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METHOD OF INFLUENCING THE SURFACE PROFILE OF SOLID ELEMENTS, MORE ESPECIALLY OF SURFACE-IMPROVED OR PLATED METAL STRIPS OR SHEETS

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FIG.1.

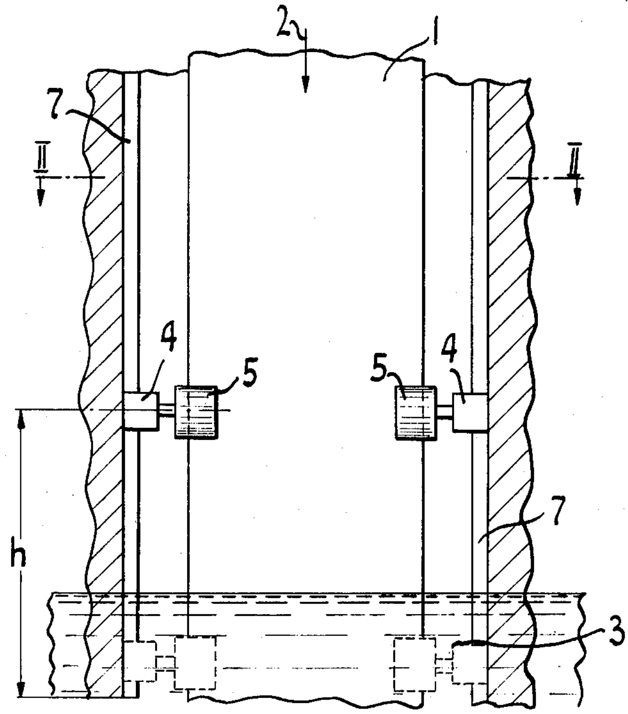
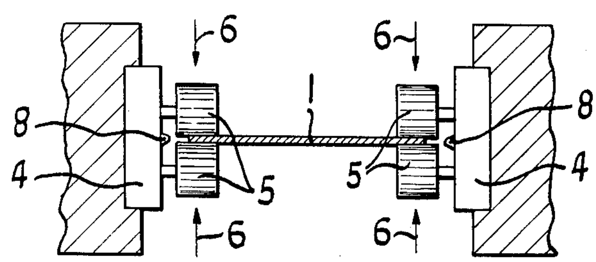


FIG.2.



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METHOD OF INFLUENCING THE SURFACE PROFILE OF SOLID ELEMENTS, MORE ESPECIALLY OF SURFACE-IMPROVED OR PLATED METAL STRIPS OR SHEETS

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The invention relates to a method of and apparatus for influencing the surface profile of solid elements, more especially of surface-improved or plated metal strips or sheets. For example, a certain surface profile or a certain roughness of the surface is desirable with metal strips or sheets which are improved by a metallic coating, in the same way as with metal strips or sheets provided with a lacquered coating or a plastic coating.

In the processing of improved metal sheets provided for example with a metallic protective coating to produce a wide variety of articles, such as, for example, cans or tins for preserving foods, the said metal sheets are deformed by folding, drawing or the like. The surface profile of the improved or plated sheets has a decisive influence on this deforming operation, so that therefore, depending on the method of deformation, a certain roughness of the surface is required. Hitherto, this desired surface roughening has only been indirectly produced by using rollers having a predetermined surface roughness in the final rolling (tempering) of the improved or plated basic material. The necessary roughness of the roller surface was produced by mechanical treatment thereof, for example by sand-blasting. With this method of working on the surface profile of the basic material, the production of quite a specific surface profile of the finished improved or plated material depends finally on the actual circumstances. It is understandable that the original surface profile produced by the final rolling or tempering of the basic material is not inconsiderably modified by the improving processes. It is for this reason that the hitherto usual method is only suitable in an indirect manner for influencing the final achieved surface of the mechanically improved material. Similar conditions also apply as regards metal sheets and strips provided with a coating of lacquer or plastics.

The object of the present invention is to produce a specific surface profile on elements and more especially surface-improved or plated metal sheets and strips in a direct and economic manner. The factors which determine the surface profile, such as roughening depth, wearing capacity and the like, are directly controlled by the method of the invention.

For this purpose, according to the invention, the surface layer is subjected in the plastic state to the effect of vibrational energy, for which relatively high frequencies and advantageously frequencies in the ultrasonic range are used.

The method according to the invention can more especially be employed for producing a specific surface profile with plated sheets or strips. For influencing the surface profile of metallised sheets or strips according to the invention, the said sheets or strips are produced with a smooth surface (by using rollers with a smooth surface in the final rolling or tempering of the strips or sheets), and after the metal coating has been applied, a surface profile rougher than that of the basic material is produced by the impact of vibrational energy. The metallised

strips or sheets treated or produced according to this method have the advantage that not only do they have a rough surface of the metal coating which is advantageous for deformation operations, but at the same time they have an excellent soldering capacity which, is for example, of great importance for the further processing of tin-plated sheets. Recent investigations have shown that with metallised sheets or strips, a substantial difference as regards the soldering capacity exists according to whether the basic material has a smooth or rough surface. It has been proved that with a basic material having a smooth surface, a better flowing of the solder is obtained during the soldering operations than with a basic material having a rough surface. With the new method which has been described, the possibility is thus provided of both methods of processing, i.e. for both the deformation and the soldering, being combined in the material thus produced. The method according to the invention can with advantage also be used in connection with electrolytically metallised sheets or strips, in which the galvanically applied metallic coating layer is subsequently also melted by heating and thereafter is quenched in a liquid. For using the new method, the sheets or strips are impacted on one or both sides with vibrational energy on being dipped into the quenching bath, the quenching liquid serving at the same time as coupling liquid. In this case, the vibration generators, for example sound heads of an ultrasonic installation, are arranged in the quenching bath at a suitable spacing and at a suitable angle relatively to the sheet or strip, so that the plastic coating layer of the sheet or strip, for example the galvanically applied and melted tin coating of an iron strip, is exposed to the vibrational energy on dipping in the quenching bath.

The vibrational energy is operative in such a manner on the improved surface that a specific profile of the improving layer is produced, this profile being the best possible profile for processing purposes. The vibration generators can be arranged either on one side or on both sides of the sheet or strip to be dipped, depending on the requirements as regards the surface roughness required on both sides. The surface profile can be modified in various ways, for example by changing the frequency of the vibrational energy, by altering the intensity thereof or even by modyifying the spacing and the angle of the vibration generator relatively to the strip or sheet, as well as by choice of a specific immersion depth of this vibration generator in the quenching bath. The surface profile can moreover be influenced by varying the strip velocity while keeping the frequency constant. Finally, the surface profile can also be controlled by superimposition of different frequencies or frequencies which are displaced relatively to one another.

In the aforementioned example, ultrasonic heads are arranged in a bath into which are dipped or immersed the elements of which the surface profile is to be influenced. The bath liquid which serves for quenching a metal coating and more especially tin coating melted by heating action simultaneously acts as a coupling liquid for the transmission of the ultrasonic energy; that is to say, the ultrasonic energy emitted from the utrasonic heads arranged in the liquid is propagated in the liquid medium and impinges on the metal coating of the element. Any influence on the surface profile during the transfer of the ultrasonic energy by means of the coupling liquid is only possible in the region between the immersion or dipping of the element to be acted upon by ultrasonic waves and the bath depth at which the metal coating is solidified. It is only here that the coating is still so plastic that its profile can be influenced by vibrational energy. Consequently, there is only a comparatively narrow region and thus a correspondingly short time available for producing the desired surface profile.

In order now to be able better to control the ultrasonic vibrations in this case, it is proposed according to the invention that the ultrasonic energy should be directly transmitted, with non-positive connection of the ultrasonic head to the said elements. In this way, it is possible for the surface profile of an element to be influenced independently of the presence of a liquid medium. The ultrasonic head or heads can be completely free in space relatively to a quenching bath which may be present and in the region of the element in which its surface is melted and capable of being influenced to the best possible degree. The advantage of this method consists in that the surface to be treated with ultrasonic vibrations can be exposed to said vibrations without being restricted to a liquid coupling medium and thus a larger range of influence exists. It is apparent from this that greater certainty exists within wide limits in the production and in the control of the desired surface profile.

One embodiment of the method according to the invention is hereinafter more fully explained by reference to the drawing, wherein:

FIGURE 1 is a side elevation of an apparatus for the direct transmission of ultrasonic energy to metal strips or the like provided with a metallic coating,

FIGURE 2 is a horizontal cross-section through the apparatus according to FIGURE 1 along the line II—II.

In the drawing, the reference 1 designates a metal strip provided with a metallic coating. The metallic coating of this metal strip is melted above the apparatus shown by means not shown. The metal strip **1** is conducted in the direction of the arrow **2** progressively into a quenching bath **3** in which the molten coating is solidified. In order to influence the surface profile of the metal strip **1**, ultrasonic heads **4** are provided. According to the invention, the vibrational energy generated by the ultrasonic heads **4** is transmitted directly to the metal strip. For this purpose, each ultrasonic head **4** is advantageously combined with a rolling element or a system of rolling elements to form a unit. In the constructional example illustrated, the rolling elements have the form of rollers **5**, which are permanently connected to the ultrasonic heads in such a way that the sound energy is transmitted from these heads into the rollers. For the transfer of the ultrasonic vibrations from the sound emitter to the rollers or rolling elements, the mounting thereof in the sound head can be placed under oil pressure. The mounting is to be so designed that the space between the sound head and the rollers or rolling elements imparting the sound to the strip is completely air-free. The rollers **5** are pressed in the direction of the arrows **6** against the moving strip **1**, the vibrational energy being propagated in the strip and thus the surface thereof assumes the desired profile. Balls or any other desired rolling elements can be used instead of rollers **5**.

The ultrasonic heads **4** are preferably arranged in guideways **7** which extend parallel to the track of the strip **1**. The guideways **7** are shown partly in section in FIGURE 1. By means of guideways **7**, it is possible to vary the height h (FIGURE 1). The ultrasonic heads can as desired be arranged in the path **3** itself as indicated in broken lines, at the height of the bath surface or as desired at any height above the bath.

For improving the transmission of sound from the ultrasonic heads **4** to the strip **1**, the rollers **5** can be wetted with oil or the like.

The invention is not restricted to the constructional example which is illustrated. In particular, the ultrasonic head or heads can also be arranged in front of or behind the strip **1** instead of laterally adjacent the said strip. Furthermore, it is possible to use a combined method in which for example ultrasonic heads are arranged in the bath, the vibrational energy of which heads is transmitted through the liquid medium, and in addition ultrasonic heads with direct transmission of ultrasonic energy can be provided above the bath.

The method according to the invention can moreover also be used for producing a predetermined surface profile of strips or sheets metallised in the molten state, by the said sheets or strips, after leaving the melt, being acted upon in an adjoining liquid with vibrational energy which at the same time serves as a coupling liquid. For example, in the hot-dip tinning of metal sheets or strips, the latter can be in palm oil arranged above the tin melt and be acted upon with vibrational energy, preferably after having passed through the wringer rolls, the vibration generators being arranged at a suitable position in this palm oil bath. If desired, the vibrational energy within or externally of the bath can also be directly transmitted by ultrasonic heads to the sheets or strips, as explained above by reference to FIGURES 1 and 2.

The invention is not restricted to the production of a specific surface profile with metallically improved metal sheets or strips. If required, the surface profile of other surface-improved sheets or strips can be influenced by means of vibrational energy, for example metal sheets or strips provided with a plastic or lacquer coating. It is also of advantage here to use relatively high frequencies which extend into the ultrasonic range.

The use of the method according to the invention for controlling the surface of lacquered sheets or strips, the lacquer coating of which is applied in a manner known per se in an electrostatic field, can also be effected by an alternating voltage or a pulsating direct voltage being superimposed on the electrostatic field. By the different influencing of the lacquer particles impinging on the strip or article to be lacquered, a predetermined surface profile is obtained.

The production of a certain roughening of the surface layer of elements and more especially sheets or strips is not only of advantage as regards the deforming processes, but a certain roughness of the surface is frequently desired, because this surface is then less sensitive to mechanical surface damage.

We claim:

1. In a process of forming on a metal sheet having a first melting point a rough surface of a coating metal having a second melting point which is lower than said first melting point, the steps of forming on said metal sheet a coating of said coating metal being at least the second melting point so that the coating is at least substantially molten; immersing at least a portion of said metal sheet with said molten coating thereon into a quenching liquid so as to cool said molten metal coating during a period of time to a temperature below said second melting point so as to solidify the coating; and subjecting the coated sheet during at least part of said cooling period to ultrasonic vibrations whereby the surface of said coating becomes uneven and said coating is solidified with its surface in an uneven state.

2. In a process of forming on a metal sheet having a first melting point a rough surface of a coating metal having a second melting point which is lower than said first melting point, the steps of electrolytically forming on said metal sheet a coating of said coating metal; heating said coating to the second melting point so that the coating is at least substantially molten; immersing at least a portion of said metal sheet with said molten coating thereon into a quenching liquid so as to cool said molten metal coating during a period of time to a temperature below said second melting point so as to solidify the coating; and subjecting the coated sheet during at least part of said cooling period to ultrasonic vibrations whereby the surface of said coating becomes uneven and said coating is solidified with its surface in an uneven state.

3. Method according to claim **2**, wherein the degree of unevenness of the surface of said coating is controlled by superimposing ultrasonic vibrations which are displaced relative to each other.

4. Method according to claim 2 wherein the quenching liquid simultaneously with cooling said coating also serves as coupling liquid for the transmission of ultrasonic vibrations so that the coated sheet is impacted on at least on side with vibrational energy on dipping into the quenching bath.

5. Method according to claim 2, wherein the degree of unevenness of the surface of said coating is controlled by varying the frequency of said ultrasonic vibrations.

6. Method according to claim 2, wherein the degree of unevenness of the surface is controlled by changing the intensity of said ultrasonic vibrations.

7. Method according to claim 2, wherein the degree of unevenness of the surface is controlled by varying the impact angle between the ultrasonic vibration and the surface of said coating.

8. Method according to claim 2, wherein the degree of unevenness of the surface is controlled by the immersion depth of the sound sources in the quenching bath.

9. Method according to claim 2, wherein the degree of unevenness of the surface is controlled by superimposing different frequencies of ultrasonic vibrations.

10. Method according to claim 2, wherein the degree of unevenness of the surface is controlled by varying the velocity of the strip during immersion of the same while maintaining said ultrasonic vibrations at a constant frequency.

11. In a process of forming on a smooth metal sheet having a first melting point a rough surface of a coating

metal having a second melting point which is lower than said first melting point, the steps of electrolytically forming on said metal sheet a coating of said coating metal; heating said coating to at least the second melting point so that the coating is at least substantially molten; immersing at least a portion of said metal sheet with said molten coating thereon into a quenching liquid so as to cool said molten metal coating during a period of time to a temperature below said second melting point so as to solidify the coating; and subjecting the coated sheet during at least part of said cooling period to ultrasonic vibrations whereby the surface of said coating becomes uneven and said coating on said smooth metal sheet is solidified with its surface in an uneven state.

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