

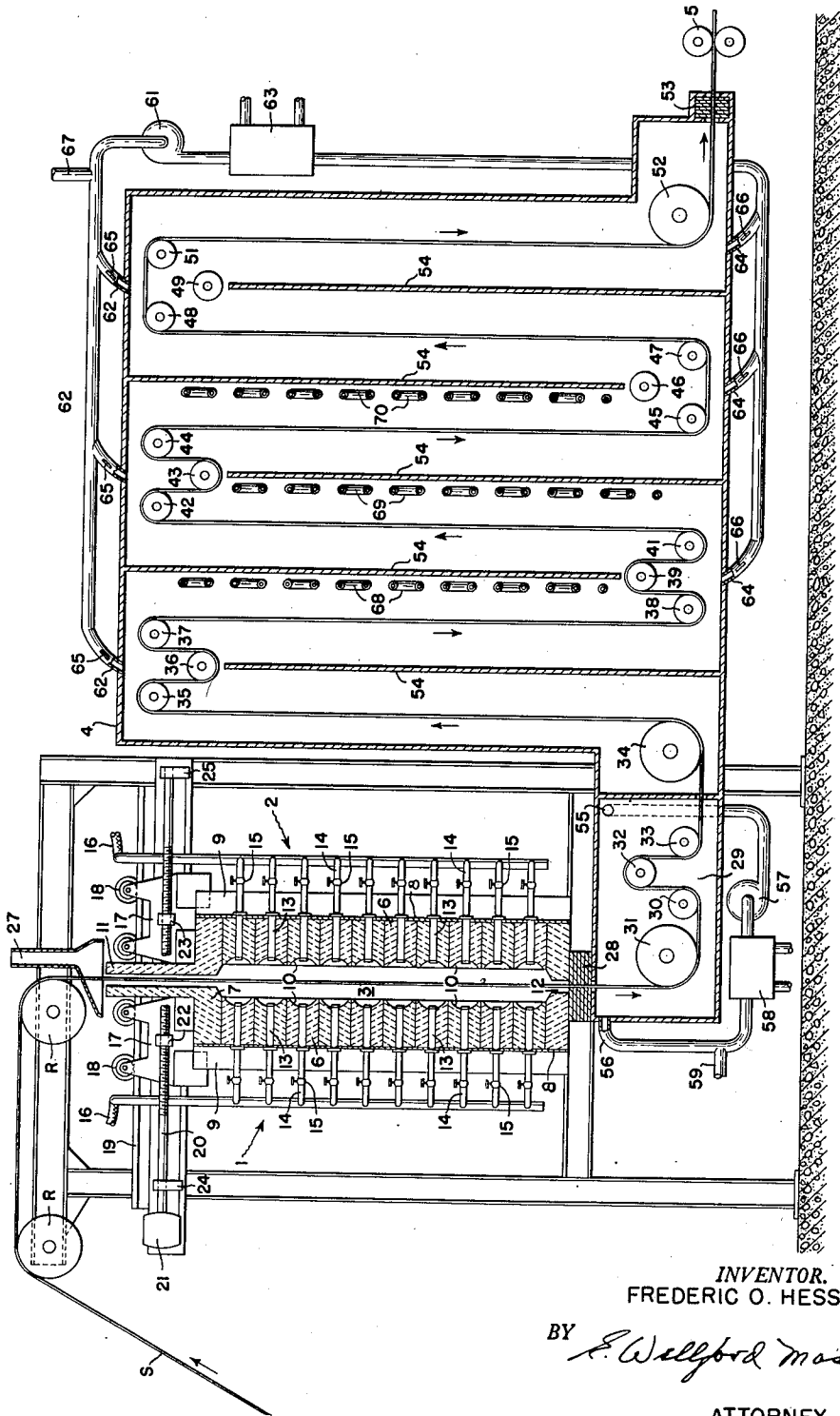
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STRIP METAL HEAT TREATING

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STRIP METAL HEAT-TREATING

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The present invention relates to the continuous heat treatment of strip metal, and more particularly to the hot working of metal strip as it is being cooled during an annealing process.

With the present invention metal strip is heated continuously to a temperature above the critical and passed immediately into a cooling zone. As the strip is being cooled it is passed over a series of flexing rolls of relatively small diameter that serve to bend the strip in reverse directions as it is being cooled. The cooling takes place in a cooling chamber in which the rolls are mounted, and the chamber is filled with a neutral atmosphere so that the surface of the strip will not be oxidized while the cooling is taking place.

It is an object of the invention to heat and then to cool continuously a strip of metal, and to hot work the metal while the cooling is taking place. It is a further object of the invention to pass a continuously moving heated strip around a series of flexing rollers while the strip is being cooled.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

The single figure of the drawing shows a sectional view of the apparatus of the invention.

The strip S is supplied from some suitable source of supply, such as a roll, in a continuous manner over a pair of guide rolls R and through a heating furnace including a pair of panels 1 and 2, which together form a furnace chamber 3. From this furnace the strip is passed through a cooling tower 4 in which a controlled cooling of the strip takes place. The strip is pulled through both the furnace and the cooling tower by means of a pair of pinch rolls 5 that are located on the exit side of the cooling tower, and is passed by the pinch rolls to suitable take-up means which may well be a re-rolling device from which the strip is sent to storage or further working apparatus.

Each of the furnace panels is similarly made and comprises a number of burner blocks 6 that are placed in the panel in a manner to give the desired heat pattern to the strip while it is being heated. Between the burner blocks and at the

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upper and lower portion of the panels there are provided refractory bricks 7 to complete the furnace chamber. The burner blocks and bricks are backed up, as in conventional furnace practice, by means of sheet metal work 8 that is supported by structural steel members 9. The entrance of the furnace chamber is contracted and extended upwardly as shown at 11, above the steel work so that the steel will be protected from the heat of the exhaust gases passing out of the furnace. The exit of the furnace is also contracted below the furnace chamber as at 12 to form a narrow exit slot.

Each of the burner blocks has formed in its face toward the strip a cup 10 into which projects the end of a distributor 13. A suitable combustible mixture of gas and air is forced through the distributors where it is burned in the cups to heat these cups to incandescence so that they will supply radiant heat to the strip passing in front of them. Convection heat is also supplied by the hot products of combustion as they pass around the strip toward the exit. The rear ends of the distributors for each panel are connected by suitable piping 14 to a flexible supply pipe 16 extending to a mixing machine or other device for supplying the combustible mixture to the burners. A valve 15 is provided in the piping leading to each distributor 13 so that the individual burners may be adjusted to give the desired amount of heat for the particular portion of the strip upon which they are directed.

The furnace panels can be moved toward and from each other in order to vary the intensity on the strip of the radiant heat that is produced by the burner cups, to thereby vary the heat put into the strip. To this end, each of the panels is provided on each side of its upper end with a hanger 17 that has rollers 18 on it. These rollers or wheels run on tracks 19 that are suitably fastened to the framework of the furnace. The panels are moved toward and from each other by a shaft 20, the ends of which are reversely threaded, which shaft is rotated in one direction or the other by a motor 21. The hanger 17 for panel 1 has upon it a threaded member 22 while the hanger for panel 2 has a threaded member 23 through which the shaft is threaded, and the ends of the shaft are supported on the framework in bearings 24 and 25 respectively.

In the operation of the furnace a combustible mixture of gas and air is supplied through the pipes 16 and the piping 14 to the various distributors 13. This mixture is burned in the cups 10 to produce a high temperature radiant heat

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and high temperature gases of combustion. Normally the supply of fuel to each of the furnace panels will be regulated so that the temperature produced in the furnace chamber will be constant and the temperature of the strip may be predetermined by the position of the panels relative to the strip. The temperature to which the strip is heated can be varied by moving the panels toward and from each other or, for a given panel position and temperature, varying the speed of the strip. The hot products of combustion are withdrawn through the entrance 11 of the furnace chamber into a hood 27 on one side of the right guide roller R. This hood is provided with a slot through which the strip passes on its way to the furnace chamber.

As the strip leaves the furnace it goes through a seal 28 and into a first chamber 29 of the cooling tower 4. The strip passes over a guide roller 31, the periphery of which is directly in line with the exit 12 of the furnace chamber, and in a U-bend around a set of flexing rollers 30, 32 and 33 to a second guide roller 34 that is located in the cooling tower proper. The flexing rollers 30, 32 and 33 are of a relatively small diameter so that the strip will be flexed to an extent approximately its elastic limit as it is passing around these rollers.

From the guide roller 34 the strip moves upwardly into the cooling tower proper. Located in the cooling tower are a number of guide rollers which direct the strip through a series of vertically disposed loops. These guide rollers are indicated at 35 and 37 for the first loop and at 38 and 41 for the bottom of the second loop, for example, and are spaced apart a distance approximately equal to the diameter of one of the rolls. Located between the guide rollers 35 and 37 is a flexing roller 36 and between guide rollers 38 and 41 is a flexing roller 39. In a like manner there are provided guide rollers 42 and 44 which have flexing rolls 43 between them and guide rollers 45 and 47 which have a flexing roller 46 between them. The last pass or loop that the strip goes over is guided by rollers 48 and 51 which have a flexing roller 49 between them. The strip then passes vertically downward and around the guide roller 52 to the exit of the cooling tower. There is provided a seal 53 through which the strip moves and which serves to prevent entrance of air to the cooling tower. Each pass of the strip as it moves through the cooling chamber is separated from each other pass by a partition 54 to control better the cooling.

In practice guide rollers 31, 34 and 52 will usually be about fifteen inches in diameter, and the remaining guide rolls and the flexing rolls will be about four inches in diameter.

In order to prevent oxidation on the surface of the strip as it is being cooled it is necessary to provide a neutral or reducing atmosphere in the cooling tower. If the strip has been heated so that there is no oxidation on its surface then only a neutral atmosphere is required in the cooling tower. If however, the strip has been heated so that a thin film of oxide is placed on its surface, a reducing atmosphere will be necessary. Provisions are made for supplying a suitable atmosphere to the chamber 29 through an inlet 55 and an outlet 56. The atmosphere is forced through the chamber by means of a pump or blower 57. Usually the atmosphere will absorb so much heat from the strip so that some type of conditioning mechanism 58, such as a conventional radiator may be inserted in the cooling line to reduce its temperature. An inlet 59 is inserted

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in the pipe in front of the conditioning mechanism in order to supply make-up atmosphere as the same is lost for various reasons, such as leakage to the furnace through seal 28, and to the main portion of the cooling tower. The atmosphere supplied to chamber 29 can be reducing in nature if it is necessary but ordinarily it will be a neutral atmosphere.

Means is also provided for circulating a neutral atmosphere through the cooling tower or chamber proper to protect the strip and help control the cooling gradient. To this end there is provided a pump 61 which removes atmosphere through a series of outlets 62 that are formed in the cooling tower adjacent to each of the series of guide rollers. The pump forces the atmosphere through a conditioning device 63 similar to that disclosed at 58 and through inlets 64 at the bottom of the cooling tower. These inlets are also located adjacent to the guide rollers which form the ends of the loops. Dampers 65 are provided in the outlets 62 and dampers 66 are provided in the inlets 64 so that the desired flow of the atmosphere may be obtained between each of the loops. In order to assist in the proper cooling of the strip as it is moving through the cooling tower, and to help control the cooling gradient of the strip there are provided a series of cooling coils 68, 69 and 70 that are located between various passes of the strip and the adjacent partitions. These cooling coils have circulated through them some cooling medium, such as water, and will therefore have an effect on the rate of cooling of the strip that may be varied by varying the amount of cooling water that is circulated through each coil.

In the operation of the system as a whole, the strip is passed through the furnace chamber 3 where it is heated to the desired temperature, which is usually in the range of 1400° F. to 1600° F. Normally the fuel supplied to the furnace is maintained constant so that the furnace will be held at some desired temperature. The temperature to which the strip is heated will be determined by a number of factors, such as the distance between the burner cups 10 and the strip; the speed of the strip and the supply of fuel. These variables can be determined empirically and after they are thus determined the system will remain in adjustment during the time that a particular type and weight of strip is being heated. The strip passes from the furnace through seal 28 into the primary chamber 29 of the cooling tower. Thereafter the strip passes around the guide roller 31 and through the various loops until it leaves the cooling tower at seal 53 at a temperature below that at which surface oxidation will occur and preferably not higher than 300° F. While the strip is passing over and between the guide rollers it is led around various of the flexing rollers in order to give a hot working effect to the strip. As shown herein, the strip is directed in a number of reverse bends around flexing rollers 30, 32, 33, 36, 39 and 43. The quality of the strip may be varied by varying the number of flexing rollers over which the strip is passed. In accordance with the invention the strip can be passed directly from guide roller 31 to guide roller 34 and from guide roller 35 to guide roller 37, for example, and can be passed around flexing roller 46 between guide rollers 45 and 47 if it is so desired. The ultimate effect on the properties of the strip which is produced by the flexing rollers will be dependent upon which of the flexing rollers the strip is passed around. For ex-

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ample, the further through the cooling tower the strip moves the less hot working effect will be produced by a given set of flexing rollers. Therefore if the strip is to be worked more while it is hot than while it is cool the arrangement will be similar to that shown in the drawing. If, however, the strip is to be worked more when it is cooler, it can be passed directly from guide roller 31 to guide roller 34 and from guide roller 35 to guide roller 37, and can be passed around the flexing rollers 46 and 49. Usually most of the working of the strip takes place while it is above 800° F. In any event, a hot working effect is produced on the strip as it is moved in the reverse bends around the flexing rollers during its passage through the cooling tower. The amount of working will be determined to some extent by the temperature to which the strip is initially heated in the furnace.

From the above description it will be seen that I have provided a mechanism for continuously working on a strip while it is being heated and cooled. The arrangement is such that various desired properties can be obtained in the strip depending which of the flexing rollers it is passed around during the time it is moving through the cooling chamber.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention, as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. A cooling tower for cooling a strip of material that is being passed continuously therethrough including a series of guide roll means located in said tower in positions relative to each other to direct the strip in a series of loops, partition means in said tower substantially to separate each pass of the strip as it is travelling through the loops, said guide roll means including a pair of guide rolls at each end of each loop, flexing rolls located between and off set from each pair of said guide rolls, said flexing rolls being so located that as the strip passes between the guide rolls and around the flexing rolls it will be moved in a series of relatively abrupt U-bends at the ends of the loops, and means to control the rate of cooling of the strip as it moves between said guide rolls.

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2. A cooling tower for cooling a strip of heated material that is being passed therethrough, guide rolls in said tower to guide said strip in a series of loops as it passes through said tower, said guide rolls being located in pairs at the ends of each loop, the rolls of each pair being spaced apart approximately a distance equal to the diameter of one of said rolls, a flexing roll between each pair of guide rolls and being so located with respect to each pair of guide rolls that the strip passing around one guide roll of a pair, a flexing roll and the other guide roll of said pair will be directed in a series of abrupt reverse bends at the end of the loops.

3. A cooling tower for cooling a strip that is moved continuously therethrough, means to guide the strip through said cooling tower in a series of loops of substantial length, said guide means at the ends of one loop including three rollers so positioned that their axes form a triangle with the apex thereof located between the sides of the loop formed thereby whereby the strip moving around said rollers will travel in a series of reverse bends while moving from one side of a loop to the other side thereof.

4. In apparatus for continuously cooling heated strip material, the combination of a cooling chamber, a first guide roll around which the hot strip passes before it reaches said chamber, a second guide roll around which said strip passes as it enters said chamber, flexing rolls between said guide rolls and so located with respect thereto that the strip will be directed in a U-bend as it moves from the first to the second guide roll, additional guide rolls in the cooling chamber to direct the strip in a series of vertically disposed loops, and flexing rolls located adjacent to the guide rolls at the end of each loop to direct the strip in a series of reverse bends at the end of each loop.

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