls 20 and 21, respectively. In the embodiment illustrated said sections 41 and 42 also comprise sections 41*a* and 42*a*, these being in the same horizontal plane as portions 43 and 44, the latter being folded-back continuations of said sections 41*a* and 42*a*, respectively. Extending from said bearing portions 43 and 44 in substantially the direction of said arms 32 and 33 are the terminal fingers 45 and 46, these being proportioned, positioned and spaced apart for entry within any one of said pairs of holes on upright wall 19, such as 23*a*, 23*b*. The said terminal fingers 44 and 45 are at the same horizontal level, and in the same plane, as the said closed portion 34.

Each of the spacer members 31 contains substantially parallel downwardly bowed arms 47 and 48 at a level below that of the closed end 49, said closed end being in the plane of and at the same horizontal level as the two outwardly extending terminal bearing portions 50 and 51 at the open end 52 of spacer 31. Said portions 50 and 51 are in the same vertical and horizontal planes, and positioned for bearing engagement with the said walls 20 and 21 of the upright portions 19 of holder member 18. The said bearing portions 50 and 51 are connected to the respective arms 47 and 48 by the upwardly and inwardly extending connecting sections 53, 53*a* and 54, 54*a*. The said closed portion 49 is in the form of a circular loop, so as to be adapted for embracing engagement with an insulating post to be hereinafter described—the said loop being connected to the said arms 47 and 48 by the connecting sections 55 and 56, respectively.

The bottom spacer member 31*a* is substantially like member 31, except that the closed end 73 thereof contains an elongated loop 74 for operatively receiving a suitably secured conductor. Said closed end also contains the outwardly arced sections 75 and 76 for embracing engagement with the insulating post with which said loop 49 and pair of arced sections 37, 38 (of members 30 and 31, respectively) are adapted for engagement, as aforesaid. The arms 47*a* and 48*a* and the bearing portions 50*a* and 51*a* are substantially like the corresponding parts of member 31, and are similarly connected together.

The spacer members 30, 31 and 31*a* are made of light gauge spring wire; and the arms thereof, 32 and 33, 47 and 48, and 47*a* and 48*a*, are proportioned for extending along the entire length "L" of the active coating of each of the cells. In this manner, maximum contact is obtained between the wire spacer members and the active rectifier coating on all the cells.

The said base 57 contains therein a plurality of longitudinally disposed holes 58, 59, 60, 61 and 62, these being employable, in a manner to be described, for rectifier plates of different lengths. Figs. 1 to 4 illustrate the use of the holder member 18 for a series of rectifier cells of predetermined maximum length, so that the outermost hole 58 is operatively employed.

Extending upwardly through said hole 58 is the metal tube 63, the lower portion of said tube containing thereon a flange 64 in abutment with the undersurface of base 57. Mounted over said tube 63 is an insulating tube 66, said last-mentioned tube resting upon the upper surface 67 of base 57, the upper portion of said insulating tube extending to the level of the upper surface 77 of arced sections 37 and 38 of the upper spacer 30. The upper end 68 of the metal tube 63 is peened over for engagement with underlying lock washer 69 which overlies the insulating washer 78.

In assembling the structure, the metal tube 63 is inserted upwardly through hole 58 until base flange 64 of metal tube 63 engages the undersurface of base 57. Then insulating tube 66 is placed over metal tube 63 and brought downwardly into engagement with the upper surface 67 of base 57. The bottom spacer 31*a* is thereafter slipped downwardly over tube 66, the latter extending through aperture 79*b*, said spacer 31*a* being brought to rest upon base 57. In this position the bearing portions 50*a* and 51*a* of the spacer 31*a* are disposed against the walls 21 and 20, respectively.

A rectifier cell 8 is placed upon spacer 31*a* with notched portion 14 disposed over ridge 22 of the holder, and the lateral edges 16 and 17 of the cell in engagement with said flat walls 21 and 20, respectively. Then a spacer 31 is placed upon said cell 8; and thereafter cells and spacers 31 are alternately placed in position until the uppermost cell 8*a* has been positioned. The upper spacer 30 is then placed in position upon cell 8*a*, with the two terminal fingers 45 and 46 extending into the respective holes 23*a* and 23*b* of the upright 19, the bearing portions 43 and 44 being in engagement with the respective walls 20 and 21 of the upright member of the holder. The insulating washer 78 is then placed over the upwardly protruding portion of the metal tube 63 and positioned upon the top of tube 66, whereafter the said lock washer 69 is placed in position thereover. The next step is the operation of upsetting the upper edge of the said metal tube 63, peening it downwardly into pressing engagement with said lock washer 69—the peened over portion 68 together with the base flange 64 serving to hold the parts in assembled relation. It should be noted that during the operation of

forming the upset ring **68** of tube **63**, downward pressure is applied, thereby flattening out the downwardly bowed arms **32** and **33**, **47** and **48** and **47***a* and **48***a* of all the stacked spacer members.

Upon the completion of the assembling operation as above described, there is firm contact between the spacers and the opposing surfaces of the rectifier cells. There is no possibility of the shifting of any one cell with respect to any of the others, or with respect to the holder structure. This is so, firstly, because the terminal fingers **45** and **46** of the uppermost spacer **30** are in interlocked engagement within the apertured portions **23***a* and **23***b* of the holder; secondly, because the pairs of bearing portions (such as **43** and **44**) of all the spacers are in flat and firm engagement with the flat walls **20** and **21** of the holder member; and thirdly, because of the interlocking engagement of the protruding ridge **22** of the holder and the notched recesses **14** of the cells. More specifically, the interlocking engagement between the terminal fingers **45**, **46** and the apertured portions **23***a*, **23***b* of the holder, in cooperation with the clamping engagement of the assembly as effected through the binding action of upset edge **68** and base **64** of metal tube **63**, prevents any vertical movement or separation of the spacer-held cells; the engagement of the flat walls **20** and **21** of the holder with the said bearing portions (such as **43** and **44**) of the spacers prevents any rotational movement of the spacers with respect to the upright wall **19** or with respect to any vertical axis; the engagement of the edges **16** and **17** of each with the said flat walls **20** and **21** of the holder similarly prevents any rotation of the cells with respect to the upright wall or with respect to any vertical axis; and the interlocking of the vertical ridge **22** with the notched portions **14** prevents any lateral shifting of the cells. Moreover, since each of the spacers contains two substantially parallel arms, such as the arms **32** and **33**, stability is further assured, inasmuch as there can not be any rotation about horizontal axes. Thus a stable structure is assured, where all the components are rigidly held in their proper predetermined and most efficient positions.

Because of the fact that each spacer has two arms extending completely across the coated surface **9**, there is a considerable area of contact between the conducting spacers and the underlying electrodes. The slight spring pressure resulting from the flattening of the normally bowed arms assures uniform contact throughout the entire length of the engaged underlying portion—and also assuring firm contact between the uppermost surfaces of each spacer and the overlying cell, that is, between bearing portions (such as **43** and **44**) and the closed end portions (such as end **34**) and the overlying cell. The combination of relatively large areas of contact and slight spring pressure is effective in giving the desired engagement between the spacer and the cells without the need for excessive pressures such as might cause damage to the rectifier material in coating **9**.

Inasmuch as the arms of each of the spacers, such as arms **32** and **33**, are vertically offset with respect to the remaining portion of the spacer, that is, since they are at different levels from the bearing portions **43** and **44** and the oppositely positioned closed end of the spacer, a two-level spacer structure is obtained which provides ample space between adjacent cells for air circulation and cooling. Thus, the combination of ample contacting area and ample air space provides a structure which will at all times remain cool and free of the danger of overheating—without the use of fins or dangerous protruding spacer elements which, in conventional devices, are frequently necessary to provide the required radiating surface.

In the preferred form of my invention the spacer members are made of wire; and with the present advanced state of the wire-forming art these members can readily be fabricated at a relatively low cost.

If it is desired to use shorter cells, all that need be done is to cut off the base **57** transversely so as to leave as the outermost hole one which will enable the device to accommodate spacers of the desired proportions. For example, by referring to Fig. 6, it will be seen that the metal tube **63** is inserted through hole **61**, thereby shortening the distance between said tube and the upright **19**. In this arrangement, the spacers **80** are shorter than the spacers in the form first-above described; and similarly the rectifier cells **81** are correspondingly shorter, although their widths may be the same.

If it is desired to use a reduced number of cells, all that need be done is to cut off upright **19** to the required height. For example, by referring to Fig. 7, it will be seen that the upright has been reduced in height so that the upper edge **82** thereof is at a lower level than the corresponding edge of the structure of Fig. 1, the upright **19** being of a length sufficient to accommodate three rectifier cells **83** and four spacers **84**. The arrangement is such that the structure can operatively accommodate a single rectifier cell, when necessary.

It is of course understood that instead of cutting off the base **57** and upright **19**, as aforesaid, they may be left in their original proportions—employing the proper holes in the base and in the upright in accordance with the size or number of rectifier components desired.

In any of the forms above-described, the unit may be attached to any base or supporting structure **72**, by a bolt member **70** extending through the metal tube **63** and downwardly below the flange **64** thereof. The lower threaded portion **71** of the bolt can be inserted in any suitably proportioned and threaded hole for securing the entire structure in place.

In the above description, the invention has been disclosed merely by way of example and in preferred manner; but obviously many variations and modifications may be made therein. It is to be understood, therefore, that the invention is not limited to any specific form or manner of practicing same, except insofar as such limitations are specified in the appended claims.

I claim:

1. In a rectifier device, a rectifier plate with an active coated surface on one face thereof, two spacer members of electrically conductive material in engagement with the opposite faces of said plate, and a holder device in supporting engagement with said plate and spacer members, said members each being of substantially U-shaped configuration and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said arms of one of said spacer members being in engagement with said coated surface of the plate substantially along the entire length thereof, the said opposite terminal portions of the other spacer member being in engagement with marginal portions of the plate's face opposite that containing said coated surface.

2. In a rectifier device, a rectifier plate with an active coated surface on one face thereof, two spacer members of electrically conductive material in engagement with the opposite faces of said plate, and a holder device in supporting engagement with said plate and spacer members, said holder device having an insulating base on which one of said spacer members rests, an upright insulating portion at one end of the base, and an elongated insulating member at the opposite end of the base and substantially parallel to said upright portion, said spacer members each being of substantially U-shaped configuration with one open end and one closed end and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said closed ends of said spacer members being in embracing engagement with said elongated member, the said arms of one of said spacer members being in engagement with said coated surface of the plate substantially along the entire length thereof, the said opposite terminal portions of the other spacer member being in engagement with

marginal portions of the plate's face opposite that containing said coated surface.

3. In a rectifier device, a rectifier plate with an active coated surface on one face thereof, two spacer members of electrically conductive material in engagement with the opposite faces of said plate, and a holder device in supporting engagement with said plate and spacer members, said holder device having a substantially L-shaped component of insulating material comprising a base on which one of said spacer members rests and an upright portion substantially normal to the base, and an elongated insulating member at the opposite end of the base and substantially parallel to said upright portion, said spacer members each being of substantially U-shaped configuration with one open end and one closed end and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said closed ends of said spacer members being in embracing engagement with said elongated member, the said arms of one of said spacer members being in engagement with said coated surface of the plate substantially along the entire length thereof, the said opposite terminal portions of the other spacer member being in engagement with marginal portions of the plate's face opposite that containing said coated surface, the said opposite terminal portions of both of said spacer members having at their said respective open ends bearing sections in engagement with said upright portion of the holder device.

4. In a rectifier device, the combination according to claim 3, at least one of said spacer members having at its said closed end an elongated loop extending beyond said elongated insulating member for receiving therethrough a conductor lead.

5. In a rectifier device, the combination according to claim 3, said upright portion of the holder device having a pair of spaced apertures therein, the said opposite terminal portion of the upper of said spacer members having at its said open end two terminal fingers extending into said apertures.

6. In a rectifier stack, a plurality of spaced rectifier plates each with an active coated surface on one face thereof, all of said coated surfaces facing in the same direction, an upper spacer member, a lower spacer member, and a plurality of intermediate spacer members, said upper spacer member being in engagement with the upper surface of the top plate of said stack, said lower spacer member being in engagement with the undersurface of the bottom plate of said stack, each of said intermediate spacer members being disposed between adjacent plates and in operative engagement with opposing surfaces thereof, and a holder device in supporting engagement with said plates and spacer members, said spacer members each being of substantially U-shaped configuration and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said arms of all the spacer members except the bottom one being in engagement with the coated surface of the underlying plate, the said opposite terminal portions of all the spacer members except the upper one being in engagement with marginal portions of the overlying plate.

7. In a rectifier stack, the combination according to claim 6, the said holder device having an apertured portion adjacent said upper spacer member, said upper spacer member being interengaged with said apertured portion.

8. In a rectifier stack, the combination according to claim 6, the said holder device having an upright portion with a plurality of vertically spaced apertures, the spacing and positioning of said apertures corresponding to that of successive terminal portions of said spacer members, the upper spacer member having a protruding portion extending into the adjacent one of said apertures.

9. In a rectifier stack, the combination according to claim 6, the said holder device having a base with an apertured portion therein, an elongated supporting member secured to said apertured portion and extending upwardly from the base, an insulating tube disposed over said supporting member, each of said spacer members having portions in partial embracing engagement with said tube.

10. In a rectifier device, a rectifier plate with an active coated surface on one face thereof, said plate having a narrow uncoated marginal portion adjacent said coated surface, an indented portion extending inwardly from an edge of the plate into and wholly confined within said marginal portion, and two lateral edges flanking said indented portion; two spacer members in engagement with opposite faces of said plate; and a holder device in supporting engagement with said plate and spacer members, said device having an upright portion and an elongated portion in engagement with opposite edges of said plate, said upright portion having a ridge thereon and two lateral walls flanking said ridge, said ridge extending into and being in engagement with said indented portion and said lateral walls being in engagement with said lateral edges of said plate.

11. In a rectifier device, the combination according to claim 10, said spacer members each being of substantially U-shaped configuration and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said arms of one of said spacer members being in engagement with said coated surface of the plate substantially along the entire length thereof, the said opposite terminal portions of the other spacer member being in engagement with marginal portions of the plate's face opposite that containing said coated surface, said spacer members having at their terminals adjacent said upright portion bearing sections in engagement with said lateral walls.

12. In a rectifier stack, a plurality of spaced rectifier plates, each having an active coated surface on one face thereof, a narrow uncoated marginal portion adjacent said coated surface, an indented portion extending inwardly from an edge of the plate into and wholly confined within said marginal portion, and two lateral edges flanking said indented portion, all of said coated surfaces facing in the same direction; an upper spacer member, a lower spacer member, and a plurality of intermediate spacer members, said upper spacer member being in engagement with the upper surface of the top plate of said stack, said lower spacer member being in engagement with the undersurface of the bottom plate of said stack, each of said intermediate spacer members being disposed between adjacent plates and in operative engagement with opposing surfaces thereof; and a holder device in supporting engagement with said plates and spacer members, said device having an upright portion and an elongated portion in engagement with opposite edges of said plates, said upright portion having a ridge thereon and two lateral walls flanking said ridge, said ridge extending into and being in engagement with said indented portions and said lateral walls being in engagement with said lateral edges of said plates, said spacer members each being of substantially U-shaped configuration and each having two longitudinally extending arms at one level and opposite terminal portions at another level, the said arms of all the spacer members except the bottom one being in engagement with the coated surface of the underlying plate, the said opposite terminal portions of all the spacer members except the upper one being in engagement with marginal portions of the overlying plate, said spacer members having at their terminals adjacent said upright portion bearing sections in engagement with said lateral walls.

13. In a rectifier stack, the combination according to claim 12, a base connecting said upright and elongated portions and in supporting engagement with said bottom spacer member, said upright portion being apertured ad-

jacent said upper spacer member and interengaged therewith, said elongated portion being supported by and extending upwardly from said base.

14. In a rectifier stack, the combination according to claim 12, a base connecting said upright and elongated portions and in supporting engagement with said bottom spacer member, said upright portion having on each of its said lateral walls a plurality of vertically spaced laterally paired apertures, the spacing and positioning of said apertures corresponding to that of successive terminal portions of said spacer members, the upper spacer member having two protruding fingers extending into two laterally paired apertures in said walls.

15. In a rectifier stack, the combination according to claim 12, a base connecting said upright and elongated portions and in supporting engagement with said bottom spacer member, said base having therein a plurality of longitudinally spaced apertures, said elongated portion comprising an inner supporting member extending upwardly through one of said apertures and through said stacked spacer members, and an outer tube disposed over said supporting member and in engagement with said spacer members.

16. A rectifier spacer member of substantially U-shaped configuration with two longitudinally extending arms and

opposite terminal portions offset in the same direction from said arms.

17. A rectifier spacer member made of resilient wire, said member being of substantially U-shaped configuration with two longitudinally extending arms and opposite terminal portions offset in the same direction from said arms, said arms, when the member is in its normal inoperative condition, being bowed in a direction away from said terminal portions.

18. A rectifier spacer member made of resilient wire, said member being of substantially U-shaped configuration with two longitudinally extending arms and opposite terminal portions offset in the same direction from said arms, said arms, when the member is in its normal inoperative condition, being bowed in a direction away from said terminal portions, the closed end of said U-shaped member being of generally looped configuration, the opposite open end having two terminal branches extending outwardly substantially transversely to the extent of said arms.

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