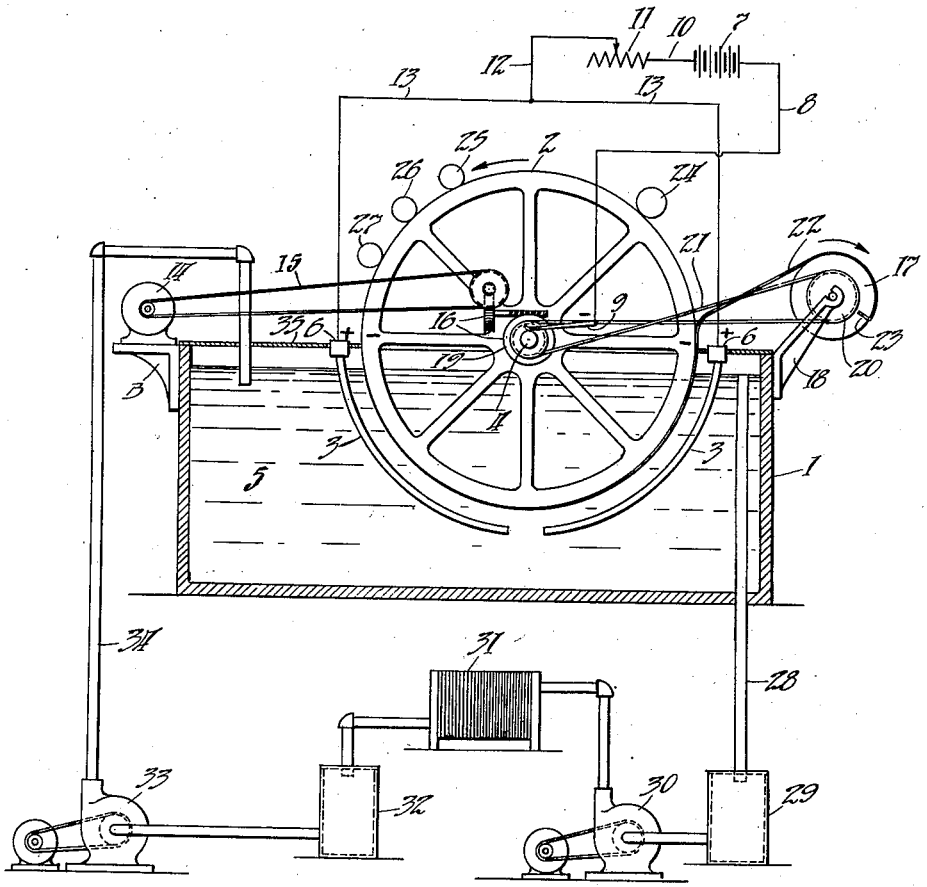
T. A. EDISON.

PRODUCTION OF THIN METAL SHEETS OR FOILS.

APPLICATION FILED JULY 16, 1920.

1,417,464. Patented May 23, 1922.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, WEST ORANGE, NEW JERSEY.

PRODUCTION OF THIN METAL SHEETS OR FOILS.

1,417,464. Specification of Letters Patent. Patented May 23, 1922.

Application filed July 16, 1920. Serial No. 396,825.

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 the Production of Thin Metal Sheets or Foils, of which the following is a description.

My invention relates to the production of metal sheets or foils and more particularly to an improved method and means for producing such sheets or foils by electro-deposition.

The principal object of my invention is to produce thin sheets or foils of metal, preferably nickle, of any desired length by electro-plating, preferably by operations which may be carried on continuously.

More specifically described, my invention resides in partially immersing in the plating bath of an electro-plating cell, the electrode on which the metal is plated, moving such electrode so that different portions thereof will successively leave the bath and continuously stripping from such electrode at a point without the bath, the metal deposited thereon in the bath so as to produce a thin sheet or foil formed of such metal, and continuing these operations until the sheet or foil thus produced is of the desired length. The surface of the electrode on which the metal is plated, is suitably treated so as to facilitate the stripping of the plated metal therefrom, preferably by providing such surface with a coating of a material containing selenium, such as a selenide of copper where the electrode is of copper, as described in my pending application Serial No. 305,821, filed June 21, 1919 and entitled Electro-plating, which has resulted in Patent No. 1,359,972, dated Nov. 23, 1920. The electrode on which the metal is plated is preferably cylindrical and mounted for rotary movement and is preferably continuously rotated by any suitable driving mechanism. Suitable means such as a rotary drum driven in any suitable manner, but preferably by means of said driving mechanism, is also provided for continuously stripping from said electrode the metal plated thereon, and to wind up the long, thin, metal foil or sheet thus produced. The thickness of the sheet or foil thus produced may be readily regulated as, for example, by varying the speed at which the electrode on which the metal is plated is moved.

Other objects and features of my invention will be hereinafter more fully described and claimed.

In order that my invention may be more clearly understood, attention is directed to the drawing accompanying and forming a part of this specification and in which the single figure is a view in end elevation, partly in section and partly diagrammatic, of one form of apparatus for producing metal sheets in accordance with my invention.

The electroytic cell of the form of apparatus shown, comprises a tank or container 1, a cathode 2 preferably in the form of a wheel or cylindrical drum, and a pair of anodes 3, 3 which conform to the periphery of the cathode drum 2 and are suitably supported in the tank from their upper ends with their lower ends slightly spaced apart. The cathode drum 2 is mounted on a shaft 4 which is journaled at its ends in suitable bearings carried by opposite walls of the tank 1 so that the drum is supported with only a portion of its periphery immersed in the electrolyte or plating bath 5 of the cell; while the anodes 3, 3 are supported at their upper ends as by means of rods 6, 6 from the top of the container or tank 1 so that they will be practically entirely immersed in the bath and substantially equally spaced at all points from the peripheral portion of the cathode drum 2 which is immersed in the bath.

A suitable source such as battery, or a dynamo may be employed for supplying current to the cell. As shown, this source consists of a battery 7 connected at one side by means of conductor 8 to a brush 9 suitably maintained in contact with the shaft 4 of the cathode drum 2, and at the other side through a conductor 10, an adjustable resistance or rheostat 11, a conductor 12 and branch conductors 13, 13 to the anodes 3, 3. All portions of the cathode drum 2 except the outer cylindrical surface thereof, which may be termed the plating surface, are covered with suitable means such as a protecting varnish to prevent the plating of metal thereon when immersed in the electrolyte or plating bath 5. The cathode drum 2 is rotated in the direction of the arrow at a very slow and uniform speed as by means of a motor 14 carried by a bracket B which is suitably secured to one wall of the container 1 adjacent the upper end thereof, and

suitable driving connections which, as shown, comprise a belt 15 and reduction worm gearing 16. In case it is desired to produce nickel sheets or foils, for which the present invention has been especially designed, the cathode drum 2 is preferably formed of copper, the anodes 3, 3 are formed of nickel and the plating bath or electrolyte 5 comprising a suitable nickel plating solution, preferably a nearly saturated solution of nickel sulphate and a suitable amount of a salt of a fatty acid such as acetate of nickel or an alkaline acetate, preferably acetate of magnesia. When such a plating bath is employed, the nickel plated on the cathode will be substantially pure and malleable, of fine and uniform texture and substantially free from brittleness, internal stresses and strains, and moreover it is possible to impress on the cell a current having a density many times greater and consequently to plate out the nickel onto the cathode many times faster than is possible in the case of nickel-plating cells employing electrolytes consisting of solutions of the usual salts employed in the nickel-plating industry. It will be aparent that the deposit of nickel on the cylindrical plating surface of the cathode 2 will increase in thickness from the point where the cathode enters the bath 5 to the point where it leaves such bath, and that in the operation of the apparatus different portions of the cathode and the plating surface thereof will successively emerge from or leave the plating bath. The metal deposited on the cylindrical plating surface of the cathode drum 2 is suitably and preferably continuously stripped therefrom without the plating bath and preferably at a point thereon with respect to the direction of the rotation of the cathode, just beyond the bath. This is accomplished by stripping from the cathode the first portion of nickel plated thereon in the operation of the apparatus just after it emerges from the plating bath, and suitably securing the same to means such as a winding drum 17 which is journaled in a bracket 18 supported on the container 1, and suitably driven in the direction of the arrow from the shaft 4 of the cathode drum 2 as by means of pulleys 19 and 20 respectively secured to the shaft 4 and the drum 17, and a crossed belt 21 running over these pulleys and capable of slipping thereon. The metal first stripped from the cathode drum 2 is attached to the drum 17 as by inserting the end portion thereof into a slit 23 in the drum 17. The pulleys 19 and 20 are of such size that if there were no slip to belt 21, the drum 17 would be driven at higher surface speed than the cathode drum 2, and accordingly the nickel sheet or foil 21 produced is constantly maintained under sufficient tension to ensure the continuance of the operation of stripping the nickel from the drum 2. The cylindrical plating surface of the hopper drum 2 preferably has a thin film or coating of a material containing selenium, preferably selenide of copper, so as to facilitate the stripping of the plated metal therefrom, as hereinbefore described. In order to insure that the plating surface of the cathode drum 2 will always be provided with this film or coating when immersed in the plating bath, a suitable wiper such as a sponge 24 soaked with a selenium solution, such as a solution of selenious acid, is suitably supported at a point adjacent the drum 2 and a short distance beyond where the nickel is stripped therefrom, so as to contact said plating surface for its entire width. The solution thus wiped onto the plating surface of the drum 2 reacts with the copper of which said drum is composed, to form the film or coating of selenide of copper. In order to prevent any surplus selenium solution applied to the drum 2 by the sponge 24, from entering the bath 5 and affecting its efficiency, means such as a series of sponges 25, 26 and 27 are suitably supported adjacent the drum 2 between the sponge 24 and the point where the drum enters the plating bath so as to contact the face or plating surface of the drum for its entire width. I find that these sponges effectually wipe off and entirely remove from the drum all the free or surplus selenium solution which may be present thereon.

Reference character 28 represents an overflow pipe disposed in the tank 1 and leading therefrom to a suitable container such as a crock 29. Impurities and the like which are produced in the bath 5 during the operation of the cell tend to accumulate on the surface of the bath and accordingly will be carried into the crock 29 with the electrolyte which passes through the overflow pipe 28. A pump 30 driven by a suitable motor withdraws the elctrolyte from the crock 29 adjacent the bottom thereof and forces the same through a filter or other cleaning means such as a filter-press 31, where all impurities and the like are removed. From the filter-press 31 the filtered electrolyte flows through a suitable pipe into another container or crock 32, and a pump 33 driven from a suitable motor withdraws the electrolyte from such container and forces the same through a pipe 34 back into the tank 1 of the cell. The arrangement is such that there will always be a considerable quantity of electrolyte in each of the containers or crocks 29 and 32 and consequently the level of the bath 5 in the tank 1 will be maintained at a substantially fixed point. In order, however, to prevent evaporation of the electrolyte, the tank 1 is provided with a suitable cover 35.

The thickness of the nickel or other metal plated on the outer cylindrical surface of the drum 2 during its movement through

the bath, may be readily regulated, as, for example, by varying the speed of the motor 14 and thereby the speed of rotation of the drum 2. When the apparatus has once been adjusted, however, the metal sheet or foil 22 formed by continuously stripping the plated metal from the drum 2, will be very uniform in thickness, and the length of such sheet or foil will be dependent on the time during which the apparatus is continuously maintained in operation.

While I have specifically described the preferred method and one form of apparatus for carrying out such method in accordance with my invention, it is to be understood that both the method and the apparatus are subject to various changes and modifications without departure from the spirit of the invention or the scope of the appended claims.

Having now fully described my invention, what I claim as new and desire to protect by Letters Patent of the United States is as follows:

1. The method which consists in continuously moving an electrode of an electrolytic cell capable of plating a metal in an endless path only part of which includes the bath of the cell, and continuously stripping from said electrode at a point in said path without said bath, the metal deposited thereon in the bath, substantially as described.

2. The method which consists in mounting for rotary movement about a fixed axis a cylindrical electrode of an electrolytic cell capable of plating a metal, so that only a portion of such electrode is immersed in the bath of said cell, continuously rotating said electrode, and continuously stripping from said electrode at a point without the bath, the metal deposited thereon in the bath, substantially as described.

3. The method of producing a metal sheet or strip of any desired length, which consists in moving an electrode of an electrolytic cell capable of plating such metal in a continuous path extending through and then out of the bath of such cell, and continuously stripping from such electrode at a point in the path of movement thereof beyond the bath, the metal deposited thereon while in the bath, substantially as described.

4. The method of producing a metal sheet or strip of any desired length, which consists in partially immersing an electrode of an electrolytic cell capable of plating such metal in the bath of the cell, moving said electrode so that different portions thereof successively leave said bath, and continuously stripping from said electrode at a point without the bath, the metal deposited thereon in the bath, substantially as described.

5. The method of producing a metal sheet or strip of any desired length, which consists in providing the plating surface of an electrode of an electrolytic cell capable of plating such metal, with a coating of a material containing selenium, moving said electrode in a continuous path extending through and then out of the bath of said cell, and continuously stripping from said electrode at a point in the path of movement thereof beyond the bath, the metal deposited thereon in the bath, substantially as described.

6. In apparatus for producing metal sheets or strips of any desired length, an electrolytic cell capable of plating such metal and comprising an electrode partially immersed in the bath of said cell, means for moving said electrode so that different portions thereof will successively leave said bath, and means for continuously stripping from said electrode at a point without said bath, the metal deposited thereon in the bath, substantially as described.

7. In apparatus for producing metal sheets or strips of any desired length, an electrolytic cell capable of plating such metal and comprising a container, a plating bath in said container, means for maintaining said bath at a fixed level, an electrode partially immersed in said bath, means for moving said electrode so that different portions thereof successively leave said bath, and means for stripping from said electrode at a point without the bath, the metal deposited thereon in the bath, substantially as described.

8. In apparatus for producing metal sheets or strips of any desired length, an electrolytic cell capable of plating such metal and comprising a container, a plating bath in said container, means for withdrawing electrolyte from said bath, cleaning such electrolyte and then returning the same to the bath, an electrode partially immersed in said bath, means for moving said electrode so that different portions thereof successively leave said bath, and means for stripping from said electrode at a point without the bath, the metal deposited thereon in the bath, substantially as described.

9. In apparatus for producing metal sheets or strips of any desired length, an electrolytic cell capable of plating such metal and comprising a plating bath, an electrode having an endless plating surface only a portion of which is immersed in said bath, means for moving said electrode so that different portions of the plating surface thereof successively leave said bath, means for stripping from said plating surface at a point without said bath, the metal deposited thereon in the bath, and means for applying a coating of material containing selenium to said surface, at a point between where the said metal is stripped therefrom and where the electrode enters said bath, substantially as described.

10. In apparatus for producing metal

sheets or strips, an electrolytic cell capable of plating such metal and comprising a rotary electrode having an endless plating surface, said electrode being mounted with only a portion of said surface immersed in the plating bath of said cell, means for rotating said electrode so that different portions of said plating surface will successively leave said bath, and means for stripping from said surface at a point without said bath, the metal plated thereon in the bath, substantially as described.

11. In apparatus for producing metal sheets or strips of any desired length, an electrolytic cell capable of plating said metal and comprising a cathode of copper having a cylindrical plating surface only a portion of which is immersed in the bath of said cell, said plating surface being provided with a coating of selenide of copper, means for continuously rotating said electrode, and means for continuously stripping from said surface at a point without the bath, the metal plated thereon in the bath, substantially as described.

This specification signed this 8th day of July, 1920.

THOS. A. EDISON.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,417,464, granted May 23, 1922, upon the application of Thomas A. Edison, of Llewellyn Park, West Orange, New Jersey, for an improvement in the "Production of Thin Metal Sheets or Foils," errors appear in the printed specification requiring correction as follows: Page 1, line 91, before the word "battery" insert the article *a;* page 2, line 66, for the word "hopper" read *copper*, and line 109, for the misspelled word "elctrolyte" read *electrolyte;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of June, A. D., 1922.

[SEAL.]

KARL FENNING,

Acting Commissioner of Patents.