

Sept. 7, 1948.

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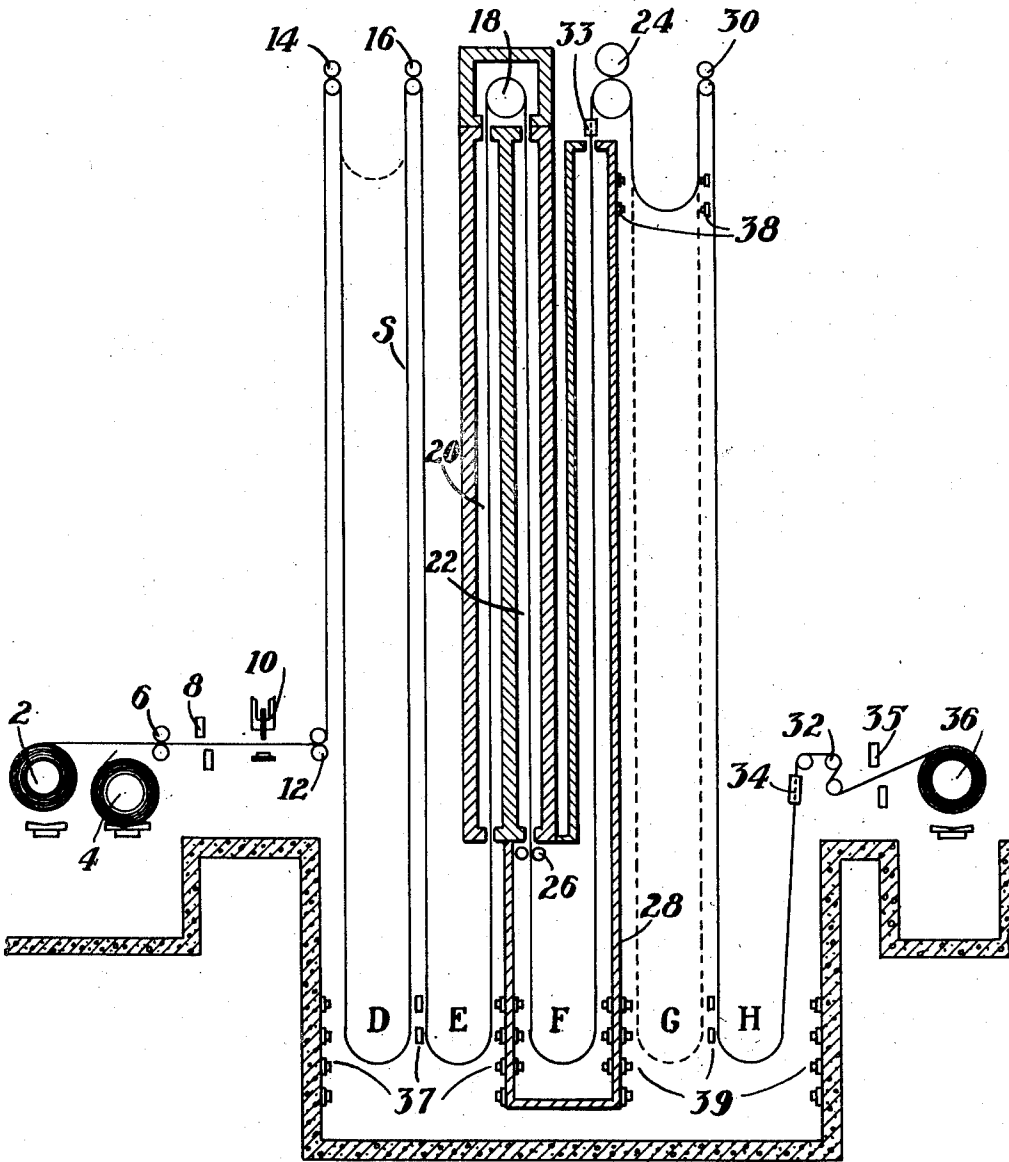
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APPARATUS FOR CONTINUOUSLY PROCESSING STRIPS

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3 Sheets-Sheet 1

Fig. 1.



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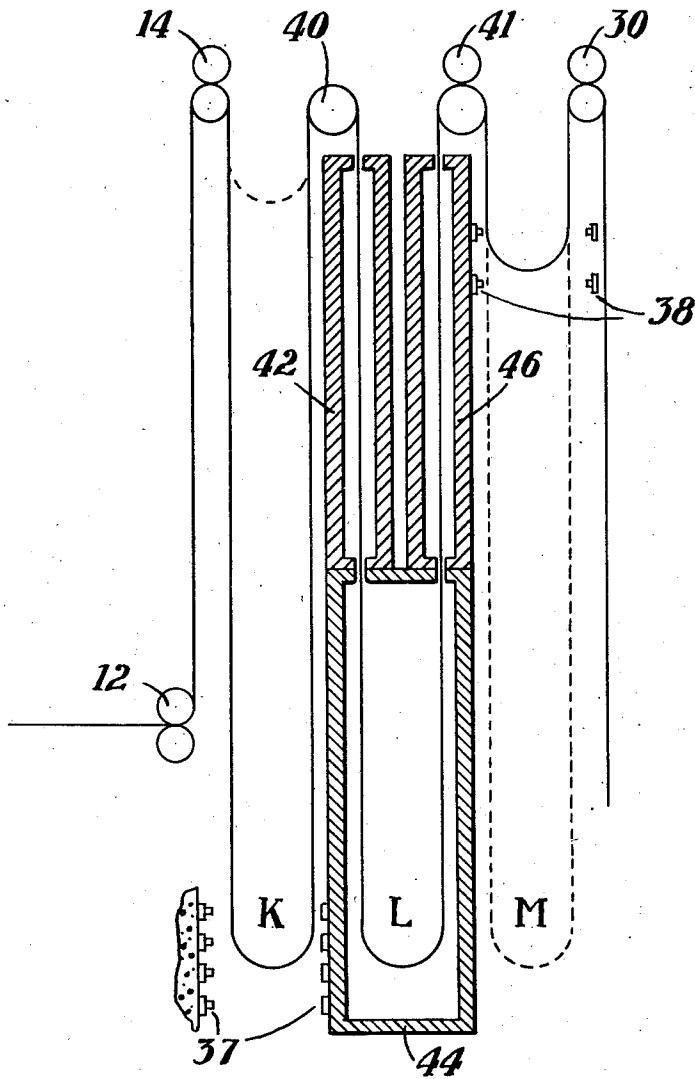
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Fig. 2.



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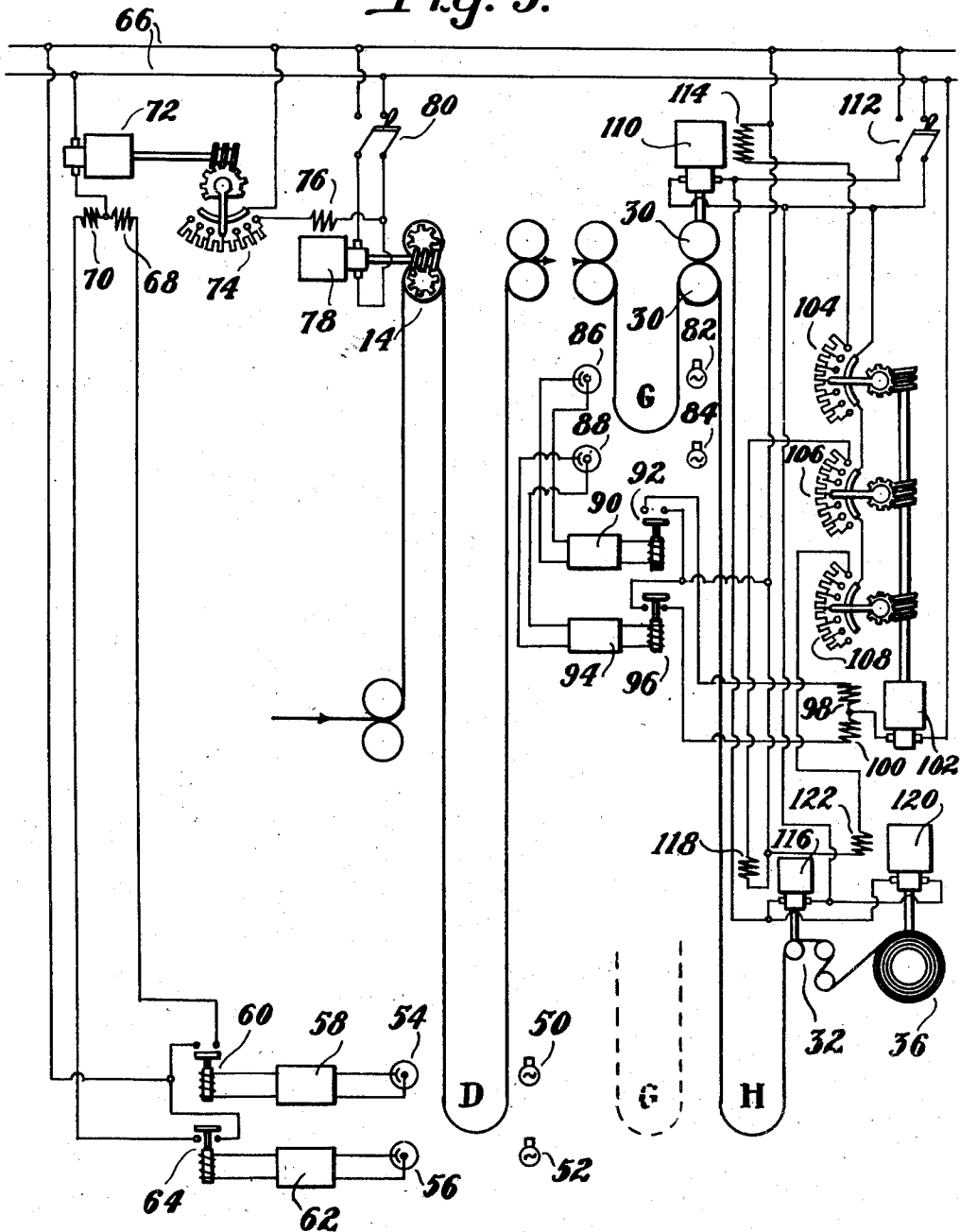
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Fig. 3.



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APPARATUS FOR CONTINUOUSLY PROCESSING STRIPS

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3 Claims. (Cl. 266—3)

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This invention relates to a method and apparatus for continuously processing strip and especially for continuously annealing or heat treating strip in a vertical furnace. Continuous metallic strip is commonly heat treated in a horizontal furnace, but such furnaces occupy considerable floor space and have other objections. For example, the usual practice is to provide long horizontal heating and cooling zones for the strip which is supported on and fed by revolving rolls. In such apparatus the strip sags between the rolls and is subjected to tension and stretching while hot. To avoid difficulties inherent in horizontal heat treating, equipment has been designed in which the strip material is positioned vertically during heating and cooling. Most of these arrangements include tensioning the strip by mechanical means in order to move the strip in the desired path of travel and, since the strip is heated while under tension, it will stretch in the same manner as when annealing in a vertical furnace. The present trend is to heat treat the strip at as high a speed as possible and this aggravates the stretching of the strip under tension.

It is an object of my invention to provide heat treating apparatus in which the strip is heated while untensioned.

Another object is to heat the strip while unsupported.

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

Figure 1 is a schematic view showing one embodiment of my invention;

Figure 2 is a fragmentary schematic view of a second embodiment of the invention; and

Figure 3 is a schematic wiring diagram showing the operation of devices 37 and 38.

Referring more particularly to the drawings, the reference numeral 2 indicates an uncoiler for supporting a coil of strip S to be treated. A second uncoiler 4 is located adjacent to and between the first uncoiler and the furnace in line with the strip as it is fed from the first uncoiler 2. Pinch rolls 6 feed the forward end of the strip from a new coil to the shears 8 and welder 10, the shears being used to trim the ends of the coils of strip before they are welded together by means of the welder 10. The strip S passes from the welder 10 through the pinch rolls 12 and then is pulled upwardly by means of a pair of power driven rolls 14. A second pair of rolls 16 is provided at the same level as rolls 14 and a loop D is formed between the two pairs of rolls. A second loop E

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is formed in the strip between the rolls 16 and a water cooled roll 18. As the strip passes upwardly in the second loop, it passes through a pre-heating furnace 20 where it is heated from room temperature to a temperature of approximately 800° to 1000° F. From the roll 18 the strip passes downwardly through a heating furnace 22 and a third loop F is formed between roll 18 and pulling rolls 24. As the strip leaves the furnace 22, at a temperature of from 1100° to 1350° F., it passes between guide rolls 26 to a cooling chamber 28 where the strip is cooled to a temperature of between 250° and 900° F. The rolls 26 are driven at strip speed and are spaced apart a greater distance than the thickness of the strip so that they do not contact it intimately. However, the distance between the rolls is less than the width of the exit portion of the furnace 22 so that the rolls prevent scratching of the strip surface by contact with the exit portion of the heating furnace 22 or the sides of the cooling chamber 28. A fourth loop of strip G is formed between the rolls 24 and pinch rolls 30 and a fifth loop H is formed between the rolls 30 and tension rolls 32. Side guides 33 are provided for the strip prior to its entry into the rolls 24 and similar guides 34 are provided on the entry side of rolls 32 to keep the strip in the desired lateral path. From the tension rolls 32 the strip passes through the shears 35 to the coiler 36. Conventional photoelectric tube arrangements or similar devices 37 are provided for maintaining loop D in full line position and similar devices 38 maintain loop G in elevated position. The remaining loops are also maintained in position by photoelectric cells 39 in a well known manner, which does not constitute part of the present invention.

The operation of the devices 37 and 38 is shown in Figure 3. To control loop D there is an upper light source 50 and a lower light source 52 at one side of the loop and an upper photoelectric cell 54 and a bottom photoelectric cell 56 at the opposite side of the loop, these constituting the photoelectric tube arrangement 37 for loop D. Photoelectric cell 54 is connected through a suitable amplifier 58, such as Westinghouse Electric's "Photo-Troller," to a relay 60 which is so arranged that it closes its contacts when light to the photoelectric cell 54 is unobstructed by loop D. Photoelectric cell 56 is connected in like manner through an amplifier 62 to a relay 64 which is so arranged that its contacts will close when light is obstructed by loop D. When either relay 60 or 64 is closed, a circuit from a power source 66 is completed to one of the reversely

wound series field windings 66 and 70, of motor 72 which controls the position of the arm of rheostat 74. Rheostat 74 is connected in the circuit of field winding 76 of the motor 78 which drives roll 14. The armature of motor 78 is energized from power source 66 through the switch 80.

It will be seen that as long as the strip is being fed into the loop D at the same speed as that at which it is being withdrawn, the length of the loop will not change and the resistance of rheostat 74 will remain constant. If the loop becomes too short, the photo-electric cell 54 will be exposed to its light source 50, causing energization of relay 60, which closes the circuit to motor 72 through field winding 66 and rotates the motor 72 in a direction which will shift the rheostat arm to weaken the field produced by winding 76 of motor 78. This increases the speed of motor 78 and causes the loop to resume its normal position. Conversely, if the loop becomes too long, the lower photoelectric cell 56 will be shadowed by the loop D and relay 64 will be energized to complete the circuit to motor 72 through field winding 70, causing the motor to run in the opposite direction. This changes the resistance of rheostat 74 so that the field produced by winding 76 is strengthened, whereby motor 78 runs at a decreased speed and the loop is shortened until it resumes its normal position. When renewing coils, switch 80 is opened, this stopping rotation of motor 78 and roll 14, whereupon loop D rises completely out of the control zone of photoelectric device 37. After the new coil is in operating position, switch 80 is closed, starting motor 78 and rolls 14 at the increased speed demanded by photoelectric cell 54. This increased speed continues until loop D returns to its normal position.

The photoelectric tube arrangement 38 consists of a top light source 82 and a bottom light source 84 located on one side of loop G and photoelectric cells 86 and 88 located on the opposite side. Photoelectric cell 86 is connected through an amplifier 90 to a relay 92 which is so connected that its contacts are closed when light is unobstructed by loop G. Photoelectric cell 88 is connected in like manner through an amplifier 94 to a relay 96 which is so connected that its contacts are closed when light is obstructed by G. Closing the contacts of either relay 92 or 96 completes a circuit to one of the reversely wound series fields 98 or 100 of motor 102 which controls the position of the arms of rheostats 104, 106 and 108. Motor 110 which drives roll 30 has its armature circuit energized from power source 66 through a switch 112 and its field winding 114 connected to voltage source 66 through rheostat 104. Motor 116, which drives the tension rolls 32, has its armature energized from power source 66 through switch 112 and its field winding 118 connected to power source 66 through the rheostat 106. Motor 120 which drives the recoiler 36 has its armature circuit energized from power source 66 through switch 112 and its field winding 122 connected to power source 66 through rheostat 108.

It will be seen that as long as the strip is withdrawn from the loop G at the same rate of speed as it is being fed, the length of the loop will not change. Should loop G become too short as happens when the withdrawal speed is too fast, the photoelectrical cell 86 will be exposed to its light source 82, causing energization of relay 92, which closes the circuit to motor 102 through field wind-

ing 100, causing the motor to rotate in a direction to shift the rheostat arms so as to strengthen the fields 114, 118 and 122 of their related motors, thus decreasing their respective speeds. If loop G becomes too long the lower photoelectric cell 88 will be shadowed and relay 96 will be energized closing the circuit to motor 102 through field winding 98, thus causing the motor to rotate in a direction to shift the rheostat arms so as to weaken fields 114, 118 and 122 of their related motors, thus increasing their respective speeds until loop G resumes its normal position. When it is desired to change coils, switch 112 is opened which stops motors 110, 116 and 120, whereupon the loop G lengthens and drops completely out of the control zone of photoelectric device 38. After the processed coil is removed and a new coil started on the recoiler 36, switch 112 is closed to start motors 110, 116 and 120 at the increased speed demanded by the photoelectric cell 88. This continues until loop G assumes its normal position.

The operation of the device is as follows:

With the processing line operating normally, the various loops are in the positions shown in full lines in Figure 1. At this time power driven rolls 14, 16, 18, 24, 26 and 30 are being driven at strip speed. The uncoiler 2 is providing just enough back tension to control the strip movement and the tension rolls 32 are providing sufficient pull tension for efficient recoiling of the treated strip by the coiler 36. It will be seen that the rapidly moving and heated strip in loops E and F is not subjected to any applied tension and the only tension existing in the strip is that due to the weight of the strip in the loops. When positioning a new coil of strip the uncoiler 2 and rolls 14 are stopped and that part of the equipment located in the line after the rolls 14 continue to operate at line speed, the strip stored in loop D supplying the necessary material until a new coil is positioned and fastened to the end of the preceding strip. Prior to exhausting the strip on uncoiler 2, a second coil of strip is mounted on uncoiler 4 and after the rolls 14 are stopped and the trailing end of the first strip squared by shears 8, the strip is entered from uncoiler 4 through pinch rolls 6 to the shears 8 which square the leading end of the strip. The ends of the coils of strip are then welded together by the welder 10. This trimming and welding operation is that which is commonly used to weld strips end to end in various processing operations and as such does not constitute part of my invention. After the ends are welded together, the rolls 14 are started and rotated faster than the other rolls in order to restore loop D to its original position as controlled by the electrical devices 37, after which uncoiler 4 and rolls 14 will automatically assume synchronization and speed relationship with the remaining rotating units of the line. It will be understood that the speed of rolls 14 and the length of loop D could be controlled manually, but it is not desired to do so since such manual operation requires constant attention.

When removing a treated coil from coiler 36, the pinch rolls 30, tension rolls 32 and coiler 36 are stopped and the strip is cut in two by the shears 35. The treated coil is removed and the sheared end of strip is threaded into the mandrel of the coiler 36 in the usual manner. During this time the treated strip coming from rolls 24 will accumulate in the loop G as shown in dotted lines. As soon as the strip is fastened to coiler

36, rolls 30 and 32 and coiler 36 are started in operation at a speed faster than line speed until loop G again resumes the position shown in full lines in Figure 1. When the loop G reaches normal position, all rotating units of the discharge end of the processing line will automatically be returned to operating speed by the electric controls 38. If desired, the stopping, starting and speed control of rolls 30 and 32 and coiler 36 may be done manually. In some instances it may be necessary to provide a second coiler adjacent coiler 36 in order that the strip S may be ready for coiling by the time loop G reaches the dotted line position.

Figure 2 shows a second embodiment of the invention in which the feed end of the line to rolls 14 and the discharge end of the line after rolls 30 are the same as in Figure 1. However, only three loops of strip K, L and M are formed between rolls 14 and 30. The loop K is formed between rolls 14 and roll 40; loop L is formed between roll 40 and rolls 41; and loop M is formed between rolls 30 and 41. The strip in loop L passes downwardly through a preheating furnace 42 where it is heated to a temperature of from 800° to 1000° F. and into a heating furnace 44 where it is heated to a temperature of from 1100° to 1350° F. From there it passes upwardly through a cooling chamber 46, which it leaves at a temperature of from 250° to 900° F. The operation of this embodiment is the same as described above for Figure 1, the rolls 14, 30, 40 and 41 normally operating at line speed. When fastening coils together the rolls 14 are stopped and the coils of strip fastened end to end as described above, the strip in loop K supplying the necessary material to keep the strip moving through the furnace. The rolls 14 and other rotating equipment in the line between the coiler and the rolls 14 are then rotated at a speed greater than line speed until the loop K returns to its normal full line position as controlled by the electrical devices 37. In removing a coil of strip from the coiler 36, the rolls 30 and 32, and coiler 36 are stopped in the same manner as described above and the strip is cut in two by the shears 35, the coil removed, and the strip fastened to the mandrel of the coiler. The rolls 30, 32 and coils 36 are then started in operation at a speed greater than line speed until the loop M returns to its normal position shown in full lines in Figure 2. When loop M reaches its normal elevated position all units in the discharge end of the processing line will be automatically returned to the operating speed by the functioning of the group of electric controls shown at 38.

While two embodiments of my invention have 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. Apparatus for continuously processing strip which comprises means for forming two freely hanging loops of strip, means for preheating said strip as it passes upwardly in the first loop, means for heating said strip as it passes downwardly in the second loop, and means for cooling said strip as it passes upwardly in the second loop.

2. Apparatus for continuously processing strip which comprises means for fastening coils of strip end to end, means for forming two freely hanging loops of strip, means for preheating said strip as it passes upwardly in the first loop, means for heating said strip as it passes downwardly in the second loop, means for cooling said strip as it passes upwardly in the second loop, and means between the fastening means and the first loop for storing sufficient strip to enable the strip to continue moving through the heating means while fastening the coils together.

3. Apparatus for continuously processing strip which comprises means for fastening coils of strip end to end, means for forming two freely hanging loops of strip, means for preheating said strip as it passes upwardly in the first loop, means for heating said strip as it passes downwardly in the second loop, means for cooling said strip as it passes upwardly in the second loop, means between the fastening means and the first loop for storing sufficient strip to enable the strip to continue moving through the heating means while fastening the coils together, a coiler at the end of the processing line, means for cutting said strip located in front of the coiler, and means between the second loop and cutting means for storing sufficient strip to enable the strip to continue moving through the heating means while removing a coil from the coiler.

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