(No Model.) 7 Sheets—Sheet 1.

E. M. BUTZ.

ROLLING MILL.

No. 499,651. Patented June 13, 1893.

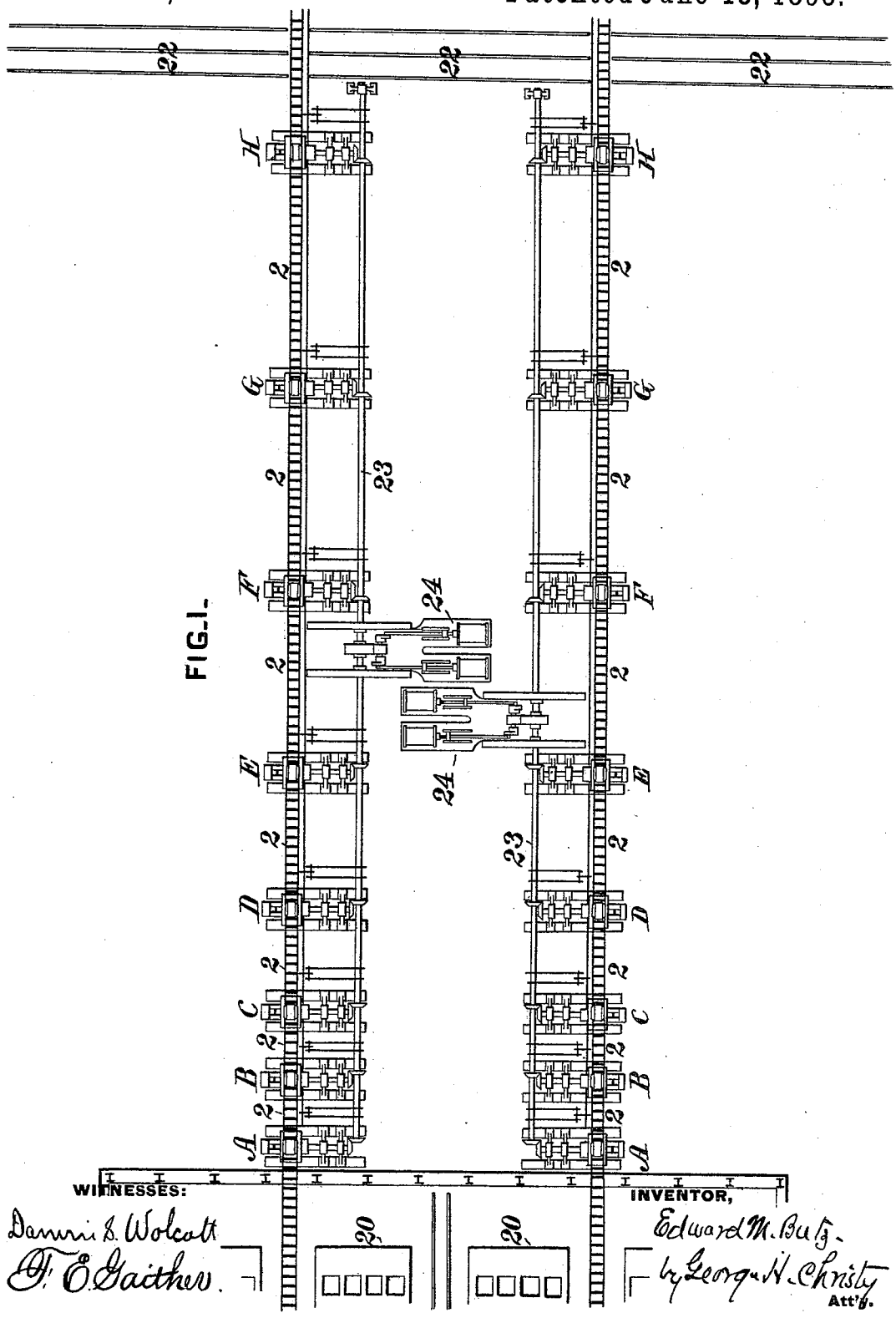

FIG. 1.

WITNESSES:
Dennis S. Wolcott
T. E. Gaither.

INVENTOR,
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by George N. Christy
Att'y.

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E. M. BUTZ.

ROLLING MILL.

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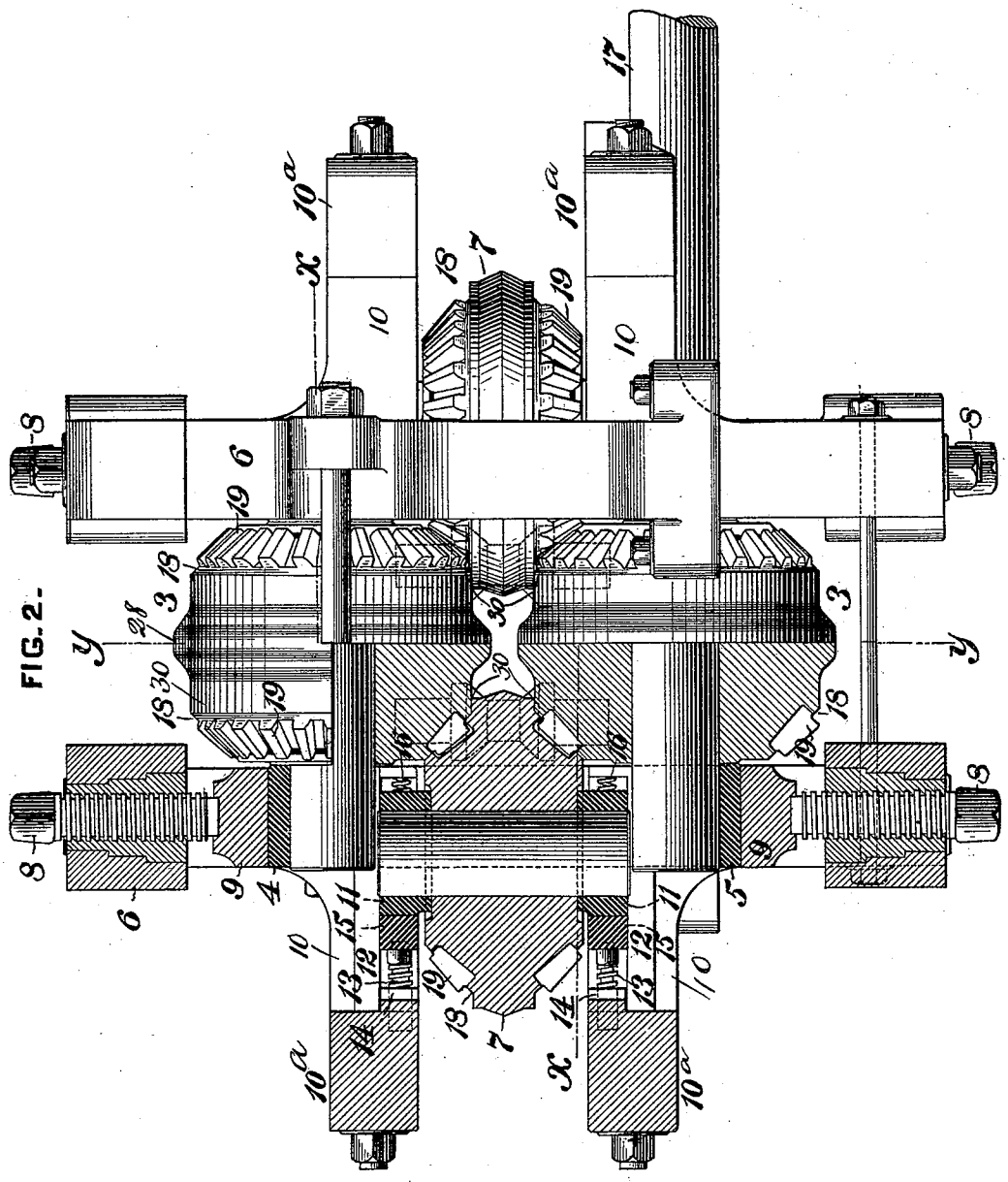

FIG. 2.

WITNESSES:

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(No Model.)

7 Sheets—Sheet 3.

E. M. BUTZ.

ROLLING MILL.

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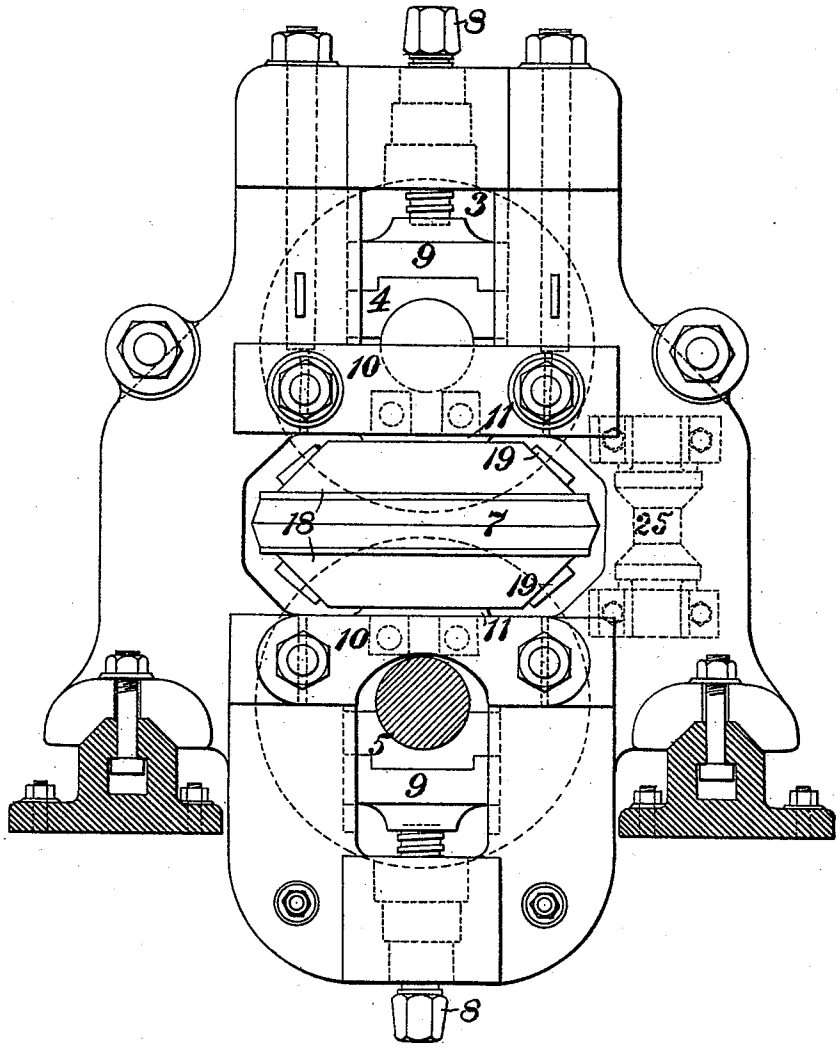
FIG. 3.



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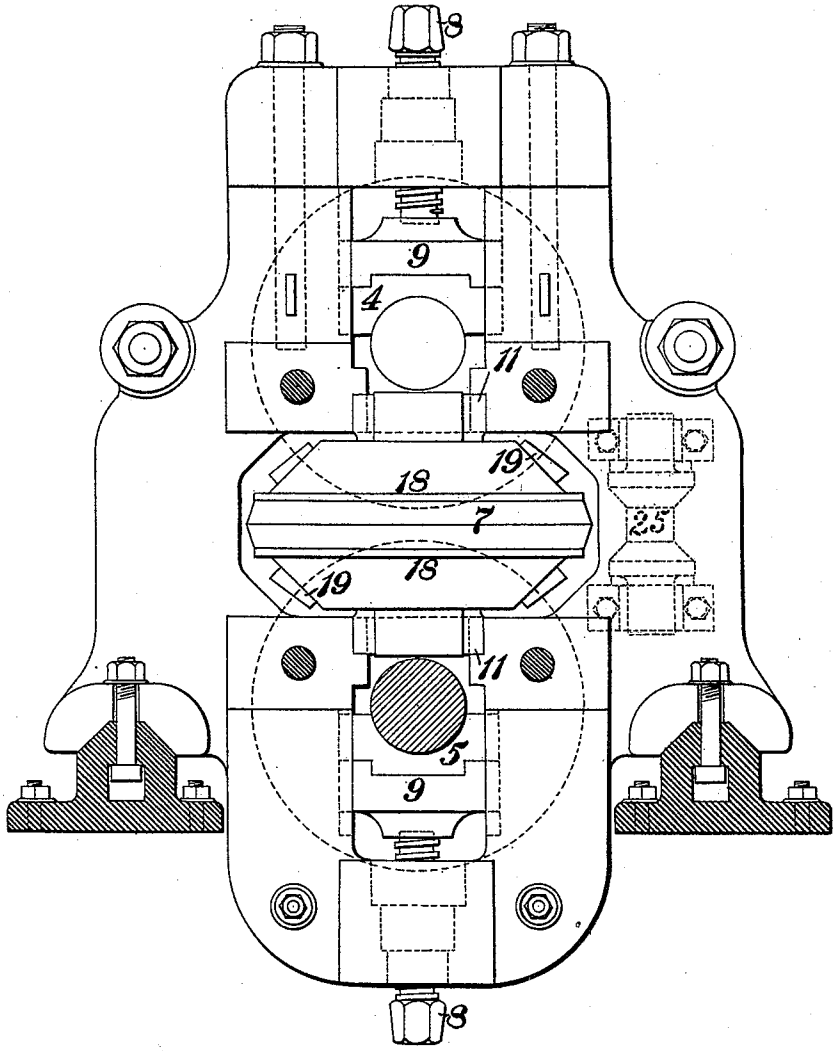
(No Model.) 7 Sheets—Sheet 4.

E. M. BUTZ.

ROLLING MILL.

No. 499,651. Patented June 13, 1893.

FIG. 4.



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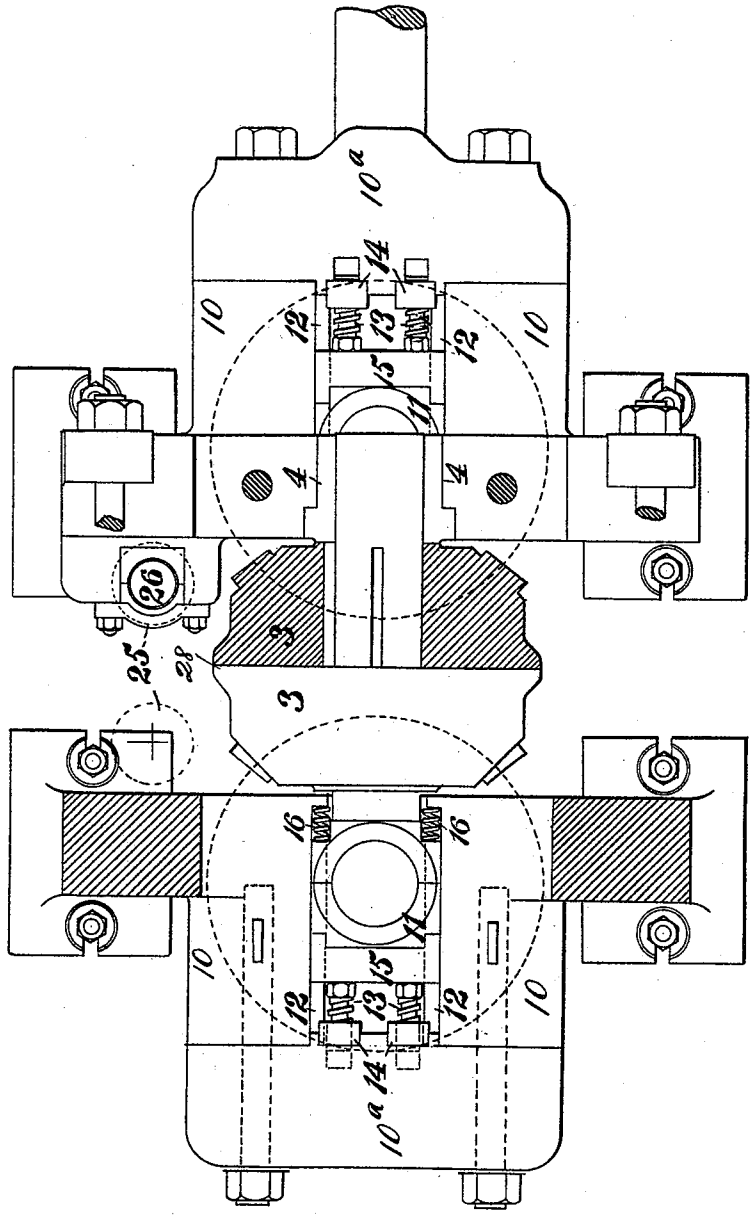
(No Model.) 7 Sheets—Sheet 5.

E. M. BUTZ.

ROLLING MILL.

No. 499,651. Patented June 13, 1893.

FIG. 5.



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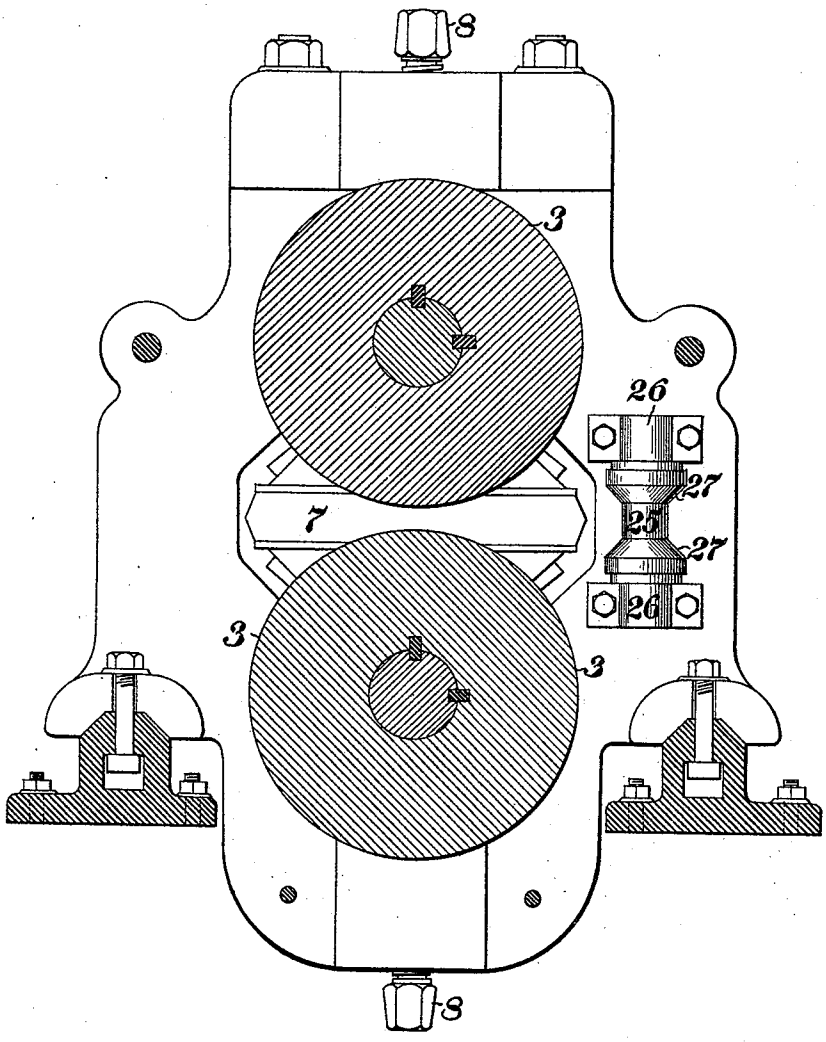
(No Model.) 7 Sheets—Sheet 6.

E. M. BUTZ.

ROLLING MILL.

No. 499,651. Patented June 13, 1893.

FIG. 6.



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Att'y

(No Model.) 7 Sheets—Sheet 7.

E. M. BUTZ.

ROLLING MILL.

No. 499,651. Patented June 13, 1893.

Fig. 7.

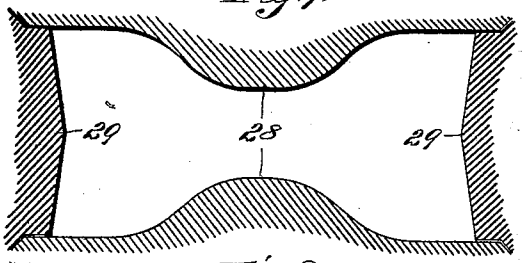


Fig. 8.

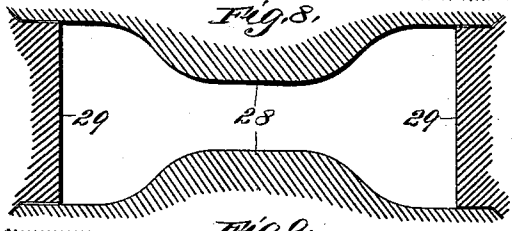


Fig. 9.

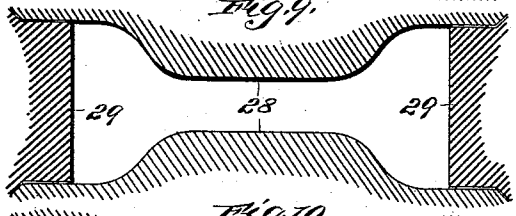


Fig. 10.

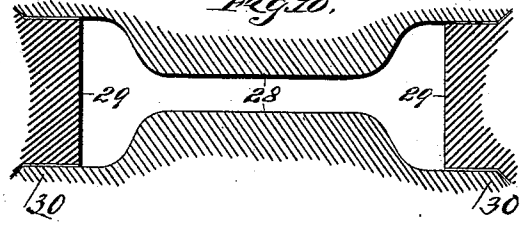


Fig. 11.

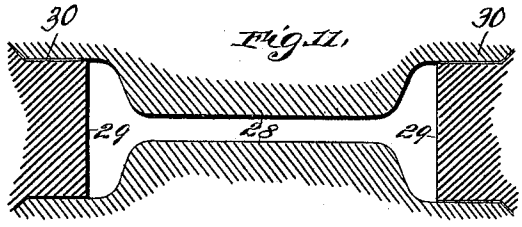


Fig. 12.

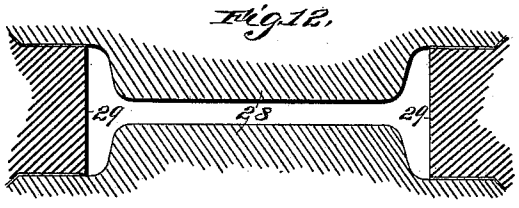


Fig. 13.

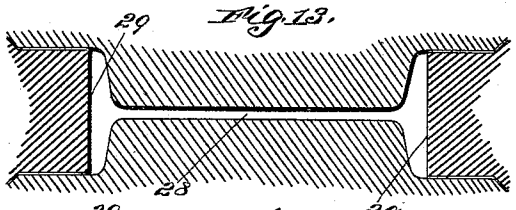


Fig. 14.

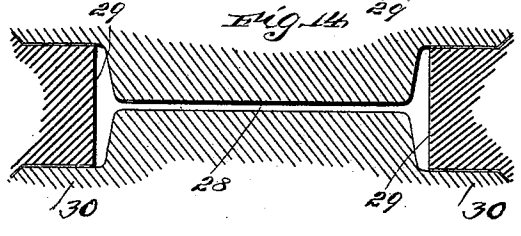
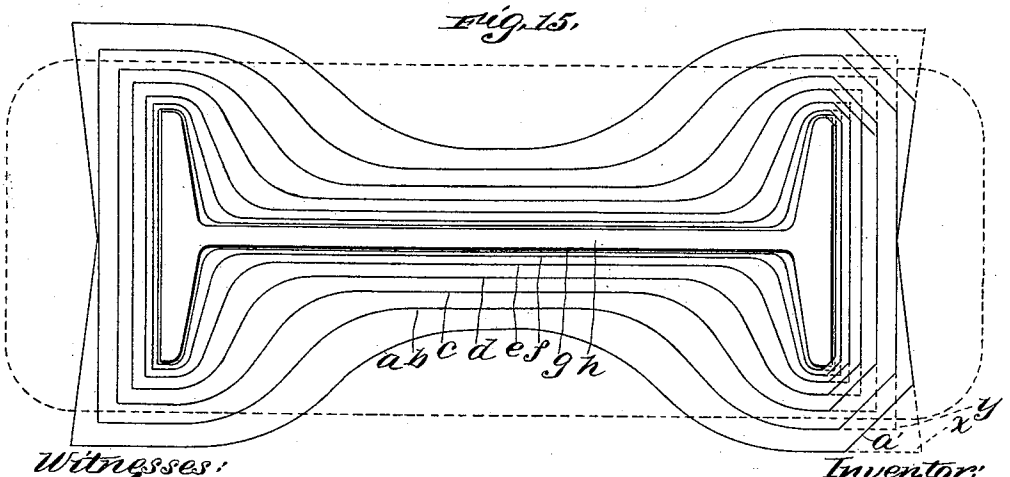


Fig. 15.



Witnesses:
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Jas. W. Thompson.

Inventor:
Edward M. Butz
by Dennis S. Wolcott Atty

UNITED STATES PATENT OFFICE.

EDWARD M. BUTZ, OF ALLEGHENY, PENNSYLVANIA.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 499,651, dated June 13, 1893.

Application filed January 3, 1893. Serial No. 457,014. (No model.)

To all whom it may concern:

Be it known that I, EDWARD M. BUTZ, a citizen of the United States, residing at Allegheny, 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 mills for reducing ingots, blooms or slabs to structural shapes. The mills generally employed in the art are of two classes, one a two or three high mill having horizontal rolls which are suitably grooved for the shape desired, and the other the universal mill having a pair of horizontal rolls and a pair of vertical rolls arranged to act in sequence. Mills of the former kind are not adapted for the production of the larger sizes of structural shapes for the reason that the deep grooving of the rolls, even when the latter are of large diameter, so weakens them that they are quickly broken; and, further, as the reduction is effected almost entirely on two sides of the article being rolled, the metal in the flanges is subjected to excessive tensional and torsional strains. While the universal mill is free from the foregoing objections, the article being rolled is disturbed by reason of the sequence of operation of the two sets of rolls, as, for example, the horizontal rolls while reducing the web portions of the article, crush down the flanges, and the vertical rolls while operating on the outer faces of the flanges, bend and distort the web. Mills have also been designed for rolling structural shapes, having a pair of vertical rolls arranged with their axes in or approximately in the same vertical plane as the axes of the horizontal rolls. In one form of these mills the vertical rolls are rotated by frictional contact with the horizontal rolls or with the article being rolled, or in both ways. Where the vertical rolls are driven by frictional contact with the horizontal rolls, the surfaces of the rolls in contact are quickly cut and worn by the cinder and other foreign matter being caught between said surfaces, so that the operation of the vertical roll becomes irregular and uncertain. In those mills where the vertical rolls are driven by contact with the article being rolled the article is dragged between the vertical rolls by the action of the driven horizontal rolls. This onward movement imparted by the horizontal rolls to the middle portions of the article and the restraining or dragging back of the edges by the vertical rolls produces an injurious strain or stretching of the edge portions of the articles rolled in this class of mill. The proposed mills of this kind, for none so far as I am aware, have been put into practical operation, may be divided into two classes, *i. e.*, those having an open pass and those having a semi-closed pass. A mill having what I term an open pass is described and shown in Letters Patent No. 410,107, granted to Julian Kennedy and Henry Aiken on August 27, 1889. It will be observed that in this mill, openings are left between the vertical and horizontal rolls, into which openings the metal of the bloom or ingot is forced during reduction thereby necessitating the employment of two grooved horizontal rolls, designed to operate on the edges of the flanges for the purpose of forcing back the thin fin of metal squeezed out between the horizontal and vertical rolls. A mill having a semi-closed passage is illustrated in Letters Patent No. 318,513. In this mill the horizontal rolls are provided with grooves into which the edges of the vertical rolls project, thereby forming a wall between the horizontal and vertical rolls to prevent the metal from flowing between them. But as both the vertical and horizontal rolls are adjusted toward and from each other, thereby changing the dimensions of the pass, while the contours of the operative faces of the rolls are unchanged. I designate this construction as the semi-closed pass. Both the vertical and the horizontal rolls in these forms of mills are adjusted toward each other to change the sizes of the pass and the reduction is effected by passing the article back and forth between the adjusted rolls.

The object of the present invention is to so construct a mill that both the vertical and horizontal rolls of each stand or set of rolls shall be simultaneously operative along a common line of bite on the article; that both pairs of rolls shall be equally operative to move the article along between them and shall have the same surface or peripheral

speed, that the operative faces of the horizontal rolls shall project between the operative faces of the vertical rolls, and that the operative faces of both pairs of rolls of each stand or set shall have narrower operative faces than those of the rolls of the preceding set or stand.

In general terms, the invention consists in the construction and combination substantially as hereinafter described and claimed.

In the accompanying drawings forming a part of this specification, Figure 1 is a plan view of a rolling mill embodying my invention. Fig. 2 is a view partly in front elevation and partly in section of one stand or set of rolls. Fig. 3 is an end elevation of the same. Fig. 4 is a similar view with the supplemental housings removed. Fig. 5 is a horizontal section taken on the line x, x, Fig. 2. Fig. 6 is a vertical section taken on the line y, y, Fig. 2. Figs. 7 to 14 inclusive, illustrate the shapes and relative arrangements of both pairs of rolls in the several stands or sets of my improved mill; and Fig. 15 is a diagrammatic view illustrating the reduction effected at each pass.

In reducing ingots, slabs, billets, &c., to structural shapes I employ a series of stands of rolls A, B, &c., each adapted to effect one and only one reduction, the article being carried from one stand or set of rolls to another by feed tables 2, provided with driven rolls. Each stand or set of rolls consists of two horizontal and two vertical rolls, each roll being positively driven at the same surface or peripheral speed as the others, and all the rolls being arranged with their axes in or approximately in the same vertical plane. The horizontal rolls 3 have their journals mounted in boxes or brasses 4 and 5, which are arranged in windows formed in the main housing 6. The rolls 3 are held in proper relation to each other and to the vertical rolls 7 by screws 8 passing through the ends of the housings and bearing against the bearing blocks 9, which in turn bear against or support the brasses or boxes 4 and 5. On the outer sides of each of the main housings are secured two yokes or supplemental housings, each consisting of the arms 10 projecting horizontally from opposite sides of the windows of the main housings, and a cap 10^a, which is bolted on the ends of the arms 10. The brasses or boxes 11 for the reception of the journals of the vertical rolls, are provided with shoulders which rest upon ribs 12, formed on the inner walls of the yokes or supplemental housings 10, and also formed on the walls of the windows in the main housings. The rolls 7 are held in proper relation to each other and to the horizontal rolls by means of screws 13, passing through nuts 14 arranged in suitable recesses in the caps 10^a of the yokes or supplemental housings, and bearing at their inner ends against the blocks 15, which, in turn, bear against the brasses or boxes 11. The inner halves of the boxes or brasses are held in position by springs 16, which are not designed to effect any adjustment of the rolls as the latter are not adjusted except as regards the primary arrangement thereof in setting up the mill, and such small adjustment as may be necessary to compensate for wear. The lower horizontal roll is positively driven by the shaft 17, which is connected by suitable coupling to the neck of said roll. In order to effect a positive driving of the other rolls, the ends of all the rolls are beveled off at an angle of about forty-five degrees, so that a close fitting joint may be formed between the several rolls.

The beveled faces 18 of the rolls are provided with teeth 19, which intermesh with each other, that is to say, the teeth on the ends of the lower horizontal or driving roll intermesh with the teeth on the lower ends of the vertical rolls, while the teeth on the upper ends of the vertical rolls intermesh with the teeth on the ends of the upper horizontal rolls. This manner of intergearing of the several rolls insures an equal peripheral speed to all the rolls. The teeth may be located along the middle of the beveled faces, as shown, and if desired may extend to the outer edges of the beveled faces, but should not extend to the inner edges of said faces, as it is necessary that the rolls should have an uninterrupted bearing on each other adjacent to the faces operative in shaping the metal, in order to prevent the formation of fins by the entrance of metal in between the rolls at points outside of the rolling faces.

The operative faces of the horizontal rolls are provided with ribs or collars 28, which project when the horizontal rolls are arranged in operative relation to each other, between the operative faces 29 of the vertical rolls and serve to displace the metal along the middle of the article outwardly toward the edges thereof. The vertical rolls operate on the metal at the edges of the article, and on that displaced by the action of the collars of the horizontal rolls, and cause it to flow vertically into the spaces between the ribs or collars 28 and the operative faces of the vertical rolls. As shown in Figs. 7 to 14 inclusive, this overlapping of the operative faces of the horizontal and vertical rolls is characteristic of the rolls of each stand or set, but the operative faces 29 of the vertical rolls gradually decrease in width and the ribs or collars 28 increase in width and project farther in between the operative faces 29 of the vertical rolls in each successive stand or set, thereby effecting a gradual step by step reduction in the width of the article, a reduction of the thickness of the article along the middle thereof and also a narrowing of the flange portions of the article, as shown in Fig. 15. It will be observed that the side walls of the ribs or collars 28 of the horizontal rolls of the first stand or set have a considerable out-

ward curve or inclination, but become more and more abrupt or vertical at each succeeding stand or set.

As hereinbefore stated, the rolls of my improved mill are not adjustable in the sense that their operative faces may be shifted toward or from each other in order to effect two or more reductions of the same article, but each set or stand of rolls is designed to form a part of a train of rolls, such, for example, as is shown in Fig. 1. The number of stands or sets of rolls composing a train is dependent upon the relative sizes of the bloom, slab or billet, and the article to which it is to be reduced, and also upon the amount of reduction by each stand or set of rolls. For example, the rolls shown are shaped for the reduction of a slab to an **I** beam, and by reference to Fig. 15, it will be seen that such reduction is effected in eight passes, and, hence, for the reduction of such a slab to an **I** beam, a train of eight sets or stands of rolls is required.

As shown in Fig. 1, the first stand of rolls A, is located adjacent to the heating furnaces or soaking pits 20. The next stand of rolls B, is preferably located at such a distance from the stand A, that the article will be entirely off the rolls of the stand A, before the front end of the article will be caught by the rolls of the stand B. The other stands of rolls are similarly arranged, the distance between the sets or stands increasing in proportion to the elongation produced at each reduction. The article in course of reduction is carried by feed tables 2 having positively driven rolls, from the soaking pits or furnaces to the first stand or set of rolls and to each succeeding stand or set of rolls, and from the last set of rolls to the cooling and straightening tables 22.

As shown in Fig. 1, the several sets or stands of rolls are driven from a shaft 23 extending the entire length of the train and driven from a single engine 24. If desired, however, each set of rolls may be driven by an independent engine, or the train may be divided into groups of two or more stands or sets of rolls, each group being driven by an independent engine. While preferring to so arrange the sets or stands of rolls composing the train so that the article operated on may pass entirely from between one set of rolls before being caught by the next set, the sets or stands may be arranged so that the succeeding set or stand will commence to operate on the article while being reduced by the previous set or stand. In such case, however, each succeeding set or stand is driven at a higher rate of speed than the preceding set, proportional to the elongation of the article in the preceding set.

The rolls shown in Figs. 2 to 5 inclusive have their operative faces constructed to effect the reduction of the slab indicated by dotted lines in Fig. 15, to the transverse shape indicated by the line *a*, Fig. 15, and the rolls of the other sets or stands, B, C, D, &c., have their operative faces constructed to produce in due succession the transverse shapes indicated by the lines *b*, *c*, *d*, &c., Fig. 15.

While it is believed that the inner portions of the beveled faces 18 adjacent to the operative faces of the rolls, will bear so closely against each other as to prevent the entrance of metal between them, all liability of the formation of a fin in that way, can be removed, by means of small rolls 25 mounted in suitable bearings 26 on the inner walls of the main housings and in the rear of the main rolls so as to operate on the article as it passes out of the main rolls. These rolls 25 are provided with operative faces 27 arranged to bear upon the corners or edges of the article and flatten or bevel such corners to such an extent that the reduction effected by the succeeding rolls will cause only such lateral flow of the metal as to just fill the space or opening bounded by the main rolls. The action of the rolls 25 is illustrated at the right hand end of Fig. 15. As the article passes out from the set or stand A, the rolls 25 on the housing of this set, reduce or flatten the corner *x* produced by the main rolls to the line *a'*. It will be observed that this line is a short distance within the corner *y* which the rolls B would normally produce, so that the corners of the article are so flattened that the metal will not quite fill the pass of the set or stand B; hence, as the metal of the article does not flow entirely into the corners there is no liability of the formation of fins. Each set or stand of rolls, except the last one, is provided with these corner reducing rolls.

It is characteristic of my improved mill that each stand or set of rolls has a fixed pass, that is to say, the rolls of each set or stand of rolls are non-adjustable for the purpose of altering the size or shape of the pass.

In order that the teeth of the several rolls may intermesh as hereinafter described it is necessary that the ends of the several rolls should be beveled at an angle of forty-five degrees and the teeth arranged on such beveled faces. This construction of rolls has been employed for driving the rolls of a mill for rolling regular forms, *i. e.*, round or square in cross-section. But in these mills these beveled faces have extended to the operative faces of the rolls, so that there is a **V**-shaped gap between adjacent rolls into which the metal is squeezed during reduction, thereby producing a fin along the article. In order to avoid this finning, one pair of rolls, as, for example, the horizontal rolls are provided with extensions 30 at the ends of their operative faces. These extensions overlap the shoulders on the other rolls as shown in Figs. 2, 7 and 11. This construction places the beveled faces of the vertical and horizontal rolls a distance from the operative faces of said rolls equal to the lengths of the extensions 30,

which serve to force the metal of the article inwardly from the gaps between the beveled faces of the rolls.

I am aware that it has been proposed to arrange a series of sets or stands of fixed converging rolls, having their operative faces constructed for reducing a piece of metal of regular cross-section, *i. e.*, round or square, to a bar of similar cross-section, but of smaller dimensions, in a common line of feed. But, so far as I am now aware, I am the first to manufacture articles such as T-beams, I-beams, H-beams and other articles having an irregular cross-sectional shape, by progressively expanding portions of an ingot, slab or bloom beyond and reducing other portions below or within the original periphery of the ingot, bloom or slab, and then as part of the same operation, forcing the expanded portions back within the original lines of ingot, bloom or slab, to the finished shape. This shaping or reduction is effected at one heat, and at each pass all portions of the article, the web, the flanges and the edges of the flanges, are subjected to a reducing action, thereby avoiding the formation of fins along the sides and edges of the flanges which must be rolled in by a set of especially constructed rolls.

In rolling regular shapes, *i. e.*, round or square, the metal is forced inwardly in radial lines and backwardly, but in reducing ingots, blooms or slabs to irregular structural shapes, as I-beams, H-beams, &c., the metal from the middle of the bloom or ingot is forced outwardly toward the edges of the bloom or ingot, the metal at the edges of the bloom or ingot is spread out forming, during the first passes, embryonic flanges, and the edges of such embryonic flanges are subjected to a compressive action. This action on the metal of the bloom or ingot is continued at every pass, except that the flanges are gradually reduced in width at every pass after the first pass.

So far as I am aware no one prior to my invention has ever attempted to effect the progressive, continuous reduction of an ingot, bloom or slab at one heat, to an irregular structural shape by a series of passes between fixed converging rolls, two pairs of said rolls having ribs or collars projecting between the operative faces of the other pair, said collar gradually increasing in height and width at each successive pass, while the faces of the second pair of rolls gradually decrease in width at each pass.

While I have confined the illustration and description herein to rolls for the production of I-beams, those skilled in the art can readily construct rolls for the production of other structural shapes, and substitute such rolls for those shown and described.

The method herein described with some particularity, of rolling structural shapes, is not claimed herein, but is reserved as the subject matter of an application filed April 24, 1893, and numbered serially 471,603.

I claim herein as my invention—

1. In a plant for the manufacture of structural shapes, the combination of a series of stands or sets of rolls arranged in a common line of feed, each set or stand consisting of a pair of positively driven non-adjustable horizontal rolls and a pair of positively driven, non-adjustable vertical rolls, both pairs of rolls having their axes in or approximately in the same vertical plane, thereby forming a closed pass, the operative faces of the horizontal rolls projecting in between the operative faces of the vertical rolls whereby the metal is displaced from the middle outwardly by the action of the horizontal rolls and vertically beyond its original outer plane by the action of the vertical rolls, substantially as set forth.

2. In a plant for the manufacture of structural shapes, the combination of a series of stands or sets of rolls arranged in a common line of feed, each set or stand consisting of a pair of positively driven, non-adjustable, horizontal rolls and a pair of positively driven, non-adjustable vertical rolls, both pairs of rolls having their axes arranged in or approximately in the same vertical plane, thereby forming a closed pass, the operative faces of the horizontal rolls of each stand or set projecting a greater distance in between the operative faces of the vertical rolls and being of a greater length than in the preceding set or stand and the operative faces of both pairs of rolls decreasing in width at each succeeding set or stand, substantially as set forth.

3. In a rolling mill the combination of a pair of horizontal rolls, a pair of vertical rolls and a pair of rolls having their operative faces arranged at an angle to the operative faces of the other rolls, substantially as set forth.

4. In a rolling mill, the combination of main reducing rolls operative on substantially the entire perimeter of the article, and rolls located outside the main rolls and operative on portions only of the article being rolled so as to reduce said portion during one pass beyond the line of reduction to be effected at the next pass, substantially as set forth.

5. In a rolling mill, the combination of a pair of horizontal rolls, and a pair of vertical rolls, both pairs of rolls having their axes arranged in or approximately in the same vertical plane, and provided on their ends with intermeshing teeth, one pair of rolls being provided with extensions at the ends of their operative faces and between their operative faces and the teeth on their ends, said extensions being arranged to overlap the shoulders at the ends of the operative faces of the other pair of rolls, substantially as set forth.

In testimony whereof I have hereunto set my hand.

EDWARD M. BUTZ.

Witnesses:
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