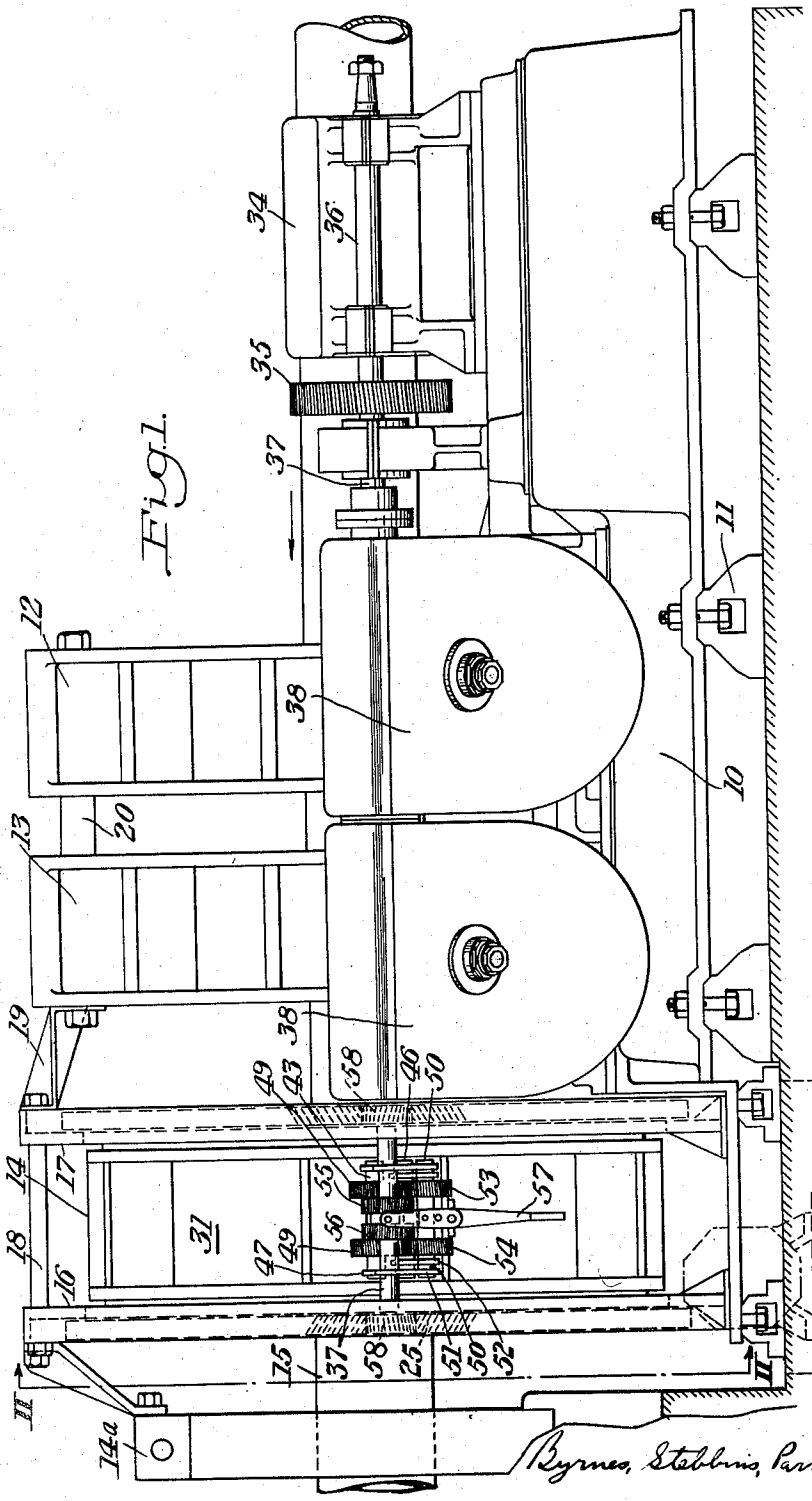
Feb. 16, 1937. J. L. ADAMS, JR 2,071,154

METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 1

Fig. 1.



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METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 2

Fig. 8.

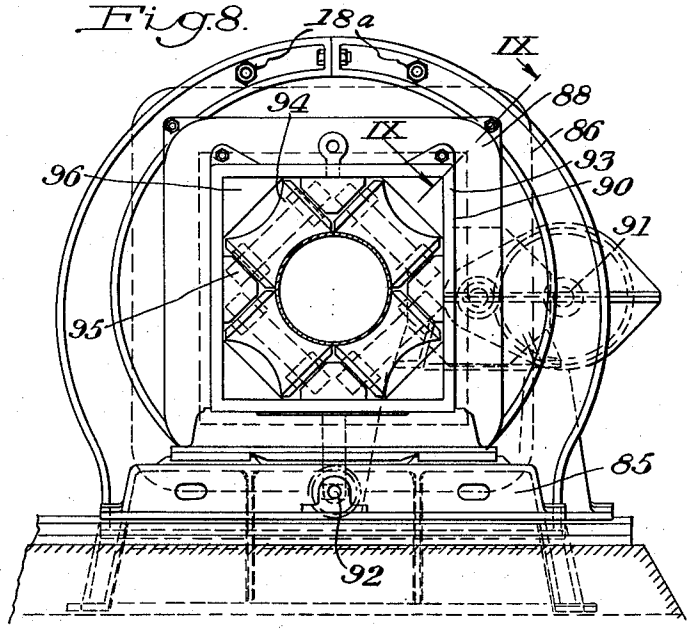
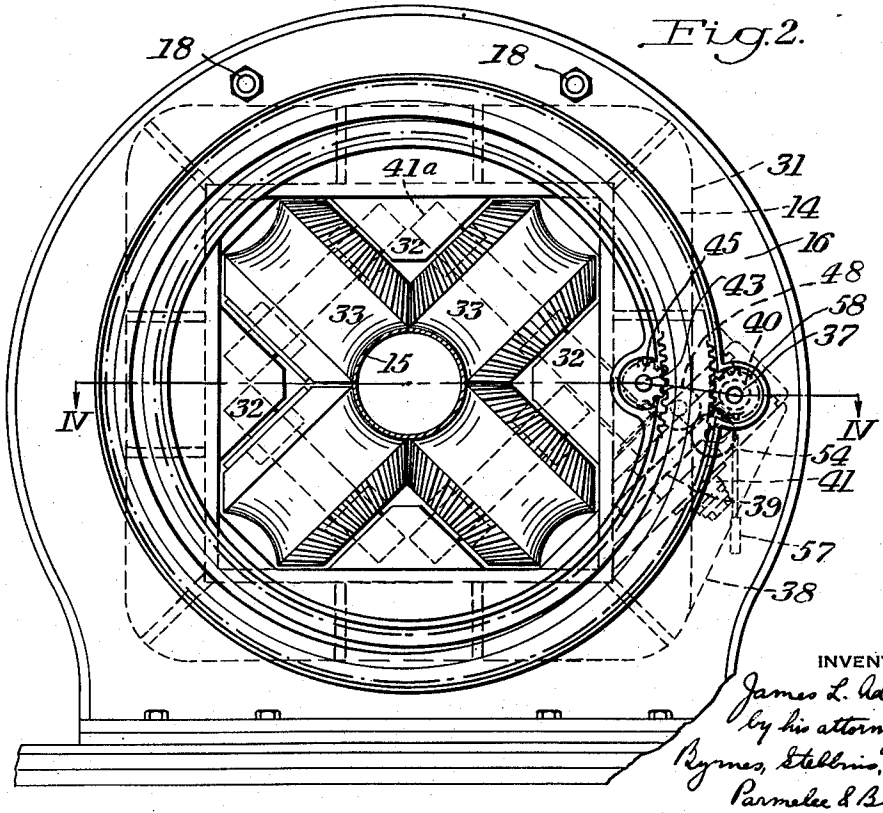


Fig. 2.



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METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 3

Fig. 6.

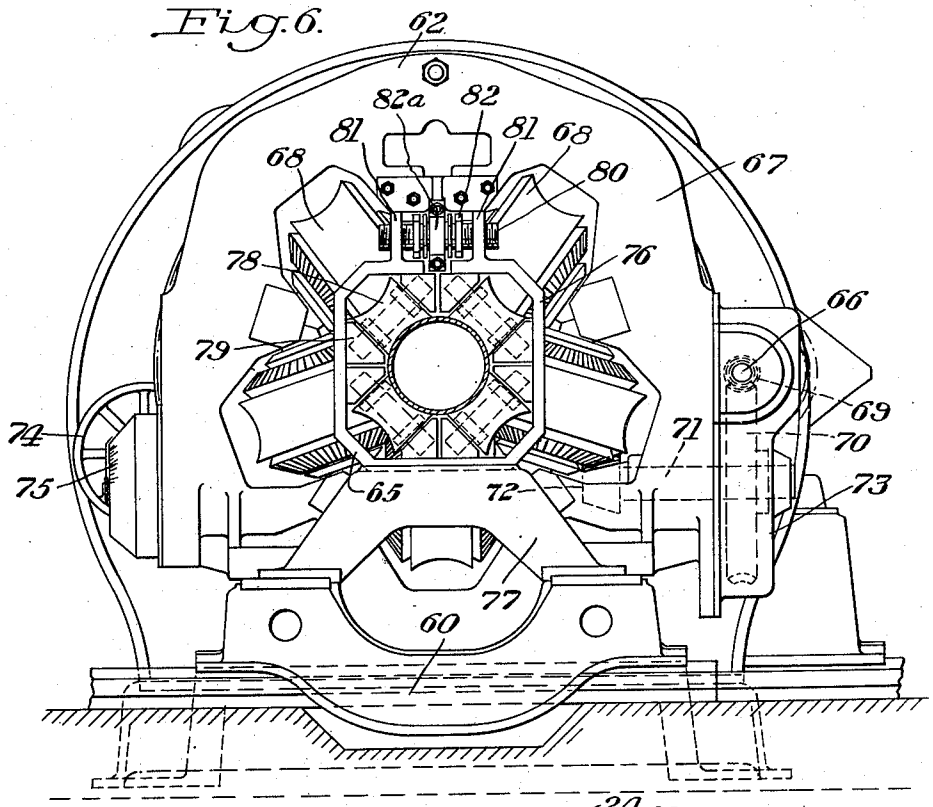
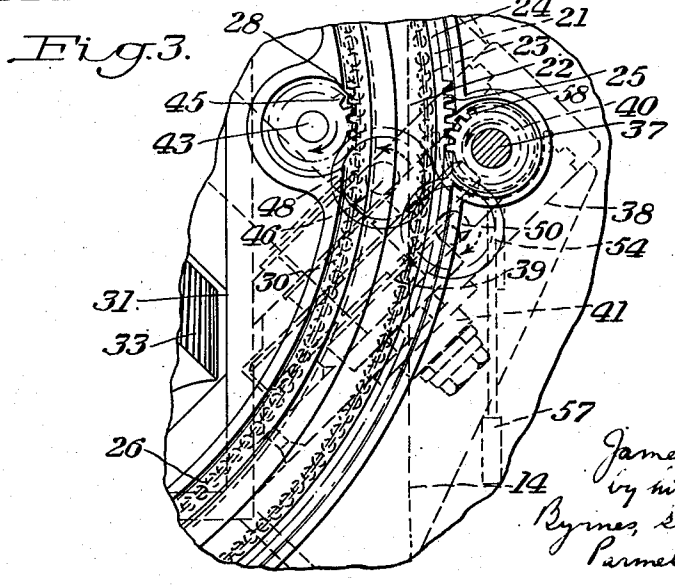


Fig. 3.



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METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 4

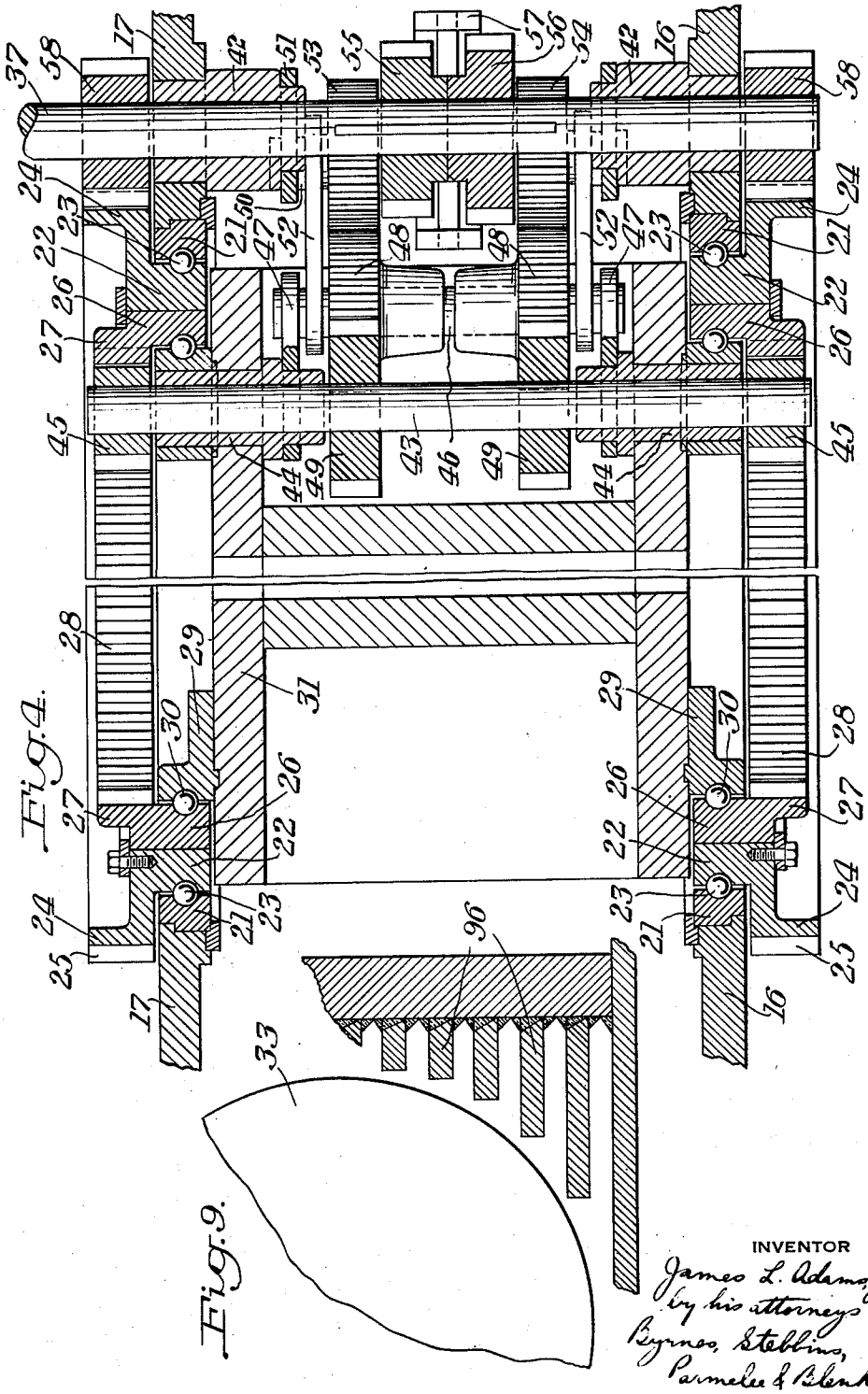


Fig. 4.

Fig. 9.

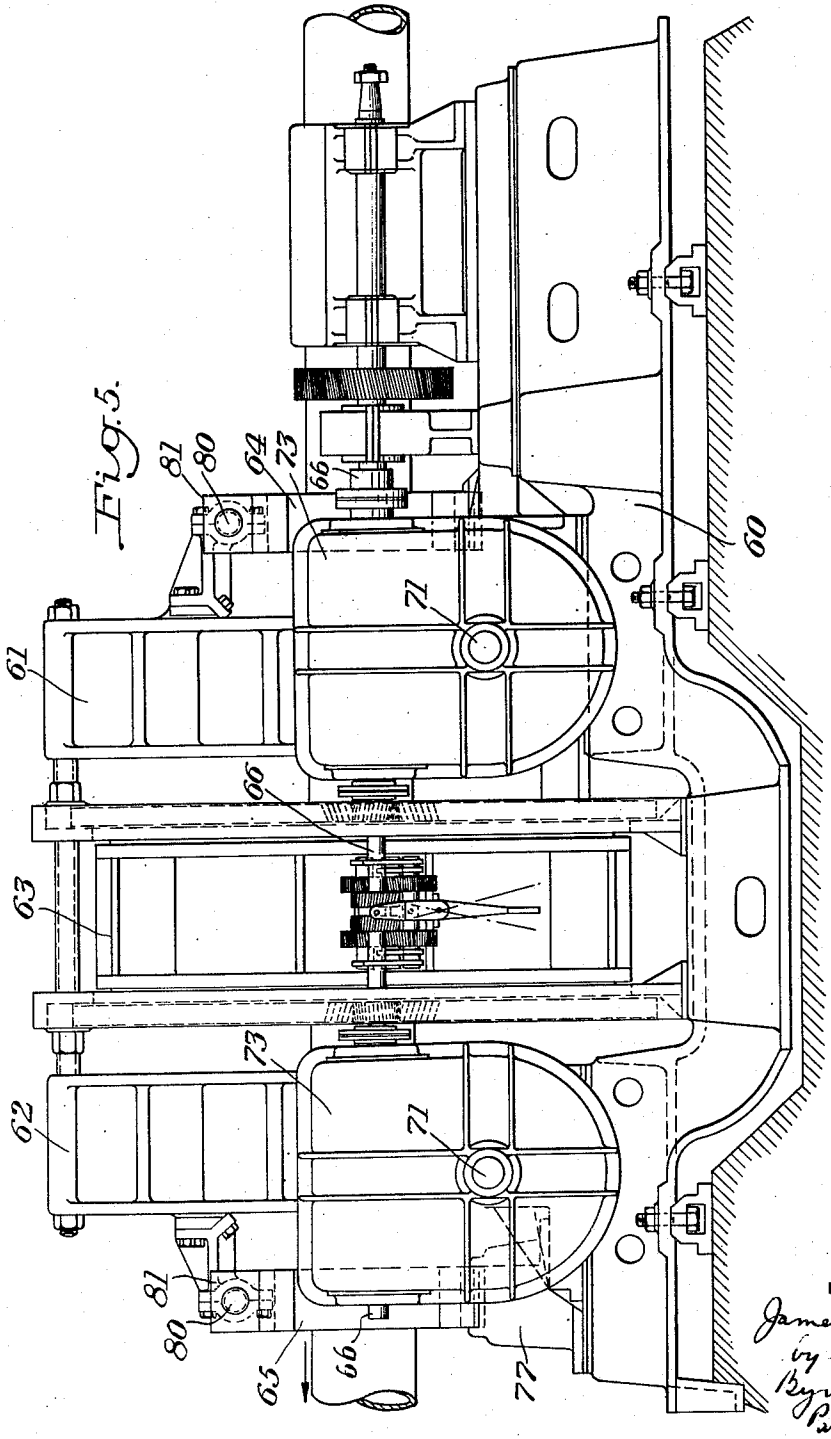
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METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 5

Fig. 5.



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METHOD OF AND APPARATUS FOR PIPE FINISHING

Filed July 20, 1933 6 Sheets-Sheet 6

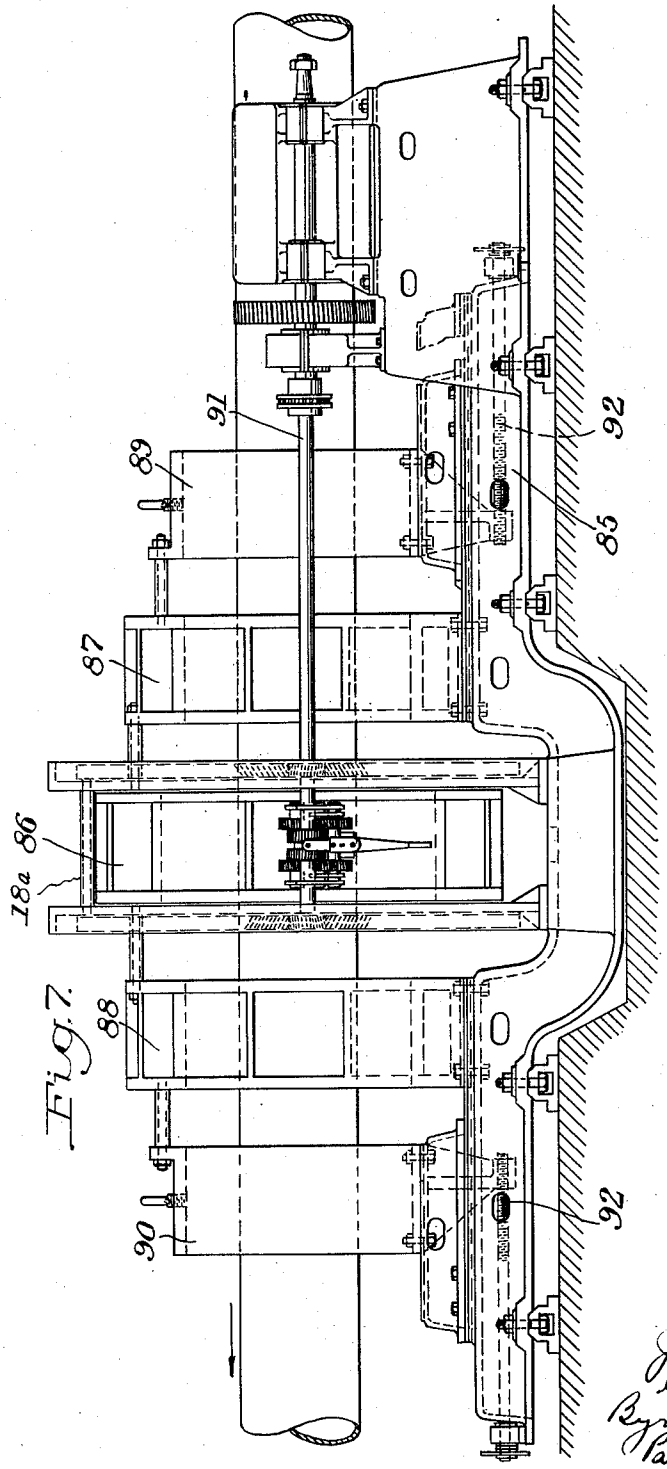


Fig. 7.

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Patented Feb. 16, 1937 2,071,154

UNITED STATES PATENT OFFICE

2,071,154

METHOD OF AND APPARATUS FOR PIPE FINISHING

James L. Adams, Jr., Youngstown, Ohio, assignor to The Youngstown Sheet & Tube Company, Youngstown, Ohio, a corporation of Ohio

Application July 20, 1933, Serial No. 681,391

18 Claims. (Cl. 153—54)

My invention relates to the finishing of metallic articles produced in long lengths and, in particular, to the sizing and straightening of pipe, although the invention is not limited to this particular application.

It is known in the art of making metallic articles of considerable length, such as pipe, that the product must be subjected to a finishing operation for the purpose of bringing it precisely to the desired finished size and to straighten it so that any bends or cambers introduced during the manufacture will not appear in the finished product. It has been the practice heretofore in the finishing of pipe, for example, to pass the pipe while hot through reeler rolls. Cold rolling through cross roll machines has also been employed, as well as a press, for the purpose of straightening bent pipe. Reeler rolls are objectionable because they mark the pipe and tend to impart an elliptical section thereto. Cross rolls are not entirely satisfactory because they cannot conveniently be made strong enough to handle heavy wall pipe cold, and the feed therethrough must be relatively slow, so that such machines have a low output tonnage per diem. Inaccurate straightening, especially near the ends of the pipe, results. The press is objectionable because it is slow, indefinite, and laborious, and is a cut and try method, often requiring two or three repeat operations at 90° to each other to get the requisite straightening, as actual trial has shown.

I have, however, invented a method and apparatus for precision straightening and sizing metal lengths, such as cold, heavy pipe, continuously, and at high speed. In accordance with my invention, I simultaneously crush to size and straighten the pipe. The compression is effected by suitable, heavy rolls and the straightening by accurately aligning the pipe in a plurality of roll stands simultaneously with and on each side of the crushing position.

In the straightening operation, I find it advantageous sometimes to rotate at least one of the roll stands bodily about the axis of the pipe in a plane perpendicular thereto. This rotation is unnecessary for low carbon steel tubes, however, and even for high carbon steels is preferably such as to only deflect a straight pipe to, but not beyond, its surface fiber elastic limit. Thus a pipe which is straight initially will not be bent, but a pipe which is initially cambered will be bent beyond its surface fiber elastic limit in the precise direction necessary to straighten it. This straightening operation is facilitated if the pipe is simultaneously being subjected to high compression or crushing to size. This follows from the fact that the crushing causes some considerable molecular flow which momentarily vastly increases the susceptibility of the product to straightening. The material takes a permanent set as it progressively passes the crushing zone and if rigidly held straight as it enters and leaves the crushing roll stand, the finished product is found to be free from all camber, as has been amply demonstrated by long continued, commercial tests.

In accordance with my invention, I provide a plurality of roll stands for simultaneously engaging a pipe. The number and arrangement of the roll stands may vary but it is preferable to employ at least four or five roll stands. The rolls should be driven preferably and should be adjustable for precision alignment and for pipe diameter. One stand of rolls may be made rotatable about the axis of the pipe being straightened, in order to be able to straighten high carbon steel tubes, and I mount such roll stand in a pair of slightly eccentric rings and provide means for driving the rings to rotate the roll stand. I also provide means for adjusting the throw of the eccentrics between zero and a certain maximum, whereby the degree of eccentricity may be accurately controlled.

For a complete understanding of the invention, reference is made to the accompanying drawings illustrating several possible embodiments of the invention. The method of my invention will be explained in the course of the description of the apparatus by which it is carried out. In the drawings:

Figure 1 is a side elevation of one form of the invention in which the rotatable stand has non-driven rolls;

Figure 2 is an end elevation of a similar, driven roll type, rotatable stand looking from the left as seen from the line II—II in Figure 1;

Figure 3 is a partial end elevation to enlarged scale;

Figure 4 is a sectional view partly broken away, with parts omitted for the sake of clearness, substantially along the line IV—IV of Figure 2;

Figure 5 is a view similar to Figure 1 showing a modified form of the invention;

Figure 6 is an end view thereof;

Figure 7 is a side elevation of a further modified form;

Figure 8 is an end view thereof; and

Figure 9 is a sectional view along the line IX—IX of Figure 8.

Referring now in detail to the drawings and, for the present, to Figures 1 through 4 particularly, pipe finishing apparatus in accordance with my invention includes a base 10 resting on cross rails 11. Sizing and straightening roll stands 12, 13, 14, and 14A are mounted on the base 10. The stands 12 and 13 are similar and the latter at least is provided with sizing rolls, while the stand 14 is provided with straightening rolls mounted either for rotation about the axis of the tube being straightened, which is indicated in Figure 1 at 15, or for stationary positioning in accurate alignment with tube axis. The roll stands 12 and 13 are made very stiff or rigid, but otherwise of more or less conventional design, and such description as they require will be given as an incident to the description of the other parts of the apparatus. Since the principal constructional novelty resides in the straightening stand 14, the detailed description thereof will be emphasized more particularly. The roll stand 14 comprises a pair of opposed, flanged plates 16 and 17 secured to the base 10 and tied together adjacent their upper ends by bolts 18. Spacers 19 and 20 tie the tops of the stands 12 and 13 together and to the top of the plate 17. The plates 16 and 17 are provided with circular windows in which bearing raceways 21 are seated. Rings 22 are rotatably seated by means of ball bearings 23 in the raceways 21. The rings 22 have outwardly extending flanges 24 which are provided with gear teeth 25.

The rings 22 have circular windows therein eccentric to the axes of the windows in the plates 16 and 17. Rings 26 are rotatably seated in the eccentric windows in the rings 22. The rings 26 have outwardly projecting flanges 27 which are internally toothed as at 28. Central rings 29 are rotatably seated in eccentric openings in the rings 26 on ball bearings 30.

A roll housing frame 31 is supported on the central rings 29. The frame is rectangular in outline, as shown in Figure 2, and is substantially U-shaped in section, as shown in Figure 4. The frame 31 has bearing blocks 32 (Fig. 2) disposed in the window thereof for providing bearings for the shafts of straightening rolls 33. The straightening rolls may be geared together by bevel teeth on the lateral faces thereof, and driven by means of the through shaft 41A, by any convenient propelling means, if so desired. In this case the eccentric adjustment would normally be placed on the opposite side of the apparatus, however, from that shown in Figs. 1, 2, and 5.

The crushing roll housings 12 and 13 are similar in general to the frame 31 of the housing 14 except that the housings 12 and 13 are stationary and not movable as is the housing 31, in a manner to be described later. The rolls of the stands 12 and 13 are driven while the rolls 33 of the stand 14 may be idler rolls, although they are preferably geared together for simultaneous rotation, and driven by shaft 41A, as noted.

The drive for the rolls of the stands 12 and 13, and 14, if desired, includes a motor 34 mounted on the base 10 disposed laterally of the path of travel of the pipe 15. A pinion on the motor shaft engages a gear 35 carried on a back shaft 36 on the motor. The shaft 36 is coupled to a shaft 37 extending alongside the roll stands, 12, 13 and 14. Gear housings 38 on the stands 12 and 13 enclose worm wheels 39 which mesh with worms 40 on the shaft 37. The worm wheels 39 are keyed to shafts 41 which drive one of the rolls 33 of the stands 12 and 13.

The shaft 37 also extends through bearings 42 (Fig. 4) on the frames 16 and 17 of the housing 14.

A shaft 43 journaled in bearings 44 (Fig. 4) extending from the frame 31 is provided with pinions 45 meshing with the internal teeth 28 on the flanges 27 of the rings 26.

A stationary auxiliary shaft 46 is suspended by links 47 from the outside of bearing bushing 44 carrying the shaft 43. Long hubbed pinions 48 running freely on the shaft 46 mesh with pinions 49 on the shaft 43.

A secondary stationary auxiliary shaft 50 is similarly supported by links 51 from the bearing bushing 42 carrying shaft 37. Links 52 connect the shafts 46 and 50. In actual practice links 47 and 52 may be united in one, as shafts 43, 46, and 50 are in a straight line anyway. This link system also prevents any continued rotation of stand 14 as a whole, about the pipe as an axis. Pinions 53 and 54 on the shaft 50 mesh with the pinions 48 on the shaft 46 and are adapted to be engaged by pinions 55 and 56, respectively, which are keyed to the shaft 37. A gear-shifting lever 57 permits either of the pinions 55 and 56 to be moved into engagement with its cooperating pinion, the two shifting pinions 55 and 56 being attached together by any convenient means, so as to slide as one unit. It will be apparent that the linkages 47, 51 and 52 with the pinions thereon, provide a flexible geared connection between the shaft 37 and the shaft 43. In other words, a moderate transverse movement of the shaft 43 relative to the shaft 37, will not interfere with the gear connections therebetween.

Pinions 58 on the shaft 37 mesh with the external gear teeth 25 on the flanges 24 of the rings 22.

It will be observed that the pinion 55 is slightly smaller in diameter than the pinion 56 so as to give about one less tooth. Pinions 53 and 54 are reversely dimensioned. The size of the meshing pinions is such that when the gear shift lever 57 is thrown to the left to cause the pinion 55 to mesh with the pinion 53, the shaft 37 will drive the rings 26 at a speed very slightly different from that at which the rings 24 are driven. The shaft 37, of course drives the rings 24 directly through the pinions 58. It also drives the rings 26 indirectly through the pinions 55, 53, 48, 49, and 45.

Rotation of the rings 22 and 26 at very slightly different speeds for a few seconds only, will cause a change in the eccentricity of the central rings 29 relative to the windows in the plates 16 and 17. When the desired degree of eccentricity has been attained, as may be determined by suitable index markings, the adjustment is terminated by restoring the shift lever 57 to central position. As already explained, it is one object of the invention to provide a roll stand, the rolls of which may, if desired, be made to rotate or gyrate circularly about the axis of the pipe being straightened. By the operation just described, the frame 31 of the roll stand 14 can be adjusted to the desired degree of eccentricity with respect to the axis of the pipe 15. Once properly adjusted, the frame 31 may now be rotated continuously through a path determined by the eccentricity of

the central rings 29 relative to the windows in the plates 16 and 17, by shifting the lever 57 to the right so that the pinion 56 will mesh with the pinion 54. The dimensions of the pinion 56 and its cooperating pinions are such that the rings 22 and 26 will be driven at the same speed. There is thus no further variation in the eccentricity of the central rings 29 as a result of this rotation, but the whole frame 31 of the roll stand gyrates slowly and circularly about the axis of the pipe being straightened, or with a suitable compensatory adjustment of the rings 22 and 26, the eccentricity can be cancelled out completely, if desired, as in the case of low carbon steel pipes, where the gyration is found to be unnecessary.

In using the apparatus described above to practice the method of my invention, I adjust the eccentricity of the rings 22 and 26 to the desired low value and then advance the pipe to be straightened through the crushing stands 12 and 13, the straightening stand 14 and the final guiding stand 14A. The rolls of the crushing stands reduce the pipe to the required cross sectional dimensions and shape, and at the same time hold the pipe firmly. The straightening stand 31 gyrating and continuously effects a straightening of the pipe by effecting a progressive permanent set in the metal thereof while the latter is in a condition of molecular flow facilitated by the crushing rolls.

Figures 5 and 6 illustrate a modified form of the invention which is actually the preferred form. In this form, the apparatus comprises a base 60, stationary crushing stands 61 and 62 and a gyrating straightening stand 63. In addition, I provide secondary straightening or guiding stands 64 and 65. The drive for the stands 61 and 62 and for the oscillation of the stands 63 is effected through a shaft 66 similar to the shaft 37 of the modification already described. Corresponding elements are indicated by the same reference numerals. The construction of the stand 63 is substantially identical with that of the stand 14 of Figure 1.

Each of the crushing stands 61 and 62 of Figure 5 comprises a housing 67 (Fig. 6) having crushing rolls 68 journaled therein. Lateral faces of these rolls have meshing gear teeth formed thereon and the drive therefor extends from the shaft 66 through a worm 69 thereon, a worm wheel 70, a shaft 71 and a bevel pinion 72. The worm wheels 70 are enclosed in housings 73. The size of the roll pass may be adjusted by means of a hand wheel 74 in accordance with the invention disclosed in my co-pending application Serial No. 453,888, filed May 20, 1930, for Welding apparatus and method of welding, the adjustment of the rolls being always indicated by a dial and pointer 75.

The construction of the stands 64 and 65 of Figure 5 is also further shown in Figure 6. A rectangular frame 76 which is preferably split on its top side, is mounted on a base 77 and is provided with rolls 78 journaled in bearing blocks 79 carried by the frame. An adjusting screw 80 having its ends oppositely threaded engages lugs 81 extending upwardly from the split top of the frame. The frame may be sprung to a limited degree by turning the screw and a corresponding adjustment of the roll pass effected. Lock nuts 82 hold the screw in adjusted position, while the thrust block 82A centers said screw on the housing 67.

The function of the secondary guiding and straightening stands 64 and 65 is principally very accurately to centre and guide the pipe to be straightened into the pass of the crushing and straightening stands and accurately to centre and support the pipe as it emerges therefrom. The structure shown in Figures 5 and 6 permits a more accurate straightening than the one first described because the pipe is rigidly supported accurately over a greater length, on each side of the crushing position.

Figures 7 and 8 illustrate a further modification of the invention which is similar in general to that shown in Figures 5 and 6 but differs therefrom in some details. As shown in Figures 7 and 8, a base 85 is provided with a straightening stand 86 similar to those shown at 63 and 14, crushing stands 87 and 88 on opposite sides thereof, and guide stands 89 and 90. The oscillatable straightening stand 86 is driven through a shaft 91. No drive for the rolls of the crushing stands 87, 88, or the guide stands 89, 90, is shown although such would always be provided as the preferred construction. The crushing stands 87 and 88 are fixed to the base 85. The guide stands 89 and 90 are adjustable therealong by adjusting screws 92. This permits the spacing of the guide stands to be varied so that the length of the pipe over which it is rigidly gripped and positioned by the stands may be varied.

The construction of the crushing and guide roll stands 88 and 90 will be understood from Figure 8. These stands are somewhat alike, differing principally in size and strength. The stand 90 comprises a rectangular frame 93 with rolls 94 journaled therein in bearing blocks 95. The corners of the frame 93 are reinforced by a plurality of gusset plates 96 welded therein, the plates being of graduated width to provide clearance for the rolls.

The crushing stand 88 is quite similar in detail to the guiding stand 90 and further showing and description thereof are believed to be unnecessary. Possible means for roll adjustment have already been described. The general principle of operation of my invention is as follows: If a long 20" pipe, for example, be firmly fixed in a concrete block at one end, so that it is immovable, and a moderate transverse stress applied to the other end, the pipe may be flexed slightly by the latter stress, but it will not be permanently bent thereby.

If, however, some hydraulic or other means be now provided to crush the tube to a very slightly smaller diameter near its point of support, while the above side stress is still maintained, then it will be found on removal of the crushing force, that the above very small side stress has produced a permanent set in the tube in its own direction. And if this crushing operation be made progressive along the pipe, and the small side stress be produced progressively in all transverse directions, as by a weaving motion around the centre of the pipe to a very slight extent, then the pipe will come through straight, as well as precisely sized and circularized at the same time. No previous method of operation has accomplished these three desirable ends at the same time, to the same extent as is readily accomplished by the apparatus of my invention, or to anything like the same speed.

In the case of low-carbon steel tubes, simply holding the tube straight for a sufficient distance, as it passes through several tandem situated accurate guide stands of sufficient rigidity of structure, introduces sufficient side stresses due to this

forced holding straight thereof, to give the desired straight set to the progressively crushed tube, without any weaving or gyration of the straightening stand, as has been amply proved by several months of commercial operation of a large straightening unit.

It will be apparent from the foregoing description that the invention provides a highly desirable method and apparatus for straightening and sizing or finishing pipe at high speed. The apparatus employed is comparatively simple and may easily be constructed to provide the required strength and rigidity, the latter being an important element in pipe straightening operations. It will be obvious that known devices will be used for supplying pipe to the apparatus and receiving it therefrom. Instead of driving the crushing rolls, external means might be employed for advancing the pipe through the straightening apparatus. The opposed eccentric rings permit the degree of eccentricity of the straightening roll stand to be accurately determined and maintained, when such eccentricity is required. For this purpose, a suitable pointer and index scale on the two rings, respectively, will be of assistance.

The principal advantages of the invention are that it permits pipe to be finished with precision at high speeds, giving accurate circularity, perimeter, and straightness from end to end, and it leaves the pipe with a perfectly smooth exterior. These advantages do not characterize the methods and apparatus of the prior art recited at the beginning of this specification. The straightening is very much better than that produced by a hydraulic press, when operating on say 50 feet lengths of 24" or 26" heavy-wall pipe, for example, and the speed about ten times that of the latter. Other advantages are found in the ease with which the apparatus may be maintained and the rolls re-ground to compensate for the inevitable wear. The apparatus is less costly than those of the prior art and its energy requirements are also much less. It is particularly applicable to tubes.

Although I have illustrated and described herein but a few modifications of the invention, it will be apparent that many changes therein may be made without departing from the spirit thereof or the scope of the appended claims.

I claim:

1. In a method of straightening a pipe, the steps including exerting a crushing transverse pressure on a short portion of the length thereof progressively, and simultaneously causing gyration of an adjacent portion of the pipe about its own axis.

2. In a continuous pipe finishing machine, a shaping roll stand effective to exert a crushing action on a short portion of the length of the pipe progressively and to cause flow of the metal in such portion, and cooperating means for simultaneously straightening the pipe progressively as it passes said stand, said means including other roll stands, said shaping stand being mounted for gyration in a circular path about the pipe axis.

3. Progressive pipe finishing apparatus comprising three alined roll stands operative in tandem, each stand including a plurality of rolls journaled substantially in a common plane transverse to the pipe axis, the rolls of said stands providing working passes of substantially the same contour, the pass of the middle stand being adjusted to a smaller diameter than that of the stand initially engaging the pipe and effective to crush the pipe beyond its elastic limit progressively, and means for causing gyration of at least one roll stand.

4. The apparatus defined by claim 3 characterized by means for adjusting the radius of gyration of said intermediate roll stand.

5. In a straightening roll stand, a supporting frame, a ring thereon having an eccentric opening, a disc rotatably seated in the opening, a roll housing supported on said disc, means for driving said ring and disc temporarily at slightly different speeds for adjusting the eccentricity of said housing, and means for driving the ring and disc at the same speed to cause gyration of the housing about a fixed axis.

6. In a straightening apparatus, a supporting frame, rings journaled therein having gear teeth formed thereon, eccentric openings in the rings, discs rotatably seated in said openings, a roll housing supported on the discs, means for driving said rings and discs at the same speeds for causing gyration of the roll housing, or at different speeds for adjusting the eccentricity of its gyration.

7. In a method of straightening a hollow, tubular article, the steps including moving the article axially, gripping the article at a plurality of spaced alined points along its length, and throughout substantially its entire periphery at said points, maintaining the portions of the article at said points in alinement, and progressively crushing the article from end to end, without substantially elongating it.

8. Apparatus for straightening metal lengths, comprising entering and exit guide roll stands, fixed sizing and shaping roll stands therebetween, and a straightening roll stand between the sizing and shaping roll stands, the straightening roll stand including a frame member, a ring having an eccentric opening rotatable in said member, and a disc rotatable in said ring, a roll housing supported on said disc, and means for rotating the ring to cause gyration of said housing about the axis of the other roll stands.

9. In a method of straightening pipe, the steps including passing it axially through a crushing zone, exerting transverse crushing pressure radially of the pipe in said zone progressively along the pipe length without materially elongating the pipe, and simultaneously maintaining an adjacent portion of the pipe in accurate axial alignment with the portion subject to crushing pressure.

10. In a method of finishing pipe, the steps including continuously passing it axially through a crushing zone, applying crushing force radially of the pipe in said zone and progressively along the pipe length without materially elongating the pipe, and maintaining an adjacent portion of the pipe in precision alignment.

11. In a straightening roll stand, a frame, a window therein, a member rotatably disposed on said frame in overlying relation to said window, said member having an eccentric opening therein, a roll housing carried on said member in line with said opening, and means for rotating the member to effect gyration of the housing.

12. In a method of straightening, sizing, and circularizing an elongated hollow tubular article, the steps comprising continuously moving the article axially, progressively gripping the article around substantially its entire periphery at a plurality of longitudinally spaced positions therealong, similarly gripping said article at another

plurality of spaced positions therealong, maintaining all these gripping positions in precision alignment, and exerting a crushing force around substantially the entire periphery of said article and progressively along the length thereof at a point intermediate the two sets of gripping positions above mentioned without substantially elongating the article.

13. In a method of finishing pipe, the steps including exerting a transverse crushing pressure progressively on a narrow zone of the pipe without materially elongating it, while causing relative axial movement between the pipe and said zone, and maintaining alignment of adjacent portions of said pipe.

14. The method defined by claim 13 characterized by maintaining in alignment with said zone, the portions of the pipe on both sides thereof.

15. The method defined by claim 13 characterized by maintaining alignment of a plurality of spaced portions of the pipe lying on the same side of said crushing zone.

16. In a method of straightening a hollow, tubular article, the steps including progressively advancing the article axially while gripping the article substantially around its periphery at a plurality of zones spaced longitudinally of said article, without exceeding the elastic limit, maintaining said zones in accurate alignment, and exerting a crushing pressure beyond the elastic limit substantially around the entire periphery of another zone of the article without materially elongating it.

17. The method defined by claim 16 characterized by imparting gyratory motion to said crushing zone.

18. A straightening roll stand comprising a stationary supporting frame having a window opening therein, a ring rotatably positioned in said opening and supported by said frame, the interior edge of said ring being eccentric to the exterior edge, a roll housing mounted within and supported by said ring, and means for rotating said ring to cause gyration of said housing.

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