Aug. 14, 1928. 1,680,522

L. JONES

METHOD OF AND MILL FOR ROLLING STRIPS AND SHEETS

Filed Jan. 19, 1924 4 Sheets-Sheet 1

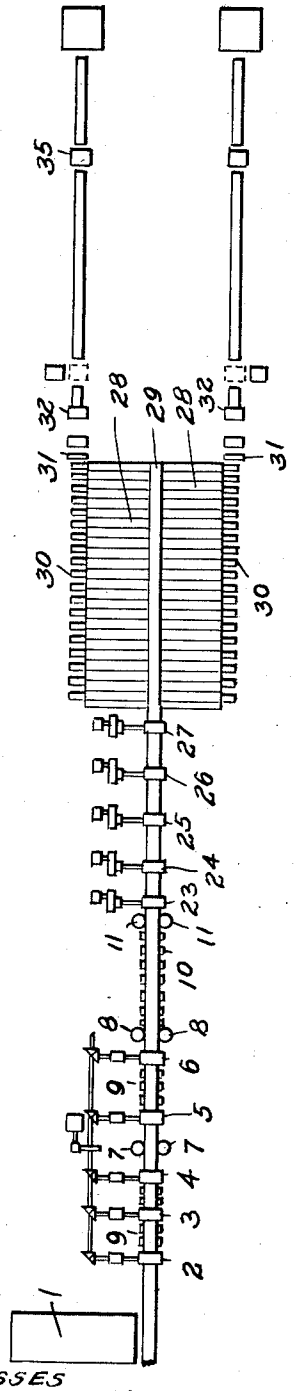

FIG. 1.

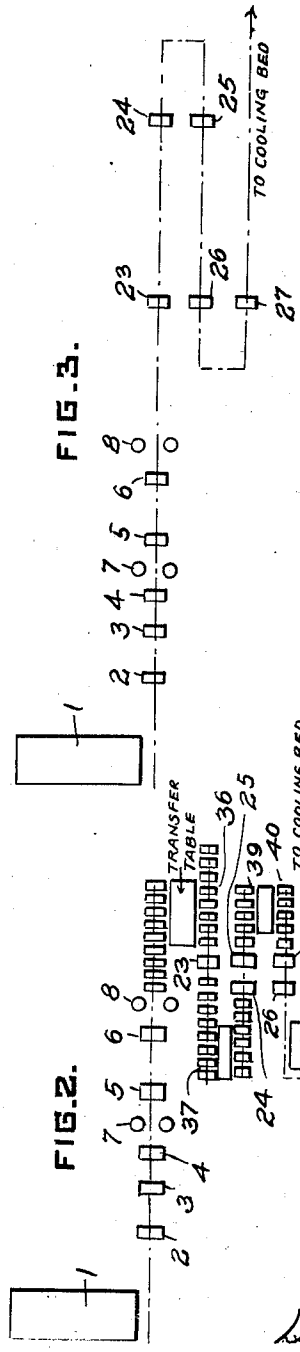

FIG. 3.

FIG. 2.

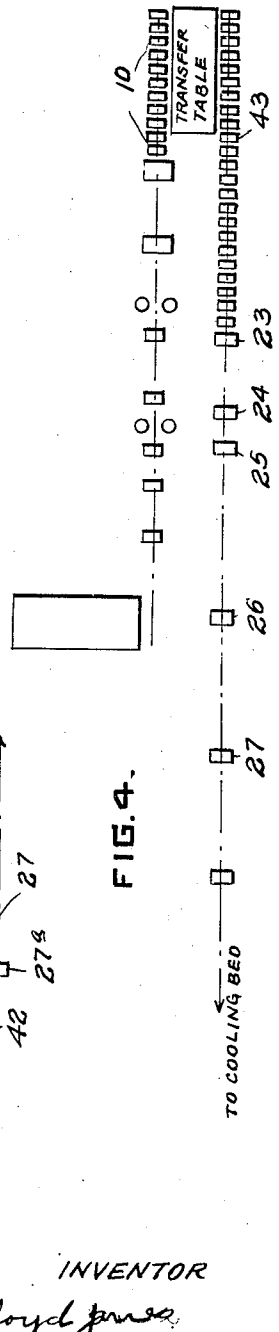

FIG. 4.

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METHOD OF AND MILL FOR ROLLING STRIPS AND SHEETS

Filed Jan. 19, 1924 4 Sheets-Sheet 2

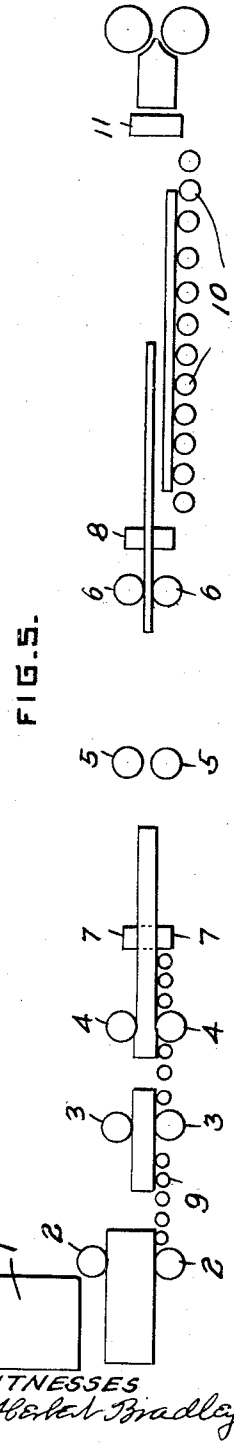

FIG. 5.

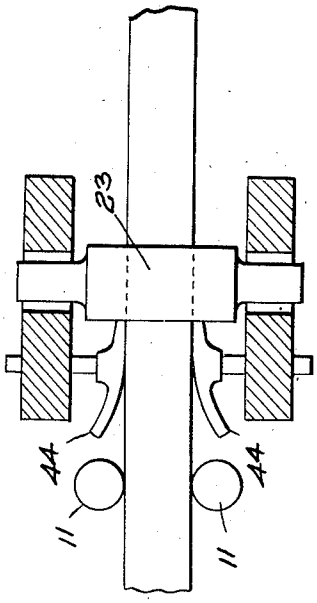

FIG. 7.

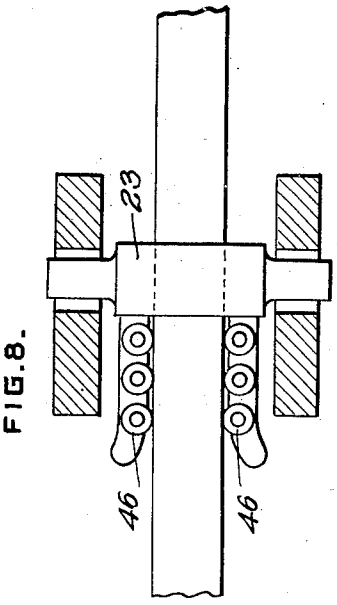

FIG. 8.

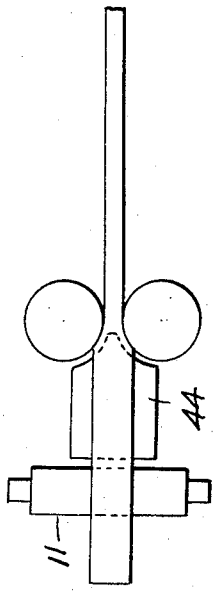

FIG. 6.

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METHOD OF AND MILL FOR ROLLING STRIPS AND SHEETS

Filed Jan. 19, 1924 4 Sheets-Sheet 3

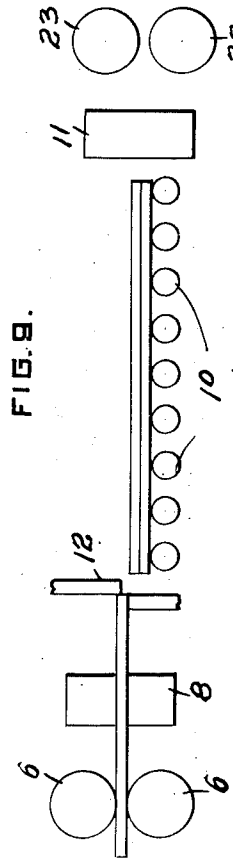

FIG. 9.

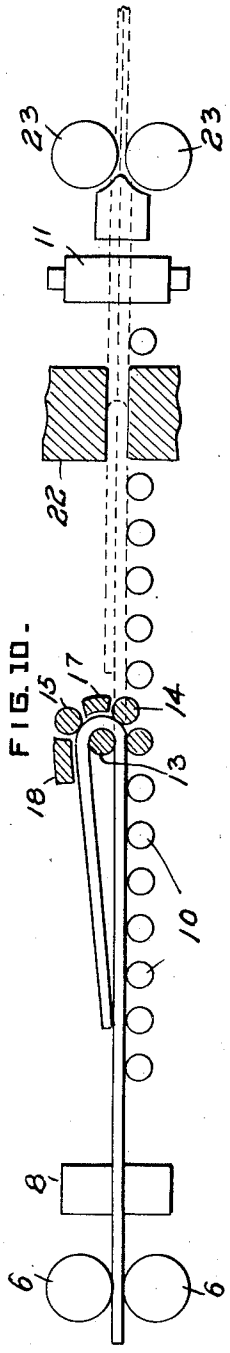

FIG. 10.

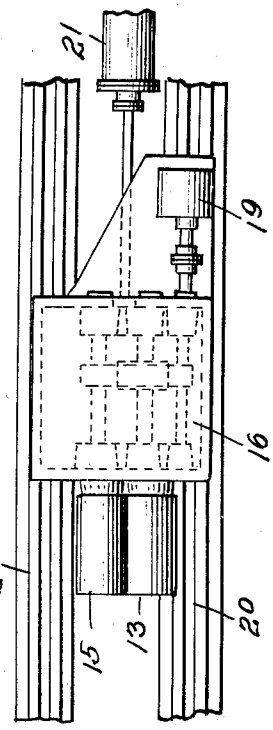

FIG. 12.

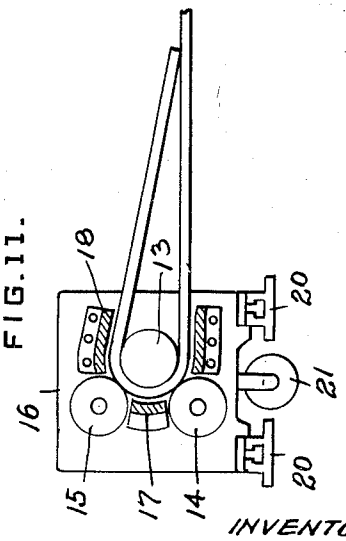

FIG. 11.

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Aug. 14, 1928. 1,680,522

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METHOD OF AND MILL FOR ROLLING STRIPS AND SHEETS

Filed Jan. 19, 1924 4 Sheets-Sheet 4

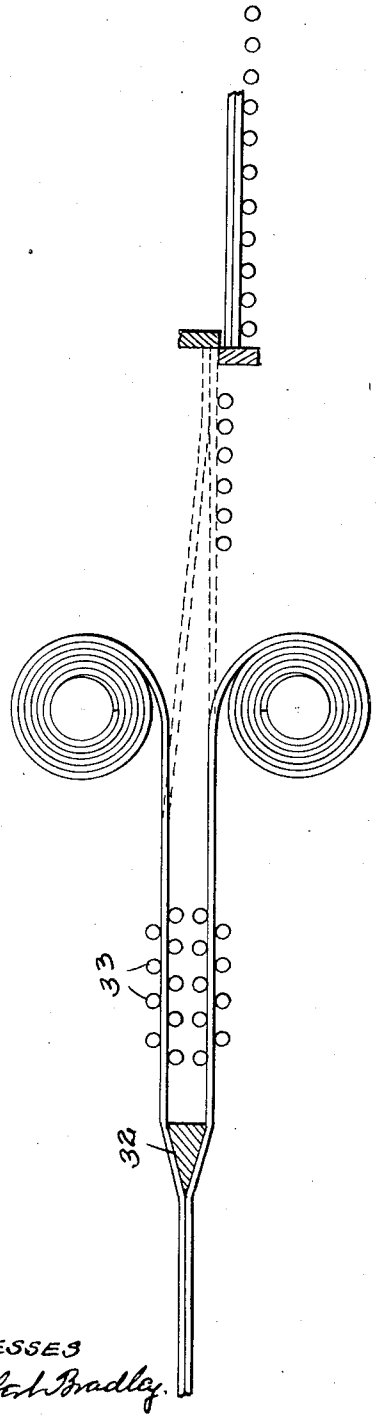

FIG. 13.

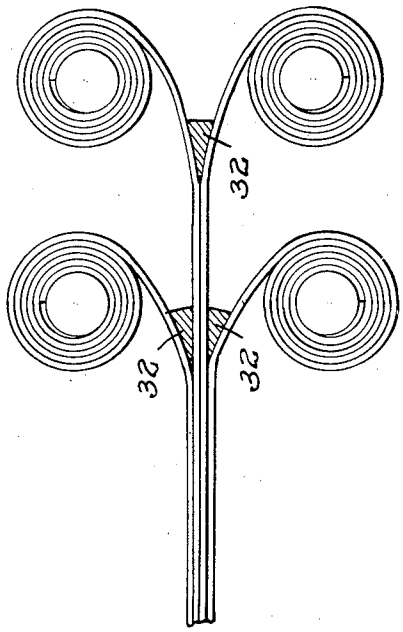

FIG. 14.

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Patented Aug. 14, 1928. 1,680,522

UNITED STATES PATENT OFFICE.

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METHOD OF AND MILL FOR ROLLING STRIPS AND SHEETS.

Application filed January 19, 1924. Serial No. 687,337.

In the manufacture of sheets it is the practice to break down the sheet bars by passing them laterally between rolls until the transverse dimensions of such broken down bar is somewhat greater than the desired width in the sheets to be produced. Subsequent reduction is effected in a direction at right angles to that employed in breaking down the bars. It is practically impossible to form sheets of the desired gauge by rolling the sheets singly, hence it is the practice after the sheets have been brought approximately to the required thickness, to place two or more, one upon the other, and then roll such pack. In most cases single sheets are placed one upon the other and sometimes one or more sheets are doubled. Under the present methods no provision is made for preventing or controlling the lateral spreading of the metal and the sheets produced have ragged and irregular edges, hence the sheets as they come from the rolls must have a width sufficiently greater than that desired in the finished article to permit of the shearing off of the ragged edge portions which have a width varying from about three-quarters of an inch to an inch and a half or more.

Under the present practice of manufacturing strips, that is reducing a single thickness on the successive rolls to thin or sheet gauges, the spring of the rolls prevents reduction to what might be termed sheet gauges.

One object of the invention described and claimed herein is to produce strips of sheet gauges and sheets having finished, i. e., straight smooth edges and of a width only a small fraction of an inch greater than that required in the finished article.

Another characteristic of the improved method consists in effecting the entire reduction of the slab to the finished article without reheating. Reduction of temperature of the article being rolled is mainly due to radiation, the amount of heat radiated being approximately proportional to the areas of the radiating surfaces. In the manufacture of sheets, there is a rapid increase in the areas of the surfaces from which heat is radiated and a constant decrease in the mass of metal, and consequently there is a progressively increasing loss of heat, the loss being greatest during the stage of the old method preceding the matching as heat is radiated from both surfaces of the article. In the improved method, provision is made for reducing radiating areas at a time when the metal is plastic or at a high temperature. This reduction of radiation areas is effected by matching, piling, or doubling the article. The point in the rolling operation at which the piling or doubling should be effected, will be dependent upon partly the thickness of the slab and the gauge desired in the finished sheet. As for example, if the slab is about two inches in thickness, the doubling or piling could be effected when the article is between a half and a quarter of an inch in thickness. But in any event, the piling or doubling should be effected while the article is at a good rolling temperature. As will be readily seen, the superposing of the plates, one on another, eliminates two or more surfaces from which heat was formerly radiated. It has been found that by this method, sufficient heat will be conserved to permit of the completion of the reduction or rolling operation.

In the accompanying drawings forming a part of this specification, Fig. 1 is a diagrammatic plan view of a sheet mill for the practice of the invention claimed herein; Figs. 2, 3 and 4 illustrate modifications in the arrangement of the elements of the finishing portion of the mill; Fig. 5 is an elevation of the front portion of the mill shown in Fig. 1; Figs. 6 and 7 are detail views showing elevations and sectional plan of adjacent stands of vertical and horizontal rolls; Fig. 8 is a view similar to Fig. 7 illustrating a modification; Fig. 9 is an elevation illustrating a combination of stands of horizontal and vertical rolls, a shear and means for superposing sheared sections, one upon the other; Fig. 10 is a view illustrating a combination of stands of horizontal and vertical rolls and mechanism for bending or doubling the sheets; Fig. 11 is a sectional elevation; and Fig. 12 is a plan view of a doubling mechanism; Fig. 13 is a sectional view illustrating mechanism for separating sheets combined with reeling and shearing mechanisms; Fig. 14 illustrates means for opening packs consisting of more than two sheets and reels for the separated sheets.

In the practice of the invention, ingots are reduced in any suitable manner to slabs two or more inches in thickness, of any desired length, and having a width greater than that desired in the strips or finished sheets. The slabs, if sufficiently hot, are passed through the mill claimed herein. They may be heated

in a furnace of any suitable construction. From the furnace the slab is passed through a plurality of stands of horizontal rolls 2, 3, 4, 5 and 6. One of these stands of rolls, preferably the first stand 2, is constructed to give an edging pass, the slab being in a vertical position while being reduced. The rolls for edging are adjusted to reduce the slab approximately to the width desired in the strips or finished sheet. In the other stands of rolls the slab is reduced in thickness and elongated. As is well known to those skilled in the art, there will be little, if any, flow of metal laterally or in a direction parallel with the axes of the rolls of the stands in which reduction in thickness and elongation is effected, but in order to eliminate any bulging of the metal at the edges of the slabs, and to ensure straight finished edges in the strips or sheets, a sufficient number of stands of vertical rolls 7 and 8 are arranged intermediate the stands of horizontal rolls. It is preferred that the slab should not be reduced in the edging pass to the exact width desired in the finished sheet and that reduction in width may be effected by the vertical rolls. As shown, the stands of rolls 2 to 8 are arranged in tandem, but they are separated such distances apart that the article will be out of the bite of the rolls at one stand before entering the bite of the rolls of the succeeding stand, the movement of the article intermediate the stands being effected by feed rollers as indicated at 9.

Reduction in the stands of rolls 2 to 8 is carried to a point where greater efficiency will be attained by placing two or more strips or sheets one upon the other whereby such a conservation of heat is effected that reduction to the desired finish gauge may be effected without reheating. This superposing of the plates one upon the other can be effected in several ways, as for example, in the combination of elements shown in Figs. 1 and 5, two comparatively short slabs would be passed through the stands of rolls 2 to 8 in quick succession and the first plate will be held on a table 10 having feed rollers until the succeeding plate or plates have passed onto the preceding plate or plates. In order to facilitate the placing of the sheets one on the other, the feed table is so arranged that upper portions of the rollers of the feed table are a sufficient distance (dependent on the number of plates to be piled) below the plane of movement of the article from the last stand of rolls. As shown in Figs. 1 and 5, the piling table is preceded by the vertical rolls 8, and a similar stand of rolls 11 is arranged in the rear of the piling table, thereby ensuring not only the exact alinement of the plates of the pile, but also tranverse reduction to the desired width.

As shown in Fig 9, a flying shear 12 of any suitable construction may be arranged intermediate the vertical rolls 8 and the piling table, the latter being so located vertically that the upper portions of its rollers will be below the plane of movement of the plates through the shear. In the construction shown in Figs. 1 and 5, vertical rolls 11 are arranged in the rear of the piling table 10.

The construction shown in Figs. 1 and 5 and in 2 and 9 are preferable in cases where reduction to a gauge at which doubling is difficult is effected in the stands of rolls preceding piling. Where reduction to a comparatively thin gauge is effected in rolls 2 to 8, the piling can be effected either in the manner above described and shown in Figs. 1, 2, 5 and 9, or piling may be effected by doubling a sheet on itself, as shown in Figs. 4, 10, 11 and 12. This doubling may be effected by any suitable means such for example as that shown, which consists of a plurality of overhanging rolls 13, 14 and 15, rotatably mounted in a housing 16 and guide plates 17 and 18. One of the rolls, as 13, serves as a former around which the end of the sheet is bent by the action of the rolls 14 and 15 and guides 17 and 18. The rolls 13, 14 and 15 are preferably driven by a motor 19 mounted on the housing 16, which is movable on rails 20 by a motor 21 into and out of the line of movement of strips or sheets along the piling table 10. As a sheet is advanced along the table 10, its end will enter between the rolls 13 and 14 and by the action of said rolls and the guides 17 and 18 and rolls 15 the sheet will be directed back along the advancing portion of the sheet. As soon as one portion has been superposed on the other portion, the motor 21 is operated to withdraw the doubling mechanism. The folded end then moves under the movable pressing head 22 which will flatten the folded portion so that it will enter the first of a series of stands of horizontal rolls whereby reduction may be completed. After the flattening of the fold, the doubled material passes between vertical rolls 11 which will ensure the edge alinement of the folded piece.

From the vertical edge alining rolls 11, the piles of two or more sheets are passed through a plurality of stands of horizontal rolls 23, 24, etc., whereby final reduction is effected, and after reduction the piles preferably pass onto cooling beds 28 which may be made in two sections arranged respectively on opposite sides of a feed table indicated at 29. This cooling bed is provided with suitable means whereby the piles may be moved transversely onto feed tables 30, 30a. These tables feed the piles onto shears 31 for shearing off the closed end, as is necessary when the piles are formed by doubling. The piles are then fed to sheet separating mechanism (indicated at 32) of any suitable construction such for example as that shown and described in Letters Patent No. 1,372,013, granted March 2, 1921, to Robert Edwards. In order to eliminate any bends or irregularities produced by the action of the opening mechanism, it is pre-

ferred to pass the sheets through a straightening device 33. After straightening, the sheets may be passed to reels 34 or if short lengths are desired, through shears 35.

As before stated, the stands of rolls 2, 3, 4, 5, and 6, are arranged in tandem, but preferably not in such proximity that the piece being rolled will be in the bite of adjacent stands of rolls. It is preferred, however, that the stands of rolls 23, 24, etc. forming the finishing portion of the mill, should be arranged in tandem and also in such proximity that the piles being rolled will be in the bite of the rolls of two or more stands, simultaneously, the successive pair of rolls being driven at a higher speed than the preceding pair or stand, proportional to the reduction effected in the latter, as is the practice in the operation of continuous mills.

While the arrangement of the several elements of the mill shown in Figs. 1 and 5, is preferred, the arrangement of the several parts of the mill subsequent to piling, relative to the anterior portion of the mill and the arrangement of the several elements of the posterior portion of the mill, relative to each other, may be changed without departing from the invention claimed herein. As for example, in Fig. 2, after piling, the piled sheets are shifted laterally by any suitable construction of transfer mechanism, indicated at 36, to a feed table 37, operating to move the pile in a direction the reverse of the movement of the pieces prior to piling, to the stand of rolls 23. After passing through the stand of rolls 23, the piece is again transferred laterally and fed through. Two examples of desirable arrangements of the finishing portion of the mill are illustrated in Figs. 2, 3 and 4. In Fig. 2 provision is made for the lateral shifting of the pile from the piling table to the feed table 36 of the stand of rolls 23, from the receiving table 37, by transfer table, to the feed table in front of two stands of rolls 24 and 25, by transfer table from receiving table 39 to feed table 40 in front of stands of rolls 26 and 27, from receiving table of rolls 26 to feed table 42 in front of a stand of rolls 27^a and from the latter to the cooling bed.

In the arrangement shown in Fig. 3 two of the finishing stands of rolls 23 and 24 are in alinement with the piling table, the succeeding stands 25, 26 and 27, etc. are arranged parallel with the line of feed through the stands 23 and 24, but the direction of feed through the rolls 25 and 26 is reverse of that through the stands 23 and 24 and the direction of feed through the stand 27 is the reverse of that through the preceding stands. Suitable transfer tables are employed for moving the pile from one line of feed to the other.

In the arrangement in Fig. 4 the pile is moved laterally from the piling table to a feed table 43 in front of the first of the series of finishing stands of rolls 23 to 27, which are arranged in tandem, may be spaced so that the pile will not be operated on by two adjacent mills simultaneously or may be spaced so that the pile will be in the bite of the rolls of two or more stands simultaneously.

As shown in Fig. 7, it is preferred to employ guides 44 to ensure the proper entrance of the pile between the rolls as it advances from the following stands of the mill and also to maintain the desired edge alinement of the pieces forming the pile. If desired the guides may be constructed as shown in Fig. 8, that is with the portions bearing on the edges of the pile formed by rollers 45.

It is characteristic of the improvement described and claimed herein that slabs are reduced to strips of sheet gauge or to sheets having finished edges by continuous rolling lengthwise of the sheet and that the width of the strip or sheet is determined by edge rolling in early stages of reduction and is maintained during all subsequent reductions.

I claim herein as my invention:

1. The method herein described of manufacturing strips or sheets, which consists in subjecting a slab to the action of a plurality of pairs of horizontal rolls whereby the slab is reduced in thickness and elongated, effecting a reduction in the width of the slab, superposing one rolled portion on another, subjecting such superposed portions to the action of a plurality of pairs of horizontal rolls to reduce such portions to the desired gauge, and subjecting the edges of the superposed portions to the action of rolls whereby the edges of such portions are brought into and maintained in alinement.

2. The method herein described of manufacturing strips or sheets, which consists in subjecting a slab to the action of a plurality of pairs of horizontal rolls whereby the slab is reduced in thickness and elongated, effecting a reduction in the width of the slab, superposing one rolled portion on another, subjecting such superposed portions to the action of a plurality of pairs of horizontal rolls to reduce such portions to the desired gauge, and subjecting the edges of the superposed portions to the action of rolls whereby the edges of such portions are brought into and maintained in alinement and reduced transversely to the desired width.

3. A mill for the manufacture of sheets and strips having in combination a plurality of stands of horizontal rolls, a plurality of stands of rolls for effecting edgewise reduction, means for piling partially reduced pieces, a plurality of stands of finishing rolls, means for ensuring the alinement of the edges of the piled pieces whereby the partially reduced pieces forming the pile are reduced to the desired gauge and with finished edges.

4. Continuous process of making commercial hot rolled sheet gauge stock which con-

sists in taking highly heated slab from the furnace, rolling the same down to and beyond sheet bar gauge, piling approximately at such gauge, and pack rolling and reducing to sheet gauge in strip mill length, all on original slab heat.

5. The method herein described of manufacturing strips or sheets, which consists in subjecting a slab to the action of a plurality of pairs of horizontal rolls whereby the slab is reduced in thickness and elongated, superposing one rolled portion on another, subjecting such superposed portions to the action of a plurality of pairs of horizontal rolls to reduce such portions to the desired gauge, and subjecting the edges of the superposed portions to the action of rolls whereby the edges of such portions are brought into and maintained in alinement.

In testimony whereof, I have hereunto set my hand.

LLOYD JONES.