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(72) Inventors: PAUL METZ
FERNAND WAGNER


## (54) CONTINUOUS THERMAL PROCESSING OF METAL SHEETS


(71) We, ACIERIES RÉUNIES DE BURBACH-EICH DUDELANGE S.A., ARBED, of Avenue de la Liberté, Luxembourg, a société anonyme organised under the laws of Luxembourg, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–


The present invention concerns plant for the continuous thermal processing of metal sheets, particularly cold-rolled sheets, to impart thereto an improved resilient elongation limit and/or capacity for pressing. The plant can be integrated in a production line for galvanized sheets.

A previously contemplated process for such purposes is distinguished by the fact that the sheet previously brought to a temperature between 650° and 950° is submitted to controlled cooling by immersion in a bath of molten salts maintained at a temperature comprised, according to need, between 250° and 500°C. For thermal processing combined with galvanizing, it was contemplated that the sheet be treated successively in a bath of molten salts and in a zinc bath, using a receptacle with compartments of the syphon kind whose inlet compartment contains the bath of molten salts floating on the surface of the zinc bath, whereas the latter only occupies the outlet compartment. However, these processes have the disadvantage of not allowing much variation of processing time for a fixed throughout speed giving acceptable productivity. The present invention can remedy this drawback and cater for a variety of thermal processes whether or not combined with galvanizing.

According to the invention there is provided a plant for the continuous thermal processing of metal sheet comprising a heating oven, an enclosure partly occupied by compartments provided with heating and/or cooling means and partly by a receptacle for a molten salt bath, and guiding means for passing the sheet through the oven and then sequentially through the compartments, the guiding means including guide members between successive compartments and means for individually and at will displacing any said guide member to immerse the sheet in the salt bath between the corresponding successive compartments.

In an advantageous embodiment of the invention, means are provided at the base of the vertical compartments and/or on the surface of the salt bath which allow the salt bath to be isolated, at least partially, from the rest of the plant while allowing passage of the sheet for immersion in the salt bath. The compartment outlets may be provided with movable closure means delimiting slots for the passage of the sheet; valves may be disposed between the compartments and the receptacle, each valve being closable when the corresponding guide member directs the sheet to the next compartment without immersion. The first compartment may be a second oven provided with radiant heating tubes.

Control and regulation of the temperature and cooling capacity of the bath is preferably effected by circulation of the bath material through a secondary enclosure by means of a pump. This pump is usefully a mammoth pump worked by water which is at least partially vaporized. In the secondary enclosure the water is separated from the molten salt and the cooled molten salt returns (e.g. under gravity) to the bath.

The outlet from the compartments can be constituted by an enclosure provided with guiding rollers and, if need be, with means for cooling and/or heating.

When the plant is combined with a plant for galvanizing the sheet the outlet enclosure, preferably having the form of a diving bell, extends into a second bath of molten salt, which corrects, by way of a partitioned member in the form of a syphon, with a molten zinc bath. This second salt bath serves to eliminate and to retain the salt particles entrained from the first bath with which it is preferably connected as part of the above-

mentioned cooling system for the molten salt. In one of the applications of the invention, and more particularly when the production of stiffer sheets is required, the first salt bath is not used and the second salt bath acts as tempering bath,

An embodiment of the invention is described below, by way of example only, with reference to the accompanying drawing in which the single Figure represents a diagrammatic section through a plant for the thermal processing and galvanizing of sheet steel.

Referring to the drawing, the steel sheet 1 to be processed passes over a deflector roller 2 and through an inlet slot 3 into a vertical direct heating oven 4. It then passes to a heating oven 5 equipped with radiant tubes 6 before entering, at a raised temperature, into an enclosure 10 subdivided into vertical compartments 10', 10", 10"'. A compartment can serve as a heating oven by means of radiant tubes 6, as a retention area, or as a cooling chamber with jet coolers 13. Each compartment of enclosure 10 can be closed at its base by valve 25. Oven 5 is effectively the first compartment of an enclosure 5,10.

The return rollers 7, 9, 11, which serve to guide the sheet in its progress to the bottom of the enclosure 5, 10 between the oven 5 and the successive compartments 10', 10", 10"', are vertically movable and can be displaced individually into the salt bath 15 after opening of the corresponding valve 14, whose axis is perpendicular to the plane of the figure. The immersion of the end of a loop of the sheet in the salt bath results in the sheet being rapidly and uniformly cooled at the desired temperature.

From the outlet 16 from the compartments, which outlet can have heating tubes 6 or coolers 13 or both, the sheet passes through a diving bell 18, without coming into contact with the air, into a second salt bath 19 contained in the inlet compartment of a receptacle 21 whose two partitions 22 and 23 delimit a syphon. It then passes through a zinc bath 20 in which it is deflected towards the outlet by a guiding roller 24. Compared to the conventional thermal cycle, the plant according to the invention allows the cooling rate to be increased by a factor of 10 and the choice at will according to the object to be attained of the stages 7, 9, 11 and 18 for the start of cooling.

The possibility of modifying the thermal cycle at will allows ready realisation of the principle slight variations in sheets to be found on the market. In particular, from the same analysis of base steel, a wide range of qualities in galvanized sheets can be obtained, from full hard to deep pressing.

As an auxiliary and in a no less important way, this process, for the same line, can allow productivity to be appreciably increased.

To obtain plates for deep pressing, the tempering is suitably effected at the stage 7 at a temperature in the neighbourhood of 700°C, the salt bath being at a temperature of 300 to 550°C. Thus an optimum length of oven is arranged to effect the drawing of temper. The length of oven in which the drawing operates can be easily calculated to obtain a determined tempering effect. The latter is achieved all the more rapidly as the cooling speed is high. Due to this the duration of drawing can be limited to 60 seconds at the maximum.

For steel sheets for construction, tempering is suitably effected at stage 9, 11 or 18. The strength and the resilient limit increase as the tempering point is displaced towards the zinc bath. The increase in strength and resilient limit obtained may be to the detriment of elongation, but the residual elongation is sufficient for the majority of applications.

In pressable sheets of high resilient limit a high resilient limit must be allied to an increased elongation. A variety of steel of high manganese content will also be chosen. Tempering will then preferably be effected at stage 7.

An advantage of the invention resides in the fact that commercial quality sheet product, corresponding to 60% of the needs of the market, can be realised by effecting a tempering at stage 11. The parts of the oven otherwise useable for cooling, can thus serve when necessary as a heating section. The maximum line speed can thus be used for greater thicknesses, giving increased productivity. Conversely for equal productivity, a line with the salt tempering can be more compact than a standard line.

The plant according to the invention can be used for galvanizing hot dipped sheets whose processing in standard ovens poses well known problems of zinc adherence.

Thus, when hot coils are galvanized, one has the advantages of limiting the heating temperature to 500°C. In the case, the bath 19 will serve advantageously as flux to improve zinc adherence.

The methods described above illustrate that the plant according to the invention can carry out efficiently (as regards cost and quality) a variety of processes on products of different kinds.

WHAT WE CLAIM IS:—

1. Plant for the continuous thermal processing of metal sheet comprising a heating oven, an enclosure partly occupied by compartments provided with heating and/or cooling means and partly by a receptacle for a molten salt bath, and guiding means for passing the sheet through the oven and then sequentially through the compartments, the guiding means including guide members between successive compartments and means for individually and at will displacing any said guide member to immerse the sheet in the salt bath between the corresponding successive compartments.

2. Plant according to Claim 1 wherein the compartment outlets are provided with movable closure means delimiting slots for the passage of the sheet.

3. Plant according to Claim 1 or 2 including valves between the compartments and the receptacle, each valve being closable when the corresponding guide member directs the sheet to the next compartment without immersion.

4. Plant according to any of Claims 1 to 3 wherein the first compartment is a second oven provided with radiant heating tubes.

5. Plant according to any of Claims 1 to 4 including means for controlling the temperature and cooling capacity of the molten salt bath.

6. Plant according to Claim 5 in which the said control means comprises a pump which, under the action of at least partially vaporized water, can continuously or intermittently drive a portion of the molten salt from the bath to a further receptacle, means for removing water from the molten salt in the further receptacle, and means for returning the partially cooled molten salt therefrom to the bath.

7. Plant according to any of Claims 1 to 6 having an outlet enclosure communicating with the final compartment and provided with heating and/or cooling means.

8. Plant according to any of Claims 1 to 7 wherein the outlet enclosure extends into a seperate molten salt bath which can connect, by way of a partitioned chamber in the form of a syphon, with a molten zinc bath.

9. Plant for the continuous thermal processing of metal sheet, the plant being substantially as hereinbefore described with reference to the accompanying drawing.

10. A process for the continuous thermal processing of metal sheet when conducted in plant according to claim 1.

REDDIE & GROSE,
Agents for the Applicants,
6, Bream's Buildings,
LONDON EC4A 1HN.

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1589085 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

