F. ENGEL.

STORAGE BATTERY PLATE AND PROCESS OF FORMING THE SAME.

APPLICATION FILED FEB. 20, 1909.

1,190,989.

Patented July 11, 1916.

3 SHEETS—SHEET 1.

Fig. 2.

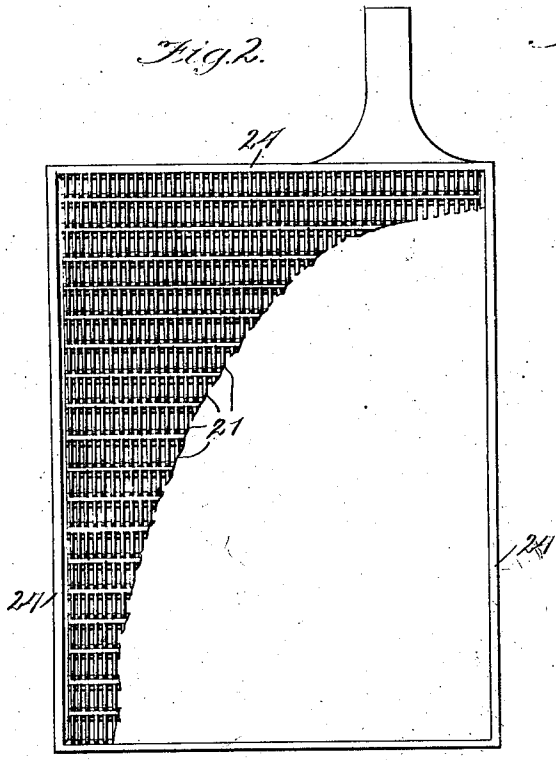


Fig. 3.

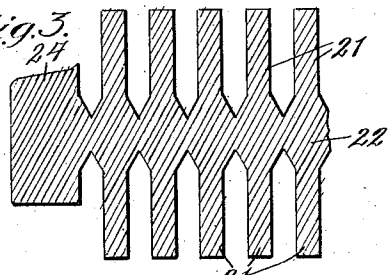


Fig. 4.

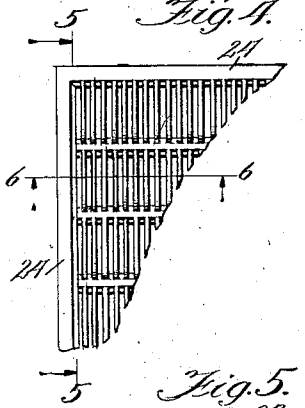


Fig. 5.

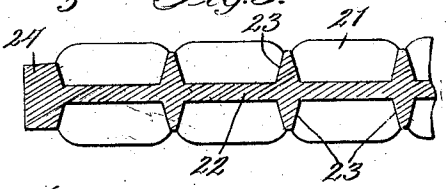


Fig. 1.

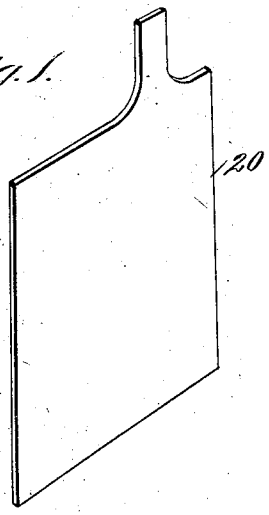
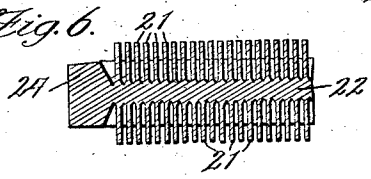


Fig. 6.



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3 SHEETS—SHEET 2.

Fig. 7.

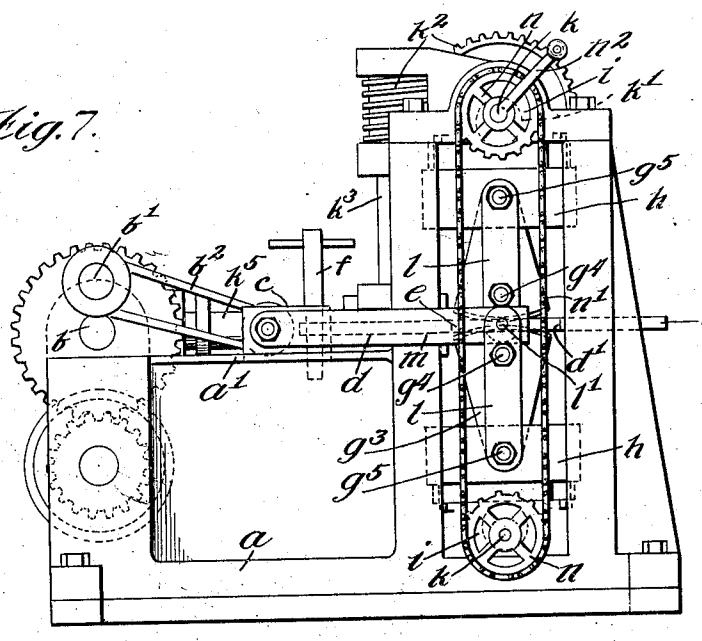
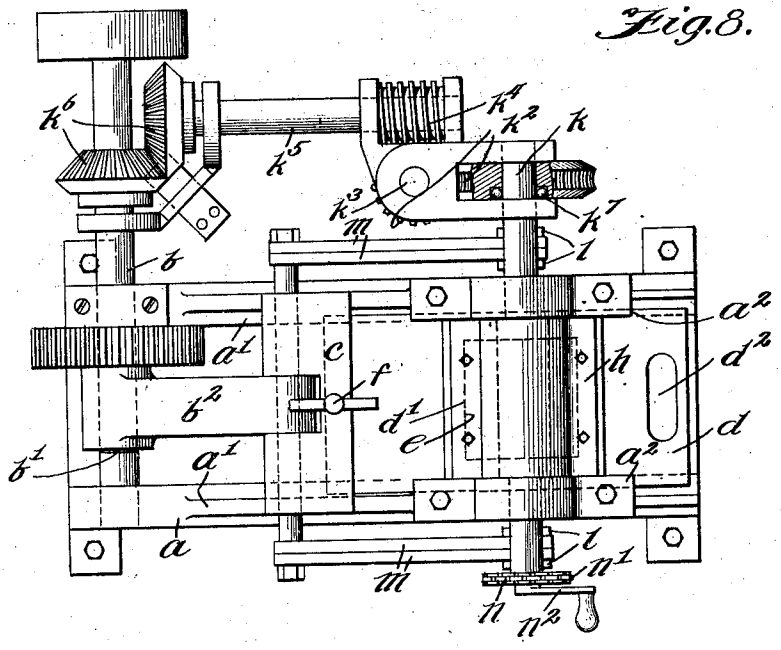


Fig. 8.



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3 SHEETS—SHEET 3.

Fig. 9.

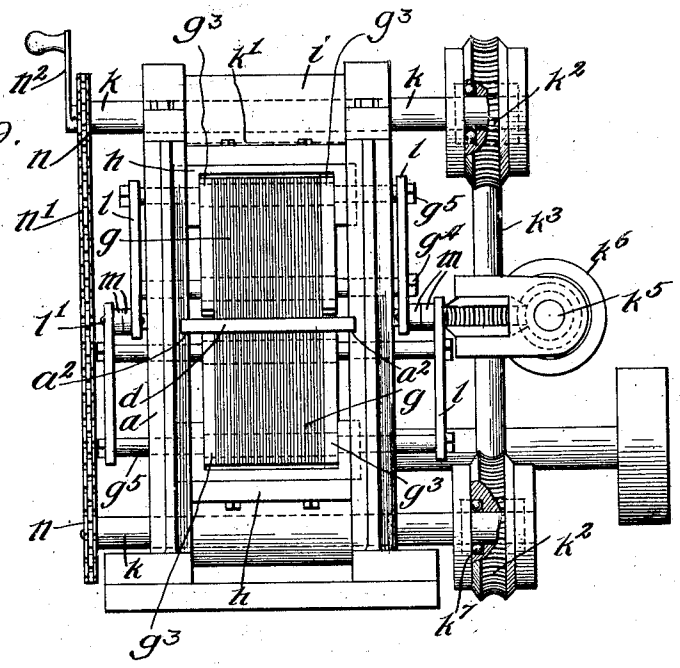


Fig. 10.

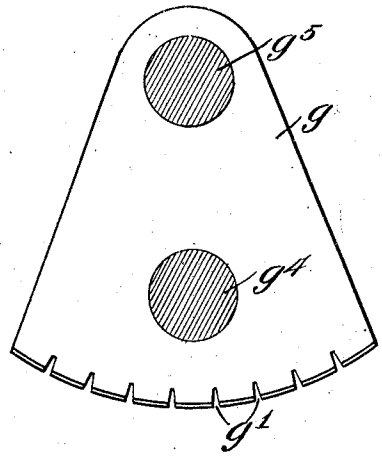
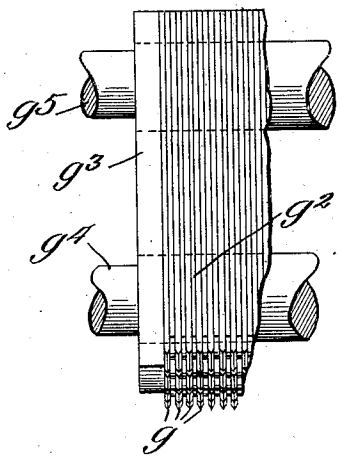


Fig. 11.



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By: Edwin B. Hopkins Jr.

Atty.

UNITED STATES PATENT OFFICE.

FRANK ENGEL, OF BUFFALO, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO U. S. LIGHT & HEAT CORPORATION, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF NEW YORK.

STORAGE-BATTERY PLATE AND PROCESS OF FORMING THE SAME.

1,190,989. Specification of Letters Patent. Patented July 11, 1916.

Original application filed November 14, 1907, Serial No. 402,164. Divided and this application filed February 20, 1909. Serial No. 479,070.

To all whom it may concern:

Be it known that I, FRANK ENGEL, a citizen of the United States, residing in the city of Buffalo, in the county of Erie and State of New York, have invented a certain new and useful Storage-Battery Plate and Process of Forming the Same, of which the following is a specification.

This application is a division of the one filed by me on the 14th day of November, 1907, Serial Number 402,164.

The object of my invention as herein claimed is to produce a plate having great density, a large contact area, regularity and uniformity of configuration and accuracy of formation, uniform consistency, smoothness of surface, and increased stiffness and mechanical strength.

Another object is to produce a configuration which will protect the center core from electrochemical action and prevents unequal growth.

In the preferred form of my plate a number of parallel rows of projections or ribs are formed upon its faces between which rows are reinforcing bars, these reinforcing bars being located at rather close intervals, and the ribs and bars being integral. The ribs greatly increase the contact area and the reinforcing bars give the plate increased stiffness.

My process broadly considered contemplates subjecting a blank to a swaging or kneading action to increase the density of the plate and to produce the desired surface configuration to increase the contact area.

The way in which I prefer to practice my process is hereinafter more particularly described.

The product itself and a suitable form of machine for obtaining it are illustrated in the accompanying drawings, in which:

Figure 1 is a perspective view of a blank from which the plate may be formed. Fig. 2 is a face view of a plate showing one of the various forms of outline which the finished plate may assume. This figure also indicates the preferred arrangement of the fins or webs upon the plate. Fig. 3 is a greatly enlarged section of the plate taken transversely of the projections or ribs. Fig. 4 is a fragmentary view showing the face of the plate in its preferred form. Fig. 5 is an enlarged section taken on line 5—5 Fig. 4. Fig. 6 is an enlarged section taken on the line 6—6 Fig. 4. Figs. 7, 8 and 9 are side, plan and end views respectively of a machine suitable for practising my process. Figs. 10 and 11 are detail views on a larger scale of the formers employed in said machine.

The machine is shown and described in my aforesaid application filed November 14, 1907, Serial Number 402164..

I will first describe the plate in its preferred form as shown in Figs. 1 to 6 inclusive. The blank 20 illustrated in Fig. 1 may be of any suitable outline and consists of lead or other suitable material. The finished plate shown in Figs. 2 to 6 has a number of parallel rows of fins or ribs 21 projecting from the core 22. These ribs are formed on both sides of the core and are arranged parallel to each other with a space between them at the sides, the space being preferably of approximately the same width as the width of the ribs. The ribs do not extend continuously along the plate but are interrupted by cross bars 23 which are low, compared to the height of the ribs. These bars stiffen the plate, especially in a transverse direction, and in this stiffening function they are supplemented by a marginal flange or frame 24. As shown in Fig. 5, the ribs, in their preferred form, extend at their full height to a point close to the bars, at which point they drop sharply down toward the bars instead of sloping gradually. This increases the contact area of the ribs. The stiffening bars have substantially vertical sides as shown in Fig. 5 which makes it possible to place the bars close together and at the same time gives further increase to the contact area of the ribs.

It is desirable that the plate be symmetrical on the two sides with a rib on one side directly opposite to a rib on the other and a cross bar on one side directly opposite to a cross bar on the other. The bottom of the grooves or channels between the ribs are preferably substantially V shaped as shown in Fig. 3. The oxid so forms upon this V

shaped bottom that it does not eat into the core appreciably as would be the case if the bottom were flat.

The plate which I have described above I produce by a kneading or swaging process as distinguished from a cutting or spinning process. By kneading the plate into shape I densify the metal and produce an accurate configuration and a rigid structure. My process broadly considered contemplates applying pressure to a blank to produce the plate. I preferably apply pressure to both sides of the blank simultaneously so that the blank is squeezed and compressed. Parts of the blank are pressed inwardly and thereby other parts are forced outwardly, and thus the ribs which I have described above are produced. The front edge of the ribs protrude beyond the original surface of the blank and the grooves between the ribs extend back therefrom. Accordingly ribs are formed which have large contact area.

The pressure is applied to the blank and the ribs are formed by a tool, die or former having thin tapered projecting edges between which the lead of the blank rises to form the ribs. The angle at which the pressure is applied is substantially normal to the blank surface. This insures the compacting and densifying of the lead without disrupting or tearing it. If the pressure were applied obliquely to the surface, the tendency would be to push the surface strata of lead ahead of the former, thus causing a disrupting and weakening of the plate structure. The angle of pressure should, therefore, to obtain the best results, be such that the lead will not be pushed ahead of the former or rolled out in the direction of reciprocation of the former as it is rocked or oscillated to alternately apply and release the pressure which accomplishes the kneading of the lead. As the formers are oscillated back and forth, they apply pressure to the plate intermittently, each successive rolling action causing the plate to assume the finished form gradually.

As a final act all parts of the ribs, including their front edges and sides, as well as the bottoms of the grooves between the ribs are subjected to pressure. Accordingly the ribs are accurately formed, as are also the other parts of the plate. Moreover the density of the ribs and other parts of the plate is increased, thereby producing a practically non-porous surface. The outer portion of the plate is toughened and strengthened and the particles consolidated.

The spinning process, which has heretofore been employed to produce certain types of battery plates, draws and pulls the metal, thereby separating its molecules, and making it more or less porous. Consequently the electrolyte penetrates into the pores and produces an irregular growth, which causes buckling and other deleterious effects upon the plate.

The advantages of a plate formed by my process are important. First, the growth is uniform on all parts, because the metal is dense, and non porous, and furthermore the surface configuration is uniform and regular. Second, the contact area is greater than in spun plates. Third, the ribs can be much more accurately formed than in plates produced by spinning or by casting under pressure; fourth, the cross stiffening bars can be placed much nearer together than in spun plates for the diameter of the knives is necessarily so great as to produce long sloping sides on the stiffening bars instead of substantially vertical ones as shown in Fig. 5; the increased number of these bars increases the strength and stiffness of the plate without decreasing its contact area. This latter is advantageous because the capacity of the plate varies in proportion to its contact area; fifth, the densifying of the plate increases its strength, and sixth, the conductivity of the plate is increased, as a result of which current is more readily conducted to the terminals of the plate through the core or body thereof.

In some cases it is advantageous to have the grooves or channels between the ribs extend completely through the plate. This form is especially advantageous for negative plates for it permits a free passage of the electrolyte through the plate. A suitable machine for practising the above described process is shown in the accompanying drawings, Figs. 7 to 11 inclusive and will now be described. Mounted upon a suitable frame or housing a, is a crank shaft b, driven in any suitable manner, the crank pin b' thereof being connected by a pitman b^2 with a crosshead c which is supported to slide to and fro upon ways a' upon the frame a. A frame or holder d having an opening d' therein to receive snugly the blank lead plate 20 is mounted in suitable ways a^2 in the frame and is connected to the crosshead c by any suitable means, as by a pin f so as to be reciprocated therewith. The holder d may also be provided with a handhole d^2 by which the holder may be withdrawn from the machine when disconnected from the crosshead.

In the machine shown in the drawings the blank is subjected simultaneously on opposite sides to the rolling action of two formers. As shown in Figs. 10 and 11 each former is made up of thin blades g separators g^2, outside supporting plates g^3, and bolts g^4 and g^5 by which the blades and separators are firmly bound together between the plates g^3. Said blades have curved edges which are notched at intervals at at g' for forming the stiffening bars 23. The intervening separators are shorter than the blades

and are adapted to contact the tops of the ribs and stiffening bars. Each set of formers is pivotally mounted, as by means of the extended bolt g^5, in a block h, movable toward and from the holder d in suitable ways in the frame a. Each block h is suitably connected, so as to permit the necessary relative movement, to an eccentric block i mounted on an eccentric k' formed on a shaft k which is supported in suitable bearings in the frame. The shafts k are rotated slowly, so as to cause the sets of formers to approach each other slowly, by any suitable means, as, for example, by worm gearing k^2, shaft k^3, worm gearing k^4, shaft k^5, and beveled gears k^6 from the shaft b. The formers are oscillated in synchronism with the reciprocations of the blank e and for this purpose the two formers may be provided with arms l which overlap and are connected in the center plane of the plate holder d, as at l', with links m which in turn are connected to the reciprocating crosshead c.

The operation of forming battery plates or units with the machine described will now be readily understood. A blank e having been placed in the holder d and the sets of formers having been drawn apart, the holder is slipped into the ways a^2 provided therefor in the frame a and is coupled to the reciprocating crosshead c. Power then being applied to the shaft b, the holder d, with the blank e, is reciprocated and the formers are oscillated in synchronism therewith. At the same time the formers are caused to approach each other slowly and thus produce a kneading or swaging action which gradually displaces the lead in a direction from the center core of the plate toward the axes of the formers. If the blank is of proper thickness the lead will be displaced as described until it comes in contact with the edges of the separators g^2, so that the fins or webs of the finished plates shall be of uniform height above the center core. The parts of the formers and the eccentrics which cause them to approach each other are preferably so proportioned, with reference to the thickness of the blank operated upon, that the side plates g^3 reach the surface planes of the holder d at the same time that the displaced lead, forming the ribs or webs of the plate, reaches the edges of the separators g^2, so that the plate is finished as to its frame 24 simultaneously with the finishing as to the ribs 21. Thus all parts are subjected to the kneading and densifying action above described.

In order that the formers may be withdrawn rapidly after the completion of a plate means may be provided for rotating the eccentrics k' independently of the driving mechanism. Thus worm gears k^2 may be engaged with the shafts k through roller clutches indicated at k^7, so as to drive the shafts positively but to permit the shafts to be rotated forwardly with respect to the worm gears, while the opposite ends of the shafts k are provided with sprocket wheels n connected by chain n' and one of the shafts k is provided with a crank n^2. The shafts k, with their eccentrics k', may thus be given a half rotation simultaneously, as soon as a plate is completed, so as to withdraw the formers rapidly and permit a new blank to be substituted for the completed plate.

It will be observed that in this machine the direction of motion is reversed each time the former has completed a stroke, also that the former is continuously approaching a little closer to the plate. This produces the kneading or swaging action referred to, the metal being gradually worked or wrought and forced up from the core or body of the plate. By the use of segmental formers having relatively large radii, the tendency of the metal to roll out in advance of the moving formers is reduced to practically a negligible amount. The metal is however worked up between adjacent gradually tapering blades and is compressed gradually while being forced up, until it is reduced to the proper thickness to pass between the parallel sides of two adjacent blades. The rib so formed is forced still farther between the formers until it meets the spacing washer, whereby the edge of the rib is also compressed, the entire rib now having an exterior surface of dense metal. The ribs are so thin that the wedging action as the lead is forced up through the tapered openings formed by the tapered edges of the blades, will consolidate and increase the density of the ribs practically throughout. The spacing washer, however, insures an additional rolling for the tops of the ribs and gives the tops their finished form.

As the pressure is exerted simultaneously from both sides the density of the plate is increased with the attending advantages hereinabove pointed out. The movement of the plate back and forth between the gradually approaching formers is accurately controlled in the machine selected for illustration, and in consequence the ribs are accurately formed, the projections on the formers always accurately finding the depressions previously made by them. This is an important consideration for the ribs are in practice very thin and close together, for example one forty-eighth of an inch thick with a space between them of one forty-eighth of an inch.

What I claim as new, and desire to secure by Letters Patent, is:

1. A battery plate having a plurality of rows of uniformly formed densified ribs upon the surface thereof.

2. A battery plate having a plurality of rows of uniformly formed ribs formed upon

the surface thereof, the density of said ribs being increased, and reinforcing bars arranged between the rows of ribs, the length of said ribs being comparatively short so that the reinforcing bars occur at comparatively close intervals.

3. A battery plate having a plurality of rows of uniformly formed ribs formed upon the surface thereof, the density of said ribs being increased, and reinforcing bars arranged between the rows of ribs, the length of said ribs being comparatively short so that the reinforcing bars occur at comparatively close intervals, said reinforcing bars and ribs being integral.

4. A battery plate having a plurality of rows of uniformly formed ribs formed upon the surface thereof, the density of said ribs being increased, and reinforcing bars arranged between the rows of ribs, the length of said ribs being comparatively short so that the reinforcing bars occur at comparatively close intervals, said reinforcing bars and ribs being integral, the configuration being the same upon both sides of the plate.

5. The process of forming a battery plate from a lead blank which consists in applying a rocking pressure simultaneously to the opposite sides of the blank, the pressure being applied at an angle to the blank less than the angle beyond which, if pressure is applied to the blank, the metal of the blank will be displaced in the direction of the rocking of the pressure-applying means.

6. The process of forming a battery plate from a lead blank which consists in applying a rocking pressure to the blank along a plurality of parallel lines simultaneously, said pressure being applied substantially normal to the surface of the blank whereby the lead of the blank is forced into parallel ribs extending between the lines of pressure and rising above the original surface of the blank, whereby the surface of the plate is consolidated and densified.

7. The method of forming a ribbed battery plate from a lead blank which consists in applying pressure simultaneously to opposite sides of the blank along a plurality of parallel lines substantially perpendicular to the blank surface to cause the formation of ribs between the lines of pressure and simultaneously compressing the ribs laterally to densify and consolidate them.

8. A battery plate having a surface provided with a plurality of closely adjacent parallel ribs, the entire exposed surface of the ribs being consolidated and densified by pressure limited in force and direction, so that the metal of said ribs is not disrupted.

9. A battery plate having an irregular surface with an outer stratum composed of metal that has been subjected to work effecting a substantially uniform consolidation of the particles thereof over the whole of said surface.

10. A battery plate having a corrugated surface produced and consolidated by repeated pressures insufficient to disrupt the surface material and extending over the whole of said surface.

11. A battery plate having a surface shaped and consolidated throughout by repeated rolling pressures alternately in reverse directions at such angles as to work the metal without disrupting it.

12. A battery plate having a surface shaped, toughened and consolidated by rolling operations in reverse directions exerting pressures limited in force and direction so that the metal of said surface is not disrupted.

13. A battery plate having a surface provided with closely adjacent parallel ribs, the entire exposed surface of the ribs and the portion of the plate between the ribs having an outer stratum of metal that has been subjected to work, effecting a substantially uniform consolidation of the particles thereof over the whole of said surface.

14. A battery plate having a surface provided with closely adjacent parallel ribs, the entire effective surface thereof being shaped and consolidated throughout by repeated rolling pressures alternately in reverse directions at such angles as to work the metal without disrupting it.

15. A battery plate having a surface formed with closely adjacent parallel ribs which have been formed and the surfaces of which have been consolidated and densified by repeated pressures applied to all portions thereof, insufficient to disrupt the surface material and extending over the entire exposed surface of the ribs.

16. The herein described process of forming a battery plate, consisting in subjecting a blank to pressure to increase its contact area and to densify the metal.

17. The herein described process of forming a battery plate consisting in kneading a blank to increase its contact area and densify the metal.

18. The herein described process of forming a battery plate, consisting in alternately applying and releasing pressure upon the face of the blank to work the blank into shape.

19. The herein described process of forming a battery plate consisting in simultaneously applying pressure upon opposite sides of a blank to form it into the desired shape.

20. The herein described process of forming a battery plate consisting in subjecting a blank to pressure upon opposite sides simultaneously the pressure being applied to both sides at directly opposite points.

21. The herein described process of form-

ing a battery plate consisting in applying pressure to both sides of a blank, the pressure being applied and released alternately whereby the blank is worked into the desired shape.

22. The herein described process of forming a battery plate consisting in simultaneously kneading both sides of a blank to configurate both sides of the plate alike.

23. The process of making battery plates consisting in subjecting a blank to a kneading or swaging action to condense the metal and form the same into the shape desired.

24. The process of making battery plates consisting in subjecting a blank to pressure perpendicular to the face of the blank and also having a movement along the face of the blank to thereby produce a swaging or kneading action to increase the density of the blank and at the same time produce configurations thereon for increasing its contact area.

25. The process of forming battery plates consisting in directing pressure upon said plate from both sides simultaneously perpendicular to the face, and at the same time passing said pressure back and forth along the surface to thereby increase the density and also increase the contact area thereof.

26. The herein described process of forming a battery plate having ribs arranged side by side and spaced from each other, consisting in subjecting to pressure oblong areas arranged side by side and successively increasing the pressure.

27. The process of making battery plates consisting in subjecting said plates to a series of rolling actions in continuous contact with a former, and changing the direction of motion between each two rolling actions.

28. The process of making battery plates consisting in reciprocating the plate back and forth in a plane and subjecting the plate to constantly increasing pressure.

29. The herein described process of forming a battery plate consisting in subjecting a blank of suitable material to pressure, the pressure being applied to oblong areas upon both sides of said plate, said areas being spaced apart and the areas upon opposite sides occupying the same relative position in the plate.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

FRANK ENGEL.

Witnesses:
ELIZABETH M. NAUTH,
ALLAN F. REIF.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."