Nov. 27, 1951 G. W. ASHTON 2,576,169

HEAT TREATMENT OF STRIP METALS

Filed July 27, 1948 3 Sheets-Sheet 1

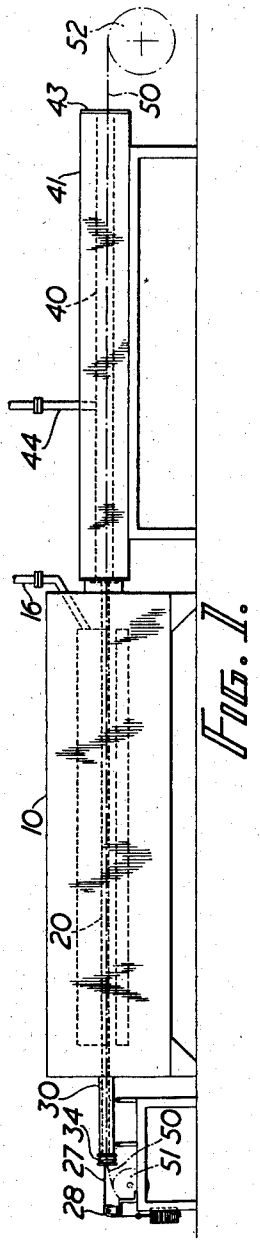


FIG. 1.

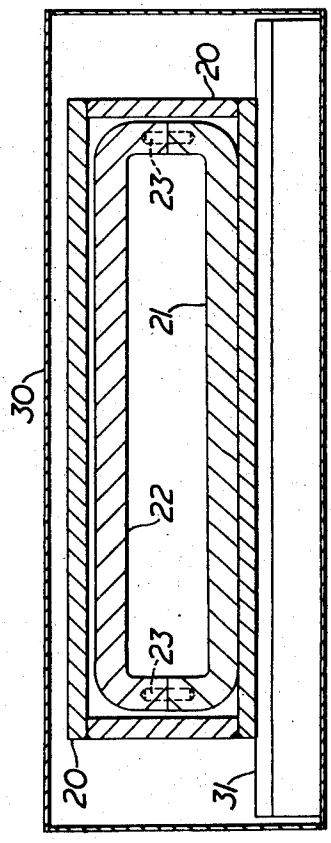


FIG. 5.

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HEAT TREATMENT OF STRIP METALS

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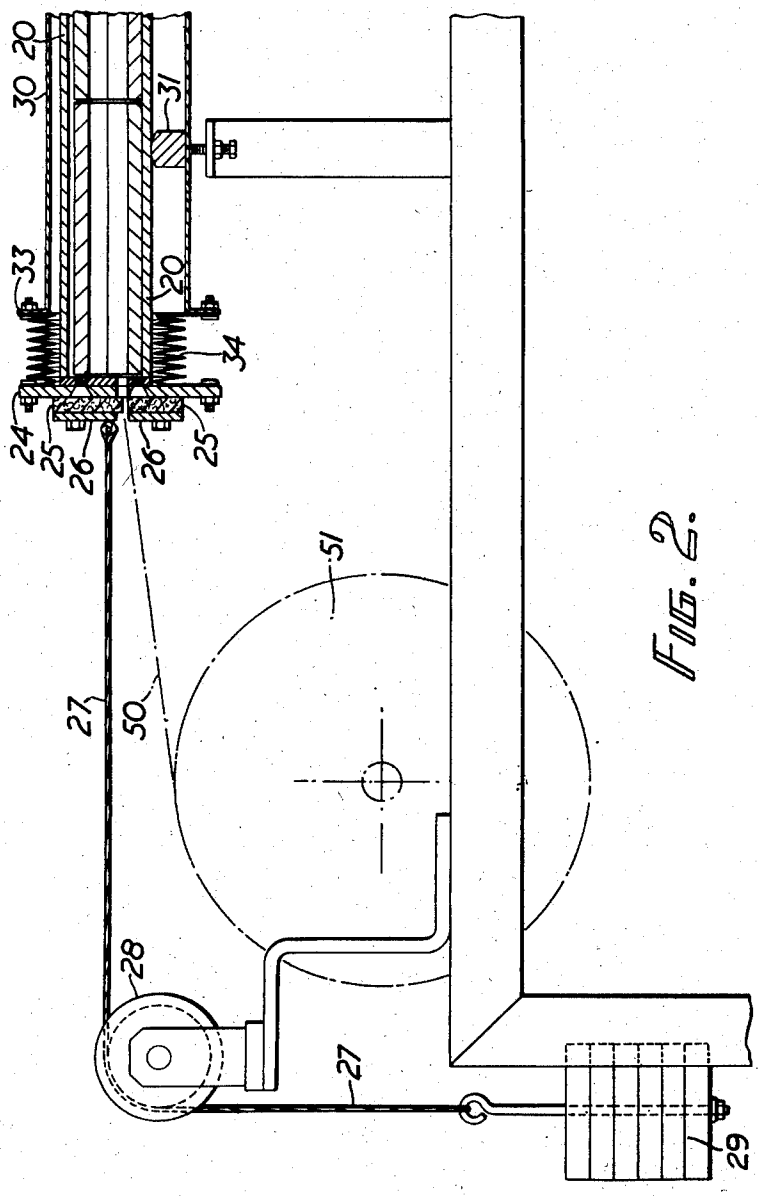


FIG. 2.

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HEAT TREATMENT OF STRIP METALS

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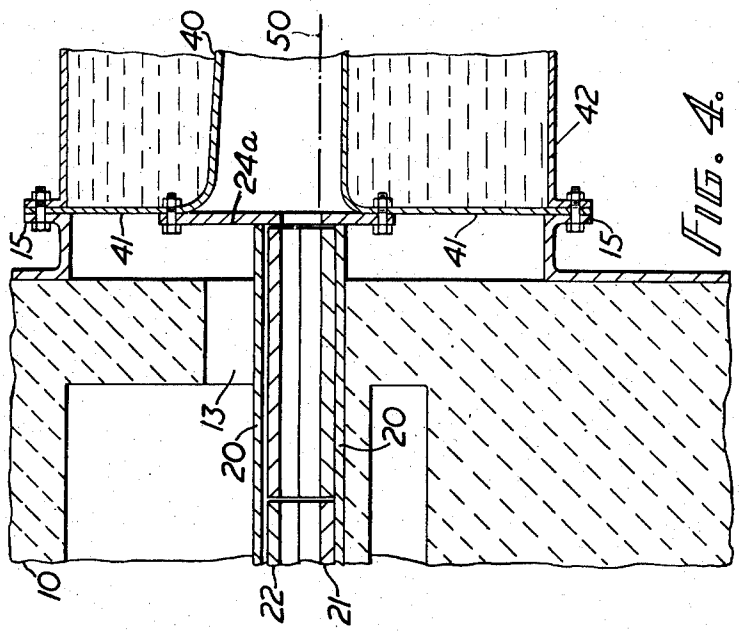


FIG. 4.

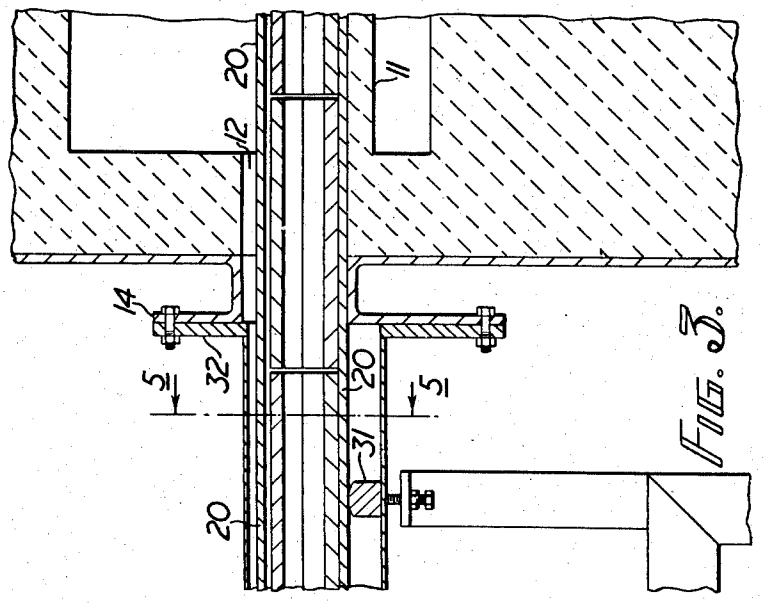


FIG. 3.

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UNITED STATES PATENT OFFICE

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HEAT TREATMENT OF STRIP METALS

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10 Claims. (Cl. 263—41)

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This invention relates to apparatus for the heat treatment of metal strip or wire. In the bright heat treatment of such continuous lengths of metal, the metal is surrounded during its passage through a furnace chamber by an elongated gas tight muffle or furnace tube within which a non-oxidising atmosphere is maintained. The forms of muffle hitherto employed have not proved satisfactory for use at temperatures above about 1000° C. Temperatures in excess of this figure are, however, required for certain heat treatments, for example, the annealing of austenitic stainless steel, and in the past attempts have been made to employ in such operations muffles composed of heat resisting steel and alloy castings and fabrications. These muffles are expensive to manufacture and have not proved satisfactory in operation.

According to the present invention, a muffle or furnace tube for use in the heat treatment of continuous lengths of metal is formed by a tube of mild steel or other metal which is in a semi-plastic condition at the operating temperature and is therefore not liable to break or crack under heating and cooling stresses, as are heat resisting steels which still have a fairly high tensile strength at the operating temperatures. This gas tight tube is supported externally by means which permit longitudinal movement of the tube and internally by blocks of heat resisting material, which may be a heat resisting steel or a refractory material, these internal supports preventing the muffle tube from collapsing at high temperatures. A reducing or neutral atmosphere is maintained inside the muffle tube to prevent oxidation both of the metal being treated and of the inside of the muffle and a similar atmosphere is maintained in the furnace chamber to prevent oxidation of the outside of the muffle. The muffle of the invention is comparatively inexpensive to construct and it remains gas tight at high temperatures over a long period of operation.

A form of apparatus in accordance with the invention is illustrated in the accompanying drawing, in which Figure 1 represents a side elevation of the complete apparatus; Figures 2, 3, and 4 show on an enlarged scale parts of a longitudinal section through the apparatus and Figure 5 shows a cross section taken on the line 5—5 of Figure 3.

The apparatus shown in the drawing includes an electrically heated furnace 10, through which there extends a gas tight muffle or furnace tube 20 of rectangular cross section built up of mild steel plates welded together as best seen in Figure 5. The muffle is not anchored to the furnace but rests upon a flat bed 11 in the furnace which supports the muffle while permitting it to move longitudinally relative to the furnace when it expands and contracts due to temperature changes. The ends of the muffle tube project freely through openings 12 and 13 in the walls of the furnace.

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The muffle tube is supported internally against collapse by blocks 21 and 22 of heat resisting steel. The blocks 21 are channelled on their upper faces and they are disposed in a row end to end with their channels in alignment. The blocks 22 are exactly similar to the blocks 21 and are similarly disposed end to end in a row, but they are reversed in position so that their channels are in their lower faces and register with the channels in the blocks 21. The blocks 21 and 22 thus define a continuous (although not gas tight) tubular passage for the metal to be treated. Each of the blocks 22 is located relative to the block 21 on which it rests by dowel pins 23, so that pairs of blocks can be assembled to form short tubular sections, these sections being then inserted into the gas tight tube 20, in which they fit freely when the tube 20 is in its original uncollapsed condition.

The part of the muffle projecting from the inlet end of the furnace is surrounded by a tubular inlet chamber 30 built up from mild steel plates and is supported within this chamber by mild steel bearers 31 which permit longitudinal sliding movement of the muffle tube. A flange 32 at the inner end of chamber 30 is bolted to a flange 14 in the furnace casing, to form a gas tight joint. A flange 33 at the outer end of the inlet chamber is attached to one end of a leather bellows 34, the other end of which is attached to an end cover 24 secured across the inlet end of the muffle tube 20. The outer end of inlet chamber 30 is thus sealed to the inlet end of muffle tube 20 in a manner which forms a gas tight joint but permits longitudinal movements of the muffle tube caused by expansion and contraction.

The end cover 24 is formed with a slot through which the metal strip 50 to be treated can enter the muffle. Clamped against the outer face of the end cover 24 by means of upper and lower front plates 26 are upper and lower sealing pads 25. The adjacent edges of these sealing pads project across the mouth of the slot in end cover 24, forming lips which resiliently engage the upper and lower surfaces of the metal strip 50 and constitute a substantially gas tight seal at the entrance to the muffle.

The upper front plate 26 of the muffle carries

near its end a pair of eye bolts to which are attached cables 27. The cables pass over pulleys 28 and carry weights 29 so that longitudinal tension is applied to the muffle tube. Any tendency for the muffle tube to buckle under thermal expansion is resisted by the tension so applied and since the mounting of the muffle permits of longitudinal movement relative to the furnace and entrance chamber by which it is surrounded and supported, buckling of the muffle is effectively prevented.

The opposite end of the muffle 20 projects only a short distance outside the furnace wall and is welded to an end cover 24a having an opening of the same size as the passage through the supporting blocks 21 and 22. A mild steel cooling tube 40 aligned with the muffle has a flange 41 at its inner end secured in a gas tight manner both to the end cover 24a of the muffle and to a flange 15 on the furnace casing. The cooling tube 40 is surrounded by a water jacket 42. The outer end of the cooling tube 40 is provided with a gas seal 43, similar in construction to that at the entrance of the muffle tube, through which the metal strip 50 leaves the gas tight enclosure formed by the aligned muffle and cooling tube.

Within this gas tight enclosure a non-oxidising atmosphere is maintained by the introduction, through a pipe 44 connected to the cooling tube 40, of cracked ammonia or other suitable reducing or neutral gas. This non-oxidising atmosphere serves the double purpose of preventing oxidation of the metal strip 50 under treatment and of preserving the interior of the muffle tube itself from attack. While the enclosure formed by the muffle 20 and cooling tube 40 has been referred to as gas tight, some leakage of gas out of it inevitably occurs at the points at which the strip 50 enters and leaves. In order to maintain the original purity of the non-oxidising atmosphere, a slight overpressure is maintained within the enclosure and fresh gas is continuously supplied through pipe 44 to make good all losses. A non-oxidising atmosphere is similarly maintained in the enclosed space within the furance chamber and the inlet chamber and surrounding the muffle tube by the introduction of burnt ammonia or other suitable reducing or neutral gas through the pipe 16 which extends through the furnace wall. This non-oxidising atmosphere protects the exterior of the muffle tube against scaling.

The strip metal 50 to be treated is drawn continuously from a supply reel 51 and passes through the gas seal formed by the sealing pads 25 into the non-oxidising atmosphere in the interior of the muffle. The strip passes through the tubular channel formed by the reinforcing blocks 21 and 22 and during its travel through the furnace chamber is heated to the required temperature. On leaving the muffle tube 20 it passes immediately into the cooling tube 40 and, still in the same non-oxidising atmosphere, is cooled by the surrounding water jacket. The strip leaves the cooling tube through the gas seal 43 and is coiled up on the take-up reel 52.

It will be appreciated that at the operating temperature of the furnace the muffle tube 20 constitutes a more or less flexible envelope so mounted that it can move freely relative to its supports. The tube can therefore yield readily to strains caused by temperature changes, thus largely eliminating the risk of broken welds and ensuring that the tube will remain gas tight.

In itself the tube has relatively low mechanical strength, but it is supported externally by the flat furnace bed on which it rests and is supported internally against collapse by the heat resisting blocks, which retain a fairly high mechanical strength at the operating temperature. The heat resisting blocks, on the other hand, while constituting a substantially continuous support for the gas tight envelope are not rigidly connected together and being each of relatively small size and simple form are not liable to break and crack under heating and cooling stresses as they would be if an attempt were made to connect them together to form a gas tight enclosure.

What is claimed is:

1. An apparatus for heat treatment of continuous lengths of metal, comprising a furnace including a heating chamber, a tube-shaped substantially gas tight muffle disposed within the furnace chamber, said furnace and muffle having an inlet and a discharge opening respectively for passing said lengths of metal through the muffle, said muffle being made of a metal substantially semi-plastic at the operating temperature of the apparatus, internal support means disposed within the muffle independently therefrom for supporting the muffle against sagging, said support means being made of a material remaining substantially rigid at said operating temperature, external support means disposed outside the muffle independently therefrom for supporting the muffle, said external support means being arranged to provide for longitudinal expansion and contraction movements of the muffle relative to the support means, and conduit means to admit a non-oxidizing gaseous medium into the furnace chamber and the muffle for maintaining a non-oxidizing atmosphere in said furnace chamber and in the interior of said muffle.

2. An apparatus as described in claim 1, wherein said muffle tube is formed of mild steel.

3. An apparatus as described in claim 1, wherein said internal support means comprise blocks made of heat resisting steel.

4. An apparatus as described in claim 1, wherein said internal support means comprise a plurality of blocks made of a material remaining rigid at said operating temperatures, each of said blocks having a channeled face, said blocks being arranged within the muffle in two rows, the blocks of each row being disposed end to end with their respective channels in alignment and with the two continuous channels thus formed in registry, the combined cross-section of said two rows of blocks being slightly smaller than the inner cross-section of said muffle tube, thereby forming a substantial tubular passage for the metal lengths to be treated and a substantially continuous internal support for the muffle tube.

5. An apparatus as described in claim 1, in combination with tensioning means including the muffle tube and arranged to exert a longitudinal pull upon the muffle tube.

6. An apparatus as described in claim 1, in combination with means fixedly holding the muffle at one end, and with weight means connected to the other end of the muffle and arranged to exert a tensioning pull upon the muffle in longitudinal direction.

7. An apparatus as described in claim 1, wherein the inlet end of the muffle protrudes from the inlet side of the furnace, and wherein a housing surrounds said protruding muffle end, one side

of said housing being sealed to the furnace and the other to the muffle, and wherein means are interposed between said other housing side and the muffle providing for relative longitudinal movements of the housing and the muffle tube.

8. An apparatus as described in claim 1, wherein the inlet end of the muffle protrudes from the inlet side of the furnace, and wherein a housing surrounds said protruding muffle end, one side of said housing being sealed to the furnace and the other to the muffle, and wherein a bellows surrounding said housing is interposed between said other housing side and the muffle providing for relative longitudinal movements of the housing and the muffle tube.

9. An apparatus as described in claim 1, wherein the inlet end of the muffle protrudes from the inlet side of the furnace, and wherein a housing made of mild steel surrounds said protruding muffle end, one side of said housing being sealed to the furnace and the other to the muffle, and wherein internal support means made of mild steel are disposed within said housing and arranged to support said protruding muffle end, and wherein means are interposed between said other housing side and the muffle providing for relative longitudinal movement of the housing and the muffle tube.

10. An apparatus as described in claim 1, wherein said internal support means are made of refractory material shaped to conform substantially to the inner cross sectional area of said muffle.

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