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CONVECTION STRIP HEATER AND CONTROL THEREFOR

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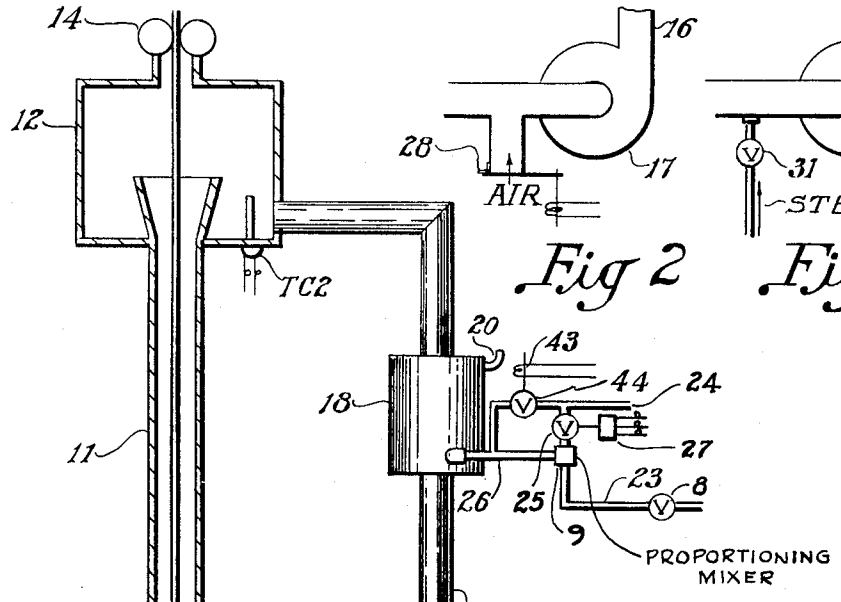


Fig 1

Fig 2

Fig 3

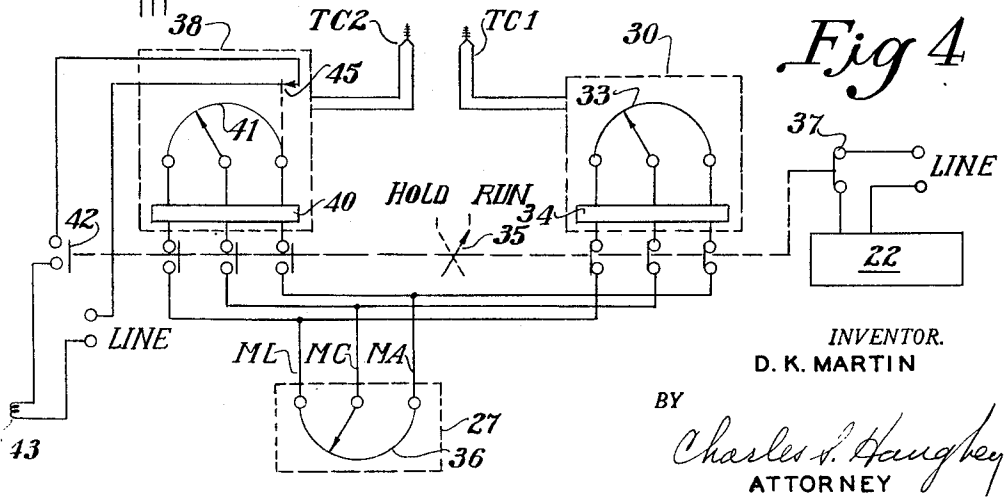


Fig 4

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CONVECTION STRIP HEATER AND CONTROL THEREFOR

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This invention relates to heating of relatively thin material, and more particularly to heating metal such as steel, brass or aluminum in strip form by passing a strand thereof through a duct which constitutes a convection heating zone, and circulating through the duct at high velocity a stream of gas, preferably an atmosphere which will protect the surface of the metal being heated, the gas being at a temperature considerably in excess of the final desired work temperature.

Convection heating of metal strip by application thereto of high velocity streams of gas whose temperature is relatively high is hereafter referred to as high heat head convection heating of strip. In such heating very high heating rates are obtained, and the size of equipment required is substantially smaller and, correspondingly, somewhat less expensive. At the same time unusually uniform treatment in the strip is obtained.

To avoid overheating of the strip in the event of strip stoppage, the mass of the heater is substantially reduced from that of the usual furnace structures, but it is desired also to rapidly reduce the moving gas temperature to safe temperatures. For example, if steel strip is heated to 1200° F. in a convection gas stream which is maintained at 1600° F. it is desirable to rapidly reduce the gas temperature to about 1150 to 1200° F. to avoid locally overheating the steel strip.

For a further consideration of what I consider to be novel and my invention, attention is directed to the drawing, the following portion of the specification and the claims appended thereto.

In the drawing:

FIG. 1 is a schematic representation of a convection heater according to this invention.

FIG. 2 shows an alternate detail for the apparatus of FIG. 1.

FIG. 3 shows an alternate detail for the apparatus of FIG. 1.

FIG. 4 is a schematic diagram of a portion of the control system for the apparatus of FIG. 1.

The convection heater of FIG. 1 comprises a heating duct **11** forming a part of a closed circuit for a convection heating stream of gas, inlet and outlet chambers **12** and **13** for strip passing through the heating duct, entrance and exit roll seals **14** and **15** to seal the atmosphere gas in the closed circuit from outside air, and a recirculating pipe **16** comprising a blower **17** and a heater **18**. Strip is drawn through the heating duct **11** by driving rolls **21** operated by a strip drive motor **22**. Heating gas is circulated in the heating duct and through the closed circuit by the blower, which preferably is a constantly operating blower.

Where flue gas forms a suitable atmosphere for the metal to be heated, as may be the case in many copper base alloys, the heater may be a direct fired type of heater, and a vent, not shown, may be provided for excess atmosphere gas. In many cases, as for example in heating steel strip, an indirect heater will be used and a specially prepared atmosphere gas will be supplied to the closed circuit by an atmosphere inlet pipe, not shown, and flue gas from the heater will be vented from vent **20**.

The heater **18** receives a mixture of fuel and air from proportioning mixer **9** via mixture pipe **26**. Fuel is supplied to proportioning mixer **9** from fuel supply pipe

23 through fuel valve **8**, and air is supplied to proportioning mixer **9** from air supply pipe **24** through proportioning air valve **25**, the proportioning air valve being operated by a proportioning air valve motor **27** responsive to suitable temperature control apparatus. The proportioning unit **9** may be a conventional proportioning mixer, not shown, such as is illustrated in U.S. patent to Barber 1,914,905. The zero pressure gas regulator of such mixers limits the flow of fuel from pipe **23** to a proportion of the volume of air passed by valve **25**.

When moving strip is heated in high heat head apparatus, an interruption in the progress of the strip will necessarily result in overheating of the strip unless the heat head can be eliminated in sufficient time. Toward this end, the heating duct **11** is designed for a minimum of heat storage, although it may be insulated. To provide for eliminating the heat head in the event of strip stoppage, cooling means are provided in the closed circuit, preferably upstream of the blower. This cooling means may take the form of an air inlet damper **28**, as shown in FIG. 2, when the metal strip being heated is not damaged thereby, as in heating aluminum strip, or it may take the form of a steam (or water) jet **31** as shown in FIG. 3 for some copper base alloys not harmed thereby. For steel it may be an indirect cooler such as an indirect water-cooled heat exchanger **32** as shown in FIG. 1, which may be constantly cooled to avoid overheating the heat exchanger. The heat exchanger **32** may be in a by pass duct as is illustrated in patent to Cone 2,479,814 (FIGS. 2 and 3). It is also preferable to interrupt fuel flow to the heater **18** by closing mixture valve **25** and pass only air therethrough by opening valve **44** until the circulating gas stream drops to the desired temperature. In some cases, as when heating relatively thick strip, or metal less sensitive to short over-heating, it may be sufficient to cool by passing air only through the heater, especially in a direct-fired heater, and other cooling means may be dispensed with if such air can be supplied in sufficient volume.

The controls for the apparatus of FIG. 1 include a Run temperature control instrument **30** for controlling the heater **18** responsive to a heat sensing device TC_1, shown as a thermocouple in the outlet chamber **13**. The Run control instrument **30** is of the proportioning control type and its wires ML, MC and MA pass from its slide-wire **33** through its control box **34** to the respective contacts of a strip control switch **35** to the slide wire **36** of the proportioning air valve motor **27**. When the switch **35** is in the Run position and the strip is moving at normal speed, the Run temperature control instrument **30** controls operation of the heater by adjusting valve **25** through motor **27** responsive to the heat sensing device TC_1, the control setting being usually about 400° F. higher than the final desired temperature of the work. The strip switch **35** may be a manual switch which also controls the strip drive motor **22** through contacts **37**, as shown in FIG. 4.

When the strip switch **35** is moved to its Hold position, the Run contacts between the motor **27** and the Run instrument **30** are opened and the wires ML, MC and MA are connected from the motor through Hold contacts in the switch **35** to a Hold temperature control instrument **38**, through its control box **40** to its slide wire **41**. The Hold instrument then controls the motor **27** to operate the heater **18** at a lower predetermined temperature at or below the final desired temperature of the work. The Hold instrument **38** controls the motor **27** responsive to a heat sensing device TC_2 in the inlet chamber **12**. The location of sensing devices TC_1 and TC_2 is largely a matter of choice.

To rapidly cool the recirculating gas upon switching strip switch **35** to Hold, a Hold contact **42** is made to

close a circuit to an air valve solenoid 43 for a valve 44 in a by-pass air line around the proportioning air control valve 25; hence when the controls call for reduced heat due to the lower setting on Hold instrument 38 than maintained on Run instrument 30, contact 45 will be closed, contact 42 will be closed by switch 35, and the valve 25 closes, an air inlet by-pass valve 44 passes cooling air through the heater to supplement the cooling effect of the cooling water coil 32 in the inlet to the blower 17. The by-pass valve 44 is subject to a contact 45 in Hold control instrument 38, so that as the desired temperature range is reached on cooling, instrument 38 goes on to normal temperature control and the by-pass air valve 44 closes.

It is, of course, within the scope of this invention to combine the elements of the control system into a single instrument having alternate temperature control ranges, or to operate both hold and run ranges from a single heat sensing element. It is also contemplated that the shift from Run to Hold may be responsive to an inertia switch 35 associated with a roller 21 on the strip, which switch in turn is operatively connected to the strip drive motor.

When this invention is applied to continuous strip heating the use of expensive looping pits and associated equipment may be dispensed with, since the strip will not be damaged by delays in the furnace. This application is a continuation-in-part of my application Serial No. 475,121, filed December 14, 1954, now abandoned.

I claim:

1. A control system for a high heat head convection heater, which comprises the combination of a convection heating duct, through which metal strip material to be heated is passed; a conduit for circulating gases from the outlet of the duct to the inlet of the duct; blower means for circulating gases through the conduit and the duct; first and second gas temperature responsive means responsive to the temperature of the circulating gases; heating means for supplying heat to the circulating gases; valve means for varying the heating effect of the heating means; a first temperature control instrument for adjusting said valve means responsive to the first temperature responsive means in a manner to provide continuous heating by the heating means to maintain a first and relatively high desired circulating gas temperature; a second temperature control instrument for adjusting said valve means responsive to the second temperature responsive means in a manner to provide continuous heating by the heating means to maintain a second and relatively low desired circulating gas temperature; conveyor means comprising a drive motor for continuously advancing said material through the duct, and means responsive to operation of said drive motor for alternatively connecting said first and second temperature control instruments to respond to said temperature responsive means.

2. A control system for a high heat head convection heater which comprises the combination of a convection heating duct through which metal strip material to be heated is pased; a conduit for circulating gases from the outlet of the duct to the inlet of the duct; blower means for circulating gases through the conduit and the duct; heating means for supplying heat to the circulating gases; valve means for varying the heating effect of the heating means; a first temperature control instrument for adjusting said valve means in a manner to provide continuous heating by the heating means to maintain relatively high circulating gas temperature; a second temperature control instrument for adjusting said valve means in a manner to provide continuous heating by the heating means to maintain a relatively low circulating gas temperature at or below the desired temperature for said material; and means for alternatively operatively connecting said first and second temperature control instruments to said valve means.

3. A control system for a high heat head convection heater which comprises the combination of a convection heating duct through which metal strip material to be heated is passed; a conduit for circulating gases from the outlet of the duct to the inlet of the duct; blower means for circulating gases through the conduit and the duct; heating means for supplying heat to the circulating gases; heating valve means for controlling the effect of the heating means; cooling means for cooling the circulating gases; cooling valve means for varying the effect of the cooling means; a first temperature control instrument for adjusting the heating valve means in a manner to provide heating by the heating means to maintain a relatively high circulating gas temperature; a second temperature control instrument for controlling the heating valve means and the cooling valve means to maintain a relatively lower circulating gas temperature; and selector means for alternatively operatively connecting the first and the second temperature control instruments to said valve means.

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