(No Model.) 9 Sheets—Sheet 1.

O. KLATTE.

ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

No. 562,621. Patented June 23, 1896.

Fig. 1.

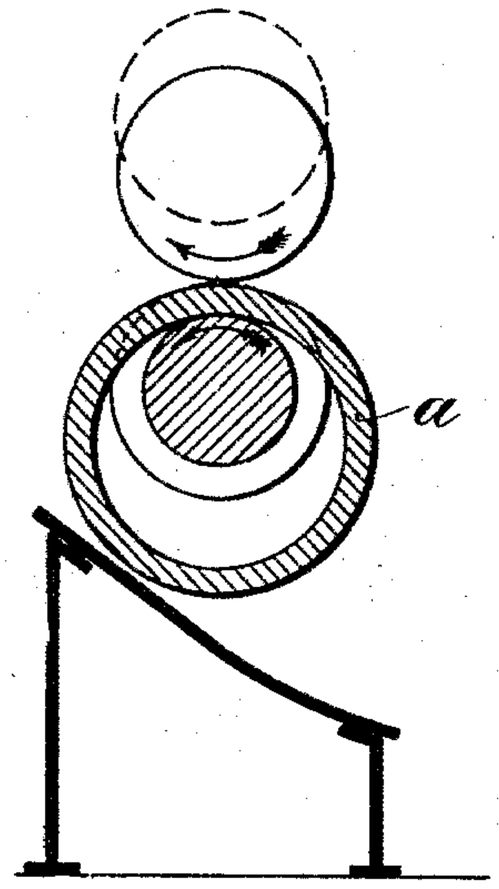


Fig. 2.

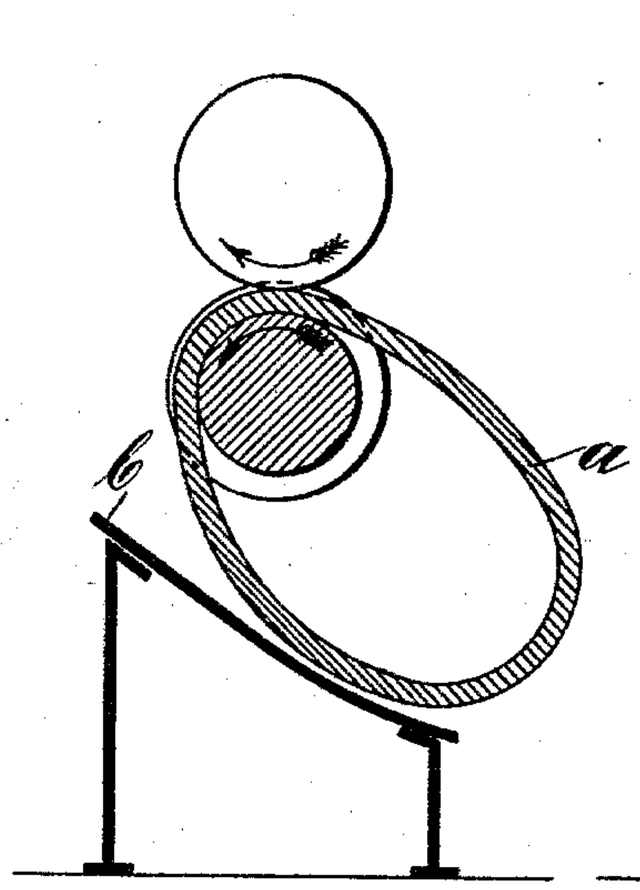


Fig. 3.

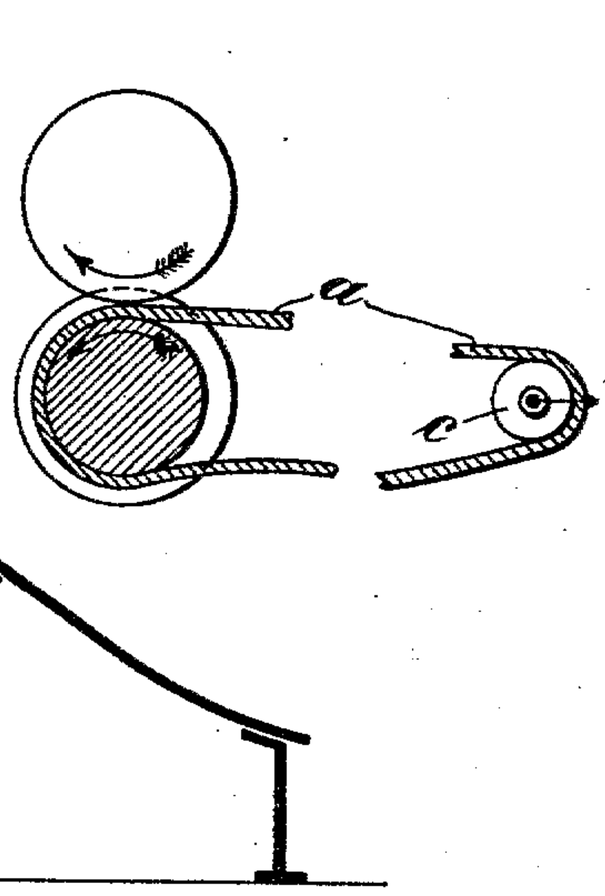
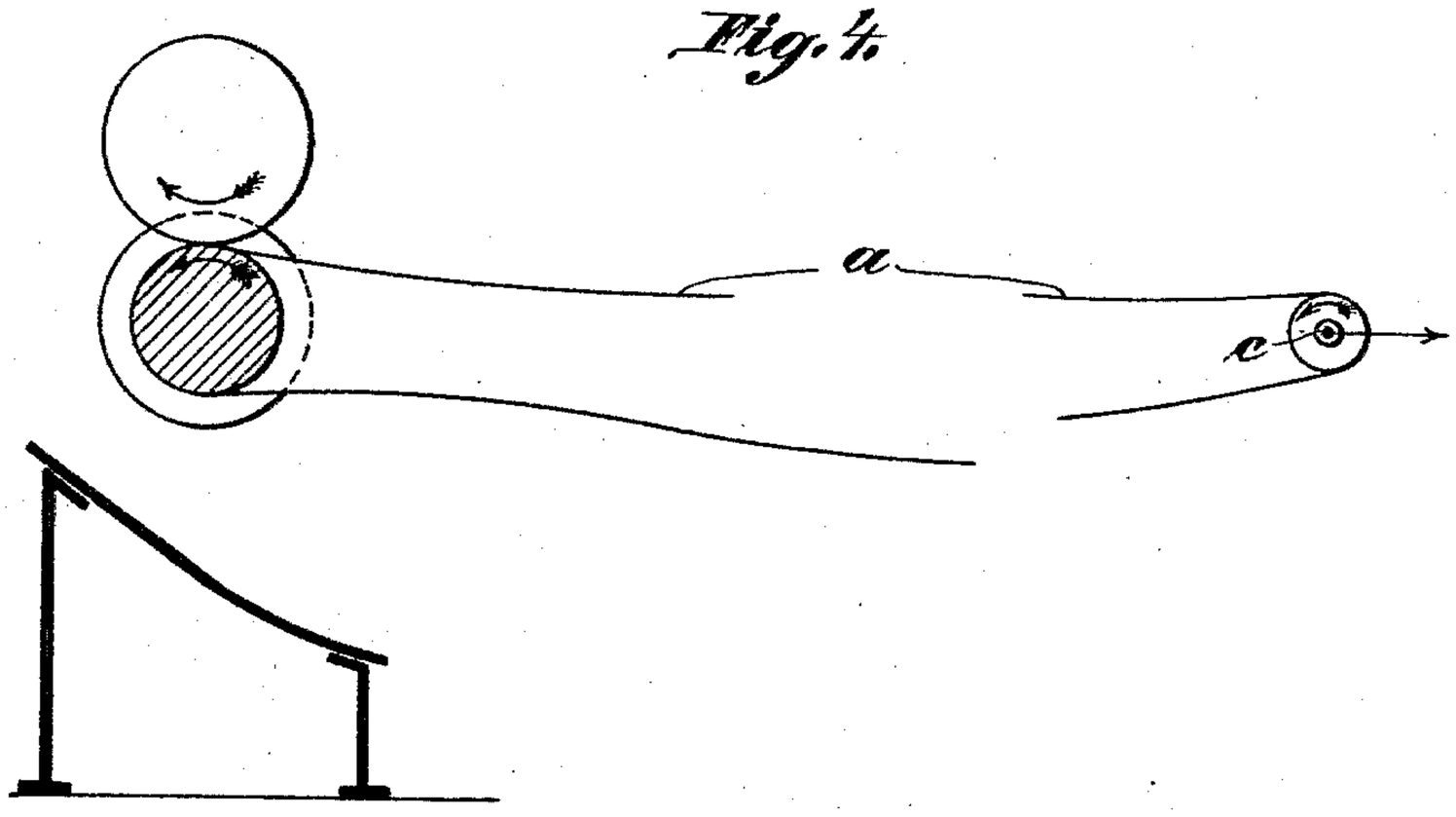


Fig. 4.



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O. KLATTE.

ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

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Fig. 5.

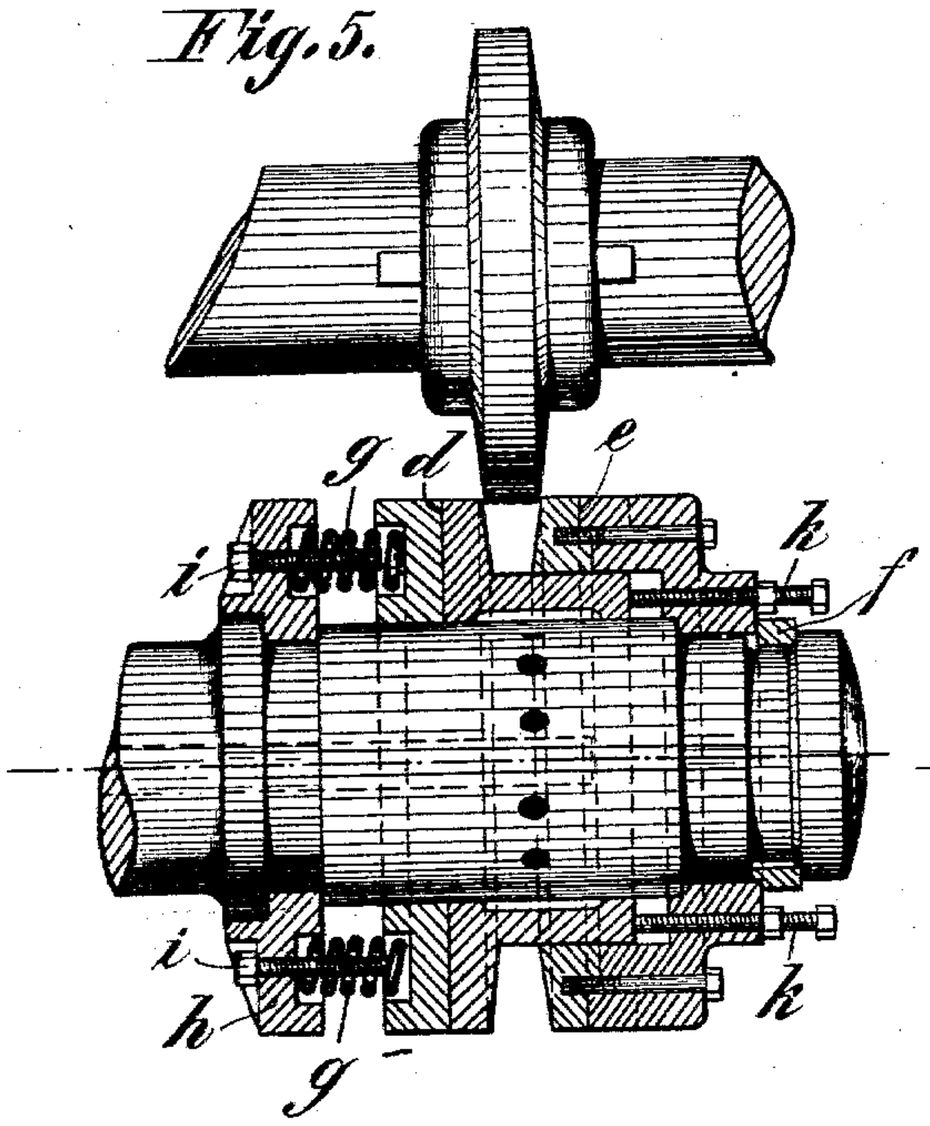


Fig. 5ª.

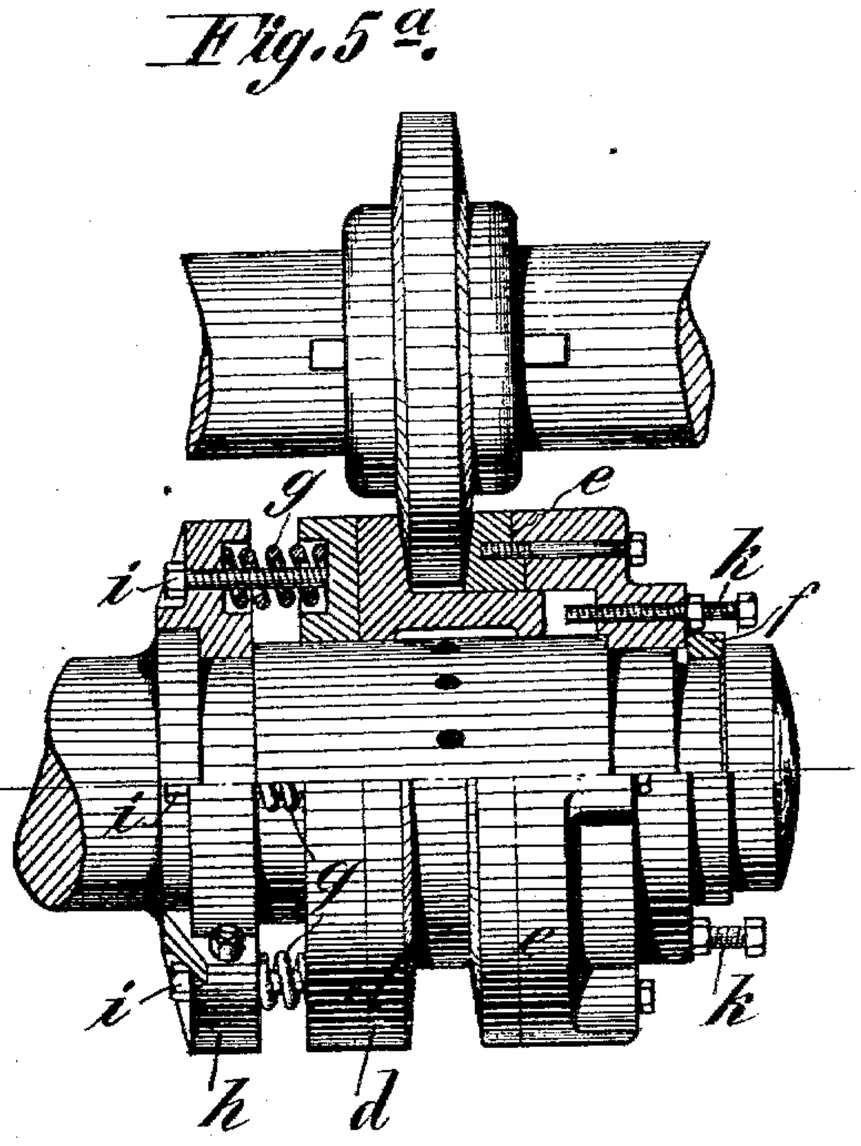
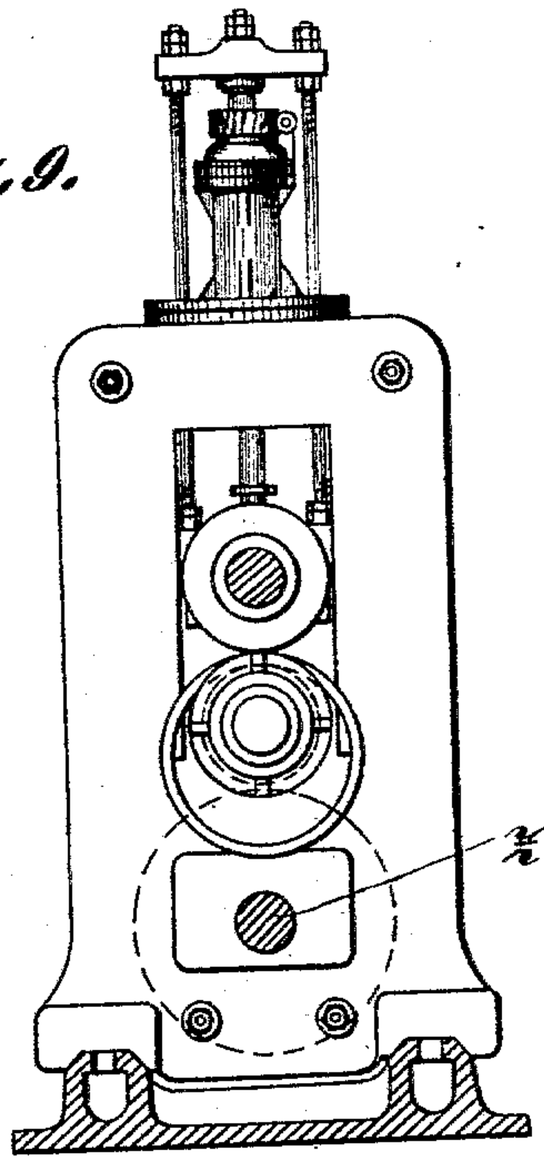


Fig. 9.



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(No Model.) 9 Sheets—Sheet 3.

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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

No. 562,621. Patented June 23, 1896.

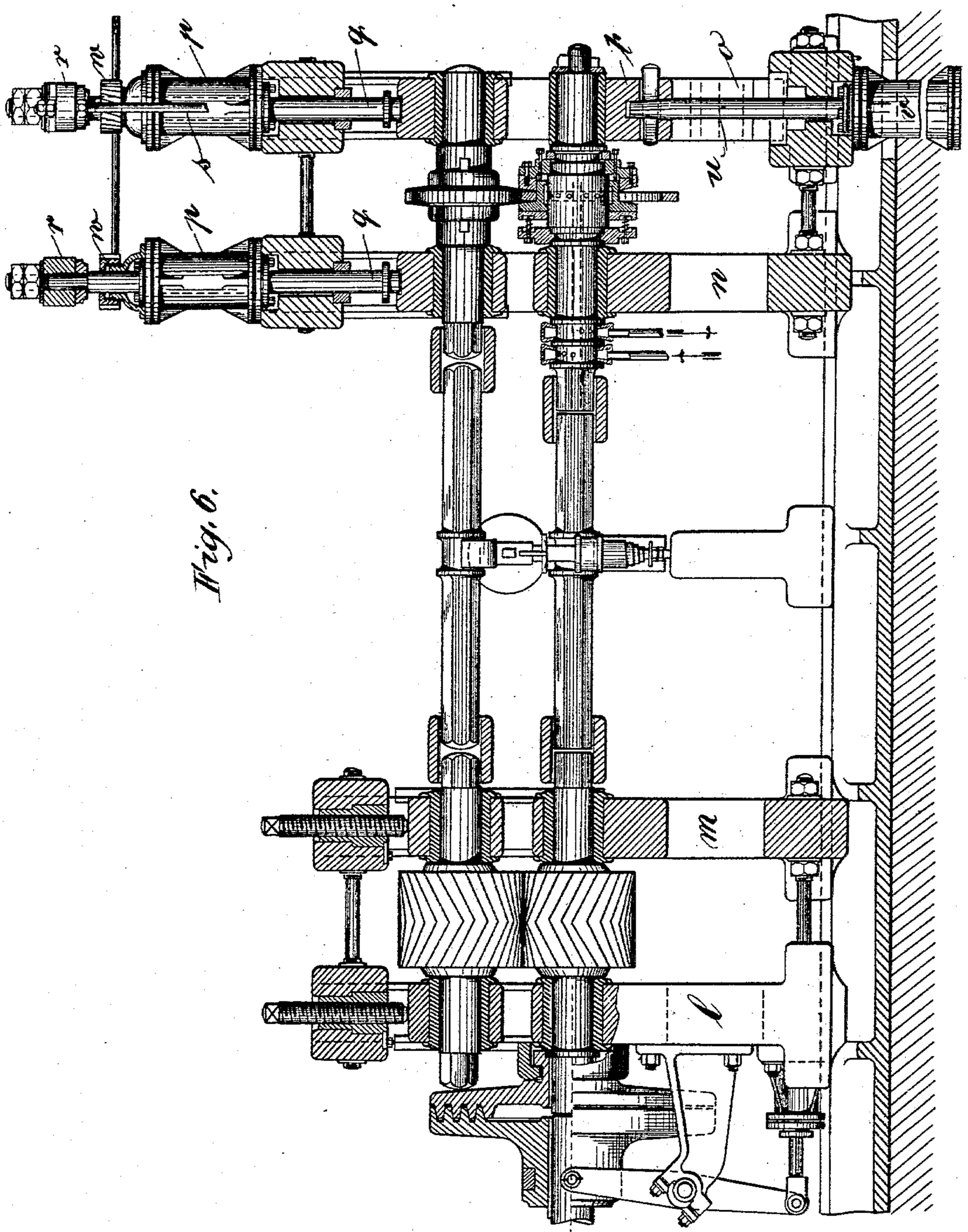

Fig. 6.

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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

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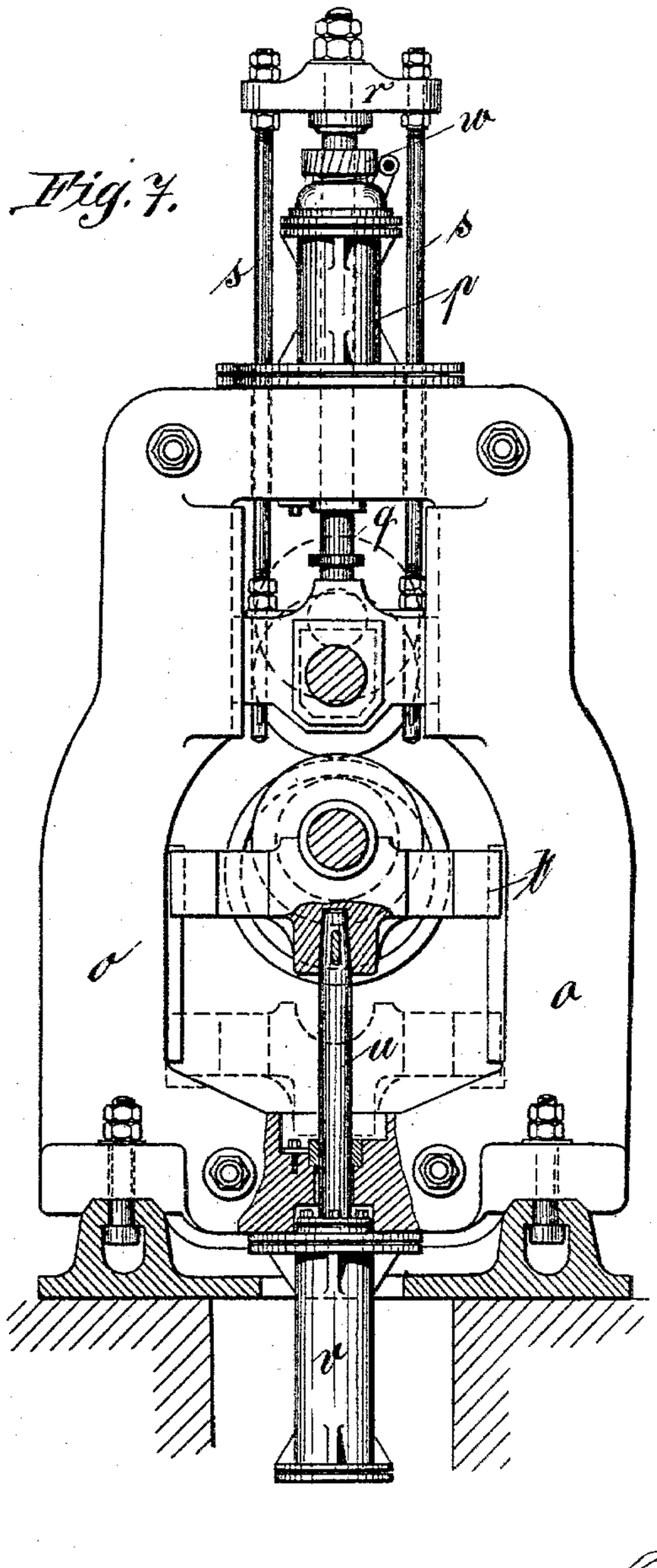
Fig. 7.



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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

No. 562,621. Patented June 23, 1896.

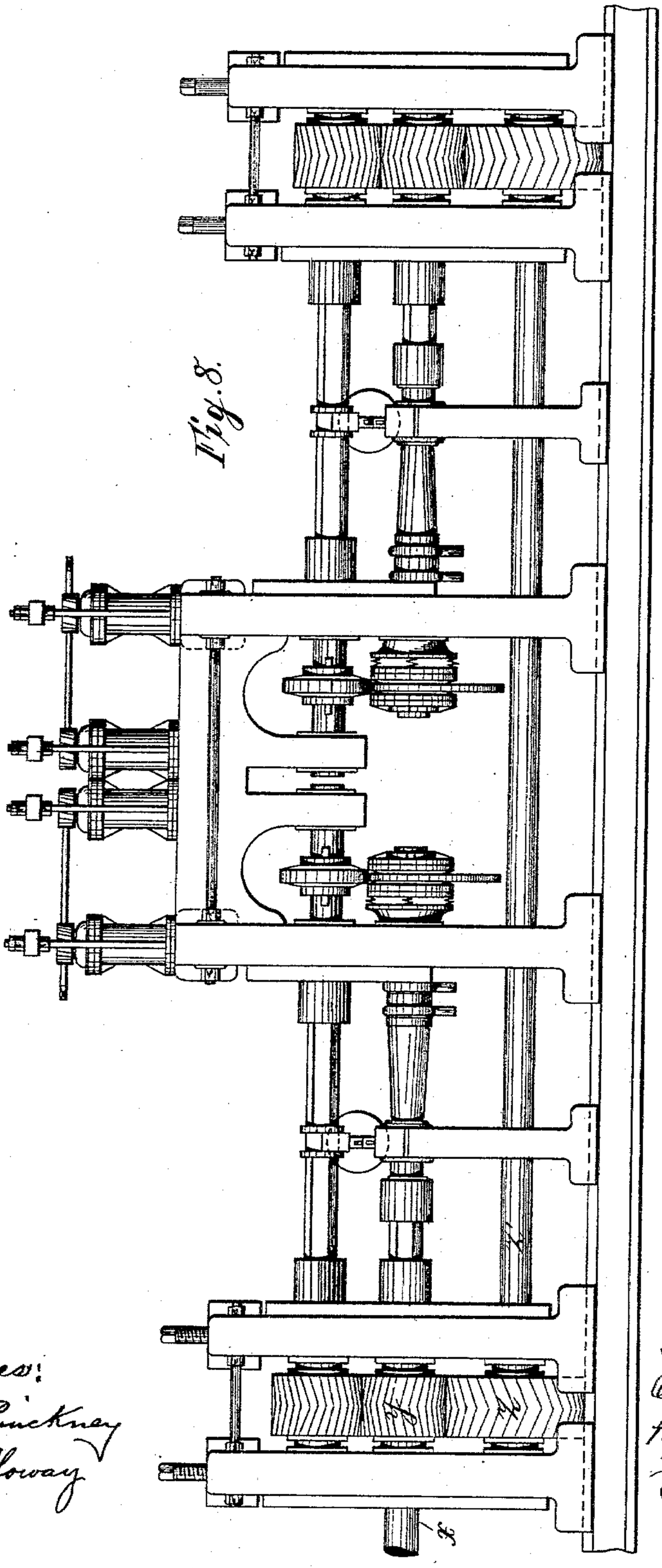

Fig. 8.

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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

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Fig. 11.

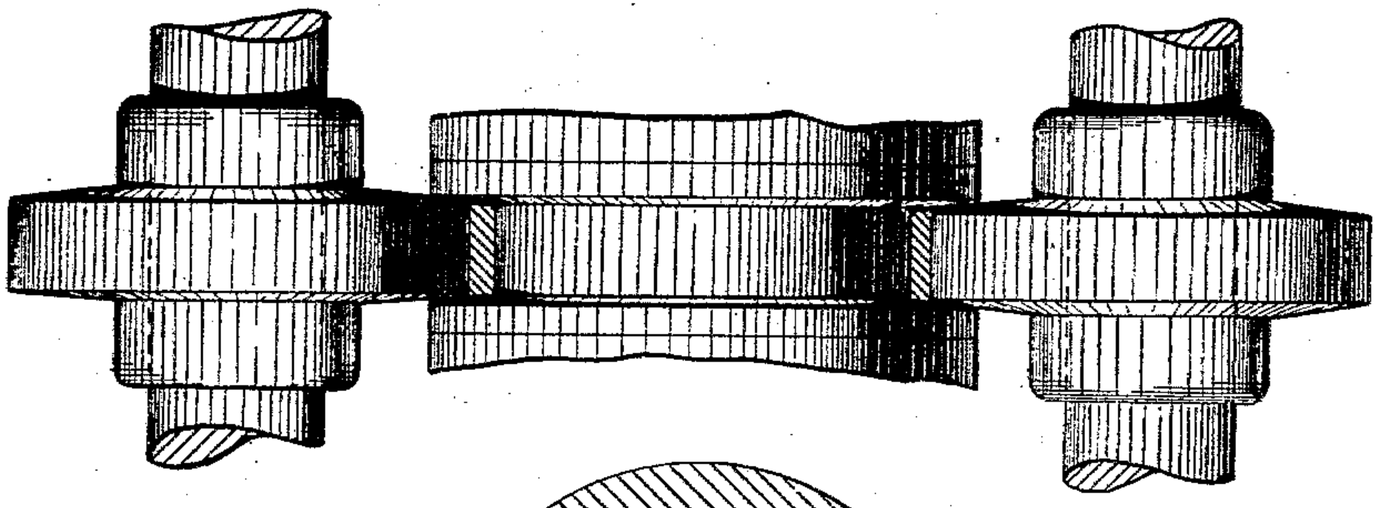
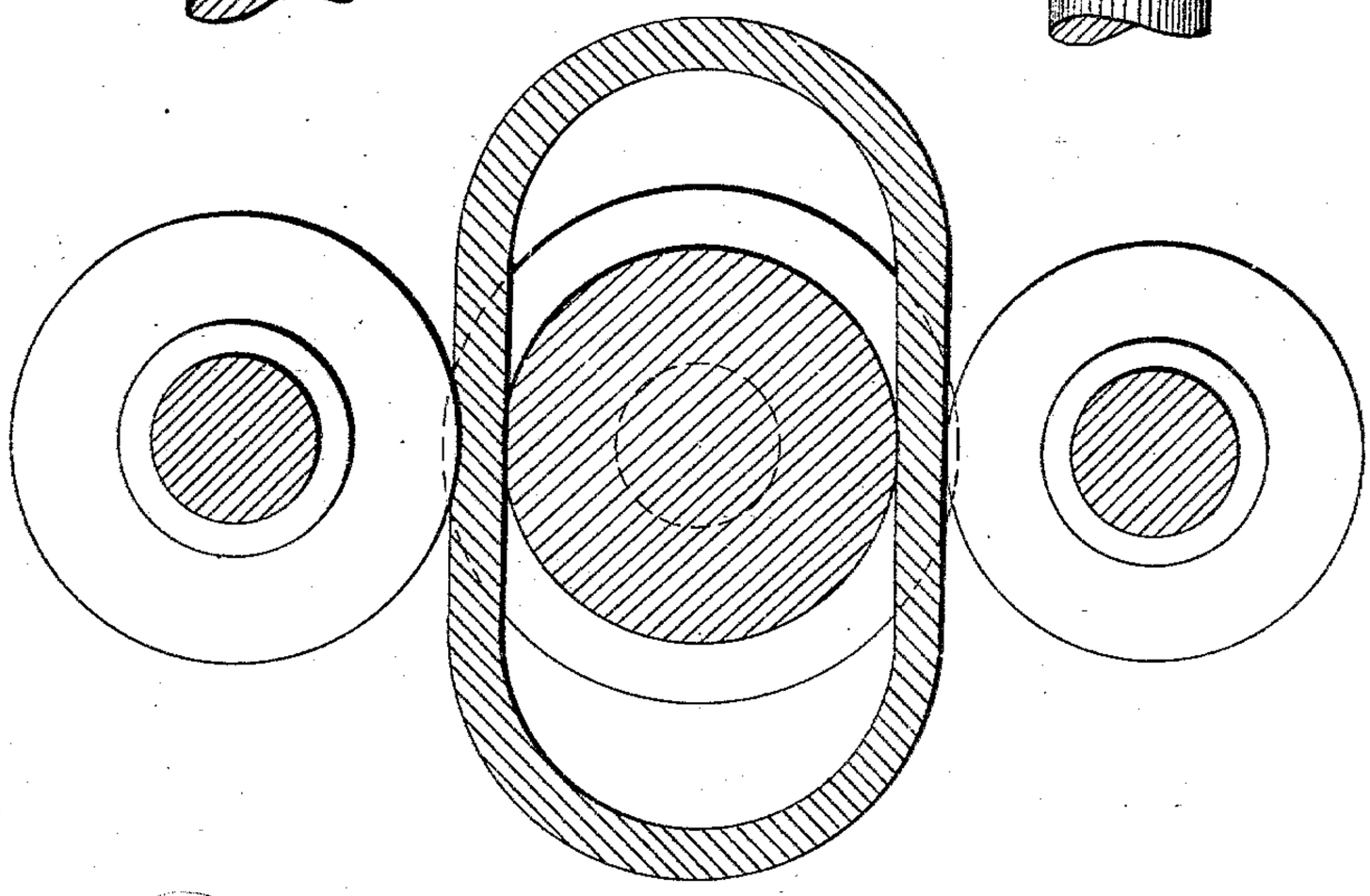


Fig. 10.



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(No Model.) 9 Sheets—Sheet 7.

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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

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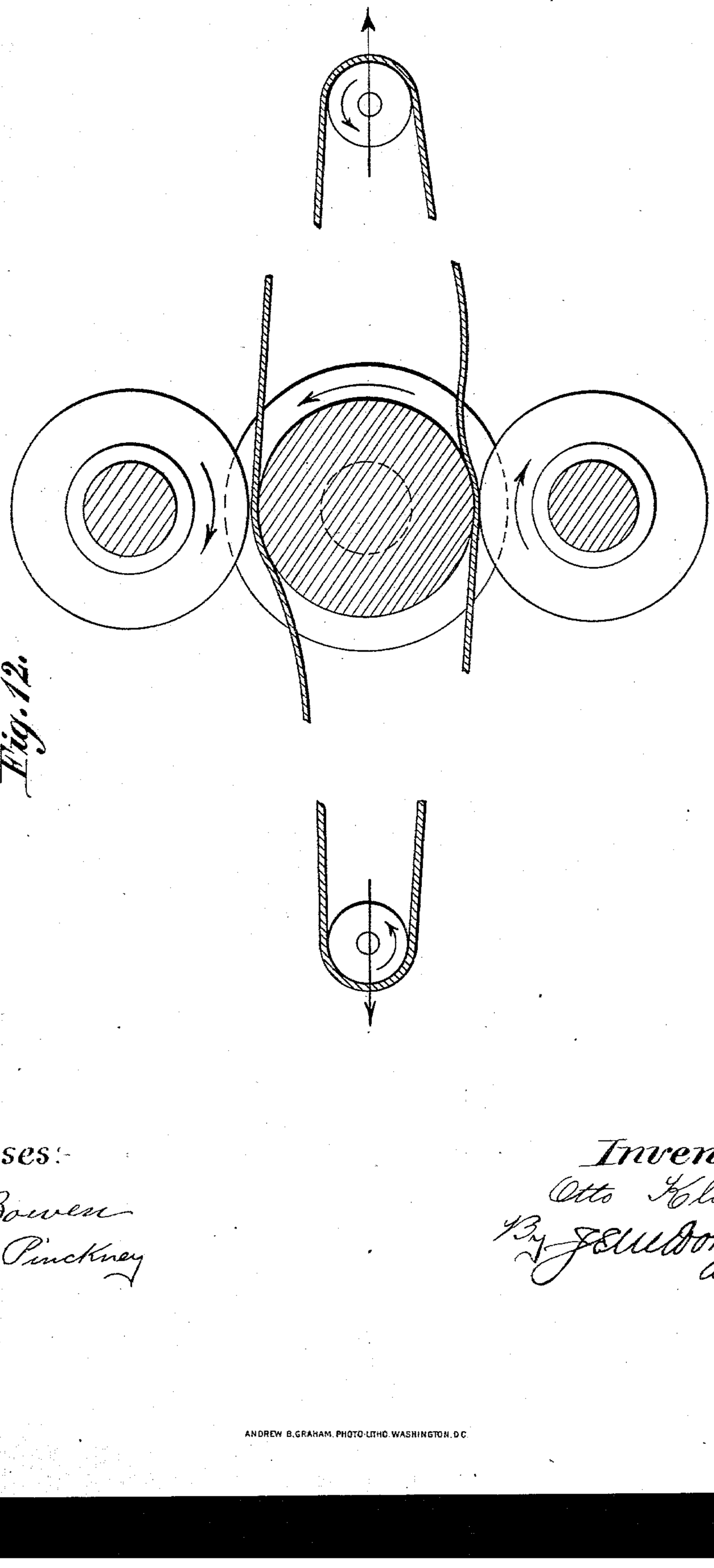

Fig. 12.

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(No Model.) 9 Sheets—Sheet 8.

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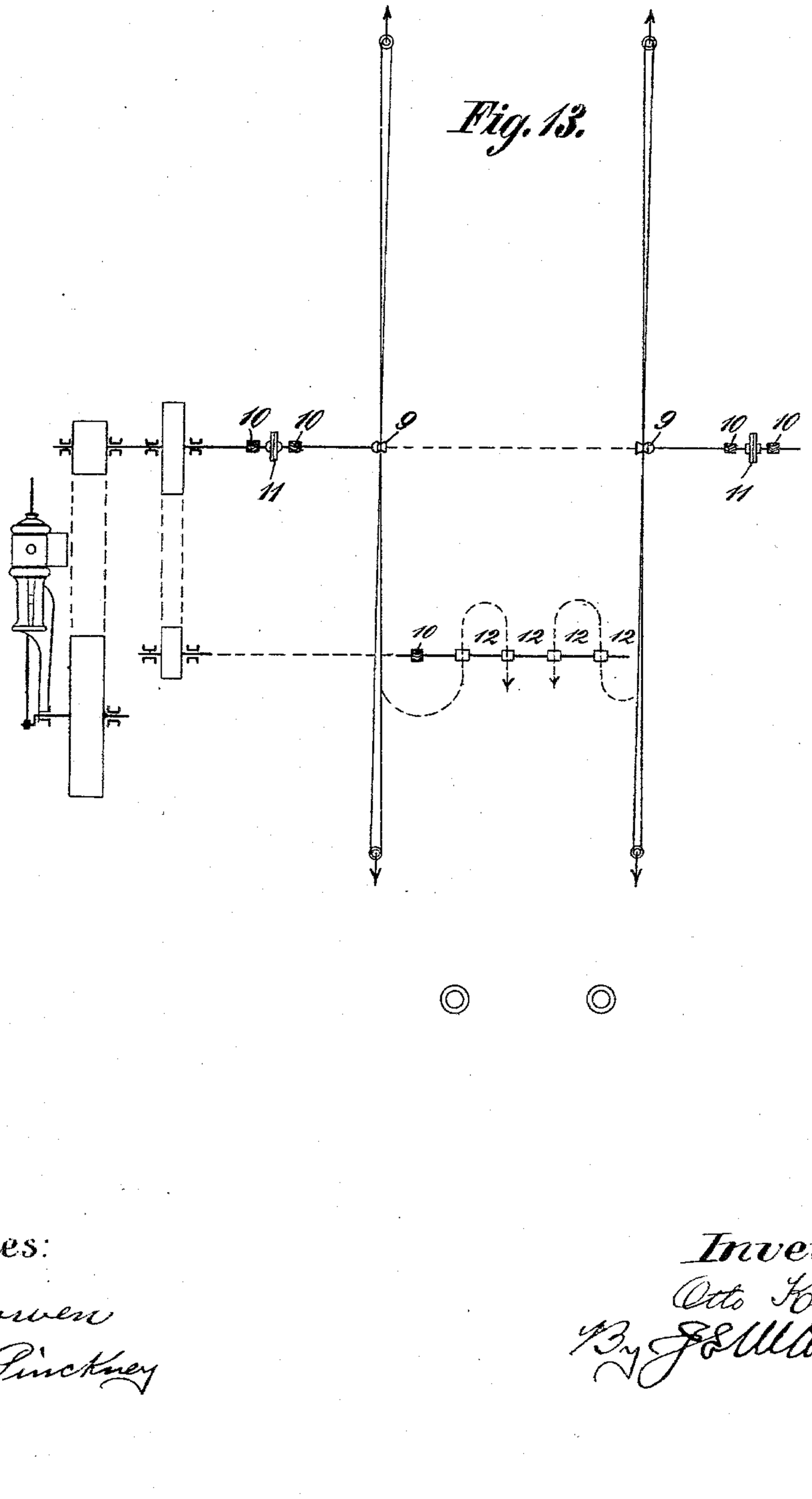
ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

No. 562,621. Patented June 23, 1896.

Fig. 13.



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ROLLING MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

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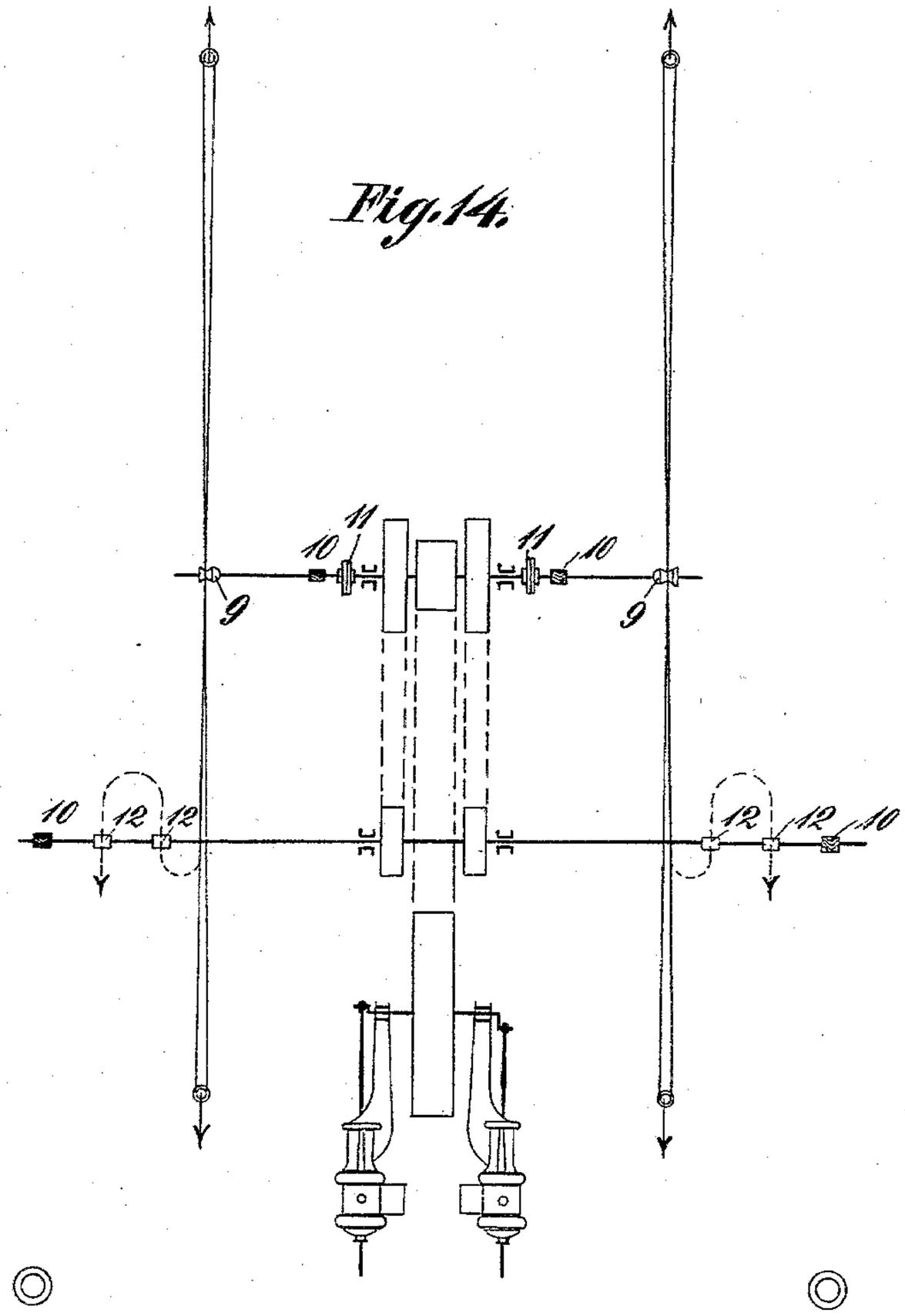
Fig. 14.



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UNITED STATES PATENT OFFICE.

OTTO KLATTE, OF NEUWIED, GERMANY.

ROLLING-MILL FOR PRODUCING CONTINUOUS AND ENDLESS ARTICLES.

SPECIFICATION forming part of Letters Patent No. 562,621, dated June 23, 1896.

Application filed December 5, 1894. Serial No. 530,904. (No model.)

To all whom it may concern:

Be it known that I, OTTO KLATTE, a subject of the King of Prussia, Emperor of Germany, residing at Neuwied-on-the-Rhine, Germany, have invented certain new and useful Improvements in Rolling-Mills for Producing Continuous and Endless Articles, of which the following is a specification.

According to the rolling processes commonly employed for producing bar, band, or wire-like goods, the metal under treatment, from beginning to end of the process, takes the form of a prismatic body, having two end surfaces and varying in section during the process. Double croppings are consequently unavoidable, which may, however, occur several times during one rolling. In order to roll the metal from its original to its final shape, the metal must pass through a certain number of groovings decreasing in section, not gradually but stepwise, such groovings being usually distributed among several rolling-trains. In the case of finer products (band-iron and wire) the number of groovings which the metal has to pass is very considerable. The metal under treatment has to be fed to each groove of the rolls, nearly always by manual labor, (in very few cases does the feed take place automatically,) with the aid of feed-hoppers, guides, trucks, &c., which have to be differently constructed for the various groovings.

According to the process hereinafter more particularly described, the metal under treatment takes the form of an endless body, *i. e.* of a ring or annular body, either round or oval in form. The rolling process from the original to the final section takes place in one and the same grooving in two or three high rolling-trains, but in the latter case in two passages through the rolls, which are, however, formed by one groove of the central roll, the endless form of the metal under treatment being retained throughout the whole process, and the rolls being caused to rotate uninterruptedly and in one and the same direction. The characteristic of the present process is that the same enables the production of bar, band, and wire-like products from an annular metal body, by continuously rolling the said body between the same rolls and without a change of grooves and allowing it to retain its endless form until the required final section has been obtained and the annular body correspondingly enlarged, whereupon the long endless band produced may be divided. Thus according to this process the waste caused by croppings will be entirely avoided, less labor and less time will be required, and the production will be increased. Guides and feed devices, &c., may be dispensed with as no shifting of the piece of metal under treatment is necessary.

It may be remarked here that it is customary in making band as also flat iron to give the same one or two "polishing" or finishing passages through special rolls and in making wire to give the same a round oval and finishing passage through special rolls. Thus in this kind of rolling products, the term "required final section" above mentioned must be construed to refer to the section obtained previous to these finishing passages.

In order to make the present invention more easily intelligible, reference is had to the accompanying drawings, in which similar letters denote similar parts throughout the several views.

Figures 1 to 4 are diagrammatical representations of the process as carried out with two rolls. Fig. 5 shows the construction of a pair of rolls according to the present system for making bar-iron having a rectangular section; Fig. 5ª, the final position of the rolls during one rolling. Fig. 6 is a sectional side elevation, and Fig. 7 an end elevation, partly in section, of a rolling-mill in which the rolls are supported in bearings at either side of the same; Figs. 8 and 9, similar views of a rolling-mill having the rolls supported at one side only. Fig. 10 is a sectional side elevation showing the process as performed with a three-high mill. Fig. 11 is a front elevation of Fig. 10; Fig. 12, a similar section to Fig. 10, showing the process in a more advanced stage. Figs. 13 and 14 represent two complete rolling-mills for carrying out the present process.

Referring to Figs. 1 to 4, the original metal body, which I shall for the purposes of this specification hereinafter term the "ring," may either be cast, or may also be formed by bending a metal bar and welding its ends together. The said metal bar may have been

previously rolled, pressed, or forged in any desired manner. The ring *a* is now placed in the groove formed by the two rolls, advantageously while still hot from the mold, or if local circumstances will not admit of this the ring should be further heated in a furnace, the upper roll being in the position shown in dotted lines in Fig. 1. Immediately after the ring has been placed in the groove the upper roll is lowered, and the rolls set in motion, if they were not in motion at the time the ring was placed between them. The upper roll is now constantly advanced toward the stationary lower roll by a suitable power acting upon it vertically from above. The section of the ring will thus be gradually decreased, its length increasing correspondingly. After having passed the rolls several times the ring will attain such a size that it will hang down on the inclined surface *b*, arranged under the rolls, as shown at Fig. 2, and will be correspondingly diverted. When the ring (or rather the metal product under treatment, which has in the meantime passed from the ring shape to that of a loop or endless band) has attained a certain size, a roll *c* may be placed in the same, Fig. 3, said roll being guided by any suitable means, so as to exercise a pull on the band in the direction of the arrow and retain the said band stretched without twisting the same. This arrangement is devised to prevent the band from getting entangled on the decrease of its rigidity through the rolling process.

The same object, however, may be attained as at present by having a boy to keep the constantly-moving loop or band in order. For the more rigid kinds of work this is not necessary. The upper roll continues to approach the lower one until it has reached a certain position corresponding to the desired final section of the metal, when the downward pressure is released or the roll arrested in its end position, as shown at Fig. 4. The length of the final product depends upon the size of the machinery and the original ring and upon the proportion of the final section to the primary section. Thus for instance a ring having a section forty by seventy millimeters and a diameter (on the center of gravity) of five hundred millimeters is to be rolled down to a band-iron having a section of forty-five by two millimeters. The endless band resulting as the final product will be 46.5 meters long, so that a space of half this length or about twenty-three meters would be necessary behind the rolls. After the metal band has passed the rolls once, (or several times,) when they are in position nearest each other or in their end position, the upper roll is again raised to its highest position (shown in dotted lines in Fig. 1) after the loop or band has been cut apart and removed from the rolls. The product of the rolls is then further treated in the usual manner. (Thus in making band-iron, the divided band may, if desired, be subjected to further passages through other rolls for polishing purposes, as previously mentioned, wire, again, would have to be further treated to change it from the square section which it has received, to the round oval and final circular section.)

In order to carry out the process which has been previously described in principle, specially-constructed rolls and rolling-mills are necessary, and I have invented certain new and useful improvements in machines for producing bar, band, and wire articles by a continuous rolling process of which the following is a description:

Fig. 5 shows rolls constructed for producing bar metal having a rectangular cross-section, flat iron, band-iron, and the like. The upper roll forms the top of the groove, and consists of a roll having cylindrical circumferential surface with slightly conical side or lateral surfaces, so that the length or width of the roll increases toward the axis of the same. This roll is adjustable lengthwise on its shaft. The lower roll has conical lateral flanges forming the sides of the groove and a cylindrical part forming the bottom of the said groove. The conicity of the lateral flanges fits that of the upper roll. The part *d* is adjustable lengthwise on the shaft, the part *e* being rigidly attached to the same advantageously by means of a clamping-ring *f*, by means of which it is pressed or retained firmly against a shoulder or collar formed on the said shaft. The parts *d* and *e* are formed of several parts, as shown in the drawings, so that when the working surfaces wear down it is only necessary to replace or renew the rings on which these surfaces are formed. At the beginning of the rolling process the ring of metal to be worked hangs in the groove (see also Fig. 6) and the upper roll is slightly advanced into the groove of the lower roll. As the rolling progresses the upper roll is gradually advanced toward the lower one, entering farther and farther into the groove of the same, and according to the conicity of the lateral surfaces gradually displacing the part *d* and moving itself slightly to the left. The springs *g*, (advantageously from four to six in number,) which bear against the collar *h*—advantageously made in two parts and fast on the shaft—press *d* properly against the upper roll and the latter against the part *e*, so that the groove is kept constantly closed. The final position of the rolls during one rolling operation is shown in Fig. 5ª. The downward motion of the upper roll is stopped and the part *d* of the lower roll contacts with the ends of the three set-screws *i*, which limit the lateral motion of the same. After the finished product has been removed from the rolls the upper roll is raised far enough to allow of the introduction of another metal ring, the springs *g* pressing the part *d* back into its original position, Fig. 5, which is limited or determined by the set-screws *k*.

During its upward motion the upper roll also returns to its original position.

The above-described roll construction allows of the adjustment and employment of the lower roll, within two once determined limits for products of any desired width. The breadth of the cylindrical circumferential surface of the upper roll determines the breadth of the required product. For other breadths a different roll-ring must be employed. In this kind of rolling machinery, as will be evident, the rolling operation is effected by decreasing the height of the metal ring under treatment, through the gradual approach of the rolls, the conical lateral surfaces of the said rolls allowing a widening of the metal under treatment within certain limits.

Under or lower rolls of the kind described may also be employed as head-rolls, *i. e.*, rolls having bearings at one side only, as shown at Fig. 5 and in connection with the mill illustrated in Figs. 8 and 9. They may, however, be provided with two trunnions, as shown in connection with the train illustrated in Figs. 6 and 7. In the former case the metal ring to be worked may be conveniently introduced between the rolls. In the latter case however a special arrangement must be provided to enable the performance of this operation, which will be hereinafter described in connection with the rolling-mills illustrated. The one-sided mounting of the rolls is sufficient for the lighter kinds of work, while for the heavier kinds (broad, flat, or band iron, and the like) it is advisable to provide bearings at each side of the rolls.

The rolling-mill shown in Figs. 6 and 7 consists of the standards *l* and *m* with the necessary gearing and the roll-standards *n* and *o* with rolls as described having bearings at either side. Between the standards are the elastically-supported shaft connections with the usual jointed couplings. Motion is imparted to the lower shaft, the coupling and uncoupling of the train as also the starting and stopping is effected by means of friction-couplings, which may be worked hydraulically, as shown at the left-hand side of the figure. The shaft connections between the two pairs of standards as also the flexibility of the couplings are kept at such proportions as to allow of the adjustment of the position of the upper roll and its vertically-adjustable bearings into the upper position (shown in dotted lines in Fig. 7) and into its lowest position corresponding to the smallest section of the metal under treatment. To the standards *n* and *o* are attached two hydraulic cylinders *p*, operated by a common valve motion and having pressure-rods *q q*, extending through both cylinder-covers, traverses *r r*, and stays *s s*. While the lower roll is, as usual, mounted in stationary bearings in the standard *n*, the right-hand trunnion or stub-shaft runs on the traverse *t*, which rests on the piston-rod *u* of the hydraulic cylinder *v*, mounted at the lower part of the standard.

Presuming the rolling process to have been completed and the finished work removed from the rolls, it is now required to place a fresh ring between the rolls, for which purpose the train is uncoupled. A little practice on the part of the workmen will, however, enable the introduction of the ring while the rolls are running. The valves are now adjusted so as to raise the plungers of the hydraulic cylinders *p* and thus lift the upper roll by means of the rods *s s* into the position shown in dotted lines in Fig. 7. Simultaneously the plunger of the cylinder *v* moves downward, moving the traverse *t*, which is laterally guided in the standard into the position also shown in dotted lines at the bottom of the said standard. By this means sufficient room will be left around the lower roll to allow of the ring being placed over the same through the standard *o*, which is widened out at this part for the purpose. As soon as this has taken place the valves are reversed, the plunger *u* moves upward until the traverse *t* closes up under the trunnion of the lower roll. The plunger is arrested in this position, so that it forms a reliable support for the trunnion or stub-shaft of the lower roll. The upper roll has been simultaneously lowered and exercises a continual pressure on the metal under treatment by means of the pressure acting on the plunger of the rod *q*.

By altering the position of the valves the quantity of pressure fluid entering the cylinder within a certain space of time may be regulated; and thus the motion of the upper roll toward the lower one determined and adjusted to suit various purposes or even altered during the rolling process. Generally speaking, however, it is advantageous to allow the pressure fluid to enter the cylinder without throttling it, so that an even pressure is exercised on the metal under treatment throughout the whole rolling operation. By this means the approach of the upper roll and the consequent diminution of the cross-section of the metal under treatment will be regulated automatically—*i. e.*, it will regulate itself, accommodating itself to the properties of the material and will be greater, the less the density of the metal or at the beginning of the process, decreasing with the increase of density of the material or toward the end of the rolling operation. The advance of the upper roll stops entirely as soon as the traverses *r* have reached the nuts *w*. These latter thus serve for determining the thickness of the finished product.

Figs. 8 and 9 illustrate a rolling-mill in which the lower roll is supported in bearings arranged at one side only of the same. This representation also shows how a double rolling-mill may be arranged, provided with the present system of rolls and driven by steam-power from an engine. The upper rolls are raised and lowered in the same manner as just described. The shaft of the lower roll is provided with a second bearing situated be-

tween the gearing-standards and the standards in which the rolls are mounted. The engine drives the shaft x and with it the left-hand pair of rolls in the usual manner. The gearing-roll y, fast on the shaft x, also drives the wheel z and with it the shaft z', which carries a gearing-roll at its right-hand end, driving the gearing of the right-hand pair of rolls. Both pairs of rolls may work entirely independently of each other and yet at the same time. If it is required to work them one at the time, it would be necessary to provide friction-couplings between the gearing-roll standards and those of the rolls proper, (similar to the arrangement shown diagrammatically in Figs. 13 and 14.)

This description has hitherto treated of the employment of two-high mills only in connection with the described process. Three-high mills may however be employed with equal advantage, as shown in Figs. 10, 11, and 12. The central roll is constructed in the same manner as hitherto described. Since according to this arrangement an approximately equal pressure is exercised on the central roll from above and below, the same is in a certain sense relieved or compensated, so that it will be sufficient to support the same in bearings at one side only, even for doing heavier kinds of work. The central roll may be arranged in stationary bearings, in which case the other two must have adjustable bearings; but if desired the lower roll may be provided with stationary bearings and the two upper ones with movable bearings. In the latter case the pressure necessary for performing the rolling operation would be applied to the top roll, which in its turn would communicate it to the central roll, whence it would be imparted to the lower groove. The cylindrical circumferential surface of one of the two outer rolls—in Figs. 11 and 12 the top roll—is somewhat broader than that of the lower roll, the conicity being the same in both rolls, so that the lower one in rolling will penetrate somewhat farther into the groove than the top one. (See Fig. 11.) On this account the top roll is arrested a little sooner than the lower one, so that the metal, during the last passage through the rolls, is only subjected to pressure between the central and lower rolls, where it is finished. (See Fig. 12.) When employing two rolls, the loop formed during the process was guided at one side of the rolls only, but in the present case it will be necessary to guide the said loop at both sides of the rolls, since the same will be formed at each side.

With the roll construction hitherto described there is a possibility of a bur being formed on the product at the point of juncture of the parts d and e, for instance, when the said parts get worn. As a rule these parts will close properly one on the other, but any bur may be easily removed by passing the material under treatment through a second pair of rolls of similar construction, but having the point of juncture of the two roll parts d and e at the opposite side. Such rolls may be mounted in the same standards, so that they only serve as trailing-rolls, *i. e.*, they are not positively driven, the rolls proper pulling the metal through them, while the pressure at which they are pressed down one on the other may be produced by the application of weights.

In all constructions an interior water cooling is provided for the rolls, as may be seen from the respective figures.

Figs. 13 and 14 show two forms of a general arrangement of rolling-mills constructed for the described endless rolling process, double sets of rolls being proposed in each case. 9 9 are the rolls for performing the endless process. 10 designates the geared rolls; 11, the friction-couplings. 12 are rolls of the ordinary construction for finishing the product in certain cases after the endless band has been divided, (cut, sawed, or otherwise separated,) *i. e.*, dressing the same, or rolling the square-sectioned wire coming from the rolls 9 9 to a round oval and final circular section.

In the rolling process hereinbefore described the rolling operation from beginning to end, *i. e.*, from the original ring of metal to the finally-attained section of the same, has been conducted in one and the same set of rolls. This is, however, not absolutely necessary. The process is equally applicable when one primary and one finishing set of rolls is employed. Thus, for instance, with a double set of rolls, as shown at Figs. 8 and 9, the original ring may be rolled on the left-hand set from its original form to a section about midway between the first and final sections, and the enlarged loop or band thus formed then transferred to the next rolls, where the process is completed, another ring being worked in the meantime on first set.

The present process may also be carried out by arranging a second mill similar to the first behind the latter and driving the same in a similar manner. The operation would then be carried out by first placing the ring in the first mill and as soon as it had obtained a sufficient size inserting it between the rolls of the second mill while the rolls are running, so that the metal would be treated by both mills simultaneously and in the same manner. In this manner a considerable saving of time is effected in conducting the process, the time required to conduct the process being reduced to the half of that required when working with one mill only. Even more mills could be employed, but the time taken by the rolling operation in most cases is so short when employing two mills that there would be hardly time for the workmen to perform the necessary manual operations between the mills if more were employed.

I claim as my invention—

1. For rolling bar, band and wire-like articles continuously and in endless form, the combination of a rotary roll having station-

ary bearings and an annular groove, conical sides to said groove adjustable to and from each other a rotary roll having an annular conical projection to fit said groove, and being laterally movable on the axis, means for pressing the sides of said groove onto the annular projection of the engaging-roll one of these conical sides being adapted to give way laterally during the working of the rolls according to the advancing of said conical projection and means for lowering and raising said adjustable roll to and from said stationary roll substantially as described.

2. For rolling bar, band and wire-like articles continuously and in endless form, the combination of a rotary roll having stationary bearings and an annular groove, conical sides to said groove adjustable to and from each other, a rotary roll having an annular conical projection to fit said groove and being laterally movable on the axis, means for pressing the sides of said groove onto the annular projection of the engaging-roll one of these conical sides being adapted to give way laterally during the working of the rolls according to the advancing of said conical projection and means for lowering and raising said adjustable roll to and from said stationary roll for introducing between said rolls an annular metal blank substantially as described.

3. In combination with rolling machinery for producing endless bar, band and wire-like articles a divided roll having stationary bearings and consisting of two parts forming when closed a conical groove adjustable in width, a rotary roll having an annular conical projection to fit said groove and being movable on the axis, means for pressing the sides of said groove on the annular projection of the engaging-roll, one of the conical sides being adapted to give way laterally during the working of the rolls according to the advancing of said conical projection and means for lowering and raising said adjustable roll to and from said stationary roll, substantially as described.

4. In combination with rolling machinery for producing endless bar, band and wire-like articles a divided roll having stationary bearings and consisting of two parts forming when closed a conical groove adjustable in width, two rotary rolls one above, the other below the aforesaid roll and having each an annular conical projection to fit said groove and being movable on their axes, means for pressing the sides of said groove on the annular projections of the engaging-rolls one of the conical sides being adapted to give way laterally during the working of the rolls according to the advancing of said conical projections and means for lowering and raising said adjustable rolls to and from said stationary roll, substantially as described.

5. In combination with rolling machinery for producing endless band, bar and wire-like articles a roll having a conical groove adjustable in width, a counter-pressure roll to engage said groove and means for pressing the same into said groove, bearings at each side of said groove, means for raising said counter-pressure roll from the grooved roll and simultaneously lowering the bearing of said stationary grooved roll at one side to allow of the introduction of an annular metal blank between the rolls substantially as described.

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

OTTO KLATTE.

Witnesses:
FRITZ SCHRÖDER,
M. NAGEL.