No. 733,112. PATENTED JULY 7, 1903.

T. V. ALLIS.

PROCESS OF REDUCING HOT METAL BARS INTO SHEETS.

APPLICATION FILED MAR. 28, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

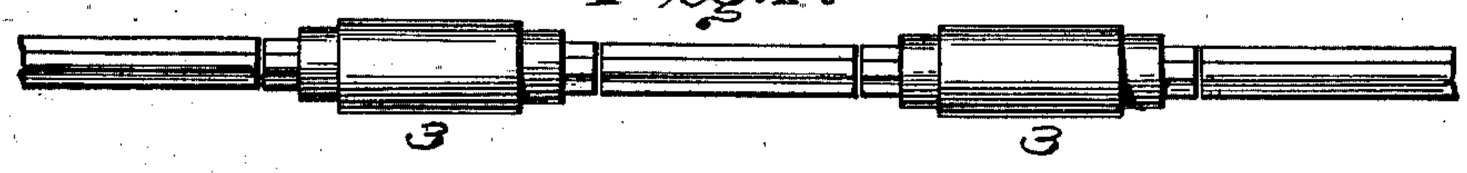
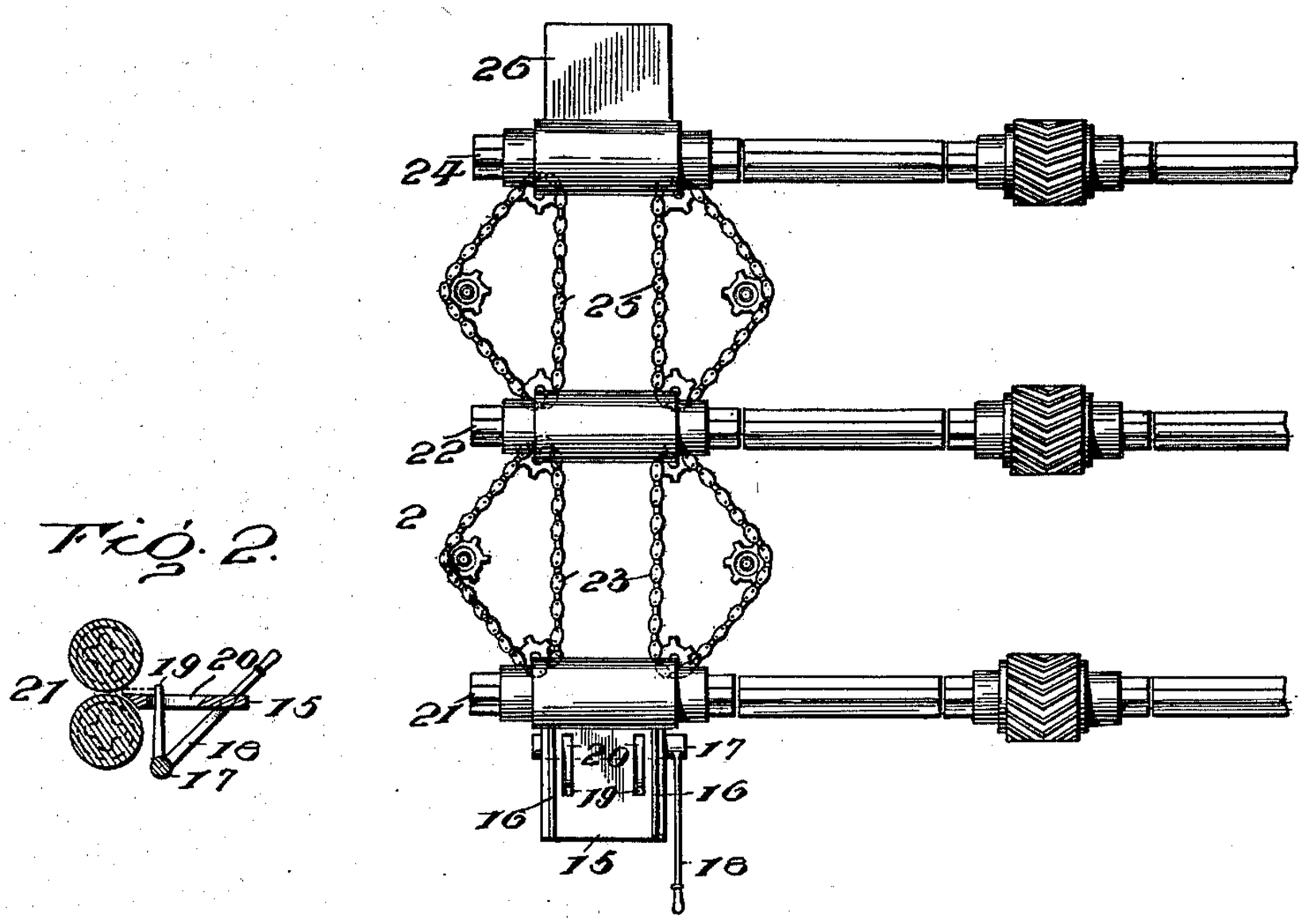
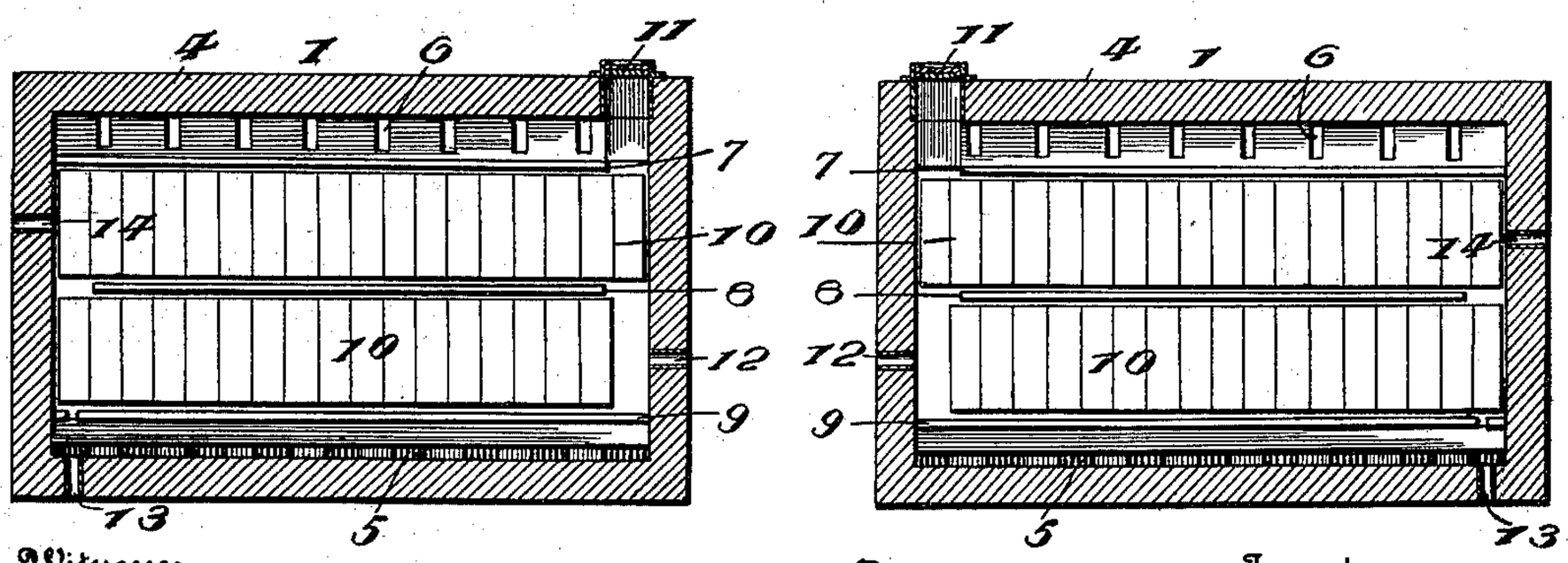


Fig. 2.





Witnesses.
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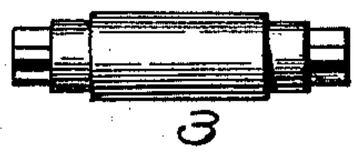
NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.



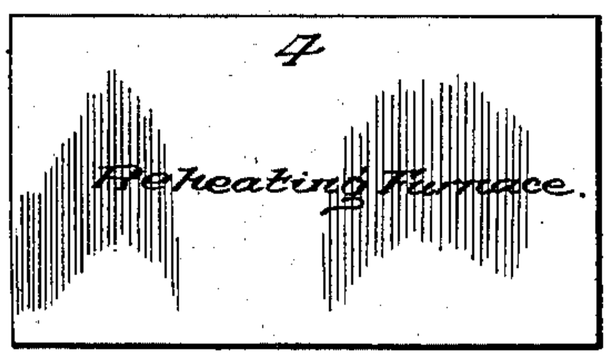
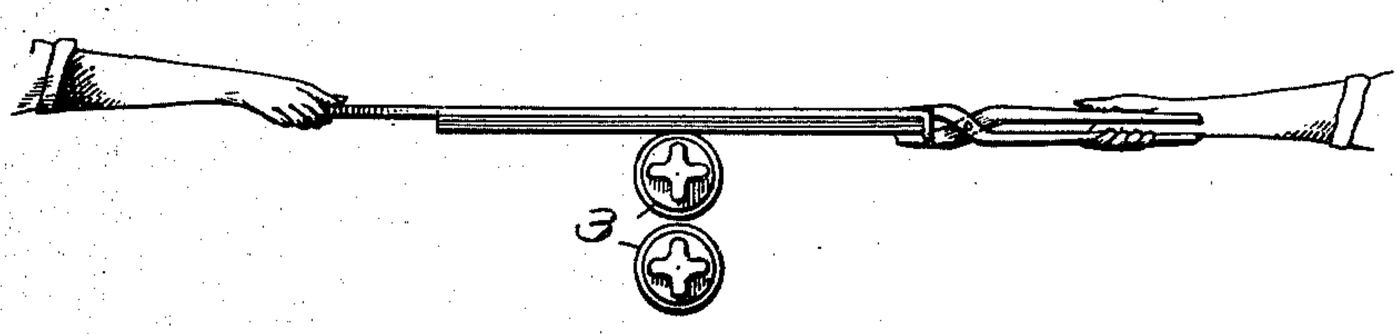


Fig. 4.



Witnesses
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No. 733,112. Patented July 7, 1903.

UNITED STATES PATENT OFFICE.

THOMAS V. ALLIS, OF BRIDGEPORT, CONNECTICUT.

PROCESS OF REDUCING HOT METAL BARS INTO SHEETS.

SPECIFICATION forming part of Letters Patent No. 733,112, dated July 7, 1903.

Application filed March 28, 1903. Serial No. 150,053. (No model.)

To all whom it may concern:

Be it known that I, THOMAS V. ALLIS, a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Processes of Reducing Hot Metal Bars into Sheets; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the art of reducing metal bars into sheets in a heated state.

My present invention consists in, first, reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train; second, making the plates thus produced into a pile or pack, and, third, reducing the plates constituting such pile or pack into sheets by rolling the pile or pack between a single pair of rolls.

The terms "pile" and "pack" are used herein in the following sense: The word "pile" refers to a plurality of plates assembled one upon another, and the word "pack" refers to such a pile doubled or folded back upon itself.

The object of my invention is to economize in the manufacture of such sheets. Most metals, and especially the baser ones, cannot be economically reduced in single plates to a thickness much below one-sixteenth of a inch. When much thinner material is required, the metal is gradually reduced hot and in pile or pack made up of a plurality of plates. In reducing iron and steel the bars for such pile or pack must be reduced to a certain extent to constitute plates before they are made into a pile or pack; otherwise they unduly adhere to each other. After having made them into a pile or pack their further reduction must be continued by the employment of rolls which have become heated by use or by special heating means, else the plates are robbed of their heat by contact with the colder rolls and but slight reduction effected. Furthermore, such contact chills the outside plates of a pile or pack and prevents their reduction and elongation to an extent equal with the inner plates. Hence the result is irregularity in the thickness and length of the sheets. It is further necessary that one or both of the rolls of the pair employed in reducing the pile or pack shall have their faces turned to a defined concave form to compensate for the change in their shape or contour occasioned by their expansion as they become heated during use. It is impracticable to maintain chilled rolls, which are necessary for use in this branch of the art and which vary in the depth and density of their chill, in definite shape, owing to the variable expansion and contraction occasioned by such unequal chill and the varying temperatures to which they are subject by friction and contact with the hot metal. This fact has prevented the use of the tandem train of rolls for reducing plates in piles or packs.

While for the reasons above given it is impracticable to reduce piles or packs of metal plates in a tandem train of rolls, such train can be used to great advantage in the reduction of single bars. My process involves the use of a train of this character in conjunction with a single pair of auxiliary rolls. The tandem train is used for roughing—*i. e.*, partially reducing—the bars singly into plates, for the reason that it is the quickest means for accomplishing such reduction. The single pair of auxiliary rolls is employed to complete the reduction of the plates in pile or pack into sheets. The operation of the auxiliary rolls is controlled by a skilled workman who is able to constantly vary their adjustment by means of screws to meet the constantly-varying conditions due to the unequal expansion and contraction of the rolls, the varying heat and temper of the metal, the thickness of the sheets to be produced, and other conditions requiring accurate judgment on the part of the roller.

The invention will be more readily understood by reference to the accompanying drawings, in which—

Figure 1 is a plan view of a rolling-mill plant comprising two heating-furnaces, a tandem train of rolls, and two pairs of auxiliary rolls, the furnace being shown in horizontal section. Fig. 2 is a sectional side elevation of the device for feeding bars to the tandem train of rolls. Fig. 3 is a plan view of a single pair of auxiliary rolls and a reheating-furnace adjacent thereto; and Fig. 4 is an end

elevation of the auxiliary rolls shown at either Fig. 1 or Fig. 3 and with a pile or pack of sheets resting upon the top roll and held thereon by the usual handling-tongs and with the usual hooked measuring-rod in position to determine the length of the pile or pack, which in turn indicates the thickness of the sheets constituting the pile or pack.

Two pairs of auxiliary rolls 3, as shown at Fig. 1, or a single pair of such rolls, as shown at Fig. 3, are or is located at any convenient distance from the tandem train, and when, as shown in Fig. 3, it may be desirable to reheat the piles or packs before rolling them in the auxiliary rolls a reheating-furnace 4 is located conveniently for that purpose.

Each heating-furnace 1 comprises a rectangular structure 4, having a hearth for supporting the bars to be heated. A series of ports 5, extending along one side of the hearth, serves to introduce a mixture of gas and air, and the products of combustion sweeping across the furnace above the bars escape through a series of downtake-ports 6 at the other side of the hearth. The hearth, which is preferably covered by a cast-iron plate, has three parallel ribs 7, 8, and 9, between which are arranged two rows of abutting cast-iron carrier-blocks 10. These carrier-blocks preferably have means for supporting the bars on edge, so that their sides will be freely exposed to the heating-gases. A door 11, extending through the side wall of the furnace at its end, serves for the introduction and removal of the bars. In charging the furnace the bars are placed singly upon a carrier-block directly in front of the door by means of a pair of tongs. The block, with its charge of bars, is then pushed endwise across the furnace into the vacant space at the end of the row of blocks lying between ribs 8 9. This row of blocks is then moved toward and nearly against the other end wall of the furnace by means of a pushing-bar operating through an opening 12. A pushing-bar is now inserted through opening 13 in the side wall and the block directly in front of it is pushed across the furnace into the vacant space at the end of the row of blocks lying between ribs 7 8. This row of blocks is then moved toward and nearly against the end wall of the furnace by means of a pushing-bar operating through opening 14. Another block is thus brought in front of the door and receives its charge of bars. As the blocks carrying the bars pass through the furnace along a rectangular path the metal is brought to the required temperature, indicated by a cherry-red color, and the bars are taken from the blocks as they arrive in succession in front of the door. Two or more furnaces are usually required to furnish a sufficient number of heated bars to occupy the capacity of the tandem train of rolls, and they are charged and discharged in succession. This type of furnace is fully described and claimed in my application, Serial No. 132,480, filed November 22, 1902.

The heated bars as taken from the blocks are carrried to the tandem train of rolls and placed in succession upon the feed-table 15. This table has guide-ribs 16 at each side. Beneath the table is a rock-shaft 17, having an operating-lever 18 and two vertical arms 19, each of which moves within a slot 20 in the feed-table. Each bar is placed on the feed-table between the ribs 16 and in front of the arms 19. The arms 19 are then moved forward by means of the lever 18, and the bar is thus pushed squarely between the first pair of rolls 21 of the tandem train, as illustrated in dotted lines at Fig. 2. The bar is then carried rapidly to the second pair of rolls 22 by means of a pair of chain conveyers 23, preferably of the construction described in my United States Patent No. 699,133. From the second pair of rolls the bar is carried to the third pair 24 by a second pair of conveyer-chains 25. The heated bars are passed through the tandem train in succession, and the bars thus reduced to plates drop successively upon a table 26 in accumulated mass as they leave the last pair of rolls, the top of this table being sufficiently below the top of the lower roll of said pair to allow a large number of the plates to accumulate upon it one upon another.

In lieu of dropping the successively-rolled plates in an accumulated mass upon the table 26 such plates may be deposited in mass upon any other suitable receptacle adapted to constitute a means for transporting such accumulated mass to any desired locality. The plates as they are delivered from the rolls in tandem train may also be piled in vertical stack form, thus confining the area of the "accumulated mass" of plates to the area or boundary of the individual plates composing the stack, and by this means the latent heat of each plate and the aggregated heat of all the plates constituting the stack contribute to keeping the mass or body of plates at a higher and more uniform temperature than would be the case with a like number of plates congregated in a disordered mass, occupying a greater area than the stack form. The advantages of the heat thus aggregated is that it acts to soften or anneal the individual plates, which is important if it be desirable or necessary to fold or double such plates, and when the reheating of a pile made from the plates constituting such stack is desirable or necessary they may be more expeditiously and economically reheated by reason of this latent and aggregated heat. Such plates may also be delivered successively from the rolls in tandem train to any suitable chain conveyer, and thus expeditiously and with the loss of a comparatively small degree of heat transported to any desired locality.

As large a mass or stack of plates as may be convenient to handle and transfer may be accumulated upon table 26 one upon another in successive order as they issue from the

last pair of rolls of the tandem train. The stack of plates received upon the table 26 when sufficiently large may be transferred bodily to the auxiliary furnace 4 or elsewhere for preliminary treatment, and if to the furnace or elsewhere they are preferably made into piles or packs in the reverse order of their issue from the tandem train and in numbers required for further reduction. When these piles or packs of plates are transferred to the auxiliary furnace and have become sufficiently heated, they are withdrawn from the furnace and reduced to the required thickness by rolling them between a single pair of rolls. When necessary to fit the plates to the shape of the auxiliary rolls, they are passed singly from a pile between said rolls in order that each plate shall conform to the shape of the rolls, and as they are successively delivered on the opposite side of the rolls they are collected into their original pile, so that the said pile as a whole likewise will conform to the shape of the said or similar rolls. They are then finally reduced to sheets of the required thickness by passing the pile between such rolls as many times as may be required.

The reason for making the plates into piles or packs in the order of their delivery from the tandem train to be reduced to sheets in a heated state by the single pair of auxilary rolls is that each succeeding plate issuing from the tandem train is nearer the size, shape, and thickness of the next preceding plate than others more remotely rolled from each other in said train. Therefore a few successive plates match and assemble in a pile or pack uniformly.

Those skilled in the art will recognize the fact that although each pair of rolls in a tandem train may be set to do its proper proportion of the reduction that from various causes no great number of plates will be delivered therefrom of exactly the same shape, length, width, and thickness. Therefore to get plates rolled in a tandem train which will match uniformly in a pile or pack for further reduction it is necessary to make up such pile or pack from a comparatively small number of plates rolled successively. The variation in such small number is scarcely perceptible, while the variation in one hundred plates taken at random would be detrimentally great. Plates that do not evenly match in a pile or pack cause wasteful scrap in the finished sheet. It is therefore obviously better to successively make the plates into a pile or pack in the order delivered from the tandem train.

The regular sheet or tin-plate bars of commerce or any suitable bars may be employed in this process.

The bars are usually rolled transversely to their length or in the direction of their shortest dimension. It is most essential that the bars shall be squarely introduced into the bite of the first pair of rolls of the tamden train and thereafter conveyed to the successive pairs of rolls in the train in that position; otherwise their traverse through the train would be in an oblique course, and even though the bars succeeded in passing through the train their shape would be distorted from the desired rectangular form. Therefore I employ the locating and feeding device and guides in front of the first pair of rolls of the tandem train. This device locates the longitudinal edges of the bars parallel with the axial line of said rolls, and a movement of the lever enters the bars between them in this necessary relation thereto. The bars having squarely entered the first pair of rolls issue therefrom in the same relation, and by means of the chain-conveying guides which engage the bars at their ends while still held in the bite of the first pair of rolls they are consequently conveyed to each succeeding pair of rolls in the train in the same relation that they enter and leave the first pair of rolls. Water may be run on the first one or two pairs of rolls in the tandem train, which has the beneficial effect of removing scale from the bars, and thereby producing a smoother finished sheet.

While the tandem train of rolls is especially desirable to effect the reduction of bars to plates, piles or packs of plates cannot be finished in such train for the following reasons: First, if the rolls are not readjusted to properly compress—*i. e.*, "set"—each pile or pack at the first pass between them a condition called "patching" ensues, which means that the plates comprising the pile or pack have not sufficiently adhered to each other to prevent their shifting one upon the other in subsequent passes between the rolls, which causes the plates to cohere to the extent that separation at their finish is not only difficult, but at many times impossible; second, the unequal expansion and contraction of chilled reducing-rolls operated in a heated condition require the constant adjustment of the screws controlling the vertical position of each end of the top roll; otherwise the pile or pack would be bowed or crooked edgewise, which either ruins it or causes a wasteful quantity of side scrap to be sheared off to straighten the edges, and it is only the eye of a skilled "roller" that can detect such approaching defects and bestow the timely remedy of adjusting the controlling-screws at his command; third, as it is impossible to gage the thickness of hot plates in a pile or pack during their reduction such thickness must be determined by the elongation of the pile or pack which is measured by the roller, who places a hooked rod with the required length marked thereon over one end of the pile or pack, which when elongated to that mark indicates that the sheets therein are reduced to the required thickness. The temper of the metal which is being reduced, as well as the heat imparted to it, often vary. Consequently the treatment of the pile or pack in its reduction must vary. Frequently when but

slight reduction is required to finish a pile or pack to the proper length it is held upon the "working plate" by the roller or thrown upon the floor and allowed to partially cool before giving it the final pass between the rolls. The exact temperature of the pile or pack, which will determine its elongation and consequent reduction of the sheets therein to the required gage, must be judged entirely by the roller, whose skilled discernment cannot be supplanted by mechanical means.

In operating my novel process any suitable heating-furnace may be used instead of the furnace herein shown and described.

It will be understood that my process is equally applicable in the production of sheets in pile or plates doubled into what is understood in the art as "packs."

My invention contemplates the reduction of bars to sheets by distinct operations—first, by passing such bars between pairs of rolls in tandem train to reduce them into plates; second, preferably accumulating such plates in a mass or stack at the delivery end of the tandem train of rolls, and, third, subjecting the same to the necessary steps to convert the plates therein into sheets of the required thickness, and if it be desired or becomes necessary to transport the plates as delivered from the tandem train to any locality for treatment, such as trimming or doubling, before charging the piles or packs into a reheating-furnace they may be expeditiously and very economically transported bodily. As a sequence of this feature of my invention I am enabled to accumulate the number of such plates in stack at the delivery end of the tandem train as shall constitute a multiple of the number of plates desired to be made into a pile or pack for subsequent reduction to sheets, and hence all of the plates in the stack will be used in making such piles or packs, and consequently no plates will be left over or remain. Should plates be left over, it would be difficult to match them with other plates subsequently rolled.

What I claim as new is—

1. The process herein described of reducing metal bars into sheets in a heated state, which consists in, first, reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, second, rolling the plates thus produced singly between a single pair of rolls, third, making said plates into a pile or pack and reducing the plates therein into sheets by rolling the pile or pack between a single pair of rolls.

2. The process herein described of reducing metal bars into sheets in a heated state, which consists in first, reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, second, making said plates thus produced and undivided into a pile or pack, third, reducing the plates therein into sheets by rolling said pile or pack between a single pair of rolls.

3. The process herein described of reducing metal bars into sheets in a heated state, which consists in reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, depositing the plates thus produced in accumulated mass at the delivery end of said train, making piles or packs of the plates comprising said mass and reducing the plates in said piles or packs into sheets by rolling the piles or packs between a single pair of rolls.

4. The process herein described of reducing metal bars into sheets in a heated state, which consists in reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, successively depositing the plates thus produced one upon another in accumulated mass in vertical stack form at the delivery end of said train, making piles or packs of the plates comprising said mass and reducing the plates in said piles or packs into sheets by rolling the piles or packs between a single pair of rolls.

5. The process herein described of reducing metal bars into sheets in a heated state, which consists in reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, the number of bars which constitute a multiple of the predetermined number of plates required to form a pile or pack, collecting said plates in a stack at the delivery end of said train, making piles or packs from the plates comprising said stack, each pile or pack containing said predetermined number of plates, reducing the plates in said piles or packs into sheets by rolling the piles or packs between a single pair of rolls.

6. The process herein described of reducing metal bars into sheets in a heated state, which consists in reducing the bars into plates by passing the bars singly between pairs of rolls in tandem train, piling the plates thus produced into a vertical stack in the successive order of their delivery from said train, transferring said stack in the same order for subsequent treatment, making the plates comprising said stack into piles or packs in the reverse order they were delivered from said train and reducing the plates in said piles or packs into sheets by rolling the piles or packs between a single pair of rolls.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS V. ALLIS.

Witnesses:
DAVID L. GITT,
L. M. GOTWALD.