(No Model.) 4 Sheets—Sheet 1.

A. J. MOXHAM & J. R. TRANTER.

ROLL FOR ROLLING CAR RAILS.

No. 292,759. Patented Jan. 29, 1884.

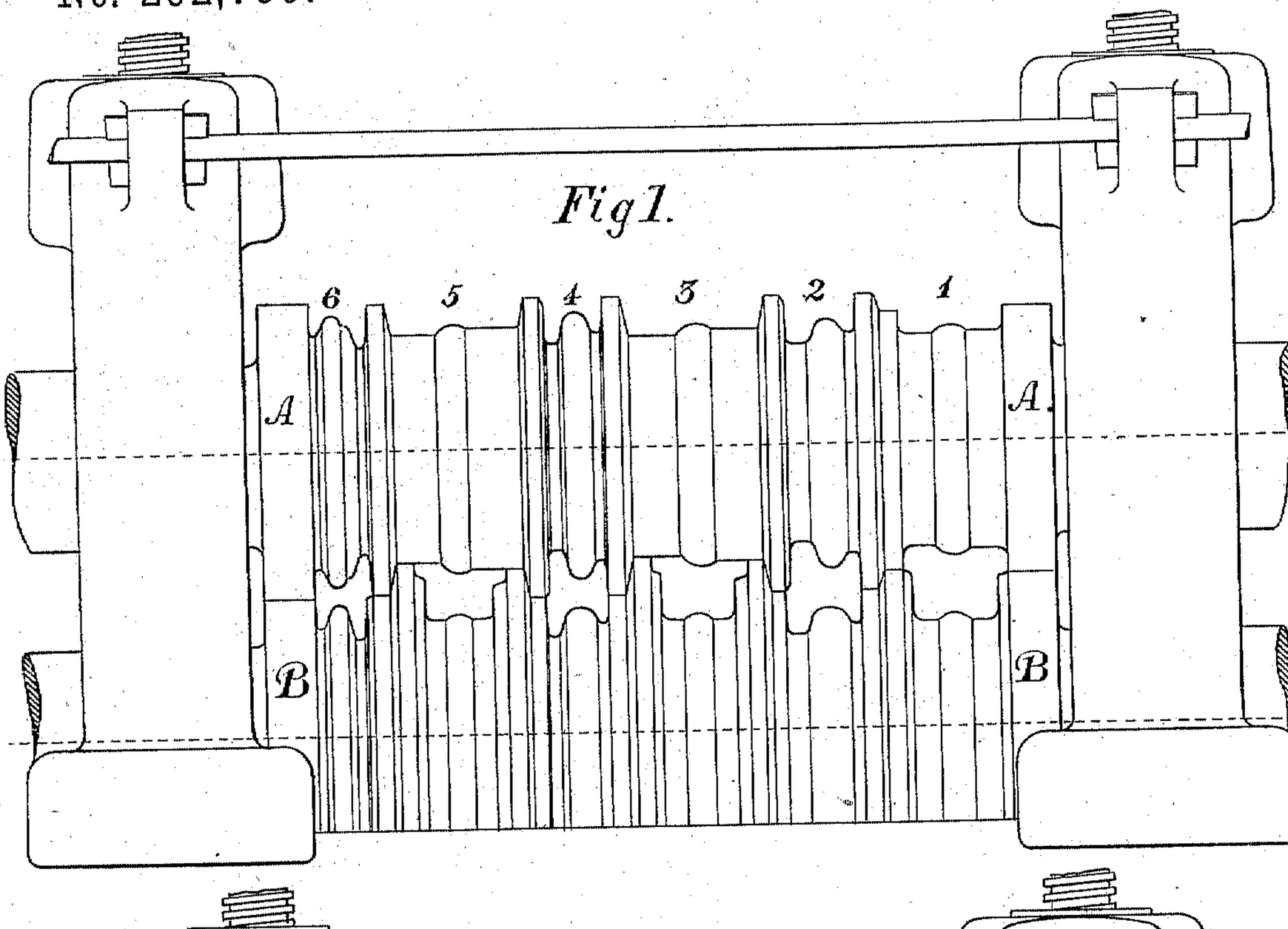

Fig 1.

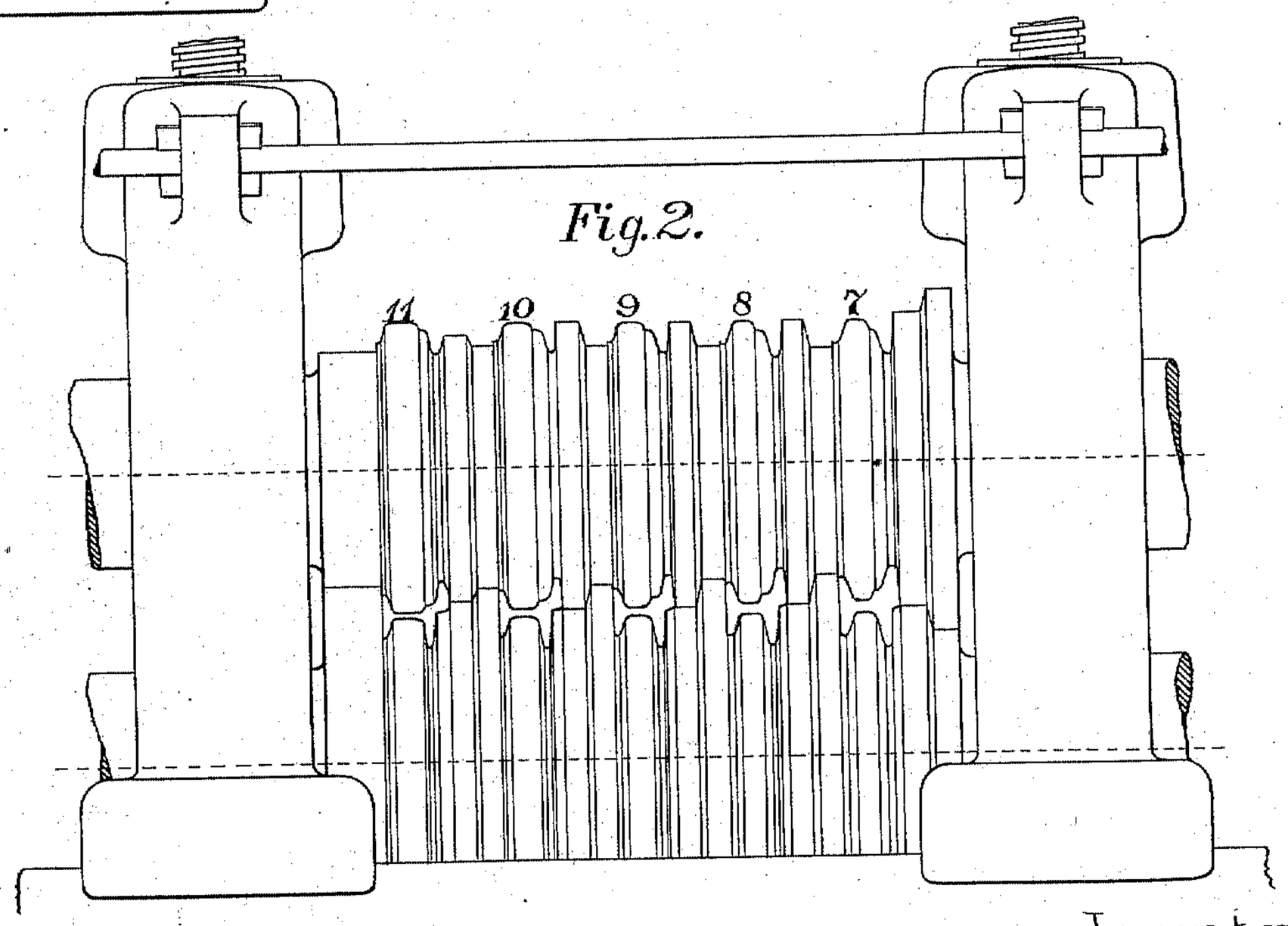

Fig. 2.

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(No Model.) 4 Sheets—Sheet 2.

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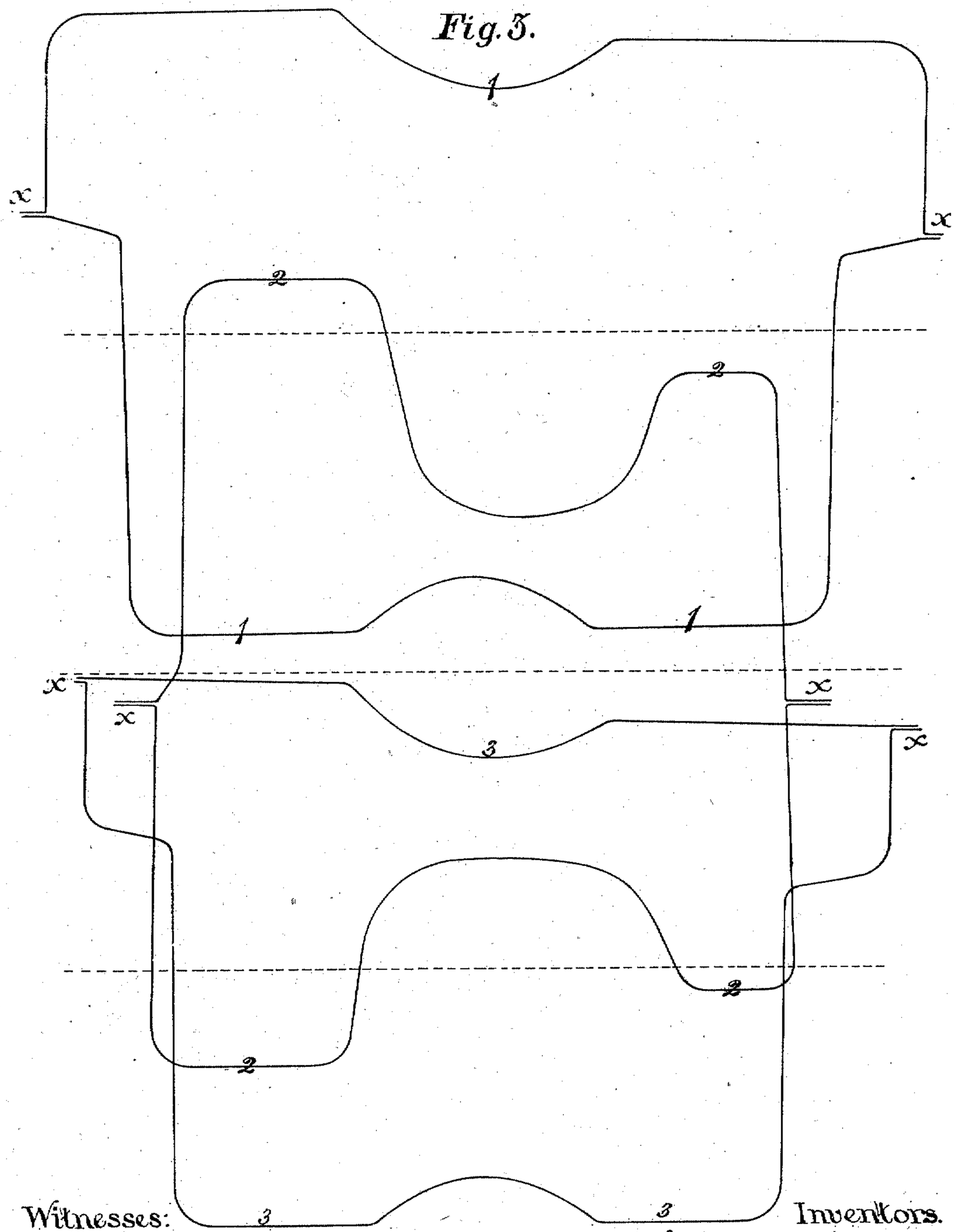
Fig. 3.



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ROLL FOR ROLLING CAR RAILS.

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Fig. 4.

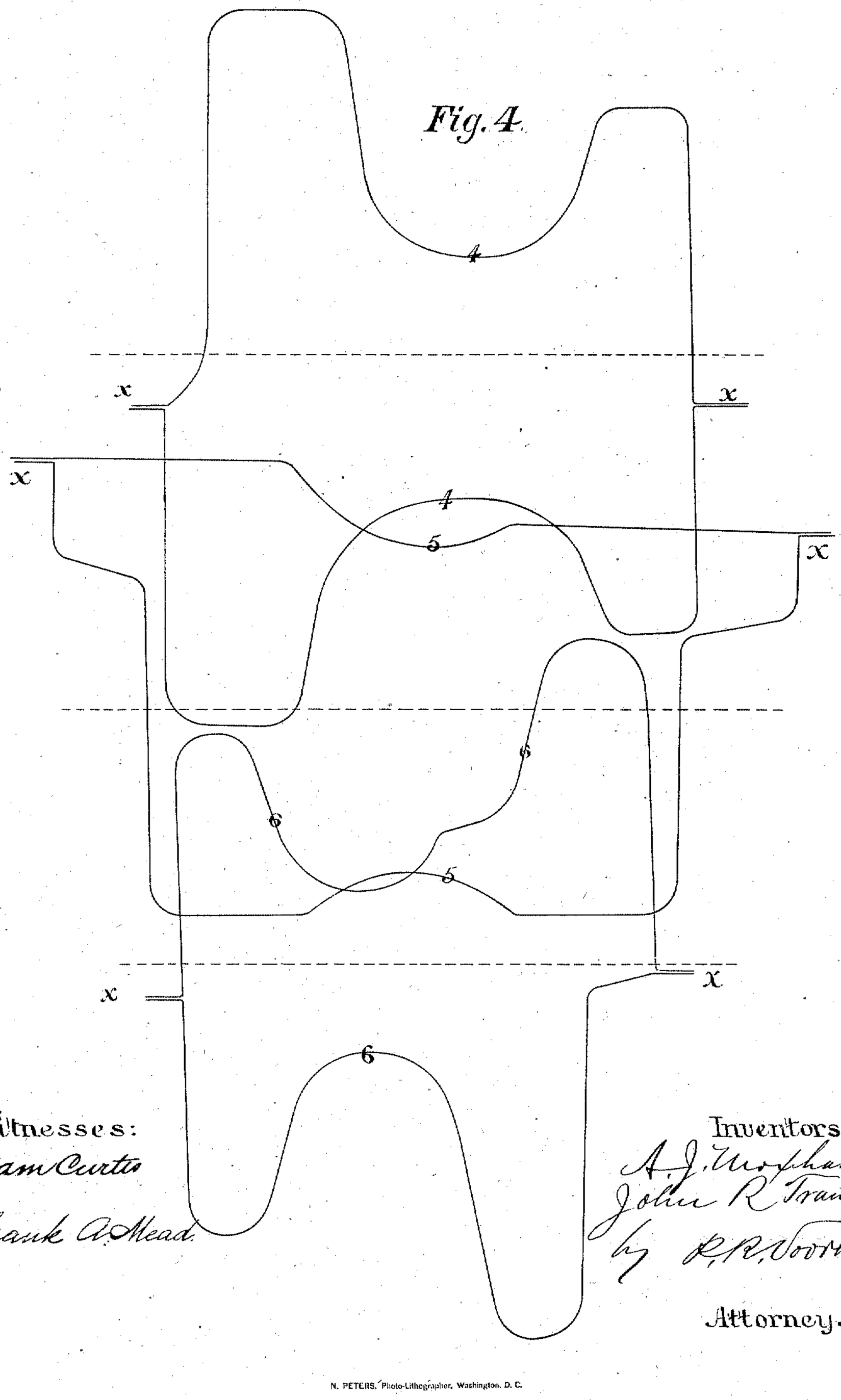

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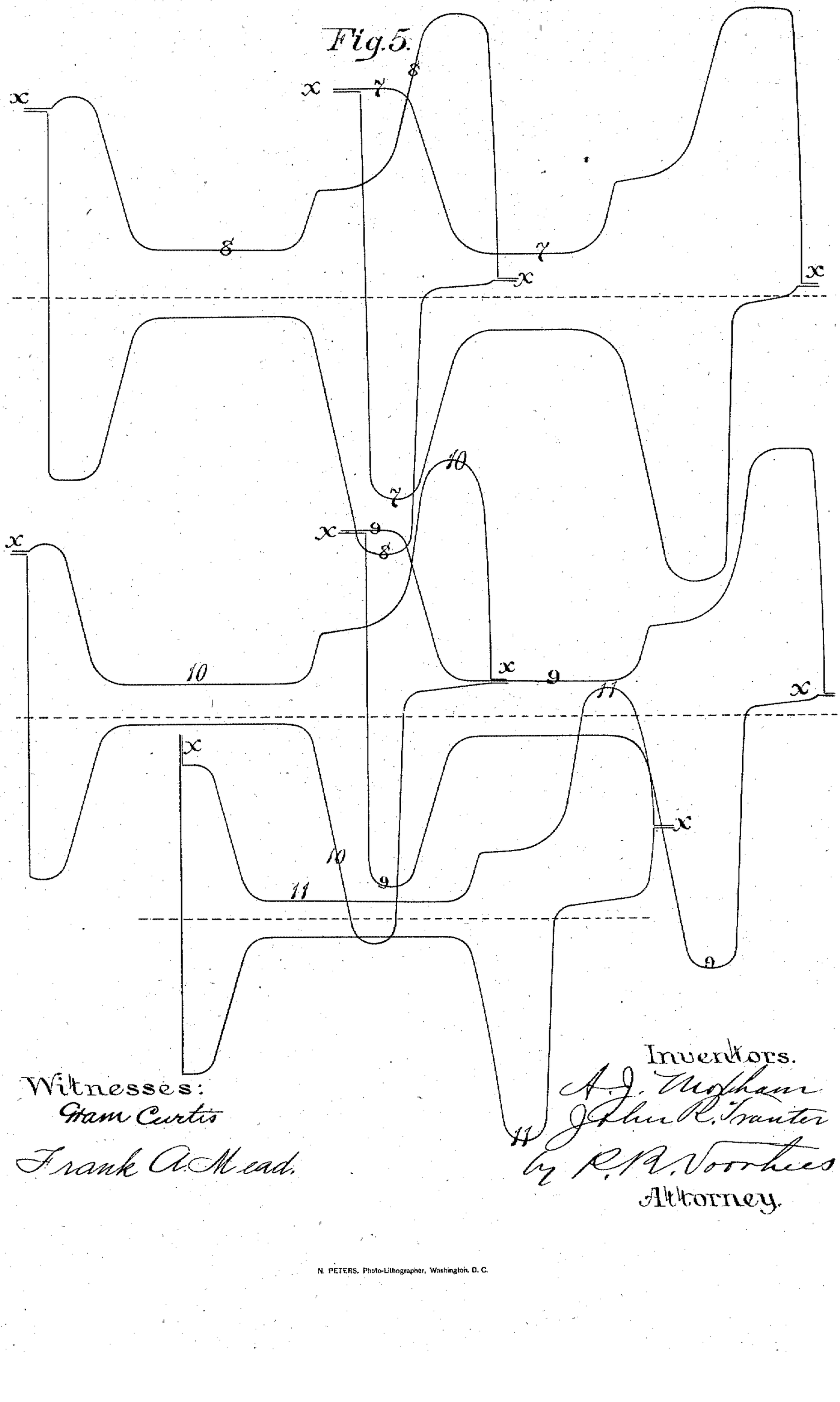
Fig. 5.



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UNITED STATES PATENT OFFICE.

ARTHUR J. MOXHAM AND JOHN R. TRANTER, OF LOUISVILLE, KENTUCKY.

ROLL FOR ROLLING CAR-RAILS.

SPECIFICATION forming part of Letters Patent No. 292,759, dated January 29, 1884.

Application filed October 23, 1882. (No model.)

To all whom it may concern:

Be it known that we, ARTHUR J. MOXHAM and JOHN R. TRANTER, both of Louisville, in the county of Jefferson and State of Kentucky, have jointly invented a new and useful Improvement in Rolls for Rolling Car-Rails of a Symmetrical Flanged Cross-Section, which invention or improvement is fully set forth and illustrated in the following specification and accompanying drawings.

The object of this invention is to construct a series of rolls whose forming and finishing grooves or passes shall have such conformation that said rolls shall be capable of rolling light rails of very irregular form of cross-section, more particularly of the new form known to the trade and in the art as the "Johnson rail." Said rail is a double-flanged girder-rail, principally used for the tracks of street-cars or tram-cars. In furtherance of this object the machinery used consists of two sets of rolls, one set roughing or forming rolls, the other finishing-rolls, which sets may be either "two high" or "three high," as preferred, said rolls being of such conformation and operating as is hereinafter described, and specifically set forth in the claims.

In the accompanying drawings, Figure 1 shows in front elevation the first rolls for roughing or forming a hot billet or ingot into a bar having some approach to the desired form of rail. Fig. 2 shows the second set of rolls for finishing the bar into a rail of the desired form. Figs. 3 and 4 show the outlines of templets of all the roughing-passes. Fig. 5 shows the outlines of templets of all the finishing-passes. Said outlines constitute full-size views of templets carefully taken from the passes of rolls in actual use, and by means of templets taken from these outlines rolls such as herein described can be accurately turned. The lines of the templets in the drawings have been drawn across each other for the sake of bringing as many templets as possible within the range of one view, and thus avoid the use of many sheets of drawings. The full-size views would otherwise take up a whole sheet to each templet, and views less than full-size might fail of delineation with sufficient accuracy. The numbering of the lines will avoid any confusion in following or tracing the outlines of the several templets. The last templet of the series above described illustrates in outline a true cross-section of the finished rail.

The absolute diameters of the rolls in the neck and in the passes, and also the length of the respective rolls, may be varied within certain limits at discretion for necessary strength; but it is best that the relative diameters in the passes (where varied) should vary substantially in the proportions hereinafter set forth. Good proportions for the rolls, however, I have found to be as follows: body of roughing-rolls, sixty-two inches long by sixteen inches diameter at the "pitch-line of delivery;" body of finishing-rolls, forty inches long by sixteen inches in diameter at the pitch-line of delivery. Necks of the rolls may be nine inches in diameter and eight inches in length. The remaining parts of the rolls may be constructed according to any rules of good practice, such as are well known to those skilled in the art.

Templet No. 1 shows a flattening-pass or "dummy," in which pass the rolls are of the same diameter. No. 2 shows a forming or edge pass, in which the top roll is one-fourth inch larger in diameter than the bottom roll. No. 3 shows a dummy or flattening-pass in which the rolls are of the same diameter. No. 4 shows an edge-pass, in which the top roll is three-eighths inch larger in diameter than the bottom roll. No. 5 shows a dummy or flattening-pass in which the rolls are of the same diameter. No. 6 shows an edge-pass in which the top roll is one-eighth inch larger in diameter than the bottom roll. Templet No. 7 shows the first pass of the finishing-rolls, all the passes in which are edge-passes. In this pass the bottom roll is one-eighth inch larger in diameter than the top roll. No. 8 shows an edge-pass in which the bottom roll is one-fourth inch larger in diameter than the top roll. No. 9 shows an edge-pass in which the bottom roll is one-eighth inch larger in diameter than the top roll. No. 10 shows an edge-pass in which the bottom roll is one-fourth inch larger in diameter than the top roll. No. 11 shows the last finishing-pass, in which the diameters of the rolls are the same. The locations of the part-

ing-lines of the rolls are indicated on the templets by the lines thereon; respectively marked *x*.

The course of the billet in being rolled into a finished rail and the operations throughout the several passes will now be explained, as follows: The hot billet of iron or steel ingot is first put flat into the grooves or pass of No. 1, then on edge into No. 2, then flat into No. 3, then on edge into No. 4, then flat again into No. 5, and then on edge into and passed through No. 6, when the billet is formed into a bar ready for the finishing-rolls. In the finishing-rolls the bar follows consecutively, without any turning over or flattening, into the grooves or passes in Nos. 7, 8, 9, 10, and 11, coming out of No. 11 straight and finished, the whole rolling operation having been accomplished at one heating. The character of rail for rolling which these have been designed is such—that is, of both a very irregular form of cross-section and comparatively small mass or light weight—that it is necessary to not only provide means for shaping the metal without tearing its small and diversely-disposed mass, but also to deliver it through each pass without any curve being imparted to it in the rolling; otherwise it cannot be both flat-rolled and edge-rolled, as is done in the roughing-rolls herein described. The bar being necessarily turned for each of said operations, it would not, if curved either upward or downward toward either roll, enter the flattening-passes or dummies when turned upon its side. Such, however, is the disposal of the mass of metal into the several passes of the rolls, as described, in conjunction with the described variations in diameter of rolls and locations of their parting-lines, that the above-mentioned objects are fully secured, such "draft" being thus imparted to the rolls that all tendency in the metal to curve, either laterally or vertically, is completely neutralized, and the billet or bar is delivered straight and uninjured from the several passes, without being either torn or strained beyond its powers of cohesion.

In rolling either iron or steel into the sectional shape above given, our experience has shown that it is very difficult to produce a rail of such sectional contour by the means ordinarily adopted for rolling rails, even somewhat approximating the contour above given. In pass No. 1 of the roughing-rolls above described one side of the pile or ingot, owing to the shape of the pass, is reduced more than the other. Thus more work is put on one side thereof than on the other, which action, if not counteracted, would, by elongating the metal on one side more than on the other, deliver it from said pass curved laterally, instead of straight. It will be observed, however, that there is a large protrusion or tongue in the center of the groove in the top roll, the effect of whose obstruction in the pass is to produce what may be called a "neutral axis" between the two differently-compressed sides of the metal being rolled in said pass, and, as a consequence, said metal cannot flow from one side to the other of said axis; hence lateral or horizontal curvature in the metal as it leaves the pass is prevented and it is delivered straight from said pass. There are three passes provided with tongues of this same character—namely, flattening-passes Nos. 1, 3, and 5. It was found by experiment impossible to produce the desired offset in the billet in one pass only, and at the same time retain the efficacy of the tongues in holding the billet straight therein and so delivering it therefrom. In pass No. 2 the upper roll, A, is larger in diameter than the lower roll, B, while the sectional area of the part of the hot metal passed through the groove in roll B is smaller than that passed through the groove in roll A, said grooves together constituting said pass No. 2. This difference in sectional area of metal within the top and bottom groove, respectively, in said pass is quite manifest to the eye by observing the parting-lines of the rolls, clearly indicated at said pass, and also indicated on a larger scale on templet No. 2 by the letter *x*. The location of the parting-lines, therefore, at this pass (as well as at all the other edging-passes) determines whether more or less sectional area of metal shall be drawn by one roll or the other, for such is the shape of each groove, as shown in the pass, and clearly manifested on a larger scale by the contour lines of the templet, that no one measurement will give the effective diameter of either groove. By measuring each variation in diameter a mean diameter, however, may be obtained, said mean, however, being but the resultant of the several differential measurements; hence each of said grooves is of a differential diameter, not a uniform diameter, and this also applies to all the other edging-passes of each set of rolls. It must be evident, now, that this smaller sectional area of metal drawn through the lower groove of said pass No. 2 could only be so drawn by an excess of work—compressive, elongative, or drawing work—on the part of the bottom roll in said pass. The effect of said excess, however, is balanced by the larger mean diameter of the top roll in the upper groove of said pass, as below explained. The draft exerted in said pass No. 2 by each roll, respectively, is therefore practically equalized by reason of the greater peripheral speed of the roll of larger mean diameter in said pass. This mean diameter is properly the diameter of the circle in which lies the pitch-line of the groove. Each groove may therefore have a mean or a special diameter of its own, measured at its pitch-line—that is, a diameter whose extremes are bounded by a circle described by the mean radius of the groove—while the rolls, irrespective of their grooves and necks, are said to have only uniform or equal diameters, whose radii extend from the center of each roll to a common center between the centers of the rolls.

A line through said common center, parallel to the axes of the rolls, will lie in the "pitch-line of delivery" of the rolls. In other words, said line will lie in a plane tangent to the circumferences of two circles whose radii are equal to half the distance of the centers of the rolls apart; hence the pitch-lines of none of the grooves need necessarily coincide with the pitch-line of delivery of the rolls in order to effect a straight delivery of metal.

Wherever the metal in course of being rolled is most reduced in sectional area in one portion of a pass as compared with the rest of that pass, it is manifest that the amount of work required to produce this reduction of area must at such point or place be the greatest; hence the metal being more elongated by the roll doing the greater work in pass No. 2 (the lower roll of lesser diameter) would curve away from said roll in a vertical plane were this tendency not counteracted and straight delivery secured by the difference in diameters of the rolls in said pass, as just described. For the same reason the same straight delivery is secured in passes 4 and 6; but the tongues in the edge-passes Nos. 2, 4, and 6, instead of acting as neutral axes in said passes, merely co-operate, by reason of their peculiar shape, with the other portions of their respective grooves in the necessary forming or shaping of the mass of metal being rolled. The province of the tongues in passes 2, 4, and 6 is thus seen to be essentially different from that of the tongues in passes 1, 3, and 5, for in passes 1, 3, and 5 reliance for straight delivery, as against lateral curvature, is placed upon the tongues therein; but in passes 2, 4, and 6 reliance for straight delivery, as against vertical curvature, is placed upon difference in diameter of rolls effecting unequal reductions of area of metal in said passes, and the tongues therein have no special function in the delivery, but only in forming or shaping the rail, for it will be observed that the proportions of the last-named tongues relatively to their respective grooves are essentially different from the proportions of the tongues in passes 1 3 5 relatively to their respective grooves.

It is particularly of importance that the rails should leave the last pass (No. 11) so free from tendency to curve or twist as not to require any hot-straightening, the usual method of doing which is by blows with a wooden maul. This straightening by blows, however, is inadmissible with a rail of such small area of cross-section and light weight, as a blow of the force necessary to straighten it would warp or bend the light flanges. The rail must therefore straighten itself to great nicety during its final delivery; hence the diameters of the finishing-rolls in the final pass are made equal, but the parting-line of the rolls at said pass is thrown upward somewhat, as indicated at the points *x x* at pass No. 11. This location of the parting-line of the rolls at the final pass, in conjunction with the peculiar shape of pass, and consequent distribution of metal in and shape imparted to the rail, accurately secures the desired object by properly localizing or distributing the draft of the rolls, and the finished rail is delivered straight to great nicety.

As the respective locations of the parting-lines of a set of rolls for rolling rails of irregular forms may be made to have so appreciable an effect on the delivery of the metal from the passes contiguous to said lines, some explanation on the subject more in detail may be of importance. For the ordinary flat groove the parting-line of the rolls is always above the center of the groove, owing to the form and construction of the collars needed to secure good edges to the rolled bar. Now, the roll which takes in its embrace the greater mass of metal, the rolls having the same diameter and equal draft, will, by reason of the greater friction thus created, determine the delivery of the metal in a curve in the direction of its own rotation. In practice, the collar-rolls used for rolling flat bars or "flats" are usually placed on the bottom and the tongue-rolls on top; hence (the draft being equal in each roll) the metal tends to hug the bottom roll and to curve downward with it, the greater mass of metal being of course in the bottom roll, for the circumference only of the tongue in the top roll touches the upper surface of the metal, whereas the under and each of the side surfaces of the metal are in frictional contact with the grooves formed by the sides of the collars and the intervening surface of the bottom roll. It is evident, therefore, that the sides of the collars create a larger excess of friction in the bottom roll, but perform no rolling work in reducing or drawing out the metal. Under these circumstances the tendency above mentioned in the metal to hug the bottom roll and to curve downward in the direction of its rotation is in practice overcome by the use of a guide which catches the point of the bar coming through the pass and strips it from the roll, whence it is delivered upon said guide. Now, such curving in the direction of the rolls' rotation, due to excess of mere frictional contact between metal and roll, must not be confounded with curving or tendency to curve away from a roll either laterally or vertically, due to excess of work on the part of such roll, as hereinbefore explained. The curve or tendency to curve in delivery either laterally or vertically, due to excess of work in one roll in either a lateral or vertical direction, is technically known as "excess of draft" in such roll. The roll, therefore, doing the greater work of reduction or "drawing" is said to have an excess of draft.

As it is manifestly desirable to have a certain and regulated delivery of the metal toward that point where preparation has been made to meet it, the action or effect of the collars is sometimes increased by making the difference in diameter of rolls aid said effect.

On the other hand, should the bite or friction of the collars, due to their shape, be excessive, the diameters of the rolls are so related that they tend to counteract the collars' said action. In the former case the top roll, and in the latter case the bottom roll, is given the larger diameter, thus either aiding or opposing curvature or tendency to curve caused by friction by curvature or tendency to curve caused by draft. Now, in rolls where the grooves are deep and the friction of the collars excessive, the location of the parting-lines becomes of special importance. In the finishing-rolls herein described the several locations of these parting-lines are such that a perfect co-operation with the relative draft of the different grooves is secured, and particularly in the last finishing-pass, for it will be seen that the rail as it leaves the preceding pass (No. 10) is of such form that an excess of work is put on its long flange as said flange passes through groove No. 11 of the bottom roll—not merely enough to secure a flow of metal at this point equal to that in the rest of the rail, but enough more than this to overcome the greater friction of this deep groove through which the flange is passing. In other words, the friction being relatively greater at this point, that part of the rail is treated for this one pass, where greater nicety of delivery is required than in any of the other passes, as distinctly separate from the rest of the rail. As the friction varies with the temperature of the rail, and this temperature itself, in practice, is to a certain extent variable, the draft is made such that it will equal or slightly exceed the greatest friction. Were the parting-lines central at this final pass, the tendency of this construction would be to twist or throw the rail up. This tendency, however, is counteracted by throwing up the parting-lines. The rail is thus virtually gripped at its point of contact with the parting-line of the rolls, while the flange is thrown up (considered as being acted upon by the rolls separately from said rolls' action upon the rest of the rail) toward the rest of the rail. Thus is the flange freed from the excessive friction of the deep tongue in the bottom roll, while at the same time the rail, as a whole, is delivered straight and true. It is quite obvious that this location of their parting-lines at the final pass cannot at all interfere with the differences in diameter of the rolls in the passes elsewhere situated. With regard to the locations of the other parting-lines in the finishing-rolls, and the effect of said locations upon the delivery of the metal from the other passes in said rolls, it can only be necessary, after the very full explanations already made of the dimensions of parts and of the effect of location of parting-lines generally, to call attention to the several templets of said passes, whereon the several parting-lines at the respective passes are indicated by the letter *x*. By referring to said templets and to the general view, Fig. 2, (the templets illustrated being accurate drawings of the metal templets carefully taken from rolls in actual use in which many tons of rails have been successfully rolled,) those skilled in the art can better comprehend how to construct and proportion the grooves and to locate said parting-lines for either larger or smaller rolls or heavier rails than by any further verbal description. It will be sufficient, therefore, to state that after much practical and costly experiment, as well as study, the rolls in question were produced, and that by the co-action in the finishing-rolls of the parting-lines described with the differential diameters of one and the same groove, as well as with the difference in mean diameters, or diameters measured at their respective pitch-lines of two opposite grooves, the draft in the series of grooves is so modified or regulated as to effect a straight delivery of metal from the passes without tearing it or overstraining its powers of cohesion.

While the broad principles underlying this invention are not claimed to be new *per se*, yet said principles have been applied in so novel a manner therein as to produce effects not so produced in prior inventions. As facts in rolling-mill practice, it is of importance to consider that turning a bar in the finishing-rolls, unlike turning a bar in the roughing-rolls, involves, owing to greater length and flexibility of the bar, special preparation and additional labor and delay, all of which is costly, and the saving of which time and outlay it is desirable to accomplish. In this invention throughout the whole finishing operation there is no turning from edge-rolling to flat-rolling, or vice versa; and it may be further observed that the parting-lines in the edging-passes do not, as is usually the case, follow the conveniences of construction after the determination of other conditions, by which means such locations exercise no positive but only a neutral influence; but in this invention the other conditions of construction coact positively with the locations of the parting-lines, and thus is secured a straight delivery of metal. The respective locations of the parting-lines, however, are only claimed relatively to the grooves respectively contiguous to said lines, as heretofore described, and illustrated in the drawings.

It may sometimes be the case that the blooms to be rolled are too large to enter pass No. 1. In such case the bloom can be sufficiently reduced in size in another groove or grooves prior to its entry into pass No. 1. It may also happen that a rail may be required having its bottom flanges reduced in width or upset into a foot, or entirely obliterated to suit special methods of fastening the rail in track, as into some form of chair or otherwise. In such case the rolls can be modified without departing from the principles of construction embodied in this invention. We do not therefore limit ourselves to the precise or identical

forms of templets shown, to the exclusion of every possible modification.

We are aware that rails have been heretofore shaped by both flat-rolling and edge-rolling; but we are not aware that a rail has heretofore been produced by rolls having three dummies or flattening-passes and three edge-rolling passes alternately placed and so delivering the billet as to avoid its subsequent turning.

We are aware, also, that mere difference in diameters of rolls is not new *per se*, and such construction, *per se*, we do not claim. Nor do we claim, as an article of manufacture, a rail having the cross-section indicated by templet No. 11, known in the art and to the trade as the "Johnson rail;" but

As of our invention, we claim—

1. A set of forming or roughing rolls for rolling billets or ingots into bars for flanged girder-rails, provided with three edging-passes and three flattening-passes or dummies of the respective forms described, whereby the billet is transformed into the desired form of bar, with the flange of the proposed rail thrown below its head, ready for the finishing-rolls, so that all necessity of flat-rolling in the finishing operation is avoided, substantially as set forth.

2. A set of rolls for rolling flanged girder-rails, having flattening-passes of unequal draft laterally, in which passes the tendency of the metal being rolled to curve sidewise, due to said unequal draft, is obviated by tongues in the upper grooves of said passes and straight delivery thereby secured, substantially as set forth.

3. A set of rolls for rolling flanged girder-rails, provided with a flattening-pass of unequal draft laterally, in which straight delivery is secured by a tongue in the upper groove of said pass, and also with an edging-pass, in which straight delivery is secured by means of the rolls' difference in diameter in said edging-pass, substantially as set forth.

4. A set of finishing-rolls for edge-rolling flanged girder-rails, (without flat-rolling the same,) having parting-lines located at their respective passes, as described and shown, and a series of grooves of differential diameter each, whereby the draft in said passes is caused to vary at each of said diameters in inverse ratio to said diameters, so that the rail is delivered from said passes without tearing or overstraining its metal, substantially as set forth.

5. A set of finishing-rolls for edge-rolling iron or steel bars of irregular forms of cross-section into flanged girder-rails, (without flat-rolling the same,) said rolls having parting-lines located at their respective passes relatively to the difference in diameters of the several grooves in said passes, as described and shown, by means of which locations and differences in diameter a long and deep flange of rail can be passed out of the bottom grooves, free from the bottom roll, substantially as set forth.

6. A set of finishing-rolls for rolling iron or steel bars of irregular forms of cross-section into flanged girder-rails, said rolls having equal diameters in their last pass, and their parting-lines at said pass located as described and shown, whereby the finished rail is delivered straight or uncurved and free from tendency to curve toward either roll, thereby dispensing with the usual straightening operation after rolling, substantially as set forth.

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Witnesses:
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Correction in Letters Patent No. 292,759.

It is hereby certified that in Letters Patent No. 292,759, granted January 29, 1884, upon the application of Arthur J. Moxham and John R. Tranter, of Louisville, Kentucky, for an improvement in "Rolls for Rolling Car-Rails," an error appears in the printed specification requiring correction as follows: In line 7, page 1, the words "a symmetrical" should read *an asymmetrical;* and that the letters patent should be read with this correction therein to make it conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 26th day of February, A. D. 1884.

[SEAL.]

M. L. JOSLYN,
Acting Secretary of the Interior.

Countersigned:

R. G. DYRENFORTH,
Acting Commissioner of Patents.