(No Model.) 5 Sheets—Sheet 1.

J. HEMPHILL, J. F. WILCOX & J. FAWELL.

ROLLING MILL.

No. 525,207. Patented Aug. 28, 1894.

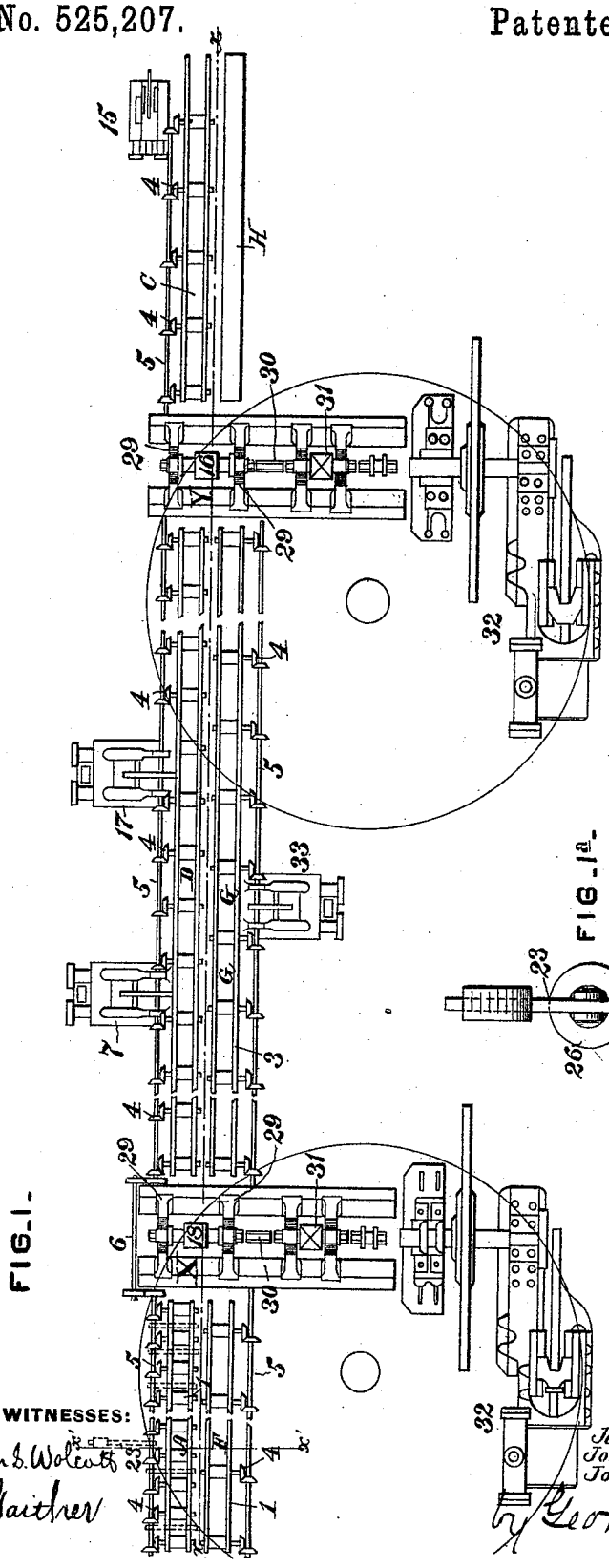

FIG. 1.

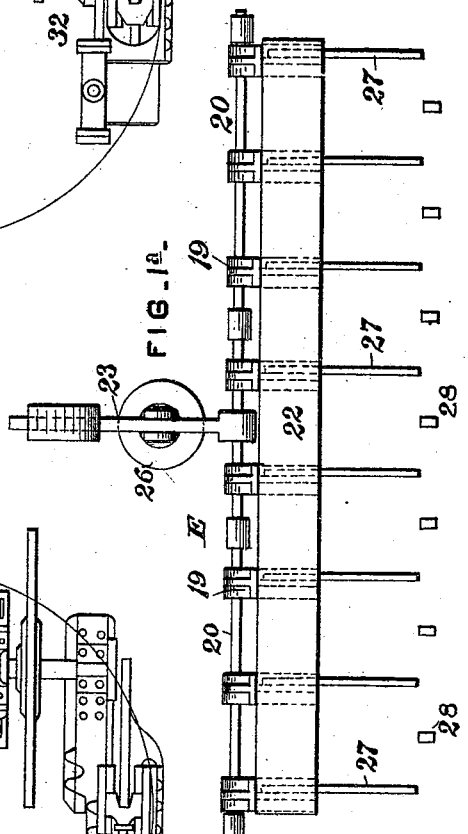

FIG. 1a.

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ROLLING MILL.

No. 525,207. Patented Aug. 28, 1894.

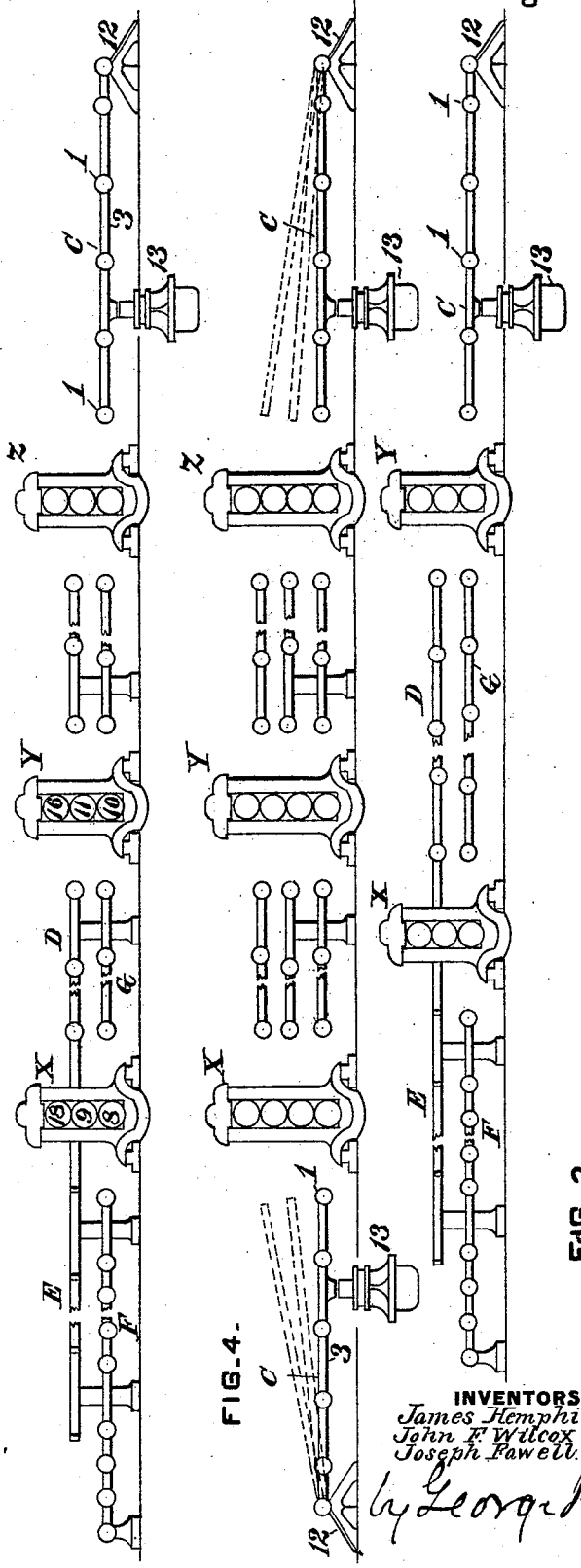

FIG. 3.

FIG. 2.

FIG. 4.

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ROLLING MILL.

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FIG. 5.

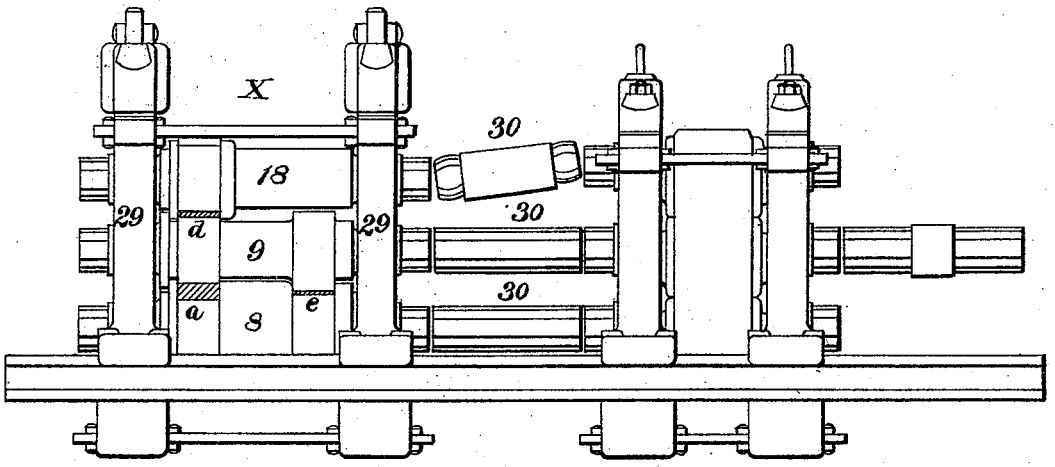
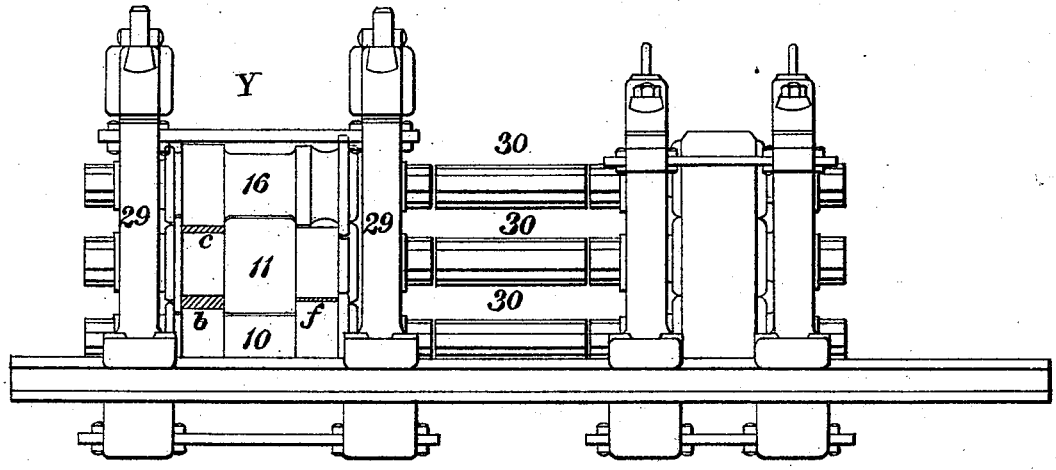


FIG. 6



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ROLLING MILL.

No. 525,207. Patented Aug. 28, 1894.

FIG. 7.

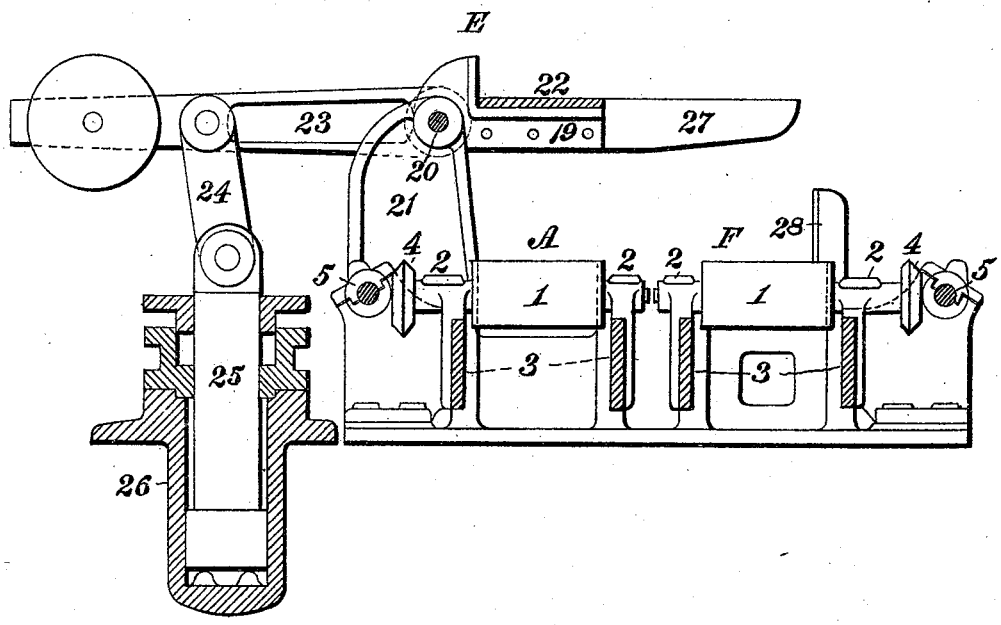
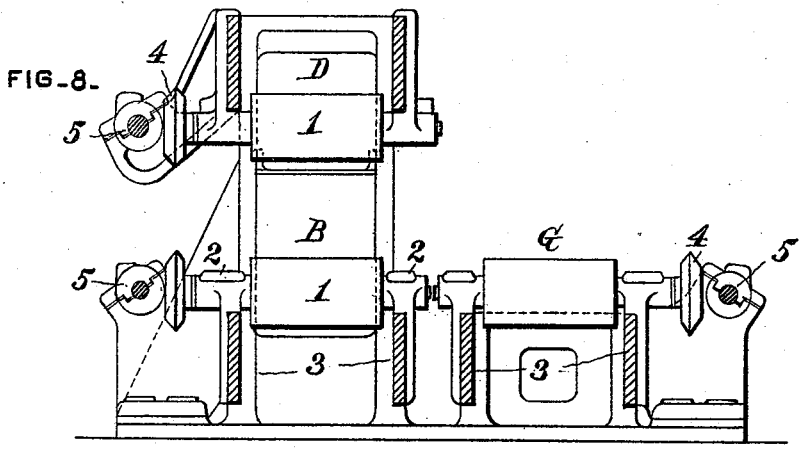


FIG. 8.



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ROLLING MILL.

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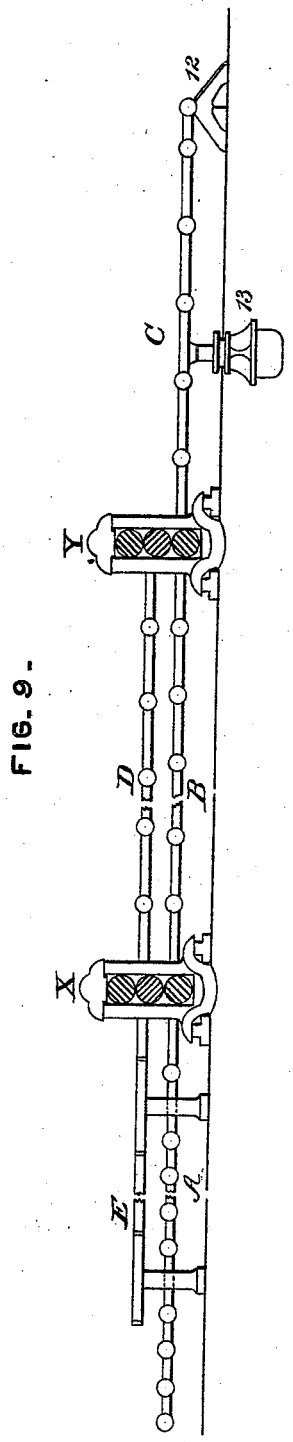

FIG. 9.

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UNITED STATES PATENT OFFICE.

JAMES HEMPHILL, JOHN F. WILCOX, AND JOSEPH FAWELL, OF PITTSBURG, PENNSYLVANIA.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 525,207, dated August 28, 1894.

Application filed July 5, 1893. Serial No. 479,649. (No model.)

To all whom it may concern:

Be it known that we, JAMES HEMPHILL, JOHN F. WILCOX, and JOSEPH FAWELL, citizens of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Rolling-Mills, of which improvements the following is a specification.

The invention described herein relates to certain improvements in rolling mills, and has for its object an arrangement of the stands of rolls and feeding tables in connection with the manner of operating the same, whereby disadvantageous features incident to mills now in use, are avoided. As, for example, three- or four-high mills as now operated are limited in capacity as only one article can be operated upon at a time. The two-high continuous mill is objectionable on account of the number of stands of rolls and engines necessary for operating the rolls, as well as the large space occupied by such a mill. Some of these objections have been overcome to a certain extent by employing two or more series, each composed of two or more stands or sets of two high rolls, the series being arranged parallel with each other, and their rolls operating in opposite directions. Such an arrangement necessitates the employment of transfer tables or other like mechanism for transferring the articles being rolled from one series to the next. And, further, such an arrangement is objectionable on account of the large number of stands or sets of rolls and their operating mechanisms employed, as each stand or set operates upon the article only once during the reduction thereof.

The object of the present invention is to provide for the successive operation of the rolls of three or four high mills upon the same article and their simultaneous operation on different articles, and, in general terms, the invention consists in the construction and combination, substantially as hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification, Figure 1 is a plan view of a mill constructed in accordance with our invention. Fig. 1ª is a top plan view of the tipping table. Fig. 2 is a side elevation of the same. Figs. 3 and 4 are views similar to Fig. 2, showing mills having three stands of three and four high rolls, respectively. Figs. 5 and 6 are views in elevation, on an enlarged scale, of the first and second stands or sets of rolls, respectively, of the mill shown in Figs. 1 and 2. Fig. 7 is an end elevation, on an enlarged scale, of the feed tables arranged in front of the first stand or set of rolls, the operating cylinder being shown in section. Fig. 8 is a sectional view of the intermediate feed tables, the plane of section being indicated by the line x', x', Fig. 1, and Fig. 9 is a longitudinal vertical section, the plane of section being indicated by the line x, x, Fig. 1.

In the practice of our invention, the article to be rolled whether ingot, bloom, billet or slab, is placed upon the feed table A, which consists of a series of positively driven feed rollers 1 having their journals mounted in suitable bearings 2 formed on the frame 3. The journals on one end of the rolls are provided with bevel pinions 4, which intermesh with correspondingly shaped pinions on the driving shaft 5, mounted in suitable bearings formed on the side of the frame 3, as shown in Figs. 7 and 8. While this shaft may be driven by a separate engine, it is preferred to drive it by means of the shaft 5 of table B through the medium of a countershaft 6, extending alongside of the housing of the stand of rolls X and provided at its ends with pinions intermeshing with pinions on the adjacent ends of the shafts 5, of the feed tables A and B. The feed table B is similar in construction and operation to the table A, but its driving shaft 5 is driven by an engine 7, either connected directly to the shaft 5 or to the countershaft 6 when it is desired to drive the rollers of tables A and B by one engine. This feed table B extends from the stands of rolls X, to the stand of rolls Y.

The feed table A, feeds the ingot, billet or slab into the pass a, formed by the rolls 8 and 9, of the stand X these being the lower and middle rolls of that stand. By the operation of the table B, the metal piece is carried into the pass b, formed by the lower and middle rolls 10 and 11, of the stand Y, and by these

rolls the article is delivered upon the feed table C, which is similar in construction as regards the feed rollers and their operating mechanism, to the table A, but the frame of this table C is hinged at its rear end to a suitable base or support 12, while its front end is connected to the piston rod of a vertical fluid pressure cylinder 13, whereby the front end of said feed table may be raised or lowered as required. After the metal piece has passed out of the pass *b* of the stand of rolls Y, the front or free end of the table C is raised a sufficient height so that, by reversing the operation of the engine 15, employed for driving the feed rollers of the table C, the metal piece may be fed into the pass *c*, formed by the middle roll 11, and upper roll 16, of the stand of rolls Y, by which the metal piece is fed onto the feed table D, arranged above the feed table B, and similar in construction thereto, and driven by an engine 17. By the operation of the feed rollers of the table D, the metal piece is fed into the pass *d*, formed by the middle roll 9 and the upper roll 18, of the stand of rolls X, and by these rolls 9 and 18, the metal piece is pushed forward onto a table E, indicated by dotted lines in Fig. 1 and consisting of a series of angular arms 19, secured upon a horizontal shaft 20, mounted in suitable bearings formed on an upward extension 21 of the frame of the feed table A, as shown in Figs. 1ª and 7. Upon the horizontal portions of these arms is secured a metal plate 22, forming a continuous bed for the reception of the metal piece. The vertical portions of these arms 19, form a guide for the metal as it slides along the metal plate. On the shaft 20, is also secured an arm 23, extending in the opposite direction from the arms 19, and the outer end of this arm is connected by a link 24, to the plunger 25, of a fluid pressure cylinder 26. The arms 19 are provided with extensions 27, which extend out over the table F, arranged alongside of the table A. As soon as the metal piece has been deposited upon the table E, fluid pressure is admitted into the cylinder 26, so as to raise the plunger, thereby so tipping the table E, that the metal piece will slide down the extensions 27, and be deposited upon the rollers of the table F. In order to insure that the metal piece will be properly deposited upon the rollers of the table F, a series of vertical posts 28, is secured to or formed along the side of the frames of the table F, and serve as stops to prevent too great a lateral movement of the metal piece, when the table E is tipped, as described. The table F is similar in construction to the table A, and is driven by the driving shaft of the table G, through the medium of the countershaft extending alongside of the stand of rolls X. The feed rollers of the table F are so rotated as to move the metal piece into the pass *e*, formed in the lower and middle rolls 8 and 9, of the stand X. By these rolls the metal piece is delivered onto the feed table G, which is similar in construction to the table B, and its rolls are driven in a similar manner by an engine 33. By this table G, the metal piece is fed into the pass *f*, formed in the lower and middle rolls 10 and 11, of the stand Y, and by these rolls the metal piece is delivered in a finished condition, so far as this mill is concerned, upon the delivery table H.

As shown in Figs. 5 and 6, each stand of rolls X and Y, consists of three rolls mounted in housings 29, of any suitable construction. These rollers are connected by suitable couplings 30, to the journals of the driving pinions 31, one of which is connected to the shaft of a suitable engine 32. If desired, one, two or more stands of rolls may be added to the mills shown in Figs. 1 and 2, as shown in Fig. 3, feed tables similar in construction and operation to those arranged between the stands of rolls X and Y, being interposed between the stand of rolls Y, and the additional stand of rolls Z. One of these feed tables is arranged in line with the feed table B, and serves to carry the metal piece from the pass between the lower and middle rolls of the stand of rolls Y, into a pass formed between the corresponding rolls of the stand of rolls Z. From the rolls Z, it is received by the table C, and raised to the pass formed between the upper and middle rolls of the stand Z, and from said stand the metal piece is carried by a table in line with the table D, into the pass formed between the upper and middle rolls of the stand of rolls Y. The third feed table is arranged in line with the table G, and carries the articles forward from the stand of rolls Y to the finishing pass formed between the lower middle rolls of the stand Z.

It will be readily understood by those skilled in the art that the shape of the passes in the several rolls may be changed from those shown, which are adapted for the formation of pipe skelps, and other forms of passes shaped in accordance with rules well known in the art for the production of any desired forms, such as rails, &c., may be employed.

It is characteristic of our invention that, while a metal piece is passing through the lower passes formed at one end of the rolls of the several stands, another piece may be passing in the opposite direction, through the upper passes on the same ends of the rolls, and a third piece may be passing in the same direction as the first piece, through the passes at the opposite ends of the lower rolls. Thus, it will be seen that by the employment of two three-high mills with feed tables arranged as described, a capacity more than one-third larger than that of two three-high mills, operated in the usual manner, is obtained, as, in addition to the fact that two more pieces can be operated on simultaneously in the same stand or set of rolls, no reversal of the rollers of the feed table is necessary, thereby effecting a considerable saving of time, as well as wear of machinery, incident to a reversal of its movements. It is, also, a characteristic of our improvement that the only lateral move-

ment of the piece being rolled necessary, is that in a vertical direction, from the lower to the upper pass of the last stand of rolls, by the feed table C, and by a combined vertical and horizontal movement from the upper to the lower pass, at the opposite end of the rolls by the table E of the first stand of rolls. These movements are very small, being equal to the diameter of the middle roll. By reason of this small lateral movement of the piece being rolled, a great saving of time is effected, as well as the simplification of the machinery necessary to effect such movement. It is, also, characteristic of our invention, *i. e.* the employment of a series of two or more stands or sets of three high rolls arranged in a common line of feed, that a greater number of passes or reductions is effected by the employment of a fewer number of rolls than in any other mill with which we are acquainted. As, for example, in our improved mill, six passes or reductions are provided, using only six rolls. In other forms of continuous mills employing two-high sets of rolls, twelve rolls would be necessary for effecting the same reduction.

While we have described an operation of our improved mill, wherein the metal piece is first operated on by the lower and middle rolls of the several stands or sets, then fed back between the upper and middle rolls, and then finished between the lower and middle rolls, it will be readily understood by those skilled in the art that the metal piece may be first fed through between the upper and middle rolls, then back between the lower and middle rolls, and finished between the middle and upper rolls.

As shown in Fig. 4, a four-high mill may be employed in lieu of the three-high. In such a mill, the feed tables at the ends of the series will be similar in construction and operation to the table C. In operating such a mill, while it is preferred to feed the metal piece through between the upper pair of rolls of each stand or set, then back through between the middle pairs of rolls, and finished between the lower pairs of rolls, this order of feeding may be reversed, the metal piece being first passed through between the lower pairs of rolls. In rolling regular forms such as skelp iron, the passes in the rolls may be arranged immediately above each other, and the feed tables similarly arranged in the same vertical planes. In rolling irregular shapes, such as rails, this arrangement of passes would not be practicable, on account of their changes of shapes. Hence, some of the passes would be arranged in one vertical plane, and others in another vertical plane. This different arrangement of passes would necessitate a slight horizontal movement of the feed tables at the ends of the series, and the feed tables intermediate of the several stands of rolls would be arranged in different vertical planes in the same manner as those shown in Figs. 1 and 2.

We are aware that both two and three high rolls have been employed in continuous mills, which have the several stands or sets of rolls arranged in such proximity to each other that the front end of the article being rolled enters the bite of one set of rolls before the rear portion thereof escapes from the bite of the preceding stand or set, so that a stand or set of rolls not only serve to reduce the article but also operate as feed rollers to feed the article to the next succeeding stand or set of rolls. In using a continuous mill it is necessary that each stand or set of rolls should be driven at a higher rate of speed than the preceding stand or set, proportional to the elongation effected by the preceding stand or set in order to prevent the article from looping out from the guide trough between the several stands or sets of rolls. These different speeds necessary in a continuous mill render it impracticable to employ three high rolls advantageously for the reason that when the article being rolled is passing from the front to the rear end of the mill, the second stand of rolls must be driven faster than the first stand and the third stand must be driven faster than the second stand, the last stand of rolls having the highest rate of speed, so that when the article is fed in the opposite direction from the rear to the front end of the mill, each successive stand or set of rolls will be rotating at a lower rate of speed than the preceding stand or set, thereby causing excessive looping out of the article.

In our improved mill the several stands or sets of rolls are placed a distance apart not less than the length of the articles to be rolled when elongated by the several passes so that the article is not at any time in the bite of two stands or sets of rolls. Hence, the relative rates of speed of adjacent stands or sets of rolls is immaterial, the article being carried from one set of rolls to the next by positively driven feed rollers. By arranging the several stands or sets such a distance apart that two adjacent sets do not operate simultaneously upon the same article, and connecting such passes of the several stands or sets as are in line with each other by independent positively driven feed rollers, it is possible to pass two or more articles through the mill at the same time, as hereinbefore stated.

It is characteristic of continuous mills that the several stands or sets of rolls must be placed in very close proximity to each other so that the shortest article to be rolled can be caught by one stand or set before being discharged from the preceding stand or set of rolls.

In our improved mill the length of the article to be rolled is immaterial as the shortest piece as well as the longest is carried forward from one stand or set to the next by the positively driven feed rollers.

We claim herein as our invention—

1. In a rolling mill plant, the combination

of a series of two or more stands or sets of three high rolls, two sets of stationary feed tables provided with driven rollers, and arranged to feed a piece of metal through passes formed in different vertical planes in the lower and middle rolls of the several stands or sets, a second set of stationary feed tables having driven rollers and arranged to feed a piece of metal in the opposite direction through passes formed in the same or approximately the same vertical plane in the middle and upper rolls of the several stands or sets and mechanism for transferring a piece of metal laterally and downwardly from the end feed table of the upper set to one of the end feed tables of the lower set, substantially as set forth.

2. In a rolling mill plant, the combination of a series of two or more stands or sets of three high rolls, two lines of feed tables having driven rollers and arranged side by side for feeding a piece of metal in the same direction through passes formed in different vertical planes in the middle and one of the outside rolls of each stand or set, a line of feed tables having driven rollers and arranged in or approximately in the same vertical plane as one of the other lines of feed tables and adapted to feed a piece of metal in the opposite direction through passes formed in the middle and the other outside rolls, mechanism for transferring a piece of metal laterally and vertically from the end feed table of one line to the end feed table of another line, and a vertically movable feed table having driven rollers arranged at the delivery end of the series of rolls, substantially as set forth.

3. In a rolling mill plant, the combination of a series of two or more stands or sets of three or four high rolls arranged in a common line of feed, and at a distance apart not less than the length of the article or product delivered from one to be fed to the other rolls of the several stands or sets, three or more lines of stationary feed tables provided with driven rollers, and arranged between the several stands or sets of rolls in line with the several passes thereof, the rollers of two lines of feed tables being driven in the same direction and those of the other line in the opposite direction, and vertically movable tables arranged at the ends of the series and provided with reversible feed rollers, substantially as set forth.

In testimony whereof we have hereunto set our hands.

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