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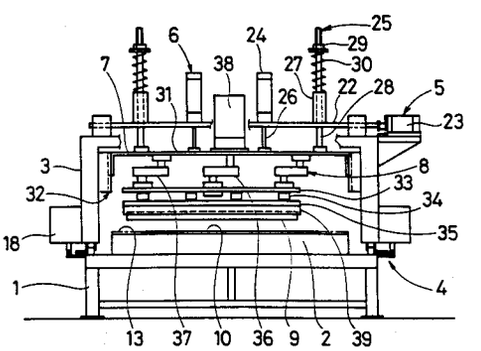
(54) Method for polishing plate and apparatus therefor.

(57) Disclosed is a method for specular polishing the surface of a metal or non-metal plate (10) to be polished, especially a large-sized plate, in which the surface of the plate is polished by rotating a polishing member (9) via cranks (36, 37), while pressing the polishing member against the surface of the plate at a predetermined pressure. Since the polishing member is rotated via cranks, while being pressed against the surface of the plate at a predetermined pressure, the predetermined pressure is uniformly distributed over the entire surface to be polished, hence, precise and uniform specular polishing of even a large-sized plate is feasible.

FIG. 1



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The present invention relates to a method and an apparatus for polishing the surface of a plate such as a metal plate and a non-metal plate, particularly suited for polishing of large-sized plates.

As polishing methods of this kind, there have hitherto been known various methods as follows:

(a) Rotary buff polishing method

This method with a buff spinning speed of 3,000rpm is suited for high-speed polishing and as oscillation polishing is feasible, relatively uniform polishing is attained.

(b) Rotary roll polishing method

This method, mainly by the use of a felt roll, is good for working environment and polishing uniformity. This is suited for wet polishing but dry polishing is also possible.

(c) True-round lapping method

This method is excellent in specular resolution of lapped specular stainless steel plate, is good for both wet and dry lapping, and is relatively good for working environment at relatively low cost. In wet lapping by the use of an oxydizing agent, this method is excellent in corrosion resistance, since a thick passivation film on the surface of a stainless steel is formed.

(d) Multi-spindle true-round lapping method

Although having the same features as the above method (c), this method enables an improvement of lapping efficiency through automation.

(e) Electrolytic composite polishing method

This method, being of composite nature, i.e. combination of electrolysis, mechanical polishing and chemical polishing, is fast in polishing speed and excellent in uniform polishing, and it enables automation of the polishing process. This is relatively suited for polishing of color stainless steel and pre-etching polishing material. This method is also useful for other than polishing of plate surfaces, being high in polishing speed.

The conventional polishing methods described above, however, have various problems to be solved as follows:

(a) Rotary buff polishing method

High speed rotation of the buff is dangerous and moving of the plate to be polished is risky unless vacuum stopping or clip stopping is applied. Working environment is aggravated due to the dry polishing which causes scattering of buffing-caused foreign matter. Since the buffing-caused roughness deteriorates the degree of mirror finish, this method is less suited for polishing of specular color stainless steel materials and specular etching stainless steel materials. Moreover, precious and uniform polishing is infeasible.

(b) Rotary roll polishing method

Buff- and roll-caused unevenness cannot be prevented perfectly. The polishing speed is low due to the small contact area in polishing. It is dangerous unless the plate to be polished is fixedly secured by vacuum stopping or clip stopping. Perfect specular finishing is difficult by this method, and this method is also less suited for polishing of colored materials, pre-etching polishing and pre-plating materials. The equipment investment required is high as the waste water treating plant required is rather expensive.

(c) True-round lapping method

Low lapping speed means a low lapping efficiency. Complicated manipulation results in poor producibility. This method is applicable to polishing of specular stainless steel materials but is liable to bring about micro-polishing unevenness. Hence, this method is less suited for polishing of specular color stainless steel materials or pre-etching polishing of specular materials. Since polishing by this method is of local intensive manner, it tends to cause local corrosion such as pitting of the plate to be polished, hence the method is not applicable to plates to be plated, especially those to be gold-plated.

(d) Multi-spindle true-round lapping method

This method, which has the same defects as described under (c), is also high in equipment cost, is subject to troubles and perfect automation is impossible. It is also high in fraction defective.

(e) Electrolytic composite polishing method

This method is bound to be of wet type and the process is complicated. The electric capacity required is large, waste water disposal is difficult and equipment cost and running cost are both high. The specular shade is less desirous and the fraction defective is high, hence, is corrective polishing is often required. Although electrolysis is used in combination, the polishing method is basically the same as described above under (d), hence it is subject to local and microscopic un-

evenness, and is less suited for pre-etching, pre-plating polishing or polishing of colored stainless steel materials. Combined application of electrolysis means an increased risk of local corrosion such as pitting.

The defects of the conventional polishing methods described above are particularly remarkable in case the plate to be polished is large in size. Hence, with the methods (a) and (b), perfectly specular polishing is infeasible. Although with the methods (c), (d) and (e), perfectly specular polishing is feasible, these methods also have many defects, and it is difficult to obtain satisfactory polishing results when the material is specular color stainless steel or specular stainless steel to be etched.

Moreover, according to these methods, polishing locus remains as visible color unevenness to thus degrade quality of products. When those are applied to pre-etching stainless steel materials, the round buff locus remains because of non-uniform pressing pressures between the central part and the peripheral part of the rotating buff, and therefore, etching unevenness never fails to appear. For this reason, it is necessary to do pre-treatment of removing a chromium oxide layer by dissolution in a dilute solution of ferric chloride. Moreover, when those are applied to pre-plating materials to be gold-plated, for example, corrosion like pitting occurs to generate innumerable pin holes and color and gloss of plating fade away to thus form plating unevenness.

It is an object of the present invention to provide a method and apparatus for polishing the surface of a plate such as a metal plate and a non-metal plate, which eliminates the foregoing drawbacks.

Another object of the present invention is to provide a method and apparatus which is especially suited fo the manufacture of a large-sized specular color stainless steel, specular etched stainless steel and specular gold-plated stainless steel.

Other objects and advantages of the present invention will be apparent for those skilled in the art from the detailed description given below.

The present inventors have made an extensive series of studies, and as a result, found that the above objects can be attained by pressing a plate-like polishing member against the surface of a plate to be polished and rotating it via cranks at a given pressure.

Moreover, the present inventors have found that polishing efficiency can be surprisingly enhanced from four times to six times by employing a pair of polishing members rotating in directions conter to each other.

The invention is described in detail in connection with the drawings in which

Fig. 1 is a front view showing an embodiment of a polishing apparatus used in the polishing method of the present invention.

Fig. 2 is a top plan view of Fig. 1.

Fig. 3 is an enlarged view of a traveling means used in the polishing apparatus shown in Fig. 1.

Fig. 4 is an enlarged top plan view of a polishing member (buff) used in the polishing apparatus shown in Fig. 1.

Fig. 5 is a front view of the polishing member shown in Fig. 4.

Fig. 6 is a front view showing an another embodiment of a polishing apparatus used in the polishing method of the present invention.

Fig. 7 is an enlarged top plan view of a pair of polishing members used in the polishing apparatus shown in Fig. 6.

Fig. 8 is a front view of the polishing member shown in Fig. 7.

Fig. 9 is a fragmentary view of Fig.7, taken in the direction of an arrow A.

The present invention encompasses, in a first aspect, a method for polishing a plate characterized in that a plate-like polishing member is pressed to the surface of a plate to be polished and is caused to rotate via cranks.

The present invention encompasses, in a second aspect, an apparatus for polishing a plate characterized in that a table on which a plate to be polished is placed is set horizontally on a stand, a gate frame is set on the stand to saddle over the table, a polishing head is hung from the gate frame via lifting-lowering means so as to be freely liftable and lowerable, the polishing head is provided with a plate-like polishing member and a rotating means for rotating the polishing member via cranks in a horizontal plane, and the major axis of rotation of the polishing member is taken as the leg span direction of the gate frame.

The present invention encompasses, in a third aspect, a method for polishing a plate characterized in that a pair of plate-like polishing members are pressed to the surface of a plate to be polished and are caused to rotate via cranks in directions counter to each other.

The present invention encompasses, in a fourth aspect, an apparatus for polishing a plate characterized in that a table on which a plate to be polished is placed is set horizontally on a stand, a gate frame is set on the stand to saddle over the table, a pair of polishing heads are hung from the gate frame via lifting-lowering means so as to be freely liftable and lowerable, the polishing heads are provided with a plate-like polishing members and rotating means for rotating the polishing members via cranks in directions counter to each other

in a horizontal plane.

An embodiment of the present invention will be described below in detail with reference to Figs. 1~5.

As shown in Figs. 1 and 2, the polishing apparatus of the present invention comprises a table 2 placed on a stand 1, a gate frame 3 set thereon via a traveling means, a polishing head 7 hung from the gate frame 3 via an oscillating means 5 and a lifting-lowering means 6 and a polishing member 9 attached to the polishing head 7 via a rotating means 8. Reference numeral 10 is a plate to be polished.

The stand 1 is rectangular and has set thereon traveling rails 11 and rack rails 12, two each along its longer edge. Hereinafter, for convenience in explanation, the longer edge is called longitudinal direction and the shorter edge is called lateral direction (See Fig. 2.).

The table 2 is a surface plate to set the plate to be polished 10 on its topside, and it is set horizontally on the stand 1. The plate to be polished 10 is a large-sized cut plate rectangular in shape. On the topside of the table 2, patches 13 having the same thickness as the plate 10 are fixedly secured to the both sides of the plate 10 for ensuring against damage of the polishing member 9 by the edges of the plate. For this purpose, the width of the patches 13 is so determined that the moving range of the polishing member 9 is not beyond the width between the both patches 13.

The gate frame 3 is set on the rails 11 provided on the stand 1 astride it sideways and it is driven by the traveling means 4 longitudinally (in the direction perpendicular to the leg span direction.

As seen from Fig. 3, the traveling means 4 comprises running wheels 14 to the legs of the gate frame 3 to be freely rotatable and running gears 15 and a driver 18 for driving the running gears 15, and further an anti-lifting mechanism 16 and an anti-sideway oscillation mechanism 17. The running wheels 14 support the gate frame 3 and run on the traveling rails 11. The running gears 15 are in mesh with rack rails 12 and the gate frame 3 is driven by a driver 18. The driver 18 comprises drive gears 42 at both ends of a drive shaft 41 provided between the legs of the gate frame 3, said drive gears 42 being in mesh with running gears 15. The drive shaft 41 is connected with a reducer 45 at its central portion through a pair of reduction gears 43, 44, to the reducer 45 is connected a drive moter 47 through a drive chain 46. The anti-lifting mechanism 16 and the anti-sideway oscillation mechanism 17 comprise an anti-lifting roller 19 and anti-sideway oscillation roller 20, respectively, the former attached to the underside of the stand 1 rotatably prevents lifting of the gate frame 3 off the traveling rails 11 and the latter rotatable in contact with the sides of the traveling rails 11 prevents sideway oscillation of the gate frame 3. The both anti-lifting mechanism and anti-sideway oscillation mechanism prevent unevenness of the polished surface.

The oscillating means 5 holds an oscillating plate 22 freely oscillatable by a pair of (left and right) oscillating guide members 21 and has the oscillating cylinder 23 connected with the oscillating plate 22.

The lifting-lowering means 6 comprises a lifting-lowering cylinder 24 and a pressure-adjusting mechanism 25 and has the polishing head 7 hung therefrom freely liftable and lowerable. The lifting-lowering cylinder 24 lifts and lowers the polishing head 7 as its piston rod moves in or out. The pressure adjusting mechanism 25 has inserted, freely liftable and lowerable, a hanging rod 28, from which the polishing head 7 is hung, through a guide cylinder 27 set erect on the oscillating plate 22, and also comprises a compression spring 30 set between an adjusting nut 29 screwed onto the upper end portion of the hanging rod 28 and the bottom of the guide cylinder 27 and is so arranged that the polishing pressure with which the lifting-lowering cylinder 24 presses the polishing surface of the polishing member 9 against the compression spring 30 is adjusted to a proper level by means of an adjusting nut 29.

The polishing head 7 is made by disposing a supporting beam 31 hung from the oscillating plate 22 via the lifting-lowering means 6 between a pair of (left and right) lifting-lowering guide members 32 attached to both legs of the gate frame 3, hanging a rotary plate 33 from the supporting beam 31 via the rotating means 8 and fixedly securing a polishing member accommodating plate 35 to the underside of the rotary plate 33 via a cushion member 34 such as rubber.

The rotating means 8 comprises a main crank 36 and two auxiliary cranks 37 arranged in a row with the main crank 36 at the center between the supporting beam 31 of the polishing head 7 and the rotary plate 33, and a drive motor 38 mounted on the supporting bean 31. The main crank 36 has its upper end connected with the drive motor 38 and its lower end connected rotatably with the rotary plate 33. The auxiliary crank 37 has its upper and lower ends rotatably connected with the supporting beam 31 and the rotary plate 33 respectively. As the main crank 36 rotates, both auxiliary cranks 37 also rotate via the rotary plate 33, and thus, the rotary plate 33 rotates. The major axis of the locus of rotation of the rotary plate 33 is sideways (along the leg span of the gate frame 3). The drive motor 38 causes the main crank 36 to rotate at a rate of 50 ~ 600 rpm. If the rotation speed is

less than 50 rpm., no sufficient polishing effect is attainable, while, if it is more than 600 rpm., the structure is bound to be too complicated.

The polishing member 9 is made of grindstone, scotch grite, buff or the like in rectangular plate shape is removably attached to the underside of the polishing member accommodating plate 35 of the polishing head 7 and is made to rotate with the rotary plate 33. The width of the polishing member 9 (in the leg span direction of the gate frame 3) is set to be larger than that of the plate 10 to be polished, which enables uniform polishing.

The polishing member 9 shown in Fig. 1 is a buff set in a buff case 39 and the polishing surface has formed therein a plurality of U-sectioned grooves 40 for storing an abrasive liquor as shown in Figs. 4 and 5 inclined in the direction of rotation. These U-sectioned grooves 40 are for scraping and retaining the abrasive liquor including the abrasive impregnated in the polishing surface and thereby preventing scattering of the abrasive liquor off the polishing surface and at the same time enabling gradual release of the stored abrasive liquor for enhancing the polishing efficiency.

The plate 10 is an object to be polished such as a metal plate of stainless steel, brass and aluminum as well as a non-metal plate of glass, plastics and the like. The plate 10 shown in Fig. 2 is a large-sized rectangular cut plate which is set horizontally on the topside of the table 2, and is fixed in place with its sides retained by the patches 13.

In order to polish the plate 10 as the object to be polished by the method of the present invention, first, the polishing surface of the polishing member 9 is impregnated with the abrasive liquor containing the abrasive and then, with the polishing member 9 being pressed against the surface of the plate 10 at a predetermined pressure by lowering the polishing head 7 by means of the lifting-lowering cylinder 24, the polishing member 9 is rotated in a horizontal plane by the drive motor 38 via the cranks 36 and 37. In this case, 0.5~1.5 kg/cm^2 is proper for the aforementioned predetermined pressure and pre-adjustment is made by changing the tightening of the adjusting nut 29 of the pressure adjusting mechanism 25. Further, the rotational speed of the drive motor 38 is controlled in the range of 100 ~ 450 rotations by means of vector inverter control and the radius of rotation for each crank 36 and 37 is adjusted to approximately 50~100 mm.

Then, the polishing head 7 is oscillated sideways by the oscillating cylinder 23 and at the same time the gate frame 3 is driven longitudinally by the driver 18. The oscillating stroke of the oscillating cylinder 23 is controlled in a range of 100~200 mm by inverter control and at the same time the oscillating cycle is adjusted to 6~30 strokes per minute. It is then preferred to adjust the traveling speed of the gate frame 3 to approximately 1~5 m per minute. Then, the surface of the plate 10 is polished by the polishing member 9 under proper conditions. Since the polishing member 9 is rotary driven via cranks, the pressure at which the polishing member 9 is pressed against the plate 10 is uniformly distributed over the entire surface to be polished and since, at the same time, the polishing member 9 is oscillated together with the polishing head 7, the simultaneous oscillation effect enables precise and uniform mirror polishing of the surface of large-sized plate 10.

Since in this embodiment the plate 10 was a cut plate, the gate frame 3 was driven longitudinally but in other examples in which the plate 10 is a band plate coiled, it is also possible to uncoil the plate 10 and feed it longitudinally instead of having the gate frame 3 travel. Then, continuous polishing is feasible and results in marked improvement of the producibility.

In the aforementioned construction, the plate to be polished is placed horizontally on the table, then, the polishing head is lowered by the lifting-lowering means so that the polishing member is pressed to the surface of the plate with a predetermined pressure, the polishing member is rotated via cranks in the horizontal plane by the rotating means to thereby polish the plate. When the plate is large-sized, the polishing member is also required to be large but if the large polishing member is driven to rotate in a simple circular pattern, the polishing effect fails to be distributed uniformly all over the surface to be polished due to the pressure concentrated at the central portion, and the uniform specular polishing is infeasible. Hence, according to the present invention, the pressure at which the polishing member is caused via cranks to be pressed at the uniform pressure against all over the surface to be polished so that the entire surface is specular polished precisely and uniformly even if the plate to be polished is quite large.

Another embodiment of the present invention will be described below in detail with reference to Figs. 1, 6 to 10.

As shown in Figs.1 and 6, the polishing apparatus comprises a table 2 placed on a stand 1, a gate frame 3 set thereon via a traveling means 4, a pair of polishing heads 7, each being hung from the gate frame 3 via an oscillating means 5 and a lifting-lowering means 6 and a polishing member 9 attached to the polishing head 7 via a rotating means 8. Reference numeral 10 is a plate to be polished.

Each of the polishing members 9 shown in Fig. 1 is a buff set in a buff case 39 and the polishing surface has formed therein a plurality of U-sec-

tioned grooves 40 for storing an abrasive liquor as shown in Figs. 7 to 9 inclined in the direction of rotation and abrasive liquor supply holes 48. These U-sectioned grooves 40 and the supply holes 48 are for scraping and retaining the abrasive liquor including the abrasive impregnated in the polishing surface and thereby preventing scattering of the abrasive liquor off the polishing surface and at the same time enabling gradual release of the stored abrasive liquor for enhancing the polishing efficiency.

In order to polish the plate 10 as the object to be polished by the method of the present invention, first, the polishing surfaces of the polishing members 9 are impregnated with the abrasive liquor containing the abrasive and then, with the polishing members 9 being pressed against the surface of the plate 10 at predetermined pressures by lowering the polishing heads 7 by means of the lifting-lowering cylinders 24, the polishing members 9 are rotated in directions counter to each other in a horizontal plane by the drive motors 38 via the cranks 36 and 37.

In the above construction, since a pair of the polishing members 9 rotate via cranks 36 and 37 in directions counter to each other, pressing pressure of the polishing members 9 against the plate 10 is distributed uniformly over the entirety of the polishing surface, products free of unevenness in color, etching and plating can be provided. Even in the case of pre-etching materials, a troublesome pretreatment is not required. As regards polishing time, for example, the apparatus shown in Fig. 2 takes 12 minutes, while the apparatus shown in Fig. 6 takes only 2 minutes, i.e., it can be reduced to 1/6, and thus productivity increases surprisingly. Further, when the polishing members 9 are caused to oscillate in the lateral direction, polishing is conducted more efficiently because of an oscillation effect added.

Hereinafter, examples, in which cut plates of various materials are polished by the polishing method of the present invention, will be described in detail.

Example 1

Object to be polished

Material....Stainless steel SUS 304 bright annealed material (BA material)

Dimensions..1.5 mm thick x 2,438 mm x 1,219 mm Polishing conditions

Apparatus ...shown in Figs. 1 to 5

Method...Buff polishing [compound abrasive of triiron tetroxide (red iron oxide) 40 g/l + nitric acid 15%]

Rotational speed...200 rpm.

Radius of rotation of cranks... 50 mm

Traveling speed....300 mm/min.

Pressing pressure..1.5 kg/cm^2

Perfectly specular stainless steel was obtained by polishing under these conditions for approximately 10 min. After polishing, a cold rinse and a final hot rinse were given in a washer and a protective tape was stuck after drying.

Example 2

Object to be polished

Material....Stainless steel SUS 304 (2B material)

Dimensions..1.5 mm thick x 2,438 mm x 1,219 mm Polishing conditions

Apparatus ...shown in Figs. 1 to 5

Method...Grindstone grinding: 1st step (PVA grindstone #800)

Grindstone grinding: 2nd step (PVA grindstone 1500)

Buff polishing: 3rd step (compound abrasive of triiron tetroxide 60 g/l + nitric acid 15%)

Rotational speed...200 rpm. (both grindstone and buff)

Radius of rotation of cranks... 75 mm

Traveling speed....150 mm/min. (both grindstone and buff)

Pressing pressure..1.5 kg/cm^2 (both grindstone and buff)

Perfectly specular stainless steel plate was obtained by 20 min. x twice grindstone grinding and 20 min. of buff polishing. After the grindstone grinding, a cold rinse was given in a washer and after the subsequent buff polishing for mirror finish, another cold rinse and hot rinse were given in the washer and a protective tape was stuck after drying.

Example 3

Object to be polished

Material....Brass plate (90% copper, 10% zinc)

Dimensions..2.0 mm thick x 1,000 mm x 2,000 mm

Polishing conditions

Apparatus ...shown in Figs. 1 to 5

Method.....Grindstone grinding (for elimination of scratches etc. with PVA grindstone #1500) Buff polishing [abrasive liquor containing PICAR (trade name) and an alumina abrasive]

Rotational speed...200 rpm.

Radius of rotation of cranks... 75 mm

Travelling speed...300 mm/min.

Pressing pressure..1.5 kg/cm^2

Perfectly specular brass plate was obtained. After buff polishing, the surface was wiped with cloth moistened with a solvent and then covered with a protective tape.

Example 4

Object to be polished

Material....Secondarily electrolyzed alumite wine red in color (alumite film 27 μm)

Dimensions..3.0 mm thick x 1,000 mm x 2,000 mm

Polishing conditions

Apparatus ...shown in Figs. 1 to 5

Method...Buff polishing [Compound abrasive of triiron tetroxide of 40 g/l and alumina 20 g/l (particle size: less than 2 μm)]

Rotational speed...200 rpm.

Radius of rotation of cranks... 100 mm

Traveling speed....150 mm/min.

Pressing pressure..2 kg/cm^2

Bright wine red or amber-colored polished surface with japan-like gloss was obtained with an average polishing of 1 ~ 2 μm without injuring the alumite film. Moreover, there was no indication of peeling of the film even in the sealed area nor any sign of deterioration of corrosion resistance.

Example 5

The same procedure as in Example 1 was conducted except that an apparatus shown in Figs. 1, 6 to 9 was employed in place of that shown Figs. 1 to 5, and that a pair of polishing members are caused to rotate in directions counter to each other.

The polishing time was reduced to 2 minutes, approximately 1/5 as compared with Example 1.

Example 6

The same procedure as in Example 2 was conducted except that an apparatus shown in Figs. 1, 6 to 9 was employed in place of that shown Figs. 1 to 5, and that a pair of polishing members are caused to rotate in directions counter to each other.

The polishing time was 3 min. × twice grindstone grinding and 3 min. of buff polishing, and thus reduced to approximately 1/6 as compared with Example 2.

The following Application Examples 1~3 show the examples in which coloring, etching and gold plating were applied to the perfectly specular stainless steel plates obtained in Examples 1 and 2.

Application Example 1

Coloring conditions

Coloring chemical...Sulfuric acid 450 g/l, chromic acid anhydride 250 g/l (according to the incocolor method)

Liquor temperature..80 °C

Treating process....Degreasing--Rinse--Oxidation development--Recovery--Rinse--Hard-film treatment--Rinse--Finish rinse--Drying

The specular stainless steel plates prepared by the conventional methods used brought about polishing unevenness and the resultant coloring unevenness affected the quality of products. The color stainless steels obtained by this Application Example 1 were, however, almost completely free of coloring unevenness, the difference being clearly distinguishable even by the naked eyes.

Application Example 2

Etching conditions

Etching chemical...Ferric chloride solution (46 • Be') containing 0.5% HCl.

Liquor temperature...40 °C

Treating process...Screen printing--Drying--High pressure shower etching (10 min.)--Rinse--Caustic soda film removal--Rinse--Neutralization with nitric acid--Rinse

The specular stainless steel plate polished by any of the conventional methods was not suited for etching since the oxide film resulting from the use of the compound abrasive comprising an abrasive and an oxidative chemical was subject to unevenness in thickness, etching unevenness was resulted if etching was carried out without complicated pretreatment of the substrate, and in consequence, satisfactory products could not be obtained. The etching stainless steel plates obtained in this Application Example 2 are, however, almost free of etching unevenness with the oxide film finished uniformly in polishing, hence a uniformly etched products were obtainable without any special pretreatment.

Application Example 3

Gold plating conditions

Gold plating liquor...HCl-acidic gold-plating liquor

Liquor temperature....40 °C

Current density.....3 A/dm

Treating process.....Alkaline electrolytic degreasing --Rinse--Activated acidic rinse--Rinse--Flush gold-plating (45 sec.)--Recovery--Rinse--Neutralization--Rinse--Hot rinse

By the conventional true round rotary lapping method, polishing is effected locally and intensively because the buffing surface is small. That results in local heating to approximately 100 °C, which gives rise to local corrosion such as pitting caused by nitric acid contained in the abrasives. This is detectable by the use of a microscope with a mag-

nification of 1:150 or so. Hence, when gold-plating is applied to the specular stainless plates polished by this method, local unevenness in gloss is clearly visible. Pitting is, however, hardly recognizable with the specular stainless steel plates polished by the method of the present invention. With the specular gold-plated stainless steel plates gold-plated (purity 97%) in this Application Example 3 are free of white turbid blurs.

As stated above, the present invention has the following numerous advantages:

(1) The aforementioned predetermined pressure is uniformly distributed over the entire polishing surface as the plate-like polishing member is caused to rotate via cranks being pressed against the surface of the plate, hence precise specular polishing is feasible even in case of a large-sized plate. Hence, the method as well as the apparatus of the invention is optimum for the manufacture of large-sized specular color stainless steel plates, specular etching stainless plates, specular gold-plated stainless steels and the like.

(2) The invention is applicable to not only metal plates but also non-metal plates.

(3) When the polishing member is oscillated along the major axis of the locus of its rotation, the oscillation effect is enhanced even better and uniform specular polishing becomes feasible.

(4) When the polishing member is caused to travel along the minor axis of the locus of its rotation, efficient polishing of a large-sized cut plate becomes feasible.

(5) When the plate to be polished is fed along the minor axis of the locus of its rotation, continuous polishing becomes feasible if the object to be polished is a coiled band plate, which results in marked improvement of producibility.

(6) By rotating a pair of the polishing members via cranks in directions counter to each other, more precise and uniform specular polishing can be attained, and the obtained products are free from unevenness in color, etching and plating.

(7) By employment of a pair of the polishing members, the polishing time can be unexpectedly enhanced to approximately 4 to 6 times.

(8) Other merits of the invention are:

① Producibility is markedly improved for the manufacture of perfectly specular materials as compared with any conventional methods.

② Operation and maintenance of the apparatus is quite simple and it is almost free from troubles.

③ Being of energy-saving type with relatively small electric capacity, the running cost is extremely low.

④ It is good for both wet and dry polishing processes.

⑤ Waste water treatment is necessary, but the working environment is better than that of the dry type, and the waste water treatment required is much simpler than in case of the electrolytic composite polishing method.

Claims

1. A method for polishing a plate characterized in that a plate-like polishing member is pressed to the surface of a plate to be polished and is caused to rotate via cranks.

2. The method according to claim 1, wherein the polishing member is caused to oscillate along the major axis of its rotation.

3. The method according to claim 1 or 2, wherein the polishing member is caused to run along the minor axis of its rotation.

4. The method according to claim 1 or 2, wherein the plate to be polished is fed along the minor axis of the rotation of the polishing member.

5. The method according to claim 1, 2, 3 or 4, wherein the rotating speed of the polishing member is in a range of 50 ~ 600 rpm.

6. An apparatus for polishing a plate characterized in that a table on which a plate to be polished is placed is set horizontally on a stand, a gate frame is set on the stand to saddle over the table, a polishing head is hung from the gate frame via lifting-lowering means so as to be freely liftable and lowerable, the polishing head is provided with a plate-like polishing member and a rotating means for rotating the polishing member via cranks in a horizontal plane, and the major axis of rotation of the polishing member is taken as the leg span direction of the gate frame.

7. The apparatus according to claim 6, wherein the topside of the table is provided with patches for protection of the polishing member so as to fit the both sides of the plate to be polished.

8. The apparatus according to claim 6, wherein the polishing member is a buff with its polishing surface provided with a plurality of U-sectioned grooves for storing an abrasive liquor.

9. The apparatus according to claim 6 or 8, wherein the width of the polishing member in the leg span direction of the gate frame is larger than that of the plate to be polished.

10. The apparatus according to claim 6, wherein the gate frame is provided with an oscillating means for oscillating the polishing head in the leg span direction of the gate frame.

11. The apparatus according to claim 6 or 10, wherein there is provided a traveling means for letting the gate frame run on the stand in the direction perpendicular to its leg span direction.

12. The apparatus according to claim 11, wherein the traveling means is provided with an anti-lifting mechanism and an anti-sideway oscillation mechanism.

13. The apparatus according to claim 6 or 10, wherein there is provided a feeding device for feeding the plate to be polished on the table along the direction perpendicular to the leg span direction of the gate frame.

14. A method for polishing a plate characterized in that a pair of plate-like polishing members are pressed to the surface of a plate to be polished and are caused to rotate via cranks in directions counter to each other.

15. The method according to claim 1, wherein the polishing members are caused to oscillate along the major axis of its rotation.

16. An apparatus for polishing a plate characterized in that a table on which a plate to be polished is placed is set horizontally on a stand, a gate frame is set on the stand to saddle over the table, a pair of polishing heads are hung from the gate frame via lifting-lowering means so as to be freely liftable and lowerable, the polishing heads are provided with plate-like polishing members and rotating means for rotating the polishing members via cranks in directions counter to each other in a horizontal plane.

17. The apparatus according to claim 16, wherein the gate frame is provided with a pair of oscillating means for oscillating the polishing heads in the leg span direction of the gate frame.

FIG. 1

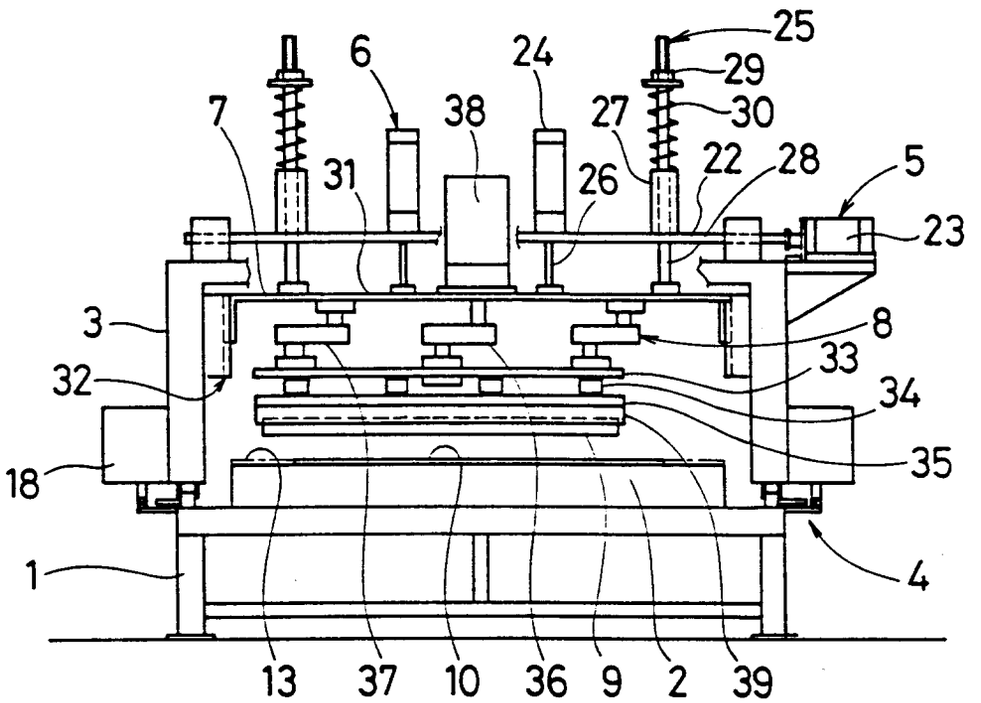
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FIG. 2

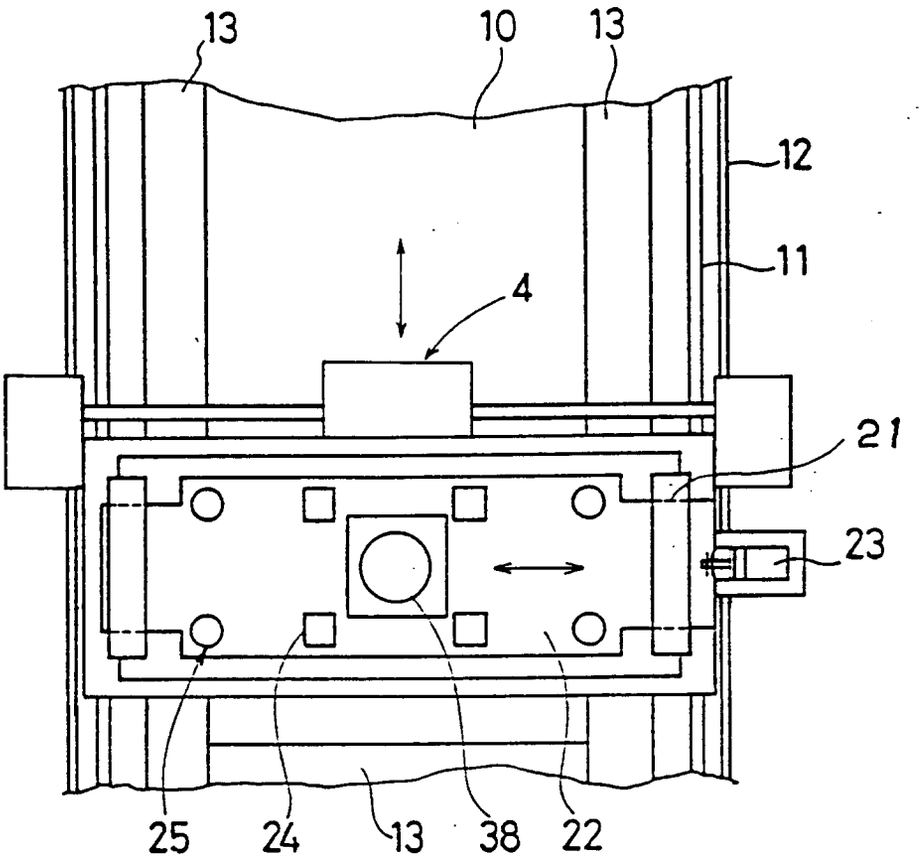


FIG. 3

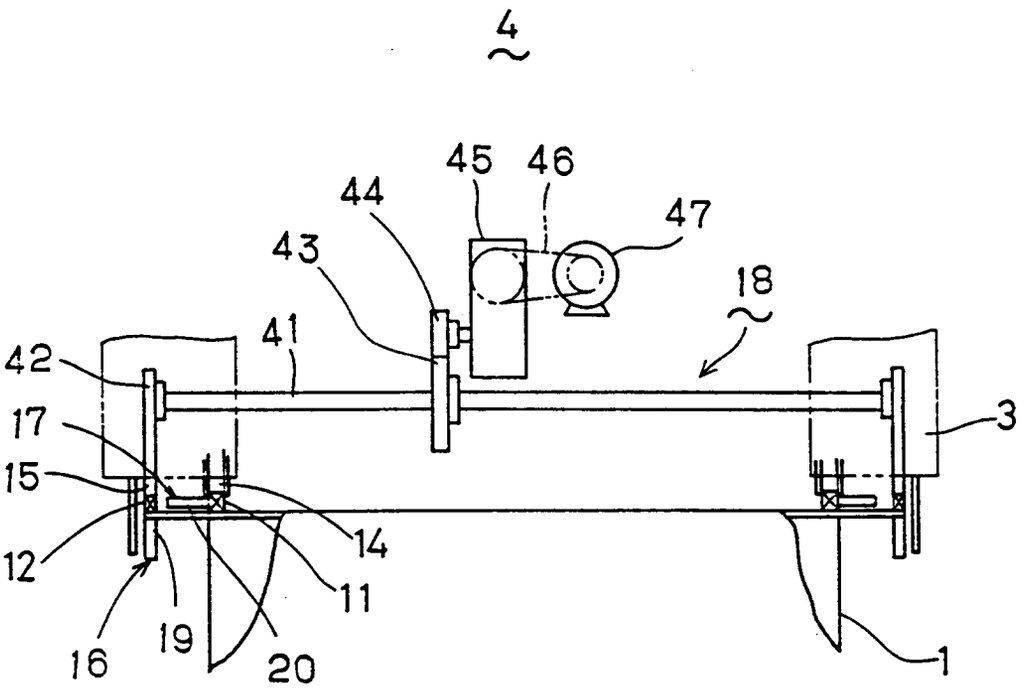


FIG. 4

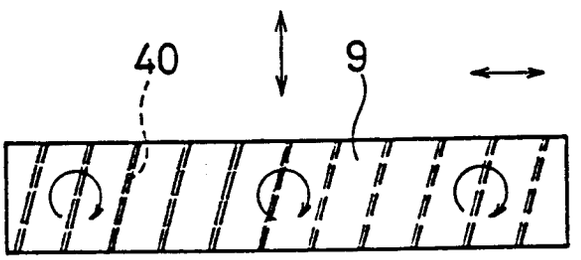


FIG. 5

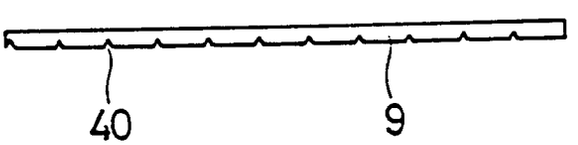


FIG. 6

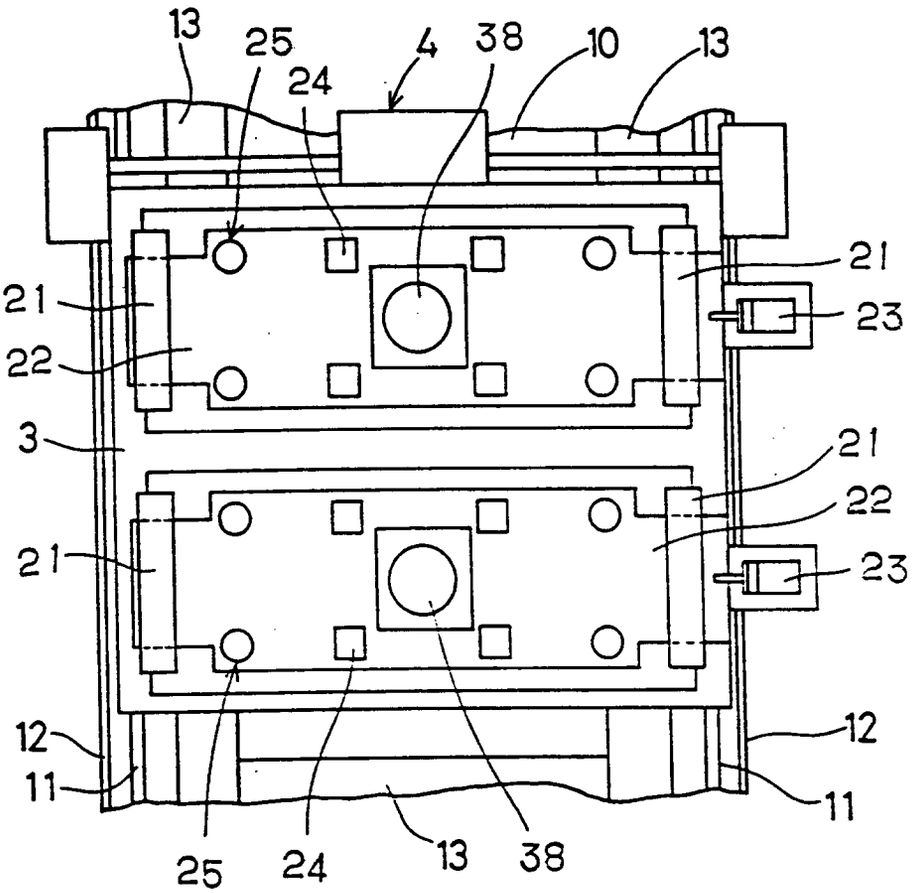


FIG. 7

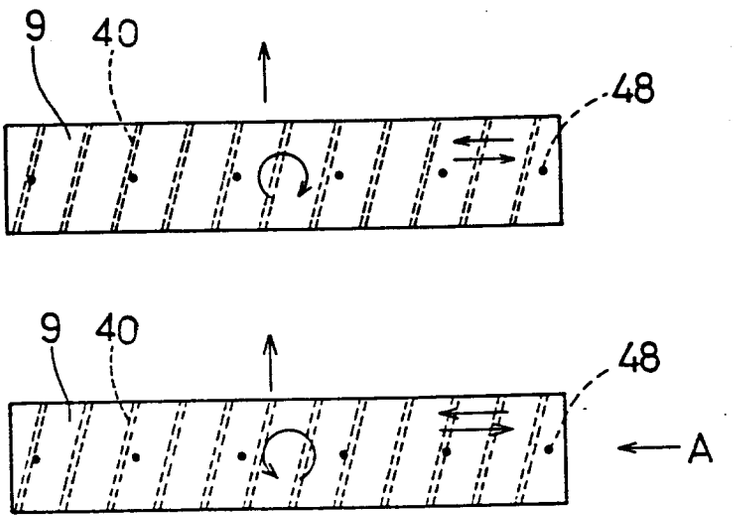


FIG. 8

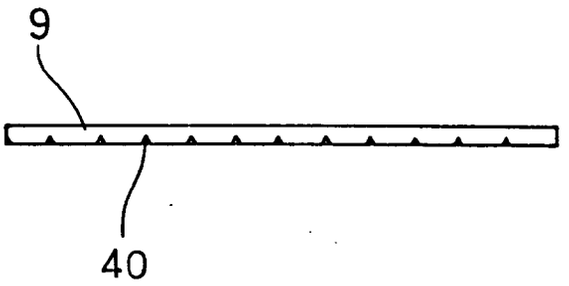
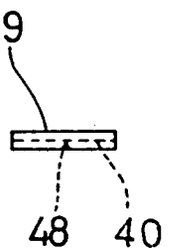


FIG. 9



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Application Number

EP 93 10 5411

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-C-680 641 (SOCIETE MARBIERE DE PARIS) * page 2, line 39 - page 3, line 22; claims 1-5; figures 1-3 *	1	B24B1/04 B24B37/04
A		14	
X	WO-A-8 903 279 (EXTRUDE HONE CORP.) * page 1, line 4 - page 9, line 29; figures 1-5 *	1	
Y		2-4,15	
Y	US-A-1 491 103 (W. E. HOKE) * claims 1-9; figures 1-4 *	2-4,15	
A	DE-A-3 433 009 (SIEMENS AG) * claims 1-25; figures 1-3 *	1,6	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 116 (M-216)20 May 1983 & JP-A-58 034 757 (SHIKISHIMA CHIPTON KK) 1 March 1983 * abstract *	1,6,14	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 11, no. 344 (M-640)11 November 1987 & JP-A-62 124 866 (HITACHI LTD) 6 June 1987 * abstract *	13	B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	15 JULY 1993	WUNDERLICH J.

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