Oct. 31, 1933. G. B. COE 1,933,314

METHOD OF AND APPARATUS FOR WORKING METAL

Filed Dec. 2, 1929 4 Sheets-Sheet 1

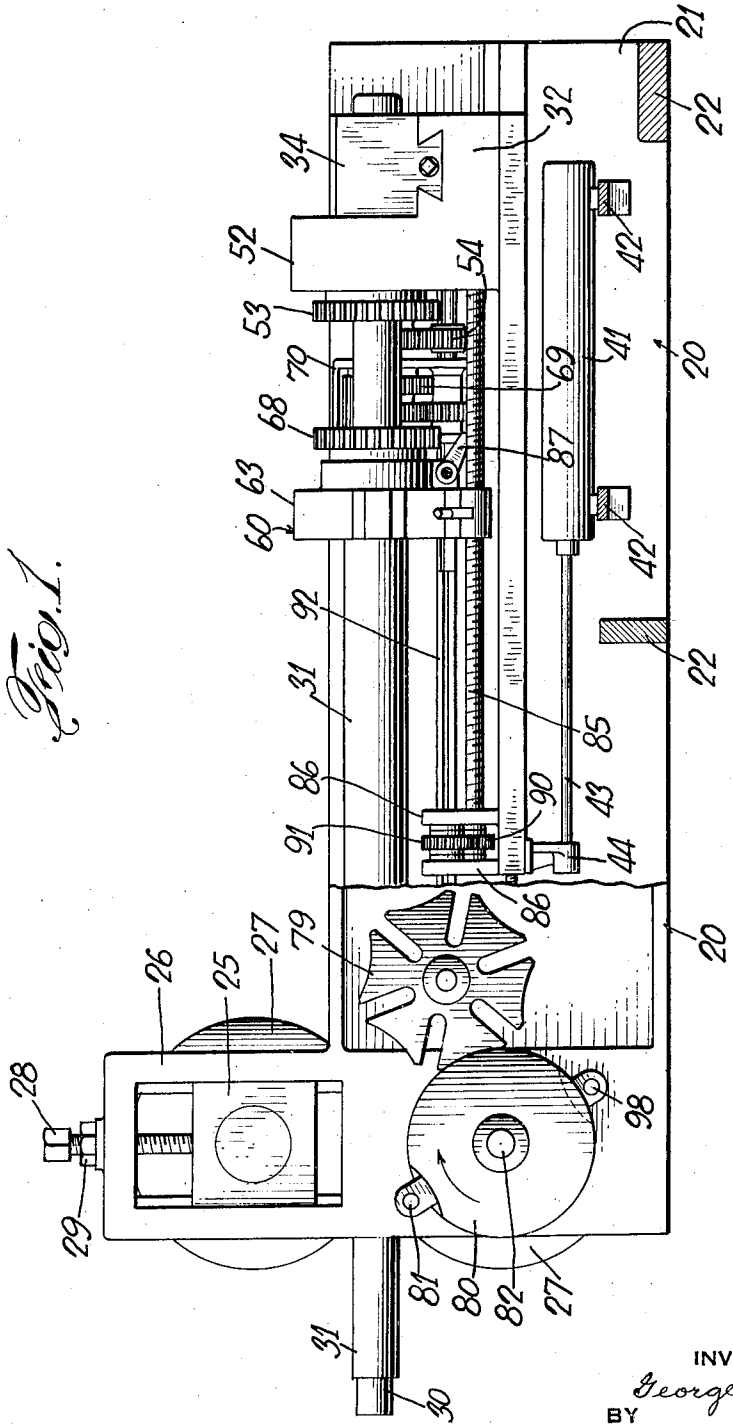


Fig. 1.

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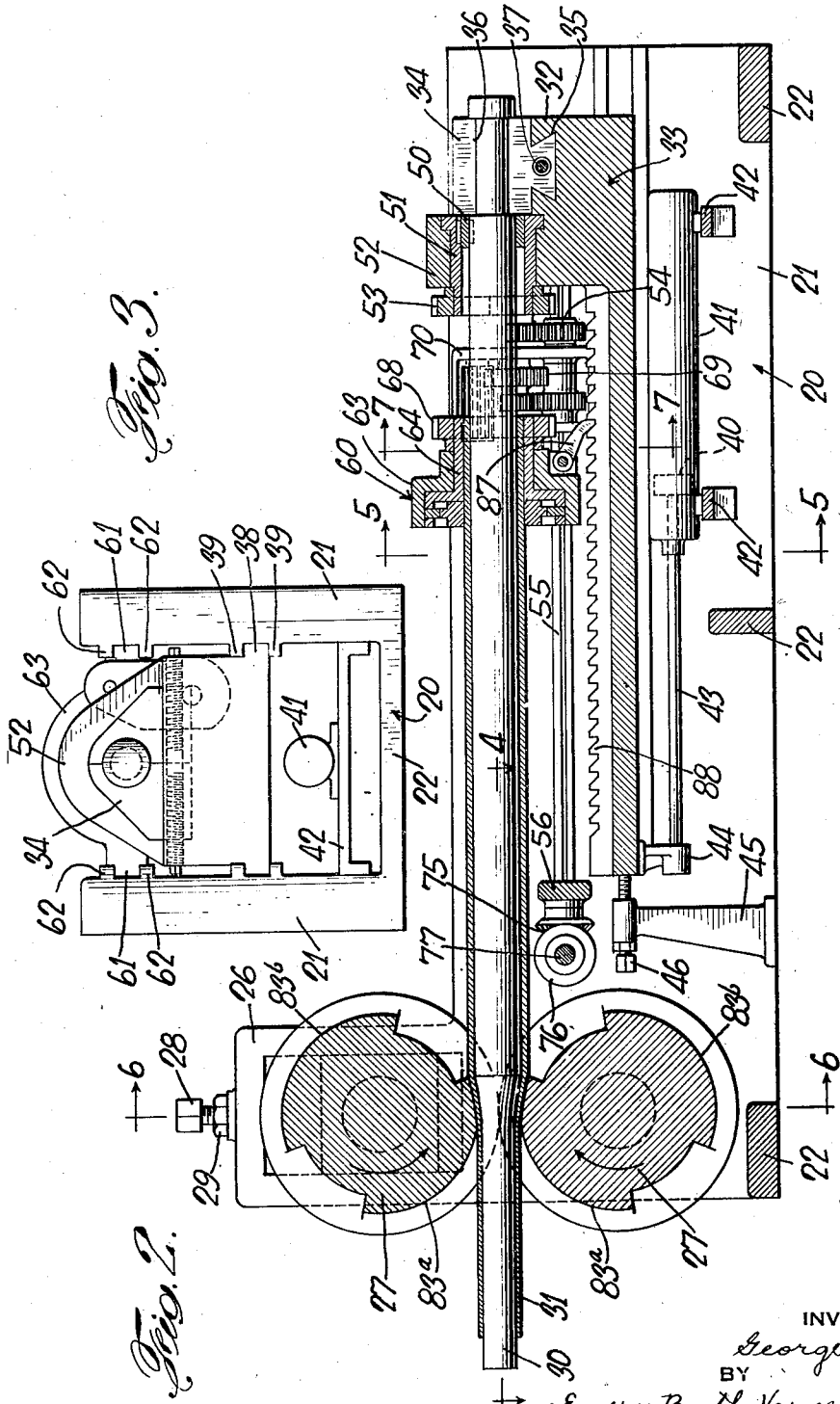


Fig. 3.

Fig. 2.

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Fig. 4.

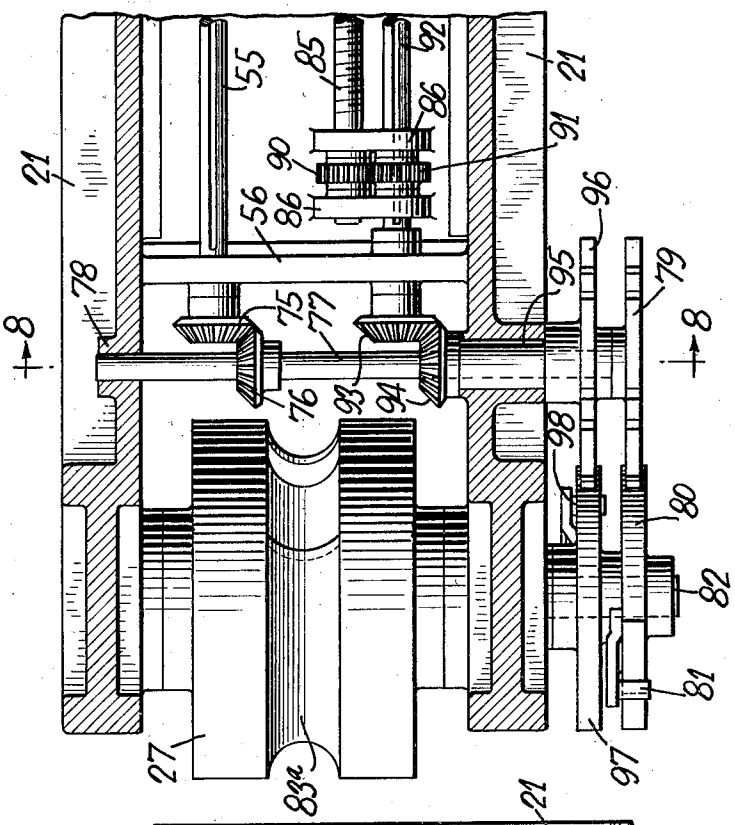
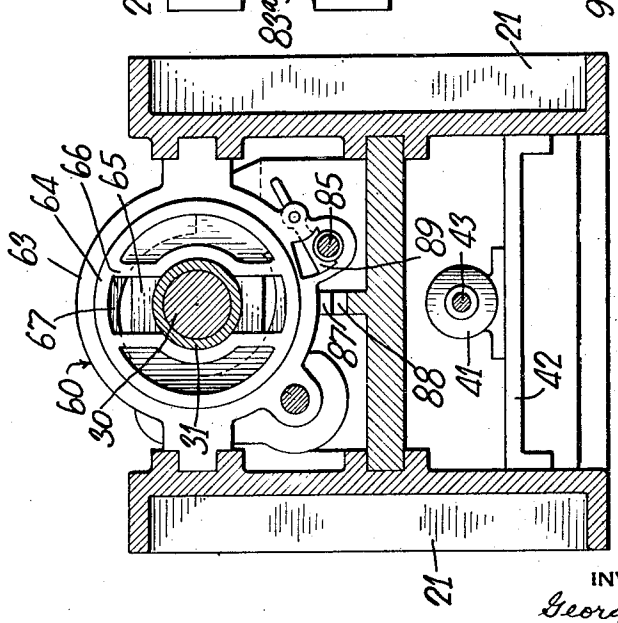


Fig. 5.



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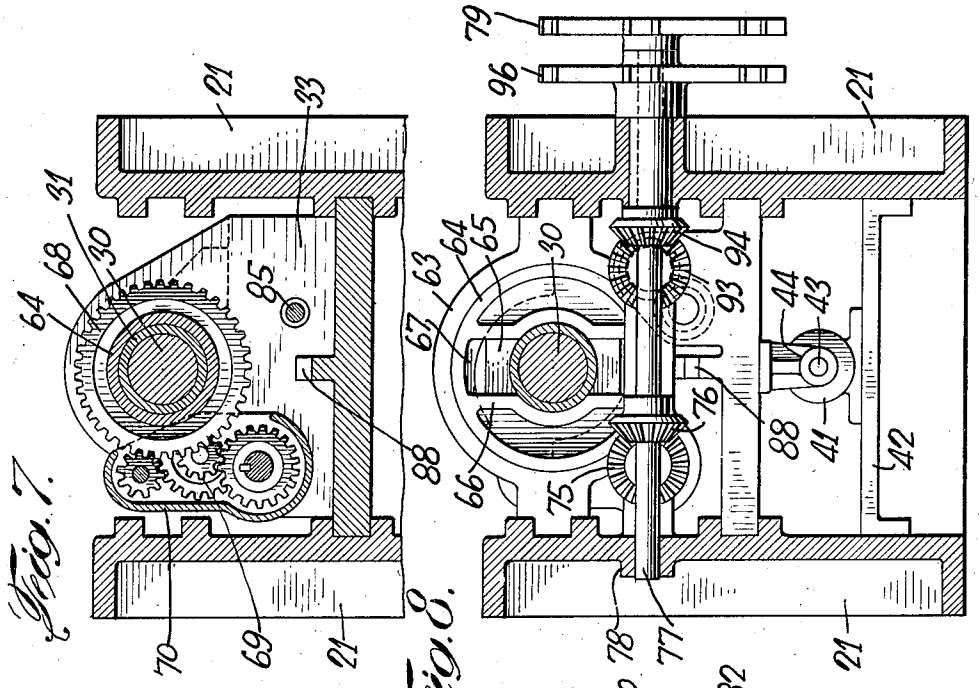


Fig. 7.

Fig. 8.

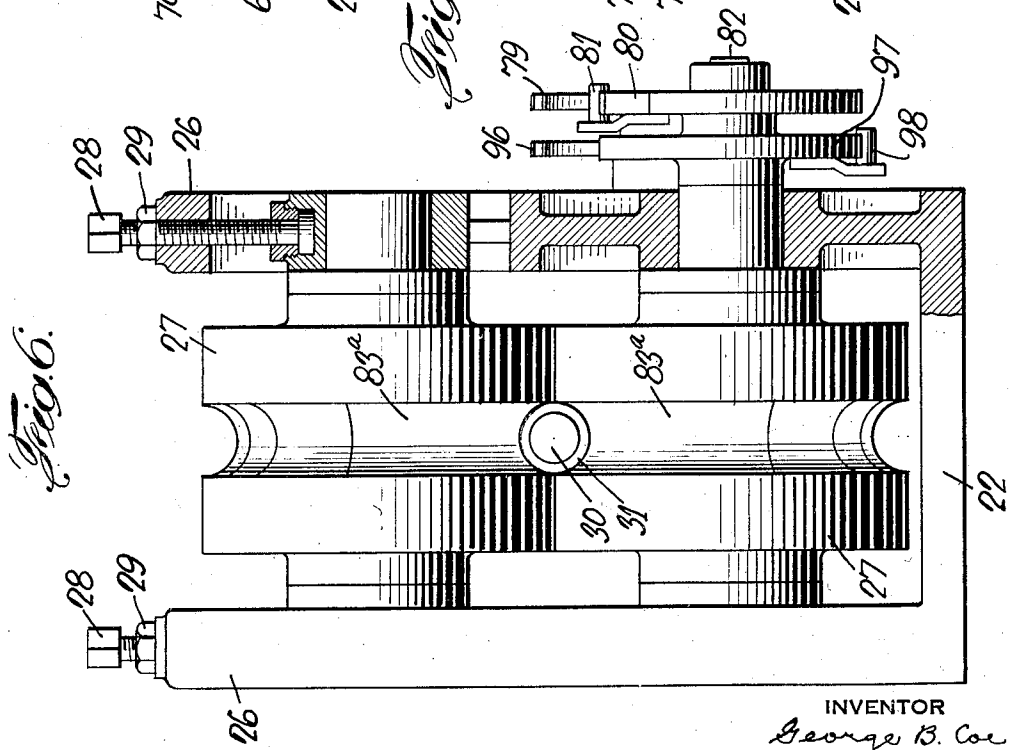


Fig. 6.

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UNITED STATES PATENT OFFICE

1,933,314

METHOD OF AND APPARATUS FOR WORKING METAL

George B. Coe, Waterbury, Conn., assignor, by mesne assignments, to Tube Reducing Corporation, Wilmington, Del., a corporation of Delaware

pplication December 2, 1929. Serial No. 410,954

26 Claims. (Cl. 80—14)

The present invention relates to method of and apparatus for working metal, whereby the cross-sectional area of the stock acted upon is reduced with an accompanying elongation of the stock; the object of the invention being to provide apparatus whereby the desired results may be accomplished in a practicable and efficient manner and without imposing excessive strain on the metal.

The invention may find its most general application to the reduction of tubular stock and, therefore, a preferred embodiment of the invention particularly adapted for the reduction of tubes has been selected for purposes of illustration and description herein. Further, since the invention relates principally to reducing apparatus employing segmental rolls which turn about fixed axes, and more particularly to apparatus employing rotary rolls, i. e. pilger mills, such apparatus has been chosen for illustration and description.

In apparatus of this general class it has been the practice to work metal hot and roughly shape it and later finish it by further processing it. According to the present invention the metal may be worked cold and in such a manner that frequent annealings are not necessary and deleterious strains are not set up in the metal. The metal may be worked to a finished smooth shape in one pass through the apparatus. Further, the invention provides apparatus which operates rapidly and economically, avoiding delay in introducing the stock and scrap loss in unworked ends incident to the operation of most prior apparatus.

Further objects of the invention and various features of novelty will be apparent from the following description of the illustrative embodiment shown in the accompanying drawings wherein:

Figure 1 is a side elevation of the apparatus with parts broken away;

Figure 2 is a central vertical section;

Figure 3 is a rear end elevation;

Figure 4 is a partial horizontal section on the line 4—4 of Figure 2;

Figure 5 is a vertical section on the line 5—5 of Figure 2;

Figure 6 is a vertical section on the line 6—6 of Figure 2;

Figure 7 is a vertical section on the line 7—7 of Figure 2; and

Figure 8 is a vertical section on the line 8—8 of Figure 4;

Upon reference to Figures 1, 2 and 3, it will be seen that the apparatus comprises a heavy metal main frame 20 including side plates 21 and cross members 22. Mounted in fixed bearings in the side plates and in adjustable bearings 25 guided in standards 26 are the reducing members, in the present instance embodied as rotary segmental rolls 27. Screws 28 set up on the rolls and are held in adjusted position by lock nuts 29.

A mandrel 30 supporting the tubular stock 31 between the rolls is held at its rear end rigid with the end wall 32 of a reciprocable carriage 33. Any suitable means may be employed for holding the mandrel but inasmuch as it is desirable to introduce stock to the machine over the rear end of the mandrel, the means employed will be such as to permit of this. Jaws 34 movable along ways 35 may be rapidly brought upon a notched portion 36 of the mandrel by a right-and-left-hand screw 37 accessible through either of the frame side plates 21.

The carriage is provided with flanged slides 38 supported upon longitudinal guides 39 on the frame side plates 21. The carriage is constantly urged toward the rolls 27 by a piston 40 operating in a constant pressure cylinder 41 supported upon frame cross bars 42, the piston rod 43 being connected to the carriage by a depending bracket 44 secured to the carriage. A fixed stop 45 provided with an adjustable stop pin 46 limits the travel of the carriage in its movement toward the rolls.

Means is also provided at the rear end of the carriage for rotating the mandrel for a purpose hereinafter to be made more apparent. As best shown in Figure 2 this means comprises a removable bushing 50 provided with integral keys fitting in keyways on the mandrel and on a sleeve 51 rotatably mounted in a standard 52 formed on the carriage. The sleeve carries a ring gear 53 which is driven by a train of gears 54 from a longitudinal gear shaft 55 rotatably and slidably mounted at its rear end in the rear end wall 32 of the carriage and at its front end (see Fig. 4) rotatably mounted in a bearing in a frame cross bar 56. The train of gears 54 will be carried in a suitable gear case secured to the carriage and the last one of the train of gears will be slidably splined to the gear shaft 55. The interior opening of the sleeve 51 of course is large enough to receive the largest size of tubular stock which may be introduced into the machine.

Means is provided for feeding the tubular stock in increments to the rolls. This means may also be used to rotate the stock independently of the means which rotates the mandrel but in unison

with the rotation of the mandrel. Referring to Figures 2 and 3, this means comprises a head 60 provided with slides 61 riding in guides 62 provided on the side plates 21.

Referring to Figures 2 and 5, the head 60 includes an annular portion 63 housing an annular sleeve 64 sufficiently large in interior diameter to receive the tubular stock. This sleeve is provided with jaws 65 for gripping the tubular stock, which jaws operate in radial guides 66 and are actuated by cams 67. Any suitable means may be provided for operating the cams 67, illustration being omitted for simplification of the drawings. The rear end of the sleeve 64 carries a ring gear 68 driven from the shaft 55 by a train of gears 69 identical in drive ratio with the train of gears 54 turning the mandrel, whereby the mandrel and tubular stock are invariably turned exactly together. The gear train 69 is carried in a gear casing 70 secured to the head 60.

The gear shaft 55, as shown in Figure 4, is provided with a bevel gear 75 driven by a bevel gear 76 secured upon a transverse shaft 77 mounted in a bearing 78 in one of the side plates 21 and in a hollow stub shaft 95 to be described presently. Beyond the end of the hollow stub shaft the transverse shaft is provided with a notched disc 79 composing part of a Geneva gear, the other portion of which including (Figures 1, 6 and 8) the pin disc 80 carrying pin 81 is mounted on the roll shaft 82.

With rolls like the ones here illustrated having two working sectors or pads 83*a*, 83*b* the gearing provided will cause the mandrel and tube thereon to turn approximately 90 degrees for each complete rotation of the rolls. By comparing Figures 1 and 2 it is found that the turning occurs just after the reducing pads 83*a* have completed their action on the tubular stock and before the other pads 83*b* engage the stock.

Means is also provided for feeding the stock to the rolls and this means alternates in its action with the stock turning means just described. That is, the feed occurs just after the pads 83*b* have completed their action on the stock and before the reducing pads 83*a* have engaged the stock.

This means for feeding the stock forward comprises (Figures 1 and 5) a feed shaft 85 threaded in the head 60, which shaft is supported in bearings in the end wall 32 of the carriage and in bearing brackets 86 provided on the front end of the carriage. The shaft 85 thus has no axial movement with respect to the carriage and will hold the head 60 in any position relative to the carriage to which it may be moved by the feed shaft.

However, since exceptionally heavy forces are exerted by the rolls tending to move the head rearwardly on the carriage there is provided on the head (Figure 2) a pawl 87 engaging the notches of a rack 88 secured to the carriage. Each time the feed shaft moves the head forward the pawl engages a new notch on the rack. When a length of tubular stock has been fed as far as possible to the rolls and a new length is to be inserted, the head is permitted to be moved back by raising the pawl from the rack and disengaging the threaded member 89 (Figure 5) on the head from the threads of the shaft 85.

The shaft 85 is provided with a gear 90 meshing with a gear 91 splined on a short shaft 92 rotatably and slidably mounted (Figure 4) in bearings in the brackets 86 on the carriage and in a bearing in the frame cross bar 56. On the end of shaft 92 there is fixed a bevel gear 93 meshing with a bevel gear 94 fast on a hollow shaft 95. The shaft 95 is provided with a notched disc 96 cooperating with the pin disc 97 carrying pin 98 which is carried by the roll shaft 82.

In operation the pads 83*a* of the rolls act on the tubular stock on the mandrel as the rolls turn in the direction of the arrows (Figure 2) to reduce the stock, the rolls acting upon an increment of length of stock which has just been fed to the rolls. The roll grooves may, if desired, be tapered for their full length but the grooves shown are merely tapered for a portion of their length and are concentric for the remainder of their length. The grooves of the reducing pads 83*a* are also stoned out on a bevel adjacent their meeting edges for the length of the tapered portions to prevent the formation of fins on the stock. Hence, instead of forming fins the rolls merely bring up rounded longitudinal ribs which are easily pressed down in the next operation, as will be observed.

During the action of the reducing pads 83*a* the stock, mandrel and carriage are moved rearwardly against the constant pressure in the return cylinder 41. As soon as the stock is released the turning mechanism is operated by the Geneva gear 79, 80, 81 to turn the stock and mandrel such amount as may be found desirable. In the present instance it will be taken as 90 degrees. At this time the stock is not fed forward on the mandrel but maintains its former position. Thereafter, and while the relieved portions of the rolls are above the stock, the constant pressure cylinder acts to return the stock to the rolls. The feed position is limited by the stop pin 46.

When the pads 83*b* of the rolls engage the stock they will act upon approximately the same longitudinal sector as the portions 83*a* acted upon, that is, in a sense they will "track" the reducing portion 83*a* but will act upon a different circumferential portion of the stock because of its having been turned. The elements of the stock which were situated at the meeting edges of the pads 83*a* will now come squarely in the bottom of the grooves of the pads 83*b* where maximum compressive force is exerted. Therefore, the slight longitudinal ribs which were formed by the meeting edges of the portions 83*a* will be smoothed out and the stock rounded up by the portions 83*b*. Here it is to be noted that the longitudinal contour of the portions 83*a* and 83*b* are substantially identical but the meeting edges of the grooves 83*b* are not beveled out as are those of 83*a*.

The reworking action of the portions 83*b* on a circumferentially turned portion of the stock also aids in loosening the stock from the mandrel if the stock is somewhat resilient in its nature as distinguished from a more plastic material. This loosening assists the slippage of the stock along the mandrel.

The slippage of the metal along the mandrel is assisted by working the metal down the taper of the mandrel (as shown in Figure 2) toward the front end thereof. This free flow of metal contributes to the better quality of the finished stock and to the economical operation of the machine.

After the roll pads 83*b* have completed their action and before the pads 83*a* again begin their action, the rotation of the rolls causes the Geneva gear 96, 97, 98 to feed the stock by an

increment of length to the rolls so that the pads 83a begin work at a point higher up on the stock than they did before.

This cycle of alternate feeding and turning with alternate reducing and smoothing continues until as much of the length of stock has been reduced as possible. Then the clamp jaws 65 are released, the threaded member 89 and pawl 87 lifted and the head 60 run back to its rear position on the carriage. The jaws 34 are opened, the bushing 50 removed and a new length of stock introduced over the rear end of the mandrel. The parts are returned to original positions and the operation resumed. The entire procedure of introducing a new length of stock, because of the nature of the machine parts, takes only a very brief time, thus affecting great economies in labor and operation.

In starting up operations the new length of tube is loose on the mandrel but engages the rear end of the preceding length so the incremental forward movement of the head 60 which grips the new length will feed the preceding length as before. Turning of the first tube is effected by the turning of the mandrel because at the time turning is required the tube is squeezed down upon the mandrel sufficiently tight to turn with it. The rolls pass without interruption in action from the old length to the new length.

The many advantages of the apparatus will be apparent to those skilled in the art from the above description, and while one illustrative embodiment has been particularly described, it is to be understood that various changes and modifications may be made within the scope of the invention as set forth in the subjoined claims.

What I claim is:

1. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel supporting said stock, an anchorage for said mandrel including a reciprocatory carriage, feed means constantly urging said carriage and mandrel to a given limited position toward said rolls, said rolls returning said mandrel and carriage against said feed means, and means for alternately feeding said stock by an increment down said mandrel and turning said stock on its axis after each return of the stock by the rolls.

2. Apparatus for reducing tubular stock comprising in combination, a set of segmental stock-reducing rolls turning about fixed axes, feed means constantly urging stock toward said rolls to a given limited position, said rolls acting to return said stock against said feed means, and means for feeding an increment of length of said stock to said rolls and for turning the stock in alternation with the feed thereof after each return of the stock by the rolls whereby after the turning of the stock the rolls act upon a different diameter of the stock but upon the same length as that on which they acted after the feed of the stock.

3. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel supporting said stock, means including said rolls for reciprocating said mandrel, means for feeding stock in successive increments along said mandrel and means including elements gripping the outer peripheral surface of said stock and parts periodically turning said gripping means for turning said stock about its axis.

4. Apparatus for reducing tubular stock comprising in combination, reducing means, a mandrel cooperating with said means for supporting the stock, and means including elements gripping the outer peripheral surface of the tubular stock and parts actuating said gripping elements for feeding the stock forward in successive increments, the gripping means continuously gripping the tube for a number of successive feeding operations.

5. Apparatus for reducing tubular stock comprising in combination, reducing means, a stock supporting mandrel cooperating with said means, and means including elements gripping the outer peripheral surface of the tubular stock and parts actuating said gripping elements for feeding the stock forward in successive increments, the gripping mechanism travelling forward with the stock by more than the length of the increments of feed.

6. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel, and means for feeding said stock along said mandrel and turning it about its axis, including a head, a shaft threaded in said head for feeding it forward, and a shaft splined to a gear mounted in said head for rotating the stock.

7. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel, means for feeding said stock along said mandrel and turning it about its axis, including a head, a shaft threaded in said head for feeding it forward, a shaft splined to a gear mounted in said head for rotating the stock, and means for actuating said shafts.

8. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel, means for feeding said stock along said mandrel and turning it about its axis, including a head, a shaft threaded in said head for feeding it forward, a shaft splined to a gear mounted in said head for rotating the stock, and means for actuating said shafts, including means periodically actuated by said segmental rolls.

9. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, a mandrel, means for feeding said stock along said mandrel and turning it about its axis, including a head, a shaft threaded in said head for feeding it forward, and a shaft splined to a gear mounted in said head for rotating the stock, and means for actuating said shafts including Geneva gears actuated by the shafts of the segmental rolls.

10. In apparatus for reducing tubular stock, in combination, pilger rolls, a mandrel, a carriage reciprocably supporting said mandrel, means on said carriage for holding and rotating said mandrel, a head slidable on said carriage, and means on said head for holding and rotating the tubular stock, said mandrel holding-and-rotating means and said stock holding-and-rotating means permitting stock to be introduced over the end of the mandrel and fed forward to said rolls.

11. In apparatus for reducing tubular stock, in combination, stock-reducing means including gapped rotatable rolls, a reciprocatory work-feed carriage, a mandrel mounted in said carriage and means for holding said mandrel, said means including releasable means engaging the mandrel for turning it and holding it longitudinally, said means permitting tubular stock to be introduced over the rear end of the mandrel and fed forward along the mandrel to said reducing means.

12. In apparatus for reducing tubular stock, in combination, pilger rolls, a mandrel, a carriage reciprocably supporting said mandrel, means on said carriage for holding said mandrel, a head slidable on said carriage, and means on said head for gripping tubular stock to feed it forward and to rotate it, said mandrel holding means and said stock gripping means permitting stock to be introduced over the end of the mandrel and fed forward to said rolls.

13. In apparatus for reducing tubular stock, in combination, reducing means acting about a fixed axis, and means for feeding the stock forward to said reducing means, including a travelling head having a bore larger than the tubular stock, and clamp jaws in said head for gripping said tubular stock, the head construction being such that stock may be passed freely through said head when said clamp jaws are open.

14. In apparatus for reducing tubular stock, in combination, reducing means moving about fixed axes, a mandrel, means for feeding said stock, means for holding said mandrel relative to said stock, and means for rotating said stock and mandrel, said feeding, holding and rotating means permitting tubular stock to be fed end-to-end to said reducing means.

15. Apparatus for reducing tubular stock comprising in combination, reducing rolls and means to feed tubular stock in increments to said rolls, said means including a travelling head, a sleeve rotatable in said head, and jaws mounted on said sleeve for gripping said stock.

16. Apparatus for reducing tubular stock comprising in combination, reducing devices movable about a fixed pivot, a mandrel reciprocable relative to said reducing devices, means for holding said mandrel including converging jaws, and means for actuating said mandrel holding means in synchronism with the action of said reducing devices.

17. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, cooperating reducing surfaces on said rolls and other cooperating surfaces on said rolls spaced from said reducing surfaces by clearance spaces, said second-mentioned surfaces having a circumferential shape approximately identical with said reducing surface and acting upon substantially the same longitudinal sector of tubular stock as the reducing surfaces.

18. Apparatus for reducing tubular stock comprising in combination, a set of segmental rolls turning about fixed axes, two segmental paracentric surfaces on each roll separated by clearance spaces, a mandrel supporting the tubular stock to be reduced, means for feeding stock forward along the mandrel without rotating it prior to the action of one of said segmental surfaces and means for rotating said stock without feeding it forward prior to the action of the other segmental surface, for the purposes set forth.

19. Apparatus for reducing metal stock comprising in combination, a set of segmental rolls turning about fixed axes, two segmental paracentric surfaces on each roll separated by clearance spaces, means for feeding stock forward without rotating it prior to the action of one of said segmental surfaces, and means for rotating said stock without feeding it forward prior to the action of the other segmental surface, for the purposes set forth.

20. Apparatus for reducing metal stock comprising in combination, a set of segmental rolls turning about fixed axes, means for feeding stock forward without rotating it prior to one operation of said rolls, and means for rotating the stock without feeding it forward prior to the succeeding action of said rolls.

21. In a pilger mill in combination, rolls provided with two pads each, and means geared and timed with the action of said rolls for alternately feeding stock forward and rotating the stock between the actions of each of said pads respectively for the purposes set forth.

22. The method of operating a pilger mill which comprises alternately feeding successive increments of stock and rotating the stock between successive actions of the pilger rolls.

23. Apparatus for reducing tubular stock comprising in combination, swaging means for intermittently reducing and releasing said stock, a mandrel held against substantial absolute longitudinal movement, whereby approximately the same longitudinal portions of mandrel and reducing devices register with each other for each stroke, and trip feeding means for feeding stock in successive increments along said mandrel, said feeding means having stock engaging means adapted to open to permit the movement of stock therethrough whereby stock may be introduced at the rear end of the machine and be fed forward to the swaging means.

24. Apparatus for reducing metal stock comprising in combination, reducing devices movable about fixed pivots; a stock supporting mandrel cooperating with said reducing devices, said mandrel being tapered in that portion traversed by said reducing devices, and means for moving said devices and mandrel coordinately in proper manner to push metal down the taper of said mandrel toward the small end of the mandrel.

25. In apparatus for reducing tubular stock, in combination, intermittently acting stock-reducing means, a mandrel, intermittently acting means for turning said mandrel to turn the stock therethrough, and means other than said stock reducing means and independent of said mandrel-turning means but acting cooperatively therewith for intermittently turning said stock by direct action thereupon.

26. Apparatus as set forth in claim 25 in which said stock turning means frictionally engages the longitudinal peripheral surface of the stock.

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