May 17, 1932. E. E. McVEY ET AL 1,858,678

SHEET METAL NORMALIZING FURNACE

Filed Feb. 23, 1929 2 Sheets-Sheet 1

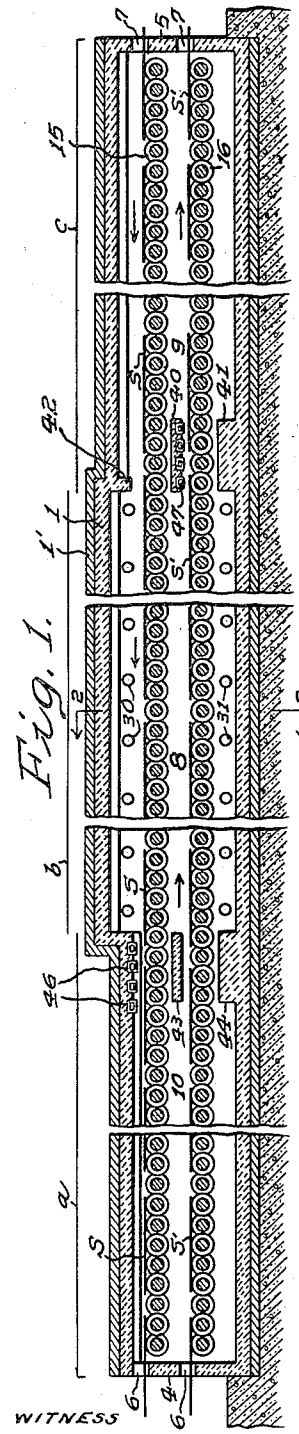


Fig. 1.

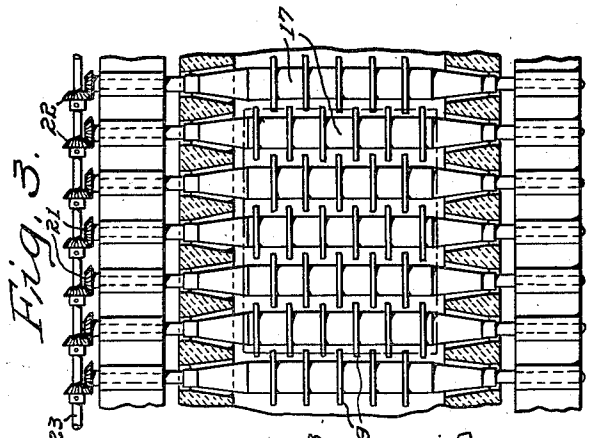


Fig. 3.

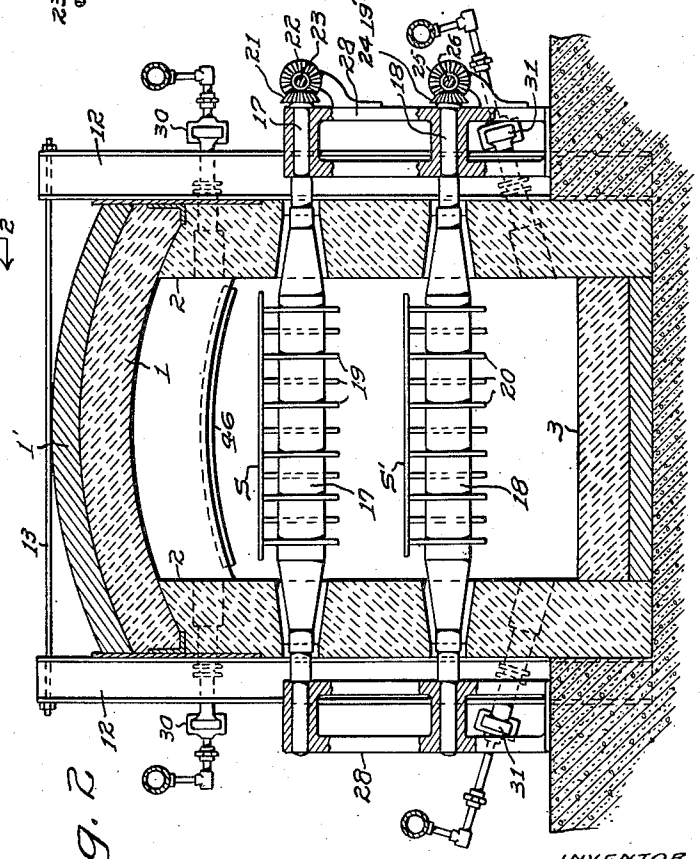


Fig. 2

WITNESS
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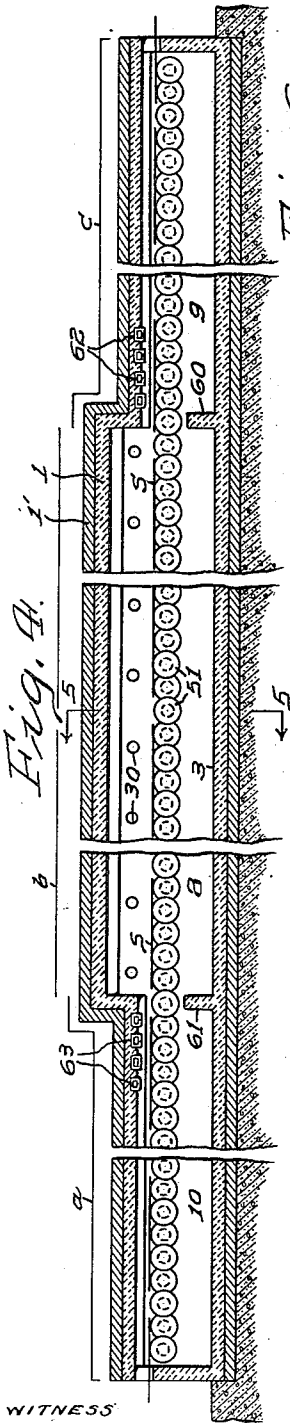


Fig. 4.

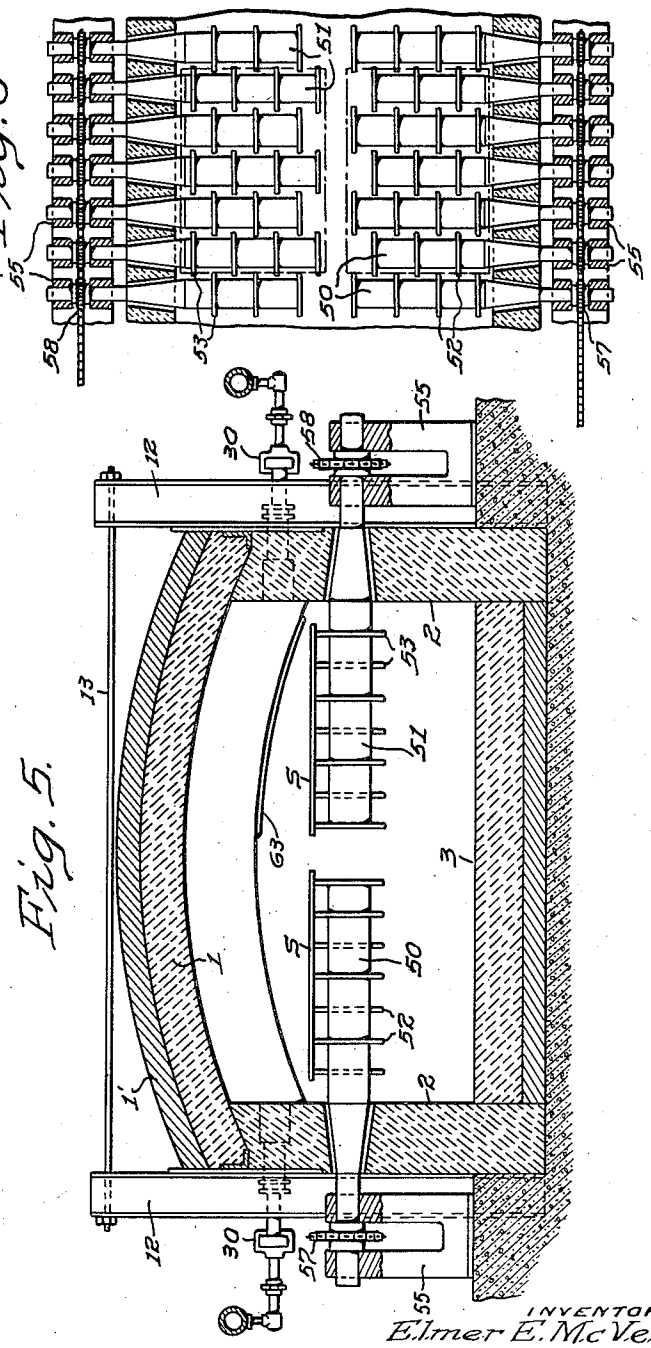


Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE

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SHEET METAL NORMALIZING FURNACE

Application filed February 23, 1929. Serial No. 341,925.

Our invention relates to that class of furnaces employed for normalizing metal sheets or the like by subjecting them to heat for the purpose of eliminating the effects of the strains and stresses incident to the preceding rolling or other operations, among the principal objects of the invention being to provide a normalizing furnace so constructed as to be capable of normalizing a much greater quantity of material in a given time than the normalizing furnaces heretofore in use and at a materially lower cost per ton of material treated; to provide a normalizing furnace in which the principles of recuperation and regeneration are employed in such manner as to preheat the incoming cold sheets by heat radiated from the outgoing hot sheets whereby material economy in fuel cost is effected through utilization for the performance of useful work of a large amount of heat which would otherwise be entirely lost, and to provide a normalizing furnace so constructed that the sheets to be normalized may be fed thereinto from opposite ends of the furnace and moved therethrough in opposite directions which results, among other things, in substantially doubling the capacity of the furnace without a corresponding increase in its size, this construction also permitting the normalizing in a single normalizing furnace of sheets supplied from separated furnaces, mills or other sources and at a far less fuel cost than would be required for normalizing a like quantity of sheets in two separate normalizing furnaces of the type usually heretofore employed and respectively located adjacent the separate sources of sheet supply.

Further objects of the invention are the provision of a normalizing furnace embodying means for rapidly reducing the temperature of the sheets passing therethrough after the same have been raised to the temperature required for normalization so as to quickly bring about a practical fixation of the fine grain structure of the metal; to provide a normalizing furnace having a central hot or final temperature zone and a cooling zone adjacent each end thereof and which embodies a system of baffles or equivalent means whereby the heat supplied to the final temperature zone is in large measure confined thereto and prevented from escaping therefrom.

Still further objects of the invention are to provide a normalizing furnace in which accurate temperature regulation may be readily obtained, which is satisfactorily and efficiently operative for the performance of its intended function, and in which, in that embodiment thereof which is generally preferred, the heat for normalizing the sheets is applied to the latter both from above and from below.

Our invention additionally includes other objects and novel features of design, construction and arrangement hereinafter more particularly pointed out or which may be apparent to those skilled in the art from the following description of certain embodiments of our invention as illustrated in the accompanying drawings.

In said drawings, Fig. 1 is a fragmentary longitudinal vertical central section through one form of normalizing furnace constructed in accordance with our invention; Fig. 2 is an enlarged transverse vertical section on line 2—2 in Fig. 1 and Fig. 3 is a fragmentary top-plan view, partially in horizonal section, of some of the conveyor rolls and adjacent parts. In Figs. 5, 6 and 7, which respectively correspond to the figures just described, we have illustrated a normalizing furnace constructed in accordance with another embodiment of our invention and in which the conveyor rolls, instead of being superposed as in the first form, are arranged side by side in the same horizontal plane as will hereinafter more fully appear. Thus Fig. 4 is a fragmentary longitudinal vertical central section through the furnace, Fig. 5 an enlarged transverse vertical section on line 5—5 of Fig. 4 and Fig. 6 a fragmentary top plan view of some of the conveyor rolls and adjacent parts. The same symbols of reference are used to designate like parts in the several figures, and all sectional views are taken in the directions indicated by the arrows on the section lines.

Referring now more particularly to that

embodiment of the invention illustrated in Figs. 1, 2 and 3, the furnace, as best shown in Fig. 1, is of elongated form and arranged to provide three zones through which the sheets are consecutively passed as they traverse the furnace from one end to the other. These zones, respectively indicated by the brackets above said figure are generally designated as *a*, *b*, and *c*, and for convenience of description we shall refer to the central zone *b* as the hot or final temperature zone and to the end zones *a* and *c* as the recuperative zones. More particularly the furnace comprises a roof 1 which may desirably be arched and supported on parallel, longitudinally extending side walls 2 joined at their lower extremities by a floor or hearth 3, the walls and roof being formed of bricks or other suitable, preferably refractory, material. End walls 4 and 5 are also provided, the former being pierced with upper and lower openings forming doors 6—6 and the latter with corresponding openings forming doors 7—7, all of these doors being desirably in the form of transversely extending slots of sufficient height to permit the introduction to and discharge from the furnace of the sheets which are to be normalized. The furnace roof may be provided with a covering 1′ of heat-insulating material to cut down radiation losses.

The furnace is of maximum height throughout the length of the hot or final temperature zone *b*, and is desirably of slightly lesser height throughout the zone *c* and of still lesser height throughout the zone *a*, said zones, of course, being in the form of chambers 8, 9 and 10 respectively bounded by the roof, sides and bottom of the furnace and communicating with each other. The side walls and roof of the furnace may be supported and tied together in the usual way by buckstays 12 and tie rods 13 as indicated in Fig. 2 or in any other suitable way as will be well understood by those familiar with the art.

In the form of the invention now being described two sheet conveyors, generally designated as 15 and 16, are provided and arranged one above the other in spaced relation. Each of these conveyors comprises a plurality of transversely extending shafts, those in the upper conveyor being designated as 17 and those in the lower as 18, respectively provided with a plurality of laterally spaced discs 19 and 20 which are arranged in staggered relation on each adjacent pair of shafts so as to form a support for the sheets operative to convey them through the furnace when the shafts are rotated. The ends of the shafts are extended through the side walls of the furnace and any suitable means is provided for driving them. Thus each of the upper shafts may be furnished at one end with a bevel gear 21 cooperative with a similar gear 22 on a driving shaft 23 extending horizontally along the side wall of the furnace and the lower shafts similarly furnished with bevel gears 24 cooperative with similar gears 25 on a lower drive shaft 26, the two shafts being driven from any suitable source of power and arranged to rotate in opposite directions so that the upper conveyor 15 will be effective to move the sheets through the furnace in one direction, for example as indicated by the arrow adjacent thereto, while the lower conveyor will be effective to move the sheets through the furnace in the opposite direction as indicated by the adjacent arrow. The conveyor shafts may be journalled in supports 28 disposed outside of the furnace and the side walls of the latter provided with apertures for the passage of the shafts of such size as to provide a certain amount of clearance therefor so that the shafts, as well as the walls themselves, are free to expand and contract under changes of temperature without interfering with the operation of the shafts. While we have shown the shafts as solid, it will of course be understood that if desired they may be made hollow and also that provision may be made for the effecting a circulation of water through them or for otherwise cooling them in any of the various ways commonly employed in the art.

The heat requisite for the normalizing operation is introduced to the hot or final temperature chamber 8 of the furnace by means of burners extended through the side walls of the latter and we prefer to employ for this purpose an upper and a lower set of burners, the former being disposed adjacent the roof of the chamber and the latter adjacent the hearth 3 so that the heat will be introduced to the chamber both above and below the conveyors. Thus, more particularly, we prefer to arrange a plurality of burners 30 at longitudinally spaced intervals throughout the length of the chamber 8 and on opposite sides thereof so that the burning gases therefrom will be projected toward the center of the chamber from each side thereof and preferably horizontally or substantially so, and we also provide another set of longitudinally spaced burners 31 below the lower conveyor on opposite sides of the chamber so that the burning gases from these burners will likewise be directed inwardly toward the center of the chamber from both sides thereof. While we have found that good results may be obtained by inclining the lower set of burners downwardly and inwardly so that the gases therefrom will be projected more or less against the furnace hearth instead of horizontally toward the center of the furnace as in the case of the upper burners 30, and have thus shown the lower burners as inclined in this manner, under certain conditions it may be preferred to dispose these burners horizontally in a

manner similar to the upper burners so that the products of combustion instead of first striking the hearth and being thence deflected upwardly, will be projected horizontally into the heating chamber. The burners may be of any suitable construction and design adapted for the burning of gas, either natural or artificial, or any other desired heating medium, and are preferably capable of individual regulation and so arranged that any desired number of them may be employed simultaneously as it frequently happens that not all of the burners are required to produce the requisite heating effect.

In order to confine within the final temperature chamber 8 as much as possible of the heat derived from the burners, we provide between this chamber and the chamber 9 an upper baffle 40 and a lower baffle 41, these baffles preferably consisting of walls extending transversely across the chamber, the baffle 40 being disposed between the conveyors and the baffle 41 below the lower conveyor. With the same end in view, we also provide a depending transversely extending baffle wall 42 adjacent the juncture of that portion of the furnace roof which is over the chamber 9 and that which is over the chamber 8, this wall extending down to a point quite closely adjacent the upper surface of the upper conveyor. At the opposite end of the final temperature chamber and for a like purpose, we provide similar upper and lower baffles 43 and 44 generally corresponding to the baffles 40 and 41, but as the roof of the chamber 10 is preferably, as hitherto stated, somewhat lower than the roof of the chamber 9 and thus lies more nearly adjacent the upper conveyor, it is ordinarily unnecessary to provide a depending baffle wall corresponding to the wall 42 at the juncture of the roof of the final heating chamber and the recuperative chamber 10.

As the sheets pass from the final temperature zone after having been raised to the requisite normalizing heat therein, it is desirable to quickly reduce their temperature to a point at which further grain growth is arrested and a practical fixation of the fine grain structure effected. We therefore provide means for bringing about a relatively rapid reduction in the temperature of the sheets at this point in their traverse through the furnace, and while said means may be of any form suitable for effecting the desired function we find that good results may be obtained by providing a plurality of transversely extending, flattened pipes 46 adjacent the inner end of the roof of the recuperative chamber 10 and thus substantially above the baffles 43 and 44, these pipes being suitably connected to a source (not shown) of cooling fluid, such as water, which is circulated through the pipes. Thus as the subjacent sheets S are moved past the relatively cool pipes they are cooled or quenched to the requisite extent. Similarly and for a like purpose, we may provide a plurality of corresponding pipes 47 adjacent the inner end of the recuperative chamber 9 and above the lower conveyor so as to suitably cool or quench the subjacent sheets S′ as they are carried past the pipes by this conveyor; these pipes 47 may be conveniently supported on the under side of the baffle 40 and connected, like the pipes 46, to a convenient source of cooling fluid supply. As stated, however, while these flattened pipes, through which a circulation of cooling fluid is maintained, are satisfactorily operative for effecting the requisite rapid cooling or quenching of the sheets as they pass from the final temperature chamber, any other means suitable for the performance of this function may be employed in lieu thereof if preferred.

In the operation of the furnace the sheets S either alone or supported on a waster sheet are consecutively fed into the furnace through the upper door 7 in the end wall 5 and are then progressively carried by the conveyor entirely through the furnace and discharged therefrom through the upper door 6 at the opposite end thereof while in a similar way sheets S′ are consecutively fed into the furnace through the lower door 6, either singly or each supported on a waster sheet, progressively carried through the furnace by the lower conveyor and finally discharged therefrom through the lower door 7 at the opposite end. Heat is of course continuously supplied to the final temperature zone 8 in sufficient quantity to bring the sheets S to the requisite normalizing temperature by the time they reach the left-hand end of this zone or chamber when viewed as in Fig. 1 and to similarly bring the sheets S′ to the requisite normalizing temperature by the time they reach the right-hand end of said zone or chamber. As the sheets S pass beneath the pipes 46 and similarly as the sheets S′ pass beneath the pipes 47, they are subjected to the action of the cooling medium which quickly lowers their temperature sufficiently to practically fix the fine grain structure of the sheets and prevent further grain-growth therein; the cooling or quenching effect, however, is desirably regulated so that the temperature of the sheets will not be reduced materially below the point at which the desired fixation of grain-structure is effected whereby as the sheets pass beyond their respective cooling or quenching points they still retain a considerable amount of residual heat which is radiated from the sheets into the recuperative zone or chamber through which they are passing and is thus effective to raise the temperature thereof and preheat the adjacent incoming sheets on the other conveyor. Thus, more particularly, as the sheets S pass into and traverse the recupera-

tive chamber 10 a considerable portion of their residual heat is given off within the chamber and reflected downwardly by the low roof thereof to the subjacent sheets on the conveyor 16 which, entering the chamber through the lower door 6, are thus progressively heated as they approach the final temperature chamber 8 so that upon entering the same they are much hotter than when introduced to the furnace with the result that they can be raised to the required normalizing temperature more quickly and with less expenditure of heat than would be required if they entered the final temperature zone at the temperature at which they were initially introduce to the furnace. In a generally similar manner, the sheets S′ as they leave the cooling pipes 47 and progressively pass through the recuperative zone 9 are effective to heat the super adjacent incoming sheets S on the upper conveyor both by direct radiation thereto as well as indirectly through the heat given off to the sides, bottom and roof of the chamber so that the sheets S on entering the final temperature zone are materially hotter than when introduced to the furnace and thus need less heat and less time to raise them to the normalizing temperature than would otherwise be required. Additionally, the radiation of heat which takes place from the hot sheets S or S′ as the case may be during their passage through the respective recuperative zones or chambers results, by the time the sheets are ready to pass out of the furnace, in so reducing the temperature of the sheets as to prevent the formation of scale thereon after they are ejected from the furnace while, of course, all of their heat which has been transferred to the relatively cold incoming sheets has been usefully employed in preheating the latter and thus conserved and utilized in the performance of useful work with consequent enhancement of economy of operation.

A further advantage of our invention resides in the fact that when waster sheets are used as a support for the sheets to be normalized and are thus ejected from the furnace with the latter at one end or the other thereof, they may be immediately separated from the normalized sheets and used on the other conveyor as supports for the unnormalized sheets which are passing into the furnace from that end; the waster sheets being thus returned to the furnace before all of the heat which they have absorbed in their passage therethrough is dissipated, a further economy is effected through the conservation in this manner of heat which is otherwise lost if the waster sheets are allowed to cool to atmospheric temperature after leaving the furnace and before being returned thereto.

When normalizing sheets of the same thickness, the conveyors are desirably run at the same speed so that the time required for the sheets to traverse the furnace on either conveyor is substantially the same. However, the furnace may be used with equal facility for normalizing sheets of two different thicknesses in which case as the thicker sheets naturally require a longer time for normalization under the same temperature conditions than do the thinner sheets, that conveyor upon which the former are carried through the furnace may be run at a lower speed than the conveyer transporting the lighter sheets thereby maintaining the heavier sheets in the furnace for the additional time required to properly normalize them.

In Figs. 3, 4 and 5 we have shown a somewhat modified form of our invention in which the conveyors, instead of being superposed, are arranged side by side thus ordinarily decreasing the height of the furnace but increasing its width for a given capacity.

Since in this form of the invention the construction of the side walls, bottom, roof and supporting means therefor are desirably substantially similar to that heretofore described, extended reference thereto would be superfluous. As stated, however, the furnace is usually made wider and lower as will be apparent from an inspection of Fig. 5 and because of this decrease in height but a single set of burners 30 will generally be found sufficient, these burners being directed into the final temperature zone just below the furnace roof.

Two horizontally aligned series or sets of conveying rolls 50 and 51 are employed and extended respectively inward through the side walls of the furnace which are provided with suitable openings for the passage thereof. The rolls are desirably of such length as to leave a longitudinally extending space between their adjacent inner ends along the center line of the furnace and those portions of the rolls within the furnace are provided with conveying discs 52, 53 corresponding to the discs 19 and 20 heretofore described. The outer end of the rolls beyond the side walls of the furnace may be journaled in supports 55 and any suitable means provided for driving each set of rolls, for example, sprockets and chains generally designated as 57 and 58 may be employed, or drive shafts and bevel gearing of the general character of that shown in connection with the form of the invention heretofore described.

For confining the heat as much as possible within the final temperature zone, the furnace may be provided with transversely extending baffle walls 60 and 61 beneath the conveyor rolls at the ends of the final temperature zone while quenching means 62 and 63 corresponding to the quenching means 47 and 46 are disposed respectively above the conveyors so as to quench the sheets as they pass from the final temperature zone in either direction. In this form of the invention, however, the quenching means, for example

the flattened pipes 62 and 63, are not carried entirely across the furnace roof but are respectively terminated substantially above the inner ends of the subjacent conveyors and are thus respectively effective only upon the sheets carried thereby.

In this form of the invention the height of the recuperative chambers is preferably the same, as shown in Fig. 4, instead of the roof of the chamber 9 being somewhat higher than that of the chamber 10 as in the other form of the invention previously described; thus there is no necessity for providing a transversely extending baffle between chamber 9 and the final temperature zone corresponding to the baffle wall 42 in that form of the invention.

In operation the two horizontal aligned series of conveyor rolls are rotated in opposite directions and the sheets S to be normalized consecutively fed thereto from opposite ends of the furnace so that they will be carried through the furnace in opposite directions and discharged from opposite ends thereof, the sheets being successively quenched by the superjacent quenching means as they pass from the final temperature zone so as to effect substantial fixation of the grain structure in the manner already described. When waster sheets are utilized for supporting the sheets to be normalized in their passage through the furnace, the waster sheets as they are discharged therefrom at the opposite ends thereof may be immediately returned to the furnace upon the other and oppositely moving conveyor so as to conserve their heat as far as possible while, as in the case of the other form of the invention, the heated sheets, and waster sheets if used, after leaving the final temperature zone and during their passage through the recuperative chambers are effective to raise the temperature of the adjacent incoming sheets so that the latter enter the final temperature zone in a preheated condition with consequent conservation of heat and reduction in operating costs as heretofore mentioned.

While we have herein described certain forms of our invention with considerable particularity, we do not thereby desire or intend to confine ourselves thereto nor to any precise details of design, construction and arrangement of the various parts, nor to the use of any particular form, number or arrangement of burners, as the same being a matter of choice may be modified in various ways and in numerous particulars without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described our invention, we claim and desire to protect by Letters Patent of the United States:

1. A normalizing furnace comprising a central chamber, and a recuperative chamber adjacent each end thereof and communicating therewith, a plurality of burners extended through the walls of the central chamber and operable to heat said chamber to a predetermined temperature, means for substantially confining within the central chamber the heat generated by the burners, adjacent conveyors extending through all of said chambers and respectively adapted to progressively carry material to be normalized therethrough from opposite ends of the furnace along vertically spaced paths and in opposite directions and means disposed adjacent the inner end of each recuperative chamber operable to quickly reduce the temperature of said material as it passes into said chamber from the central chamber.

2. A normalizing furnace comprising a central chamber and a recuperative chamber adjacent each end thereof and communicating therewith, vertically spaced conveyors extending in opposite directions through all of said chambers, burners projecting into the central chamber and adapted to heat the latter to a predetermined temperature, means adjacent each end of the central chamber adapted to confine the heat therein, and means adjacents said last mentioned means operative to rapidly reduce the temperature of material disposed on the conveyors as it is carried thereby from the central chamber into the recuperative chambers.

3. A normalizing furnace comprising a central chamber and a recuperative chamber adjacent each end thereof and communicating therewith, said recuperative chambers being of less height than the central chamber and respectively of different heights, a pair of vertically spaced conveyors extending through all of said chambers and respectively operable to convey material through the furnace in opposite directions, burners projecting into the central chamber and adapted to heat the latter to a predetermined temperature, means adjacent each end of the central chamber adapted to confine the heat therein, and means adjacent said last mentioned means operative to rapidly reduce the temperature of material disposed on the conveyors as it is carried thereby from the central chamber into the recuperative chambers.

4. A normalizing furnace comprising a central chamber forming a final temperature zone and a recuperative chamber adjacent each end thereof and communicating therewith, said recuperative chambers being of less height than the central chamber, a pair of superposed vertically spaced conveyors extending longitudinally through all of said chambers, means for driving the conveyors in opposite directions, burners extending into said central chamber operable to maintain the temperature of the latter at a predetermined degree and means adjacent the inner ends of the recuperative chambers operative to reduce the temperature of material dis-

posed on the conveyors as it is carried thereby out of the central chamber and into the recuperative chambers.

5. A sheet normalizing furnace comprising a central chamber forming a final temperature zone and a recuperative chamber of less height than the central chamber adjacent each end thereof and communicating therewith, a pair of sheet conveyors disposed one above the other and extending longitudinally through all of said chambers, means for driving the conveyors in opposite directions, burners extending into said central chamber from opposite sides thereof operable to maintain the temperature of the chamber at a predetermined degree, means adapted to confine the heat generated by said burners within the central chamber, and means adjacent the inner end of each recuperative chamber operative to quickly reduce the temperature of the sheets as they are consecutively carried by the conveyors in opposite directions from the central chamber and into the recuperative chambers.

In witness whereof we have set our hands this 19th day of February, 1929.

ELMER E. McVEY.
WILLIAM F. BARTHOLOMEW.