T. A. EDISON.

NICKEL PLATING.

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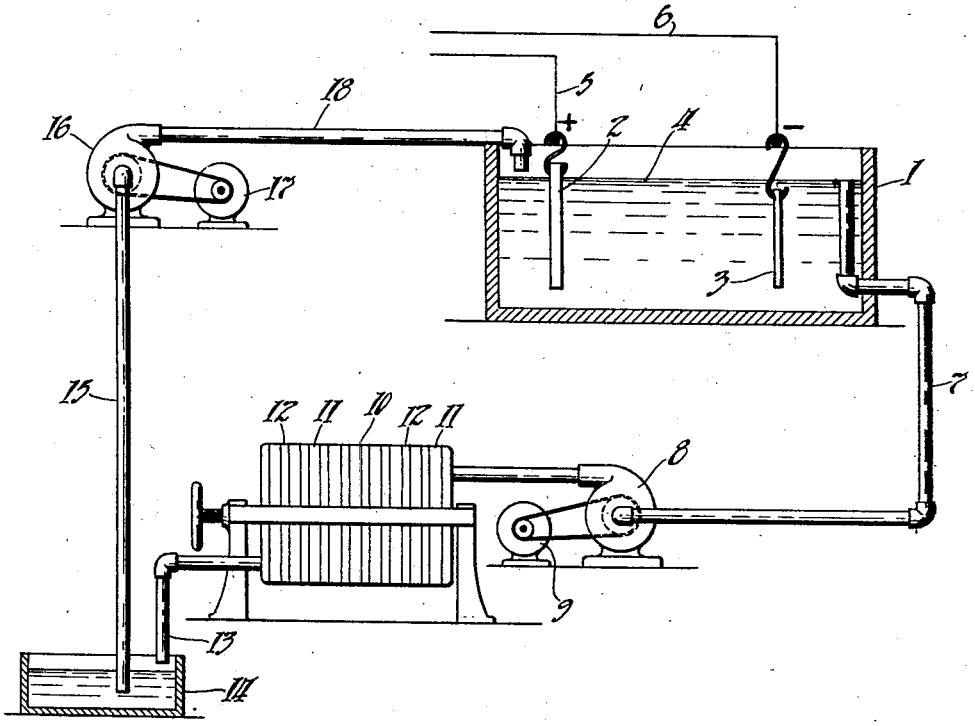
1,371,414. **Patented Mar. 15, 1921.**



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NICKEL-PLATING.

1,371,414. Specification of Letters Patent. Patented Mar. 15, 1921.

Application filed June 17, 1919. Serial No. 304,766.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, and a resident of Llewellyn Park, West Orange, Essex county, New Jersey, have invented certain new and useful Improvements in Nickel-Plating, of which the following is a description.

In plating nickel electrolytically, it has, up to the present time, been customary to employ a solution of nickel ammonium sulfate for the electrolyte or plating bath of the electrolytic cell. Nickel-plating with such a cell is a comparatively slow process, due to the fact that the strongest solution of nickel ammonium sulfate it is possible to obtain is a 7% solution, with the result that the cell will carry only a weak current and the nickel is therefore plated out of the solution only at a very slow rate.

The principal object of my invention is to provide an improved process and arrangement, whereby nickel plating electrolytically may be carried on at a much greater rate than has heretofore been practicable.

It has been proposed to use a concentrated solution of nickel sulfate as the electrolyte or plating bath of a nickel-plating electrolytic cell, as it is possible to obtain a 37% solution of nickel sulfate, and consequently with such a bath it is possible to impress a current on the cell sufficiently high to plate the nickel out of the bath onto the cathode about five times as fast as is the case when a concentrated solution of nickel ammonium sulfate is used for the electrolyte. However, in cells heretofore used in which a concentrated solution of nickel sulfate is employed as the plating bath, the latter quickly becomes acid. This is due to the fact that in the operation of such cells the nickel dissociated or separated from the nickel sulfate is plated on or taken up by the cathode more rapidly than it is replaced by nickel from the anode, or in other words, more rapidly than the nickel from the anode combines with the SO_4 dissociated from the nickel sulfate by the electric current. Consequently, the excess of SO_4 combines with hydrogen dissociated from the water in the solution by the electric current, to form sulfuric acid. The amount of sulfuric acid so formed continually increases and as this acid acts to dissolve the nickel deposited or plated on the cathode, the efficiency of such cells is soon lost. Moreover, the plating baths of such cells soon become dirty and scum rapidly accumulates on the surface thereof, which also is detrimental to the efficiency and usefulness of the cells. I have discovered that by continuously withdrawing solution from the plating bath of such a cell, suitably treating the withdrawn solution with nickel hydroxid which will neutralize all the acid and react therewith to restore the solution to its concentrated condition, and then returning the same to the cell, the bath will be kept practically free from acid or substantially and continuously neutral and substantially free from dirt and scum, and consequently the efficiency of the cell will be maintained at substantially its maximum point.

For a clearer understanding of my invention, attention is directed to the drawing accompanying and forming part of this specification, in which the single figure is a diagrammatic view showing the preferred arrangement for carrying out my improved process.

Referring to the drawing, reference character 1 represents a nickel-plating electrolytic cell comprising a nickel anode 2, a cathode 3 on which the nickel is to be plated, and an electrolyte or plating bath 4 consisting of a concentrated solution of nickel sulfate in which the anode and cathode are disposed. Reference characters 5 and 6 represent conductors respectively connected to the anode 2 and cathode 3 and supplying current to the cell from any suitable source (not shown). As explained above, when the cell 1 is in operation, it tends to quickly lose its efficiency, due to the production of sulfuric acid in the plating bath. In order to prevent this, I maintain the bath substantially neutral and concentrated by continuously withdrawing solution from the bath at a very rapid rate, treating the withdrawn solution with a sufficient amount of nickel hydroxid to completely neutralize any acid which may be present therein and to react with such acid to form an additional amount of nickel sulfate sufficient to restore the solution to its concentrated condition, and then returning such neutralized and concentrated solution to the bath. In other words, I continuously and rapidly circulate the solution of nickel sulfate in an endless path including the plating bath of the cell 1, and treat the solution at a point in said path and without the plating bath so as to completely

neutralize all acid which may be present therein and restore the same to its concentrated condition. The solution of the plating bath being thus maintained substantially neutral and concentrated, I am enabled to impress sufficiently high current on the cell to continuously nickel plate at approximately the maximum rate which is possible when using a concentrated solution of nickel sulfate, namely, at about five times the rate at which it is possible to nickel plate when using an ordinary nickel plating bath consisting of a concentrated solution of nickel ammonium sulfate.

In my preferred arrangement, as shown in the drawing, the solution is withdrawn from the plating bath of the cell 1 through a pipe 7 leading to a force pump 8 which is driven by a suitable motor 9. The pipe 7 is provided with a vertical upper end portion disposed in the bath 4, the upper end of such portion terminating a slight distance below the level at which the electrolyte would stand if all of the electrolyte employed were present in the cell. Accordingly, the pipe 7 constitutes an overflow for constantly maintaining the level of the plating bath at the upper end of this pipe and for continuously withdrawing solution from the plating bath and removing from the latter dirt and scum which accumulates on its surface. The pump 8 forces the solution withdrawn from the plating bath 4 by the overflow pipe 7 through a conventional form of filter press 10 or equivalent device consisting of alternately arranged frames 11 and filter plates 12. Disposed in the frames 11 is an amount of nickel hydroxid in excess of that necessary to completely neutralize all acid which may be present in the solution withdrawn from the bath during a long period of time and to combine with such acid to form a sufficient amount of nickel sulfate to restore the solution to its concentrated condition. The nickel hydroxid is preferably introduced into the filter press by adding at the beginning of the plating operation and as often thereafter as necessary sufficient quantities of powdered nickel hydroxid to the solution at a point in its passage from the cell to the filter press, for example, at the pump 8. Porous cakes of nickel hydroxid are thus formed on all of the filtering cloths of the filter press, which insures all of the solution withdrawn from the plating bath being forced through nickel hydroxid so as to completely neutralize and restore the same to its concentrated condition. Moreover, substantially all dirt will be removed from the electrolyte in its passage through the filter press, being caught by the filtering cloths and cakes of nickel hydroxid. From the filter press 10 the clean, neutralized and concentrated solution is conveyed by a pipe 13 to a suitable tank 14 from which it is withdrawn through a pipe 15 by means of a pump 16 which is driven from a suitable motor 17, and then forced by the pump 16 through a pipe 18 back into the cell 1. The pumps 8 and 16 are preferably operated at such speeds and the parts of the arrangement shown are so proportioned and arranged that solution will be withdrawn from the plating bath and forced through the filter press at an extremely rapid rate nearly equal to the filtering capacity of the press, for the quicker the circulation of the solution through the filter press, the cleaner and more nearly neutral the plating bath will be maintained. By the use of the arrangement shown and described, all of the electrolyte is automatically and continuously maintained in substantially concentrated condition and automatically and continuously perfectly filtered and neutralized.

While I have illustrated my preferred process and the preferred arrangement for carrying out such a process, it is to be understood that both the process and arrangement are subject to various modifications without departure from the spirit of my invention and the scope of the appended claims.

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

1. The process of nickel-plating electrolytically, which consists in employing an electroplating bath consisting of a solution of nickel sulfate, continuously withdrawing solution from said bath, treating the withdrawn solution with nickel hydroxid, and continuously returning the treated solution to the bath, substantially as described.

2. The process of nickel-plating electrolytically, which consists in circulating a solution of nickel sulfate in an endless path including the plating bath of the electrolytic cell, and treating such solution in said path and without the bath with nickel hydroxid, substantially as described.

3. The process of nickel-plating electrolytically, which consists in circulating a solution of nickel sulfate in an endless path including the plating bath of the electrolytic cell and a filter press or equivalent device containing nickel hydroxid, substantially as described.

4. The process of nickel-plating electrolytically, which consists in employing an electroplating bath consisting of a concentrated solution of nickel sulfate, continuously withdrawing solution from said bath and passing the same through a filter press containing nickel hydroxid for neutralizing any acid which may be present in the solution and to restore the latter to its concentrated condition, and then continuously returning the solution to the bath, substantially as described.

5. The process of nickel-plating electrolytically, which consists in employing an electroplating bath consisting of a solution of nickel sulfate, continuously withdrawing the solution from the upper surface portion of said bath and forcing the same through a filter press containing nickel hydroxid, and then returning the solution to the bath, substantially as described.

6. In an arrangement of the class described, an electrolytic cell containing a nickel-plating bath consisting of a solution of nickel sulfate, a filter press containing nickel hydroxid, means comprising an overflow pipe disposed in said bath for withdrawing solution from said bath and forcing the same through the filter press, and means for returning the solution which passes through the filter press to the bath, substantially as described.

7. In an arrangement of the class described, an electroplating bath comprising a solution of nickel sulfate, a device containing nickel hydroxid, means comprising an overflow pipe disposed in said bath for withdrawing solution from said bath and forcing the same through the nickel hydroxid in said device, and means for returning the solution which passes through the nickel hydroxid to the bath, substantially as described.

8. In an arrangement of the class described, a nickel-plating bath comprising a solution of nickel sulfate, a device containing a substance capable of reacting with sulfuric acid to form nickel sulfate, means for withdrawing solution from said bath and passing the same through the substance in said device, and means for returning the solution which passes through said substance to the bath, substantially as described.

9. In an arrangement of the class described, a nickel-plating bath comprising a solution of nickel sulfate, a device containing nickel hydroxid, means for withdrawing solution from said bath and forcing the same through the nickel hydroxid in said device, a tank, means for conveying the solution from said device to the tank, and means for returning the solution from said tank to said bath, substantially as described.

10. In an arrangement of the class described, a nickel-plating bath comprising a solution of nickel sulfate, a filter press containing nickel hydroxid, means for withdrawing solution from said bath and forcing the same through said filter press, a tank, means for conveying solution from said filter press to said tank, and means comprising a pump for withdrawing the solution from said tank and returning the same to said bath, substantially as described.

This specification signed this 12th day of June, 1919.

THOS. A. EDISON.