No. 666,153. Patented Jan. 15, 1901.

C. POLLAK.

PROCESS OF PRODUCING PLATES FOR SECONDARY BATTERIES

(No Model.) (Application filed Feb. 12, 1897.)

Fig. 1.

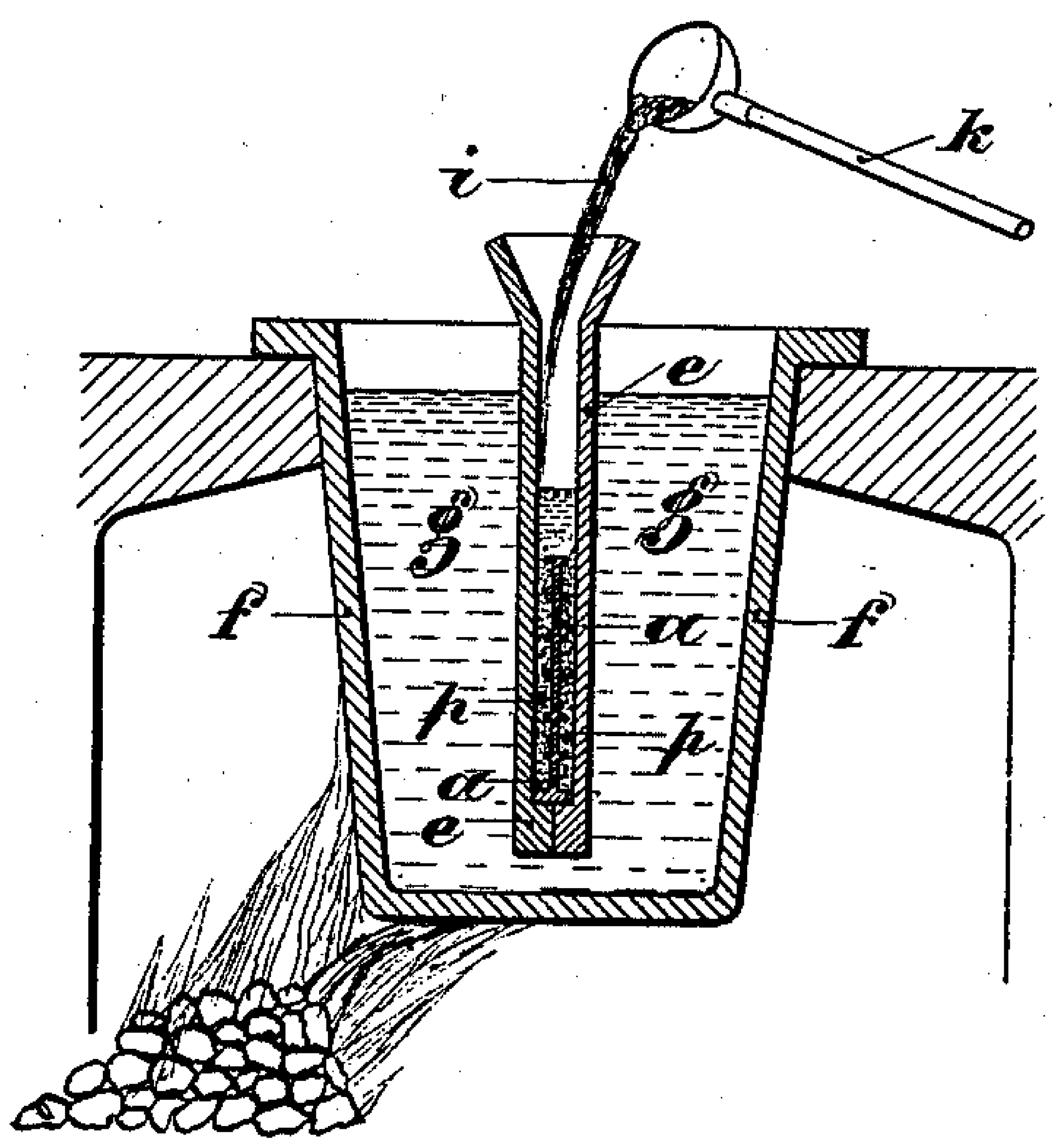


Fig. 2.

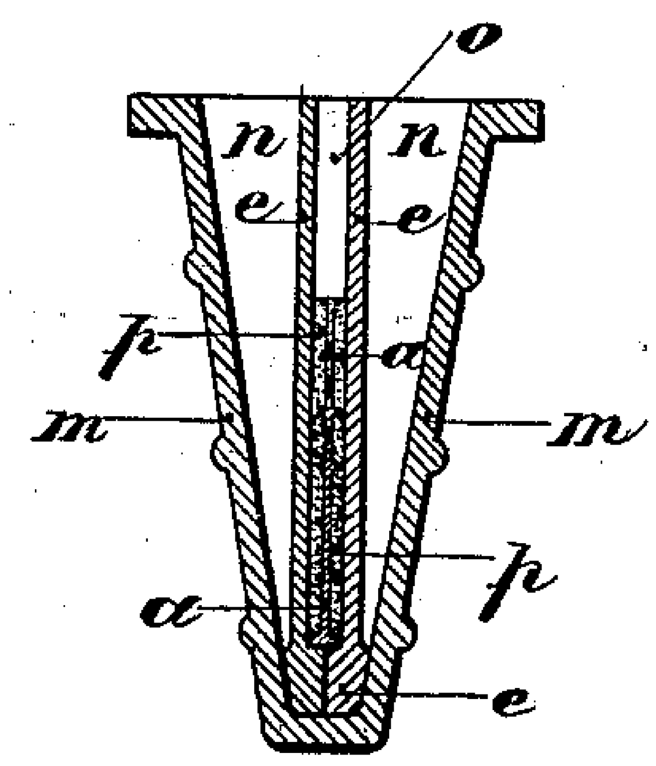


Fig. 3.

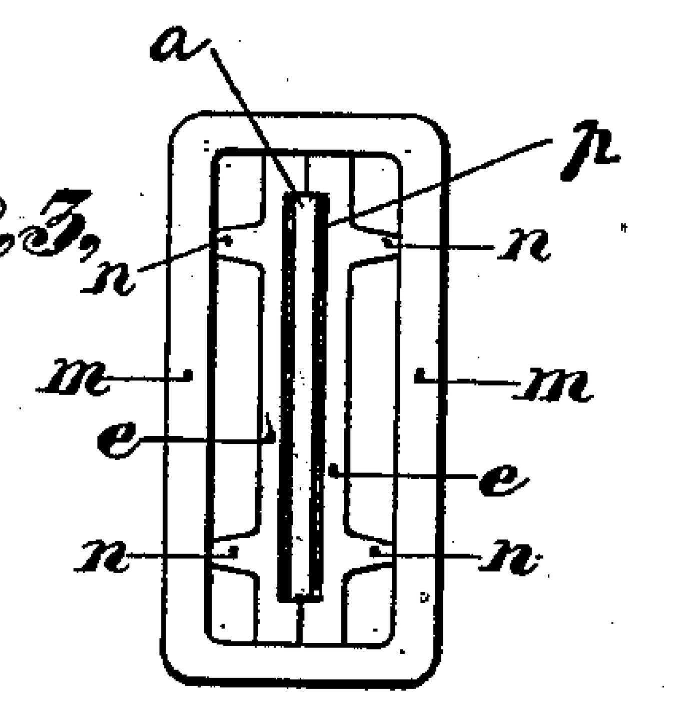


Fig. 4.

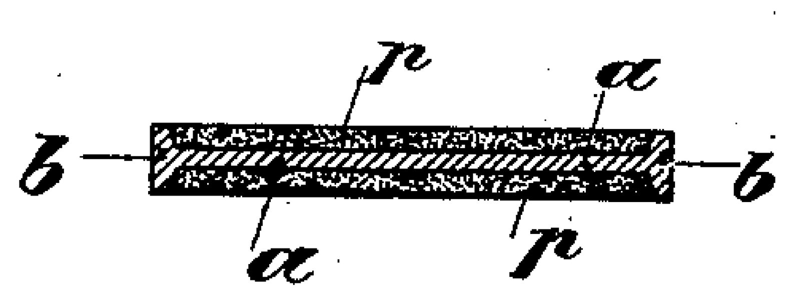


Fig. 5.

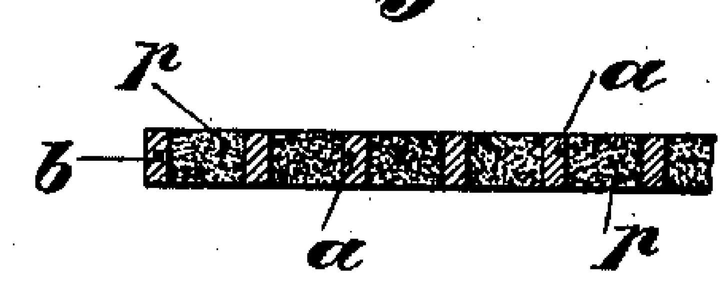


Fig. 6.

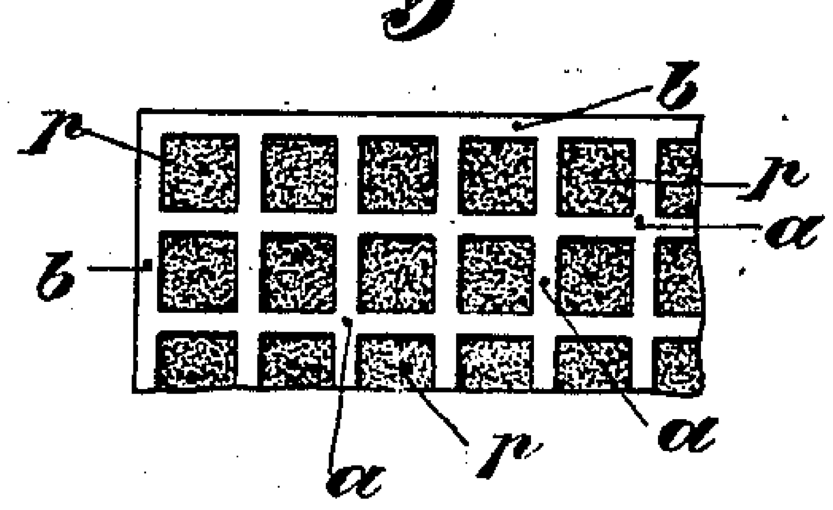


Fig. 7.

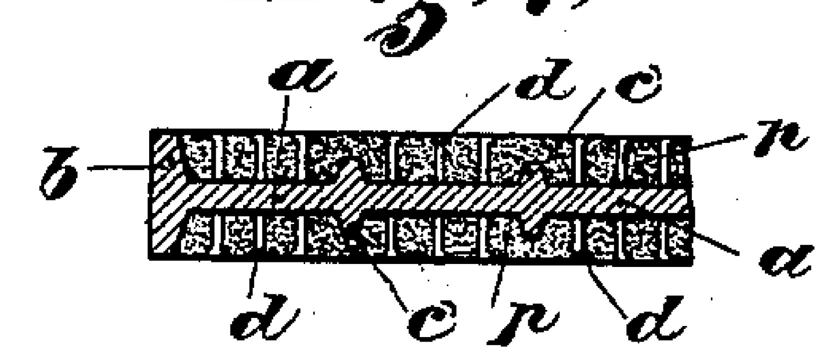
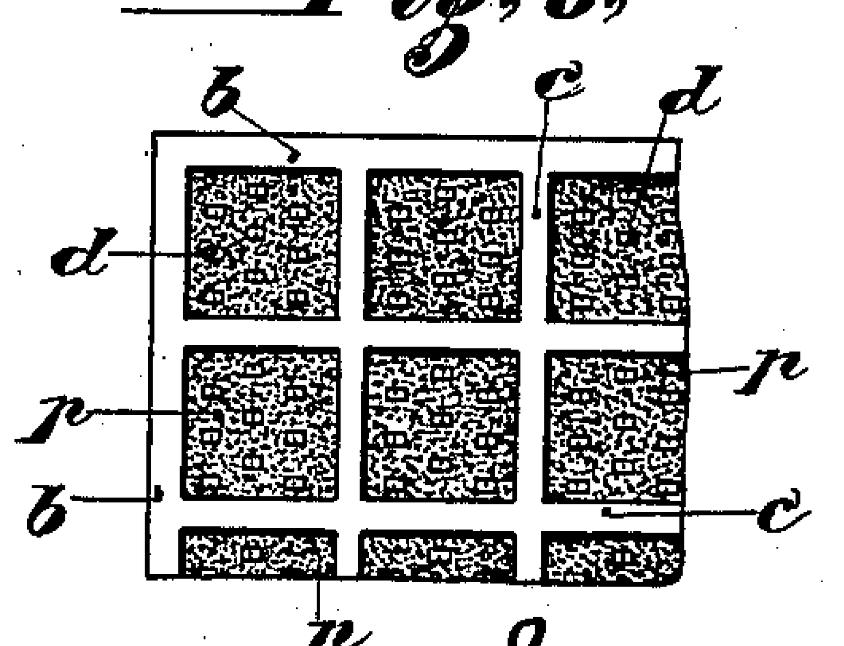


Fig. 8.



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UNITED STATES PATENT OFFICE.

CHARLES POLLAK, OF FRANKFORT-ON-THE-MAIN, GERMANY.

PROCESS OF PRODUCING PLATES FOR SECONDARY BATTERIES.

SPECIFICATION forming part of Letters Patent No. 666,153, dated January 15, 1901.

Application filed February 12, 1897. Serial No. 623,066. (No specimens.)

To all whom it may concern:

Be it known that I, CHARLES POLLAK, a subject of the Emperor of Austria-Hungary, residing in Frankfort-on-the-Main, Germany, have invented certain new and useful Improvements in Processes of Producing Plates for Secondary Batteries, of which the following is a specification.

The present invention consists of an improved method for producing plates for secondary batteries by simple metallurgical means, the method being cheap and convenient and the plates thus obtained being of greater strength, durability, and capacity than heretofore.

The plates manufactured by this method consist of one metal only, which forms a solid core of any desired shape and a porous portion most intimately connected to the core, as both parts are produced simultaneously by one casting operation and in one piece only, the porous part being a metallic progression or extension of the solid core. As the method herein described gives a highly-polished product, any additional covering with active substance—such as metallic oxids, chlorids, &c.—is not necessary, and the plates can be subjected directly to the electrolytic action known as the "process of formation."

In the accompanying drawings, Figures 1 to 3 represent the mold *e* ready for pouring, the mold being placed in a vessel *f*, filled with molten metal, for the purpose of heating the mold to the temperature required, Fig. 2 being the cross-section, and Fig. 3 the plan, of a mold for producing single plates, with a detachable inner part and an outer vessel which may be immersed in molten metal or kept in any suitable stove heated to the necessary degree. Fig. 4 is a cross-section of a plate obtained by the present method, consisting of a solid metal core *a* of uniform thickness, an outer frame *b*, and a porous part *p*. Fig. 5 is a cross-section, and Fig. 6 a front elevation, of a plate with a lattice-work solid core *a*, an outer frame *b*, and the porous part *p*. Figs. 7 and 8 represent a cross-section and a part elevation of another plate having a core with an outer frame and numerous hooks which support the porous part.

The following example will serve to explain the nature of this mode of manufacture: A solid metal core of any desired shape is placed in a suitable mold and surrounded by a finely-grained pulverous material, as sulfate of soda or other bodies free of water capable of standing the melting temperature of the metal used. The said pulverous body can subsequently be eliminated from the finished product in any way—as, for instance, by lixiviation—this operation, however, being not absolutely necessary. The mold containing the powder and the solid metallic core is now put in a stove or vessel filled with molten metal or any other body kept at the temperature required for melting the metal inside the mold. After being heated to this degree the mold is filled carefully with the same molten metal as the solid core is made of—for instance, lead. While the high temperature of the mold causes the solid core to become liquid, the pressure of the fresh molten metal poured in forces the metal of the core into the interstices of the porous or pulverous body, the metal thus displaced being simultaneously replaced by the fresh supply filled into the mold. Thus the space for the core remains intact and forms a receptacle from which the fluid metal is forced in all interstices of the porous body. In order to overcome the cohesion of the molten metal, the resistance of friction and of the air inclosed in the extremely small interstices of the grained or porous body, a considerable pressure by means of a high funnel at the inlet or by other artificial methods must be applied to the metal, and this pressure must last incessantly until the metal sets, as without this precaution the particles of metal filling the interstices would be withdrawn partially by the combined influence of the cohesion of the molten metal and of the pressure of hot gases inclosed in the mold. The same phenomenon may be easily observed by using mercury and a finely-grained body, as mercury resembles the properties of the molten metals in contact with such bodies. For obtaining a perfect product means must be provided also for the elimination of air and gases from the mold in the usual manner. After the casting operation the mold is slowly cooled down and the plate removed and then transferred into a bath, where the pulverous body is dissolved in water or any other substance. The plate is dried subsequently and finally can be placed in an electrolytic cell for the process of formation, being afterward ready for use as an accumulator-electrode.

Several modifications of the process just described may be explained now.

It is not always necessary to continue the heating of the mold until the solid core is molten, as the fresh metal poured in, if sufficiently hot, not only pervades all interstices of the grained body, but also melts the metal of the core at the surface of contact and is fused together with it. This method makes it possible to use different metals as core and porous part if only these metals can solder with one another at the points of contact.

According to a further modification of the described method the space to be occupied by the solid core may be formed by a pattern-core, which would have to be carefully removed before the casting operation. In this case a coherent grained or porous refractory substance must be used instead of the pulverous body.

The process may be modified in different other ways; but the main feature of the invention remains unaltered—viz., the combination of operations for producing a solid core and a porous part in a single casting, more particularly the use of a solid metal core surrounded by a pulverous refractory body, this core being of any desired shape and in most cases placed entirely inside the porous mass—a result until now not attainable by the casting methods known; furthermore, the application of high (considerable) pressure during the casting operation until the metal sets; finally, lixiviation and electrolytic treatment of the plates.

With reference to Figs. 1, 2, and 3 a description of the molds employed in this method will be presented.

In Fig. 1 a mold *e* is shown in position ready for pouring, a cross-section being chosen for greater clearness' sake. The mold *e* is immersed in any substance *g* having the required temperature—as, for instance, molten lead—contained in the vessel *f*. Inside the mold the cross-section of the solid core *a*, surrounded by the porous or pulverous body *p*, is visible. The fresh molten metal *i* is poured in by a ladle *k*. A high free space is seen above the pulverous body, which is to be filled with metal to the top for the purpose of having a sufficient pressure necessary in order to obtain a good product.

Fig. 2 shows an improved form of mold in cross-section; Fig. 3, the same in plan. In this model the mold proper consists of two parts *e e*, provided with wedges or keyes *n n*, pressed in a pot *m*. This pot, together with the inner mold, may be now immersed in molten lead or put in a stove or furnace, like the mold described in Fig. 1. *a* is the solid core, and *p* the porous grained body above which the free space *o* for a runner to create the required pressure is visible. After the casting operation is finished the inner mold can be easily drawn out of the pot *m* and the plate removed from its mold. In the pot *m* more than two parts *e* can be placed side by side, and so the simultaneous manufacture of a greater number of plates may be attained.

The result of this process is a plate having a solid core of any desired shape surrounded by an extremely finely divided porous part most intimately connected to the said core, which porous part, owing to the method employed, forms a continuation or ramification of the solid part.

In applying these plates to accumulators it is necessary to subject them to electrolytic action, known as the "process of formation." The positive plates of this kind will be covered at all surfaces of the porous part accessible to the electrolyte with a very thin layer of peroxids firmly supported by the metallic ramification or branches of the solid core. The negative plates may be again obtained by reducing the peroxid of the positive plates into metal by means of reversing the current in the electrolytical cell, and they possess the same advantages as the positive ones.

The mode of manufacture of the plates gives to the electrolyte free access to the whole porous part right through to the core, so that the plates will possess a great capacity without straining the porous part to any great extent, and therefore will be able to stand a great rate of discharge-current. Another important advantage of these plates is that between the core and the porous part no injurious sulfate or oxid formations can appear, both parts of the plate being one continuous metallic body.

The method herein described enables me to give any desired shape to the core, although symmetrical or inner cores may be preferable. Several forms of cores are shown on the accompanying drawings, in which the juncture of the core with the porous part is drawn in full lines, although in practice no exact line of demarcation will be present between these two parts.

Fig. 4 shows a section of a plate having a solid core *a* of even thickness, a frame *b* around the same, and a porous part *p*.

Fig. 5 is a section, and Fig. 6 a part elevation, of a plate having a lattice-work core *a*, an outer frame *b*, and the porous part *p*.

Fig. 7 is a part section, and Fig. 8 a part elevation, of a plate having an inner core of even thickness *a*, an outer frame *b*, strengthening-ribs *c*, a number of hooks or barbs *d*, and the porous parts *p p*.

The present method differs from the methods hitherto known by the fact that the whole plate is obtained in one casting operation with a solid core of any shape and an extremely-porous and finely-divided part, where-as by means of the modes hitherto employed coarsely-grained plates only could be obtained and one-sided cores only could be cast.

I do not limit my invention to the production of accumulator-plates only, as other objects—for instance, lead plates for precipitating gold, vessels with porous partitions, &c.—may be manufactured by the same method.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The method of manufacturing plates, which consists in placing around a metal body in a mold a porous material having a higher melting-point than said metal body, raising the temperature of the mold sufficiently to melt said metal body but not high enough to melt the porous material, and applying pressure to the melted metal body whereby a part of the melted metal of said body will be forced into interstices of the porous body, said part remaining integrally connected with the metal body, and then removing the porous material.

2. A method of manufacturing accumulator-plates or other objects provided with a solid metallic core and porous parts connected therewith, by a single casting operation which consists in putting into a mold a metal body or core, placing around it a finely-grained body or powder, raising the temperature of the mold sufficiently to melt said metal core, but not high enough to melt the powder, then pouring in molten metal and leaving it under pressure until the metal sets, whereby a part of the metal core will be forced into the interstices of the finely-grained body, so that the core and porous parts of the product will consist of one continuous metallic body, substantially as described.

3. A method of manufacturing accumulator-plates or other objects with a solid metallic core and porous parts connected therewith, by a single casting operation which consists in putting into a mold a metal body or core, placing around it a finely-grained body or powder, raising the temperature of the mold sufficiently to melt said metal core, but not high enough to melt the powder, then pouring in the molten metal and leaving it under pressure until the metal sets, whereby a part of the metal core will be forced into the interstices of the finely-grained body, so that core and porous parts of the product will consist of one continuous metallic body, and finally removing the powder from the product, substantially as described.

4. The method of manufacturing plates, which consists in placing around a metal body in a mold a porous material having a higher melting-point than said metal body, raising the temperature of the mold sufficiently to melt said metal body but not high enough to melt the porous material, and applying pressure to the melted metal body, and maintaining the pressure until the metal in the mold sets.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES POLLAK.

Witnesses:
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FRANK H. MASON.