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METHOD AND APPARATUS FOR COATING
FERROUS-METAL STRANDS

This invention relates to a method of coating a ferrous-metal strand, in strip, wire or rod form, with a metallic coating medium which is a zinc-containing alloy, and to apparatus for use in performing the method.

5 The hot-dip method which is the subject of Australian Patent No. 481,508 has proved largely satisfactory in use; however, that method is relatively expensive and somewhat complicated to perform since it requires use of gas heated to at least 750°F; moreover, although the prior invention is directed to the provision of a strand coating "free of pin hole and bare spot defects" and, by comparison with still earlier coating methods, is
10 largely effective in contribution to that aim, experiment has shown that the prior invention is not wholly successful in preventing pin-holing and the like, due to uncoated areas. Indeed, we have found it doubtful as to whether pin-holing defects can be eliminated absolutely.

15 Another shortcoming due to the prior invention is that the hood (marked 16 in the drawings of the prior patent) tends to accumulate, on its inner surface, zinc and zinc oxide deposits and thus has to be regularly cleared of those deposits at relatively frequent intervals (about every month for example). Again, heater elements are desirably used to heat the strand in an annealing furnace preceding the hood, and these are usually
20 electrically energized. Thus, a further disability is that the mentioned deposits frequently short the heater elements thus necessitating repair which is detrimental in itself and unpredictably renders disjunctive a strand treatment process which, under modern practice, is usually required to be continuous.

25 The object of the present invention is to overcome or ameliorate the mentioned shortcomings in a simple way, by the provision of a strand coating method which eliminates need for a hot reducing gas, reduces the gas volume required, still further reduces pin-holing and like defects by comparison with the results obtained by practice of the prior invention; and,
30 avoids formation of zinc or other deposits within the hood employed, either completely or so nearly as to be inconsequential.

According to the present invention in one aspect there is provided a method of coating a furnace-heated ferrous-metal strand with a metallic coating medium which is a zinc-containing alloy comprising the steps of:

5 (a) moving the strand longitudinally through a protective hood having a strand-departure end dipping into a bath of the metallic coating medium in molten condition, so that said departure end encloses a fraction of the medium's top surface,

(b) maintaining a reducing atmosphere within said hood which is substantially quiescent at least in the vicinity of said departure end,

10 (c) introducing a reducing gas into a strand furnace outlet duct disposed upstream of said hood and through which said strand proceeds on its way to said hood, and so that said gas diffuses into said hood, and

(d) restricting the amount of gas diffusion from said duct into said hood thereby to maintain said atmosphere substantially quiescent by adding
15 to that atmosphere an amount of gas which is no greater than is necessary to maintain the quantity and composition of the gas in said hood substantially constant.

According to the present invention in another aspect there is provided apparatus for performing the method of the present invention,
20 comprising:

(a) a strand-heating furnace having a strand outlet duct terminating in a hood whereof the end remote from said duct dips into a bath of molten metallic coating medium which is a zinc-containing alloy,

25 (b) means to feed said strand longitudinally from said furnace, through said duct, through said hood and through said bath,

(c) means to feed a reducing gas into said duct to maintain a plenum condition therein, and

(d) baffle means located substantially at the junction wherein said duct meets said hood thereby to control the amount of gas entering the hood
30 thereby to maintain the atmosphere within the hood substantially quiescent by adding to that atmosphere an amount of gas which is no greater than is necessary to maintain the quantity and composition of the gas in the hood substantially constant.

Embodiments of apparatus for carrying out the method will now be
35 described, by way of examples, with reference to accompanying drawings, in which:-

Figure 1 is a sectional side elevation showing the outlet duct of a strand furnace, a hood associated with that duct and a bath of molten coating medium, and

Figure 2 substantially repeats a right-hand end portion of Figure 1, on a larger scale and incorporating a minor modification.

Referring to Figure 1 a strand to be coated is indicated at 3. It proceeds through a furnace outlet duct 4 to a hood 5, then into a bath 6 of molten coating medium which is a zinc-containing alloy, such as an aluminium/zinc alloy and thence into a stripping zone 7 in which excess coating medium deposit may be removed by gas wiping or otherwise in conventional manner. Hood 5 has a strand departure end 5A which dips into the molten coating material in the bath 6.

While the strand is in the duct 4 (the actual furnace is not shown, it being of conventional design) it is subjected to a gaseous reducing atmosphere which experiment has shown may be a gas mixture composed primarily of nitrogen, but may include hydrogen to an extent not exceeding 15% by volume of the mixture. This gas is preferably de-humidified. The reducing gas may be fed into duct 4 in any convenient manner; for example, by way of a series of inlet nozzles 8 fed from a supply header 9. Used or excess gas may be led away from duct 4, also in any convenient manner, for instance, by way of outlets 10 leading to a take-off header 11. The gas may be fed into duct 4 at any suitable temperature; ambient temperature is quite satisfactory.

Duct 4 contains a number of holed partitions such as 12, 13 and 14. The strand 3 proceeding from the furnace to the bath passes through the partition holes, being encompassed thereby as closely as is compatible with providing sufficient mechanical clearance for the through-going strand.

It will be appreciated that there may be some back-flow loss of gas through the holed partitions 12 and 13. Any such loss is not important.

Gas will also diffuse through partition 14 into hood 5 where it serves as make-up gas to maintain the gas content of the hood 5, and the gas composition therein substantially constant. Obviously some gas will be lost by entrainment with the strand 3 leaving the hood 5, and there may be very slight gas losses in the hood 5 due to oxidation.

The gas entering outlet furnace duct 4 is preferably sufficiently just above atmospheric pressure as will suffice to maintain plenum conditions

within the outlet duct, but in any case both the gas intake and take-off may be controlled to give not only the mentioned plenum effect, but, at the same time, ensure that the gas entering the hood 5 is at least sufficient to take care of gas loss due to leakage or otherwise.

5 The rate of gas feed into the hood 5 should be the minimum inflow which will serve the required make-up function within the hood 5, while preserving the quiescent state of the gas in the hood 5, at least in the outlet end vicinity of the hood 5. To this end, gas about to pass from duct 4 into hood 5 is preferably throttled back in any convenient way, for example, by
10 use of conventional seal rollers as indicated at 15 or by use of baffles or the like located in the furnace outlet duct 4 adjacent the strand take-off end thereof.

 Referring to Figure 2, the arrangement there shown is virtually the same as that already described, except for the baffle means located in the
15 vicinity of the junction of the duct 4A and the hood 5A.

 Trial practising of the invention has disclosed that maintenance of the required gas conditions in the hood 5 will be effectively accomplished, especially where the strand 3 being handled is in the form of a continuous strip whereof the width closely approaches that of the hood interior, by a
20 pair of baffles such as those indicated at 16 and 17.

 Baffle 16 is an inbuilt wall of refractory material which extends across the intake end of the hood 5 and extends upwardly from the floor of the hood to a level just below that of the strand 3A.

 Baffle 17 may be in the form of a beam, made of suitably re-inforced
25 ceramic fibre or other refractory material. This beam could be built in but preferably is mounted on a rotatable shaft 18 so that the beam may be turned into the position indicated by dotted lines 17A to facilitate initial threading of the leading end of the strand 3A into and through the hood. For the same purpose an access port 19 is preferably provided in the hood. When
30 the apparatus is in use, port 19 is closed by a removable cover as indicated at 20.

CLAIMS

1. A method of coating a furnace-heated, ferrous-metal strand with a metallic coating medium which is a zinc-containing alloy comprising the steps of:

(a) moving the strand longitudinally through a protective hood having a strand-departure end dipping into a bath of the metallic coating medium in molten condition, so that said departure end encloses a fraction of the medium's top surface,

(b) maintaining a reducing atmosphere within said hood which is substantially quiescent at least in the vicinity of said departure end,

(c) introducing a reducing gas into a strand furnace outlet duct disposed upstream of said hood and through which said strand proceeds on its way to said hood, and so that said gas diffuses into said hood, and

(d) restricting the amount of gas diffusion from said duct into said hood thereby to maintain said atmosphere substantially quiescent by adding to that atmosphere an amount of gas which is no greater than is necessary to maintain the quantity and composition of the gas in said hood substantially constant.

2. A method according to claim 1 wherein said medium is an aluminium/zinc alloy.

3. A method according to claim 1 or claim 2 wherein said reducing gas is a dehumidified mixture of nitrogen and hydrogen with the quantity of hydrogen not exceeding 15% by volume of said mixture.

4. Apparatus for use in performing the method according to claim 1 comprising:

(a) a strand-heating furnace having a strand outlet duct terminating in a hood whereof the end remote from said duct dips into a bath of molten metallic coating medium which is a zinc-containing alloy,

(b) means to feed said strand longitudinally from said furnace, through said duct, through said hood and through said bath,



(c) means to feed a reducing gas into said duct to maintain a plenum condition therein, and

(d) baffle means located substantially at the junction wherein said duct meets said hood thereby to control the amount of gas entering the hood thereby to maintain the atmosphere within the hood substantially quiescent by adding to that atmosphere an amount of gas which is no greater than is necessary to maintain the quantity and composition of the gas in the hood substantially constant.

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10 5. Apparatus according to claim 4 wherein said duct has a plurality of internal partitions disposed transversely of it, each of said partitions having a hole in it to permit said strand to travel freely therethrough.

15 6. Apparatus according to claim 5 wherein said baffle means comprise a pair of seal rollers between which said strand proceeds in moving towards said hood, and one of said partitions.

20 7. Apparatus according to claim 5 wherein said baffle means comprise a refractory wall extending transversely of said hood and extending from the floor of said hood to a level close to, but below that of a strand proceeding through the hood, and a refractory beam extending transversely of the hood and extending from the top of the hood down to a level close to, but above that of said strand.

25 8. Apparatus according to claim 7 wherein said beam is mounted on a rotatable shaft extending transversely of said hood so to permit rotation of said beam thereby to increase the spacing of said beam from said strand.

30 9. Apparatus according to claim 8 wherein said hood has an access port formed in it adjacent said beam, and said port is furnished with a removable cover.

10. A method of hot coating a ferrous-metal strand substantially as hereinbefore described with reference to the accompanying drawings.



11. Hot-dip coating apparatus substantially as hereinbefore described with reference to and as illustrated in Figure 1 or Figure 2 of the accompanying drawings.

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