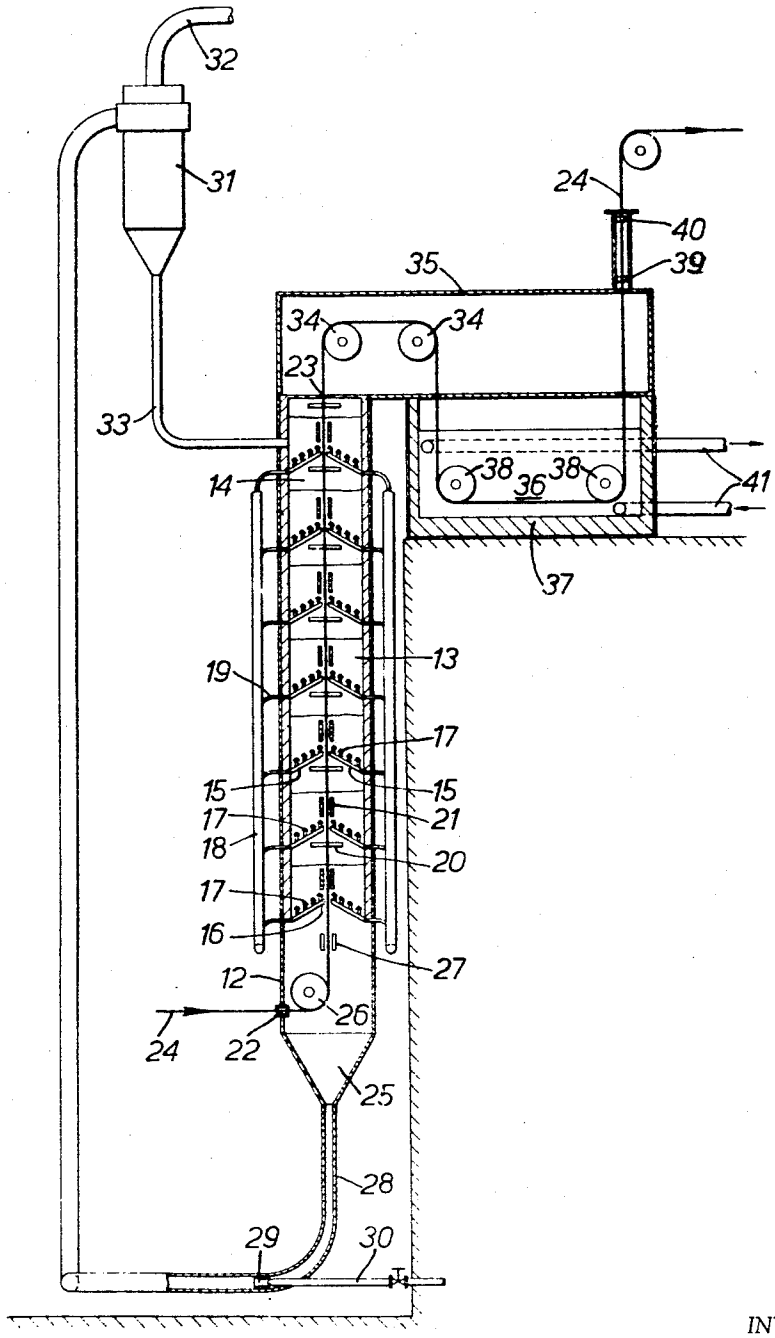
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FLUIDIZED BED HEAT TREATMENT APPARATUS

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# 3,391,915
# FLUIDIZED BED HEAT TREATMENT APPARATUS

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This invention relates to annealing of elongate metallic material. The invention is particularly applicable to the annealing of ferrous strip in which the material is rapidly raised to a sub-critical annealing temperature (approximately 700° C.), a super-critical annealing temperature (approximately 800° C.) or a super-critical annealing temperature (approximately 900° C.) and is then rapidly cooled.

In one aspect the invention provides a method of continuously annealing elongate metallic material in which the material is passed in a substantially vertical direction through a series of fluidised beds in succession, the beds being maintained at progressively increasing temperatures.

In another aspect the invention provides apparatus for continuously annealing elongate metallic material comprising a fluidised bed container having a series of contiguous compartments arranged vertically above one another, means for passing the material through the compartments in succession, and means for maintaining fluidised beds in the compartments at progressively increasing temperatures.

The material may thereafter be rapidly cooled by passing it through a liquid metal bath maintained at a relatively low temperature.

An embodiment of annealing line, in accordance with the invention, will now be described, by way of example only, with reference to the accompanying drawing which shows a section through an annealing line.

Referring to the drawing, a refractory lined, steel, fluidised bed container **12**, of cylindrical form with its axis vertical, is divided into seven compartments **13** by diffuser plates **14**, which also form the basis of the compartments for supporting the bed material. The bed material may be any particulate material, such as sand which can stand the elevated temperatures to which the fluidised beds will be raised and which does not react with the strip **24** to be annealed. Each diffuser plate is formed with a slot **16** to permit passage of the material **24** therethrough. Each diffuser plate is also provided with a plurality of bubble cap jets **17** to which fluidising gas is supplied from main conduits **18** via branch conduits **19**. Each compartment is provided with a gas exhaust vent **20**, connected to a dust separator (not shown). The fluidising gas may be nitrogen or any gas which does not react with the strip being annealed.

Electric heaters **21** are arranged in each compartment adjacent the strip path and arranged to be immersed by the particulate material when in a fluidised state. In operation the heaters are controlled so that the compartments are maintained at different increasingly elevated temperatures along the path of the material. For example the lowest compartment may be maintained at a temperature which will heat the strip to about 200° C., while the uppermost compartment may be maintained at a temperature which will heat the strip to about 800° C., or for a super-critical anneal to around 900° C. The intermediate compartments are maintained at temperatures gradually increasing from the bottom to the top of the container **12**.



Slots **22**, **23** are provided at the top and bottom respectively of the container **12** for entry and exit of the material **24**. The lower portion **25** of the container **12** has a guide roll **26** for guiding the material **24** entering through the slot **22** into the compartments **13**. Gas jets **27** are arranged to blow any particulate material falling from the lowest compartment **13** clear of the guide roll **26** and the strip. The portion **25** is open to an outlet duct **28** in which falling particulate material is collected and passed to an ejector pump **29** from where it is pneumatically transported by a gas stream issuing from a pipe **30** to a cyclone separator **31** having a gas outlet **32** and a particulate material outlet **33** leading to the uppermost compartment **13**.

At the exit end of the container **12** is a further closed container **35** containing a lead-bismuth bath **36**. In operation the lead-bismuth bath is maintained at a comparatively cold temperature, for example 200° C. This may be achieved by circulating the liquid lead-bismuth between a bath and cooling means (not shown) via the pipes **41**. In an alternative arrangement the lead-bismuth may be brought into heat exchange relationship with the fluidised beds. In this way the otherwise waste heat in the lead-bismuth is used to heat the fluidised beds. Above the surface of the lead-bismuth the container **37** is filled with an inert gas such as nitrogen. At the exit of the container **12** guide rolls **34** are provided to reverse the direction of the strip leaving the container, and guide rolls **38** are provided in the bath to guide the material through the bath. Pinch rolls **39**, **40** are provided at the exit of the container **25** to form a seal.

In operation strip **24** enters through the slot **22** passes round the guide roll **26**, through the chambers **13** in which it is heated, over the guide rolls **34**, is quenched in the liquid bath **36**, and emerges through the pinch rolls **39**, **40**.

I claim:

**1.** Apparatus for annealing elongate metallic material comprising a fluidised bed container having a series of contiguous compartments arranged vertically above one another, means for passing the material vertically through the compartments in succession, and means for maintaining fluidised beds in the compartments at progressively increasing temperatures.

**2.** Apparatus according to claim **1** in which the container is divided into compartments by diffuser plates each formed with a slot for passage of the elongated material.

**3.** Apparatus according to claim **2** in which each diffuser plate carries a plurality of bubble cap jets, and including means for applying fluidising gas to the jets,

**4.** Apparatus according to claim **3** in which the means for maintaining the fluidised beds at progressively increasing temperatures comprise heaters immersed in the beds.

**5.** Apparatus according to any one of claim **1** in which the means for maintaining the beds at progressively increasing temperatures are arranged to maintain the beds at temperatures such as to heat the material through the range 200–800° C.

**6.** Apparatus according to any one of claim **1** including a lead-bismuth bath maintained at a temperature of around 200° C. and arranged to receive the material following its issuance from the fluidised bed container.

(References on following page)

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**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,441,500 | 5/1948 | Miess | 266—3 X |
| 3,163,566 | 12/1964 | Jenkins et al. | 266—3 X |
| 3,181,977 | 5/1965 | Sturgeon | 266—3 X |
| 3,197,324 | 7/1965 | Brooks | 118—405 X |
| 3,282,249 | 11/1966 | Ramsay | 118—405 X |

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OTHER REFERENCES

Chemical and Process Engineering, Developments in Applications of Fluidisation, March 1963, pp. 127–131, TPI. C368 (copy in group 322).

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