No. 774,796. PATENTED NOV. 15, 1904.

R. C. STIEFEL.

ROLLING MILL.

APPLICATION FILED JULY 24, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 7.

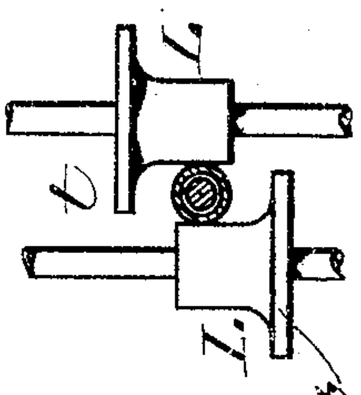

Fig. 6.

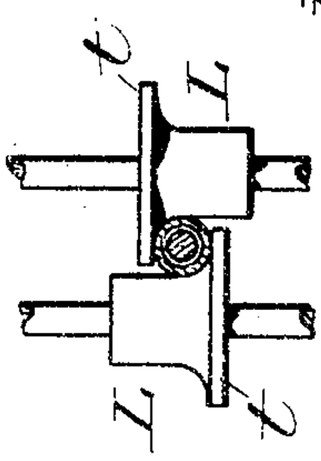

Fig. 5.

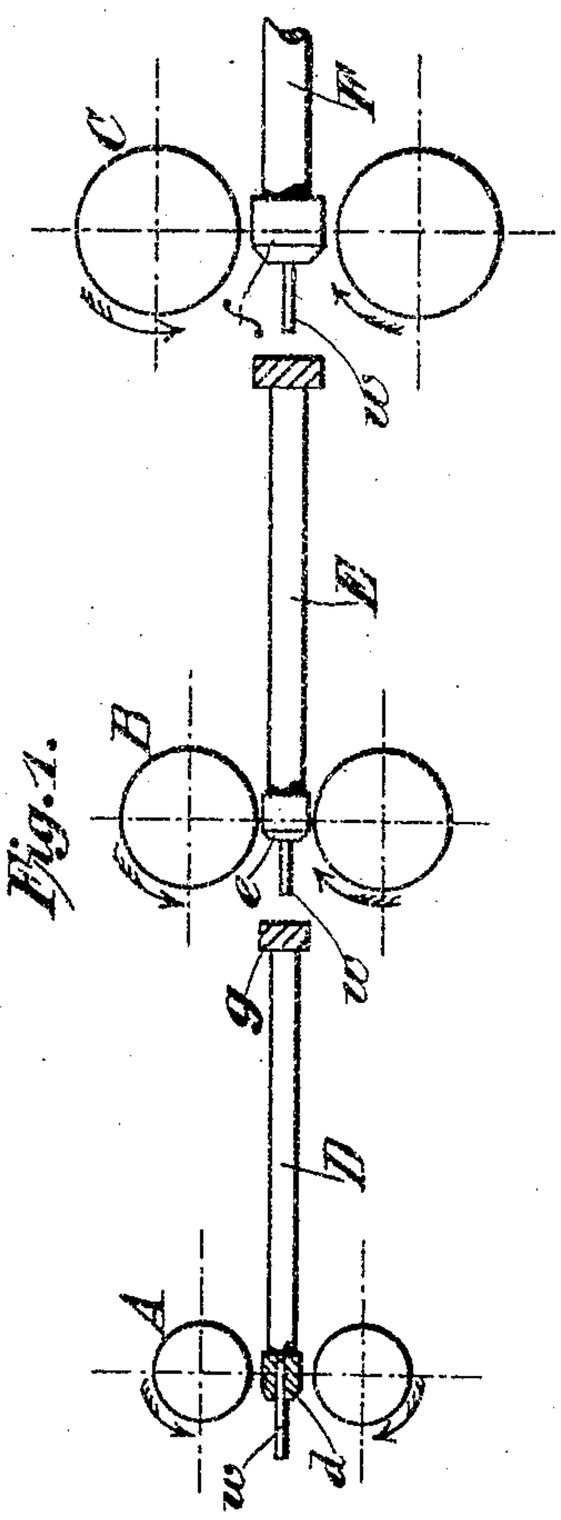

Fig. 9.

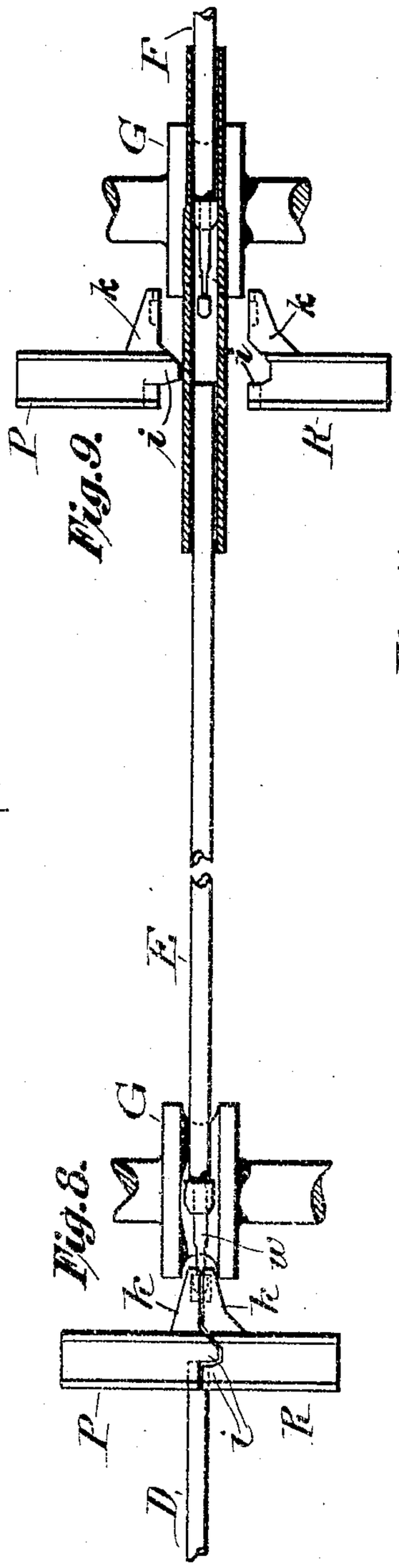

Fig. 11.

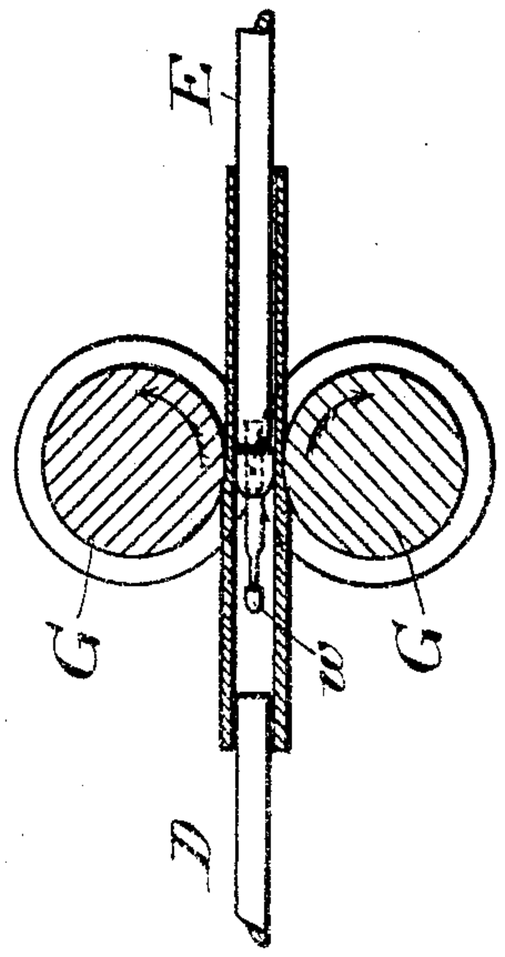

Fig. 10.

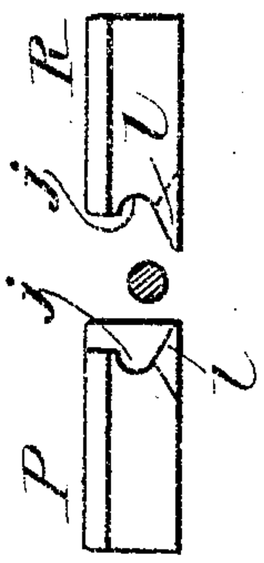

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PHOTO-LITHOGRAPHED BY SACHETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

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NO MODEL. 4 SHEETS—SHEET 2.

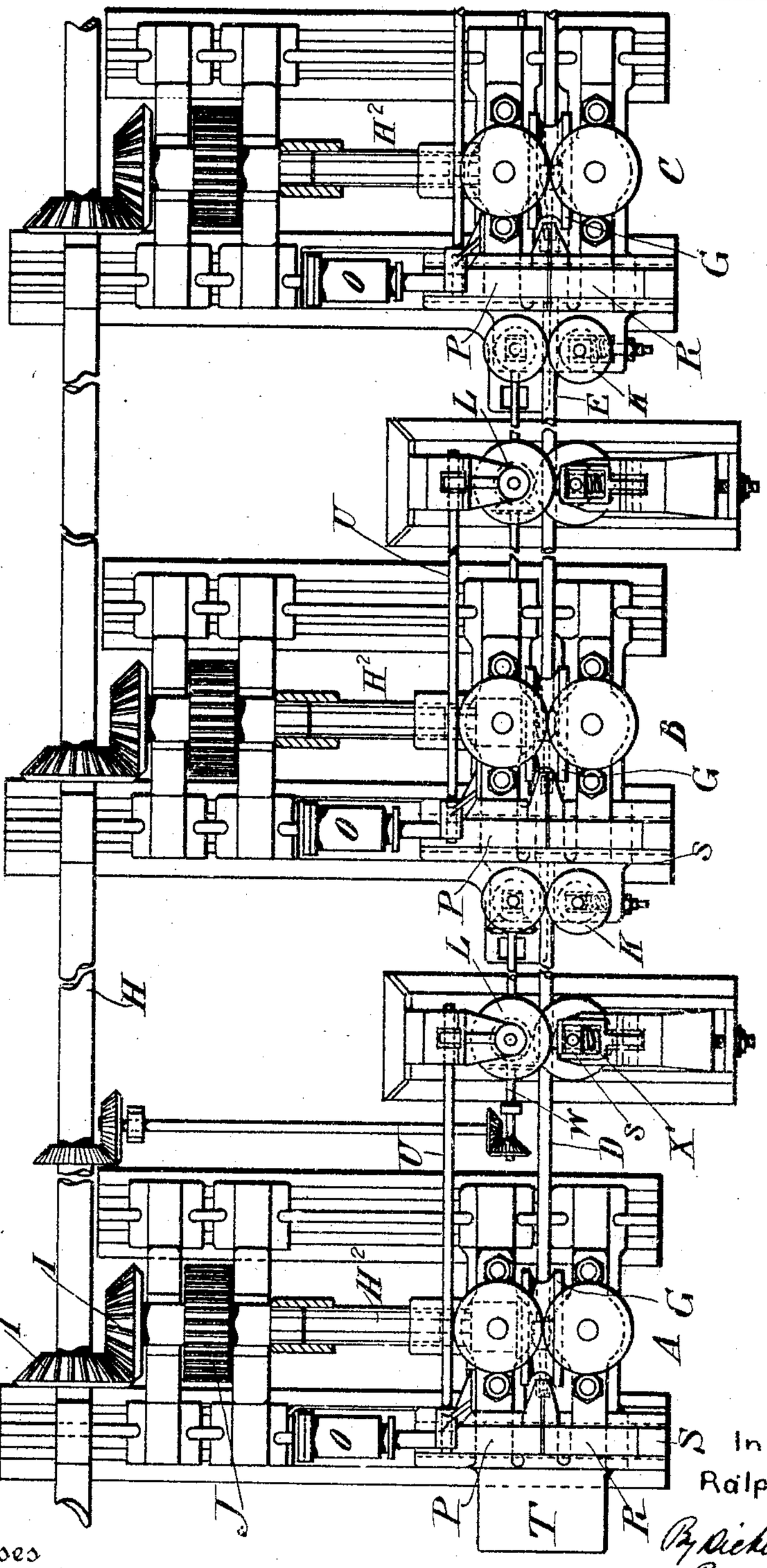

Fig. 2.

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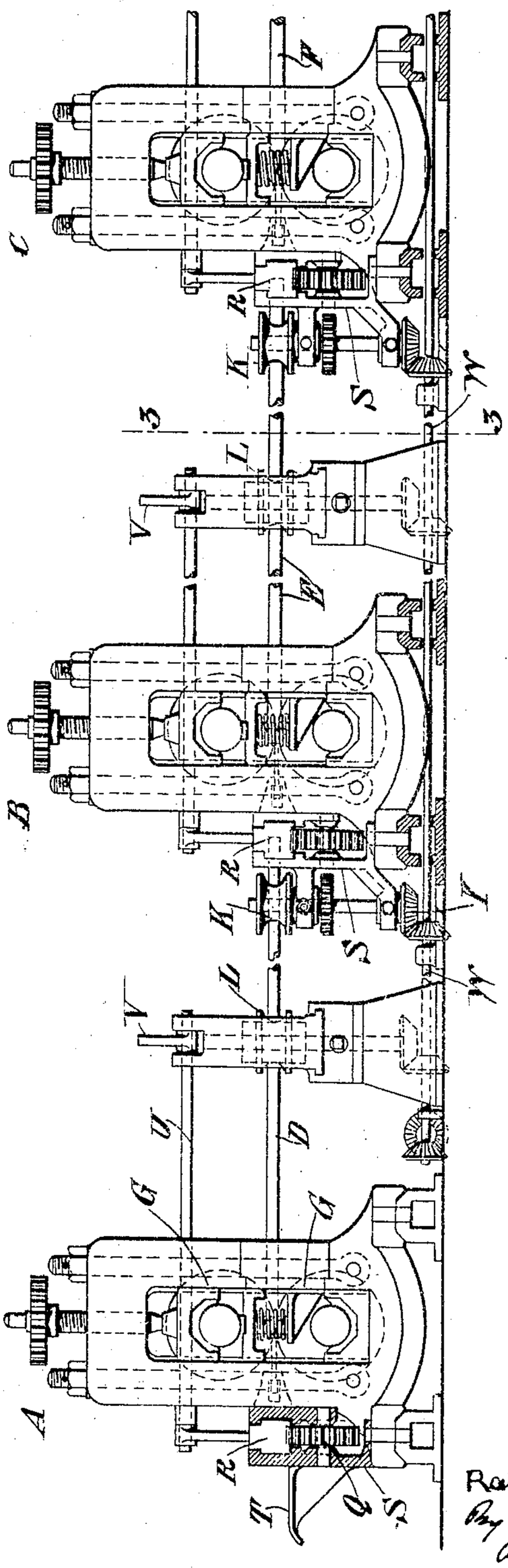
NO MODEL. 4 SHEETS—SHEET 3.

Fig. 3.



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APPLICATION FILED JULY 24, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 5.

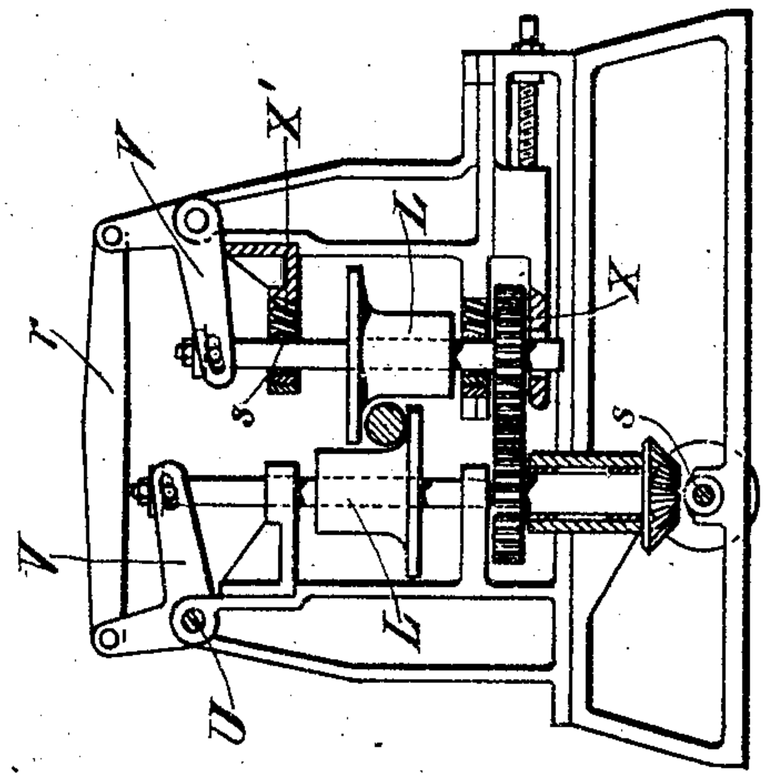
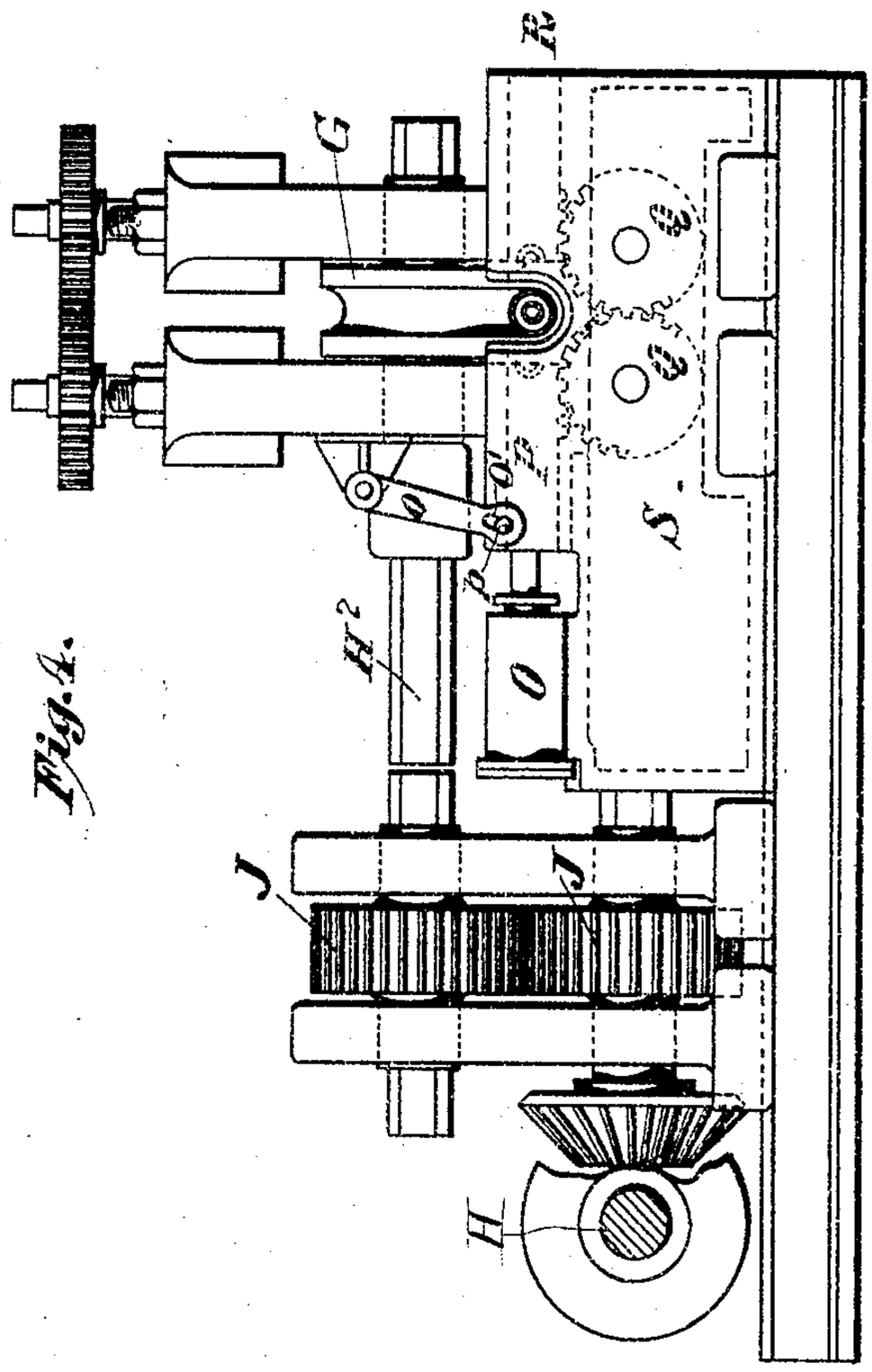


Fig. 4.



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No. 774,796. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

RALPH CHARLES STIEFEL, OF ELLWOOD CITY, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NATIONAL TUBE COMPANY, A CORPORATION OF NEW JERSEY.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 774,796, dated November 15, 1904.

Application filed July 24, 1902. Serial No. 116,850. (No model.)

To all whom it may concern:

Be it known that I, RALPH CHARLES STIEFEL, a citizen of the Swiss Republic, residing at Ellwood City, in the State of Pennsylvania, have invented certain new and useful Improvements in Rolling-Mills, of which the following is a specification accompanied by drawings.

My invention relates to improvements in rolling-mills, but more particularly to that class of mills known as "continuous" rolling-mills for rolling tubular bodies.

The objects of my invention are, broadly, to expedite and simplify the manufacture and reduce the cost of manufacturing hot-rolled tubular bodies.

Further objects of my invention are to enable a number of tubular billets to be continuously rolled by means of a plurality of pairs of rolls and independent mandrel-bars and mandrels and to provide for partially rotating the tubular body after it passes each pair of rolls.

Further objects of my invention will hereinafter appear; and to these ends my invention consists in a continuous rolling-mill constructed and arranged and having the general mode of operation substantially as hereinafter fully described, and shown in this specification and accompanying drawings, in which—

Figure 1 is a diagrammatic view illustrating the operation of my invention. Fig. 2 is a plan view of apparatus embodying my invention. Fig. 3 is a side elevation, partly in section, of the same. Fig. 4 is an end elevation of the same. Fig. 5 is an elevation, partly in section, of the guide-rollers for turning the tube, taken on the line 3 3 of Fig. 3. Figs. 6 and 7 are detail views of the guiding and rotating rollers. Figs. 8 and 9 are detail views, partly in section, of the supporting and gripping devices. Fig. 10 is a detail view of the supporting and gripping devices; and Fig. 11 is a detail view, partly in section, showing a tubular billet between the rolls.

Referring to the drawings, in Fig. 1 my invention is illustrated diagrammatically. According to my invention a plurality of pairs of rolls are provided, as A, B, and C, of which there may be any desired number of pairs, three (3) being shown by way of illustration. Each pair of rolls is provided with its mandrel-bar D, E, and F and mandrel or bulb *d*, *e*, and *f*. A tubular billet is passed through the first pair of rolls A and over the first mandrel D, located in the pass of said rolls. Then according to my invention the tube is turned through substantially ninety (90) degrees by means not shown in Fig. 1 and the support *g* of the first mandrel-bar D is removed, thereby leaving an unobstructed passage for the tube toward and between the second pair of rolls B. Prior to removing the support *g* of the first mandrel-bar D the small end *w* of the mandrel-bar D, extending through the mandrel *d*, is to be gripped by a suitable device hereinafter illustrated in order to hold the mandrel-bar D stationary while the tube is moved toward the second pair of rolls B. After the tube has passed through the second pair of rolls the mandrel-bar support *g* is brought back again to its normal position for supporting the mandrel-bar D, as shown in the figure. The gripping device above mentioned is then made to release the small end of the mandrel-bar D, and the first pair of rolls is ready again to receive another tubular bullet. Substantially this same operation takes place for each mandrel-bar—that is to say, the rear end of one mandrel-bar is supported and simultaneously therewith the front end of the next adjacent mandrel-bar is gripped or held—and in the accompanying drawings apparatus is shown and will be described for carrying out these operations and for rotating the billet after it leaves each pair of rolls and before it is fed to the next pair of rolls.

The mandrel heads or bulbs *d e f* when they are worn too small may easily be replaced by new ones, as there is nothing to prevent their removal one at a time, as desired, and any one mandrel head or bulb may be removed without removing any of the others. It is only necessary to pull the mandrel heads or bulbs off the small end of the bar, as by means of a pair of tongs.

The series of operations described in connection with Fig. 1 may be repeated through

as many consecutively-arranged pairs of rolls as may be necessary to reduce the wall of the original tubular blank or billet to the required thickness of the finished tube, three (3) to five (5) pairs of rolls being ordinarily enough to suit all practical requirements.

In Figs. 2 and 3 but three (3) pairs of rolls A, B, and C are illustrated, the distance between the pairs of rolls increasing progressively as the tube is increased in length by the action of the rolls. The rolls G of each pair are driven from a suitable source of power, as from a main driving-shaft H, with which they are connected in any suitable manner, as by means of beveled gears I, gearing J, and shafting H^2. The mandrel-bars D, E, and F are suitably supported and guided, in this instance the supporting and guiding means being shown as live-rollers K and L, the rollers L not only forming guides for the mandrel-bars, but being also for the purpose of turning the tube after it leaves the grip of the rolls. The live-rollers K are for the purpose of guiding the mandrel-bars and tubes and for conveying the tube after it has left one pair of rolls to the next following pair of rolls. The last mandrel-bar should be provided with a support.

As hereinabove stated, means are provided for simultaneously supporting the rear end of one mandrel-bar and gripping the front end of the next following mandrel-bar, and in connection therewith means are provided for rotating the tubes, said rotating means, described as the rollers L, being controlled by the operation and movements of the supporting and gripping mechanism.

Suitable actuating means are provided for the supporting and gripping mechanism, in this instance hydraulic cylinders O being arranged in connection with each pair of rolls and connected to slides P, provided with racks which actuate, by means of the pinions Q, the slides R in such manner that when the slide P is moved forward toward the mandrel-bar the slide R is likewise moved toward the mandrel-bar, and each of these slides is provided with means for supporting the rear end of one mandrel-bar and for gripping the front end of the adjacent bar. The slides P and R may be moved sufficiently far apart to admit of a tube passing between them, and in Fig. 8 they are shown gripping a tube, while in Fig. 9 they are shown moved apart to permit the tubular billet to pass. The frame S, which serves as a guide for the slides P and R, is cut out at the pass (see Fig. 4) in order to allow the tube to be fed without obstruction when the slides are opened.

Referring more particularly to Figs. 8 and 9, it will be seen that each slide is provided with a projection *i*, which projections coöperate with each other when the slides are closed together and serve as a support for the rear end of a mandrel-bar, the end of the mandrel-bar entering between the cut-away portions *j*. (Shown in Fig. 10.) The arms *k* on each slide are arranged at the same time to grip the reduced portion *w* of the front end of the adjacent mandrel-bar or next following bar. The slides P R are also shaped so that they will when closed together reach under the small end of the next following mandrel-bar and lift it to the pass-line previously to closing upon and gripping said small end. This construction is illustrated in Fig. 10, in which protruding points *l* are provided with inclined upper portions which coöperate to lift the mandrel-bar.

The slides P and R, located on the first mill, are not provided with the projections *i* for supporting a bar, since there is no mandrel-bar to be supported in front of the first mill. Therefore the slides of the first pair of rolls or mill are only provided with the gripping-arms *k*. The frame S of the first mill is also provided with a projecting table T, upon which the end of the billet may be seated before introducing it between the first pair of rolls.

As hereinbefore stated, the driving-rollers L are also arranged to cause rotation of the tube through a given angle, as substantially ninety (90) degrees, before it is fed to the next mill, and while any suitable means may be provided for actuating said rollers L to accomplish this result I have shown said rolls as controlled in their operation by the motor or hydraulic cylinder O, which produces the movements of the supporting and gripping slides P and R.

The rock-shaft U extends from a frame of one mill to the supporting-frame of the rollers L and bears an arm *o*, which is provided with a slot *o'*, receiving a pin *p* on the slide P, so that the reciprocating movement of the slide P will rock said shaft U. Adjacent the rollers L means are provided for imparting the movements of the rock-shaft U to said rollers in an endwise direction. To this end bell-crank levers V are supported on the frame of said rollers L and also on the rock-shaft U, they being connected to each other by a link *r* and each bell-crank lever V being connected to the shaft of a roller L. One of the bell-crank levers V is directly actuated by the rock-shaft U, the other being actuated through the medium of the link *r*.

The rollers L are live-rollers and are continuously rotated by any suitable means, as by means of gearing X and shafting W connecting with the main shaft H, the said rollers L exerting a yielding pressure upon the tube, as by means of suitable springs X' inserted behind the bearing-blocks *s*.

The mechanical connections between the slide P and rollers L are so arranged and adjusted that when the slides P and R are closed, as in Fig. 8, the live-rollers L are in the position shown in Fig. 7—that is to say, the flanges *t* of the rollers L are farthest removed

from the tube. When the slides P and R are opened, as shown in Fig. 9, the adjustment of parts is such that the live-rollers L are then closed together, as shown in Fig. 6. In other words, the rollers L are moving apart from the position shown in Fig. 6 to that shown in Fig. 7 during the time that the slides P and R are being closed, and while the said rollers L are being moved apart they turn the tube gripped between then around its own axis, the travel of the live-rollers L being so regulated that the tube will be turned through substantially ninety (90) degrees. When the live-rollers L are in the position shown in Figs. 5 and 6, the mandrel-bar or the tube which has passed over said bar is guided between the bodies and flanges of the rollers L.

The guide-rollers L are rotating at all times, so that a tubing gripped between them will be conveyed toward the live-rollers K and the next following mill at the same time that it is being turned about its own axis. The rollers K, as with the rollers L, are driven from the auxiliary shaft by means of the beveled gearing Y.

One of the live-rollers K is also preferably adjustable toward and away from the pass, thereby exerting a yielding and adjustable spring-pressure upon the tube in order to convey it with the required power between the rolls of the next following mill. This adjustability of one of said rollers K is shown illustrated in Fig. 2. The guide-rollers K are also provided with grooves to suit the diameter of the tube to be rolled, embracing the full circumference of the tube, and therefore gripping and forcing it between the next following pair of rolls with more power than do the live-rollers L, inasmuch as the latter are in the position shown in Fig. 7 during the time that the tube is being conveyed to the next following mill. In the position of Fig. 7 the rollers L are but slightly in contact with the tube, and as they might not grip it powerfully enough to overcome any resistance against the first advance of the tube over the mandrel and between the rolls of the next mill following the live guide-rollers K come into play and insure the advance of the tube.

Having now described the general characteristics and arrangement of my improved continuous rolling-mill, I will describe the operation of it briefly, as follows: The supporting and gripping device of the first mill is opened, as shown in Figs. 9 and 10, to allow the hollow billet or blank to be presented to the rolls of the first mill. As soon as the billet has passed entirely through the rolls of the first mill A the supporting and gripping devices on the slides P and R are closed, as shown in Fig. 8, and at the same time the live-rollers L are brought from the position of Fig. 6 to that of Fig. 7, whereby the tube is turned to ninety (90) degrees. The tube is now gripped by the live-rollers K of the second mill and fed forward. If the slides P and R of the second mill are opened, the tube will be conveyed to the rolls and mandrel of the second mill. If, however, for any reaons it is desired not to convey the tube directly to the rolls of the second mill, it is simply necessary to close the slides of that mill, so that the end of the tube will abut against the bar-support and the live-rollers will slide on the tube until the slides are opened, when the tube, always in the grip of the live-rollers, will again begin to advance toward and between the rolls of the second mill B. After the tube has passed through the second mill the slides P and R of said mill are again closed, thereby causing rotation of the tube through ninety (90) degrees and affording a support for the rear end of the mandrel-bar D of the first mill and gripping the front end of the mandrel-bar E of the second mill. Then the slides of the first mill A can be opened again, and a fresh hollow billet may be presented to the rolls of the first mill while the previous blank is continuing its passage through the third mill C. The operations described are repeated and continued until the tube has passed through all the mills. In this manner several tubes can be operated upon at the same time by several of the mills constituting the complete continuous mill. There is no loss of time and no necessity for any such loss between the consecutive rotations of the tube, and therefore little loss of heat, and increased facility is secured for finishing the tube without reheating between rotations, all of which results in greatly-increased output and tubes freer from scale-marks. All the hydraulic cylinders O operating the supports of the mandrel-bars and the apparatus for turning the tube between rotations may be controlled from one central place, which results in a reduction of labor.

Obviously some features of my invention may be used without others, and my invention may be embodied in widely-varying forms. Therefore, without limiting myself to the construction shown and described nor enumerating equivalents,

I claim, and desire to obtain by Letters Patent, the following:

1. In a continuous tube-rolling mill, the combination of a plurality of pairs of rolls, a removable mandrel-bar between each pair separate from the mandrel-bar between any other pair, and removable supports for the rear ends of the mandrel-bars, means for supporting the mandrel-bars in position relatively to the rolls, and means for operating the said parts to pass the tubular billet successively through all the rolls and onto each of the mandrels, for substantially the purposes set forth.

2. In a continuous tube-rolling mill, the

combination of a plurality of pairs of rolls, disconnected mandrels, means for independently supporting the mandrels in position relatively to the rolls, means for passing the tubular billet successively through all of said rolls and onto each of said mandrels, and means for turning said billet after its passage between each pair of rolls, for substantially the purposes set forth.

3. The combination of a plurality of pairs of rolls, movably-supported mandrel-bars for each pair of rolls, and means for simultaneously supporting the rear end of one bar and gripping the front end of the next adjacent bar, substantially as and for the purposes set forth.

4. The combination of a plurality of pairs of rolls, and means for simultaneously supporting the rear end of a bar in advance of and adjacent to a pair of rolls and gripping the front end of the next adjacent bar, substantially as and for the purposes set forth.

5. The combination of a plurality of pairs of rolls, mandrel-bars therefor, means for simultaneously supporting the rear end of one bar and gripping the front end of the next adjacent bar, and means controlled by said supporting means for rotating the tube, substantially as and for the purposes set forth.

6. The combination of a plurality of pairs of rolls, mandrel-bars therefor, movable means for supporting said mandrel-bars, and means controlled by said supporting means for rotating the tube, substantially as and for the purposes set forth.

7. The combination of a plurality of pairs of rolls, mandrel-bars therefor, movable means for supporting the mandrel-bars, and means controlled by said supporting means for rotating the tube when the bar-support is withdrawn, substantially as and for the purposes set forth.

8. The combination of a plurality of pairs of rolls, mandrel-bars therefor, means for supporting the rear end of one bar while gripping the front end of the adjacent bar, and means controlled by said supporting and gripping means for rotating the tube when the bars are released, substantially as and for the purposes set forth.

9. The combination of a plurality of pairs of rolls, mandrel-bars therefor, means for supporting and gripping adjacent mandrel-bars, and means for rotating the tube controlled by the movements of the said clamping and gripping means, substantially as and for the purposes set forth.

10. In a rolling-mill, the combination with the rolls and mandrel-bars, of guide-rollers for the tube and the mandrel-bar, and means for simultaneously rotating said rollers and moving them endwise, whereby the tube is turned and fed forward, substantially as and for the purposes set forth.

11. In a rolling-mill, the combination with the rolls and mandrel-bars, of guide-rollers for the tube and mandrel-bar adapted to exert yielding pressure on the tube, and means for simultaneously rotating said rollers and moving them endwise, whereby the tube is turned and fed forward, substantially as and for the purposes set forth.

12. In a continuous rolling-mill, the combination of a plurality of independent pairs of rolls and mandrels, and means for successively supporting the rear end of each bar and gripping the front end of the next following bar, during the time that the billet is being passed between the rolls of the supported bar, substantially as and for the purposes set forth.

13. In a continuous rolling-mill, the combination of a plurality of independent pairs of rolls and mandrels, means for passing billets through the rolls, and means for successively supporting the rear end of each mandrel during the time that the billet is passing through the rolls for said supported bar and simultaneously therewith gripping the end of the next following bar during the time that a billet is being fed from said bar, substantially as and for the purposes set forth.

14. In a continuous rolling-mill, the combination of a plurality of independent pairs of rolls and mandrels, means for movably supporting said bars, means for gripping the end of each bar as the billet passes from the bar and for supporting the rear end of each bar as the billet passes through the rolls of said bar, and means for affording a free passage to the billet through the rolls of the bar, the rear end of which is supported, substantially as and for the purposes set forth.

15. In a continuous tube-rolling mill, the combination of a plurality of pairs of rolls, one pair arranged behind the other, and removable mandrel-bars and mandrels, the mandrels being also arranged one behind the other and spaced apart between the separate pairs of rolls so that any mandrel may be removed at will without removing any of the others, for substantially the purposes set forth.

16. In a continuous tube-rolling mill, the combination of a plurality of pairs of rolls and independent mandrel-bars and mandrels for each roll, means for passing a billet through said pairs of rolls, and means in connection with each pair of rolls for simultaneously supporting the rear end of one mandrel-bar while gripping the front end of the next following bar, substantially as and for the purposes set forth.

17. In a continuous tube-rolling mill, the combination of a plurality of pairs of rolls and independent mandrel-bars and mandrels for each roll, means for passing a billet through said pairs of rolls, means in connection with each pair of rolls for simultaneously supporting the rear end of one mandrel-bar while gripping the front end of the next following bar, and means for rotating the billet after it

emerges from each pair of rolls, substantially as and for the purposes set forth.

18. In a rolling-mill, the combination of a plurality of pairs of rolls and removable mandrel-bars extending therefrom, one between each two adjacent pair of rolls, the pair of rolls beyond the pair from which each mandrel-bar extends being located beyond such mandrel-bar so that the mandrel-bars are separate from and independent of each other, for substantially the purposes set forth.

19. In a rolling-mill, the combination of a plurality of pairs of rolls, removable mandrel-bars extending therefrom, one between each two adjacent pair of rolls, the pair of rolls beyond the pair from which each mandrel-bar extends being located beyond such mandrel-bar so that the mandrel-bars are separate from and independent of each other, and a removable support for each mandrel-bar, for substantially the purposes set forth.

20. In a rolling-mill, the combination of a plurality of pairs of rolls, removable mandrel-bars extending therefrom, one between each two adjacent pair of rolls, the pair of rolls beyond the pair from which each mandrel-bar extends being located beyond such mandrel-bar so that the mandrel-bars are separate from and independent of each other, and a removable support for each mandrel-bar, the supports being in line with the roll-pass, for substantially the purposes set forth.

21. In a rolling-mill, the combination of a plurality of pairs of rolls, removable mandrel-bars extending therefrom, one between each two adjacent pair of rolls, the pair of rolls beyond the pair from which each mandrel-bar extends being located beyond such mandrel-bar so that the mandrel-bars are separate from and independent of each other, and means coöperating with said bars to provide for the reception of a given mandrel, for substantially the purposes set forth.

22. In a rolling-mill, the combination of a plurality of pairs of rolls, removable mandrel-bars spaced at intervals apart, and means working in the spaces between the mandrel-bars and coöperating with said bars to preclude the reception of more than a given length of tubing at a time on a given mandrel, for substantially the purposes set forth.

23. In a rolling-mill, the combination of a plurality of pairs of rolls, movably-supported mandrel-bars, one for each pair of rolls, and means for supporting the rear end of one bar and gripping the front end of the next adjacent bar, for substantially the purposes set forth.

24. In a rolling-mill, the combination of a plurality of pairs of rolls, and means for supporting a bar from its rear end between the pairs of rolls and gripping the front end of the next adjacent bar, for substantially the purposes set forth.

25. In a rolling-mill, the combination of a plurality of pairs of rolls, mandrel-bars therefor, means for supporting the rear end of one bar and gripping the front end of the next adjacent bar, and means for rotating the tube on the bar, for substantially the purposes set forth.

26. In a rolling-mill, the combination of a plurality of pairs of rolls, removable mandrel-bars extending therefrom, one between each two adjacent pair of rolls, the pair of rolls beyond the pair from which each mandrel-bar extends being located beyond such mandrel-bar so that the mandrel-bars are separate from and independent of each other, removable means for supporting said mandrel-bars, and means for rotating the tube before the same passes to the next pair of rolls, substantially for the purposes set forth.

27. In a rolling-mill, the combination of a plurality of pairs of rolls, mandrel-bars therefor, means for supporting the rear end of one bar while gripping the front end of the adjacent bar, and means for rotating the tube when the bars are released, for substantially the purposes set forth.

28. In a rolling-mill, the combination of a plurality of pairs of rolls, mandrel-bars therefor, means for supporting and gripping adjacent mandrel-bars, and means for rotating the tube, for substantially the purposes set forth.

29. In a rolling-mill, the combination of guide-rollers and means for rotating said rollers and for simultaneously moving them endwise in relatively opposite directions to impart a partial turn to the article being rolled, while feeding it.

30. In a rolling-mill, the combination of axially-movable guide-rollers, means for moving them in relatively opposite directions, and means for rotating said rollers.

31. In a rolling-mill, the combination of axially-movable guide-rollers and means for rotating said rollers and means for moving them equally in opposite endwise directions.

32. In a rolling-mill, the combination of axially-movable guide-rollers, each provided with a flange, and means for rotating said rollers and for simultaneously moving them endwise in opposite directions.

33. In a rolling-mill, axially and oppositely movable positively-driven guide-rollers for the article to be rolled.

34. In a rolling-mill, axially and oppositely movable rollers, and means for positively and continuously driving them.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

RALPH CHARLES STIEFEL.

Witnesses:

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R. E. BUTLER.