(No Model.) 6 Sheets—Sheet 1.

H. GREY.

APPARATUS FOR ROLLING METALLIC BEAMS, COLUMNS, GIRDERS, &c.

No. 587,958. Patented Aug. 10, 1897.

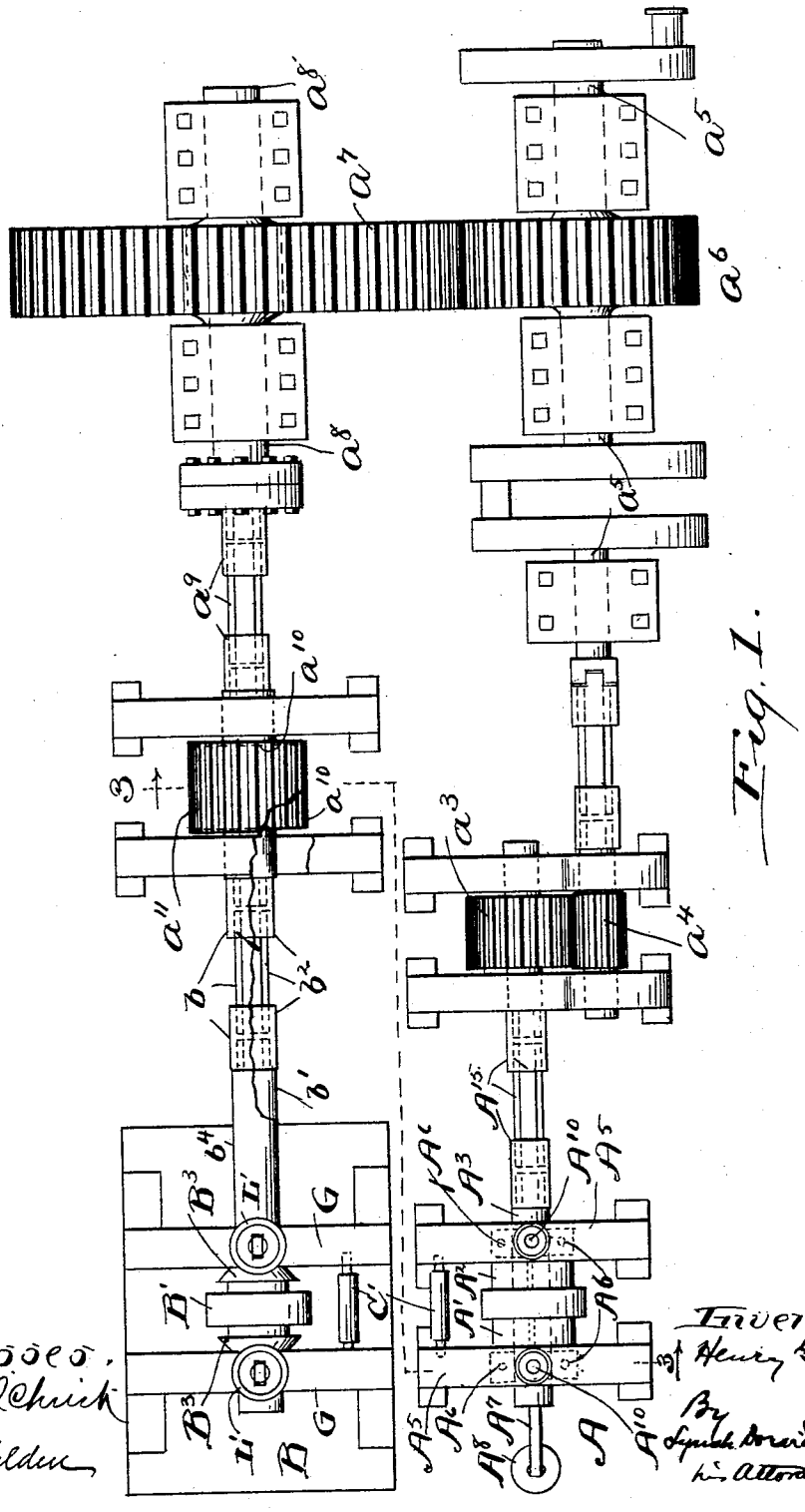


Fig. 1.

Witnesses,
E. B. Gilchrist
Ella E. Tilden

Inventor:
Henry Grey
By Lyndale Dorsett & Donnelly
his Attorneys

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(No Model.) 6 Sheets—Sheet 2.

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Fig. 2.

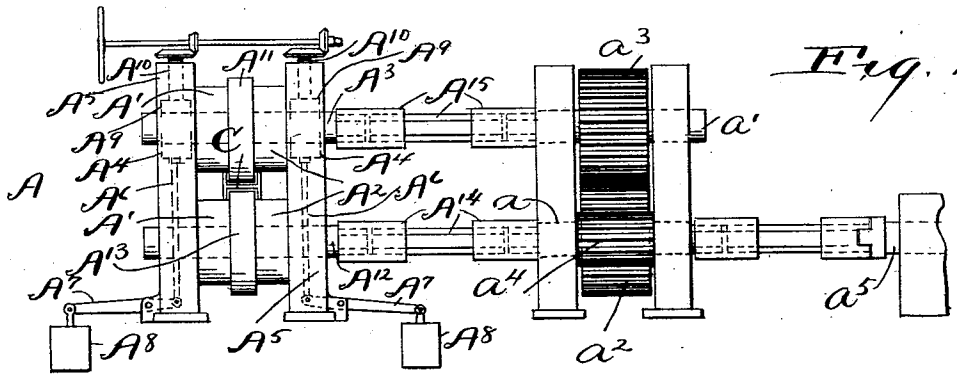
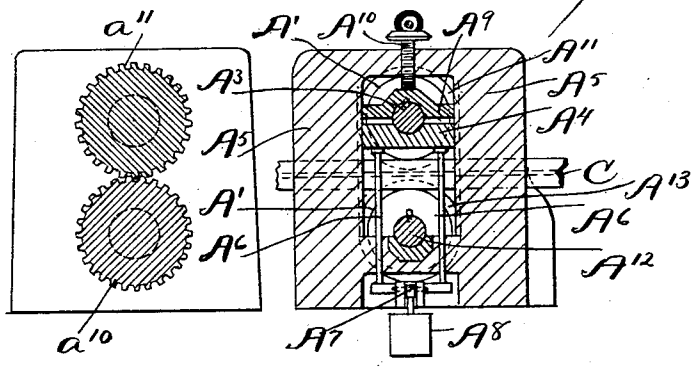


Fig. 3.



Witnesses:
E. B. Gilchrist
Ella E. Tildon

Inventor:
Henry Grey
By
Lynch, Dorer & Donnelly
his Attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

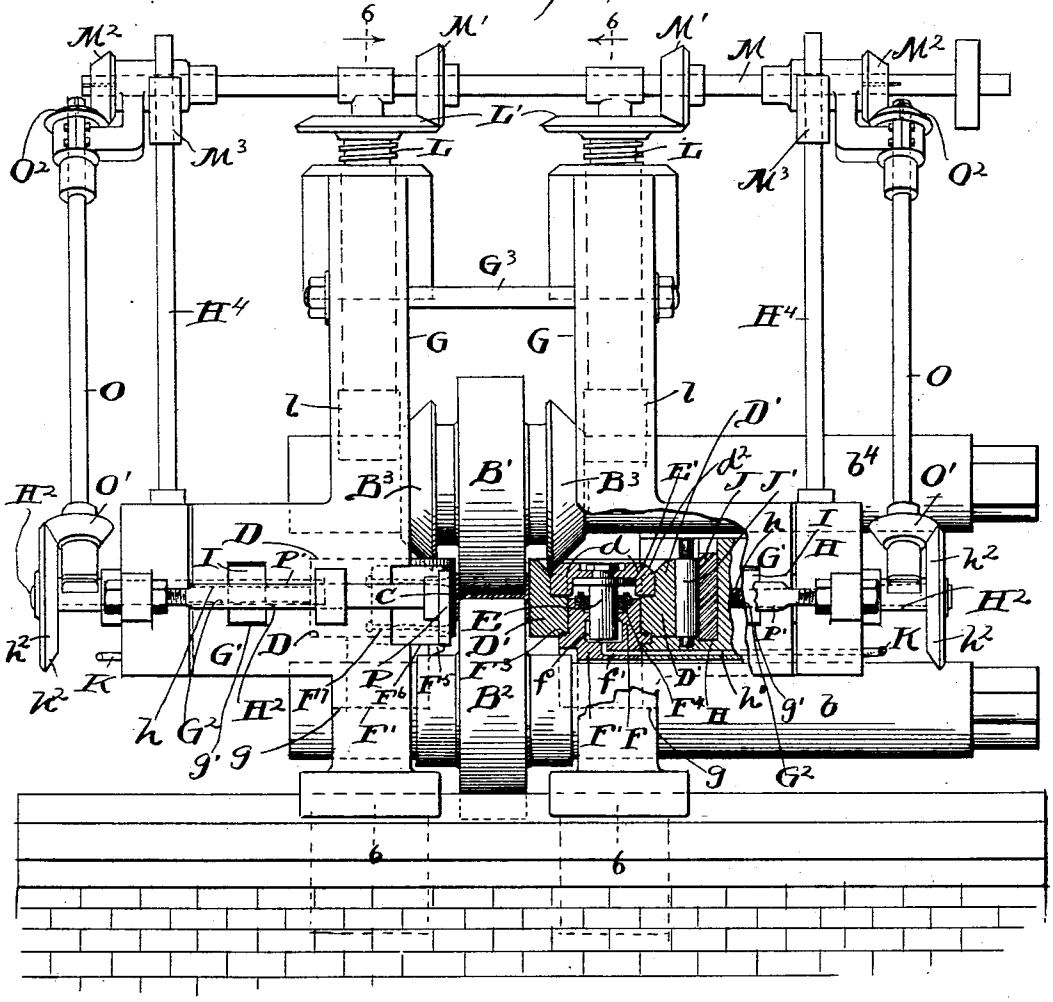
(No Model.) 6 Sheets—Sheet 3.

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Fig. 4.



Witnesses:
E. B. Gilchrist
Ella E. Tildon

Inventor:
Henry Grey
By Lynch, Dorer & Donnelly
his Attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

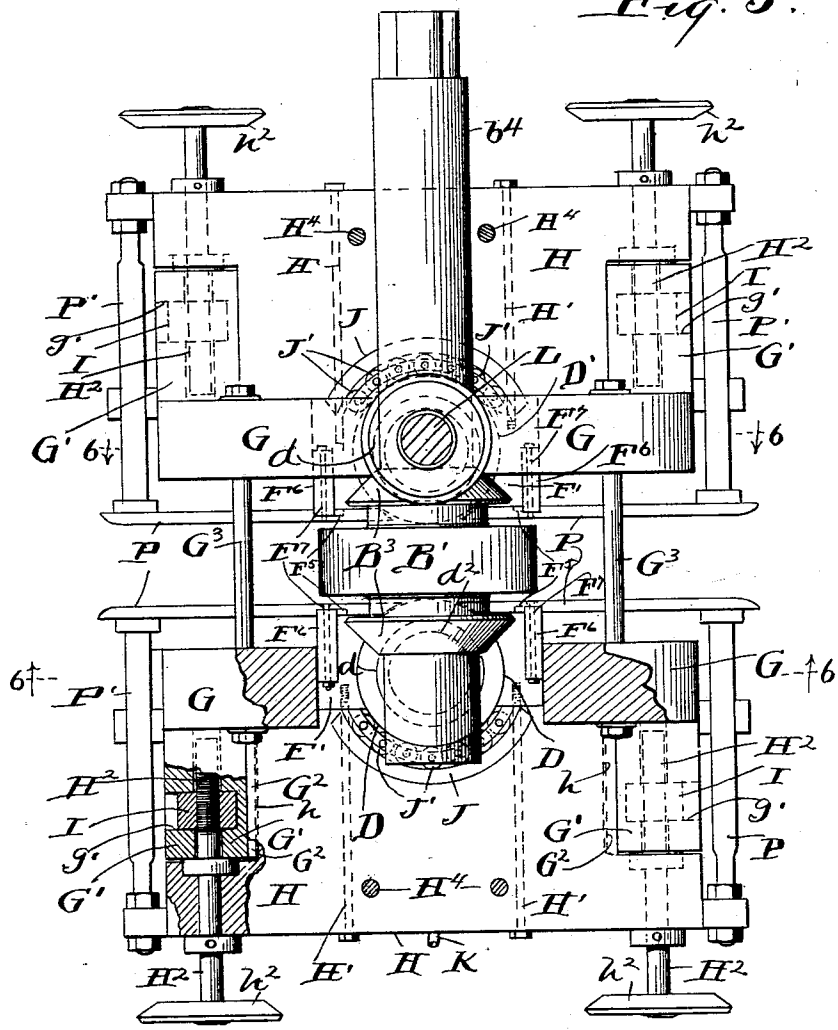
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Fig. 5.



Witnesses.
E. B. Gilchrist
Ella E. Tilden

Inventor.
Henry Grey
By Church, Dorer & Donnelly
his attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

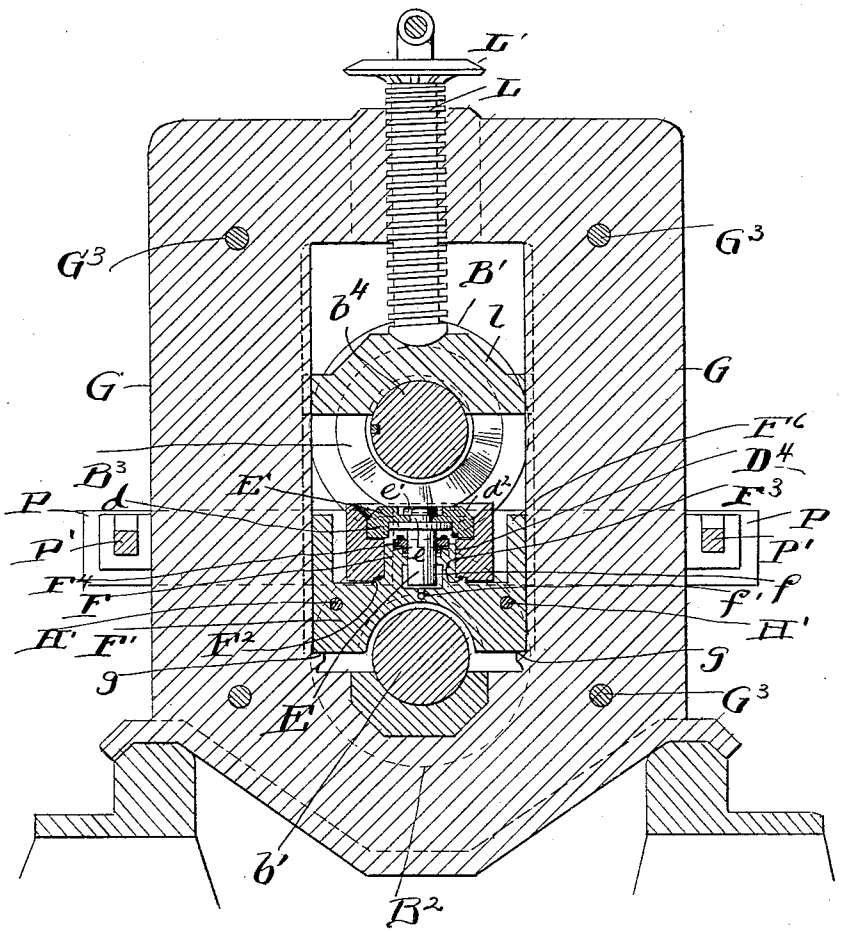
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Fig. 6.



Witnesses:
E. B. Gilchrist
Ella E. Tilden

Inventor:
Henry Grey
By Lynch, Dorer & Donnelly
his Attorneys

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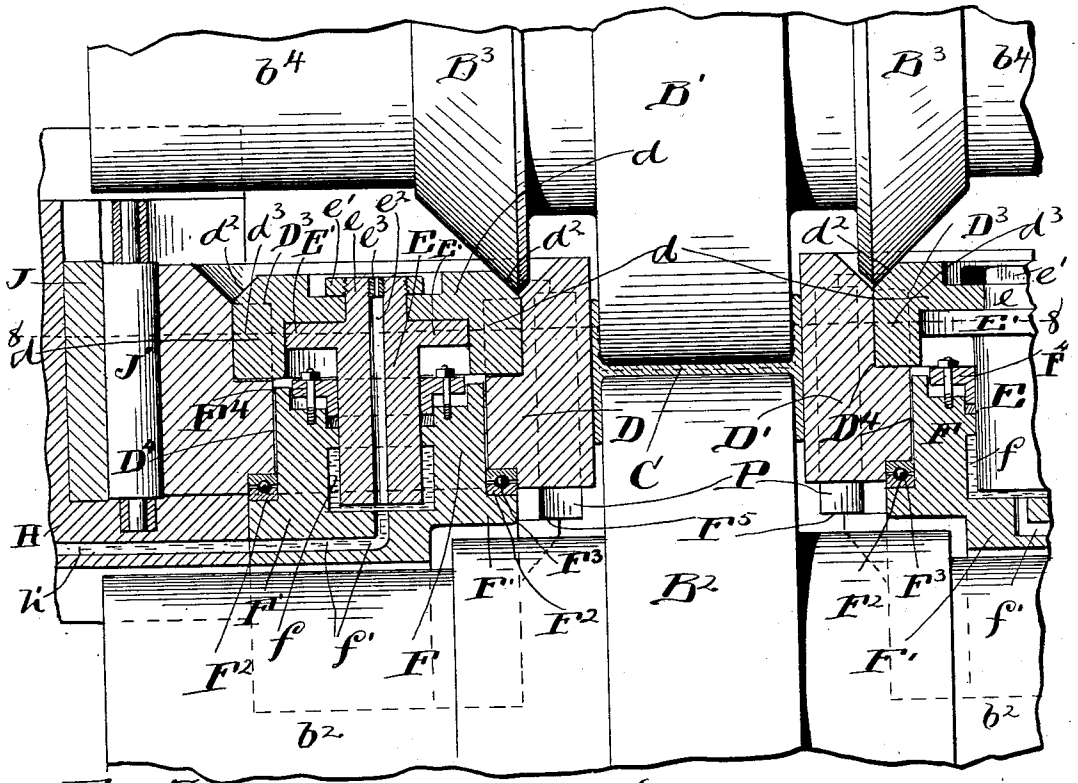


Fig 7.

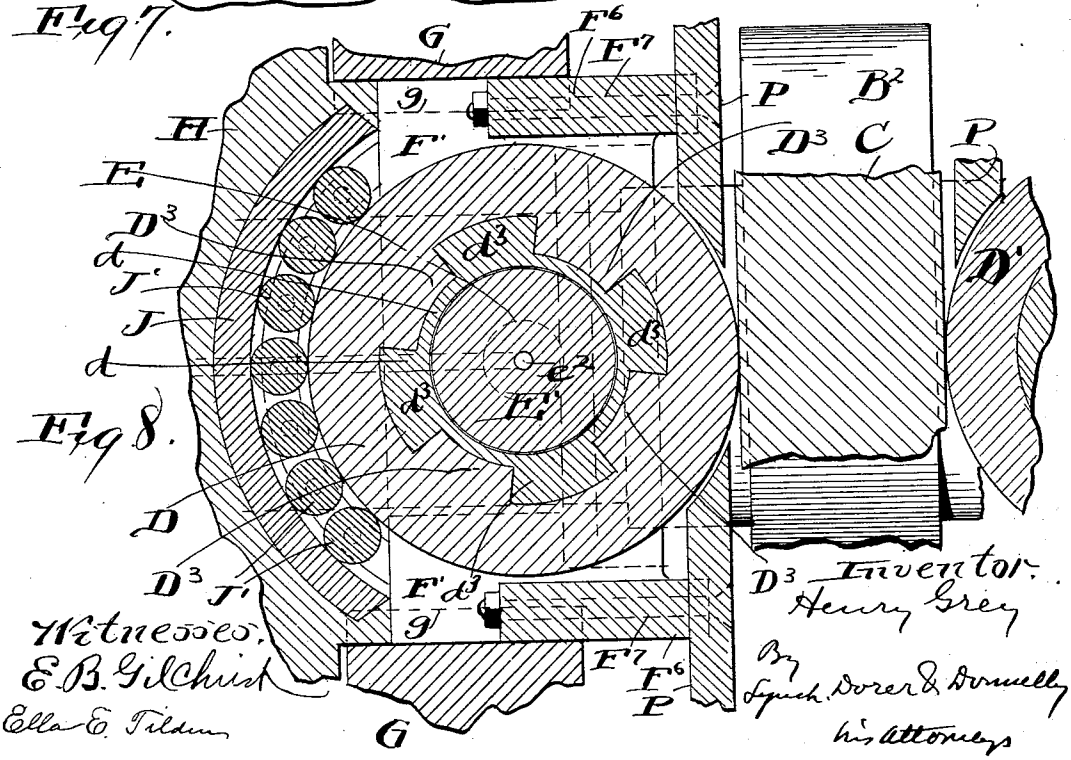


Fig 8.

Witnesses:
E. B. Gilchrist
Ella E. Tilden

Inventor:
Henry Grey
By Church, Dorer & Donnelly
his attorneys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

HENRY GREY, OF DULUTH, MINNESOTA.

APPARATUS FOR ROLLING METALLIC BEAMS, COLUMNS, GIRDERS, &c.

SPECIFICATION forming part of Letters Patent No. 587,958, dated August 10, 1897.

Application filed May 6, 1896. Serial No. 590,409. (No model.)

To all whom it may concern:

Be it known that I, HENRY GREY, of Duluth, St. Louis county, Minnesota, have invented certain new and useful Improvements in Apparatus for Rolling Metallic Beams, Columns, Girders, &c.; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to improvements in apparatus for rolling metallic beams, girders, or columns, and comprises, primarily, a pair of suitably-rotated parallel rolls arranged horizontally, one above the other, and in the same vertical plane and adapted to roll the web and inner sides of the heads or flanges of the column, beam, or girder, and a pair of upright rolls arranged centrally between the axes of the two horizontally-arranged rolls and at opposite ends, respectively, of the horizontal rolls and adapted to roll the outer sides of the flanges or heads of the column, beam, or girder, in combination with simple and reliable means for driving the upright rolls in unison with the horizontal rolls and compelling the upright rolls to participate in the feeding of the work between the rolls.

My invention involves also an apparatus of the character indicated that comprises, in addition to the system of rolls for rolling the web and opposite sides of the heads or flanges of the work, another system of rolls arranged to roll the edges of the work's flanges or heads and arranged, furthermore, sufficiently near to the first-mentioned system of rolls to cause the blank or work to be operated upon by either one of said roll systems before it has left the other roll system, and suitable driving machinery for operating both of said roll systems in unison.

My invention consists also in certain novel and meritorious features of construction and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a top plan, partly broken away, of two systems of rolls suitably arranged in the required proximity to each other and the machinery employed for causing the rolling or operating surfaces of the rolls of both roll systems to be driven at the same speed and in the required direction. Fig. 2 is a side elevation of the system of rolls employed in rolling the edges of the column, beam, or girder. Fig. 3 is a vertical section on line 3 3, Fig. 1, looking in the direction of the arrow. Fig. 4 is a side elevation of the system of rolls and appurtenances employed in rolling the web and opposite sides of the heads or flanges of the column, beam, or girder. Portions are broken away and in section in this figure to more clearly show the construction. Fig. 5 is a top plan, and portions are removed and broken away and in section in this figure to more clearly show the construction. Fig. 6 is a vertical section on each of lines 6 6, Figs. 4 and 5, looking in the direction of the arrow. Fig. 7 is an enlarged side elevation of adjacent portions of the pair of horizontal rolls B' B^2 and a side elevation, mostly in central vertical section, of the two upright rolls and appurtenances arranged at opposite ends, respectively, of said horizontal rolls, and exhibits also the operative connection employed between said upright rolls and the horizontal rolls. Fig. 8 is a top plan in horizontal section on line 8 8, Fig. 7.

My improved apparatus for rolling columns, beams, or girders, as illustrated in Fig. 1, comprises two systems of rolls—one roll system, A, for rolling the edges of the heads or flanges of the column, beam, or girder, and the other roll system, B, for rolling opposite sides of the flanges or heads and the web of the girder, beam, or column. The two roll systems A and B are located side by side and in such proximity to each other that the work can be fed from the one system to the other, and the work, in feeding it from the one to the other roll system, shall be received by the latter before it has left the former, and the rolling or operating surfaces of the rolls of both systems of rolls are driven, preferably, at the same speed, and the work is fed in opposite directions, alternately, between and through the two roll systems as many times as required to complete the rolling of the work. The rolls of the two systems of rolls are of course rotated in the direction required to feed the work and the direction of their rotation is of course reversed

preparatory to feeding the work in the opposite direction after the latter has been fed in either direction through the systems of rolls.

The roll system A, employed for rolling the edges of the heads or flanges of the beam, girder, or column, comprises two pairs of parallel horizontal rolls. (See Figs. 1, 2, and 3.) A′ designates the rolls of one of said pairs of rolls, and A^2 represents the rolls of the other pair of rolls. The two pairs of corresponding rolls are arranged a suitable distance apart, and the rolls of each pair of rolls are arranged one below the other and in the same vertical plane. The upper rolls of the two pairs of rolls are operatively mounted upon or connected with a horizontal shaft A^3, that is adjustable vertically and has bearing in half-boxes A^4, movable up and down within the two upright housings A^5 and resting upon or supported from any suitable number of upright bars A^6, operatively connected at their lower ends with vertically-tilting weighted levers A^7, whose weights A^8 somewhat more than counterbalance the weight of shaft A^3 and the rolls upon said shaft and act in the direction required to elevate said rolls. Saddles or blocks A^9 rest upon shaft A^3 above half-boxes A^4, and suitably-operated screws A^{10} engage correspondingly-threaded holes in the tops of the housings and engage the upper surfaces of saddles A^9 and limit the upward movement of shaft A^3 and the rolls upon said shaft. Means or mechanism of the character indicated for adjusting a horizontal roll vertically and retaining it at the desired elevation are well understood by those skilled in the art and do not require further description in this specification. Suffice it to state that screws A^{10} should be uniformly operated and that the upper rolls are elevated or lowered according as said screws are turned in the one direction or the other. The two upper rolls are confined upon shaft A^3, between the different housings A^5 A^5, respectively, and a collar A^{11}, formed upon said shaft centrally between the two housings. The two lower rolls are operatively mounted upon or connected with a horizontal shaft A^{12}, suitably supported from housings A^5, and said lower rolls are confined upon said shaft A^{12}, between the different housings, respectively, and an annular collar A^{13}, formed upon the shaft centrally between the housings.

Although I have illustrated rolls adapted for the production of I-beams or girders, I would have it understood that the principle of my invention is not merely applicable to the rolling of this particular form of beam or work. The suitably-heated blank or I-beam or work C in the case illustrated is of course fed longitudinally and with its flanges or heads arranged edgewise between the upper and lower rolls of the pairs of rolls A′ A^2, and the two flanges or heads of the blank or work are operated upon by the different pairs of rolls, respectively, and the two rolls of each pair of rolls operate upon opposite edges, respectively, of the respective flange. Collars A^{11} and A^{13} are larger diametrically than the rolls, but are narrower than the web of the work-constituting beam and are not sufficiently large diametrically to make contact with or operate upon the web. In other words, collars A^{11} and A^{13} merely serve as lateral guides for the work during the rolling operation and effectually prevent displacement of the work laterally during the said operation, and the upper rolls can be readjusted vertically after each pass of the work to accommodate the widening of the heads or flanges of the work during the preceding pass.

Shaft A^{12} (see Fig. 2) is operatively connected, by means of suitable couplings or connections A^{14}, with a suitably-supported horizontally-arranged shaft a, and shaft A^3 is operatively connected, by means of suitable couplings or connections A^{15}, with a horizontal shaft a', arranged above and parallel with shaft a. Two spur-gears a^2 a^3, operatively mounted upon shafts a and a', respectively, and having a corresponding number of teeth, mesh with each other, and gear a^2 meshes with a driving-pinion a^4, operatively connected in any approved manner with a suitably-supported and suitably-actuated driving-shaft a^5. By the construction thus far described it will be observed that the rolls of each pair of rolls A′ and A^2 are driven in opposite directions, respectively, as required.

Another pinion a^6 (see Fig. 1) is operatively mounted upon driving-shaft a^5 and meshes with a spur-gear a^7, operatively mounted upon a horizontal shaft a^8, suitably supported at one side of and a suitable distance from shaft a^5 and operatively connected, by means of suitable couplings or connections a^9, with a spur-gear a^{10}, arranged in line with shaft a^8 and between said shaft a^8 and the trunnion b' (see Fig. 1) of the lower roll B^2 of the pair of parallel corresponding horizontal rolls B′ B^2, arranged one above the other in the same vertical plane and parallel with rolls A′ A^2 and employed in rolling the web and the inner side of the heads or flanges of the beam that is being rolled, and any suitable couplings or connections b^2 establish operative connection between said trunnion b' and gear a^{10}. A spur-gear a^{11} is arranged above and parallel and meshes with spur-gear a^{10}. Gear a^{11} is operatively connected, by suitable couplings or connections b^3, with one of the trunnions b^4 of the upper roll B′ of the aforesaid pair of horizontal rolls. The arrangement and relative size of the gear-wheels employed in establishing operative connection between the engine-shaft and rolls A′, A^2, B′, and B^2 are such that the rolling or operating surfaces of said rolls shall be driven at the same speed, or nearly so.

The two rolls B′ B^2 are driven in opposite directions, respectively, and the upper roll B′ and the lower roll B^2 are driven in the same direction as the upper rolls and lower rolls, respectively, of the two pairs of rolls A′ A^2,

and hence the work can be fed from rolls A' A^2 to rolls B' B^2, or vice versa, according as the driving-shaft is actuated in the one direction or the other, and the two systems of rolls are arranged in sufficiently close proximity to each other to enable the one system of rolls, as already indicated, to operate upon the work before the latter has left the other roll system. Of course rolls B' B^2 are arranged in line with collars A^{11} and A^{13}, respectively, of shafts A^3 and A^{12}, but said rolls B' B^2 are sufficiently wider and diametrically larger than said collars to enable them to properly operate upon the web and the inner sides of the flanges of the beam that is being rolled. The upper roll B' is of course adapted to operate upon the upper side of the web and adjacent inner surfaces of the heads or flanges of the beam, and the lower roll B^2 is adapted to operate upon the lower side of said web and the adjacent inner surfaces of said heads or flanges.

Any suitable number of suitably-supported horizontally-arranged rolls C' (shown in Fig. 1 only) are preferably arranged between the two systems of rolls in position to afford a bearing for the beam or work in the passage of the latter from the one to the other system of rolls.

Two suitably-supported side rolls D and D', shown arranged vertically at opposite ends, respectively, of the horizontal rolls B' B^2 and centrally between the axes of said horizontal rolls, (see Figs. 4, 5, 7, and 8,) are adapted to roll or operate upon the outer sides of the oppositely-located flanges or heads, respectively, of the beam. It is obvious that in order to accommodate repeated rollings of the work and different sizes of work the upper roll B' must be adjustable vertically and the two upright rolls D and D' must be adjustable apart.

Before referring to the mechanism employed for effecting the adjustment of said adjustable rolls I would remark that in order to render the rolling of a flanged beam, column, or girder practicable live surfaces should be presented to all sides of the work, and consequently the upright rolls for rolling the outer sides of the flanges must be driven in unison with the horizontal rolls B' B^2, and the very simple and durable operative connection I have devised between each of said upright rolls and the adjacent trunnion of the upper horizontal roll B' comprises, preferably, a horizontal friction wheel or disk *d*, (see Figs. 4, 6, 7, and 8,) operatively connected with the respective upright roll in any approved manner and preferably by the formation of interlocking lugs d^3 and D^3 upon said friction-wheel and the roll, respectively. The upright roll is bored centrally, as at D^4, (see Fig. 7,) and the lugs D^3 are formed upon the upper portion of the surrounding wall of said bore. (See also Fig. 8.) The friction-wheel is therefore arranged within or extends into the upper portion of the bore through the roll, and the aforesaid interlocking lugs are arranged vertically to accommodate an up-and-down movement or adjustment of the friction-wheel for the purpose hereinafter made more apparent. Said friction-wheel *d* at its upper end is provided with an external annular beveled or conical friction-surface d^2, that is frictionally engaged by a corresponding annular beveled or conical friction wheel or disk B^3, formed upon or operatively connected with the adjacent trunnion of the upper horizontal roll B'.

The two friction-disks B^3 are reversely arranged and engage the inner or oppositely-located extremities, respectively, of the different friction wheels or disks *d d*, respectively, so that the two upright side rolls D D' shall be driven in opposite directions and in the direction necessary to render said upright rolls instrumental, as required, in feeding the work between them and between the horizontal rolls. It is obvious that all of the live surfaces operating upon the work should be driven at the same speed, and hence the relative diameters of wheels *d* and the connected rolls D D' are so proportioned to the relative diameters of disks B^3 on rolls B' B^2 that the rolling or operating surfaces of all of said rolls shall be driven at the same speed, or nearly so. Friction-disks B^3 are preferably removably mounted upon the supporting roll-trunnions to accommodate their use with any size of rolls employed in rolling the web of the blank or work. By means of the vertical adjustability of disks *d* frictional engagement is maintained between said friction members and the friction-disks B^3 upon elevating or vertically readjusting the upper horizontal roll B'.

The means acting to elevate each friction-disk *d* and maintain frictional engagement between said friction member and the engaging friction-disk B^3 comprises, preferably, a piston E, provided at or near its upper end with an external annular flange E', that engages the under side of and supports member *d*, that is secured to the piston preferably by a nut *e'*, (see Fig. 7,) mounted at the upper side of said member *d* upon an externally-screw-threaded upright lug *e* of the piston and extending upwardly through the central portion of said member *d*. The piston extends downwardly into the chamber *f*, formed in the vertical cylindrical lug or cylinder F, formed upon the upper side of a block F', and upon said cylinder the upright roll that is operatively connected with the aforesaid friction-disk *d* is mounted. Block F' at the lower end of cylinder or bearing F is provided with a horizontal annular shoulder F^2, (see Fig. 7,) and antifriction-balls F^3 are interposed between said shoulder and the lower end of the roll and reduce the friction had between the opposing surfaces of said roll and shoulder during the operation of the roll to a minimum. A port or passage-way *f'* for

conducting water or fluid under pressure to chamber f is formed in any approved manner within block F′ and communicates with the aforesaid chamber. The fluid under pressure within said chamber acts to force the piston upwardly, and thereby causes the horizontal friction-disk d to be held in frictional contact with the engaging friction-disk B^3. A stuffing-box F^4 is provided around the piston at and supported by the upper end of cylinder F and prevents upward leakage of the fluid under pressure from chamber f. Block F′ straddles but does not rest upon the adjacent trunnion of the lower horizontal roll B^2, as shown in Figs. 4, 6, and 7. Said roll B^2 has its trunnions suitably supported within the lower ends of the two upright housings G G, arrranged at opposite ends, respectively, of rolls B′ B^2, and said block F′ rests upon horizontal shoulders g, formed upon the opposing internal walls of the adjacent housing. (See Fig. 6.) Blocks F′ slide upon shoulders g during the adjustment of the two upright rolls D and D′ toward and from each other.

Each housing G, near its lower end and at the top of the trunnions of the lower horizontal roll, is provided with laterally and outwardly projecting brackets G′, having tongues G^2, engaged by the grooves h, (see Figs. 4 and 5,) formed in a slide H—that is, two horizontally-movable slides H H are arranged at the outer sides of the different housings, respectively, and each roll-bearing block F′ is rigidly secured to the adjacent slide H by any suitable number of bolts H′, extending through the slide into said block F′, as shown in Fig. 5, and hence the upright roll borne by said block F′ is adjusted toward or from its companion roll according as slide H is moved laterally of the supporting-housing in the one direction or the other. Each slide H is provided, preferably, with two screws H^2, arranged parallel with the slideways for said slide and a suitable distance apart and operatively connecting with the slide in any approved manner. Said screws engage correspondingly-threaded nuts I, confined or rendered stationary within recesses g', formed in the outer sides of the aforesaid housing-brackets, as shown in Fig. 5. By this construction it is obvious that each slide H and the members supported thereby are adjusted toward or from the pair of horizontal rolls according as the engaging screws are turned in the one direction or the other.

Housings G are preferably tied together and braced apart by any suitable number of suitably-applied horizontally-arranged rods G^3.

Each slide H is also provided with a thrust-bearing for the upright roll that is indirectly supported from said slide, and said thrust-bearing consists, preferably, of a segmental plate J, (see Figs. 5, 7, and 8,) composed of very hard metal or material and supported on edge from the slide at that side of the roll that is opposite to the point at which the roll operates upon the work. Said thrust-plate is furthermore arranged concentrically of the axis of the roll, and any suitable number of suitably-supported upright antifriction-rollers J′ are preferably interposed between the thrust-plate and the roll to reduce the friction between the opposing surfaces of said plate and roll to a minimum. The port or passage-way f', formed within each block F′, is arranged in line and communicates with a port or passage-way h', that extends through the slide H, with which said block is operatively connected, and communicates at its outer end, preferably, with a flexible pipe or hose K, (see Fig. 4,) that connects with any suitable source (not shown) for supplying the fluid under pressure, and by virtue of its flexibility accommodates the adjustment of said slide.

To prevent overheating of the mutually-engaging friction-wheels d and B^3 and the connected rolls, each chamber f communicates with a port e^2, (see Fig. 7,) extending upwardly through the piston that extends into said chamber, and said port at its upper end terminates in a nozzle or nipple e^3, arranged to discharge upwardly above the adjacent friction-wheel d and against the adjacent trunnion of the upper horizontal roll B′, and the water or cooling agent spreads or circulates to the engaging surfaces between said friction-wheels. The upper horizontal roll B′ is supported, preferably, exclusively from the fluid under pressure, and through the medium of pistons E, upon which said fluid acts, and the friction disks or wheels interposed between said pistons and the trunnions of said roll.

Two upright screws L L (see Figs. 4 and 6) engage correspondingly-threaded holes formed in the tops of housings G G, and are arranged to form stops that limit the upward movement or elevation of the upper horizontal roll B′. Saddles l are shown interposed between the lower ends of said screws and the trunnions of said roll.

By the construction hereinbefore described it is obvious that upon turning screws L in the direction required to elevate them the upper horizontal roll B′ will be elevated by the action of the fluid under adequate pressure upon pistons E.

Having described suitable means for obtaining the adjustment of the upright rolls D and D′ toward and from each other not only to accommodate different sizes of work, but as required during the rolling of work of the character indicated, and having also described suitable means for effecting a vertical adjustment of the upper horizontal roll B′ toward and from the lower horizontal roll B^2 and indispensable in the process of doing work of the character indicated, I would remark that it is also desirable to have the screws employed in effecting the vertical adjustment of said upper horizontal roll and the screws employed in effecting the adjustment of the vertical or upright rolls D and D′ operatively connected with each other,

and this is readily accomplished by means of the following well-known gearing and shafting: A bevel-gear L′ is operatively connected with the upper end of each screw L. A suitably-actuated horizontally-arranged shaft M is suitably supported from said screws, and two bevel-pinions M′ M′, operatively mounted upon said shaft M, mesh with the corresponding sides of the different bevel-gears L′ L′, respectively. A bevel-gear h^2 is operatively mounted upon the outer end of each screw H^2 and meshes with a beveled pinion O′, that is operatively mounted upon a suitably-supported upright shaft O. A suitably-supported bevel-gear O^2 is operatively and slidably mounted upon the upper end of each shaft O and meshes with a bevel-pinion M^2, that is operatively and slidably mounted upon shaft M and provided with a vertically-arranged sleeve M^3, slidably mounted upon a vertical upright H^4, that is rigid with the slide H below.

Two pairs of horizontal guide-bars P (see Figs. 4, 5, and 6) are arranged at opposite sides, respectively, of and centrally between the axes of rolls B′ B^2, and the bars of each pair of guide-bars are arranged at opposite sides, respectively, of the path of the work. Said bars prevent lateral displacement of the work during the feeding of the latter to and from the rolls. The members of each pair of guide-bars are adjustable apart and are secured in any approved manner, by means of rods P′, to the different slides H H, respectively, and each of the guide-bars is seated near its inner end upon a shoulder F^5, formed upon the block F′, that is secured to the slide instrumental in supporting said bar, and said block is provided, preferably, with an upright lug or flange F^6, bolted, as at F^7, to the guide-bar. By this construction each guide-bar P is well supported at or near each end and is not liable to be bent laterally or buckled by the work.

What I claim is—

1. In rolling apparatus of the character indicated, the combination of the positively-driven top and bottom rolls, the friction-disks operatively connected with one of said rolls, the two vertical or upright side rolls arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the axes of said last-mentioned rolls, the sliding friction-disks operatively connected with the upright side rolls, and means acting continuously during the operation of the machine upon said last-mentioned disks and maintaining them in frictional engagement with the first-mentioned disks.

2. In rolling apparatus of the character indicated, the combination of the positively-driven top and bottom rolls, the friction-disks operatively connected with the top roll, the two vertical or upright side rolls arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the axes of said last-mentioned rolls, the friction-disks operatively connected with the upright side rolls, and means bearing upwardly upon said last-mentioned disks and retaining them in frictional engagement with the first-mentioned friction-disks, substantially as and for the purpose set forth.

3. In rolling apparatus of the character indicated, the combination of the positively-driven top and bottom rolls, the upright side rolls arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the axes of said last-mentioned rolls, the two driving vertical friction-disks B^3 B^3 operatively connected with the different trunnions, respectively, of the top roll, and arranged with their diametrically larger ends vis-à-vis, the driven horizontally-arranged beveled or conical friction-disks operatively connected with the different upright rolls, respectively, and arranged below the different vertical friction-disks, respectively, and with their diametrically smaller ends uppermost, and means bearing upwardly upon the horizontal friction-disks and retaining their beveled or conical surfaces in frictional engagement with the beveled or conical surfaces of the vertical disks, substantially as and for the purpose set forth.

4. In rolling apparatus of the character indicated, the combination of the two positively-driven horizontal top and bottom rolls, the two upright side rolls arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the axes of said last-mentioned rolls, a horizontal friction-disk transmitting motion to each upright roll, interlocking lugs formed upon said last-mentioned roll and the friction-disk instrumental in transmitting motion to said roll, vertical friction-disks frictionally engaging the horizontal friction-disks and operatively connected with one of the aforesaid horizontal rolls, means acting to lift the horizontal friction-disks and retain them in frictional engagement with the vertical friction-disks, and the parts being so arranged that all of said rolls shall participate in the feeding of the work.

5. In rolling apparatus of the character indicated, the combination of the lower horizontal roll B^2; the upper horizontal roll B′ adjustable vertically; mechanism for positively driving said rolls in opposite directions, respectively; two suitably-supported vertical or upright side rolls arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the axes of said last-mentioned rolls, and each of said upright rolls having a centrally-located bore and the surrounding wall of said bore being provided with vertical lugs; a suitably-supported horizontally-arranged friction-disk within said bore and provided with vertical lugs interlocking with the lugs formed upon the surrounding wall of the bore; another friction-disk having frictional contact with said horizontal friction-disk and operatively connect-

ed with the top roll, and means acting to retain the aforesaid horizontal friction-disk in frictional contact with the engaging friction-disk, substantially as and for the purpose set forth.

6. In rolling apparatus of the character indicated, the combination of the two positively-driven top and bottom rolls, the two upright side rolls adjustable apart and arranged at opposite ends, respectively, of the top and bottom rolls and centrally between the latter's axes, driving friction-disks operatively connected with or formed upon the trunnions of the top roll, other friction-disks operatively connected with the upright side rolls and frictionally engaging and driven by the friction-disks upon the aforesaid trunnions, pistons supporting said driven friction-disks and passage-ways for conducting fluid under pressure to the lower ends of said pistons, and the arrangement of parts being such that all of said rolls shall participate in the feeding of the work, substantially as and for the purpose set forth.

7. In rolling apparatus of the character indicated, the combination of the two suitably-driven top and bottom rolls and arranged one above the other in the same vertical plane; the two vertical or upright side rolls adjustable apart and arranged at opposite ends, respectively, of the horizontal rolls, and centrally between the latter's axes; friction-disks operatively connected with or formed upon the trunnions of the top roll; horizontally-arranged friction-disks operatively connected with the upright rolls and frictionally engaging the friction-disks upon the aforesaid trunnions; pistons supporting the horizontal friction-disks; chambers formed around the lower ends of said pistons; passage-ways for conducting fluid under pressure to said chambers, and the arrangement of parts being such that all of said rolls shall participate in the feeding of the work, substantially as and for the purpose set forth.

8. In rolling apparatus of the character indicated, the combination of the two suitably-driven top and bottom rolls arranged one above the other in the same vertical plane; two vertical or upright side rolls arranged at opposite ends, respectively, of the first-mentioned rolls and centrally between the latter's axes; friction-disks operatively connected with or formed upon the top roll; horizontally-arranged friction-disks operatively connected with the upright rolls and frictionally engaging the first-mentioned friction-disks; hollow upright cylinders arranged centrally within the upright rolls; pistons supporting the horizontal friction-disks and extending into the said cylinders; the stuffing-boxes at the upper ends of the cylinders; passage-ways for conducting fluid under pressure to the cylinders' chambers, and the arrangement of parts being such that all of said rolls shall participate in the feeding of the work, substantially as and for the purpose set forth.

9. In rolling apparatus of the character indicated, the combination of the two suitably-driven top and bottom rolls arranged one above the other in the same vertical plane; two vertical or upright side rolls arranged at opposite ends, respectively, of the first-mentioned rolls and centrally between the latter's axes; friction-disks operatively connected with or formed upon the trunnions of the top roll; horizontally-arranged friction-disks operatively connected with the upright rolls and frictionally engaging the friction-disks upon the aforesaid trunnions; upright hollow cylinders affording bearing for the upright rolls and each cylinder having an external annular shoulder formed upon its lower end, and anti-friction-balls interposed between the opposing surfaces of said shoulder and the roll supported upon said shoulder; pistons extending into the chambers of the cylinders and bearing the horizontal friction-disks; passage-ways for conducting fluid under pressure to said cylinder-chambers, and the arrangement of parts being such that all of said rolls shall participate in the feeding of the work, substantially as and for the purpose set forth.

10. In rolling apparatus of the character indicated, the combination of the two suitably-driven top and bottom rolls arranged one above the other in the same vertical plane; two suitably-supported vertical or upright side rolls adjustable apart and arranged at opposite ends, respectively, of the first-mentioned rolls and centrally between the latter's axes; friction-disks operatively connected with or formed upon the trunnions of the top roll; horizontally-arranged friction-disks operatively connected with the upright rolls and frictionally engaging the friction-disks upon the aforesaid trunnions; pistons supporting the horizontal friction-disks; chambers formed around the lower ends of said pistons; passage-ways for conducting fluid under pressure to said chambers; ports extending upwardly through the pistons from and in open relation with said chambers and terminating, at their upper ends, in nozzles or nipples arranged to discharge upwardly, and the arrangement of parts being such that all of said rolls shall participate in the feeding of the work, substantially as and for the purpose set forth.

11. In rolling apparatus of the character indicated, the combination of the two suitably-driven horizontal and parallel rolls arranged one above the other in the same vertical plane; two positively-driven vertical or upright side rolls arranged at opposite ends, respectively, of the horizontal rolls and centrally between the latter's axes; the suitably-supported upright segmental thrust-plates for said upright rolls, and said plates being arranged on edge and opposite to the place of rolling, and any suitable number of suitably-supported upright antifriction-rollers interposed between said plates and the rolls, substantially as and for the purpose set forth.

12. In rolling apparatus of the character indicated, the combination of the two suitably-driven horizontal and parallel rolls arranged one above the other in the same vertical plane; upright housings at opposite ends, respectively, of said rolls and supporting the lower roll; two positively-driven vertical or upright side rolls arranged at opposite ends, respectively, of the horizontal rolls and centrally between the latter's axes; two blocks bearing the different side rolls, respectively, and supported from the different housings, respectively, and means for adjusting the upper horizontal roll vertically; two slides secured to the different roll-bearing blocks, respectively, and supported from the different housings, respectively, and means for adjusting said slides toward and from each other, substantially as set forth.

13. In rolling apparatus of the character indicated, the combination of the two suitably-driven horizontal and parallel rolls arranged one above the other in the same vertical plane; upright housings at opposite ends, respectively, of said rolls and supporting the lower roll; two positively-driven vertical or upright side rolls arranged at opposite ends, respectively, of the horizontal rolls and centrally between the latter's axes; two blocks bearing the different side rolls, respectively, and supported from the different housings, respectively, and means for adjusting the upper horizontal roll vertically; two slides secured to the different roller-bearing blocks, respectively, and supported from the different housings, respectively, means for adjusting said slides toward and from each other, a pair of guide-bars arranged at opposite sides of the work's path leading to the rolls; another pair of guide-bars arranged at opposite sides, respectively, of the work's path leading from the rolls, and the members of each pair of guide-bars being rigidly secured to the adjacent roll-bearing block and the slide connected with said block, and shoulders or seats formed upon the said blocks for the guide-bars, substantially as and for the purpose set forth.

14. In rolling apparatus of the character indicated, the combination of the positively-driven horizontal rolls arranged to operate upon the inside of the flanges and both sides of the web; positively-driven vertical or upright rolls arranged to work on the outside of flanges; positively-driven horizontal rolls arranged to operate upon the edges of the flanges, and mechanism or apparatus for working all of said rolls in unison in a like direction at a like speed, and said rolls having furthermore such relative arrangement that all of them simultaneously operate upon the piece of work under manipulation during every pass of said work.

In testimony whereof I sign this specification, in the presence of two witnesses, this 25th day of April, 1896.

HENRY GREY.

Witnesses:
C. H. DORER,
ELLA E. TILDEN.