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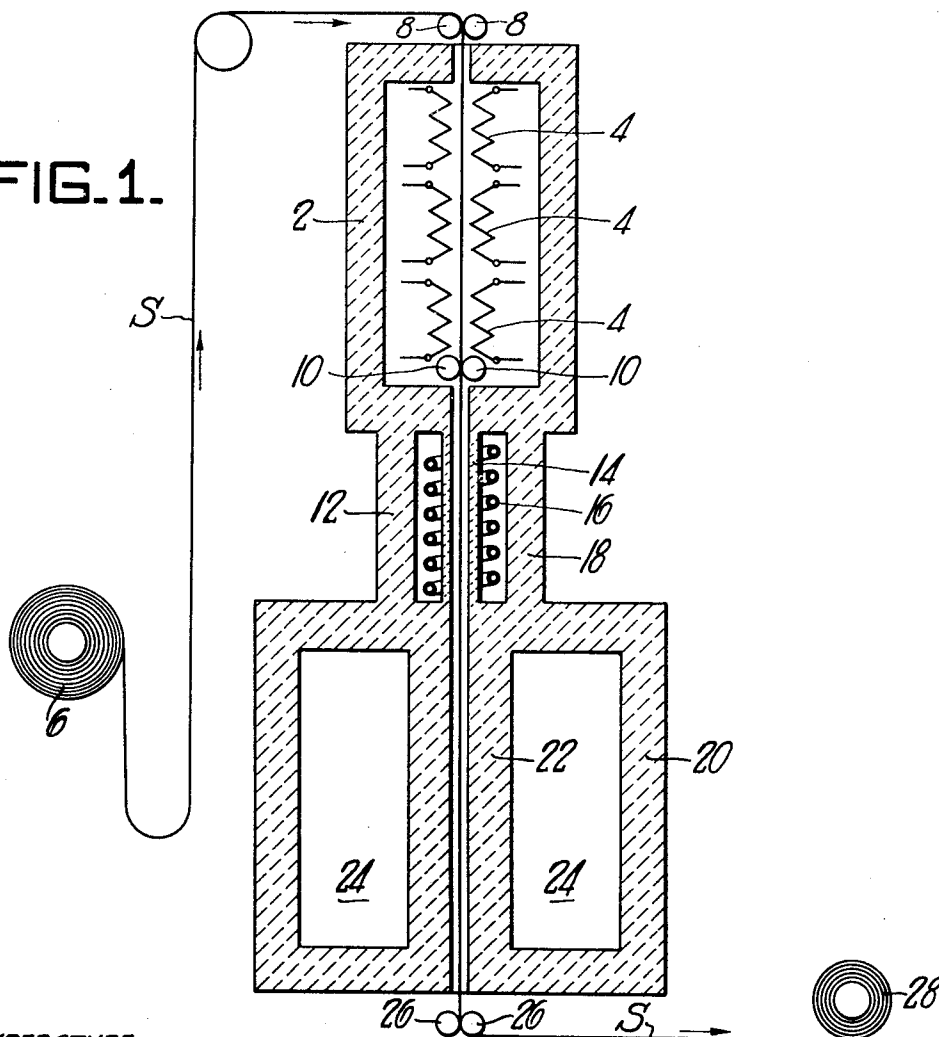
F. MIESS

2,504,440

HEATING CONTINUOUSLY TRAVELING METAL STRIP

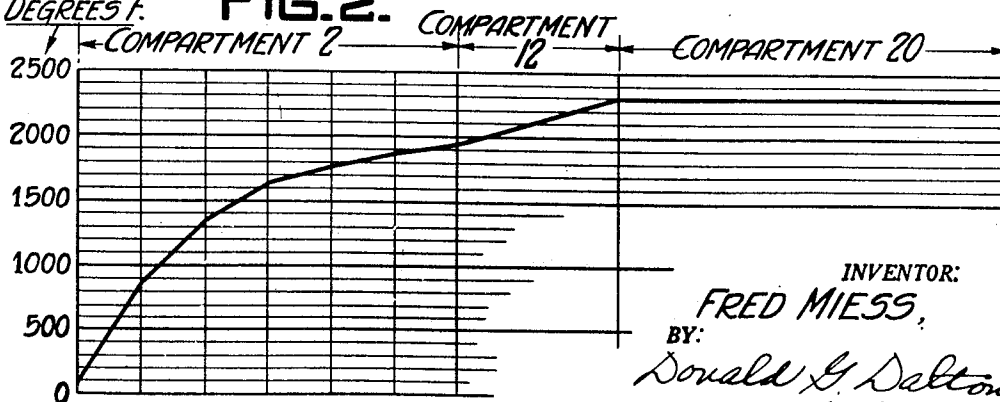
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FIG. 1.



TEMPERATURE
DEGREES F.

FIG. 2.



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HEATING CONTINUOUSLY TRAVELING
METAL STRIP

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Application April 2, 1948, Serial No. 18,544

5 Claims. (Cl. 263—3)

1

2

This application relates to metal heating broadly but is particularly concerned with continuously heating metal strip and is a continuation-in-part of my copending application, Serial No. 528,747, filed March 30, 1944, now Patent No. 2,441,500. One usual way of heating metal strip is to cause the strip to longitudinally travel continuously through a continuous furnace provided with metal heat radiators in the form of either metal tubes inside of which a combustible mixture burns or electric resistance elements. At the present time the metallurgical art cannot provide commercially usable metal, for making these heat radiators, which can safely operate above about 2000° F., so it is impossible to heat the metal to higher temperatures although this would be desirable in some instances. Although higher temperatures might be obtained by burning flames directly inside the furnace in contact with the metal being heated, this is undesirable because it damages the metal being heated. Since presently available furnace refractory materials can be operated safely up to temperatures of 2400° F. and higher, the temperature limiting factor is set by the metal from which the heat radiators must be made.

With the above in mind, the object of the present invention is to provide for heating metal, particularly continuously traveling metal strip to higher temperatures than the metal heat radiators now available can be operated, namely, to temperatures above 2000° F. and, in fact, to temperatures limited only by available furnace refractory materials.

Another object is to provide for the heating of silicon or other alloy steel strip in controlled atmospheres at temperatures above a commercial range of metal radiant heater.

These and other objects will be more apparent after referring to the following specification and attached drawings, in which:

Figure 1 is a schematic sectional view of the apparatus of my invention; and

Figure 2 is a chart showing the temperature of the strip at the various heating stages.

Referring more particularly to the drawings, reference numeral 2 indicates a heating compartment having metal heat radiators 4 therein generally constructed according to prior art principles. The strip S to be heated is continuously fed from a coil 6 by pinch rolls 8 between the heat radiators 4 and then through guide rolls 10 into a second heating compartment 12. In this compartment a relatively thin wall of thermal insulation 14 surrounds the strip S. Heat is sup-

plied to the strip by means of a high frequency inductor 16 which surrounds the wall 14 and the strip S. In some instances it is deemed desirable to provide a relatively thick wall of thermal insulation 18 around the inductor 16. If the wall 18 is omitted, the high frequency inductor coil 16, which may be air or water cooled, will have a temperature not much above room temperature. When the wall 18 is included, the coil 16 will have a temperature intermediate that of the strip S and the surrounding atmosphere. Under these circumstances the I²R loss in the coil would be greater, but this loss would be more than off-set by the reduction of heat loss from the furnace. With this construction it is possible to have the coil 16 close to the strip so that good efficiency is obtained. From the compartment 12 the strip S passes to an open flame compartment 20. In this compartment a wall of thermal insulation 22 is provided between the strip S and the combustion chamber 24. As the strip S leaves the compartment 20, it passes between pinch rolls 26 to a coiler 28. It will be understood that cooling means such as shown in my above identified copending application could be inserted between the pinch rolls 26 and coiler 28.

A curve of typical strip temperatures at various parts of the furnace is shown in Figure 2. As the strip enters compartment 2 it will have a temperature of approximately 100° which will be increased to approximately 1900° by direct radiation in this compartment. In compartment 12 the strip is heated to a temperature of 2300° by means of the high frequency induction coil 16. In compartment 20 no heat is supplied to the strip S, but the temperature will be maintained at 2300° F. This is the soaking zone and heat loss from the strip is prevented by means of the heat in the chamber 24 which is maintained at 2300° F. Since the strip is also at 2300° F., it will be clear that there will be no heat flow through the wall 22. If desired, deoxidizing atmosphere can be delivered to compartments 2, 12 and 20 around the strip S.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A continuous metal strip heating furnace including the combination of heat radiators positioned along its length adjacent its entrance end, said radiators being exposed to the strip, open flame compartments positioned along the length

3

of the furnace adjacent its exit end, a partition between said compartments and the strip traveling path, and a high frequency inductor positioned along the length of the furnace between said metal heat radiators and said open flame compartments.

2. A continuous metal strip heating furnace including the combination of heat radiators positioned along its length adjacent its entrance end, said radiators being exposed to the strip, open flame compartments positioned along the length of the furnace adjacent its exit end, a partition between said compartments and the strip traveling path, a high frequency inductor positioned along the length of the furnace between said metal heat radiators and said open flame compartments, and a wall of thermal insulation between said inductor and the strip traveling path.

3. A continuous metal strip heating furnace including the combination of heat radiators positioned along its length adjacent its entrance end, said radiators being exposed to the strip, open flame compartments positioned along the length of the furnace adjacent its exit end, a partition between said compartments and the strip traveling path, a high frequency inductor positioned along the length of the furnace between said metal heat radiators and said open flame compartments, a relatively thin wall of thermal insulation between said inductor and the strip traveling path, and a relatively thick wall of thermal insulation surrounding said inductor.

4. A method of heating a continuously moving metal strip in a furnace having heat radiators with a limited safe operating temperature maximum, said method comprising heating said radiators to temperatures close to but below their safe operating temperature maximum, passing said strip through said furnace to directly expose said radiators thereto sufficiently to heat the strip to a temperature close to but below

4

said maximum temperature, then passing the strip through a high frequency inductor to raise its temperature to a temperature higher than said maximum while shielding and thermally insulating said inductor from said strip, and then passing said strip through open flame compartments operating at said higher temperature while isolating said strip from said open flames.

5. A method of heating a metal charge in a furnace having a plurality of heat radiating means with a limited safe operating temperature maximum, said method comprising heating said means to temperatures close to but below said maximum, directly exposing said means to said charge to thereby heat said charge to a temperature close to but below said maximum by direct radiation, then passing the charge through a high frequency inductor to raise its temperature to a temperature higher than said maximum while shielding and thermally insulating said inductor from said strip, and then passing said charge through open flame compartments operating at said higher temperature while isolating said charge from said open flames.

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