(No Model.) 5 Sheets—Sheet 1.

# F. H. DANIELS.

## ROLLING MILL.

No. 387,495. Patented Aug. 7, 1888.

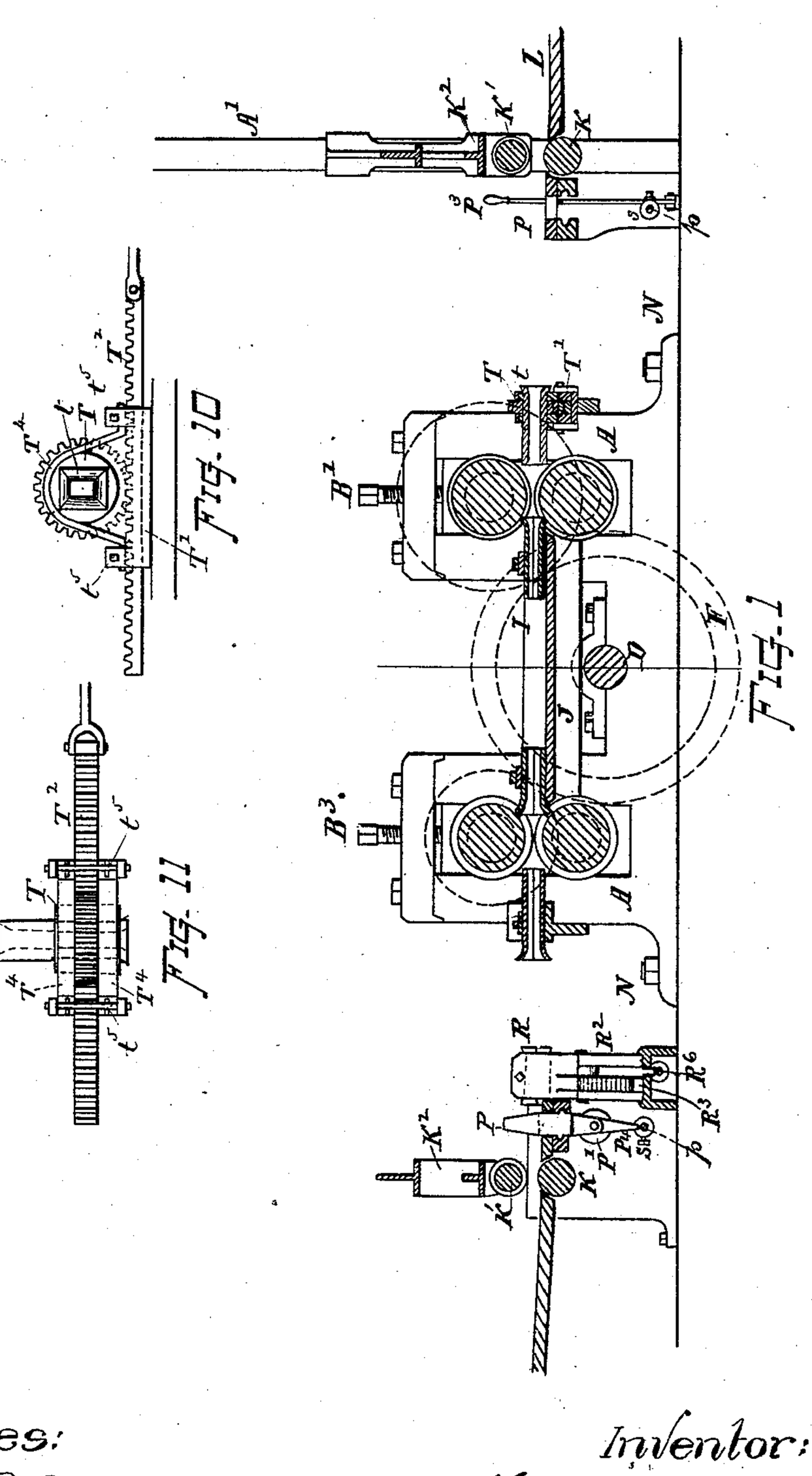

FIG. 1



FIG. 10



FIG. 11

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(No Model.)

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# F. H. DANIELS.

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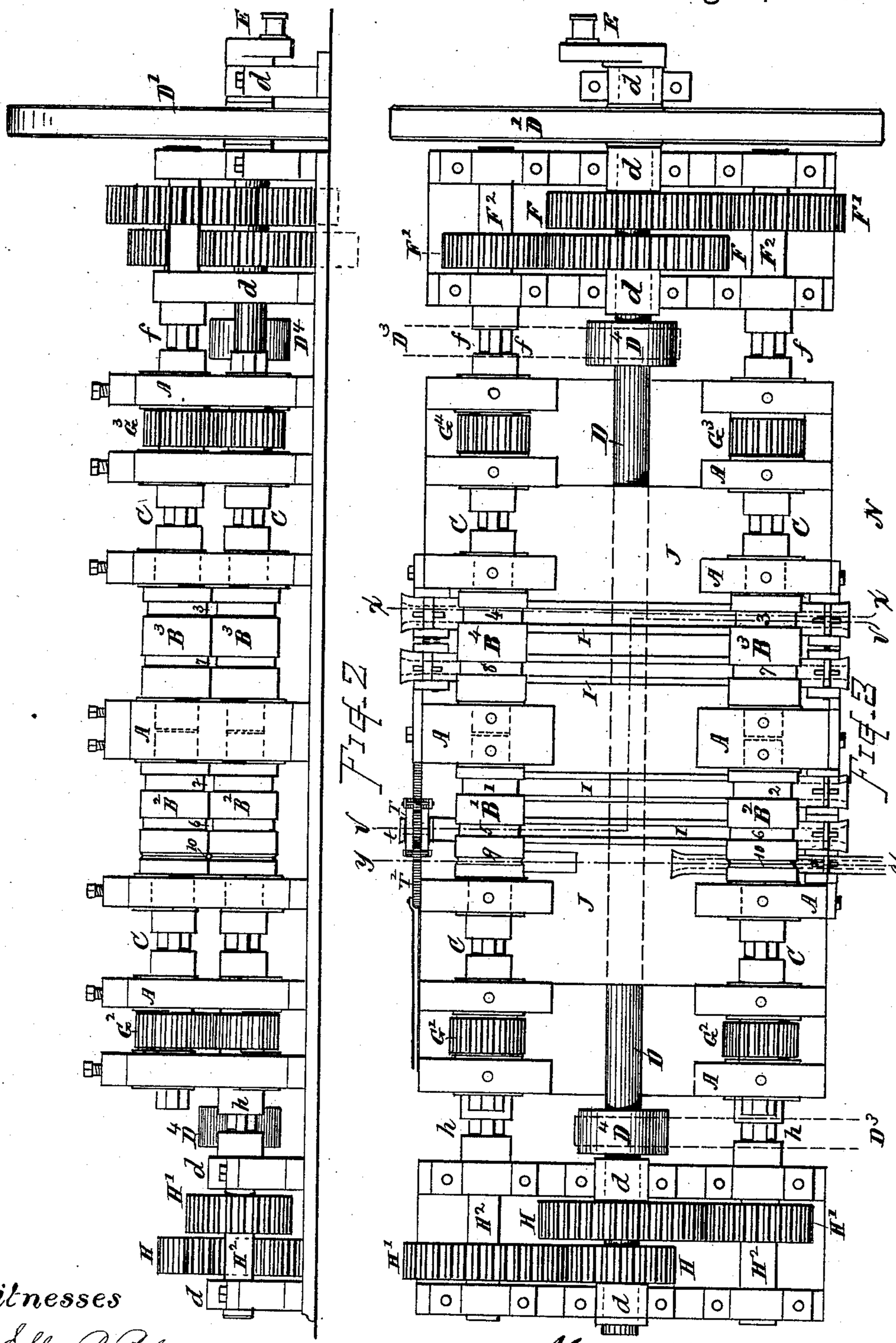

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(No Model.) 5 Sheets—Sheet 3.

# F. H. DANIELS.

## ROLLING MILL.

No. 387,495. Patented Aug. 7, 1888.

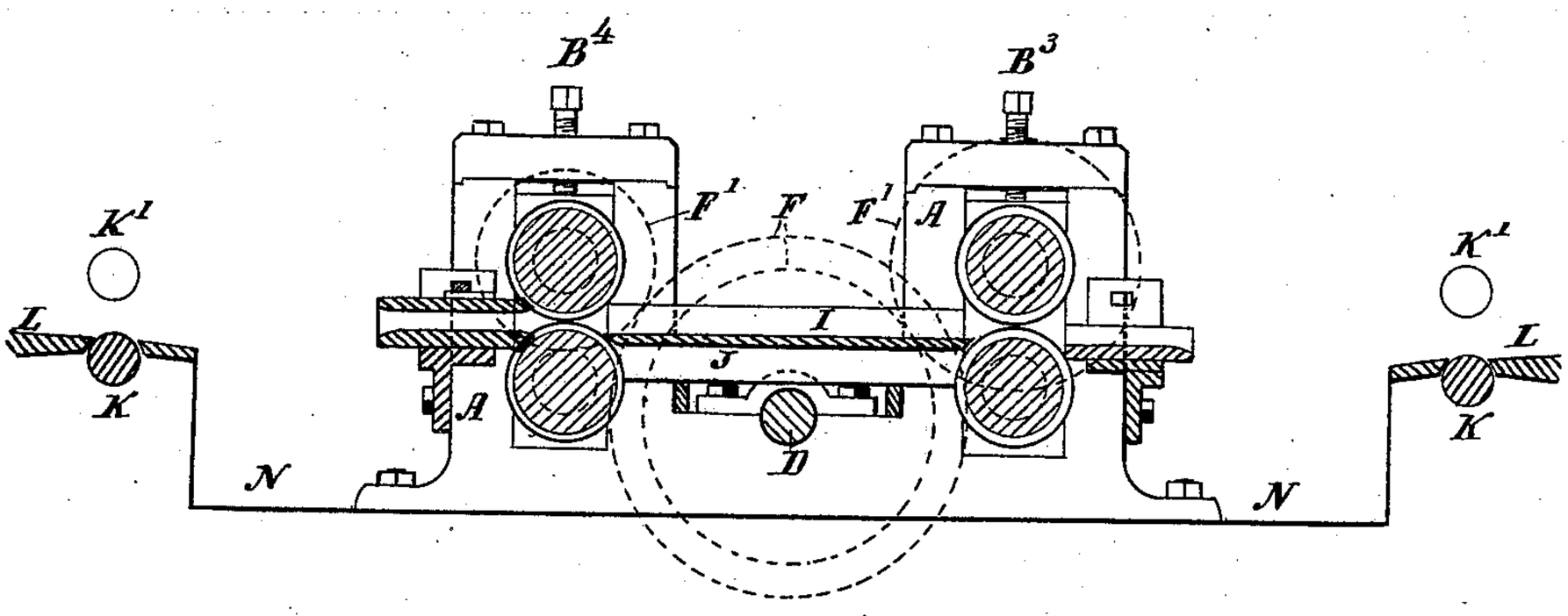


Fig. 4

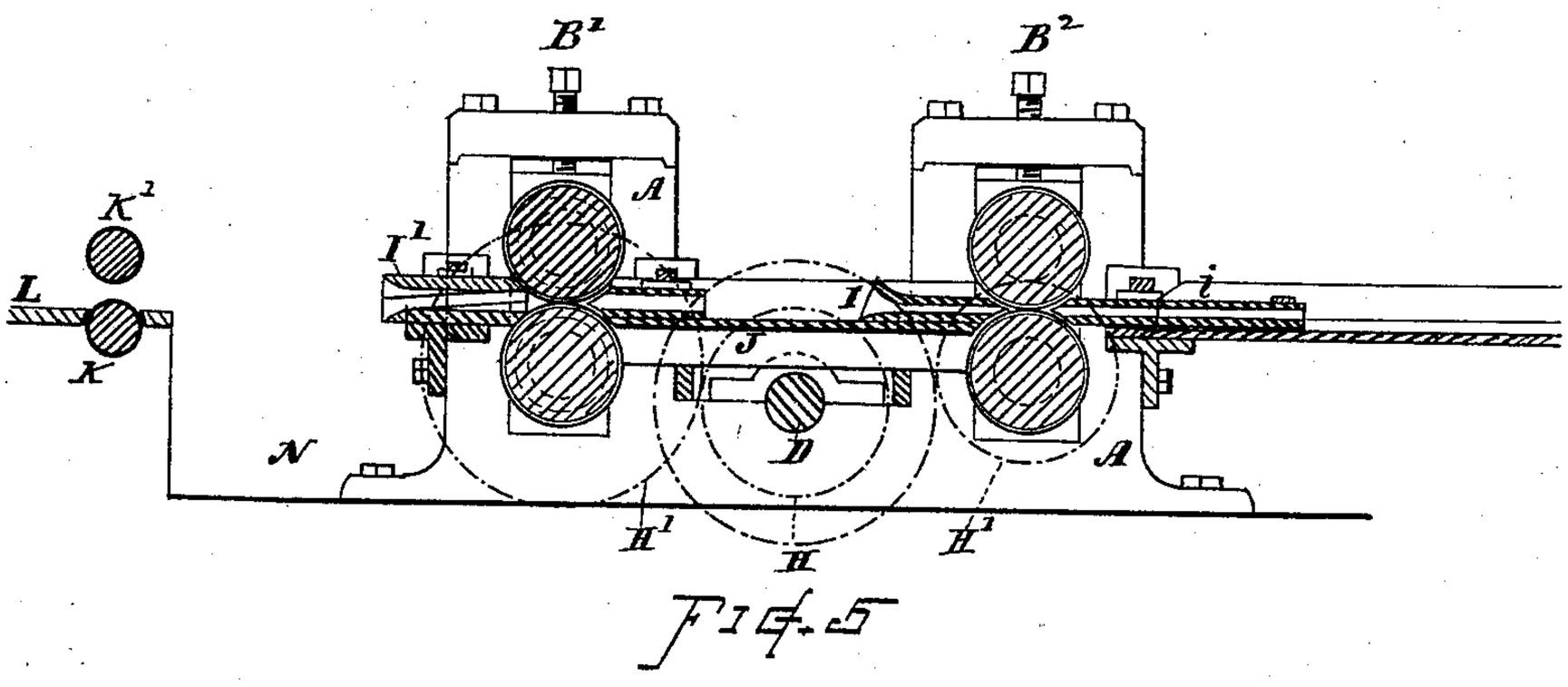


Fig. 5

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(No Model.) 5 Sheets—Sheet 4.

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## ROLLING MILL.

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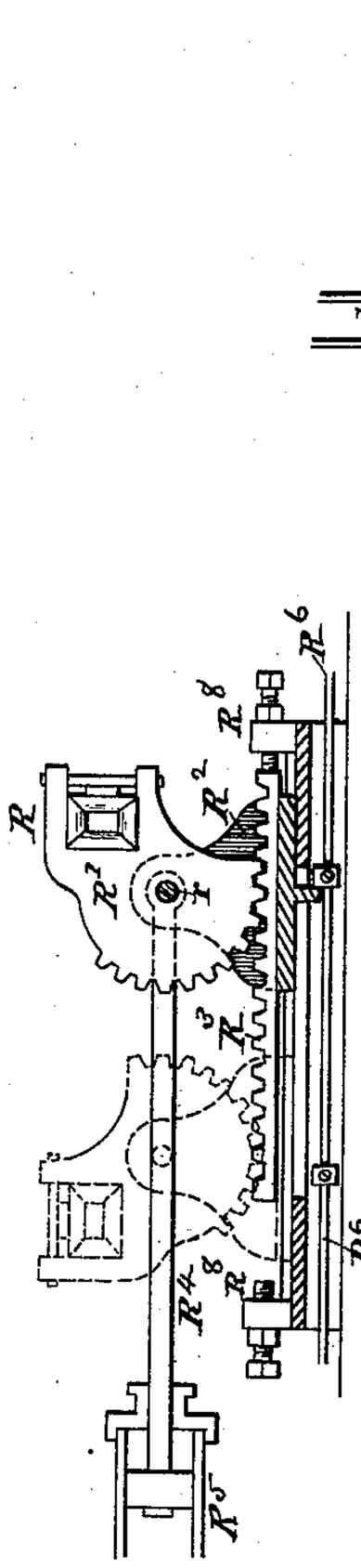

FIG. 7.

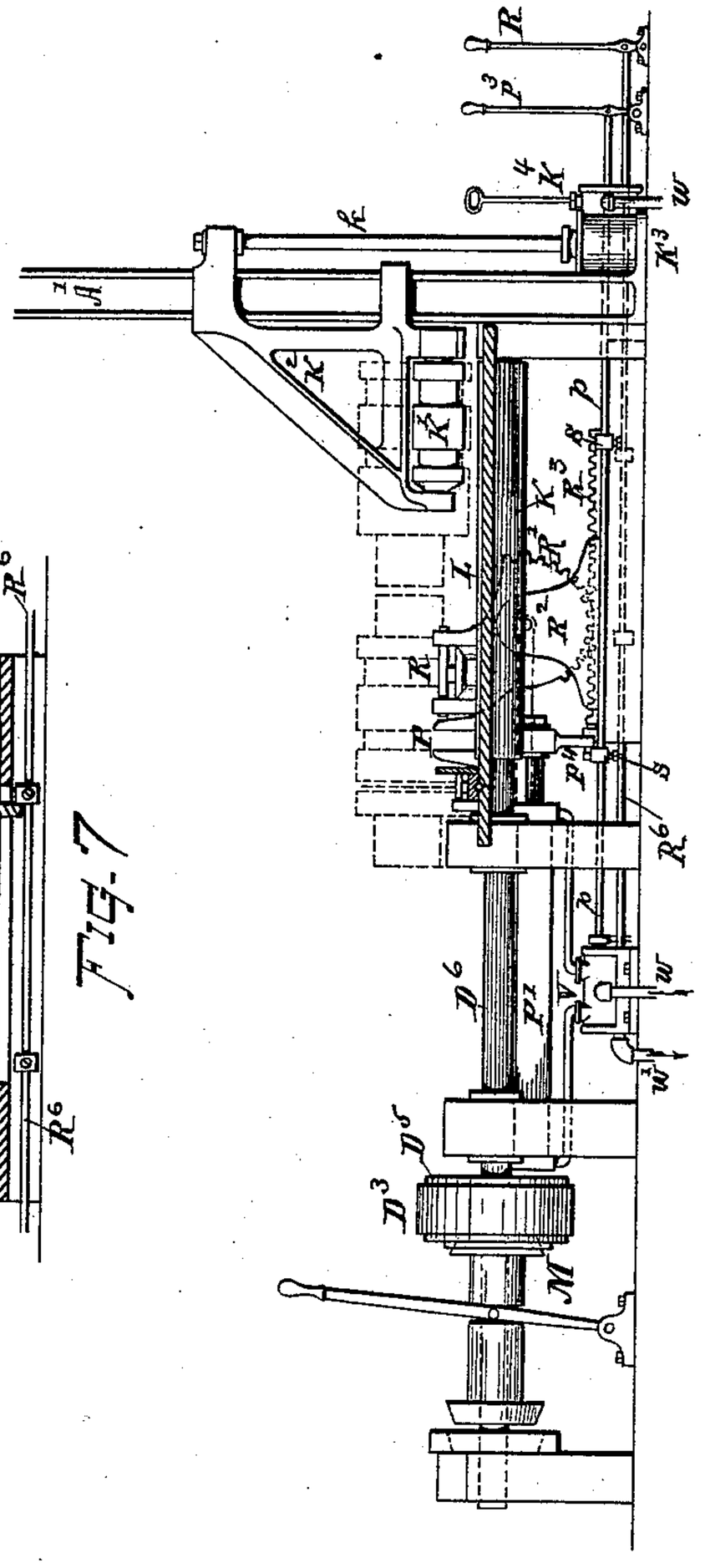

FIG. 6.

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(No Model.) 5 Sheets—Sheet 5.

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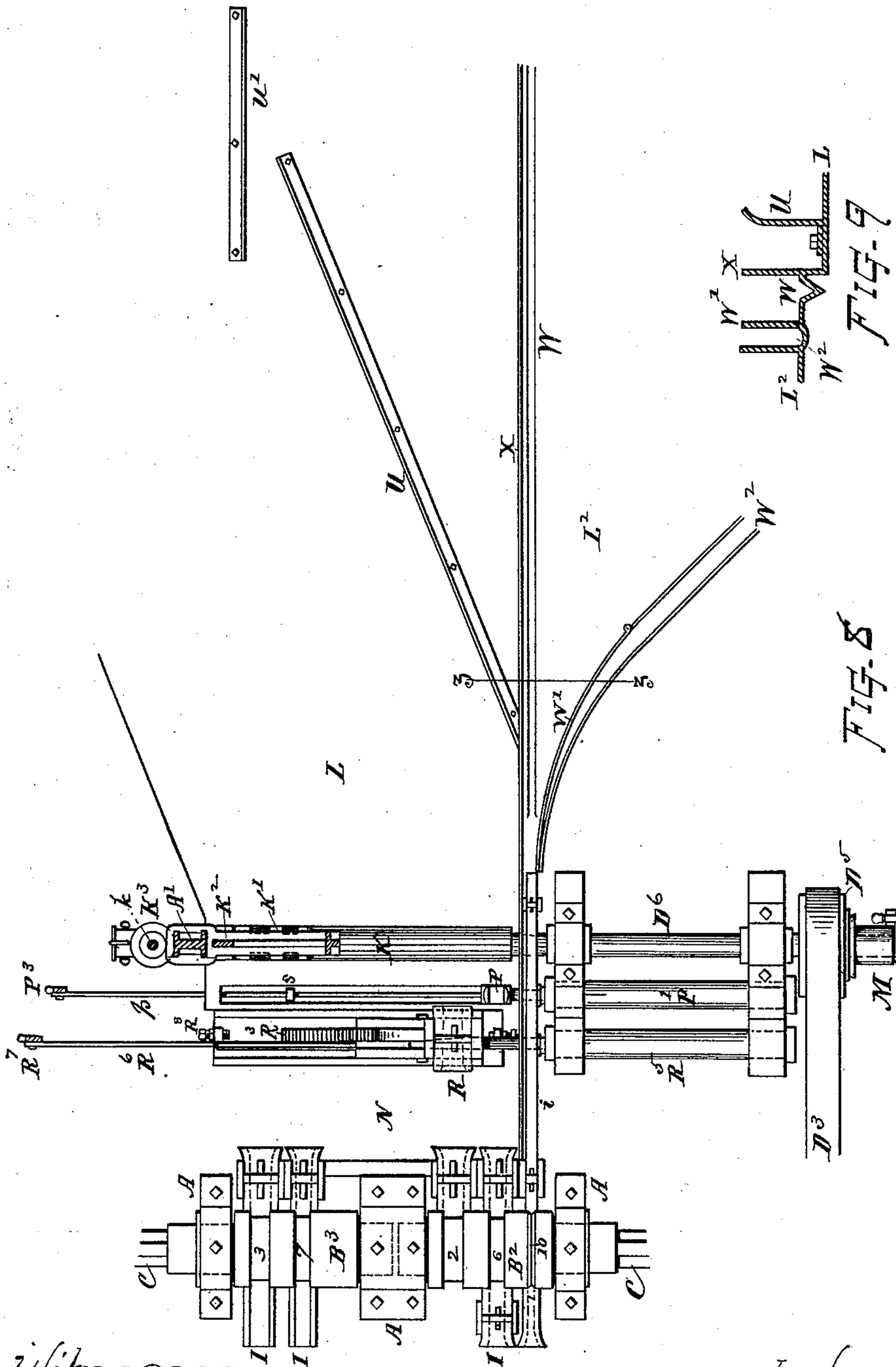
## ROLLING MILL.

No. 387,495. Patented Aug. 7, 1888.



Witnesses:
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Frank L. Wheeler

Inventor:
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# UNITED STATES PATENT OFFICE.

FRED H. DANIELS, OF WORCESTER, MASSACHUSETTS.

## ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 387,495, dated August 7, 1888.

Application filed January 31, 1887. Serial No. 225,995. (No model.)

*To all whom it may concern:*

Be it known that I, FRED H. DANIELS, a citizen of the United States, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Rolling-Mills, of which the following, together with the accompanying drawings, is a specification sufficiently full, clear, and exact to enable persons skilled in the art to which this invention appertains to make and use the same.

The object of my present invention is to provide a practical and efficient rolling-mill mechanism for economically and quickly reducing steel or iron blooms to a size of bar or billets that can be conveniently worked in a continuous rolling-mill train for the production of wire rods and other small shapes; also, to provide a rolling-mill having a plurality of sets of rolls arranged to afford oppositely-directed series of rolls for duplex action, or in such manner as to give two or more reduction passes for each introduction of the product into the mill; also, to provide a rolling-mill with a system of guiding devices and feeding mechanism for transferring, introducing, and conducting the metal into and through the several reduction-passes, as hereinafter explained; also, to afford facilities for turning or tipping the bar preparatory to feeding the same to the passes of the rolls, as may be required in its back and forth passages through the mill. These objects I attain by mechanism the nature, construction, and arrangement of which are illustrated in the drawings and explained in the following description, the particular subject-matter claimed being hereinafter definitely specified.

In the drawings, Figure 1 is a vertical section through the rolling-mill and feeding mechanism at the position indicated by line *v v* on Fig. 3. Fig. 2 is an elevation view of the rolling-mill feeding devices and guides. Fig. 3 is a plan view of the rolling-mill, showing the relative position of the sets of rolls, driving-shaft and gearing, and the intermediate platform. Fig. 4 is a transverse section at line *x x*, with dotted lines indicating the train of gearing for driving two of the pairs of rolls. Fig. 5 is a transverse section at line *y y*, with dotted lines indicating the train of gearing for driving the other two pairs of rolls. Fig. 6 is an elevation view showing the mechanism for transferring and feeding the bars into the rolling-mill. Fig. 7 is a detail view of the mechanism for automatically transferring and turning the heavy bars. Fig. 8 is a plan view showing a portion of the rolls at one side of the rolling-mill and the mechanism for transferring and feeding in the bars, with guides for conducting the bar as it runs out onto the floor or platform. Fig. 9 is a vertical section of the guides and fenders at line *z z*, Fig. 8. Figs. 10 and 11 show details of the mechanism for turning and guiding small bars into the rolling-mill.

In this description the term "sets" is used to designate the groups of rolls and mechanism which are in axial alignment with each other; the term "pairs" to designate rolls, which together form a reducing-pass for the metal, and the term "series" to denote the consecutively-acting pairs, through which the bar is fed in either forward or backward direction.

In referring to parts on the drawings, A denotes the frame or housings of the rolling-mill, which rolling-mill comprises a plurality of sets of rolls arranged in pairs, with the bite or passes of the separate series of rolls in substantially the same plane and disposed in a manner to work or operate in duplex order, or so that the single introduction of the bloom or product gives a plurality of reductions—that is, when the bloom or bar is fed into the pass of one pair of rolls it will run automatically through a second pass or pair of rolls. The relative disposition of the rolls and driving gearing and the general construction of this mill is illustrated in Figs. 1, 2, 3, 4, and 5, and consists, preferably, of four pairs of rolls, B′, $B^2$, $B^3$, and $B^4$, arranged in double sets, each consisting of two pairs ranged end to end, the respective sets being geared, so that the ingot, bar, or material will be carried forward through the passes of the rolls B′ and $B^2$ automatically without overfeed, and backward through the passes of the rolls $B^3$ and $B^4$ in similar manner. The metal is fed into the mill back and forth, end and end, until reduced to the requisite size. The pairs of rolls B′ and $B^4$ are disposed at a distance of about six feet (more or

less) on centers of axes from the pairs of rolls $B^2$ and $B^3$, the axes of the rolls B′ and $B^4$ being placed in line end to end, or to range, respectively, with each other, and the pairs of rolls $B^2$ and $B^3$ are in similar manner disposed end to end to range one with another. Each pair of rolls is provided with suitable connecting-gearing at G′, $G^2$, $G^3$, and $G^4$, to which the roll-journals are connected by couplings C, substantially such as heretofore employed for connecting the rolls and gearing in rolling-mills.

A driving-shaft, D, supported to turn in suitable bearings, *d*, extends across the mill parallel with the sets of rolls, which shaft is provided with a balance-wheel, D′, and with a crank, E, or suitable connection to receive power and motion from the engine or motor, which latter may be of any suitable kind, and is not herein shown. At one end of the mill said shaft is provided with gears F, that mesh with gears F′, fixed to auxiliary shafts $F^2$, which are connected by suitable couplings at *f* with the upper gear-shafts of the rolls $B^3$ and $B^4$, while at the opposite end of the mill said driving-shaft D is provided with gears H, that mesh with gears H′, fixed to auxiliary shafts $H^2$, which are connected by suitable couplings, *h*, with the lower gear-shafts of the rolls B′ and $B^2$. The manner of gearing the roll-axles is illustrated in Fig. 3 and by dotted lines in Figs. 4 and 5.

Between the several sets of rolls, and extending across the intervening space from one set of rolls so the other, is a table or platform, J, which serves as a stand for the attendant and also for supporting the bar as it passes from the bite of one pair of rolls to another. Flanges or guides I are arranged on said platform to prevent displacement of the bar laterally or to conduct it direct from the pass of the leading pair of rolls to the pass of the succeeding pair. In the present instance the rolls are constructed to give ten passes or reductions, which passes are denoted in their successive order by numerals (1 to 10, inclusive) on Fig. 3 of the drawings. The first eight passes, as here shown, are square or box passes. The ninth pass is made to give an oval section, and the tenth pass to give a square or diamond section.

The arrangement, number, and form of the passes may be varied to suit circumstances and different conditions of work, and I do not desire to confine my invention to any particular number of passes or forms of passes to be used in a rolling-mill of the construction and arrangement of rolls herein described.

At the front and rear of the rolling-mill I arrange mechanism for feeding the bloom or bar to the reducing-rolls and for shifting it laterally from one set of rolls to the other. This is illustrated in Figs. 1, 6, 7, and 8, and is constructed as follows: For feeding in the bar I employ a feed-roll, K, extending across the mill parallel with the reducing-rolls, with its top surface slightly above the receiving table or floor L, upon which the bar runs out. Above the roll K, and supported in bearings on a vertically-movable bracket, $K^2$, there is a presser-roll, K′, preferably having grooves corresponding in position to the roll-passes to which the bar is to be fed. This roll-elevating bracket $K^2$ is supported to slide or work on an upright guideway or post, A′, and is connected by a rod, *k*, with the piston of the hydraulic cylinder $K^3$, so as to be moved up and down for gripping and releasing the bars between the rolls K K′. The surface of the roll K is preferably corrugated along that portion beneath the roll K′ to enable it to take a firm grip on the bar.

The receiving tables or floors L, upon which the bar runs out at the front and rear of the mill, is preferably inclined upward from the rolls K to elevate the end of the bar as it runs from the rolls, and a depressed space or passage-way, N, is located along the front and rear of the rolling-mill for the convenience of the attendants in working about the mill. The roll K is rotated with its top surface running in a direction toward the rolling-mill, it being operated, preferably, by the belt $D^3$, running on pulleys $D^4$ $D^5$, mounted on the driving-shaft D and the feed-roll shaft $D^6$, respectively, a suitable clutch mechanism being provided, as at M, or in other convenient manner, for throwing the roll K into and out of action.

Adjacent to the roll K and moving in guides across the space over which the bar travels when running to and from the reducing-rolls is a shifting fork or carrier, P, which receives the rod as it runs out of the rolls, and which is operated for transferring the end of the rod laterally, so as to bring it into position for feeding into the succeeding pass of the rolls. The transfer-fork is arranged to work in a suitable guideway across the receiving-platform in front of the roll K.

A cylinder, P′, provided with a piston and rod connected to said fork, serves as a means for moving the fork to shift the end of the bar from one position to the other. The piston is preferably operated by hydraulic pressure under control of the valve V and the valve-rod *p*, which is worked by the lever $P^3$, and if desired, by a trip device, $P^4$, which engages stop-collars S, fixed on the rod.

For receiving and turning the heavy bars an oscillating guide, R, is employed, (see Fig. 7,) which guide is provided with a rocking carrier, R′, mounted in connection with a sliding support, $R^2$, that is fitted to traverse back and forth on a suitable guideway, and having a segment of gear-teeth which mesh with a rack, $R^3$, that slides through the base of the carrier in a direction with the line of movement of the carrier. The carrier is pivoted, as at *r*, to its sliding support, and is connected by a rod, $R^4$, with a piston which works in a cylinder, $R^5$, by hydraulic or other pressure, the cylinder-valve being controlled by the rod $R^6$, worked by the lever $R^7$, and by the engaging-stop on the under side of the carrier.

Stop devices $R^8$, adjustable or otherwise, are

arranged at the ends of the guideway R, along which the carrier-support $R^2$ travels, which stops engage with the rack $R^3$ as the carrier-support approaches the limit of its movement, and by stopping the advancement of the rack $R^3$ before the movement of the supporter ceases effects the oscillation or partial rotation of the guide-carrier, so as to bring the guides and bar into a position for entering the bar into the roll-pass at ninety degrees (more or less) from that at which it was received from the preceding rolls. (See dotted lines and full lines, Fig. 7.) The dotted lines indicate the position of the guide for receiving the bar, and the full lines show the position of the guide for delivering the bar to the rolls $B^3$.

At the opposite side of the rolling-mill, for turning the bar after it has been reduced to a size which can can be conveniently managed threwith, I preferably employ an entering-guide, such as illustrated in Figs. 1, 10, and 11, wherein the guide-plates *t* are supported in a revoluble hub or carrier, T, which is provided with gear teeth about its periphery or a portion thereof, and supported to rotate in a stationary bearing-shoe, T', through which a rack, $T^2$, slides, the said rack being meshed with the gear-teeth of the carrier, so as to rotate the guide as the rack is reciprocated. Said rack may be reciprocated for turning the bar by means of a hand-lever, hydraulic cylinder, and piston, or other suitable means, the partial rotation of the guide being effected after the end of the bar has been inserted through or into the guide.

The guide-supporting hub T is preferably made in two parts, and is held in its bearings by straps $T^4$, confined by breaking-bars $t^5$, as shown in Figs. 10 and 11, in such manner that in case of accident or of choking the guides the breaking-bars will be fractured and the guides released. In the smaller passes of the mill—as, for instance, the ninth pass, or when the bar is reduced sufficiently—a guide, I', having a spiral interior way, is used for turning the bar before it enters the rolls. (See Fig. 5.)

U indicates a diagonally-disposed guard or fender, against which the advance end of the bar strikes as it runs from the rolling-mill, and by means of which it is deflected to carry it laterally over to a position in front of the return-passes, so that only the latter end of the bar will have to be transferred to bring it in position for making the return-pass through the rolls.

U' indicates an oppositely-disposed guard or deflector for directing the end of the bar again into line with the rolling movement when it has reached the required lateral deflection or a position in front of the return-pass. The fenders U U' are made as flanges or low partitions bolted or otherwise secured in position upon the floor or platform L.

W indicates a guide-channel in which the billet or finished bar runs out from the last pass of the rolls, and W' denotes a switch for deflecting the billet into a side passage, $W^2$, when said switch is swung across the guide-way W.

X indicates a guard or partition for separating the floor or platform L, on which the partially-finished bar runs out from the guide-way W or floor $L^2$, upon which the finished billet is discharged.

*w w'* indicate the inlet and outlet water-pipes for supplying hydraulic pressure to the respective cylinders and pistons which work the feeding and transfer mechanisms.

In the operation of my improved rolling-mill the bloom as it comes from the heating-furnace is introduced into the pass 1 of the rolls B' and runs across the table J and through pass 2 of the rolls $B^2$, thence out upon the platform L, passing through the eye of the turning-guide R as it issues from the discharging-guide of the pass 2. As the leading end of the bar runs out upon the platform L it is deflected by the fender U laterally across to the fender U', thereby bringing its advance end into line with the opposite pairs of rolls, $B^3$ and $B^4$, through which it is to be returned by feeding in the reverse end. When the bar is discharged from the pass 2, its rear end is stopped in the turning-guide R. The valve of the hydraulic cylinder $R^5$ is then opened by lever $R^7$ and the piston-rod forces forward the supporting carrier and guide, thereby shifting the bar from a position back of pass 2 of rolls $B^2$ to a position in front of pass 3 of rolls $B^3$, the roll K' being at the time elevated, so that the bar can pass beneath said rolls. As the sliding support $R^2$ approaches the stop $R^8$, the rack $R^3$ strikes said stop and is forced backward in its shoe, thereby causing rotation of the carrier R' to bring the bar into a position a quarter-revolution (more or less) from that at which it was received, and so as to present it in proper alignment for entering it into pass 3. When the end of the bar has arrived at the desired position, power is applied in the cylinder $K^3$ for depressing the supporting-bracket $K^2$ to bring the roll K' firmly down upon the bar, thus gripping it between said roll and the roll K, so that the motion of the latter will cause the bar to be forced forward into pass 3 of rolls $B^3$. It then runs through said pass 3 and automatically through pass 4, running out upon the table, floor, or platform L at the opposite side of the mill, and passing between the forks or receiving-pins of the transferring-guide P; also, having its end deflected by guides, such as U U', which are provided at that side of the mill and arranged in a manner substantially similar to those illustrated in Fig. 8. When the end of the bar has left the pass 4, the transfer device is shifted by drawing back lever $P^3$ and opening the valve of its operating hydraulic cylinder, and the end of the bar is carried to a position in front of the guide T. The feed-rolls K K' are then brought into action for advancing the end of the bar into said guide T, and the roll K' is then elevated for an instant while the rack $T^2$ is moved endwise

sufficiently to rotate the guide T and turn the bar to a position ninety degrees (more or less) from that which it occupied when entering said guide. The roll K is then again depressed upon the bar for advancing it into the pass 5. Thence it runs automatically across the table J, through the pass 6, and out upon the platform L, passing between the forks of the transferring-guide P, and being deflected by the fenders U U', as before. The end of the bar is shifted across to be entered into pass 7 and carried again through the rolls in a manner substantially similar to that above described. The entrance-guide to pass 7 may be made rotatable, similar to that shown in Fig. 10, or a guide having a spiral interior for turning the rods may be employed; or, again, a plain entering-guide may be used and the rod turned by hand, as preferred. From pass 7 the rod runs automatically through pass 8, after which its end is transferred and entered to pass 9, and runs thence through pass 10 and is discharged into the guideway W, or in such direction as may be desired.

What I claim as of my invention, and desire to secure by Letters Patent, is—

1. A rolling-mill having a plurality of sets of rolls, each set composed of two pairs of rolls, with driving mechanism for rotating the pairs in opposite direction, said sets of rolls being disposed with their passes in line for advancing the bar in either direction through the several sets in duplex or continuous order, substantially as described, whereby each introduction of the product backward or forward gives a plurality of passes for reduction.

2. A rolling-mill having a plurality of sets of two-high rolls arranged in double pairs with their reducing passes in substantially the same horizontal plane, disposed one set in front of the other for operating in duplex order, and the respective pairs of rolls at the right and left in each set rotating in opposite directions for giving backward and forward passes of the bar, and means, substantially as described, for directing the bar across the space between the rolls, and mechanism for imparting motion to said rolls, substantially as set forth.

3. A rolling-mill having a series of pairs of rolls, as $B'$ $B^2$, for giving forward passes, and a series of pairs of oppositely-rotating rolls, as $B^3$ $B^4$, arranged end to end, with operating-gearing for the several pairs at the right and left, respectively, and a main driving-shaft, D, provided with gearing for simultaneously operating all of the respective pairs of rolls at the requisite speeds for reducing the bars in their back-and-forth passes, substantially as described.

4. A rolling-mill having a plurality of sets of rolls arranged one in front of the others to work in duplex or continuous order, in combination with a bar supporting platform arranged parallel with the axial plane and extending across the space between the respective sets of rolls adjacent to the plane of their reduction-passes, substantially as and for the purpose set forth.

5. A rolling-mill having a plurality of sets of rolls, each set composed of two oppositely-rotating pairs of rolls disposed with the pairs of rolls in one set in front of correspondingly-rotating pairs in the other sets to work in continuous or duplex order, in combination with guides leading across the space between the sets in alignment with the passes of the rolls, and means for rotating said rolls for effecting backward and forward passage of the bar, substantially as set forth.

6. A rolling-mill the rolls in which are arranged, in the manner herein described, for giving double backward and forward passes, the rolls combined with a system of guides for conducting the bar across the space between the sets of rolls, and a shifting device for carrying the bar laterally from the position of its exit to a position for its entrance into the roll-passes, substantially as set forth.

7. In a rolling-mill, the combination of a plurality of sets of rolls arranged in double pairs, end to end, rotating in opposite directions, with the bite of the rolls substantially in the same plane, the product to be carried through the duplex passes in one direction in one series of pairs of rolls and back through another series, and a laterally-movable oscillating carrier-guide for shifting and turning the end of the bar when reversing the feed thereof, substantially as set forth.

8. The combination, with the reducing-rolls, and the feeding-roll K, disposed in relation thereto as described, of the presser-roll K', having a groove for the reception of the bar and mounted on the overhanging vertically-reciprocating bracket $K^2$, substantially as and for the purpose set forth.

9. The combination, substantially as hereinbefore described, of the reducing-rolls disposed in oppositely-rotating pairs, the feed-roll K, with driving mechanism for rotating the same, the presser-roll K', the upwardly and downwardly movable bracket $K^2$, overhanging one end of said feed-roll and supporting the journals of said presser-roll, the guiding-standard A', the hydraulic cylinder $K^3$, piston-rod *k*, connected with said bracket, and the valve $K^4$, for the purposes set forth.

10. In a rolling-mill adapted for reducing bars by forward and backward end and end feeding, the combination, with the reducing-rolls, of the fenders U U', arranged substantially as set forth, and for the purposes specified.

11. In a rolling-mill arranged for the back and forth feeding of the bar, the combination, with the reducing-rolls, of a feed-roll over which the bar is projected, a presser-roll, and means for raising and depressing the same, and a diagonally-disposed fender for deflecting the advancing end of the bar, and a hydraulic carrier for shifting the rear end of the bar laterally from the pass of one pair of rolls

to the pass of the other pair of rolls, substantially as set forth.

12. The combination, with the reducing-rolls, of an entering-guide and guide-carrier adapted for partial rotation for turning the bar, and means for rotating said guide-carrier and guide, substantially as and for the purpose set forth.

13. The combination, with the reducing-rolls and rolls for feeding the bar to the pass of said reducing-rolls, of an entering-guide and guide-carrier adapted for partial rotation for turning the bar, a rack for rotating said guide-carrier and guide, and means for effecting movement of said rack, substantially as and for the purpose set forth.

14. The combination, with the reducing-rolls in a rolling-mill, of a twisting-guide adapted for turning the bar before entering the reducing-pass of said rolls, and a feeding-in mechanism for advancing the bar through said guide, substantially as and for the purpose set forth.

15. The combination, with reducing-rolls, of the guide-carrier R′, the reciprocating supporter $R^2$, the rack $R^3$, mounted to slide on said supporter and engaging with said guide-carrier, stops for engaging said rack, and means for imparting reciprocative action to said supporter and carrier, substantially as and for the purpose set forth.

16. In a rolling-mill for reducing bars by forward and backward end and end passage, the combination, with the reducing-rolls, of a reciprocating guide or carrier for shifting the bar laterally, an operating cylinder, piston, and connections, and means for automatically closing the cylinder-valve when said shifting-carrier has reached its desired limit of action, substantially as set forth.

17. The combination, with the oscillating guide-carrier R′, its shifting supporter $R^2$, provided with an engaging-lug, of the operating-cylinder $R^5$ and connecting-rod, and the valve-controlling rod $R^6$, provided with collars or lugs, substantially as and for the purpose set forth.

18. The combination, in a rolling-mill, of a plurality of sets of reducing-rolls disposed in oppositely-rotating pairs, with the bite or passes of said rolls in substantially the same plane, driving mechanism imparting motion thereto, an intermediate platform, and guides between the sets of rolls, a receiving-platform upon which the bar is projected as it runs from the rolls, a feed-roll arranged across said platform, a presser-roll in front of the entering-pass, and means for operating the same for forcing the bar down upon said feed-roll, a movable carrier for shifting the end of the bar laterally of said platform, an actuating cylinder and piston connected with said carrier, and valve-operating mechanism to control the pressure in said cylinder, substantially as hereinbefore set forth.

19. The combination, in a rolling-mill, of a plurality of sets of reducing-rolls disposed in oppositely-rotating pairs, with the bite or passes of said rolls in substantially the same plane, driving mechanism for imparting motion thereto, a support for the bar between the rolls, a receiving-platform upon which the bar is projected as it runs from the rolls, a diagonally-disposed fender, and a reversing-fender fixed upon said platform, a laterally-movable carrier for shifting the end of the bar laterally of said platform, an actuating cylinder and piston connected with said carrier, and valve-operating mechanism to control said cylinder, substantially as hereinbefore set forth.

20. The combination, in a rolling-mill, of a plurality of sets of reducing-rolls disposed in oppositely-rotating pairs, with the bite or passes of said rolls in substantially the same plane, means, such as described, for operating said rolls, a support, and guides for directing the bar between the several sets, a receiving-platform upon which the bar is projected as it runs from the rolls, a feed-roll arranged across said platform, a presser-roll in front of the entering-pass, and means for operating the same to force the bar down upon said feed-roll, a diagonally-disposed fender, and a reversing-fender fixed upon said platform, an actuating cylinder and piston connected with said presser-roll, and valve-operating mechanism to control the pressure in said cylinder, substantially as hereinbefore set forth.

21. In a rolling-mill, the combination of a plurality of sets of reducing-rolls severally comprising a plurality of oppositely-rotating pairs of rolls, with intermediate guides disposed for operation upon the bar in duplex order, a pair of feed-rolls at either side of said mill, a driving-shaft, as D, provided with gearing F H, and pulleys $D^4$, auxiliary gear-shafts $F^2$ $H^2$, coupled with the respective roll-shafts, belts $D^3$, pulleys D, and clutch mechanism M, substantially as and for the purpose set forth.

22. The reciprocating carrier P, the cylinder P′, and piston connecting-rod, the valve V, valve-rod *p*, provided with collars S, engaging-lug $P^4$, and actuating-lever $P^3$, in combination with the feed-rolls K K′ and reducing-rolls in a rolling-mill, substantially as and for the purpose set forth.

Witness my hand this 22d day of January, A. D. 1887.

FRED H. DANIELS.

Witnesses:
CHAS. H. BURLEIGH,
ELLA P. BLENUS.