

July 13, 1965 ARTHUR DEAN SMITH ALSO KNOWN AS A. DEAN SMITH
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 ALUMINUM AND ITS ALLOYS

Filed March 17, 1960

2 Sheets-Sheet 1

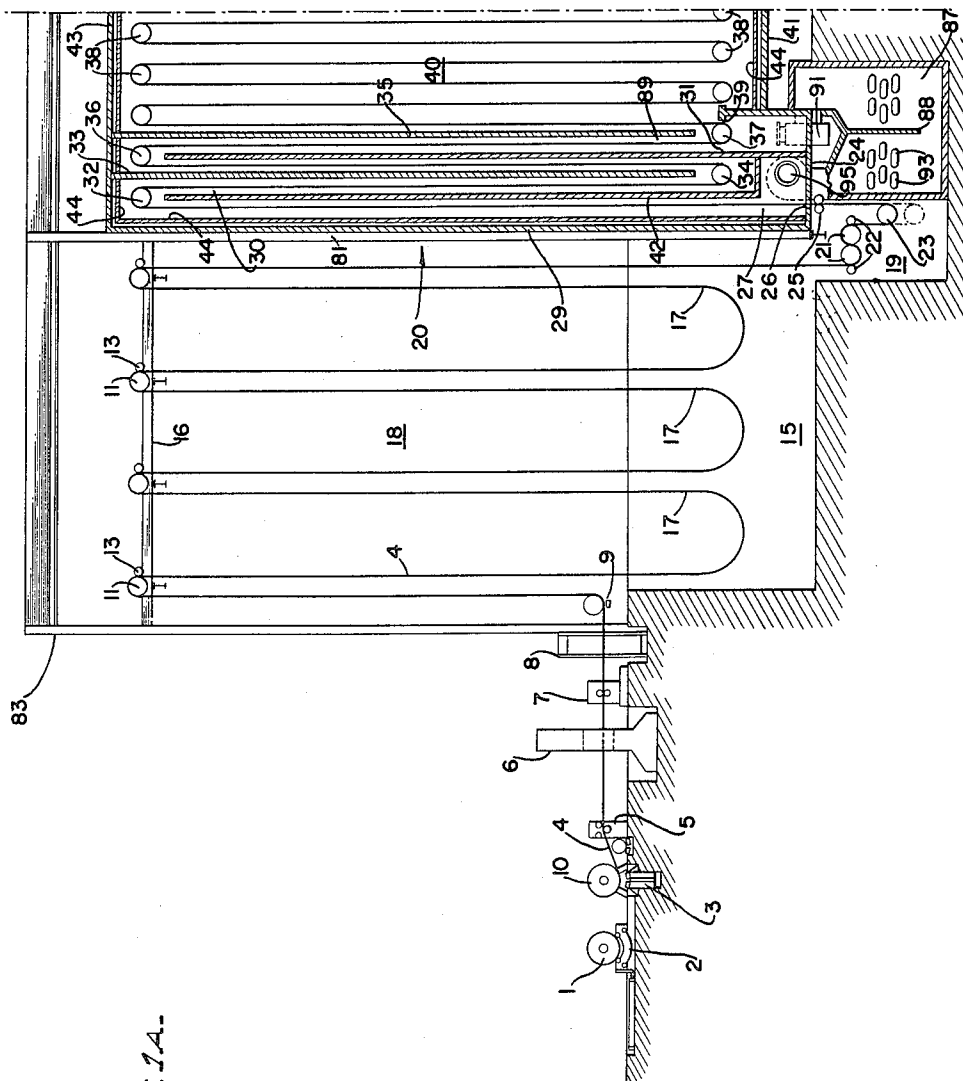


FIG. 1A.

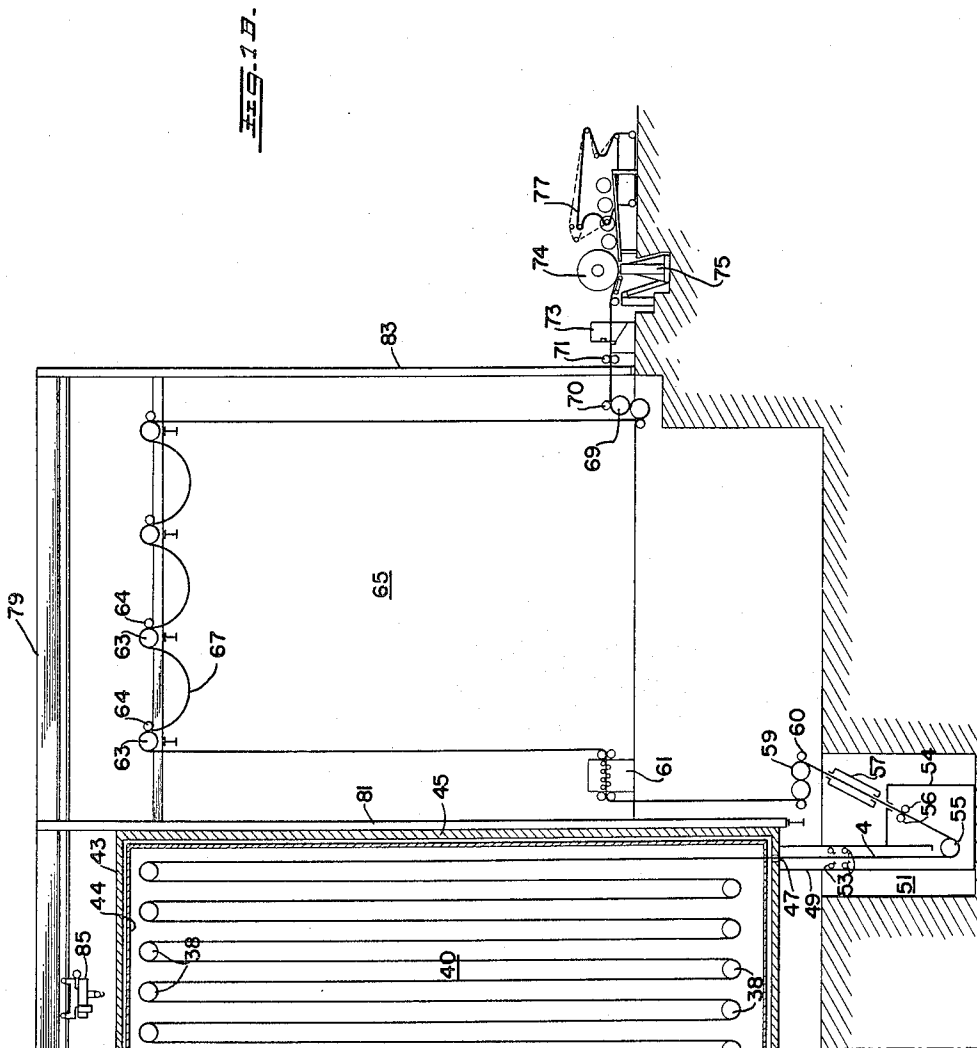
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APPARATUS FOR CONTINUOUSLY SOLUTION HEAT-TREATING ALUMINUM AND ITS ALLOYS

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3 Claims. (Cl. 266—3)

This application is a continuation-in-part of my co-pending application Serial No. 664,068 filed June 6, 1957, and now abandoned.

This invention relates in general to the treatment of metals. More specifically this invention relates to continuously solution heat treating a strip, sheet, wire, etc. of heat treatable aluminum alloys.

The high strengths of the heat treatable alloys of aluminum, such as alloys 2024 (having a nominal composition of 4.5% copper, 0.6% manganese, 1.5% magnesium, balance aluminum and normal impurities), 6061 (having a nominal composition of 0.25% copper, 0.6% silicon, 1.0% magnesium, 0.25% chromium, balance aluminum and normal impurities) and 7075 (having a nominal composition of 1.6% copper, 2.5% magnesium, 5.6% zinc, 0.3% chromium, balance aluminum and normal impurities) are obtained primarily by subjecting the metals to two thermal treatments, namely, solution heat treatment and precipitation hardening or aging. Solution heat treatment consists of heating the metal to a temperature at which the soluble constituents of the alloy dissolve, holding the material at this temperature for a sufficient length of time to allow substantially all of the soluble elements or constituents to go into solid solution and then rapidly quenching to prevent or retard precipitation of these constituents from the supersaturated solid solution. The solution heat treating temperatures of heat treatable aluminum alloys will vary from about 800° to 980° F. depending upon the alloying constituents and their amounts. The precipitation or age hardening treatment follows the solution heat treatment process and is carried on at either room temperature or at an elevated temperature depending on the desired aging time and composition of the alloy. By precipitating in a finely dispersed state some of the dissolved constituents out of solid solution, the age hardening treatment develops maximum mechanical properties of the metal.

In the present practice of solution heat treating aluminum alloys the solution heating is essentially a batch type operation. This practice requires that the metal be in the form of small units, such as individual sheets, coils of strip material, coils of wire, etc. Such processing is quite expensive inasmuch as considerable manual labor is required, the operation is time consuming, and scrap loss is high. For example, one conventional present day practice involves individually suspending sheets within a furnace maintained at a temperature within the solution heat treating range for a predetermined period, removing the heated sheets from the furnace and rapidly quenching the sheets. Such practice results in considerable warpage and wrinkling of the sheets necessitating a straightening operation. This is generally done under tension by clamping each end of the sheet. The clamps employed for such straightening operation make clamp marks on the ends or edges of the sheet which marks must be eliminated by cutting off that portion of the sheet on which the clamp marks appear. This results in edge scrapage which wastes a considerable amount of material and, in addition, results in a smaller sheet.

Attempts to solution heat treat a coil of strip or wire as a unit are not generally satisfactory because of the inability to uniformly quench the entire coil rapidly

enough to retain the constituents in solid solution. The quenching or cooling medium does not have sufficient access to the inner portions of the coiled sheet or wire.

It has been proposed in the past to solution heat treat continuously by unwinding coiled sheet or wire into a furnace, then through a quenching means and on to a rewinding wheel. None of these proposals have been satisfactory when applied to aluminum metal because of several obstacles that have not as yet been overcome by the art. In the continuous heat treatment of aluminum sheet, there is a necessity of obtaining a rapid quench in order to have a satisfactory solution heat treat aluminum article, since the quenching operation must be very rapid in order to prevent or retard the soluble constituents from coming out of the solution. In operating a continuous solution heat treating process, the material must be in a furnace a sufficient length of time to allow substantially all of the soluble constituents to go into solution. This time is affected by the speed of the sheet and by the length of travel of the sheet within the furnace. The metal must pass through the furnace at a high rate of speed in order to effect rapid quenching; consequently, the length of travel within the furnace must be great. Horizontally extending furnaces designed to accommodate the great length of travel are impractical because of the tremendous amount of floor space required. Also, one of the chief difficulties in the prior art has been in providing a furnace which uniformly and rapidly heats the metal to the solution heat treating temperature and maintains the metal at this temperature until substantially all the soluble constituents go into solid solution. Various heating means have been employed for heating these large continuous heat treatment furnaces such as, induction heating, resistance heating, and oil or gas burners. However, none of the prior art heating furnaces for continuously heat treating strip metal have proved successful for commercial adaptation.

Therefore, it is the primary object of this invention to provide an improved method and apparatus for continuously solution heat treating elongated heat treatable aluminum alloy members which eliminates or substantially reduces the problems associated with methods and apparatus as heretofore known.

It is another object of the invention to provide an improved method and apparatus for continuously heat treating an elongated heat treatable aluminum alloy member whereby the member may be uniformly and rapidly heated to the solution heat treating temperature and maintained at this temperature until substantially all the soluble constituents of the metal go into solid solution.

It is a further object of this invention to provide an improved method and apparatus for continuously heat treating aluminum alloys whereby a rapid rate of movement through the heating zone is achieved with consequent rapid quenching without requiring an excessive amount of floor space for the heat treating operation and whereby scarp losses due to straightening operations are eliminated.

It is also an object of this invention to provide a method and apparatus for continuously solution heat treating heat treatable aluminum alloys whereby the metal is heated to the solution heat treating temperature to dissolve the soluble constituents in solid solution in the parent metal and whereby said strip is held at said temperature the optimum time and thereafter quenched rapidly enough to prevent precipitation of said constituents.

These and other objects are accomplished by the instant invention by providing a continuous solution heat treating method and apparatus wherein an elongated member of a heat treatable aluminum alloy, such as strip, sheet and wire, is rapidly and uniformly heated to the solution heat treating temperature by conveying the member in

a tortuous path through a heating furnace comprised of a plurality of heating chambers, after which the member is passed through a holding furnace which is maintained at the solution heat treat temperature of the metal. After passage through the holding furnace, the metal is subjected to rapid quenching means. Means are provided for conveying a high velocity heated gas through the tortuous path of the heating furnace opposite to the direction of travel of said elongated member in said heating furnace, thereby rapidly and uniformly heating the metal to the solution heat treat temperature of the aluminum alloy composition. Means are provided for controlling the heating and holding furnaces at the maximum allowable solution heat treating temperature for the particular metal being treated thereby maintaining the heating and holding furnaces at substantially zero heat head above the solution heat treating temperature. Also, means are provided for supporting the metal during its passage through the heating and holding furnaces as well as means for conveying the metal through said furnaces whereby the stress is maintained substantially equal throughout the length of the metal member within said furnaces and at a value below the yield strength of the metal at its solution heat treat temperature.

These and various other objects, novel features and advantages of the invention will become more apparent from a consideration of the following description taken in connection with the accompanying drawing wherein:

FIGURE 1, comprising FIGS. 1A and 1B, illustrates a cross-sectional view of a solution heat treating apparatus embodying the principles of the invention. Some of the elements of the heat treating apparatus assembly are shown diagrammatically in order to simplify the drawing.

With reference to the drawing, there is shown a solution heat treating apparatus for continuously processing a metal member, such as sheet, and which is generally comprised of a heating furnace 20, a holding furnace 40 comprising an undivided chamber, quenching pit 51, looping towers 18 and 65, and superstructure 83. Suitable accessory equipment for facilitating the continuous operation, such as coilers, welders, etc., are also shown and are specifically discussed hereinbelow.

In FIGURE 1A, the coil 1 of sheet metal rests on the coil carriage 2 and is shown in position to be transferred to the coil unwind device 3 when coil 10, which is shown as being processed through the solution heat treating apparatus, is completely unwound. As coil 10 is unwound the sheet metal 4 successively passes through straightening rolls 5 which flatten the sheet and serve to relieve the curl found in the sheet caused by coiling.

In order that the operation may be continuous for an indefinite amount of metal, a fastening device, such as a welder 6, is provided whereby the trailing edge of the sheet from a coil being processed may be joined to the forward edge of the sheet of a new coil. An edge trimmer 7 is provided to trim off any cracked edges of the sheet thereby preventing a stress concentration from occurring which could cause the sheet to break within the furnace. The scrap from the edge trimming operation is removed from trimmer 7 by a suitable scrap conveyor 8.

In order to hold the sheet stationary during the welding operation a brake 9 is provided to stop the travel of metal through the welder 6 to allow time for the trailing edge of the sheet to be welded to the forward edge of the sheet of the new coil. In order not to stop the passage of the sheet through the heating and holding furnaces, a sufficient length of sheet metal is stored in the form of loops 17 in a looping tower 18. Thus, the sheet 4 is stationary during the welding operation at all points to left of brake 9 as shown in the drawing. The looping tower 18 is comprised of a pit 15 into which the loops extend from a group of driven guide rolls 11 which are suitably supported in bearings from a span

supporting member 16. Each roll 11 is a relatively large driven roll and is positioned adjacent a relatively small rubber covered idler roll 13. One driving roll 11 and one idler roll 13 are hereinafter referred to as a pair of pinch rolls. The distance between the outer surfaces of the driven roll 11 and the idler roll 13 is somewhat less than the thickness of the sheet metal 4 so that when the metal passes between the pinch rolls the driven roll 11 exerts a force on the strip 4 serving to continuously drive the metal through the storage loops and into the heating zone. Looping tower 18 may contain two or more pairs of pinch rolls depending on the metal storage capacity desired.

The pinch rolls are capable of being rotated intermittently at high speed by either automatic controls or by an operator, so that the looping tower may be filled with sheet after a portion of the sheet stored in the looping tower is depleted during the time of the welding operation. The pinch rolls 11 and 13 control the speed of the sheet in the tower so that the tower can be filled without changing the speed of the sheet in the furnace. Although one particular means is shown for storing metal to allow for time for fastening successive coils of sheet metal together, this is given only in the way of example and not in the way of limitation, as any suitable means for storing metal may be used for this purpose.

The sheet 4 after passing through the looping tower 18 passes through pinch rolls 21 and 22 which, in conjunction with pinch rolls 59 and 60 at the discharge side of holding furnace 40, control the speed at which the sheet is fed into the heating furnace 20. The metal sheet 4 then passes around the dancer or garland roll 23, which serves to control the tension of the sheet prior to its entrance into the furnace. The sheet metal will then pass through a pair of sealing rolls 25 and thence through the inlet 26 and into the heating furnace 20. The sealing rolls 25 prevent the escape of heated air from the heating furnace 20. The sheet metal 4 enters the heating furnace at the bottom of the first heating chamber 27 and travels upward around driven roll 32 and into the second chamber 30 where it passes down through the second chamber and around the furnace roll 34 and up through the third heating chamber and around the roll 36 after which it passes downward into the final heating chamber. As the metal sheet 4 travels down through the last heating chamber it travels around the driven roll 37 which in turn directs the metal upward and into the holding furnace 40. The sheet metal 4 then travels through a tortuous path in a holding furnace 40 by traveling around a series of driven rolls 38 suitably supported at the top and bottom of the holding furnace.

The several elongated heating chambers of the heating furnace 20 are vertically extending and parallel to each other. Alternate chambers have openings at the top while the other chambers have openings at the bottom so that the sheet can pass through the chambers in a tortuous path. The holding furnace 40 is suitably designed so that the metal will remain within its confines a sufficient time to dissolve in solid solution substantially all the soluble constituents of the metal but yet allow for sufficient speed of the metal to discharge through outlet 47 and into the spraying compartment 49 at a rate sufficient to cool the sheet and initially retain the soluble constituents in solid solution.

The furnace rolls 32, 34, 36, 37 and 38 are driven at exactly the same speed at which the strip 4 is traveling through the heating and holding furnaces. Each of the furnace rolls is driven individually by a small direct current torque motor (not shown), through suitable gear reduction drive mechanism. These motors are coordinated with a variable voltage drive which controls the speed of the strip 4 through the furnace. The power inputs to the furnace rolls are designed to be only enough to compensate for friction lost in rotating the rolls and

for acceleration from one speed to another. In other words, there is no pull or drag placed on the sheet by the furnace rolls. Thus, for example, a given tension or pull put on the sheet at the discharge side would exert the same tension at the entry side of the furnace. As a consequence, a uniform stress on the sheet or strip is maintained throughout the length of the sheet within the furnace and the stress is maintained below the yield strength of the metal at its solution heat treatment temperature.

The furnace rolls are shaped so that the center portion (that is the portion on which the sheet is supported) is slightly larger in diameter than the ends of the roll. Thus the sheet rides on a crown. The furnace rolls are supported in journals (not shown) which are positioned outside the furnace walls.

The metal passes through the outlet 47 of the holding furnace 40 and into a spray duct 49 wherein spray nozzles 53 are positioned. Both sides of the sheet 4 are contacted by the cooling water from the spray nozzles thereby quenching the sheet 4 at a rapid rate to approximately room temperature. The lower extremity of the duct 49 is submerged below the level of the water provided level in a quench tank 54, located in quenching pit 51. Preferably the end of the duct 49 is positioned a substantial distance below the water level, for example, at least 20 inches and thus the water serves as a seal to prevent the discharge of heated gas or air from the discharge side of the furnace. The metal then passes out to the bottom of the spray duct 49 around idler roll 55 and through the squeegee rolls 56 which serve to remove excess water from the sheet whereupon the sheet is passed through a suitable drier, such as a manifold dryer 57.

The sheet metal is next passed through pinch rolls 59 and 60 which convey or pull the metal sheet through the quenching pit 51 and feed the sheet into a suitable straightening means such as leveler 61. The pinch rolls 59 and 60 at the discharge side of the holding furnace 40 and the pinch rolls 21 and 22 at the entry side of the heating furnace 20 control the speed of the strip through the furnaces. Either the pinch rolls 21 and 22 at the entry side of the heating furnace or the pinch rolls 59 and 60 at the delivery side of the holding furnace will be operated at a constant speed. Suitable means may be provided whereby the position of the dancer roll 23 can regulate the pair of pinch rolls not operating at a constant speed to control the speed of the sheet in the furnace. The unsupported weight of the dancer roll 23 can be varied to develop the desired strip tension, e.g. 115 to 2700 pounds, by using counterweights or other suitable means.

The leveler 61 straightens or flattens the quench warped strip and aids in relieving quenching stresses set up during the quenching process. The sheet then passes between pinch rolls 63 and 64 which serve to convey the sheet into looping tower 65. Two or more sets of these pinch rolls may be used to form loops and thus store the metal as discussed previously in regard to looping tower 43 for storing metal prior to its entry into the heating furnace 20. On the discharge side of the holding furnace 40, it is necessary that the looping tower 65 be empty or the loops 67 short when the sheet is stopped to cut out the weld and remove the coil so that the sheet emanating from the furnace 40 can be accommodated or stored in the looping tower 65 during the cutting and removal operations. The sheet 4 passes from the last set of pinch rolls 63 and 64 in the looping tower to a set of pinch rolls 69 and 70 which convey the sheet metal at floor level to the rewinding operation. The pinch rolls 69 and 70 at the discharge side of the looping tower 65 control the speed of the sheet in the tower so that it can be emptied regardless of the speed of the strip in the furnace. At this point the sheet metal passes through the super structure 83 and through guide rolls 71 and the

shearing device 73. When sufficient metal is rewound on the coil to give the desired coil size, the shears 73 operate to shear the strip of metal transversely. Preferably the strip is sheared at the weld made by welder 6. A belt wrapper 77 may be used to ensure proper coiling of the sheet.

A super structure 83 which provides a housing for the looping towers and furnaces, has removable sections to permit access to the looping towers 18 and 65, heating furnace 20, holding furnace 40 and the equipment contained therein. The cat walk 79 across the top of the super structure 83 permits access to the rolls in the looping towers and the top of the heating furnace 20 and the holding furnace 40 for maintenance and repair purposes. A hoist or crane 85 is suspended from the cat walk 79 to aid in the replacement of rolls and other equipment in locations not accessible from the ground level. Bridle supports 81 are disposed on either side of the heating and holding furnaces and attached to the super structure 83 at its upper horizontal cross member 79. In order to reduce the height to which the furnaces and looping towers extend above the ground level, a pit 15 is provided which contains the looping towers and furnaces.

The inside heating chambers of furnace 20 consists of vertically extending partition walls or baffles which provide a continuous path through the heating furnace. This is accomplished by providing partition walls or baffles 31, 33, 35 and 42 whose length is somewhat less than the height of the heating furnace. A passageway is provided between adjacent heating chambers, around one end of the partition wall. Since adjacent partition walls abut the top and bottom of the furnace, alternately, a tortuous passageway is provided through the heating furnace. The adjacent partition walls alternately abut the floor 24 of the heating furnace 20, for example, partition wall 31 and the roof 43 (partition walls 33 and 35). Partition wall 35 which extends from the roof 43 of the furnace 20 is the dividing wall between the holding furnace 40 and the heating furnace 20. Partition walls 31, 33, 35 and 42 are supported not only from the top but also from the front and back walls (not shown) of the furnace by welding. The inner partition walls or baffles are preferably manufactured from sheet metal, such as 11 gauge 430 stainless steel sheet, and are insulated in any suitable inexpensive manner, such as with mineral wool or fiber glass insulation. The insulation may be held in place with a large mesh wire or other suitable means. The top and bottom of the furnaces are made of removable sections to permit ready access to the rolls and sheet.

The common outer shell of the heating and holding furnaces comprises walls 29, 41, 43, 45 plus the front and back walls (not shown). This outer shell is welded gas tight to avoid leakage of the recirculating heated air. Radiation shield 44 is mounted inside of the outer shell and in spaced relationship therewith. Air may be circulated through the space between the shell and the radiation shield 44 by small circulating fans (not shown). The air from this space is recirculated by suitable means to the heating compartment 87 where it is reheated along with the mainstream of high velocity air. This radiation shield construction aids in maintaining a uniform temperature within the furnaces by minimizing radiation losses to the outside wall and providing for the recirculation and reheating of the coldest air in the furnaces. Thus the sheet, during its travel through the heating and holding furnaces, does not face an outside wall. The temperature of the sheet in the furnace is regulated by controlling the heated air blown into the furnaces from the heating compartment. The air is controlled at the maximum allowable heat treating temperature, and the measurement of the air temperature is a substantially accurate measurement of the temperature of the sheet. This method of temperature control insures a uniform temperature throughout the furnaces. Since there is no point within either furnace which is at a higher temperature than the heat treating

temperature, that is, there is substantially zero heat head in either furnace above the solution heat treat temperature, it is impossible to over heat the strip in the event that the sheet is stopped or its speed changed.

The strip 4 is brought up to the solution heat treating temperature entirely by circulating, opposite to the direction of travel of the strip 4, very high velocity heated air in the tortuous path of the heating furnace 20. The air is heated in the heating compartment 87 and blown into the last chamber 89 of the heating furnace 20 by a group of blowers 91 connected in series. The heating chamber 87 contains radiant heating tubes 93. Hot products of combustion from burners (not shown) pass through the alloy radiant tubes, generally in a U or W form, and air passes over the outside of these tubes to pick up the necessary heat. Alternate methods for heating the air would be by passing the products of combustions directly into the circulating air or by passing the air over electrically heated resistance elements.

An example of discharge of heated air from a heating compartment is 40,000 cubic feet per minute at a pressure of approximately 20 inches of water. The air circulated by blowers 91 flows in the direction opposite or counter-current to the travel of the sheet through the heating furnace and is exhausted at the charging end 27, and, for purposes of illustration, may have a velocity of 6000 to 9000 feet per minute. Heating by this means has been found sufficient to permit the speed of the sheet traveling through the continuous heat treating furnace to be between 40 and 400 feet per minute.

The suction fans 95 recirculate the air from the first chamber 27 of the heating furnace 20, the recirculated air being taken off at a point approximately at the sealing rolls 25 and recirculated through heating chamber 87. Circulation of the air around tubes 93 is promoted by baffle 88 located in heating chamber 87. The base of partition wall 42 may be suitably attached to partition wall 31 (rather than floor 24) for support (as shown in FIGURE 1A), in order to provide space for exhaust blowers 95. Since the suction side gauge pressure is equal to approximately zero there is little tendency for air to leak either in or out at the sealing rolls 25. The holding furnace 40 is operated at the inlet pressure of the high velocity air which may be on the order of 20 inches of water. The spray compartment 49 is submerged below the water level in the quench tank 54 by at least 20 inches so as to seal the discharge side of the furnace against the operating air pressure.

The holding furnace 40 is maintained at the same temperature as the heating furnace 20 with common heating means by passing a portion of the heated high velocity gas introduced in the heating furnace into the holding furnace. A relatively small amount of hot air is bled off from the large volume of high velocity air flowing into the chamber 89 from the heating compartment, through passageway 39, to heat the holding furnace 40.

Since the strip 4 is already heated to temperature when it reaches the holding furnace, very little heated air need be added to the holding furnace.

While an embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. Apparatus for continuously solution heat treating an elongated heat treatable aluminum member comprising a heating furnace, a holding furnace adjacent said heating furnace, said heating and holding furnaces having an outer shell, a radiation shield mounted inside said shell in spaced relationship therewith, partition walls within said heating furnace which define a tortuous path, said holding furnace comprising an undivided chamber, common heating means for heating said aluminum metal member in said heating furnace to solution heat treating temperature while maintaining substantially zero heat

head in the furnace above the solution heat treating temperature and for maintaining said holding furnace also at said temperature, said common heating means comprising means for conveying high velocity heated gas both along said tortuous path in said heating furnace in a direction opposite to travel of said metal member and into the undivided chamber comprising said holding furnace, means within said heating furnace for supporting said member during travel along said tortuous path, a vertical divided wall between said heating and holding furnaces said wall being provided with an opening to permit passage of said metal member from said heating furnace to said holding furnace, means within said undivided chamber comprising said holding furnace for supporting said metal member, and means for continuously moving said member through said heating and holding furnaces while maintaining the stress substantially equal throughout the length of said metal member in said furnaces and at a value less than the yield strength of said metal member.

2. Apparatus for continuously heat treating an elongated heat treatable aluminum alloy member comprising a heating furnace, a holding furnace adjacent said heating furnace, said heating and holding furnaces having an outer shell, a radiation shield mounted inside said shell in spaced relationship therewith, partition walls within said heating furnace which define a tortuous path, said holding furnace comprising an undivided chamber, common heating means for heating said aluminum metal member in said heating furnace to solution heat treating temperature while maintaining substantially zero heat head in the furnace above the solution heat treating temperature and for maintaining said holding furnace also at said temperature, said common heating means comprising means for conveying high velocity heated gas both along said tortuous path in said heating furnace in a direction opposite to travel of said metal member and into the undivided chamber comprising said holding furnace, a plurality of driven rolls within said heating and holding furnaces for supporting said member during travel therethrough, said holding furnace being adapted to receive said member as it emerges from said heating furnace and being of sufficient capacity to hold said member at the solution heat treating temperature of said member for a time sufficient to allow substantially all of the alloy constituents to go into solid solution, a vertical, insulated, dividing wall between said heating and holding furnaces, said wall being provided with an opening at its lower extremity for a passage of said member, means for continuously moving said member through said heating and holding furnaces while maintaining the stress substantially equal throughout the length of said member within said heating and holding furnaces and at a value less than the yield strength of said member, means for quenching said member as it emerges from said holding furnace, means for removing excess water from said member as it emerges from said quenching means, means for drying said member, and means for continuously straightening said member after it has been quenched and dried.

3. Apparatus for continuously heat treating an elongated heat treatable aluminum alloy member comprising a heating furnace, a holding furnace adjacent said heating furnace, said heating and holding furnaces having an outer shell, a radiation shield mounted inside said shell in spaced relationship therewith, partition walls within said heating furnace which define a continuous tortuous path, said holding furnace comprising an undivided chamber, common heating means for heating said aluminum metal member in said heating furnace to solution heat treating temperature while maintaining substantially zero heat head in the furnace above the solution heat treating temperature and for maintaining said holding furnace also at said temperature, said common heating means comprising means for conveying high velocity

heated gas both along said tortuous path in said heating furnace in a direction opposite to travel of said metal member and into the undivided chamber comprising said holding furnace, external pinch roll means for controlling the speed of said elongated member through said heating and holding furnaces, a plurality of internal rolls within said heating and holding furnaces for supporting said member during travel therethrough, said internal rolls being driven at exactly the same speed as said elongated member as defined by said external roll means whereby the elongated member is continuously moving through said furnaces while the stress is maintained substantially equal throughout the length of said member within said furnaces and at a value less than the yield strength of said member, said holding furnace being adapted to receive said member as it emerges from said heating furnace and being of sufficient capacity to hold said member at the solution heat treating temperature of said member for a time sufficient to allow substantially all of the alloy constituents to go into solid solution, a vertical, insulated, dividing wall between said heating and holding furnaces, said wall being provided with an opening at

its lower extremity for the passage of said member, means for quenching said member as it emerges from said holding furnace, means for removing excess water from said member as it emerges from said quenching means, means for drying said member, and means for continuously straightening said member after it has been quenched and dried.

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