Nov. 23, 1937. M. M. STERNFELS 2,099,873

MACHINE AND PROCESS FOR PRODUCING FLAKE METAL BY ELECTRODEPOSITION

Filed June 14, 1934 2 Sheets-Sheet 1

Fig. 1.

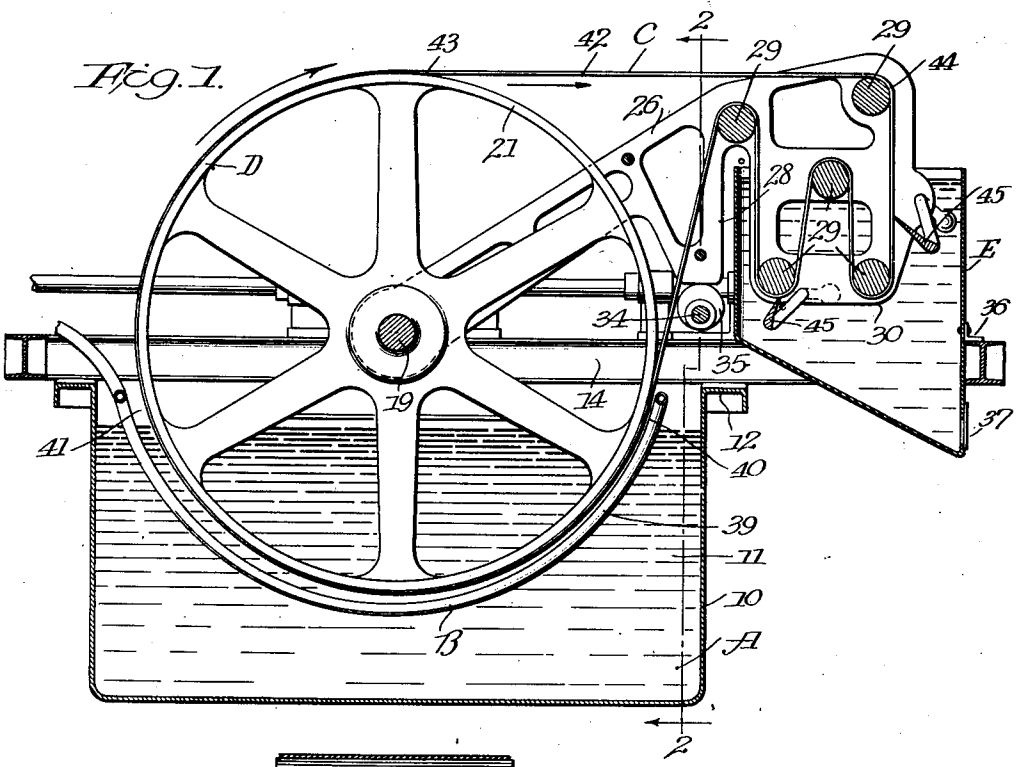
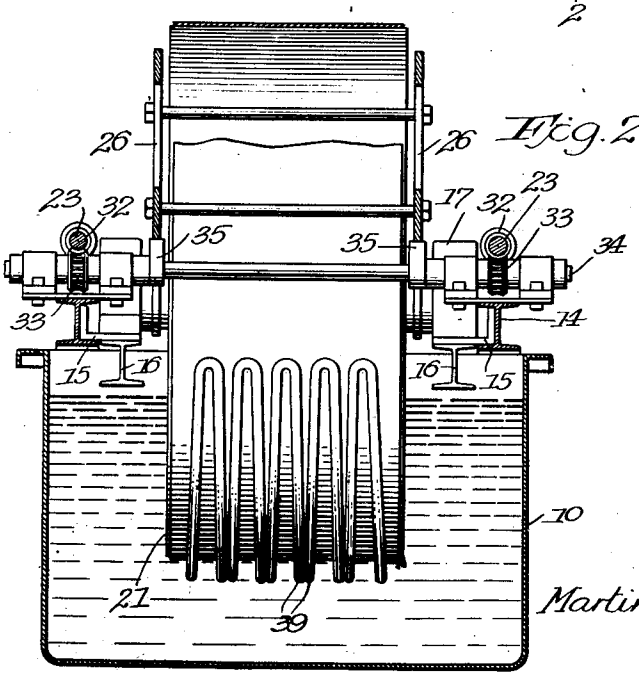


Fig. 2.



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Fig. 3.

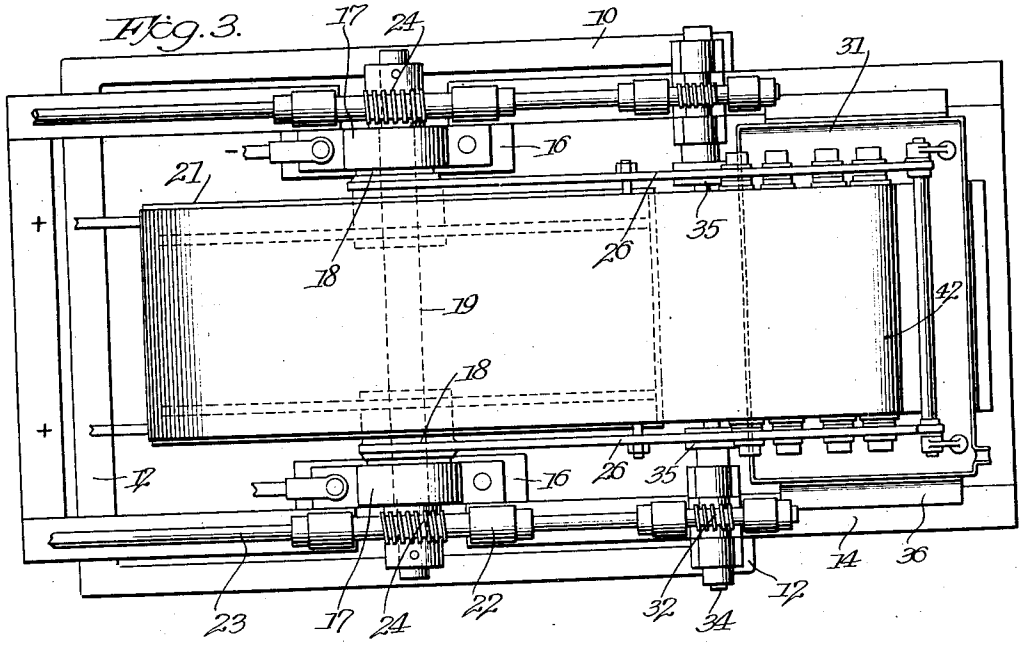
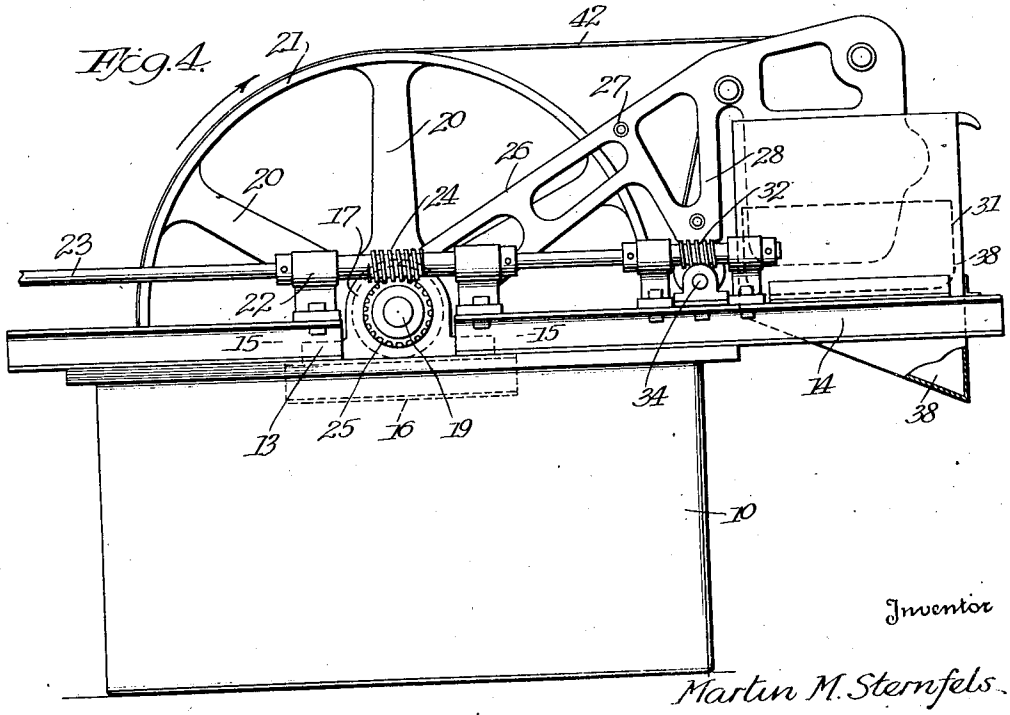


Fig. 4.



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2,099,873

MACHINE AND PROCESS FOR PRODUCING FLAKE METAL BY ELECTRODEPOSITION

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Application June 14, 1934, Serial No. 730,673

18 Claims. (Cl. 204—5)

The present invention relates to a machine and process for producing flake metal by electrodeposition. It is particularly useful for obtaining flake chromium, but may be employed in connection with the electro-deposition of other metals.

An important feature of the invention resides in using a continuously movable flexible cathode formed of material upon which the flakes are collected as a non-coherent, i. e., discontinuous, poorly adherent and curly, deposit. The flexible cathode, in the form of a belt, preferably moves over a cylinder or drum rotating in the bath and in association with an anode, the latter substantially conforming to the contour of the drum and cathode thereon.

An object of the invention is to maintain the curvature of the cathode constant, so that the curly, weakly adherent flakes will not be loosened either in the neighborhood of the anode, thereby avoiding loss of the flakes and the possibility of short-circuiting, or before the belt assumes a position where any change in curvature tending to release the deposit would result in the flakes falling from the cathode. Stated briefly, the belt is maintained in rigid engagement with the drum and of constant curvature while associated therewith, and this engagement is maintained up to the point of disengagement of the belt and drum exteriorly of the bath. At this point where the belt undergoes a change in curvature, the position of the belt, i. e., substantially perpendicular to the vertical diameter of the drum, is such that the flakes which are loosened or completely released by the change in curvature will not be permitted to fall from the cathode and thereby be wasted.

My improved machine assures a maximum deposit of curly flakes which may be released upon sharply bending or changing the curvature of the cathode. In this manner, the substantially discontinuous deposit is to some extent cracked, but primarily the bending of the cathode acts to move or draw the belt away from the weakly adherent flakes, so that the flakes are loosened or released and rendered readily removable, as by a doctor blade.

I effect preliminary loosening of the flakes in the presence of the atmosphere by changing the curvature of the cathode, as stated, at a point where the flakes cannot fall from the belt, usually a point tangent to the vertical diameter of the drum. Thereafter, the cathode and deposit undergo a sharp bending and the flakes are preferably removed in an inert bath, for example, of water through which the cathode travels and where the water which may be circulated washes away the chromic acid. The latter acts as an adhesive to hold the flakes to the belt, and the removal under water overcomes the tendency of the flakes to adhere to each other or to the doctor blade, as well as to the belt.

The curved or conforming anode is disposed in the bath eccentrically spaced with respect to the drum and cathode thereon. Hence, as the deposit builds up upon the cathode, at no time will the curled flakes be permitted to engage the anode, and in fact the anode assumes substantially a position of concentricity to the deposit. The anode preferably comprises a tubular coil and forms a means of receiving a circulating medium to control the temperature of the bath.

Other features and objects of the present invention will be more particularly described in the following description.

Referring to the drawings:

Figure 1 is a central longitudinal section of my improved machine.

Figure 2 is a transverse section on the line 2—2 of Figure 1.

Figure 3 is a plan view of the machine, and

Figure 4 is a side elevation of the machine.

In carrying out the process of the present invention, I employ a bath of the solution A, in which is disposed the anode B, and the continuously moving belt cathode C moves through the bath over a rotating drum D. The flexible strip cathode is maintained in firm engagement with the drum D and does not suffer a change in curvature from the point where it enters the bath until it is disengaged from the drum at a point substantially tangent to the vertical diameter of the drum. The change in curvature which the belt undergoes at the point of disengagement from the drum acts to release the deposit and loosen the same, but since the belt travels in a substantially horizontal plane, the flakes are not permitted to drop and be lost. Thereafter, the belt undergoes a sharp bending or flexing, and since the belt is more flexible than the deposit, it is drawn away from the deposit to release the same or to very substantially loosen the weakly adherent flakes. The deposit is removed under water or suitable inert liquid in a tank E where the flakes are collected and the water in the tank E may be given a circulatory motion. Likewise, the belt may be reciprocated to accelerate the bending or flexing action. At all times the anode is spaced from the cathode in such a manner, i. e., eccentric thereto, but substantially concentric to

the deposit, that the weakly adherent flakes may not engage the anode to either be removed or to set up a short circuit, which would result in damaging the apparatus. The belt cathode C is formed of a material which will assure a deposit of the flakes thereon as a discontinuous film, i. e., one which is noncoherent, and particularly the chromium or other metal is collected on the belt as a poorly adherent curly deposit. The flakes are recovered in the tank E, and so efficient is the process that substantially all of the deposit is removed and collected.

In Figure 1, I have indicated at 10 a tank containing, for example, a chromic acid solution 11. The tank 10 may be of any suitable shape and size and formed of any satisfactory material.

At its upper edge, the end walls of the tank are provided with flanges 12, upon which, but insulated from which, rest side-rails in the form of I-beams 14. The adjacent or central ends 13 of the side-rails are spaced apart as illustrated in Figure 4. A bracket 15 is suitably connected to each of the adjacent ends of each pair of side rails, as shown in Figure 2, which brackets are in the form of angle members. The pairs of brackets 15 on their underside are connected to and support an I-beam 16, which is offset with respect to the central ends of each pair of rails, and is disposed within the tank as shown in Figure 2. It will be observed that the pairs of brackets 15, which support the I-beams 16 on each side of the tank, serve to connect each pair of spaced side rails through the instrumentality of the I-beams 16, the latter spanning the distance between the adjacent ends of the rails. If desired, the side rails 14 may be integral instead of split, as shown. The respective side rails and I-beams constitute a unitary support for the drum, the cathode, the washing tank, and associated operating mechanism, which may be removed from the tank as a whole.

Referring to Figures 2 and 4, there is fixed on the I-beams 16 on each side of the tank, bearings 17 in which run journals 18, of the drum shaft 19. Hubs having spokes 20 are connected to the shaft and carry the cylinder or drum 21.

The journals 18 are electrically connected to the spokes, which in turn are electrically connected to the cylinder 21, over which the cathode moves. The negative connection is made by means of a copper or aluminum bus bar running to the bearings 17, as shown in Figure 3.

Each side rail 14 has suitable bearings 22 rotatably supporting a drive shaft 23, carrying a worm 24, engaging a gear 25 mounted on the drum shaft 19, whereby the drum is rotated from any suitable source of power associated with the shafts 23.

Also freely supported for reciprocation on the journals 18, are the ends of spaced plate members 26, one on each side of the tank and exteriorly of the cylinder, and which are held in spaced relation by tie rods 27. The said plates extend to the washing tank E, and each plate has an intermediate downward projection 28, and the plates form a carriage for a plurality of rollers 29. Each plate member at its free extremity also has a pair of downwardly projecting portions 30 in which are carried certain of the rollers 29. The projections 30 and rollers 29 carried thereby are disposed in a washing tank 31, which contains a washing fluid, such as water or other inert liquid, as shown in Figure 1. The purpose of the rollers 29 is to guide the cathode and maintain it rigidly, as well as to sharply flex or bend the same, and the plates 26 forming a carriage for the rollers being reciprocably mounted will accelerate this bending and assure circulation of the water in the tank 31.

Also carried by the shafts 23 on each side of the tank are worms 32, each of which engages a gear 33, carried by a shaft 34 mounted for rotation in suitable bearings on the side rails. This shaft has fixed to it eccentrics 35, and the rotation of the shaft 34 with consequent movement of the eccentrics, will impart to the plates 26 an oscillating motion about shaft 19 as a center by reason of the lower ends of the projections 28 of said plates freely resting upon the eccentrics 35. This action, as stated, serves both to flex the belt and agitate the washing water in tank 31.

The tank 31 may be of any suitable design and is supported by the adjacent side rails 14, as shown in Figures 1 and 4, being supported by them by means of suitable angle brackets 36, fastened to the tank 31. A port 37 or outlet may be employed for washing out the accumulated flakes from tank 31, and, if desired, the tank 31 may have a removable foraminous container nested therein, as shown at 38 in Figure 4, to remove the flakes.

An anode 39 is supported in the tank 10, but insulated therefrom, and suitably connected to positive terminals, preferably at each end as shown at Figure 1. The anode 39 is of curved contour and formed as a continuous tubular coil, for example, of lead pipe, as shown in Figure 2, so as to receive and circulate a suitable medium, such as a cooling liquid to assist in controlling the temperature of the bath. The anode or coil 39 is illustrated in detail in Figure 2, and, as stated, is shaped to conform to the curvature of the cylinder 21, as shown in Figure 1. The anode is mounted eccentrically with respect to the surface of the cylinder, so that at one end 40, namely, the end at which the cathode enters the bath, the coil is closer to the anode than at its opposite end 41. The purpose of this construction and its importance will later be more fully set forth.

The cathode is indicated at 42, and comprises a continuous flexible strip or belt of metal which is preferably an aluminum alloy. This alloy may be of any one of the following compositions:

	Al	Mn	Cu	Mg	Si
51 ST	Bal.	-----	-----	0.6	1.0
43 SH	Bal.	-----	-----	-----	5.0
17 ST	Bal.	0.5	4.0	0.5	-----

I prefer aluminum alloys of the type above described for forming the cathode because of the efficient results secured. Not only do I obtain a non-adherent deposit, but of particular importance, the deposit is cracked, i. e., discontinuous and the curling of the flakes is of a more pronounced nature. This results in optimum removal and recovery of the flake metal.

A further and equally valuable advantage of a cathode formed of a material of the character described resides in the reduction in plating time. It is desirable to have the plating time as short as is consistent with getting good flaking of the deposit; the shorter the period the thinner the flakes, enabling them to be more readily removed and easily crushed.

Stated briefly, by using a cathode formed of an aluminum alloy of the character described, I obtain a discontinuous deposit of pronounced curly

nature in a minimum of plating time and the flakes are thin, and adherent to the cathode at one point only. They are easily removable and their crushability is enhanced.

It will be appreciated that by having a curled and discontinuous deposit, a substantial purchase is provided for the doctor blade. Moreover, the bending action to which the cathode is subjected and the washing operation insure a substantially complete removal and recovery of the flake metal.

In addition to a belt formed of aluminum alloys of the type mentioned, I may also use other aluminum alloys as well as nickel, copper and alloys thereof. The particular alloys referred to give the very pronounced curled and non-coherent deposit as well as weakly adherent deposit and the plating is accomplished with a substantial reduction in operating time.

The belt, as shown, passes around the curved surface **21** of the drum and over the rollers **29** carried by the plates **26**. The movement of the belt is in the direction of the arrow as shown in Figure 1. It will be noted that the cathode is held rigidly in engagement with the drum **21**; that is, its curvature is constant from the time it enters the bath adjacent the end **40** of the anode **39** until it is disengaged from the drum.

The belt is preferably disengaged from the drum at a point tangent to the vertical diameter of the drum and initially moves from this point in a horizontal plane. No opportunity is presented for releasing the flakes due to change in curvature prior to the cathode and deposit thereon reaching the predetermined point of disengagement. Hence, notwithstanding that the deposit may be cracked or the flakes released due to the change in curvature of the cathode, falling of the deposit therefrom is obviated, since, as stated, the belt moves from the drum initially in substantially a horizontal plane.

The anode is positioned at a uniform distance from the surface of the deposit on the cathode at all times by reason of its eccentricity with respect to the drum and belt. The curly deposit may extend as far as three-fourths of an inch from the surface of the belt and hence, I make the eccentric disposition of the anode quite substantial. This is of great importance in that the curled deposit is prevented from coming in contact with the anode, thereby avoiding pulling off the weakly adherent flakes back into the bath, and likewise short-circuiting of the machine is prevented.

It is to be noted that the anode due to its conforming character and eccentric disposition with relation to the drum is progressively spaced from the drum in the direction of movement of the belt.

Since the belt traveling in the bath will accumulate a deposit thereon which increases in thickness as the belt progresses through the bath, the value of the corresponding increased spacing of the anode from the cathode will be appreciated. In effect, while the anode is eccentric relative to the drum and cathode, it is concentric with the deposit thereon, assuring efficient plating action.

The surface of the cathode upon which the chromium has been deposited is strongly bent in order to loosen the weakly adherent deposit. This bending first takes place at the point of tangency **43** of the belt with the drum, and thereafter the belt is strongly bent on the roller **29**, as shown at **44**, exteriorly of the tank **31**. The belt passes over the rollers **29**, which are immersed in the tank **31**, and is strongly bent in each instance. Where the bending takes place in the air, in effect, the metal of the belt is drawn away from the flakes which are not as flexible as the belt and the air is permitted to enter and aid in loosening the deposit. In bending the cathode in the presence of the liquid in the tank **31**, the same drawing of the belt from the deposit will occur and the water will enter under the flakes. Moreover, chromic acid, forming the bond between the flakes and cathode, will be washed off by the water.

A doctor blade **45** is positioned at any suitable point in the tank **31** and by reason of the discontinuous deposit and the curly nature of the flakes as well as the preliminary loosening to which they are subjected before immersion, the engagement of the doctor blade with the cathode while it is immersed effects a substantially complete removal of the flakes.

The gradual charging of the tank **31** with chromic acid dragged over from tank **10** is insufficient to effect solution of the flakes which are stripped from the belt, but this does form a protective coating for the metal parts of the tank. One or more doctor blades **45** may be used or the single one employed positioned between any pair of the rollers which are immersed in the liquid.

The bending of the cathode is increased by reason of the reciprocatory motion accorded the plates **26** carrying the rollers **29**. This construction is advantageous, since the projections **30** of the plates and the rollers thereon when reciprocated set up circulation of the water in the washing bath.

By removing the flakes from the cathode immersed in the liquid of the tank **31**, they are readily collected and are prevented from sticking to the belt or to the doctor blade.

If the cooling coils of the anode are insufficient to maintain the temperature sufficiently reduced, an additional cooling means may be employed either immersed in the bath or arranged exteriorly of the tank. In such case, the cooling fluid in the anode will preferably be brine, while the cooling fluid in the auxiliary cooling coils will be cold water.

I claim:—

1. A machine for producing flaked metal by electro-deposition comprising a bath, a cathode, and curved anode, said anode being in the form of a coil arranged to receive a circulating medium and spaced progressively farther and farther from said cathode in accordance with the thickness of the deposit thereon.

2. A machine for producing flaked metal by electro-deposition comprising a bath, an anode, a continuously moving cathode, a washing bath, and means for passing the cathode and the deposit thereon through said washing bath, and means for agitating the bath for removing the deposit from the cathode in said washing bath.

3. A machine for producing flaked metal by electro-deposition, comprising a bath, an anode, a continuously moving cathode, an inert bath, means for passing the cathode and the deposit thereon through said second bath and reciprocating the cathode for removing the deposit from the cathode while in said bath.

4. A machine for producing flaked metal by electro-deposition comprising a bath, an anode, and a continuously moving flexible belt cathode, a cylindrical drum over which said cathode moves partially disposed in said bath, said cathode being held in firm engagement with said drum during deposition and disengaged from said drum ex-

teriorly of the bath, the cathode upon disengagement from the drum undergoing a change in curvature to loosen the deposit and moving in a direction to prevent the loosened flakes from falling from the cathode.

5. A machine for producing a flaked metal by electro-deposition comprising a bath, an anode, and a continuously movable flexible belt cathode, a cylindrical drum over which said cathode moves disposed partially in said bath, said cathode being held in firm engagement with said drum and disengaged therefrom exteriorly of the bath, the cathode being disengaged from the drum tangentially to the vertical diameter of the drum and undergoing a change in curvature to loosen the deposit and moving in a direction to prevent the loosened flakes from falling from the cathode.

6. A machine for producing flaked metal by electro-deposition comprising a bath, an anode, and a continuously moving flexible belt cathode, a cylindrical drum over which said cathode moves disposed partially in said bath, said cathode being held in firm engagement with said drum during deposition and being disengaged from the drum exteriorly of the bath, the cathode being disengaged from the drum at a point tangentially to the vertical axis of the drum and moving in a direction substantially at right angles to the vertical diameter of the drum whereby the cathode undergoes a change in curvature to loosen the flakes without permitting the flakes to fall from the cathode.

7. A machine for producing flaked metal by electro-deposition comprising a bath, an anode, and a continuously moving flexible belt cathode, a cylindrical drum over which said cathode moves partially disposed in said bath, said cathode being held in firm engagement with said drum during deposition and disengaged from said drum exteriorly of the bath, the cathode upon disengagement from the drum undergoing a change in curvature to loosen the flakes and moving in a direction to prevent the loosened flakes from falling from the cathode, and means for sharply changing the direction of movement of the cathode.

8. A machine for producing flaked metal by electro-deposition comprising a bath, an anode, and a continuously moving flexible belt cathode, a cylindrical drum over which said cathode moves partially disposed in said bath, said cathode being held in firm engagement with said drum during deposition and disengaged from said drum exteriorly of the bath, the cathode upon disengagement from the drum undergoing a change in curvature to loosen the flakes and moving in a direction to prevent the loosened flakes from falling from the cathode, and means for sharply changing the direction of the cathode, said last means disposed in a washing bath.

9. The process of producing flaked metal by electro-deposition which comprises passing an endless flexible belt cathode over a curved surface in the plating bath, maintaining the curvature of the cathode and the deposit thereon fixed until a predetermined point is reached, disengaging the cathode from said curved surface and changing the curvature of the cathode to draw the belt away from the deposit and loosen the flakes.

10. The process of producing flaked metal by electro-deposition which comprises passing a continuous flexible cathode belt over a curved surface in the plating bath, maintaining the curvature of the belt substantially constant throughout the entire period of deposition and maintaining the deposit fixed on the belt until a predetermined point out of the bath is reached, disengaging the belt from said curved surface and changing the curvature of the belt to draw the belt away from the deposit and loosen the flakes.

11. A machine for producing flaked metal by electro-deposition which comprises a plating bath, an anode in said bath, a cylindrical drum partially immersed in said bath, an endless metal strip serving as cathode passing around the immersed portion of said drum, said metal strip conforming to the surface of said drum without change of curvature while flaked metal is being deposited thereon, means for continuously driving said metal strip along a defined path passing partly inside and partly outside said bath, a bath for washing said metal strip after it has passed outside said plating bath, means for passing said metal strip through said washing bath and means for removing the flaked metal in said washing bath.

12. The process which comprises depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip out of said bath, sharply bending the same in air to loosen said flaked metal, removing said flaked metal and then returning said strip to said bath.

13. The process which comprises depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip out of said bath, removing flaked metal therefrom under water and then returning said strip to said bath.

14. The process which comprises depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip out of said bath, sharply bending the same in air to loosen said flaked metal, removing said flaked metal under water and then returning said strip to said bath.

15. The process which comprises depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip upwardly out of said plating bath and then downwardly into a second bath, removing flaked metal in said second bath and then returning said strip to said plating bath.

16. The process which comprising depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip out of said plating bath and into a second bath, removing flaked metal in said second bath by bending said metal strip and agitating said second bath and then returning said strip to said plating bath.

17. A machine for producing flaked metal by electro-deposition which comprises a plating bath, a cylindrical drum partly immersed in said bath, an endless metal strip serving as cathode

passing around the immersed portion of said drum, said metal strip conforming to the surface of said drum without change of curvature while flaked metal is being deposited thereon, an anode substantially conforming to the shape of the immersed portion of said cathode mounted in said bath close to said cathode but spaced progressively therefrom in the direction of motion of the surface of said cathode and so constructed and arranged as to provide space for the progressive building up of deposited flaked metal on said cathode, means for continuously driving said metal strip along a defined path passing partly inside and partly outside of said bath and means for removing deposited flaked metal from said strip at a point outside of said bath, said removing means including means for changing the curvature of said strip in such manner as to loosen the deposited metal from said strip.

18. The process which comprises depositing flaked metal from a plating bath on an endless metal strip while passing said strip into and through said plating bath, maintaining the curvature of said strip substantially constant during its passage through said bath, passing said strip out of said bath and into a second bath, sharply bending said strip while in said second bath for removal of flaked metal in said bath and then returning said strip to said plating bath.

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