May 18, 1965 L. WILSON 3,184,225

REGENERATIVE FURNACE

Filed April 8, 1963 5 Sheets-Sheet 1

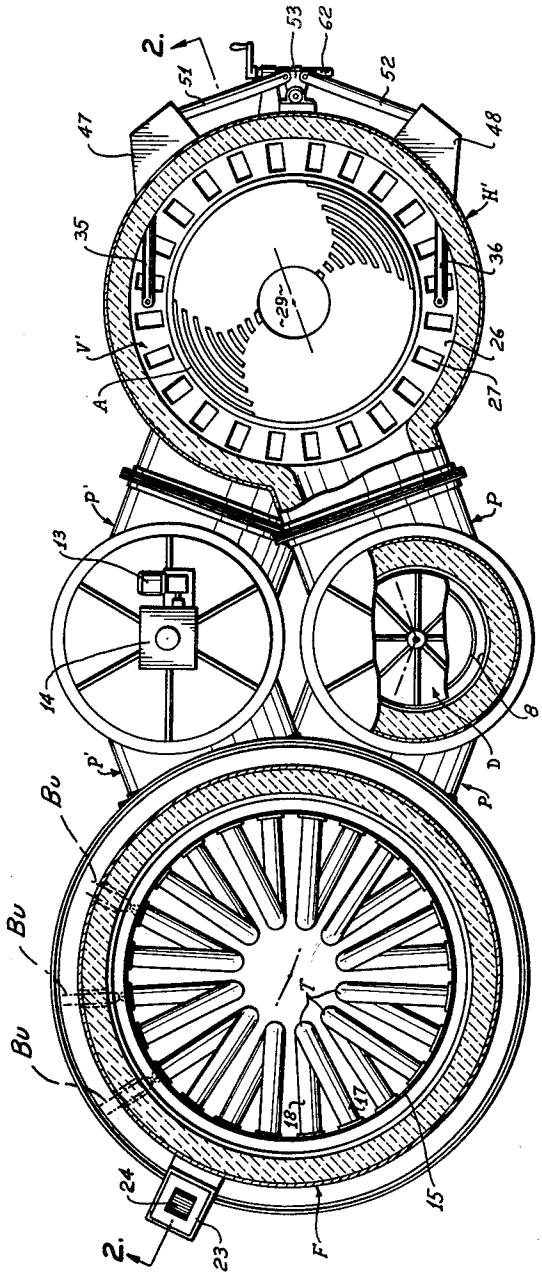

Fig. 1.

INVENTOR.
LEE WILSON
BY Bosworth, Sessions, Herrstrom & Kinnaird
ATTORNEYS.

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REGENERATIVE FURNACE

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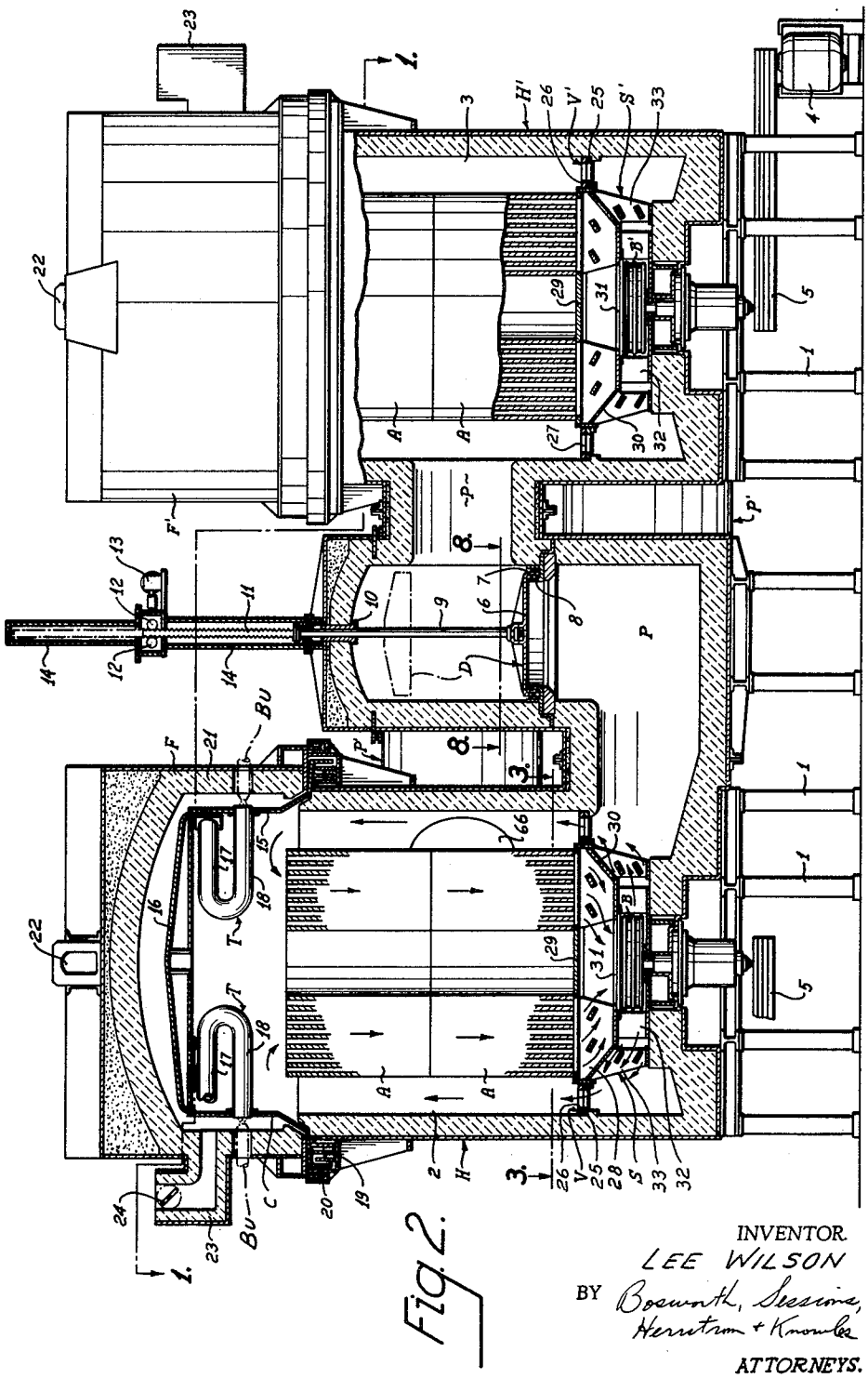

Fig. 2.

INVENTOR.
LEE WILSON
BY Bosworth, Sessions, Herrstrom & Knowles
ATTORNEYS.

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REGENERATIVE FURNACE

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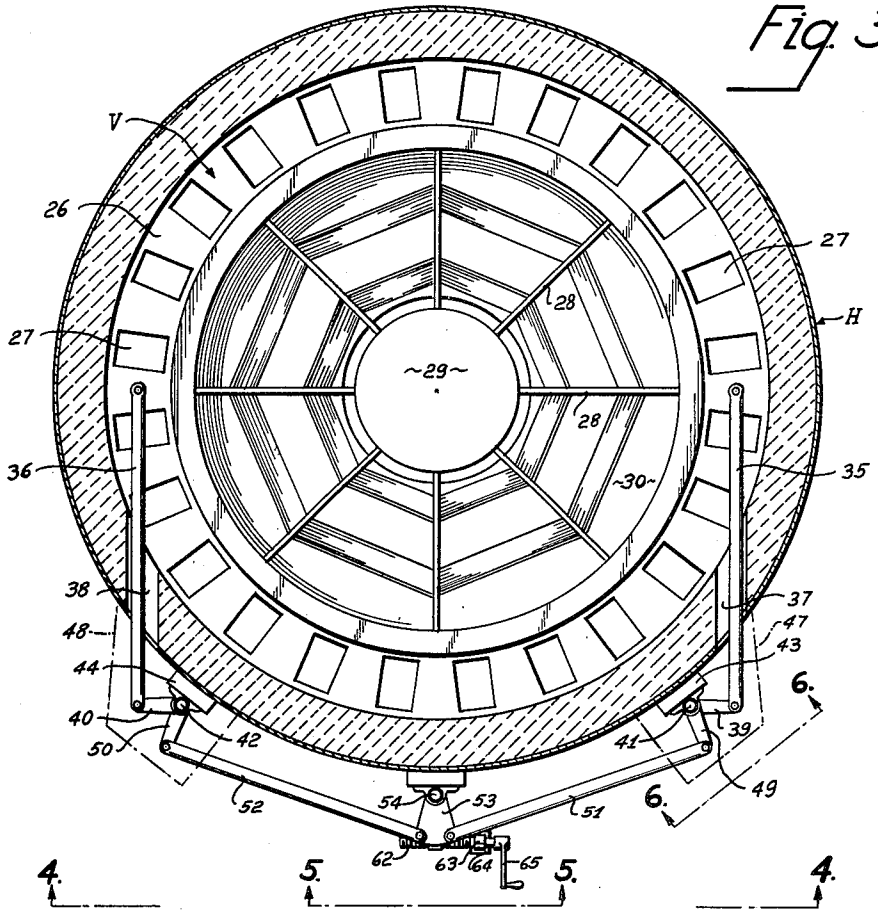
Fig. 3.



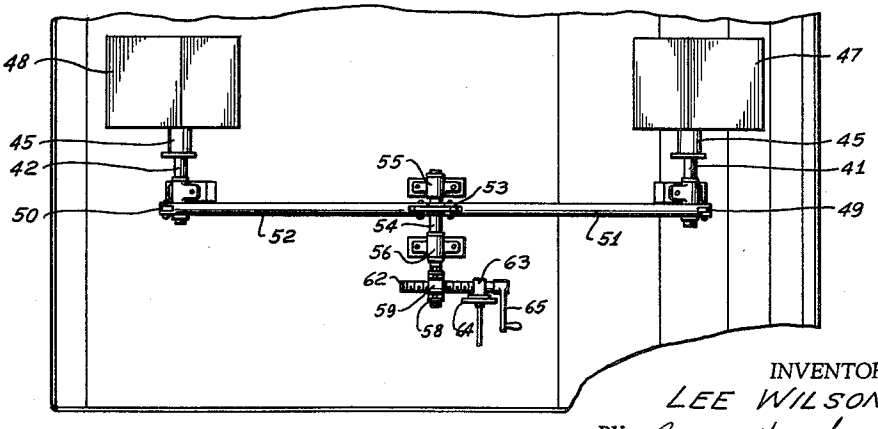


Fig. 4.

INVENTOR.
LEE WILSON
BY Bosworth, Sessions, Herrstrom & Knowlton
ATTORNEYS.

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REGENERATIVE FURNACE

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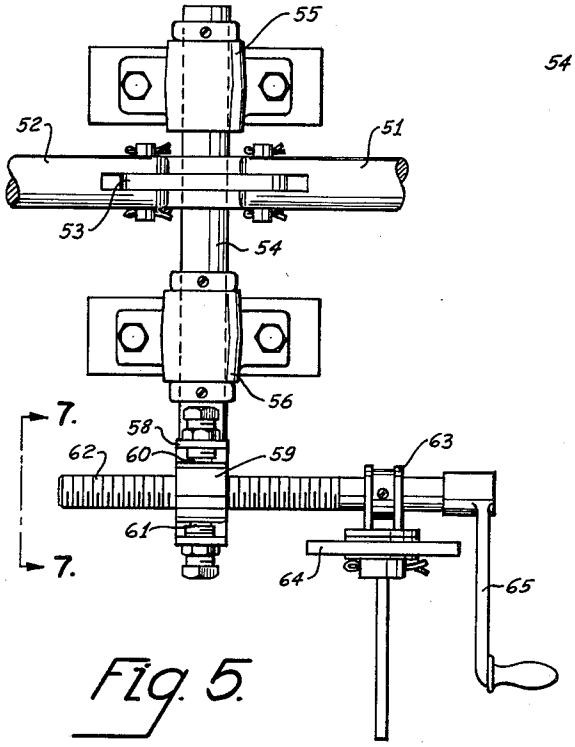

Fig. 5.

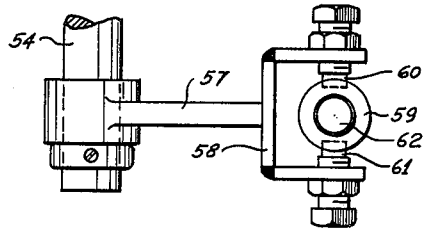

Fig. 7.

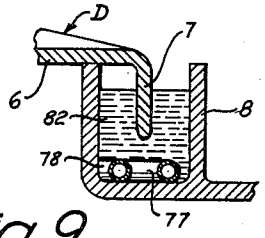

Fig. 9.

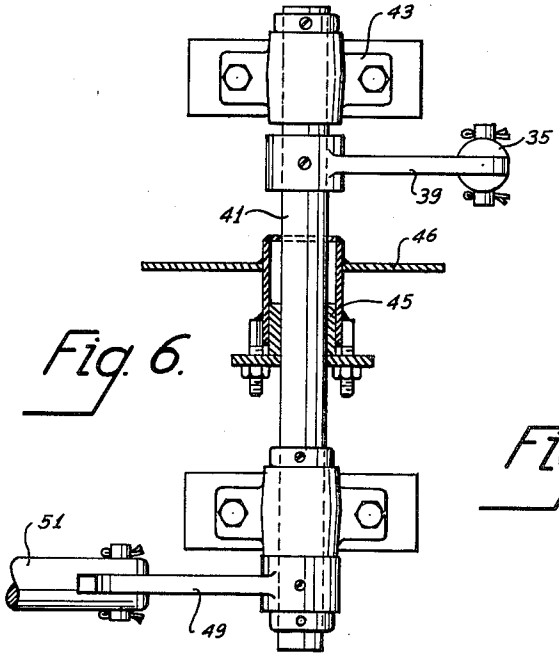

Fig. 6.

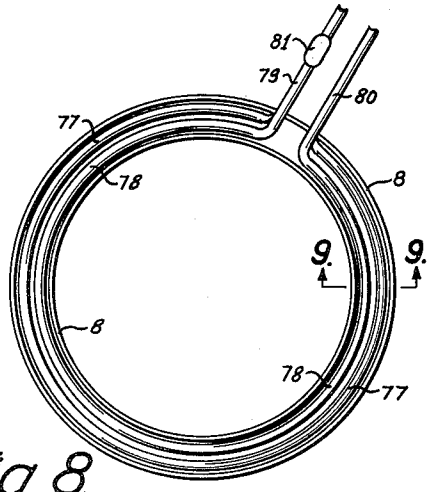

Fig. 8.

INVENTOR.
LEE WILSON

BY Bosworth, Sessions, Herrstrom & Knowles

ATTORNEYS.

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REGENERATIVE FURNACE

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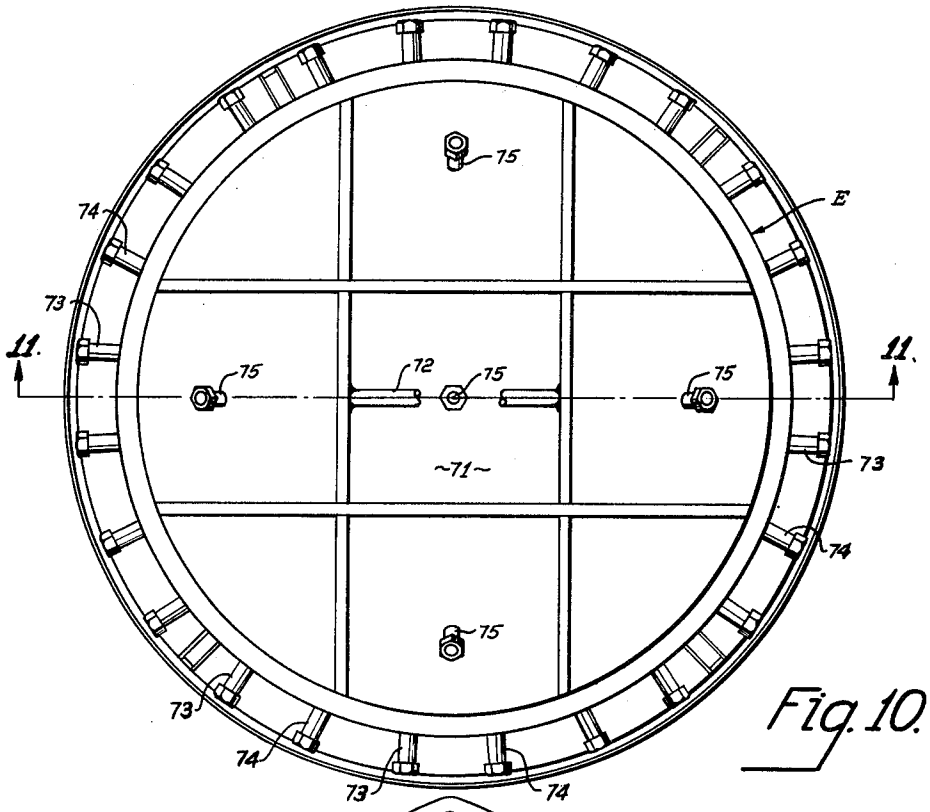

Fig. 10.

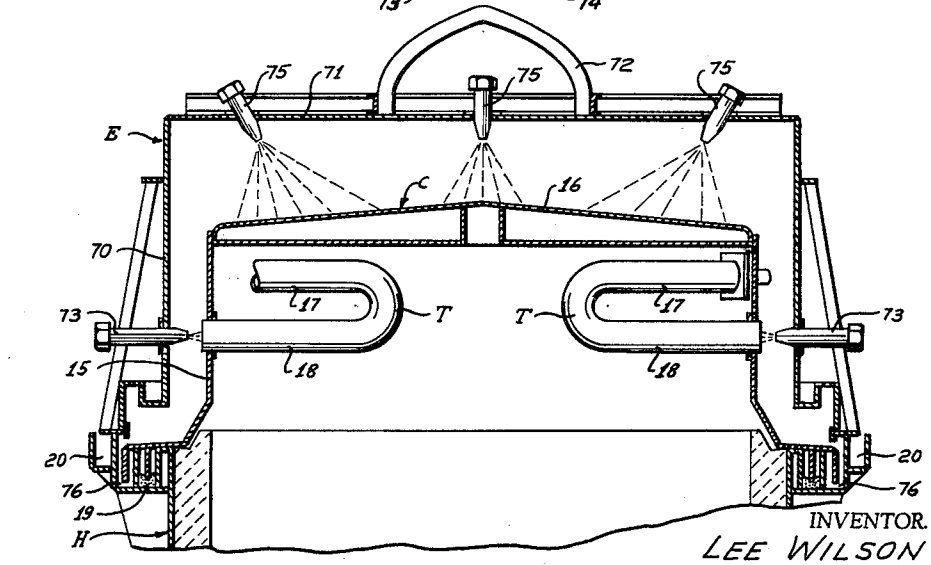

Fig. 11.

INVENTOR.
LEE WILSON
BY Bosworth, Sessions, Herrstrom & Knowles
ATTORNEYS.

United States Patent Office 3,184,225 Patented May 18, 1965

3,184,225

REGENERATIVE FURNACE

Lee Wilson, Rocky River, Ohio, assignor to Lee Wilson Engineering Company, Inc., Cleveland, Ohio, a corporation of Ohio

Filed Apr. 8, 1963, Ser. No. 271,413
15 Claims. (Cl. 263—36)

This invention relates to apparatus for heating strip metal and more particularly to improvements in regenerative furnaces for heating open coils of strip metal.

In the copending United States patent application of myself and Edwin A. Corns, Serial No. 639,939, filed February 13, 1957, entitled "Method of and Apparatus for Annealing Strip Metal," now Patent No. 3,114,539, granted Dec. 17, 1963, there is disclosed a process of and apparatus for heating coils of strip metal wherein a tight wound coil is recoiled into open form with the laps of the coil spaced apart and a heated atmosphere is then forcefully and repeatedly circulated through the spaces between the laps of the coil to effect very rapid, uniform and efficient heating of the strip. During the annealing of open coils of strip metal, and also after other treatments that may be given strip metal in open coil form, the heated coils must be cooled down before they can be removed from the furnace for further processing. With single furnaces of the type shown in the above referred to copending United States patent application cooling of a coil takes a long time and the heat given off by the coil in cooling is dissipated and serves no useful purpose. It is, therefore, an object of my invention to provide a recuperative furnace structure for heating open coils of strip metal whereby heat given up in cooling one coil may be utilized to preheat another coil.

Other objects of my invention include the provision of a regenerative furnace structure of compact design which is particularly adapted for the heating of open coils of strip metal, which may be operated to effect substantial economies in open coil heating of strip metal, and which may be economically constructed and maintained.

The above and other objects of my invention will appear from the following description of one embodiment thereof reference being had to the accompanying drawings in which:

FIGURE 1 is a horizontal cross-sectional view of my improved regenerative furnace structure, the view being taken substantially on line 1—1 of FIGURE 2;

FIGURE 2 is a vertical cross-sectional view, some parts being shown in elevation, taken substantially on line 2—2 of FIGURE 1;

FIGURE 3 is a horizontal cross-sectional view taken substantially on line 3—3 of FIGURE 2 and illustrating one of the rotating blocking valves and its operating mechanism;

FIGURE 4 is a fragmentary elevational view taken substantially on line 4—4 of FIGURE 3 and illustrating the blocking valve actuating mechanism;

FIGURE 5 is an enlarged fragmentary elevational view taken substantially on line 5—5 of FIGURE 3;

FIGURE 6 is an enlarged fragmentary elevational view taken substantially on line 6—6 of FIGURE 3;

FIGURE 7 is a fragmentary view taken substantially on line 7—7 of FIGURE 5;

FIGURE 8 is a horizontal cross-sectional view taken on line 8—8 of FIGURE 2 and illustrating the shut-off valve sealing trough, the valve being omitted for clearness of illustration;

FIGURE 9 is an enlarged cross-sectional view of the shut-off valve sealing trough taken substantially on line 9—9 of FIGURE 8;

FIGURE 10 is a plan view of a cooling cover which

is adapted for use during further cooling of a coil after regenerative cooling thereof; and

FIGURE 11 is a vertical cross-sectional view taken substantially on line 11—11 of FIGURE 10 and illustrating the cooling cover of FIGURE 10 in position on the furnace structure.

Referring now to the drawings, my regenerative furnace structure includes two adjacently disposed furnace housings H and H' supported in side-by-side relation on foundation columns 1 and connected by a pair of atmosphere conducting conduits generally indicated at P and P', it being understood that more than two furnace housings may be employed if desired.

As is clearly seen in FIGURE 1 the furnace housing H forms an open topped furnace chamber 2 and in like manner the housing H' forms an open topped furnace chamber 3. These chambers 2 and 3 provide coil receiving wells in which the open coils A are lowered by magnets or other suitable means. The open upper ends of each of chambers 2 and 3 are adapted to be closed by removable inner covers C, the one on housing H being seen in FIGURE 2. Insulated furnace covers F and F' (see FIG. 2) enclose the inner covers C when the furnace is in operation and are removably carried by the top of the furnace housings H and H', respectively.

Supported on the base of the furnace chambers 2 and 3 are coil support and plenum chamber units S and S' respectively and centrifugal fans or blowers B and B', adapted to be externally driven as by motor 4 and belt drive 5, are disposed in the lower portions of the units S and S' respectively and are adapted to effect the desired flow of atmosphere in and through the furnace structure as will be later explained.

In each of the furnace chambers 2 and 3, between the outer periphery of the coil support and plenum chamber units S and S' and the inner walls of the furnace chambers, are blocking valves, generally indicated at V and V', which, when open, are adapted to permit the flow of atmosphere from the blowers B and B' upwardly into the upper portions of the furnace chambers 2 and 3 and, when closed, to shut off the lower portions of the furnace chambers from the upper portions thereof and prevent such flow of atmosphere.

As previously noted, the furnace chambers 2 and 3 are connected by conduits P and P'. As clearly seen in FIGURE 2 conduit P extends from the lower portion of furnace chamber 2 below the blocking valve V and, after making a double right angle bend, enters the furnace chamber 3 above the blocking valve V'. In like manner the conduit P' leaves from the lower portion of furnace chamber 3 below the blocking valve V' and enters the upper portion of furnace chamber 2 above the blocking valve V.

Disc-type shut-off valves D are positioned in each of the conduits P and P' and are supported for movement from a closed position wherein they block their conduit and an open position in which free flow is permitted through the conduit. In FIGURE 2 the valve D in conduit P is seen in closed position in full lines and in open position in phantom lines. The valve consists of a disc-like body portion 6 having a depending circular flange 7 which, when the valve is closed as seen in FIGURE 2 is disposed in the sealing trough 8. As will be later described fusible metal sealing means are provided for effecting a positive closure of the valve D.

As is also seen in FIGURE 2, the disc 6 of valve D is carried by a valve rod 9 which extends upwardly through a sealing bushing 10 in the upper part of conduit P. A toothed rack 11 is secured on the upper end of rod 9 and is adapted to be engaged by driving gears 12 which, when rotated by motor 13, will lift or lower the rod 9 and valve D. In order to prevent any leakage of

atmosphere to or from the interior of the furnace structure gas tight housings **14** enclose the racks **11** and their associated lifting mechanisms. It will be understood that the valve D which is mounted in the conduit P' is similar to that just described and seen in FIGURE 2 in conduit P and operates in the same manner.

Having generally described the major elements of my regenerative furnace structure the detailed arrangement of these elements will now be explained.

The removable inner covers C have vertical side wall portions **15** and top portions **16** (see FIG. 2) and a plurality of generally U-shaped combustion tubes T are supported by and have their ends in and opening through the side wall **15**. As seen in FIGURES 1 and 2 these combustion tubes are so disposed that the upper leg **17** of each tube is vertically above and circumferentially off-set from the lower leg **18**. The outer periphery of the lower portion of the side wall **15** of inner cover C is provided with sealing flanges which enter the sealing trough **19** on housing H (see FIG. 2). The trough **19** may be filled with sand or liquid to provide an effective gas seal in well-known manner.

The plurality of circumferentially arranged, radially extending combustion tubes T of inner covers C are so disposed that they overlie the top end of the uppermost of the open coils A that are supported on the coil support and plenum chamber S for heating. The furnace covers F and F', which are disposed on the housings H and H' during the heating operation, overlie the inner covers C and are provided with sealing flanges at their outer peripheries which are disposed in sealing troughs **20** (FIGURE 2) having sand or other suitable sealing material therein. To prevent undesired loss of heat the covers F and F' are completely lined with suitable insulating material **21** and preferably each has a lifting eye **22** to facilitate handling thereof.

The side wall of the furnace cover F (it being understood that cover F' is identical in construction with cover F) supports a plurality of fuel burners B*u* which extend through the cover F and, when the cover is properly indexed on the housing H, are so disposed that there is a burner directly opposite the open end of the lower leg **18** of each one of the combustion tubes T. These burners B*u* are seen in FIGURE 2 and, for purposes of explanation, three of them are indicated in FIGURE 1 in phantom lines although the section of FIGURE 1 actually is above the burner B*u*. To permit the escape of products of combustion from within the cover F an outlet flue **23**, which may be provided with a regulating damper **24**, is provided.

The coil support and plenum chamber units S and S', which are carried on the furnace base and are centered in the lower portions of their respective furnace chambers **2** and **3**, each includes an open grid structure **28** and a center plate **29** for closing the center opening of the coil A which is supported on the grid structure **28**. Below the grid **28** is an inwardly extending baffle wall **30** which directs the flow of atmosphere leaving the open coil A to the inlet opening **31** of the blower B. A plurality of diffuser vanes **32** surrounds the blower B and directs the output of the blower radially outwardly through the vertical support members **33** (FIGURE 2) into the lower portion of its furnace chamber.

As has been previously noted, blocking valves V and V' are supported in the furnace chambers **2** and **3** respectively and divide same into what is referred to herein as upper and lower portions. As these valves V and V' are identical only valve V will be specifically described. This valve comprises a lower fixed annular valve ring or plate **25** having a plurality of circumferentially spaced openings therein. Resting on top of fixed valve ring **25** is a rotatable valve ring **26** which is provided with identically formed and located circumferentially spaced openings **27** (see FIGS. 1 and 3). It will be noted that the openings **27** are circumferentially spaced apart a distance slightly

greater than theier circumferential width. When the valve is open, as seen in FIGURES 1, 2 and 3, the holes **27** in the rotatable ring **26** are directly above and aligned with the corresponding holes in the fixed bottom ring **25**. Thus the flow of atmosphere between the lower portion and the upper portion of the furnace chamber **3** is permitted.

When it is desired to shut the valve V and thus block the flow of atmosphere through the space between the outer periphery of the grid structure **28** of the coil support and plenum chamber unit S and the inner wall of the furnace chamber **2**, the rotatable valve ring **26** is moved circumferentially a distance such that the openings **27** therein are completely out of alignment with the corresponding openings in the fixed ring **25** and are blocked by the solid imperforate portions of ring **25**. When in closed position the passageway between the outer periphery of the grid **28** and the adjacent inner wall of the furnace chamber is completely blocked and no atmosphere may move therethrough.

In order to effect opening and closing movement of the valves V and V' I have provided an externally operable mechanism which is best seen in FIGURES 3–7, inclusive. Referring particularly to valve V in furnace housing H, a pair of operating rods **35** and **36** are pivotally secured to the rotatable valve ring **26** at diametrically opposed points. These rods extend through openings **37** and **38** in the outer wall of the furnace housing H and, as best seen in FIGURES 3 and 6, their outer ends are pivotally secured to levers **39** and **40** which are in turn secured to vertical shafts **41** and **42**. These shafts are supported in suitable brackets **43** and **44** mounted on the housing H and extend downwardly through gas tight packings **45** (see FIG. 6) in the bottom wall **46** of the enclosing boxes **47** and **48**. These boxes are gas tight and prevent the entry or escape of atmosphere to or from the chamber H through the openings **37** and **38**.

Levers **49** and **50** are mounted at the lower ends of shafts **41** and **42**, respectively, and have connecting rods **51** and **52** pivotally secured to their outer ends. As best seen in FIGURES 3 and 5, the inner ends of connecting rods **51** and **52** are pivotally secured to a plate **53** which is secured to and supported by the vertically extending shaft **54**. This shaft is supported by bearings **55** and **56** mounted on the furnace housing H and an operating arm **57** (see FIGURE 7) is secured to the lower end of shaft **54**. At the outer end of operating arm **57** is a yoke member **58** between the horizontally extending arms of which a nut **59** is pivotally supported on pivot pins **60** and **61**. A threaded operating screw **62** is mounted in a bearing **63** which in turn is pivotally supported on a horizontal plate **64** which is mounted on the outer face of housing H and forms a supporting bracket for adjusting screw **62**. An operating handle **65** is secured to the outer end of screw **62**, the inner threaded end of which extends through the nut **59**.

From the above description of the apparatus for operating the valve V (it being understood that similar apparatus is supplied for operating valve V') it will be seen that when the handle **65** is turned in one direction the rotation of screw **62** will cause the nut **59** to move in a corresponding direction, swinging the operating arm **57** and turning the shaft **54**. This rotation of shaft **54** will swing plate **53** in a corresponding direction which will result in movement of the connecting rods **51** and **52** and, through their connections to shafts **41** and **42**, will effect rotation of these shafts in the same direction. Such rotation of shafts **41** and **42** will, as is apparent from FIGURE 3, cause one of the arms **35** and **36** to be moved outwardly of the furnace housing H and the other to be moved inwardly. This opposite movement of arms **35** and **36** will effect a corresponding rotational movement of the rotatable valve ring **26**.

When the parts are in the positions seen in FIGURE 3 the valve V is open, the openings **27** in ring **26** are

aligned with the corresponding openings in the fixed ring 25, and rotation of the handle 65 in either direction will effect movement of the nut 59 on the screw 62 and will swing the plate 53 correspondingly. Assuming that the plate is swung to the right as seen in FIGURE 3 this will cause the rod 35 to move inwardly of the furnace housing and the rod 36 to move outwardly. The result will be a counter-clockwise rotation of the rotatable valve ring 26 and, by stopping the rotation when the openings 27 in the ring 26 are out of alignment with the corresponding openings in the fixed ring 25, the valve V will be closed. Rotation of the handle 65 in the opposite direction will, of course, open the valve from its closed position.

The operation of the above described furnace structure for the regenerative heating of open coils of strip metal will now be described.

Assuming that it is desired to start up the illustrated apparatus for a series of coil heating and cooling operations, open coils of strip metal A will be deposited in the furnace chambers 2 and 3 on the supporting grid structures 28. As illustrated, two superimposed coils are seen in each of the furnace chambers but it will be understood that one, or any other number of coils within the vertical capacity of the structure, may be charged into each chamber. The blocking valves V and V' will both be open as seen in FIGURE 2 and the two shut-off valves D in the conduits P and P' will be closed as seen in FIGURE 2. Thus there can be no flow of atmosphere between the chambers 2 and 3.

To start the operation the burners B*u* in the furnace housing F will be ignited thus heating the combustion tubes T carried by the inner cover C on furnace chamber 2. The blower B will be started and atmosphere will circulate in the chamber 2 up around the outside of the coils A, down through the spaces between the laps thereof, into the plenum chamber S, back to the blower through the inlet 31, outwardly from the blower through the diffuser vanes 32, and up through the open blocking valve V and again up along the outside of the coils A. When the desired heating of coil A has been effected the valves V and V' are both closed and the shut-off valves D in conduits P and P' are both opened. Now the blowers B and B' are both operated and the circulation of atmosphere will be from the blower B through the conduit P (because the atmosphere cannot flow upwardly in chamber 2 past closed valve V), into chamber 3 above the closed valve V', down through the open coils A in chamber 3, and through the blower B' and outwardly into the lower part of chamber 3. As the atmosphere exiting from blower B' cannot move upwardly past the closed valve V' it must flow out through the conduit P' and the open valve D therein and into chamber 2 through the outlet opening 66 of conduit P' above the closed valve V. This atmosphere can only pass downwardly through the open coils A in chamber 2 to the inlet of blower B where it is picked up and again forced through conduit P back to the upper portion of chamber 3.

During this circulation of atmosphere through the open coils and between the two chambers heat from the heated coils in chamber 2 will be transferred to the cool coils in chamber 3. The circulation will be continued until the coils in chambers 2 and 3 reach substantially equal temperature at which time the valves D will be closed and the valves V and V' opened. The preheated coils A in chamber 3 will now be brought up to required temperature by lighting the burners in the furnace cover F' and continuing the operation of the blower B' to circulate heated atmosphere through the coils B and over the combustion tubes T of inner cover C on furnace chamber 3.

While the coils in the chamber 3 are being brought up to the desired temperature further cooling of the partially cooled coils in chamber 2 may be expedited by removing the furnace cover F and replacing it with a cooling cover E as seen in FIGURES 10 and 11. This cooling cover E has a side wall 70 and a top wall 71 and may conveniently be provided with a lifting ring 72. A bottom row of water spray nozzles 73 and an upper row of spray nozzles 74 are supported by the side wall 70 of cooling cover E. These nozzles are so spaced circumferentially, and are so located vertically, that when the cooling cover E is in position on the top of the furnace housing H as seen in FIGURE 11, and is properly indexed relative to the inner cover C, a spray nozzle 73 will be opposite to and adapted to discharge a spray of water into the bottom leg 18 of each of the combustion tubes T. In like manner a spray nozzle 74 will be located opposite the open end of the upper leg 17 of each of the tubes T and will spray water thereinto. Suitable water connections (not shown) are provided for supplying water to these spray nozzles which serve effectively to cool the tubes T and thus permit them rapidly to absorb heat from the atmosphere that is being circulated in chamber 2 and in inner cover C by the blower B. Additional heat absorption and removal is provided by spray nozzles 75 mounted in the top wall 71 of cooling cover E. These are also supplied with water by suitable piping (not shown) and are adapted to direct sprays of water over substantially the entire area of the top wall 16 of the inner cover C.

The water sprayed onto inner cover C and into combustion tubes T by the nozzles of the cooling cover E will flow down into the trough 76 on the housing H from which it may be conducted to a place of disposal. By utilizing the cooling cover E, and maintaining circulation of atmosphere within the chamber 2, the open coils A therein may very rapidly be brought down to a temperature suitable for removal and further handling. While this is being done the open coils in chamber 3 are being heated to the desired degree by combustion of fuel in the combustion tubes T of the inner cover C on furnace chamber 3.

When the cooling of the coils in chamber 2 is completed the cooling cover E and inner cover C are removed and the treated coils are taken out of the furnace and replaced by new coils to be treated. The inner cover C and the furnace cover F are then replaced in position. Now, when the heating operation is completed in the chamber 3 the valves D in conduits P and P' are opened and the valves V and V' are closed. Continued operation of the blowers B and B' will result in the circulation of atmosphere between the chambers 2 and 3 and through the open coils therein so that heat will be transferred from the hot coils in chamber 3 to preheat the cool coils in chamber 2. When the temperatures of the coils are substantially equalized the shut-off valves D will be closed and the blocking valves V and V' will be opened, the partially cooled coils in chamber 3 will be subjected to further cooling by removing the furnace cover F' and placing the cooling cover E on the housing H' and starting the water sprays, and the preheated coils in chamber 2 will be brought on up to the desired temperature by lighting the burners B*u* in furnace cover F and repeatedly circulating the atmosphere in chamber 2 through the open coils A and over the heated combustion tubes T.

In order effectively to prevent any atmospheric leakage or flow through the valves D when in their closed positions as seen in FIGURE 2, I provide a fusible metal seal which is illustrated in FIGURES 8 and 9. Ordinary materials such as sand or water or oil cannot be used in the sealing trough 8 of the valves D. As to sand or the like, the velocity of flow of atmosphere through the conduits P and P' is so great that sand would be picked up out of the trough 8 and carried into the adjacent furnace chamber where it would be deposited on the coils being treated with extremely undesirable results. Water or oil, at the temperatures encountered in, for example, the an-

nealing of strip steel, would vaporize thus destroying the seal and adding undesirable elements to the furnace atmosphere.

In order to solve this problem I provide a pair of annular pipes 77 and 78 which, as clearly seen in FIGURE 9, lie in the bottom of sealing trough 8 and extend circumferentially therearound. These pipes are fed by a common water supply pipe 79 and discharge into a common outlet pipe 80. A thermostatically controlled valve 81 is provided in the supply pipe 79 and is adapted to control the rate of flow of cooling water through the pipes 77 and 78. In order to form an effective high temperature seal the trough 8 is filled, to approximately the level indicated, with a low melting point metal alloy. This may be of any suitable and well-known composition which does not contain elements which might give off damaging fumes or vapors and which, for example, has a melting point of about 400° F. As the temperature of the atmosphere adjacent the trough 8 reaches values much greater than 400° F., I provide cooling pipes 77 and 78 and the thermostatic control valve 81 which controls the flow of water therethrough. This flow control is responsive to the temperature of the metal 82 in the trough 8.

With the above described sealing arrangement the sealing metal 82 will become liquid when the temperature reaches its melting point (for example 400° F.). The thermostatically controlled valve 81, which is made responsive by suitable and well-known means to the temperature of the metal 82, is so set that, for example, when the temperature of the metal 82 goes over 600° F. (at which point the metal is in liquid state assuming a melting point of 400° F.) the flow of water through pipes 77 and 78 will be increased, and when the temperature of the molten metal goes below 600° F., the flow of water will be decreased. This control will prevent the low melting point metal 82 from ever reaching such a high temperature that any of its elements will vaporize off and be carried over into one of the furnace chambers and deposited on the strip being treated with undesirable results.

From the above description of the illustrated embodiment of my regenerative furnace for heating coils of strip metal it will be observed that rapid and efficient heating and cooling of successive charges of strip metal may be carried out. Although the illustrated apparatus has been described in considerable detail it will be understood that variations and modifications may be made without departing from the spirit of my invention. I do not, therefore, wish to be limited to the exact design and arrangement illustrated and described herein but claim as my invention all embodiments thereof coming within the scope of the appended claims.

I claim:

1. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, and blocking valve means for blocking said passageway adapted when open to permit flow of atmosphere through said passageway and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said blocking valve means; and means for operating said shut-off valve means.

2. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of the chamber whereby an atmosphere passageway is formed therebetween, and blocking valve means for blocking said passageway adapted when open to permit flow of atmosphere through said passageway and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough; means for operating said blocking valve means; means for operating said shut-off valve means; and independent blower means in each of said furnace housings disposed to discharge atmosphere outwardly and below the said atmosphere passageway of the furnace housing in which the particular blower is disposed.

3. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, and blocking valve means for blocking said passageway adapted when open to permit flow of atmosphere through said passageway and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said blocking valve means; means for operating said shut-off valve means; removable inner covers for each of said furnace housings; said removable inner covers having side wall and top portions, a plurality of radially inwardly extending generally U-shaped combustion tubes supported on said side wall portion and having inlet and outlet openings on the outside of the side wall portion; and removable furnace covers for each of said furnace housings adapted to be supported thereon over and spaced from said inner covers; said removable furnace covers having side wall and top portions, a plurality of burners supported by said side wall portions and disposed to be aligned one with each of said inlet openings of said combustion tubes when said inner cover and furnace cover are on a furnace housing, and means for conducting products of combustion from the space between said covers.

4. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, a fixed ring extending across said passageway and having a plurality of spaced atmosphere openings therethrough, a rotatable ring supported on said fixed ring and having a plurality of spaced atmosphere openings therethrough, and means operable from outside of the furnace housing for rotationally moving said rotatable ring between an open position with the openings therein aligned with the openings in said fixed ring whereby flow of atmosphere through said passageway is permitted and a closed position with the openings therein completely out of alignment with the openings in said fixed ring whereby flow of atmosphere through said passageway is prevented; conduit means

extending from one of said furnace chambers below its said fixed ring to the other of said furnace chambers above its said fixed ring; a second conduit means extending from above said fixed ring to said one of said furnace chambers to below said fixed ring of said others of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; and means for operating said shut-off valve means.

5. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of the chamber whereby an atmosphere passageway is formed therebetween, and blocking valve means for blocking said passageway adapted when open to permit flow of atmosphere through said passageway and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means; means for operating said shut-off valve to below said blocking valve means of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough; means for operating said blocking valve means; means for operatin gsaid shut-off valve means; independent blower means in each of said furnace housings disposed to discharge atmosphere outwardly and below the said atmosphere passageway of the furnace housing in which the particular blower is disposed; removable inner covers having side wall and top portions, a plurality of radially inwardly generally U-shaped combustion tubes supported on said side wall portion and having inlet and outlet openings on the outside of the side wall portion; and removable furnace covers for each of said furnace housings adapted to be supported thereon over and spaced from said inner covers; said removable furnace covers having side wall and top portions, a plurality of burners supported by said side wall portions and disposed to be aligned one with each of said inlet openings of said combustion tubes when said inner cover and furnace cover are on a furnace housing, and means for conducting products of combustion from the space between said covers.

6. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, a fixed ring extending across said passageway and having a plurality of spaced atmosphere openings therethrough, a rotatable ring supported on said fixed ring and having a plurality of spaced atmosphere openings therethrough, and means operable from outside of the furnace housing for rotationally moving said rotatable ring between an open position with the openings therein aligned with the openings in said fixed ring whereby flow of atmosphere through said passageway is permitted and a closed position with the openings therein completely out of alignment with the openings in said fixed ring whereby flow of atmosphere through said passageway is prevented; conduit means extending from one of said furnace chambers below its said fixed ring to the other of said furance chambers above its said ring; a second conduit means extending from above said fixed ring of said one of said furnace chambers to below said fixed ring of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said shut-off valve means; and independent blower means in each of said furnace housings disposed to discharge atmosphere outwardly and below the fixed ring of the furnace housing in which the particular blower is disposed.

7. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, a fixed ring extending across said passageway and having a plurality of spaced atmosphere openings therethrough, a rotatable ring supported on said fixed ring and having a plurality of spaced atmosphere openings therethrough, and means operable from outside of the furnace housing for rotationally moving said rotatable ring between an open position with the openings therein aligned with the openings in said fixed ring whereby flow of atmosphere through said passageway is permitted and a closed position with the openings therein completely out of alignment with the openings in said fixed ring whereby flow of atmosphere through said passageway is prevented; conduit means extending from one of said furnace chambers below its said fixed ring to the other of said furnace chambers above its said fixed ring; a second conduit means extending from above said fixed ring of said one of said furnace chambers to below said fixed ring of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said shut-off valve means; removable inner covers for each of said furnace housings; said removable inner covers having side wall and top portions, a plurality of radially inwardly generally U-shaped combustion tubes supported on said side wall portion and having inlet and outlet openings on the outside of the side wall portion; and removable furnace covers for each of said furnace housings adapted to be supported thereon over and spaced from said inner covers; said removable furnace covers having side wall and top portions; a plurality of burners supported by said side wall portions and disposed to be aligned one with each of said inlet openings of said combustion tubes when said inner cover and furnace cover are on a furnace housing, and means for conducting products of combustion from the space between said covers.

8. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of said chamber whereby a passageway is formed therebetween, a fixed ring extending across said passageway and having a plurality of spaced atmosphere openings therethrough, a rotatable ring supported on said fixed ring and having a plurality of spaced atmosphere openings therethrough, and means operable from outside of the furnace housing for rotationally moving said rotatable ring between an open position with the openings therein aligned with the openings in said fixed ring whereby flow of atmosphere through said passage way is permitted and a closed position with the openings therein completely out of alignment with the openings in said fixed ring whereby flow of atmosphere through said passageway is prevented; conduit means extending from one of said furnace chambers below its said fixed ring to the other of said furnace chambers above its said fixed ring; a second conduit means extending from above said fixed ring of said one of said furnace chambers to below said fixed ring of said other of said furnace chambers; shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said shut-off valve means; independent blower means in each of said furnace housings disposed to discharge atmosphere outwardly and below the fixed ring of the furnace housing in which

the particular blower is disposed; removable inner covers for each of said furnace housings; said removable inner covers having side wall and top portions, a plurality of radially inwardly generally U-shaped combustion tubes supported on said side wall portion and having inlet and outlet openings on the outside of the side wall portion; and removable furnace covers for each of said furnace housings adapted to be supported thereon over and spaced from said inner covers; said removable furnace covers having side wall and top portions, a plurality of burners supported by said side wall portions and disposed to be aligned one with each of said inlet openings of said combustion tubes when said inner cover and furnace cover are on a furnace housing, and means for conducting products of combustion from the space between said covers.

9. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber providing a coil receiving well, an open grid structure supported in said well and having a coil supporting surface adapted to support an open coil thereon, blower means below said grid structure, said grid structure having its outer periphery spaced from the inner periphery of the furnace chamber whereby an atmosphere passageway is provided therebetween, means for closing the center opening of a coil supported on said grid structure, baffle means below said grid structure, said baffle means and said means for closing the center opening of the coil being disposed to direct atmosphere from said blower means through the passages between the laps of an open coil disposed on said grid structure, and blocking valve means for blocking the passageway between the outer periphery of said grid structure and the inner wall of said furnace chamber, said valve means when open being adapted to permit flow of atmosphere from said blower over the full height of the outside of a coil supported on said grid structure and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means for each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit flow of atmosphere therethrough; means for operating said blocking valve means; and means for operating said shut-off valve means.

10. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber providing a coil receiving well, an open grid structure supported in said well and having a coil supporting surface adapted to support an open coil thereon, blower means below said grid structure, said grid structure having its outer periphery spaced from the inner periphery of the furnace chamber whereby an atmosphere passageway is provided therebetween, means for closing the center opening of a coil supported on said grid structure, baffle means below said grid structure, said baffle means and said means for closing the center opening of the coil being disposed to direct atmosphere from said blower means through the passages between the laps of an open coil disposed on said grid structure, and blocking valve means for blocking the passageway between the outer periphery of said grid structure and the inner wall of said furnace chamber, said valve means when open being adapted to permit flow of atmosphere from said blower over the full height of the outside of a coil supported on said grid structure and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means for each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit flow of atmosphere therethrough; means for operating said blocking valve means; means for operating said shut-off valve means; removable inner covers for each of said furnace housings; said removable inner covers having side wall and top portions, a plurality of radially inwardly generally U-shaped combustion tubes supported on said side wall portion and having inlet and outlet openings on the outside of the side wall portion; and removable furnace covers for each of said furnace housings adapted to be supported thereon over and spaced from said inner covers; said removable furnace covers having side wall and top portions, a plurality of burners supported by said side wall portions and disposed to be aligned one with each of said inlet openings of said combustion tubes when said inner cover and furnace cover are on a furnace housing, and means for conducting products of combustion from the space between said covers.

11. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber providing a coil receiving well, an open grid structure supported in said well and having a coil supporting surface adapted to support an open coil thereon, blower means below said grid structure, said grid structure having its outer periphery spaced from the inner periphery of the furnace chamber whereby an atmosphere passageway is provided therebetween, means for closing the center opening of a coil supported on said grid structure, baffle means below said grid structure, said baffle means and said means for closing the center opening of the coil being disposed to direct atmosphere from said blower means through the passages between the laps of an open coil disposed on said grid structure, and blocking valve means for blocking the passageway between the outer periphery of said grid structure and the inner wall of said furnace chamber, said valve means when open being adapted to permit circulation of atmosphere from said blower upwardly around the outside of a coil supported on said grid structure and down through the open coil back to the blower and when closed to block such circulation; conduit means extending from the lower portion of one of said furnace chambers below its blocking valve means to the other of said furnace chambers at a point above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers; shut-off valve means for each of said conduit means adapted when closed to prevent flow of atmosphere therethrough and when open to permit the flow of atmosphere therethrough; means for operating said blocking valve means; and means for operating said shut-off valve means; said blocking valve means and said shut-off valve means being so disposed that, when both of said blocking valve means are open and both of said shut-off valve means are closed, operation of a blower in its furnace housing will effect circulation of atmosphere within the particular housing repeatedly up around the outside of a coil supported on the grid structure and down through the spaces between the laps of the coil and, when said blocking valves are both closed and said shut-off valves are both open, operation of said blowers will coact to effect repeated circulation of the atmosphere in said furnace chamber down through an open coil in one of said furnace chambers, through the conduit which extends from the bottom portion of said one chamber to the other chamber, down through an open coil in said other chamber, out through the conduit extending from the bottom of said other chamber and into said one of said chambers at a point above the blocking valve thereof, and then again down through the

open coil in said one of said chambers, whereby heat exchange between coils in said adjacent chambers may be effected.

12. In apparatus for heating coils of strip metal, two adjacently disposed furnace housings; each of said housings having a furnace chamber, coil support means in the furnace chamber having an outer periphery spaced from the inner periphery of the chamber whereby an atmosphere passageway is formed therebetween, and blocking valve means for blocking said passageway adapted when open to permit flow of atmosphere through said passageway and when closed to block such flow; conduit means extending from one of said furnace chambers below its blocking valve means to the other of said furnace chambers above its blocking valve means; a second conduit means extending from above the blocking valve means of said one of said furnace chambers to below said blocking valve means of said other of said furnace chambers, a shut-off valve means in each of said conduit means adapted when closed to prevent flow of atmosphere therethrough, said shut-off valve means each including a movable disc portion having a depending flange portion, a sealing trough into which said flange portion extends when the valve is closed, a cooling fluid pipe in and extending around said trough, a body of fusible sealing metal in said trough, and valve means, responsive to the temperature of said fusible metal for controlling the flow of cooling fluid through said pipe whereby as the temperature of the fusible metal increases the flow of cooling fluid through said pipe will be increased, means for operating said blocking valve means, and means for operating said shut-off valve means.

13. In sealing means comprising a sealing trough and a flange member adapted to be moved into and out of sealing position in said trough, a body of fusible metal in said trough, a cooling fluid conducting conduit disposed in cooling relation to said metal in said trough, means for supplying cooling fluid to said conduit, and means, responsive to the temperature of said fusible metal in said trough, for controlling the flow of cooling fluid through said conduit whereby, when the temperature of said metal increases above a certain predetermined value said flow of cooling fluid will be increased and when said temperature falls below said value said flow will be decreased, said control means being adapted to control said flow of cooling fluid whereby said fusible metal is maintained at a temperature below its vaporization point.

14. Apparatus for heating coils of strip metal including two adjacently disposed furnace base structures each having a coil support thereon, furnace chamber enclosure means supported by said base structures and forming spaced furnace chambers thereon, atmosphere outlets at the center of each of said coil supports, independent blower means connected to each of said atmosphere outlets and adapted to withdraw atmosphere through said outlets from said furnace chambers, conduit means extending from one of said blower means to the furnace chamber from which the other of said blower means is adapted to withdraw atmosphere, and conduit means extending from said other of said blower means to the furnace chamber from which said one of said blower means is adapted to withdraw atmosphere, each of said conduit means entering its furnace chamber above the said charge support therein, shut-off valve means in each of said conduit means, atmosphere conducting means associated with each of said furnace chambers for conducting atmosphere withdrawn from the furnace chamber by its blower means back to the same furnace chamber to effect circulation of atmosphere within the chamber, and valve means in each of said atmosphere conducting means adapted when open to permit flow therethrough and when closed to prevent flow therethrough.

15. Apparatus for heating coils of strip metal as defined in claim 14 including a plurality of spaced apart U-shaped radiant heating tubes extending radially inwardly in the top portions of each of said spaced furnace chambers.

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CHARLES SUKALO, *Primary Examiner.*

JOHN J. CAMBY, *Examiner.*