June 13, 1972 KURT-JURGEN SCHULZE ET AL 3,669,761

PATENTING OF STEEL WIRES WITH LEAD

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FIG. 1

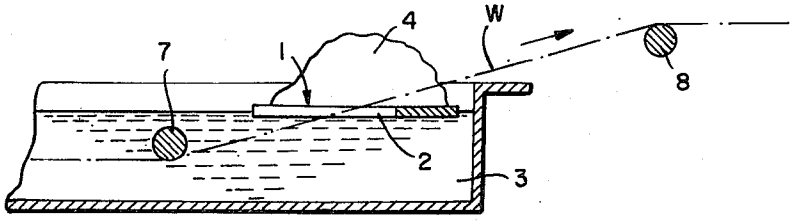


FIG. 2

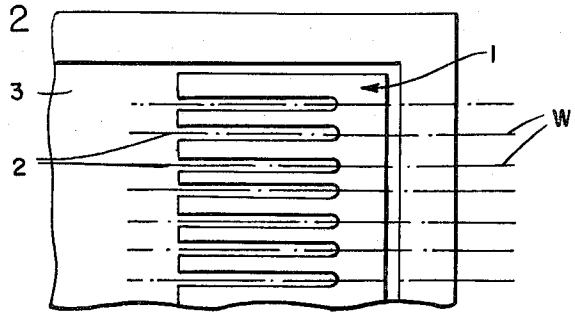


FIG. 3

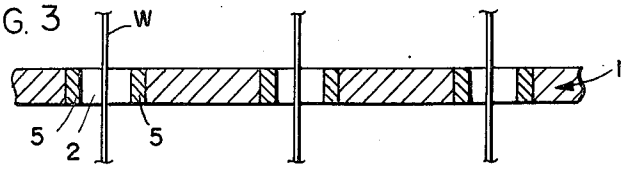


FIG. 4

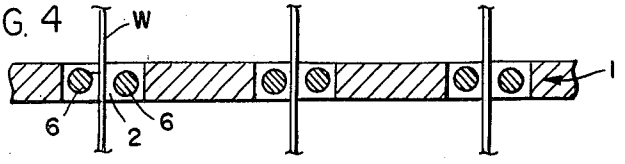
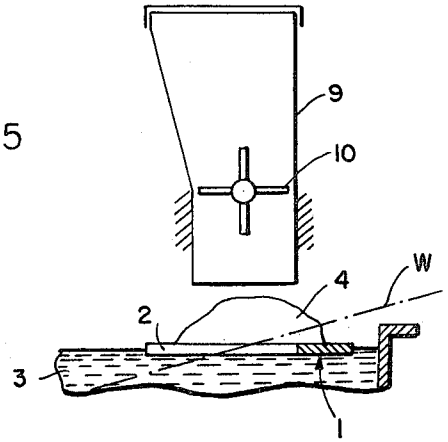


FIG. 5



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PATENTING OF STEEL WIRES WITH LEAD

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ABSTRACT OF THE DISCLOSURE

Apparatus and method for substantially reducing the entrainment of lead in the patenting of steel wires using a molten lead bath wherein a thin slotted plate is floated on the surface of the bath with the emerging wires passing through the slots thereof and a layer of a granulated amorphous carbon is deposited on top of the plate to cover said slots.

This invention generally relates to a method and suitable apparatus for reducing the entrainment of lead, i.e. to prevent so-called "lead-drawing" in the patenting of steel wires which involves conducting the wires through a bath of molten lead. The known process of patenting steel wires, i.e. wires composed of an iron-based alloy, requires the wires to be first heated above their critical temperature range and this heating step is then followed by cooling to a lower temperature below the critical temperature range but advantageously at a still highly elevated temperature, e.g. between about 315° C. and 650° C., preferably between about 500° C. and 530° C. Cooling or quenching at these temperatures is advantageously accomplished in a bath of molten lead through which the wires can be conducted so as to be fully immersed. Such steel wires can be continuously processed in this lead-patenting process, for example as a finishing treatment or as a preliminary step in the further drawing of the wires to a narrower diameter.

Difficulties are still encountered in any further processing of lead-patented steel wires on account of the phenomenon known as lead-drawing or lead-entrainment. The steel wire, initially heated to temperatures around 900° C. and subsequently quenched in molten lead at a temperature of from about 500 to 530° C. to establish optimum drawing conditions, entrains small balls or globules of lead or lead films as it leaves the lead bath and emerges into the surrounding atmosphere. These lead globules or films of lead cannot be easily removed or are removed only to a limited extent during a subsequent pickling or etching step and give rise to serious disturbances during subsequent processing operations. Since the steel surface is no longer uniformly clean, such operations as bonderizing, liming, boraxing, drawing and galvanizing are adversely affected, in some cases to a very considerable extent.

It is known that the entrainment of lead can be prevented to some extent by covering that surface of the lead bath where the wires emerge with a non-inflammable granular material as a means of obtaining both a lead-stripping effect and also a reduction in the extent to which the surface of the lead bath is oxidized. More or less fine gravel or sand is used as the granular material for this purpose. Lead oxide is known to adhere very persistently to the steel wires, especially in the form of pure lead. In referring to the entrainment of lead or its adherence to the wires, it will be understood that this includes lead in the form of lead oxide.

Another known method of counteracting the entrainment of lead is to cover the surface of the lead bath

where the wires emerge with charcoal or coke of suitable grain size. This also tends to permit a stripping effect and a reduction in the extent to which the surface of the lead bath is oxidized.

Unfortunately, none of these preventive measures against the entrainment of lead has proved to be satisfactory. Careful investigations have shown that, in spite of the presence of granular substances coating the bath surface, there is gradually formed in the vicinity of each emerging wire a viscous sticky cone consisting of a mixture of lead and lead oxide. This cone, as it continues to grow, increases its wire-adhering properties even further as the distance separating its tip from the surface of the lead bath increases. This accelerated formation of the cone occurs due to the accompanying decrease in temperature as the cone is elevated above the bath surface. For this reason, all the problems resulting from lead entrainment soon increase again during continuous processing, i.e. over any extended period of operation.

One object of the present invention is to substantially reduce or even eliminate the entrainment of lead from the bath onto the steel wires as they are conducted continuously through a lead patenting bath. Another object of the invention is to reduce such lead-drawing or lead-entrainment to such an extent that it will not have any serious or undesirable influence on subsequent processing of the steel wires. Still another object of the invention is to provide apparatus and a procedure which reduces lead entrainment in the known process in an economical and easily controlled manner. Other objects and advantages of the invention will become more apparent upon consideration of the following detailed specification.

It has now been found, in accordance with the invention, that a very desirable reduction of the above-noted lead entrainment can be achieved during the conventional patenting of steel wires in a molten lead bath having means to convey a plurality of wires through said bath so as to emerge or be removed at a surface outlet zone of the bath, by providing in combination therewith a thin plate positioned to float on the surface of the bath at the outlet zone, the plate having a plurality of slots to receive the wires as they emerge from the bath, and a layer of a granulated amorphous carbon spread over and covering the top surface of the plate including the slots at the outlet zone of the wires in an amount sufficient to substantially reduce the entrainment of lead on the wires.

The method of the invention, in addition to the conventional steps of patenting the steel wires, essentially includes the steps of freely floating a slotted plate on the surface of the lead bath at the point of emergence of the wires while conducting the wires through the slotted portions of the plate, and covering the top surface of the plate including the slotted portions with a granulated amorphous carbon in an amount sufficient to cause smoldering of the carbon and blanketing the emerging wires with a non-oxidizing atmosphere.

Certain preferred embodiments of the invention are illustrated and explained in conjunction with the accompanying drawing, wherein:

FIG. 1 is a schematic side sectional view of the wire outlet end of an elongated lead bath to illustrate at least one wire being drawn through a slotted plate;

FIG. 2 is a partial top plan view of one embodiment of a slotted plate of the present invention;

FIG. 3 is a transverse sectional view of a slotted plate similar to that shown in FIG. 2, the side walls of the slots being lined with a hard wear-resistant material;

FIG. 4 is a transverse sectional view as in FIG. 3 but illustrating another embodiment of the slotted plate in which each slot contains two wear-resistant pins; and

FIG. 5 is a partly schematic side elevational view of the apparatus of the invention, certain portions being omitted, but illustrating a layer of charcoal on the slotted plate as supplied from above by a suitable metering unit.

In principle, the plate **1** which is provided with slots **2** to allow passage of the wires W as they emerge from the bath can be made from a variety of metallic or non-metallic materials. Certain rather obvious restrictions are placed on the choice of the plate material. For example, the slotted plate should not soften, melt or become deformed at the temperature of the bath of molten lead. Also, the plate should exhibit adequate mechanical strength and be substantially inert to electrochemical interaction with the molten lead. Examples of suitable materials include iron alloys, nickel-chrome alloys, ceramic materials and the like. It will also be apparent that the plate must have a density sufficiently low as to freely float on the surface of the lead bath. The plate can be constructed of a single material or preferably using separate materials in component parts or surfaces to achieve maximum strength and durability together with good abrasion resistance where the transported wires occasionally contact the guiding surfaces of the slots.

The thickness of the plate is not critical, being variable within relatively wide limits. As a rule, the plate has a minimum thickness of about 8 mm. because otherwise the plate might possibly warp at the temperatures prevailing in the lead bath, depending on the particular material used in constructing the plate. Substantial distortion of the plate raises the possibility of air bubbles being formed between the plate and the surface of the lead, and this should be avoided. On the other hand, the maximum thickness of the plate is largely a matter of economy while the length of the plate depends to some extent upon the angle at which the wires emerge from the bath surface as indicated in FIG. 1.

In the context of the invention, the expression "amorphous carbon" has its conventional meaning as one of the three allotropic modifications of carbon, i.e. as distinguished from the graphite and diamond varieties, and is intended to include industrial or commercial products which consist essentially of carbon but may contain normal impurities. In general, it is desirable to employ a granular amorphous carbon with a grain size in excess of about 5 mm., these granular materials being readily available, for example hard-coal coke, wood charcoal, brown-coal coke, etc. Charcoal particles are especially suitable. The layer thickness or depth of carbon granules on the top surface of the plate, including a blanket or cover over the slots, is also variable within relatively wide limits. It is most convenient to provide an irregularly shaped bed **4** as indicated in FIGS. 1 and 5 wherein the amount of granulated carbon only has to meet the requirement of ensuring a coherent, smoldering cover on top of the plate **1** and its slots **2**. This bed or layer **4** is thus sufficient to cause smoldering of the amorphous carbon so as to blanket the emerging wires W with a non-oxidizing atmosphere.

It has been found to be of particular advantage to use a slotted steel plate which will float on the surface of the lead bath and can be easily positioned in the vicinity of the wire outlet zone.

It is not necessary to attach the floating plate **1** to the walls of the bath container or to an exterior support, particularly if the plate is proportioned to fit with a relatively narrow gap space between the side walls and near the end walls of the container as indicated in FIG. 2. On the other hand, suitable spacers or flexible mounting means (not shown) can be provided to hold the plate approximately in position to receive the wires in the slots, thereby avoiding excessive contact of the wires with the walls of the slots. In general, the freely floating plate itself is sufficiently heavy together with the relatively dense lead bath to remain in position in spite of occasional contact with the running wires or the slight pressure exerted on the plate by the wires as they are withdrawn from the bath.

To prevent mechanical wear on the opposing sides or walls of the slots which may occur as the steel wires pass through the slots, it is also of advantage for the slots in the steel plate or in a plate composed of another material to be bordered or lined with strips **5** of a highly wear-resistant material extending over the length of the slot on either side thereof and firmly fixed to the plate material **1** by welding or by recessed bolts or the like (see FIG. 3). Alternatively, each slot can be provided with two elongated pins **6** composed of a material having a wear-resistance greater than that of the material from which the plate is made (see FIG. 4). The pins can be mounted along the opposing sides of each slot, e.g. by threading the pins into the non-slotted end of the plate or by welding directly to the side walls. The pins must of course be spaced sufficiently apart to permit the wire to pass freely through the more narrowly defined slot. Pins or lining strips composed of oxide ceramics, hard metals such as AKRIT N–G, chrome steels and tungsten steels, for example, have been found to be particularly effective as highly wear-resistant materials.

The apparatus and method according to the invention is illustrated by but not limited to the following example.

EXAMPLE

A group of steel wires W consisting of seven individual wires 5.5 mm. in diameter are patented under conventional conditions by first being heated to about 900° C. The wires are then immediately conducted in parallel at a rate of 3 meters per minute through an elongated lead bath heated to about 520° C. as generally shown in FIG. 1. A 10 mm. thick steel plate **1** provided with slots as shown in FIG. 1 floats on the surface of the molten lead bath **3** in the vicinity of the wire outlet zone, i.e. adjacent the exit end of the lead bath. With the assistance of at least one immersion roller **7** and a guide roller **8** the group of wires is guided out of the bath through the slots **2** in the steel plate, each of which is bordered by two chrome steel pins **6** as shown in FIG. 2. Conventional wire transporting means can be used for conveying the individual wires or group of wires through the patenting process, e.g. by using typical draw rolls or the like (not shown). The steel plate including the slots is covered with a charcoal bed or layer **4** consisting of charcoal granules having a particle size of about 15 mm. (the thickness or height of the bed being about 15 cm.). The height of the granular bed is maintained by means of a metering unit or supply bin **9**, e.g. one which is equipped with a rotatable metering gear or paddle wheel **10**, of the type indicated in FIG. 5. This bin **9** contains a relatively large supply of granular amorphous carbon such as charcoal for continuous feed at about the rate at which the bed **4** is consumed. The layer or bed of charcoal ignites immediately and continues to smolder so that atmospheric oxygen is substantially excluded in the wire outlet zone. The charcoal granules completely cover the slots where the wires emerge and smaller particles may even fall into these slots without disturbing the running wires to any serious extent. The slots are largely insulated by the granular bed so as to maintain a high temperature at the surface of the bath as well as to effectively provide a non-oxidizing atmosphere around the emerging wires. Under the conditions indicated, no expanding or growing cone of lead or lead oxide is formed on the slots, and the group of lead-patented steel wires can be further processed in subsequent operations without any difficulty and without the usual heavy film or entrainment of lead globules on the wire surfaces.

Any number of minor modifications can be made in the apparatus or method of the invention without losing its essential features, for example in the overall construction of the bath of molten lead as well as in various em-

bodiments of the floating slotted plate which supports the bed or cover layer of granular amorphous carbon. Thus, the slotted plate can be provided with thin vertical side walls around its periphery or along each slot in order to maintain a more or less uniform height of the granulated carbon above each slot and over its effective length. Also, the individual slots may be widened along the path of the emerging wire while providing a narrower extension of the slot as a means of initially threading or introducing the wire while minimizing the exposed surface of the bath in the wire outlet zone.

Furthermore, the plate can be divided into two component parts, e.g. a relatively thick and heat-resistant lower portion in which the slots can be relatively wide and an upper more thinly constructed portion having narrower slots and composed of a very wear-resistant material or lined on the opposing sides of each slot with the wear-resistant material. These and other modifications will be readily apparent to one skilled in this art in providing a satisfactory slotted plate which will serve its intended purpose over long periods of continuous operation.

The invention is hereby claimed as follows:

1. In a method of patenting steel wires with lead by heating said wires above their critical temperature followed by cooling at a lower temperature as said wires are conducted in substantially parallel paths through a bath of molten lead, the improvement for reducing entrainment of lead as the wires emerge from the bath which comprises:

freely floating a slotted plate on the surface of the lead bath at the point of emergence of the wires while conducting the wires through the slotted portions of the plate; and

covering the top surface of the plate including said slotted portions with a granulated amorphous carbon in an amount sufficient to cause smoldering of the carbon and blanketing the emerging wires with a non-oxidizing atmosphere.

2. A method as claimed in claim 1 wherein said amorphous carbon consists essentially of charcoal.

3. A method as claimed in claim 1 wherein said granulated amorphous carbon has a grain size in excess of about 5 mm.

4. A method as claimed in claim 1 wherein said slotted plate is composed of steel and is sufficiently heavy to remain in position while floating on said lead bath against occasional contact with the running wires.

5. A method as claimed in claim 1 wherein the amount of carbon covering the top surface of the plate is regulated to maintain a predetermined height of the resulting bed of carbon particles as said wires are conducted therethrough.

References Cited

UNITED STATES PATENTS

361,550	4/1887	Scarles	117—102 M
1,053,664	2/1913	Sommer	117—102 M
1,362,321	12/1920	Johnson	266—3 R
1,551,751	9/1925	Kozak	118—125
2,300,329	10/1942	Wood et al.	148—18 X
2,556,349	6/1951	Trautman	266—3 R
2,793,144	5/1957	Crowley	148—15

CHARLES N. LOVELL, Primary Examiner

U.S. Cl. X.R.

117—102 M; 118—125; 134—9; 266—3 R