(No Model.) 3 Sheets—Sheet 1.

C. HOEPFNER.

APPARATUS FOR ELECTROLYTICALLY PRODUCING ZINC.

No. 598,180. Patented Feb. 1, 1898.

Fig. 2.

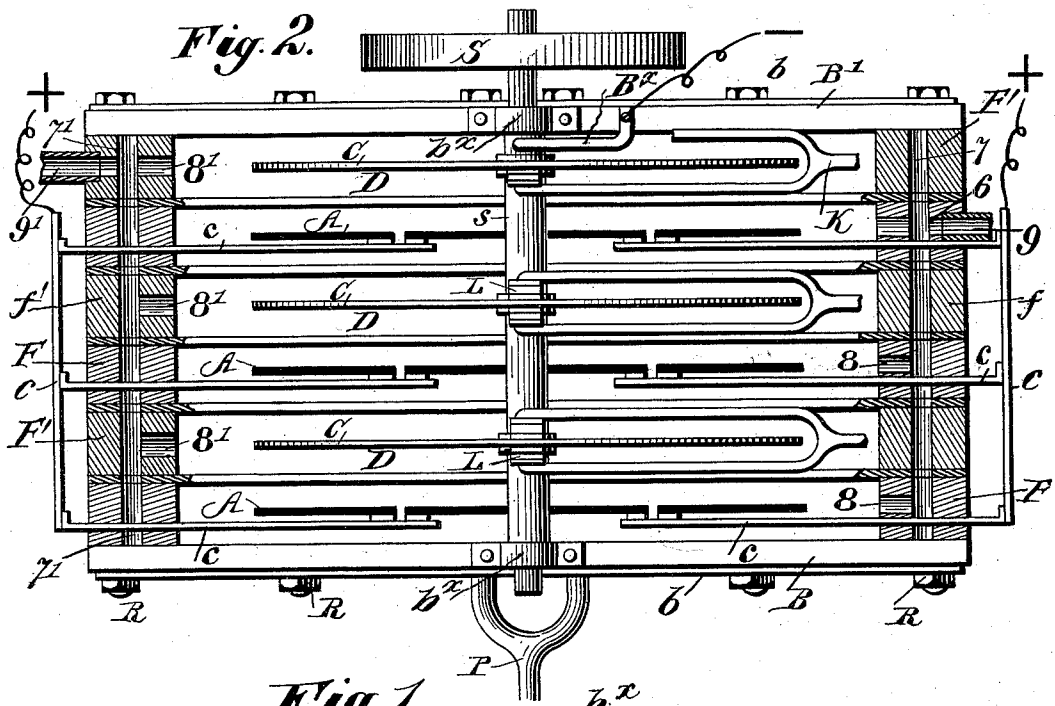
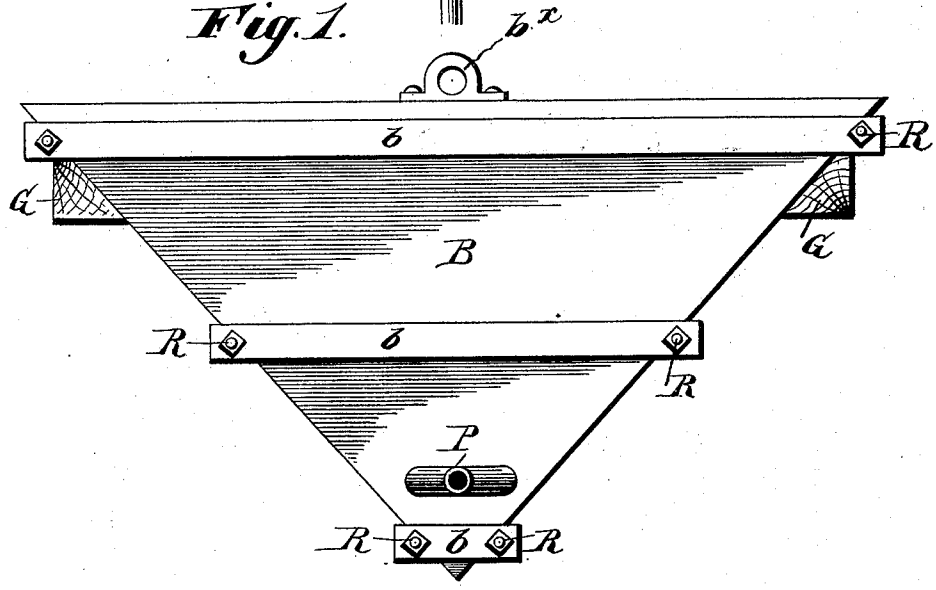


Fig. 1.



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Fig. 3.

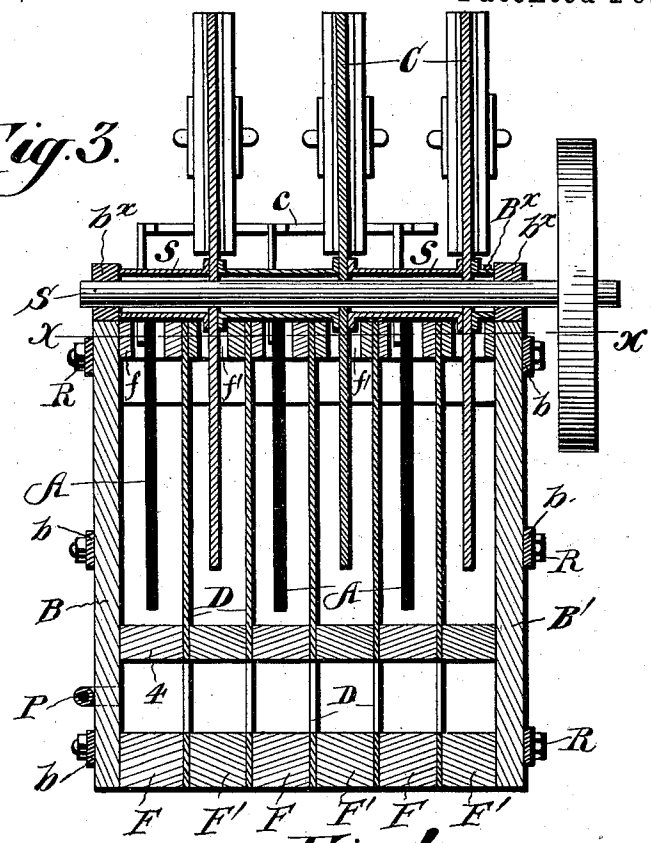
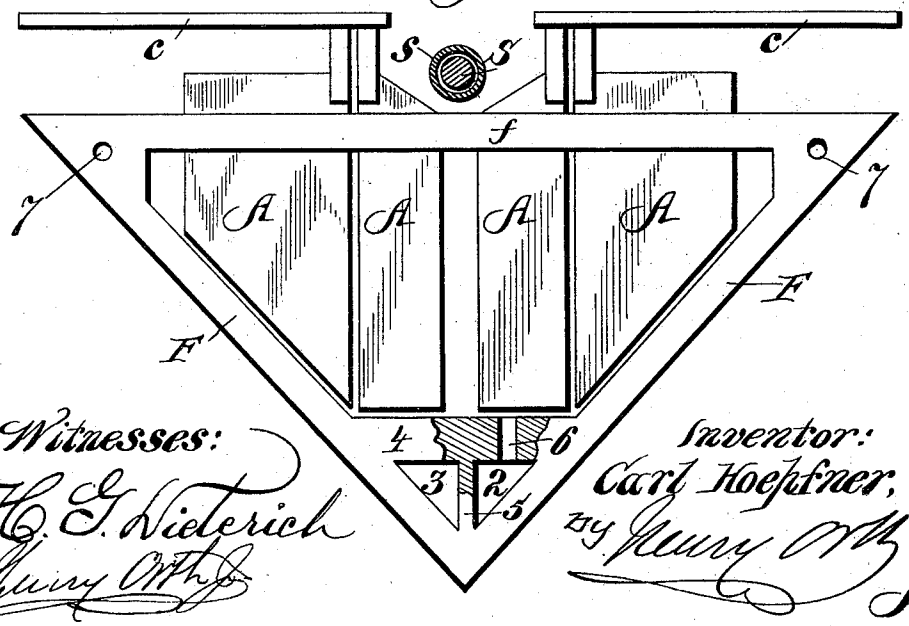


Fig. 4.



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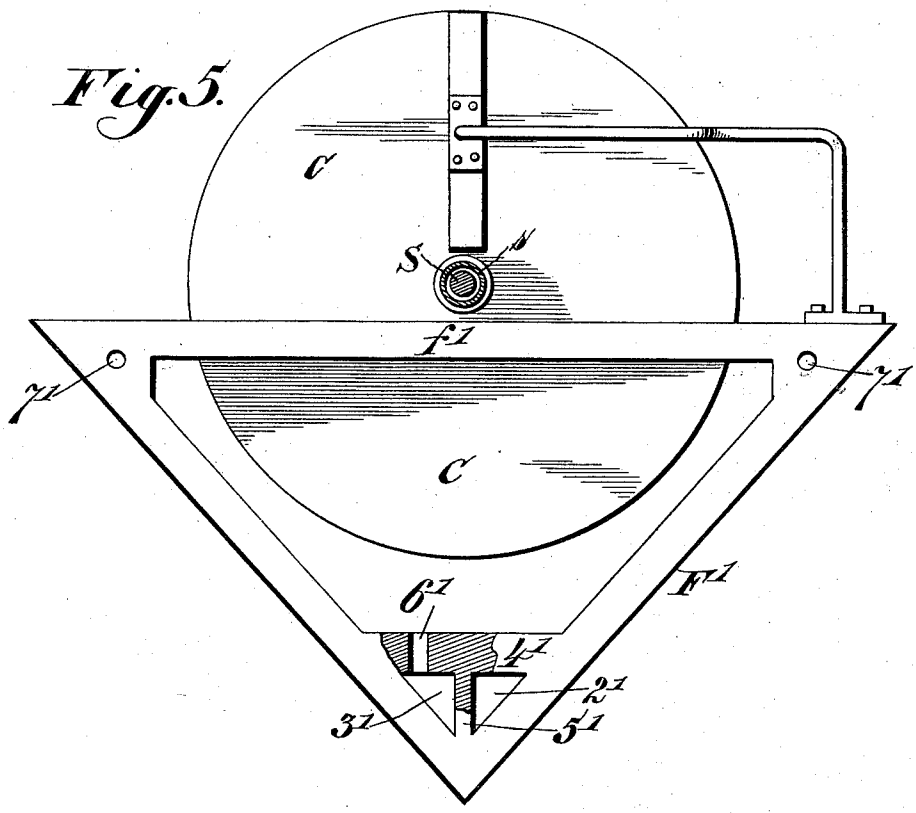
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Fig. 5.



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UNITED STATES PATENT OFFICE.

CARL HOEPFNER, OF GIESSEN, GERMANY.

APPARATUS FOR ELECTROLYTICALLY PRODUCING ZINC.

SPECIFICATION forming part of Letters Patent No. 598,180, dated February 1, 1898.

Application filed October 7, 1893. Serial No. 487,414. (No model.)

To all whom it may concern:

Be it known that I, CARL HOEPFNER, a subject of the Emperor of Germany, residing at Giessen, Germany, have invented certain new and useful Improvements in Apparatus for the Electrolytic Production of Zinc; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters and figures of reference marked thereon, which form a part of this specification.

My invention has relation to the electrolytical production of zinc; and it consists in the process of obtaining said metal electrolytically, as will now be fully described.

So far as I am aware the electrolytic production of zinc from zinc chlorid has before my invention not been carried out on a remunerative basis owing to difficulties in obtaining the metal in a homogeneous and pure state. This I have found to be due to the nature of the cathodes used, experiments having demonstrated the impossibility of obtaining a homogeneous and solid product with stationary or vibrating immersed cathodes, although solid zinc can be obtained with such cathodes from zinc salts other than the chlorid—as, for instance, from the sulfate or acetate—nor is it possible to commercially produce chlorin, together with pure zinc, from its chlorid with rotary horizontal or cylindrical cathodes, immersed or partially immersed, as in this case the economical production and utilization of the chlorin is not possible, owing to the great internal resistance due either to the great distance between the electrodes or to the chlorin settling upon the diaphragm-surfaces and blocking or impeding the passage of the current.

I have discovered that zinc-chlorid solutions only can be economically electrolyzed by the use of discoidal rotating cathodes when partly immersed in the electrolyte and the zinc obtained in a homogeneous pure solid condition, and that with such cathodes currents of high density can be used when it is desired to produce chlorin, together with zinc, such currents of high density being necessary, as otherwise the chlorin evolved at the anode would become diffused in the electrolyte and again combine with the zinc.

It has been stated that the decomposition of zinc chlorid cannot be economically effected with either stationary or vibrating or cylindrical rotating cathodes immersed in the electrolyte. This is probably due to the inefficient action of the current and to the irregular escape of the hydrogen evolved at the cathode, due to unavoidable decomposition of chlorids other than zinc chlorid, which I have found not to be detrimental when discoidal rotating cathodes partly immersed in the electrolyte are used, the current acting more uniformly and at all times upon the undecomposed portions of the electrolyte, while the bubbles of hydrogen are rapidly carried out of the electrolyte after they form at the cathode, the current also acting "intermittingly," so to speak, as fresh surfaces of the cathode move into the electric circuit and into contact with the electrolyte, whereby a uniform homogeneous solid deposit of zinc is obtained, as stated, which would not be the case otherwise, because if the current were to act upon decomposed portions of the electrolyte or portions deficient in zinc in contact with the cathode the metal would be deposited in the form of sponge.

For the purposes of this invention the cathodes are made of a suitable metal, as zinc or iron, in the form of thin disks, while the anodes must be made of a material insoluble in the electrolyte and indifferent to the action of the current, as carbon, and as free from soluble iron as possible.

In the electrolytic decomposition of zinc from its chlorid it is absolutely necessary that the anode should be mechanically separated from the cathode in such manner as to admit of the diffusion of the electrolyte and so as to offer the least possible resistance to the passage of the current, but so as to prevent chlorin bubbles from passing to the cathode, as well as disintegrated particles of the anode. To these ends I preferably use diaphragms of a nitrated cotton fabric. The nitration of this fabric can readily be effected by treating the fabric with very strong or concentrated nitric acid, care being taken to exclude water, which would defeat the operation. The zinc-chlorid solution may be a neutral one,

though I prefer to keep the solution slightly acidulated to avoid its becoming basic by the action of the air on the revolving cathode.

I am aware that the use of discoidal rotating cathodes was known before my invention in the electrolytical production of bleaching agents from compounds the base of which deposits in solid form, as from calcium and magnesium chlorid; but I believe that I am the first to discover that the electrolytic extraction of zinc from its chlorid cannot be practically and economically effected except in the presence of such cathodes and whereby currents of high density can be used for the production of zinc and chlorin in an economical manner and on a commercial scale. To increase the conductivity of the electrolyte, I prefer to use zinc-chlorid solutions containing a chlorid of a metal of the alkalies or of the alkaline earths.

Referring now to the drawings, in which I have illustrated an apparatus suitable to the carrying out of my process, Figure 1 is an end elevation of the vessel or tank; Fig. 2, a sectional plan view of the apparatus on about line *x x* of Fig. 3, which latter is a central cross-section of said apparatus. Fig. 4 is a face view of one of the anode cell-frames, illustrating the means for supporting the anodes; and Fig. 5 is a like view of one of the cathode cell-frames.

The apparatus is composed of a series of anode and cathode cell-frames F and F′, respectively, of triangular form, and inasmuch as both cell-frames are constructed alike the description of one of them will suffice, like parts being indicated in both frames by like symbols, and for the purpose of distinguishing said parts in the two frames the symbols for the cathode-frames F′ are provided with an affix (′). The cross-bar *f* of the frame is slotted for the passage of the electrode, and at the apex of the frame are formed two passages 2 and 3 by a cross partition or bar 4 and a vertical partition or bar 5, and in said cross-bar 4 is formed a passage 6, that for the anode cell-frames being formed on the right of the vertical bar 5, while the corresponding passage 6′ for the cathode-frames F′ is formed on the left of said vertical partition. In the corner of the base of the triangle is formed a passage 7. Furthermore, each of the cell-frames has a passage 8, that communicates with the passage 7, the passage 8 of the anode-frames being formed on the right, while those 8′ of the cathode-frames are formed on the left, as shown in Fig. 2, so that when alternate anode and cathode frames are assembled, with a suitable diaphragm D interposed between them, provided with openings corresponding with the passages 2, 3, and 7 and 2′, 3′, and 7′ in the respective cell-frames, there will be formed two through-passages at the apex and two through-passages in the opposite upper corners of the frames, that on the right communicating with the anode-cells through passages 8 and that on the left with the anode-cells through passages 8′. The lower through-passages 2 and 3 are connected with a branched feed-pipe F, Figs. 1 and 2.

It is obvious that when an electrolyte is fed under a sufficient head through pipe P it will flow into the anode and cathode cells through the vertical passages 6 and 6′ in the respective frames. As the electrolyte rises in the cells and is decomposed it flows out through passages 8 and 8′ into passages 7 and 7′, and thence out of the apparatus through discharge-pipes 9 and 9′, which pipes are connected with the cell-frame of each series farthest from the supply, as shown in Fig. 2.

B and B′ indicate the end boards, of the same configuration as the cell-frames, provided with tie beams or bars *b*, whose ends project beyond the edges of said boards and are perforated for the passage of tie-rods R, by means of which and suitable nuts the cell-frames are tied together.

By means of the construction of apparatus so far described it is adapted for suspension from girders G, thereby dispensing with a base, facilitating the arrangement of a series of apparatus in battery, and facilitating the removal of any one apparatus from its support when this becomes necessary.

A indicates the carbon anodes, which may be constructed of a single piece, though I prefer to construct them in sections, which as a whole take the general form of the cells, as shown in Fig. 4, the anode-sections being supported from conductors *c*, electrically connected together and to the positive pole of a suitable source of electricity in any suitable manner, as illustrated in Fig. 2.

The end boards B and B′ are each provided with a bearing $b^{\times}$ for a shaft S, to which the discoidal cathodes C are secured and to which motion is imparted from any suitable prime motor.

As shown in the drawings, the cathodes C, of zinc or iron, are held on shaft S and suitably spaced by means of conductive sleeves *s*, which latter are connected by a brush $B^{\times}$ with the negative pole of the source of electricity, the driving element, as a belt-pulley, being of course insulated from the shaft.

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

1. An electrolytic apparatus comprising a vessel containing a zinc-chlorid solution, a suitable insoluble anode, and a discoidal revoluble cathode, the latter dipping partly into said solution, means for preventing chlorin bubbles formed at the anode from coming into reactive contact with the cathode, and electrical connections between the anode, the cathode and the source of electricity respectively, for the purpose set forth.

2. An electrolytic apparatus comprising a vessel containing a zinc-chlorid solution acidulated with an organic acid, a suitable insoluble anode and a discoidal revoluble cathode, the latter dipping partly into said solution,

means for preventing chlorin bubbles formed at the anode from coming into reactive contact with the cathode, and electrical connections between the anode, the cathode and a source of electricity respectively, for the purpose set forth.

3. An electrolytic apparatus comprising a vessel containing a zinc-chlorid solution, a suitable insoluble anode and a discoidal revoluble cathode, the latter dipping partly into said solution, a diaphragm of a nitrated textile material, as nitrated cotton, interposed between the electrodes, and electrical connections between said electrodes and a source of electricity, for the purpose set forth.

In testimony that I claim the foregoing as my invention I have hereto signed my name in the presence of two witnesses.

CARL HOEPFNER.

Witnesses:
HENRY ORTH,
HENRY ORTH, Jr.