(No Model.) 9 Sheets—Sheet 1.

J. FAWELL & J. HEMPHILL

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

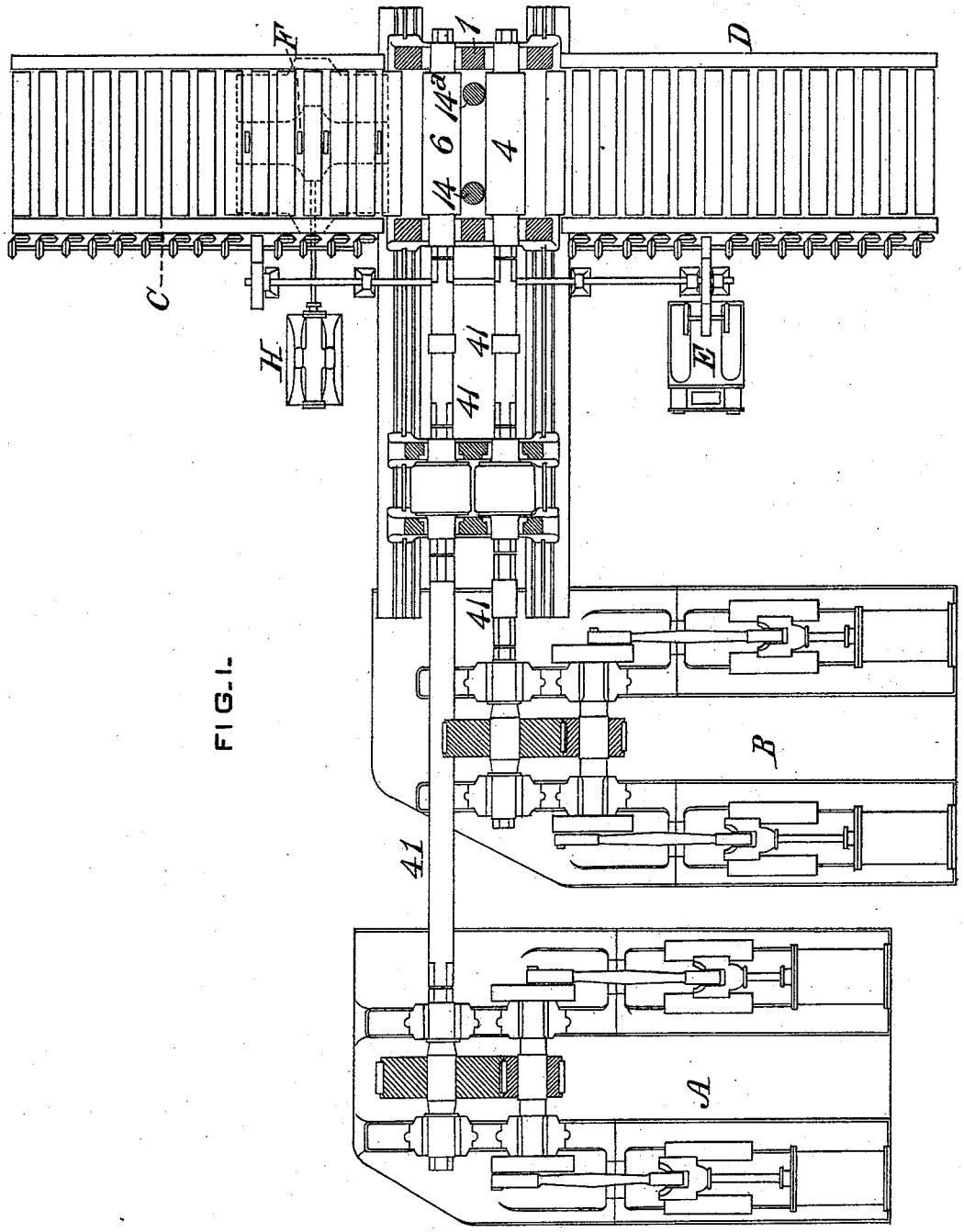

FIG. 1.

WITNESSES:

Dawson B. Wolcott

F. E. Gaither.

INVENTORS

Joseph Fawell

James Hemphill

by George H. Christ

Att'y.

(No Model.) 9 Sheets—Sheet 2.

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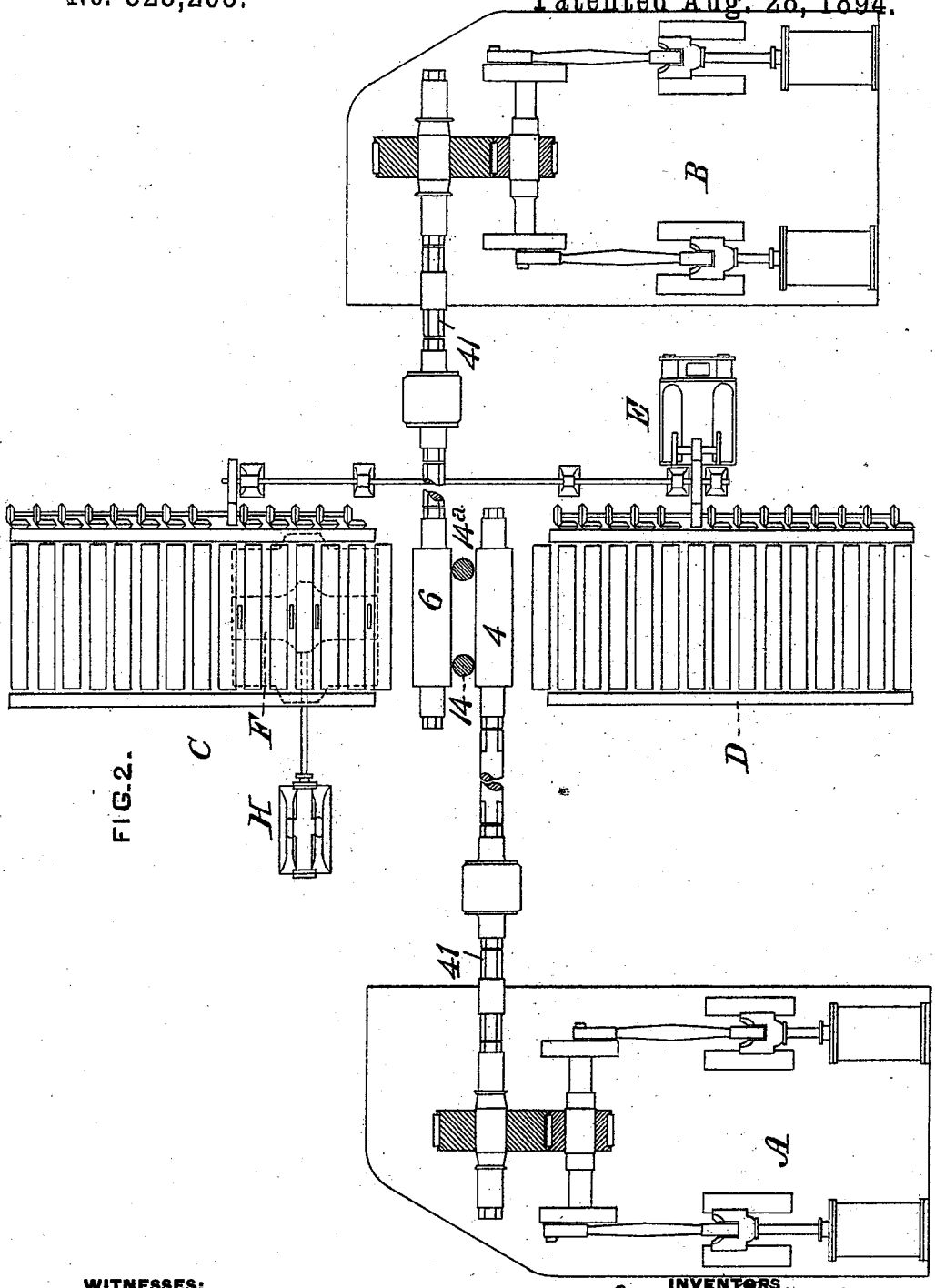

FIG. 2.

WITNESSES:

Darwin S. Wolcott

F. E. Gaither.

INVENTORS.

Joseph Fawell

James Hemphill

by George N. Christy

Att'y.

(No Model.) 9 Sheets—Sheet 3.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

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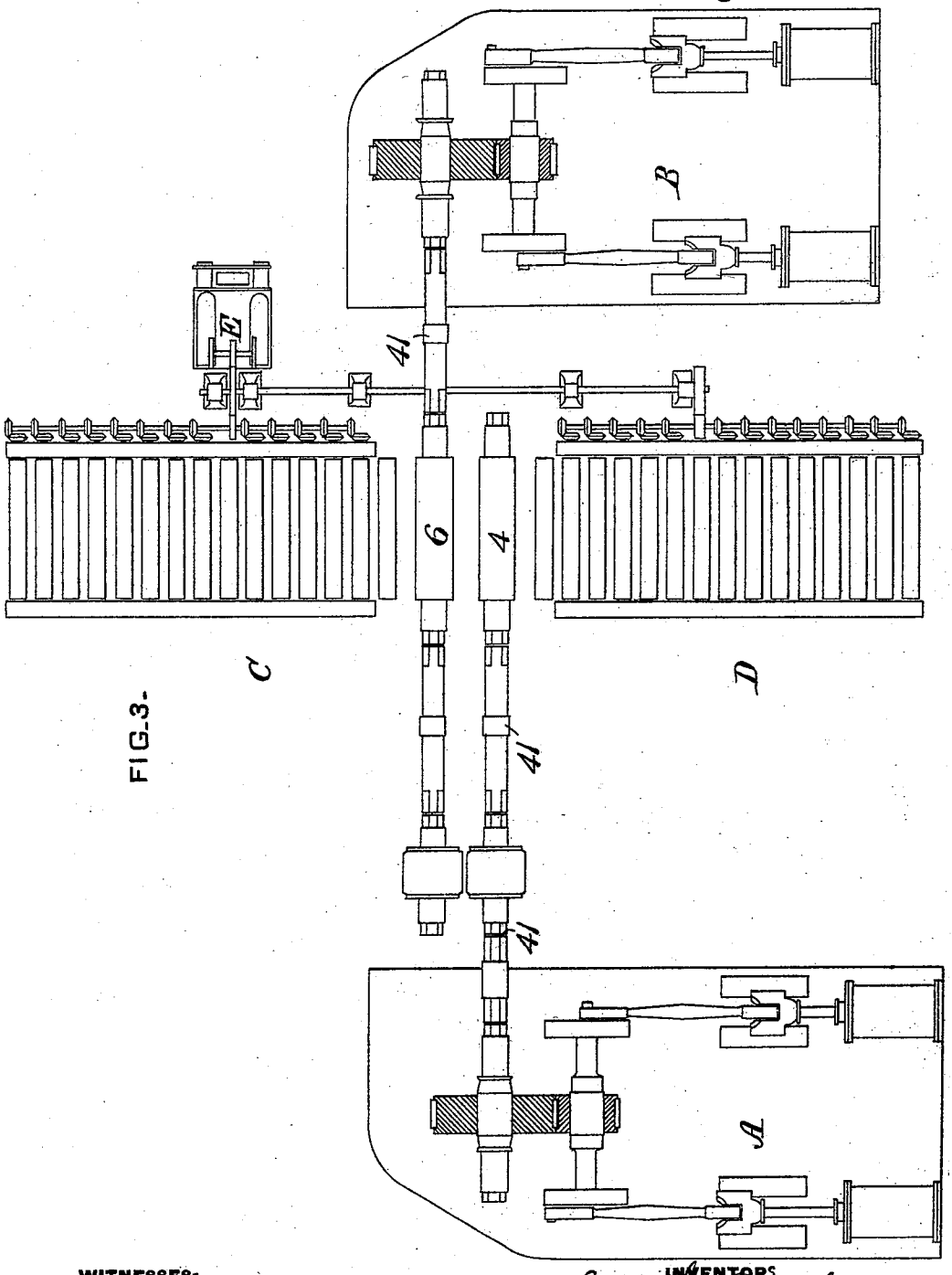


FIG. 3.

WITNESSES:
Dennis S. Wolcott
F. E. Gaither

INVENTORS:
Joseph Fawell
James Hemphill
by George N. Christy
Att'y

(No Model.)

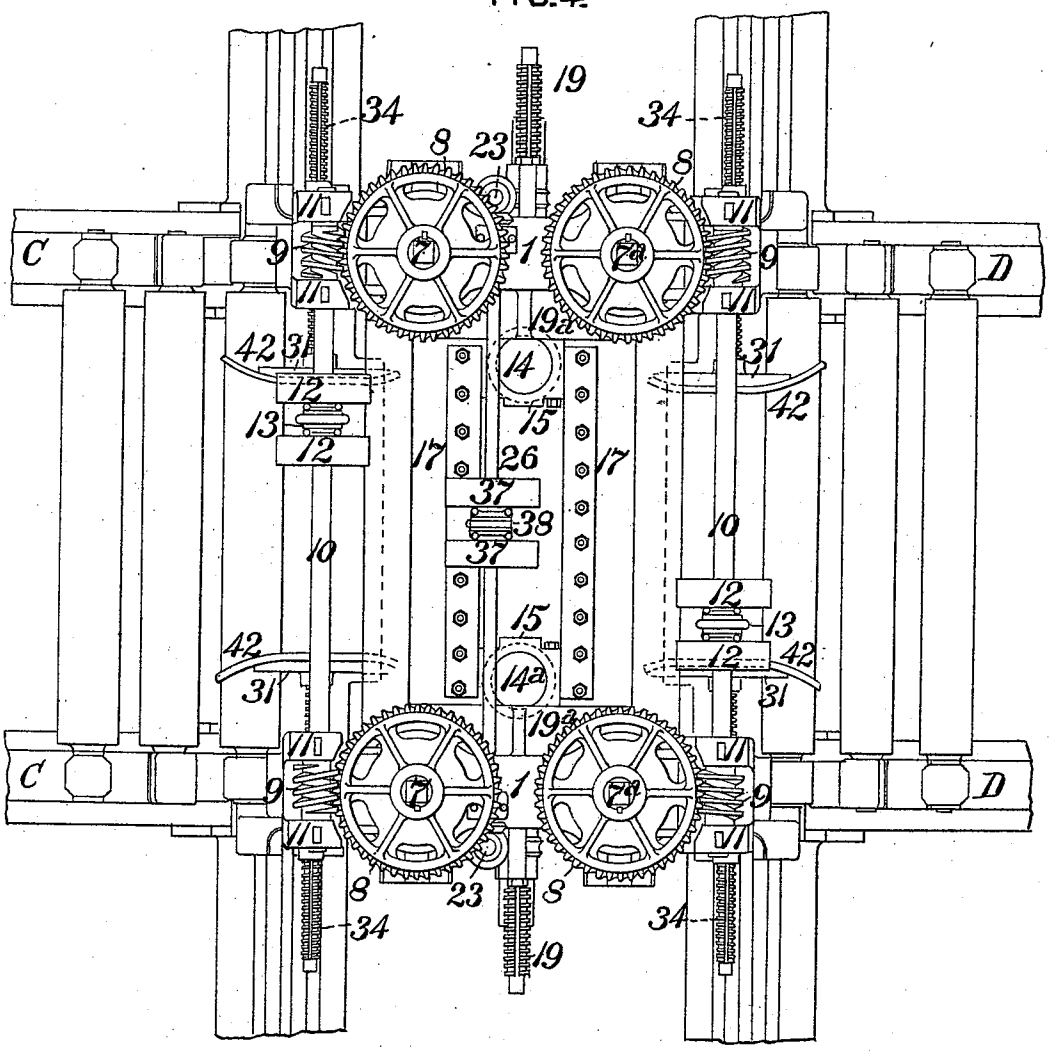
9 Sheets—Sheet 4.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 4.



WITNESSES:

Darwin S. Wolcott

F. E. Gaither

INVENTORS

Joseph Fawell

James Hemphill

by George W. Christy

Att'y.

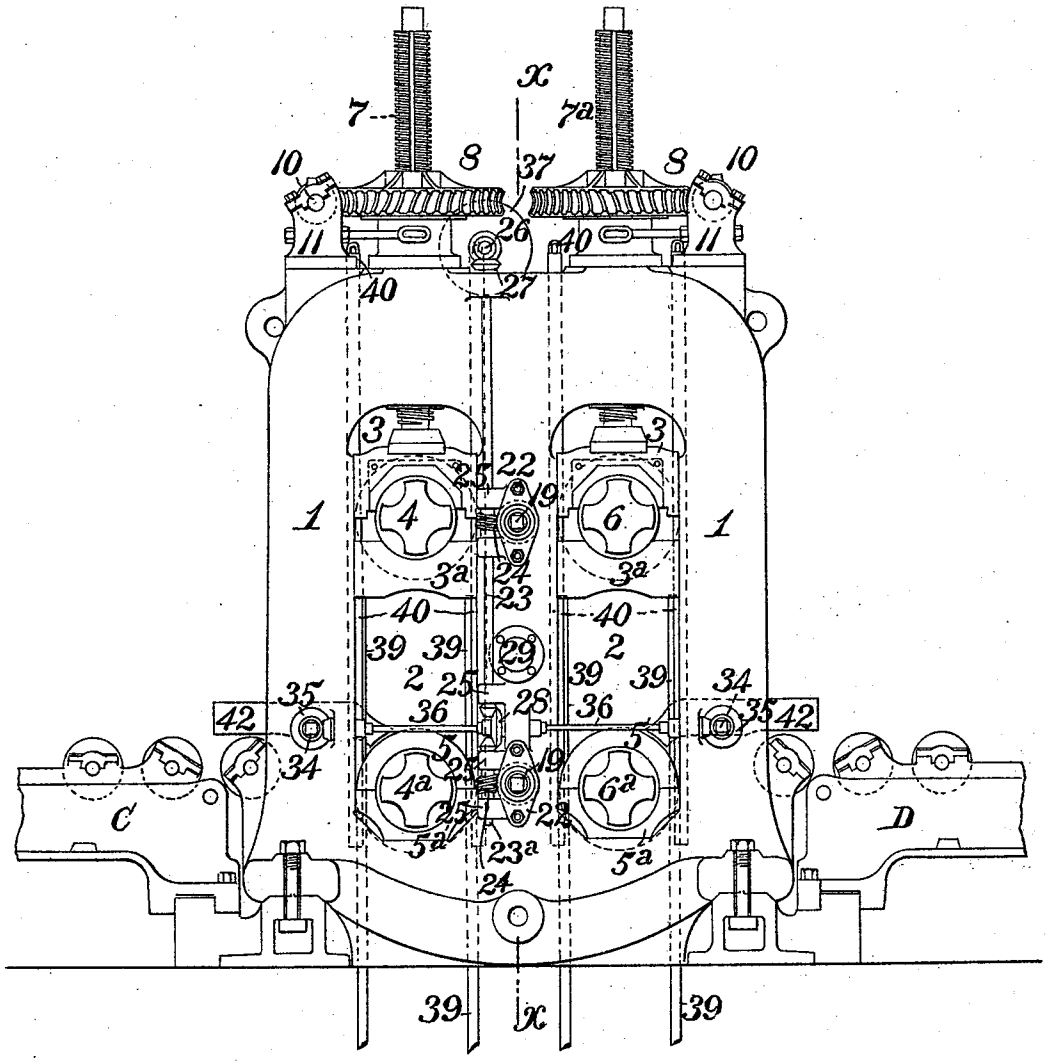
(No Model.) 9 Sheets—Sheet 5.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 5.



WITNESSES:

Dawson S. Wolcott

F. E. Gaither

INVENTORS:

Joseph Fawell

James Hemphill

by George N. Christy

Att'y.

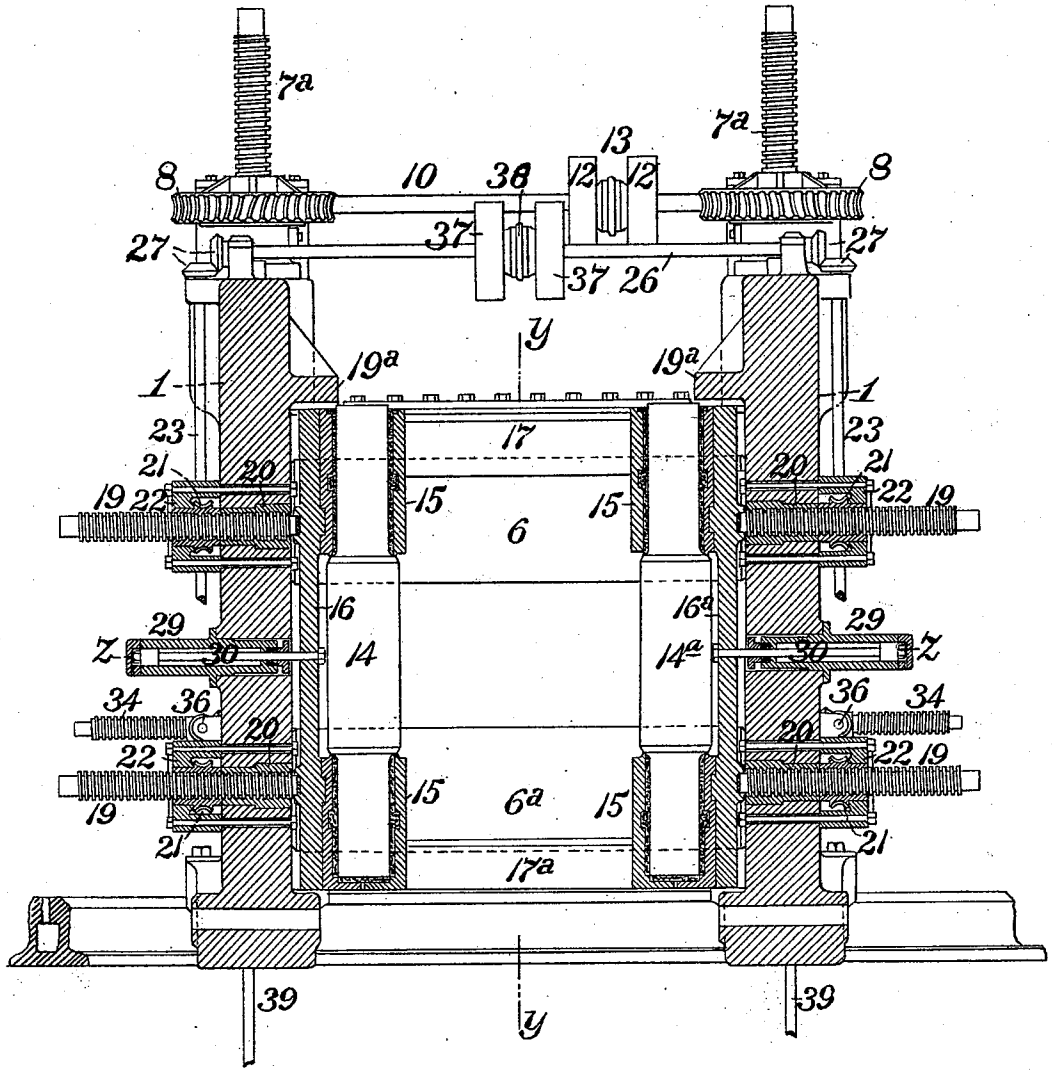
(No Model.) 9 Sheets—Sheet 6.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 6.



WITNESSES:
Darwin S. Wolcott
F. E. Gaither.

INVENTORS
Joseph Fawell
James Hemphill
by George N. Christy
Att'y.

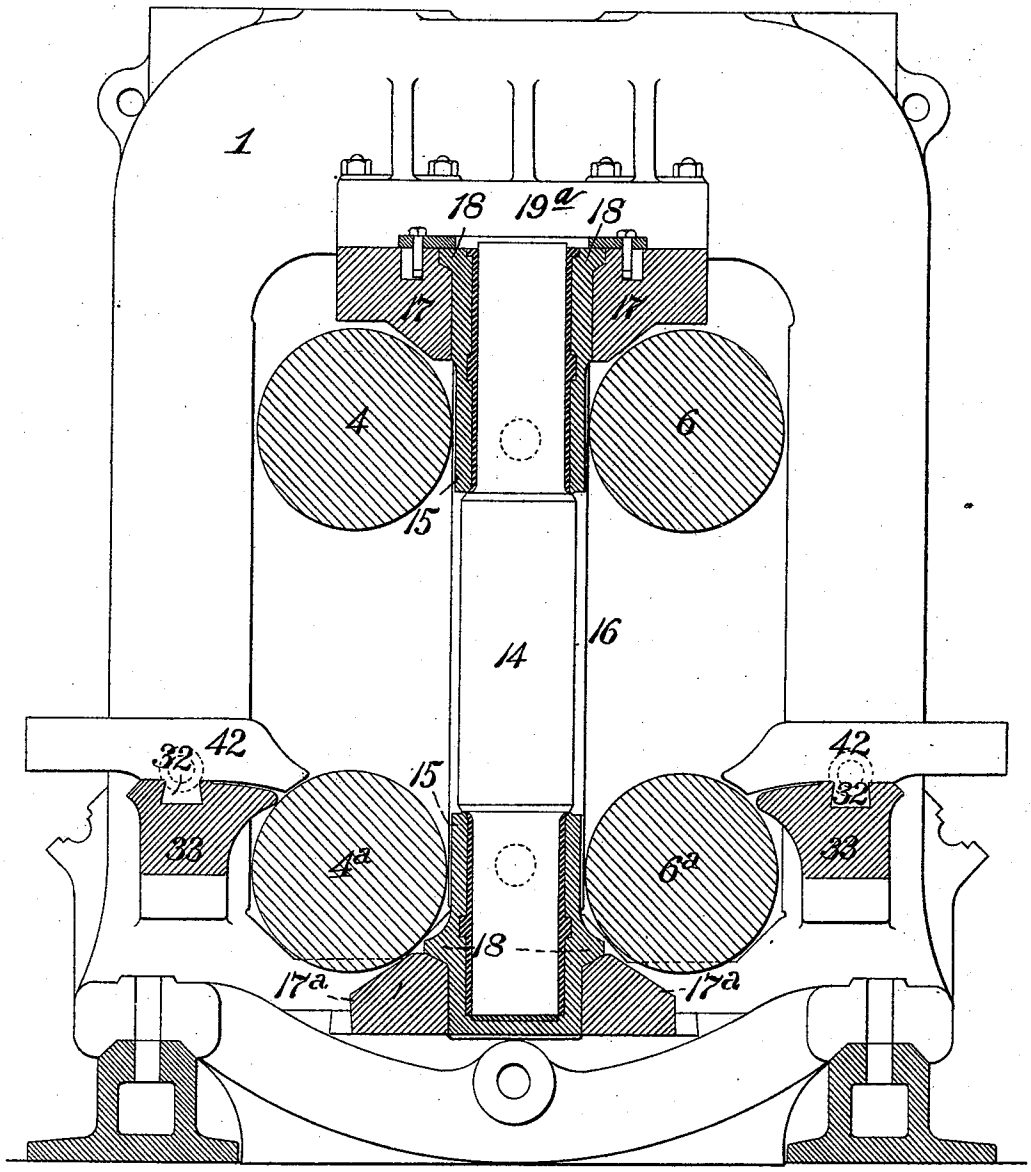
(No Model.) 9 Sheets—Sheet 7.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 7.



WITNESSES:
Dannie S. Wolcott
F. E. Gaither

INVENTORS
Joseph Fawell
James Hemphill
by George N. Christy
Att'y.

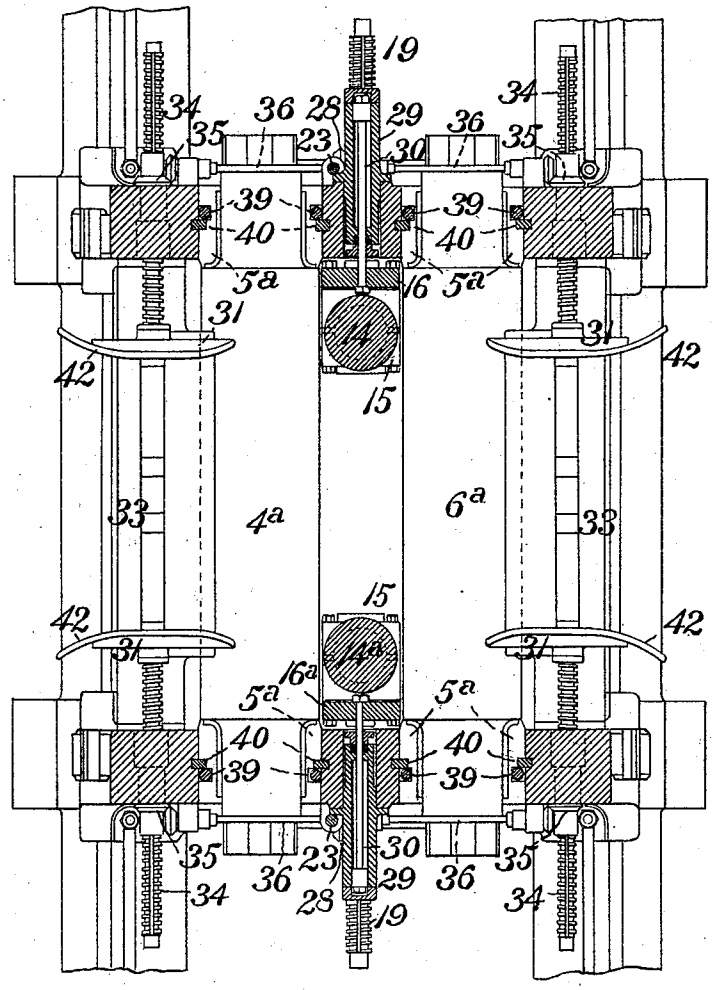
(No Model.) 9 Sheets—Sheet 8.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 8.



WITNESSES:

Dawvin S. Wolcott.

F. E. Gaither.

INVENTORS

Joseph Fawell

James Hemphill

by George H. Christy

Att'y.

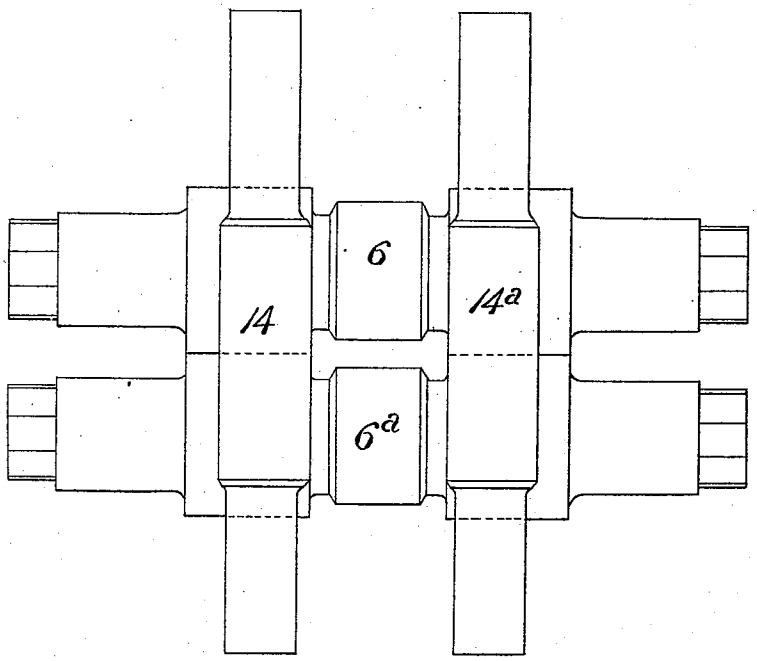
(No Model.) 9 Sheets—Sheet 9.

J. FAWELL & J. HEMPHILL.

ROLLING MILL.

No. 525,263. Patented Aug. 28, 1894.

FIG. 9.



WITNESSES:

Dannie S. Wolcott

F. E. Gaither

INVENTORS

Joseph Fawell

James Hemphill

by George N. Christy

Att'y.

UNITED STATES PATENT OFFICE.

JOSEPH FAWELL AND JAMES HEMPHILL, OF PITTSBURG, PENNSYLVANIA.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 525,263, dated August 28, 1894.

Application filed April 17, 1891. Serial No. 389,343. (No model.)

To all whom it may concern:

Be it known that we, JOSEPH FAWELL, a subject of the Queen of Great Britain, and JAMES HEMPHILL, a citizen 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, especially adapted for the reduction of heavy pieces of iron or steel, and the invention has for its object certain improvements in the construction and arrangement of the parts of the mill, whereby the same is adapted for a wider range of operations.

In general terms the invention consists in the construction and combination all as more fully hereinafter described and claimed.

In the accompanying drawings forming a part of this specification, Figure 1 is a plan view of our improved mill. Figs. 2 and 3 are similar views showing certain modifications in the arrangement of the driving mechanism. Fig. 4 is a plan view of the mill proper on an enlarged scale. Fig. 5 is an end elevation of the mill. Fig. 6 is a sectional elevation, the plane of section being indicated by the line *x*, *x*, Fig. 5. Fig. 7 is a similar view, the plane of section being indicated by the line *y*, *y*, Fig. 6. Fig. 8 is a sectional plan view, the plane of section being indicated by the line *z*, *z*, Fig. 6, and Fig. 9 is a view of rolls employed in rolling **I** beams.

The housings 1, which may be formed either as integral structures or in sections securely bolted together, have two windows or openings 2 for the reception of the journal boxes 3, 3^a of the upper rolls 4 and 6, and the boxes 5, 5^a of the lower rolls 4^a and 6^a. The upper rolls 4 and 6 are adjusted toward and from the lower rolls by means of screws 7 7^a passing through threaded openings in the housings, the rolls 4 and 6 being held against the lower ends of the screws 7 7^a by rods 39 connected at their lower ends to weighted levers, as in the usual practice. Around each of the screws is placed a worm wheel 8, through which the screws can move longitudinally, but are locked to the screws by a spline and feather, so that the screws will rotate with the wheels. Worms 9 adapted to engage with the wheels, are formed on or secured to shafts 10 mounted in suitable bearings 11 formed on the housings, as shown in Figs. 4 and 5. These shafts connect the worms engaging the wheels for operating the screws at opposite ends of the same roll, and on each of the shafts are loosely mounted the belt wheels 12, adapted to be driven in opposite directions, and to be alternately locked to the shafts by means of a suitable clutch mechanism indicated at 13. It will be understood that the rolls 4 and 6 are vertically adjusted independent of each other, so that one set of the horizontal rolls may remain idle while the other is in operation, if desired. The housings are made of a sufficient width to permit of the two pairs or sets of rolls 4 and 6 being arranged such a distance apart that vertical or edging rolls 14, 14^a, may be placed between them. The journals of these edging rolls are mounted in suitable boxes 15, secured as shown in Fig. 6 to carrier frames or plates 16, 16^a, arranged between suitable guide bars 17, 17^a, secured to the housings. The carriers 16, 16^a, are supported by means of ribs 18 formed thereon, engaging the upper edges of the guide bars 17, 17^a. The upper guide bars are bolted to brackets or shelves 19^a formed on the inner faces of the housings, and the ends of the lower guide bars rest in suitable recesses formed near the lower ends of the housings, as shown in Figs. 6 and 7. The carriers with the rolls are adjusted toward and from each other by the screws 19, passing through threaded sleeves 20 in the housings. A worm wheel 21 is mounted on each of the screws 19, and is connected thereto by a spline or feather so as to permit of the longitudinal movement of the screw through the worm, while rotating therewith. The worm wheels are held as against outward movement by collars 22, bolted to the housings as shown in Fig. 6. Shafts 23, 23^a provided with worms 24 engaging the wheels 21, are mounted in suitable bearings 25 formed on the outer faces of the housings, and the shafts 23 are driven through the medium of bevel gears 27 by the power shaft 26 mounted in bearings on top of the housing. Motion is transmitted from the shafts 23 to the shafts 23^a by the bevel gears 28 engaging corresponding gear wheels

on the adjacent ends of the shafts 23, 23ª. By the rotation of the screws 19 the carriers 16, 16ª are adjusted toward and from each other, they being held against the inner ends of the screws and drawn out as the latter are turned out by the fluid pressure cylinders 29, arranged in the housings and provided with suitable pistons, whose rods 30 are connected to the carriers. By connecting the cylinders at a point between their inner ends and the pistons, with an accumulator or other constant source of fluid pressure supply, the carriers will be held firmly against the screws and will move in or out as the screws are adjusted.

In order to properly guide the ingot so that it will pass between the vertical or edging rolls, adjustable guide plates 42 having outwardly curved ends, are secured to or formed integral with blocks 31, which are provided with dovetail projections 32 fitting in correspondingly shaped grooves in bars 33. These bars are secured to the housings outside of the horizontal rolls as shown in Figs. 4 and 7. The blocks or guide plates are attached to the inner ends of screws 34 passing through threaded nuts in the housings, and rotated by beveled pinions 35 keyed to the screws, but permitting their longitudinal movement through them. The pinions 35 are rotated by correspondingly shaped pinions on shafts 36 on which are keyed bevel gears 28 hereinbefore referred to as transmitting motion from the shafts 23 to the shafts 23ª. By thus connecting the gearing for rotating the screws 19 and that for adjusting the screws 34, equal and corresponding adjustments of the vertical rolls and the guide plates is effected. Pulleys 37 are loosely mounted on the power shaft 26, employed as stated for rotating the shafts 23, and these pulleys are rotated in opposite directions by suitably arranged belts, and are adapted to be alternately locked to the shaft 26 for rotating the same, by any suitable clutch mechanism as indicated at 38 in Figs. 4 and 6.

As shown in Figs. 5 and 8, the journal boxes of the horizontal rolls are held in the windows or openings in the housings by removable keys 40, which engage suitably shaped grooves in the sides of the boxes and of the openings in the housings. These keys are passed down through the tops of the housings into the grooves in the boxes and housings, and are provided with eyes at their upper ends to facilitate their withdrawal. This construction permits of the withdrawal outwardly of the journal boxes when it is desired to remove the rolls.

As shown in Figs. 1 and 2, each pair or set of horizontal rolls is driven by independent reversing engines A and B, connected to the power shafts 41. Each power shaft is connected by the usual or any suitable system of gearing and couplings with its respective set or pair of horizontal rolls, so that each set or pair is independent as regards its operation of the other set or pair, the adjusting mechanisms of the upper rolls being also independent as hereinbefore described. The feed tables C and D are provided with a series of feed rolls, which are positively driven by a reversing engine E through suitable interposed gearing as shown in Figs. 1 and 2. One of the feed tables is provided with any suitable mechanism F for turning the ingot and adjusting it transversely of the feed tables, said mechanism being operated by a fluid pressure mechanism H.

In operating the mill, the upper rolls on the side at which the ingot enters are adjusted to effect the required draft or reduction, on the upper and lower faces of the ingot. The vertical rolls are also adjusted to effect the required reduction on the sides of the ingot, and the upper roll on the egress side of the mill is also adjusted. The ingot is then fed to the first pair of horizontal rolls, the plates 42 guiding it into proper transverse position. By the action of the first pair of horizontal rolls the ingot is forced between the vertical rolls, which are driven by frictional contact with the ingot. When the ingot has entered between the last pair of horizontal rolls, it will be pushed by the first pair and pulled by the second pair of horizontal rolls, the latter being driven at a speed higher than that of the first pair proportional to the elongation of the ingot effected by the first pair of horizontal rolls, and the vertical rolls. After the ingot has passed through in one direction, the mill is reversed, and the above operations repeated, both pairs of horizontal and the vertical rolls with their guides being properly adjusted.

In Fig. 3 is shown an adaptation of the present invention as regards one of its principal characteristics, *i. e.*, independently driven pairs of rolls arranged in a common line of feed or with their axes parallel, for the production of plates or sheets. When the mill is employed for rolling plates or sheets, the vertical or edging rolls with their guide plates are omitted, and one set or pair of rolls is used exclusively for roughing down the ingots to approximately the thickness desired and the other set or pair of horizontal rolls is used during the finishing operation.

It has been the practice heretofore to either employ the same set of rolls both for breaking down and finishing, or else to employ two mills arranged in line with each other, driven simultaneously by the same engine or engines and each provided with suitable feed tables. The use of one mill or set of rolls for both operations is objectionable, as the rolls soon become untrue or grooved by reason of their use in roughing down, and require very frequent turning down or dressing. The other construction is objectionable not only on account of the cost of two mills with their feed tables, but also on account of the necessity of driving a pair of rolls, and the rollers of their feed tables.

The advantages accruing from the use of our improved mill will be readily apparent to those skilled in the art. During the roughing down operation the upper one of the pair of rolls designed to be employed in finishing is raised up, so as not to come in contact with the ingot, and the driving engine of said pair of rolls remains idle. As soon as the roughing down operation is finished the upper one of the roughing rolls is raised and their engine stopped, and the finishing rolls brought into operation. This construction of mill permits of the use of the same feed tables for both operations, the two pairs of rolls being arranged in such relation to each other and to the feed tables, that the ingot or plate can be fed and delivered past or through the rolls adjusted for non-use to and from the pair in operation, thereby avoiding the transference of the piece from one mill or set of rolls to another, and obviating the necessity of frequent dressing of the rolls. While it is preferred to employ one set or pair of rolls for roughing down and the other pair as finishing rolls, both pairs may be used for roughing down, and one or both pairs for finishing the plates.

In Fig. 9 is shown a construction and arrangement of rolls for breaking down ingots to or approximately to shape of **I**-beams. When the mill is designed to be used for such purpose, the horizontal rolls of both pairs are provided with grooves and collars suitably shaped for reducing the sides of the ingot to the desired contour while the vertical rolls are made plain so as to preserve the shape of the edges of the beam. By forming grooves and collars, in accordance with rules well known in the art, other structural shapes can be readily rolled in our improved mill. In this construction of mill, *i. e.*, one having two independently driven pairs of rolls, the ingot or other article operated on serves as a regulator or equalizer of the relative speeds of the two pairs or set of rolls. As for example, if one pair of rolls is operating at a lower speed than the other, for any cause, the push or pull exerted by the more rapidly operating rolls on the ingot or other article will be transmitted to the slower rolls, increasing the speed thereof, while the speed of the faster rolls is reduced, thus equalizing the rate or speed of both rolls.

We are aware that rolling mills have been constructed with two pairs or sets of rolls arranged in a common line of feed, and capable when the article being rolled has been considerably extended, of being simultaneously operative on such article, the rolls being driven by independent mechanism. In such mills, however, the several sets of rolls are driven continuously in the same direction, and the driving mechanism is provided with a fly wheel or other momentum device, so that in passing an article through such rolls, said article within the bite of the two sets of rolls could not have any immediate regulating action upon either set of rolls. In such a mill supposing the pair of rolls last operative upon the article should be driven at a higher speed than the first pair of rolls, the result of the momentum of the fly wheel would be to cause a rupture of the article, it being, as it were, held back by the first pair of rolls. In our improved mill, however, wherein the speed of both pairs of rolls is dependent upon the load and upon the pressure of the steam operating in the engines, and wherein no momentum device such as a fly wheel is employed, any increase or decrease of the load will be immediately felt and operative upon the rolls and the driving mechanism.

We claim herein as our invention—

1. In a rolling mill the combination of two pairs of two high reversible rolls arranged in a common line of feed, a separate or independent reversing engine for driving each such pair of rolls and in either direction, a reversible feed and receiving table outside each such pair of rolls, adjusting mechanism whereby either pair of rolls may be thrown into or out of use at pleasure, each pair of rolls being arranged in convenient proximity to the other pair and to the delivery and receiving table of such other pair, whereby either feed table may deliver to or receive from either pair of rolls and either pair of rolls may receive from or deliver to either feed table or the other pair of rolls, substantially as set forth.

2. In a rolling mill, the combination of two independently driven and reversible pairs or sets of horizontal rolls, arranged in a common line of feed, a pair of vertical or edging rolls arranged between the pairs of horizontal rolls and guide plates arranged outside of the horizontal rolls for so directing the ingot or other article between the horizontal rolls that it will pass between the vertical rolls, substantially as set forth.

3. In a rolling mill, the combination of two independently driven and reversible pairs or sets of horizontal rolls arranged in a common line of feed, a pair of vertical or edging rolls arranged between the pairs of horizontal rolls, guide plates arranged outside of the horizontal rolls for so directing the ingot or other article between the horizontal rolls that it will pass between the vertical rolls, and mechanism for simultaneously adjusting the vertical rolls and the guide plates, substantially as set forth.

4. In a rolling mill, the combination of housings having windows or openings therein, journal boxes constructed to be placed and removed from said windows from outside the housings and a removable key engaging grooves formed in the sides of the windows and journal boxes, substantially as set forth.

5. In a rolling mill, the combination of two pairs of rolls arranged in a common line of feed, a separate or independent engine for driving the rolls at different speeds and in

either direction independent of any momentum device, such pairs of rolls being arranged in convenient proximity to each other whereby to be operative both at the same time on the same ingot or other article passing therethrough and whereby such ingot or other article being engaged by both pairs of rolls may regulate the relative speeds of such pairs of rolls by accelerating the speed of one pair or retarding the speed of the other pair, or performing both functions, simultaneously, substantially as set forth.

In testimony whereof we have hereunto set our hands.

JOSEPH FAWELL.
JAMES HEMPHILL.

Witnesses:
DARWIN S. WOLCOTT,
R. H. WHITTLESEY.