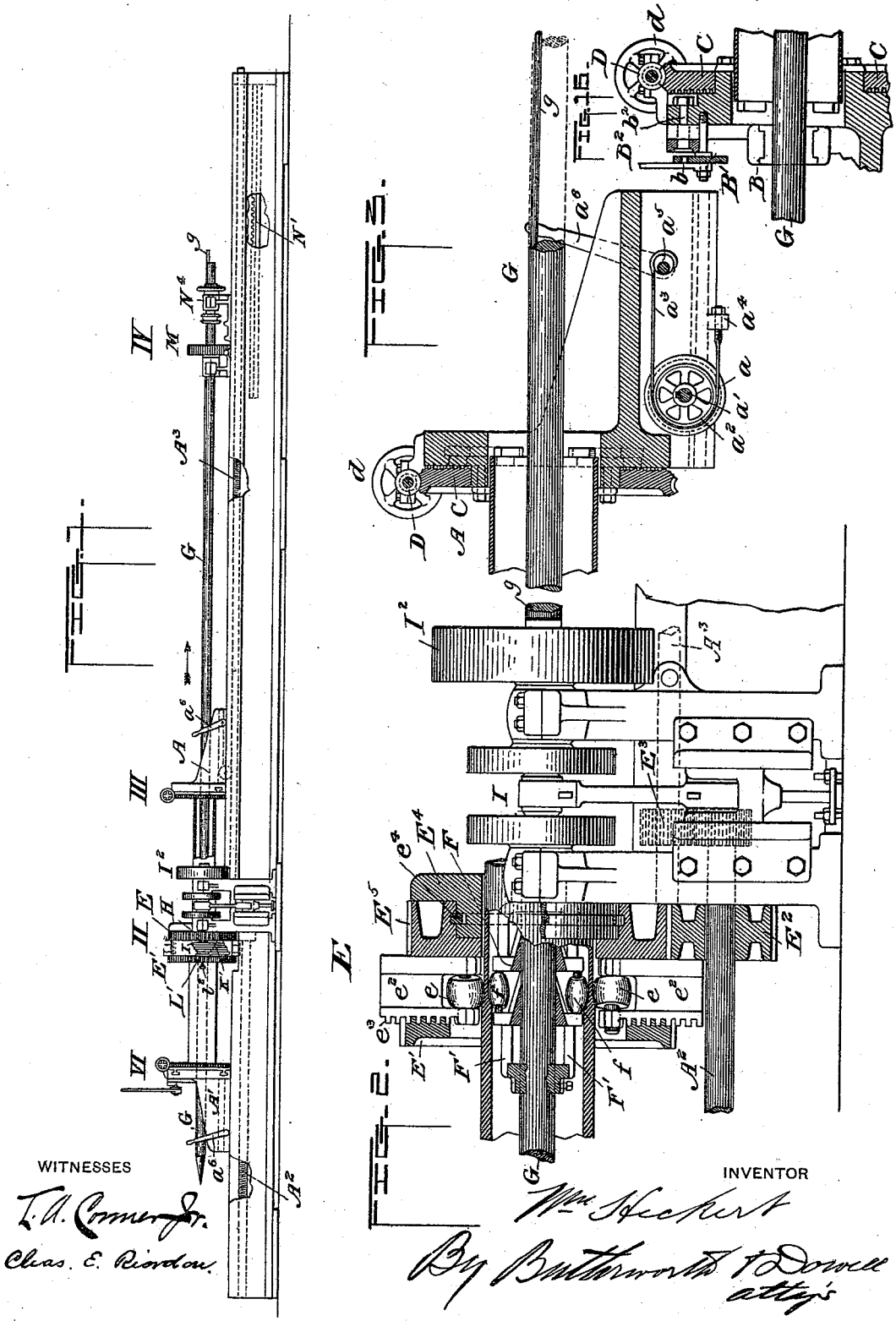
(No Model.) 5 Sheets—Sheet 1.

W. HECKERT.

UNIVERSAL TUBE ROLLING MILL.

No. 490,628. Patented Jan. 24, 1893.



WITNESSES

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atty's

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W. HECKERT.

UNIVERSAL TUBE ROLLING MILL.

No. 490,628. Patented Jan. 24, 1893.

FIG. 5.

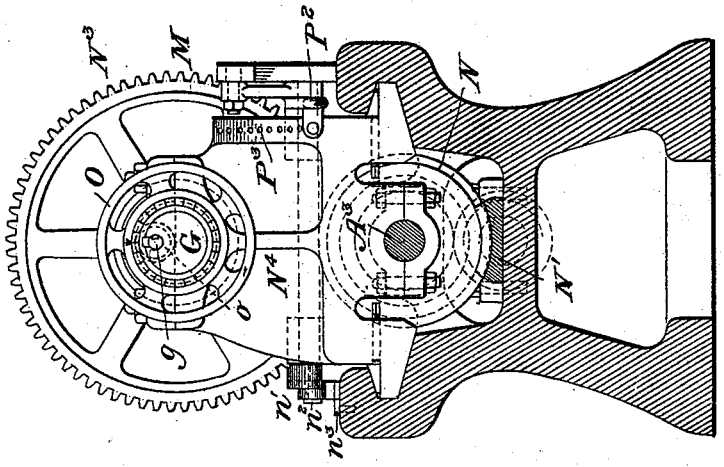
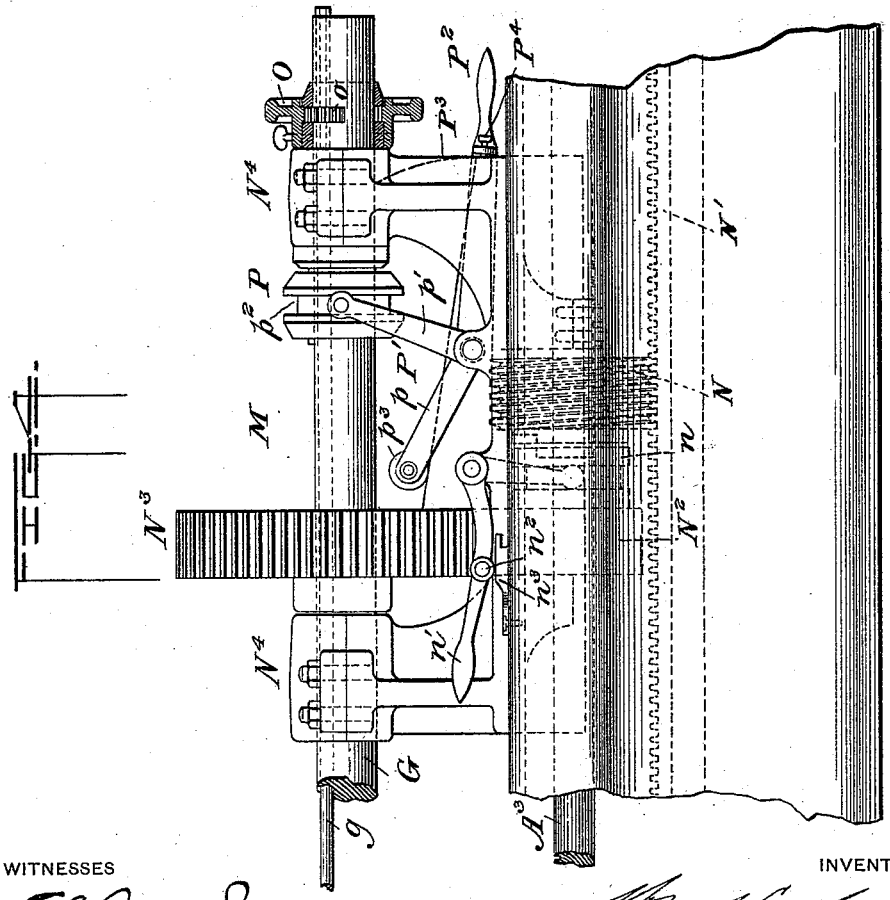


FIG. 4.



WITNESSES

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(No Model.) 5 Sheets—Sheet 3.

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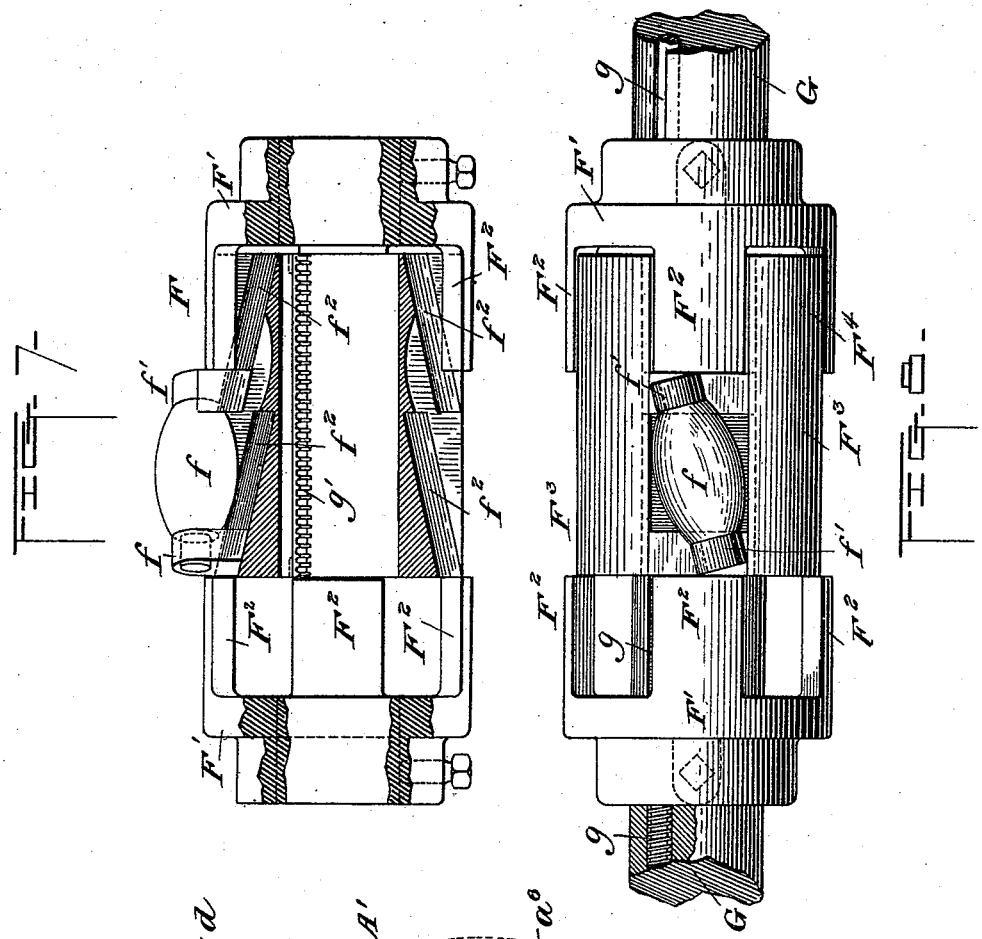
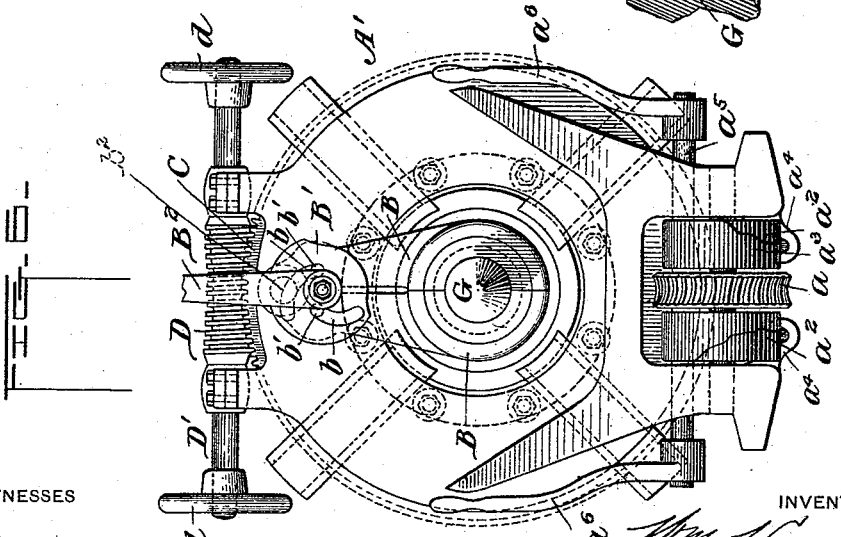
UNIVERSAL TUBE ROLLING MILL.

No. 490,628. Patented Jan. 24, 1893.





WITNESSES

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(No Model.) 5 Sheets—Sheet 4.

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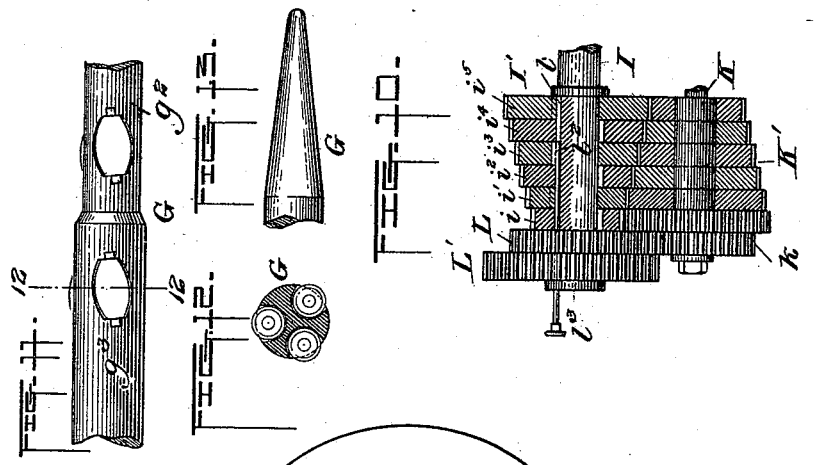
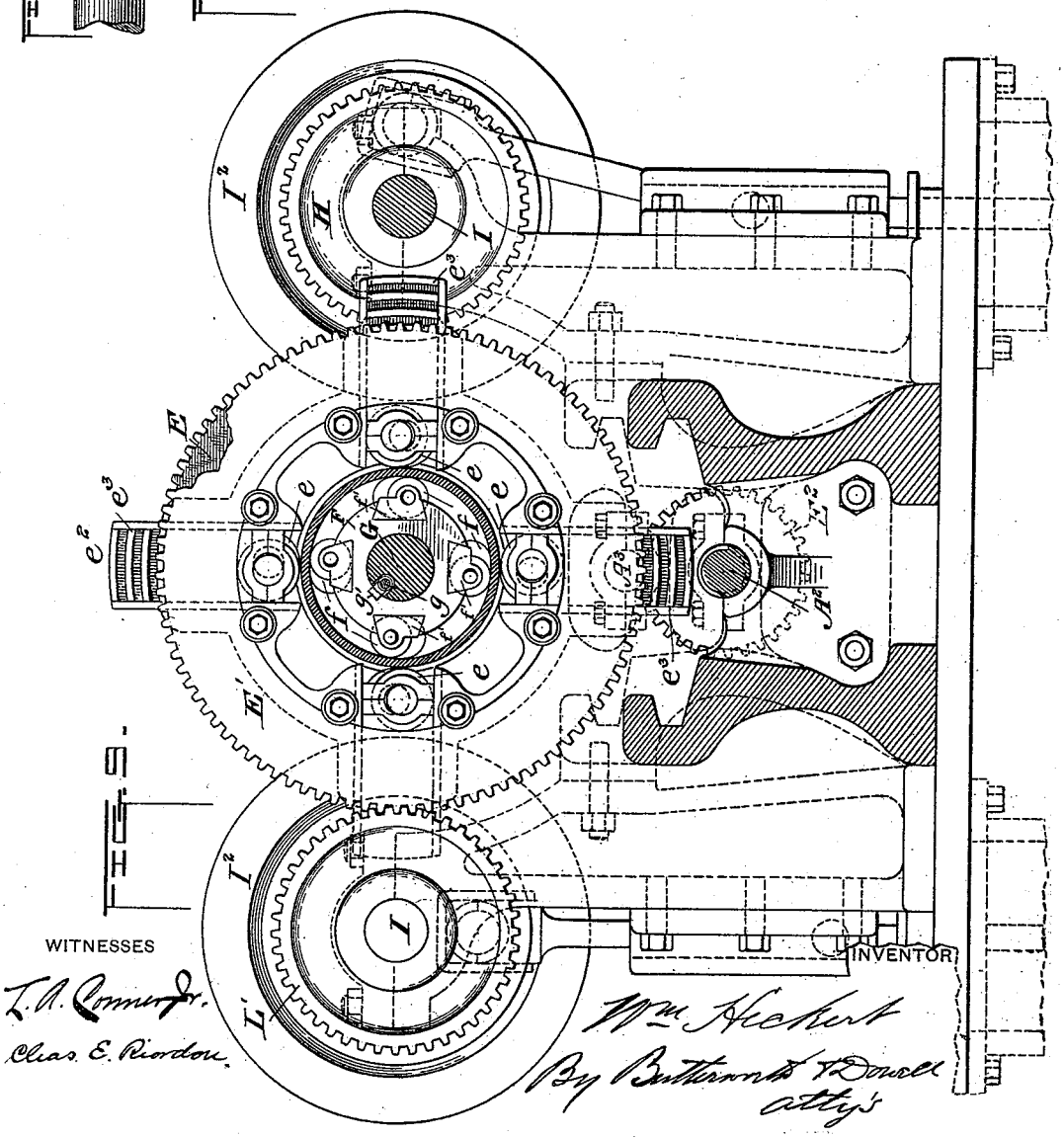
UNIVERSAL TUBE ROLLING MILL.

No. 490,628. Patented Jan. 24, 1893.





WITNESSES

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(No Model.) 5 Sheets—Sheet 5.

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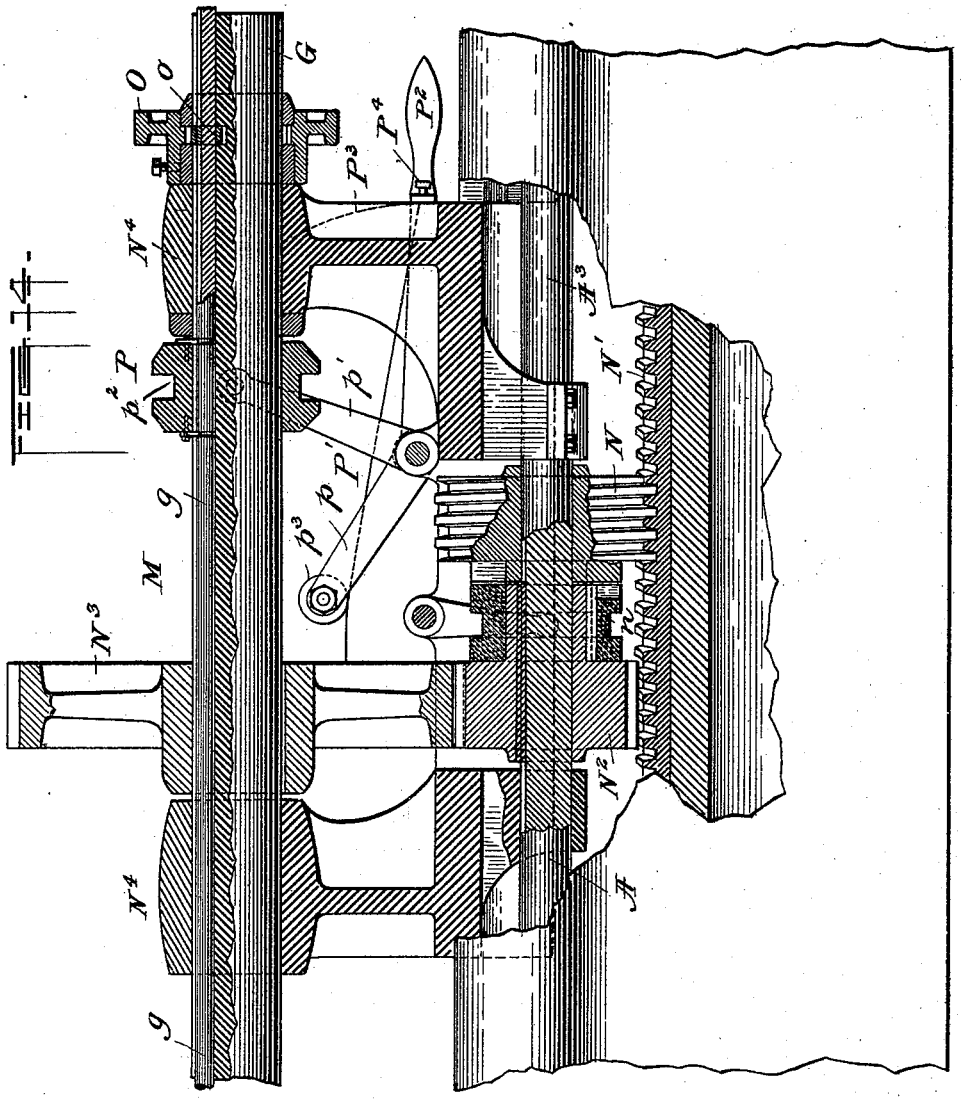
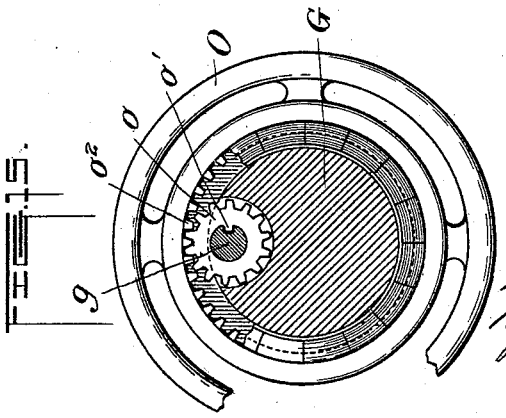
UNIVERSAL TUBE ROLLING MILL.

No. 490,628. Patented Jan. 24, 1893.





Witnesses
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Wm. Heckert
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UNITED STATES PATENT OFFICE.

WILLIAM HECKERT, OF FINDLAY, ASSIGNOR OF ONE-HALF TO BENJAMIN BUTTERWORTH, OF CINCINNATI, OHIO.

UNIVERSAL TUBE-ROLLING MILL.

SPECIFICATION forming part of Letters Patent No. 490,628, dated January 24, 1893.

Application filed December 11, 1891. Serial No. 414,685. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM HECKERT, a citizen of the United States, residing at Findlay, in the county of Hancock and State of Ohio, have invented certain new and useful Improvements in Universal Tube-Rolling Mills; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in machinery designed to be used in the manufacture of seamless or other tubes, pipes, columns, boiler-shells, flues or other tubular cylindrical articles made of metal; and the object is to simplify the construction and increase the efficiency of the machinery and appliances for rolling such tubular structures.

Heretofore tubes, pipes and other hollow cylindrical articles have been made by casting and rolling the hollow ingot or pile by successive passes of the heated ingot through a train of rolls, or by reciprocating passes through a universal mill over double mandrels. But in using mechanism of the usual construction it becomes necessary to straighten and polish the article after it is removed from the mill; and to avoid this and other objections I have devised improved appliances whereby the ingot, pile or billet, is fed or drawn between the reducing rolls by the action of the rolls themselves assisted by pushers and pullers which also hold the stock in line whereby the article which is being reduced remains neutral, or without rotation during the operation, and being held in perfect alignment by the pushers (which also act alternately as pullers, and which are placed one at either side of the mill or in front and in rear of the reducing rolls) may be cooled and polished while in the mill thereby dispensing with the subsequent straightening operation now required.

The invention will first be described in connection with the accompanying drawings, and then particularly pointed out in the claims at the end of this description.

Referring to the drawings, in which like letters of reference are used to designate like parts of the machine:—Figure 1, represents a side elevation of a universal tube mill, embodying my invention; Fig. 2, is a side elevation, partly in section, showing the rotating head which carries the exterior reducing rolls and illustrating the relative arrangement of the exterior and interior rolls; these parts being indicated at II, in Fig. 1; Fig. 3, is a sectional side elevation of the pusher indicated at III, in Fig. 1; Fig. 4, is a side elevation of the head stock which supports the rear end of the arbor, on which the interior reducing rolls are mounted, and rotates said arbor; and Fig. 5, is an end elevation of the same; these parts being indicated at IV, in Fig. 1; Fig. 6, is an end elevation of the pusher at the front of the mill, indicated at VI, in Fig. 1; Fig. 7, is a sectional side elevation on an enlarged scale; and Fig. 8, is a similar plan of the expanding head or mandrel which supports the interior reducing rolls; Fig. 9, is a sectional view of the rotating head and connections illustrating the arrangement and operation of the interior and exterior reducing rolls; Fig. 10, is a detail sectional view of the tapering feed mechanism for the exterior rolls; Fig. 11, is a partial side elevation of the end portion of an arbor adapted to be used for standard sizes of tubing; Fig. 12, is a cross section on the line 12—12, of Fig. 11; and Fig. 13, is a detail showing the free end of the arbor tapered, for making odd small sizes of tubing without using interior rolls, by bringing any point or desired diameter in line with the exterior rolls, so as to enlarge or diminish the diameter of the stock. Fig. 14 is a sectional view of the head stock and operating mechanism connected therewith; and Fig. 15, is a detail. Fig. 16 is a detailed section.

Referring particularly to the drawings; Fig. 1 represents the complete mill with all the operative parts properly assembled for action; the bed frame being partly broken away so as to show the screw feed shafts and rack for actuating the pushers and head stock which supports the rear end and gives rotation to the arbor on which the interior rolls are mounted.

A—A′ are the pushers. These pushers are arranged one at the front and the other at the rear of the reducing rolls and are adapted to

hold the ends of the stock or tube which is being rolled in proper position as it passes between the rolls, as shown in Fig. 1; the reduced end of the stock being shown in section in said figure. The pushers are connected to screw feed shafts, A^2, A^3, which are driven by pinions E^2, E^3, on the ends of shafts A^2, A^3, respectively, engaging suitable gearing connecting with the drive wheels of the engine; said pushers being adapted to move in unison back and forth so that they alternately operate as pullers, one serving to push the stock and the other to pull it during each pass. The front pusher, A′, aids in feeding the stock to the rolls and is provided with an extra pair of jaws forming a bearing for the free end of the arbor during the first pass of the stock into the mill and part of the way on the return pass, or until the extension of pipe carries it back from the end of the arbor. The rear pusher A, grasps the front end of the stock or pipe as it leaves the mill, pulling and holding the work in line. When the mill is reversed, the first mentioned pusher, A′, becomes the puller, and the stock is again returned through the rolls as will hereinafter more fully appear.

Each pusher is provided with a suitable chuck which is adapted to grasp the end of the stock or pipe which is being reduced, and they are mounted in suitable guide ways upon the bed frame of the machine, so as to slide back and forth thereon in said ways. These pushers may be geared to the screw feed shafts in any suitable manner, but I preferably provide mechanism by which the pushers are given a longitudinal motion, which may be regulated to conform to the speed of the stock. To accomplish this a worm wheel a, may be fixed on a transverse shaft, a', journaled in bearings secured to the depending portion of the frame or carriage of the pushers A, A′, as shown more clearly in Figs. 3 and 6, and at either side of the worm wheel and fixed on the same shaft, may be placed band wheels or pulleys a^2, about which is passed a friction band or bands a^3, one end of which is secured to a lug, a^4, or to a fixed part of the pusher frame or carriage, and the other end to an eccentric shaft a^5, which may be provided at each end with a hand lever, a^6, whereby the band brake may be applied so as to cause the pusher to move when the worm wheel is rotated or slackened to permit the worm wheel to rotate while the pusher remains stationary. By this means a constant pull or push upon the stock is insured irrespective of the speed at which the stock or pipe is moving, the band brake being adapted to slip to enable the pusher to move in harmony with the stock, so that the speed of the pusher will at times conform to the speed of the stock.

B, B, Fig. 6, represent the extra pair of jaws connected to the front pusher, A′, so as to form a bearing for the free end of the mandrel or arbor which supports the interior reducing rolls. The jaws B, B, are pivoted at their upper ends, as indicated by dotted lines in Fig. 6, and in detail in Fig. 16, on a stud or bolt b^2 which is arranged slightly above the axial support of a cam-slotted disk B′, by which the lower ends of the jaws may be spread apart or brought together when it is desired to cause said jaws to release or embrace the arbor. The disk B′, is provided with two reversely inclined curved or cam-slots b, b, which are adapted to receive pins b', b', projecting from the jaws below the pivotal support thereof through the respective slots so that when the disk is given a partial rotation the lower ends of the jaws will be separated to release or receive the mandrel. A partial rotation of the disk in the opposite direction will cause the jaws to embrace the mandrel and hold the same in proper position.

B^2 designates a lever which is secured to the disk, B′, for the purpose of opening and closing the jaws, the pivot of the lever being coincident with the pivotal center of the disk. The sliding jaws of the chuck with which each pusher is provided may be connected in any proper manner with a spiral groove or worm upon the face of a rotating disk, C, by which said jaws may be moved in or out of engagement with the end of the stock or tube to be rolled; the disk, C, being provided with a toothed periphery, which engages a worm D, fixed on a shaft D′ which is provided with a hand wheel d at each end thereof, as shown more clearly in Fig. 6, whereby the disk may be rotated for the purpose of expanding and contracting the jaws at will.

E designates the rotating head which supports the exterior reducing rolls e, and imparts motion from the engine to the screw-feed shafts A^2, A^3, and connected pusher-actuating mechanism. The rotating head E is provided with a peripherally toothed gear wheel E^5 which is fitted upon a circular projection or hub of a stationary frame E^4, to which it is secured by a circular key e^4, which may be sprung into coincident grooves formed in the interior and exterior contacting surfaces of the gear and hub, respectively. The teeth of the gear E^5 engage the pinion E^2 on one end of the screw feed shaft A^2, so that motion will be imparted from the rotating head to said shaft and thence to the screw-feed shaft A^3, by means of suitable gearing connecting the adjacent ends of the two shafts, as indicated in dotted lines in Fig. 2. The exterior rolls e, are mounted spirally on the inner ends of the movable carriers e^2 of the rotating head E, which receives motion from a suitable chain of gearing connecting with gear wheels or pinions, H, on the crank shafts, I, of compound reversible engines, as indicated in Figs. 1, 2 and 9; the link motion or reversing mechanism of both engines being connected together, but not shown in the drawings.

I^2, I^2, denote fly-wheels on the engine shafts I.

F, denotes the expanding head or mandrel which supports the interior reducing rolls *f*, and G denotes the arbor on which said expanding head is fixed.

The interior and exterior reducing rolls are preferably arranged at an angle to the longitudinal axis of the machine or arbor, G, and rotate in opposite directions so as to cause the stock which is being rolled to remain neutral or without rotation, while being drawn longitudinally by the spiral pitch of the rolls, aided by the pushers.

Arbor, G, is supported at its rear end by the head stock, M, (Figs. 4, 5 and 14) and extends forward through the exterior reducing rolls and its front end rests in the bearing provided by the pivoted jaws B, B, of the pusher A'. The head-stock is mounted in suitable guide ways upon the bed frame and adapted to be given an intermittent longitudinal movement thereon for the purpose of introducing and withdrawing the arbor from the exterior rolls or mill and to permit the introduction of the ingot to be rolled. To accomplish this adjustment of the head-stock a worm wheel N, fitted so as to revolve freely on the smooth portion of the screw shaft A^3 at the rear of the mill engages a rack N' which is fixed to the bed frame so that when the worm wheel is caused to rotate with the shaft the head stock will be moved back or forward according to the direction of rotation of the shaft. A pinion N^2 is also fitted on said shaft, A^3 by means of a spline or key fitting a longitudinal groove in the shaft, and on the projecting hub of this pinion adjacent to the worm wheel, is fitted by spline and groove connection a clutch *n*, as shown in Fig. 14 and in dotted lines in Fig. 4, the teeth of which are adapted to engage the teeth at the side of the worm wheel. This clutch is connected to an operating lever *n'* by which the clutch may be thrown into or out of engagement with the worm wheel. The lever *n'* is provided with a roller n^2, which is adapted to run up onto an inclined stop, n^3, as it approaches the end of its movement, so as to automatically disengage the clutch, whereupon the head stock will be held in a stationary position by means of the worm wheel which remains engaged with the rack. The pinion N^2 engages a gear wheel N^3 fixed on the arbor, G, which is supported in suitable bearings upon standards N^4, N^4, of the head stock frame or carriage, so that the revolutions of the shaft A^3, will impart a rotary movement to said arbor.

g designates a rod which is let into the arbor, G, by means of a groove extending longitudinally from the rear end of the arbor to the expanding head or mandrel F to which latter said rod is connected by a rack and screw connection as hereinafter described.

O designates a combined hand wheel and index plate which may be secured upon the arbor, G, at the rear end thereof by means of a collar and set screw as shown clearly in Figs. 4 and 14. This hand wheel is toothed internally as shown at o^2 Fig. 15, and engages a small pinion *o*, which is fitted upon the rear end of the rod *g*, and has a spline *o'* lying in a groove in said rod, so that when said hand wheel is rotated the rod *g* will also be rotated in the same direction. The rod *g* is adapted to slide back and forth in the groove of the arbor and through the pinion *o*, but is locked against independent rotary movement by said pinion and hand-wheel.

P designates a collar which is sleeved on the arbor, G, between the bearings which support the arbor on the head-stock and is secured to the rod, *g*, in such manner that the rod may rotate when actuated by the hand wheel and pinion, but is prevented from moving longitudinally independently of the collar.

P' designates a bell crank lever which has two arms, *p*, *p'*, and is provided with an operating lever P^2 for actuating the bell crank. The arm *p'* of the bell crank is held in frictional engagement with the collar, P, by means of a friction roller secured upon the end of the arm and engaging a groove p^2, in the collar. The arm *p* of the bell crank is provided with a friction roller p^3 for a purpose to be described. The lever P^2 may be provided with a suitable spring catch P^4 which engages a rack P^3 for the purpose of locking the lever in any desired position.

The rod *g* is screw threaded a portion of its length at the forward end thereof, as shown in Fig. 8 and this screw threaded portion engages a rack *g'* (Fig. 7) secured to the hub of the expanding mandrel F. This mandrel is constructed as follows: F', F' designate collars which may be secured upon the arbor G by means of set screws and which are provided with four (more or less) inwardly projecting lugs or arms F^2, which overlap the ends of a sliding hub F^3 which supports the interior reducing rolls *f*. These rolls *f*, have their bearings in suitable boxes, *f'*, which rest upon inclined ways f^2, formed in the periphery of the hub F^3, so that when said hub is slid longitudinally the rolls will be moved in or out for the purpose of expanding or contracting the head. The boxes or bearings *f'* are confined in the inclined ways between the arms F^2 of the collars F' so that longitudinal movement of the rolls is prevented. By this means when the rod *g* is rotated the hub F^3 will be moved slowly forward or back within certain limits, the projecting portions F^4 thereof alternately entering the spaces or recesses between the lugs F^2 of the collars, while the rollers *f* are held against endwise movement between the arms of the collars, but moved in or out in a vertical plane whereby the mandrel may be expanded or contracted by operating the hand wheel O, and the desired adjustment may be indicated on the hand wheel index plate.

As thus far described the machine is adapted for rolling parallel tubing, or tubing having a uniform diameter throughout. The stock or tube to be rolled is supported be-

tween the pushers whose chucks grasp the ends of the stock so that at each pass it is both pulled and pushed through the reducing rolls, each pusher being adapted to serve alternately as a puller. The spiral pitch of the rolls also has the effect of drawing the stock longitudinally between the rolls, and as the exterior and interior rolls rotate in opposite directions the tendency of the stock is to remain neutral or without rotation, so that a uniform reduction may be effected; the pushers being also of advantage in counteracting any residual tendency of the stock to rotate, by grasping and holding it in line as it is drawn through or between the oppositely rotating rolls. The interior rolls of the arbor or of the expanding mandrel are arranged in the same vertical plane with the exterior rolls of the rotating head as shown in Fig. 2. The angle at which the rolls are set in either case relative to the axis of the arbor will determine the pitch or feed of the work through the mill. Usually two passes of the stock, that is, in and out, will complete the work, but any number of rolls may be given and the stock may be cooled and polished while it is held in line between the pushers, thereby avoiding the necessity of using straightening devices subsequent to the rolling process according to the present practice in rolling stock. The reversal of the engine reverses the movement of the pushers, stock and all parts of the machine, and the engines may of course be reversed so as to cause the stock to move back and forth as often as may be desired, thus reducing the same at each pass until the desired reduction is accomplished.

When it is desired to roll the interior of the stock so as to conform to any desired pattern, the lever P^2 is released from the rack P^3 and allowed a free movement and the desired pattern which is given a longitudinal motion with the stock is caused to act on the roller p^3 of the bell crank lever, P′, which, by means of the described connection with the rod g will slide said rod forward or back and automatically expand or contract the interior rolls so as to roll the stock to correspond to the shape of the pattern on which the roller p^3 rests. When parallel tubing is being rolled the handle of the lever P^2 is locked at the point indicating the desired interior diameter of the tube on the index wheel, but when the mill is reversed the interior diameter of the rolls may be instantly changed by operating said hand lever so as to increase or diminish the interior diameter of the pipe at each pass.

In order to give a tapering action when desired to the exterior reducing rolls I provide a nest or double conical series of gears as shown in detail in Fig. 10, and partly in side elevation in Fig. 1,—one series of gears being loosely arranged on the end of the engine shaft I, so as to impart motion to the adjusting disk and movable carriers of the rotating head E, for the purpose of enlarging or decreasing the size of the opening between the exterior rolls in such manner as to gradually enlarge or reduce the stock which is being rolled and thereby taper the tube. The mechanism for this purpose is constructed as follows:—I′ denotes the nest of loose gears which are placed on the end of the crank shaft I, the individual gears being marked i, i', i^2, i^3, i^4 and i^5. K designates a fixed stud on which is placed a reversely arranged conical series or nest of solid or fixed gears K′, which may be formed integrally or secured together so as to rotate as one. The solid nest of gears K′ engage the loose nest I′, so that when any one of the loose gears is locked to the crank shaft I, and made to rotate therewith, it will impart motion to the solid nest; the speed of rotation being increased at will by shifting from a smaller to a larger loose gear.

L, designates a gear wheel which is also loose upon crank shaft I, and has secured thereto a larger loose gear wheel L′, the latter being adapted to engage the adjusting disk E′ of the rotating head E, as shown at the left of Fig. 9; (the gears k, K′, being omitted in the latter figure.) The end gear or pinion k, of the solid nest K′, meshes with the gear wheel L so that motion may be imparted from the crank shaft through any one of the series of loose gears to the fixed gears, and thence to the gears L, L′, and adjusting disk E′. The crank shaft I, is provided with a longitudinal groove or key-way l, in which is fitted a movable spline or key l^2, having an adjusting rod or handle l^3, by which the key l^2, may be slid back and forth so as to engage any one of the series of loose gears and cause the same to rotate with the shaft I; the series of loose gears being provided with key-ways or grooves which register with the longitudinal groove l, in the shaft.

The sliding jaws or carriers e^2, of the rotating head E, in which the exterior rolls e, are mounted may be supported in suitable guide ways, and provided with teeth or curved ribs e^3, which engage a spiral thread or groove upon the adjusting disk E′, so that when said disk is rotated the carriers will be thrown in or out according to the direction of rotation. By this means when the head E is rotating and the stock is being passed between the reducing rolls, the key l^2, may be shifted forward or back in the groove l, for the purpose of engaging the loose gears i, i', i^2, i^3, i^4 and i^5, in succession; the initial movement being imparted from either the large gear i^5 or the small gear i, and as the key is moved in or out the speed of the solid nest of gears may be gradually increased or diminished, so as to correspondingly increase or diminish the speed of the adjusting disk and move the exterior rolls in or out with a gradually decreasing or accelerated motion for the purpose of tapering the tube.

In Figs. 11 and 12 is shown a modification of the arbor, G, in which the interior reducing rolls are let into the arbor by means of recesses or cavities of sufficient depth to permit

the rolls to project slightly beyond the periphery of the arbor. Two sets or series of rolls are shown; the first set being fitted in the larger portion g^3 of the arbor and designed to be used for the first pass, while the second set or series of rolls is fitted in the reduced portion g^2 and designed to be used for the reverse or return pass; the arbor being adapted to be drawn back so as to bring the rolls of the reduced section in line with the exterior rolls, which latter are closed for finished diameter of tube outside.

A further modification is illustrated in Fig. 13, wherein the free end of the arbor is shown as being tapered for the purpose of making odd small sizes of tubing without using interior rolls, which may be done by bringing any portion of the tapered end of the arbor in line with the exterior rolls, so as to enlarge or diminish the diameter of the stock as may be desired.

The arbor illustrated in Figs. 11 and 12, is adapted to be used for standard sizes of tubing and the rolls therein are arranged at an angle to the central line or axis of the arbor in a manner similar to the rolls of the expanding mandrel.

It will be understood of course that various modifications may be made in the general arrangement of the machine, and in the construction of the parts thereof, without departing from the spirit of my invention, and hence, I do not desire to be understood as limiting myself to the exact construction shown and described herein.

Obviously the operating mechanism for giving a tapering action to the exterior rolls may be arranged in different ways, and the loose gears need not necessarily be mounted on the engine crank shaft, while other methods of locking the gears to the shaft may be used with the same results.

A single operating lever and hand wheel for adjusting certain parts and a single friction pulley and brake band may be also used instead of duplicate parts as shown and described, but for convenience in operating the mill and to produce the best results I preferably use substantially the arrangement and construction shown and described.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A universal tube rolling mill comprising a rotating head supporting the exterior reducing rolls, an oppositely rotating arbor or mandrel supporting the interior reducing rolls, a pair of pushers arranged one in front and the other at the rear of said rolls; each pusher being adapted to act alternately as a puller; means supported by the pushers for grasping the tube or stock and holding the same in line as it is drawn through the rolls, and mechanism for rotating said head and arbor in opposite directions, substantially as described.

2. In combination with the mandrel provided with the interior reducing rolls arranged at an angle to the axis thereof, the rotating head provided with the exterior reducing rolls arranged at a reverse angle to the axis of said mandrel, and mechanism for rotating said mandrel and exterior rolls in opposite directions, substantially as described.

3. The combination in a tube rolling mill of the rotatable head supporting the exterior reducing rolls having their axes arranged at an angle to the longitudinal axis of the machine, the arbor provided with interior reducing rolls having their axes arranged at an angle to the axes of the exterior rolls, and mechanism substantially as described for rotating said head and arbor in opposite directions.

4. In combination with the exterior and interior reducing rolls and means for rotating the same in opposite directions, the pushers provided with chucks having radially sliding jaws which are adapted to grasp and support the ends of the stock at the front and in rear of the reducing rolls; each pusher being adapted to act alternately as a puller so as to jointly assist in moving the stock at each passage through the rolls by pushing and pulling in alternation, substantially as described.

5. In a universal tube rolling mill, the combination with the rotatable head carrying the exterior reducing rolls having their axes arranged at an angle to the longitudinal axis of the machine, of the oppositely rotating arbor carrying the interior reducing rolls having their axes arranged at an angle to the axes of the exterior rolls and mechanism for actuating the rolls whereby the stock is adapted to remain neutral or without rotation in its passage through the rolls, substantially as described.

6. In combination with a tube rolling mill, the pusher mounted on suitable ways thereon, mechanism for impelling the pusher along said ways, and an intermediate friction-brake device connecting the pusher and impelling mechanism, whereby the pusher is yieldingly impelled and its speed made to conform to the speed of the stock, substantially as described.

7. The combination in a universal tube rolling mill, of the pusher and mechanism for operating the same, comprising a driving screw shaft, a worm wheel engaging said shaft, a friction brake-device connecting the worm wheel shaft with the pusher and a lever for applying the brake, whereby the pusher is frictionally geared to the driving shaft and adapted to move in harmony with the movements of the stock, substantially as described.

8. In a universal tube rolling mill, the combination of the rotating head having the exterior reducing rolls adjustably mounted thereon, the arbor carrying the interior reducing rolls, mechanism for rotating said head and arbor in opposite directions, and mechanism connected with a movable element of the machine for gradually and automatically adjust-

ing the exterior rolls for the purpose of tapering the tube, substantially as described.

9. In a tube rolling mill, the combination with the rotatable head and arbor supporting the reducing rolls, of the pushers provided with chucks for grasping and holding the stock in line between the rolls, the pivoted jaws mounted upon the forward pusher and forming a bearing for the arbor of the interior rolls, and means for opening and closing said pivoted jaws, substantially as described.

10. In a tube rolling mill, the combination with the revolving head provided with movable carriers which support the exterior reducing rolls, of the rotatable adjusting disk, engaging said carriers and mechanism for rotating the disk so as to impart a radial movement to the reducing rolls; such mechanism comprising a conical series of loose gears placed on the driving shaft, a reversely arranged conical series of fixed gears engaging the loose gears, suitable gearing connecting the fixed cone of gears with said rotatable disk, and means for locking any one of the series of loose gears to the driving shaft, substantially as described.

11. In a tube rolling mill, the combination with the rotating head supporting the exterior reducing rolls, of the oppositely rotating expansible mandrel supporting the interior reducing rolls, mechanism for rotating said head and mandrel in opposite directions, a pattern, and intermediate mechanism whereby the interior rolls may be automatically moved in and out so as to roll the interior of the stock to correspond with the pattern, substantially as described.

12. In a tube rolling mill, the rotatable head provided with the radially adjustable carriers having the exterior reducing rolls mounted spirally thereon, the interior reducing rolls adjustably mounted on an oppositely rotatable arbor at an angle to the exterior rolls, means for adjusting said carriers and interior rolls, and mechanism for rotating said head and arbor in opposite directions, substantially as described.

13. In combination with the longitudinally grooved arbor having the interior reducing rolls adjustably mounted thereon, the adjusting screw rod fitted in said groove, the pinion on said rod, the internally toothed hand wheel engaging said pinion, and means connecting the screw rod with the adjusting mechanism of the rolls, whereby the latter may be moved in or out by rotating said hand wheel, substantially as described.

14. In combination with the exterior reducing rolls mounted on a rotating head, the interior reducing rolls adjustably mounted on an oppositely rotating arbor, means for rotating said head and arbor in opposite directions mechanism substantially as described for gradually adjusting the interior rolls, and independently-actuated mechanism whereby said interior rolls may be instantly adjusted, substantially as described.

15. In combination with the longitudinally grooved arbor or mandrel, the expansible mandrel head supporting the interior reducing rolls, the sliding rod fitting the groove of said arbor and means connecting the same with said head so as to cause the rolls thereof to move out or in with the movements of the rod, the collar on said arbor connected to said rod so as to slide therewith, the bell-crank engaging said collar and provided with an actuating lever, and a suitable rack and catch for securing the lever, whereby the interior rolls may be instantly adjusted and secured in the desired position, substantially as described.

16. In a tube rolling mill, the combination with the reducing rolls, of the pushers, the screw shafts for actuating the pushers, means for rotating said shafts in opposite directions the head stock mounted in suitable guide-ways of the machine, the arbor having its rear end supported by said head stock and geared to one of said screw shafts, the worm wheel loose on the latter shaft, the rack engaging said worm wheel, the clutch adapted to lock the worm wheel to the shaft the clutch and an operating lever for engaging and disengaging the worm wheel and clutch whereby the head stock may be given an intermittent longitudinal motion for the purpose of withdrawing the arbor from the exterior rolls, substantially as described.

17. The combination in a tube rolling mill, of the arbor or mandrel having the expansible head thereon; said head comprising a pair of collars fixed to the arbor and provided with inwardly projecting lugs, a sliding hub arranged between said collars and provided with inclined guide-ways extending in the plane of the lugs, and projecting portions adapted to enter the recesses or spaces between the lugs rolls mounted in bearings which are confined between opposite lugs so as to slide in said guide-ways, and means for moving the hub longitudinally, substantially as described.

18. The combination in a tube rolling mill of the arbor having the longitudinal groove therein, and the expansible head fixed thereon; said head comprising a pair of collars fixed to the arbor and provided with inwardly projecting lugs, a sliding hub arranged between said collars and provided with inclined guide-ways extending in the plane of the lugs, and projecting portions adapted to enter the recesses or spaces between the lugs, rolls mounted in bearings which are confined between opposite lugs so as to slide in said guide-ways; and a rotatable sliding rod fitted in the groove of the arbor and connected to said hub so as to move the same longitudinally when the rod is either rotated or moved lengthwise, and means for rotating and sliding the rod, substantially as described.

19. The combination in a tube rolling mill of the reducing rolls, the pushers mounted on suitable ways on the machine, one in front and the other at the rear of said rolls, each

pusher being provided with means for grasping the end of the stock; and mechanism for imparting motion to the pushers so as to cause the same to move back and forth in the same direction along said ways in harmony with the movements of the stock, such mechanism comprising for each pusher a screw-feed shaft extending longitudinally of the machine and geared to the main driving shaft, a transverse shaft having a worm-wheel thereon engaging the screw-feed shaft, a band-wheel or wheels fixed on said worm-wheel shaft, and a friction brake-band partially encircling the band-wheel having one end fixed and the other end thereof secured to an eccentric or cam lever, whereby the speed of the pusher may be made to conform to the speed of the stock, substantially as described.

20. The combination in a tube rolling mill of the rotating head carrying the exterior reducing rolls, the arbor carrying the interior reducing rolls, the pusher movable along suitable ways upon the machine and provided with a support for the free end of said arbor, and the headstock also movable in suitable ways along the machine and having the opposite end of the arbor journaled in bearings thereon, together with mechanism for impelling said pusher and rotating said head and arbor in opposite directions, and means for imparting an intermittent longitudinal movement to said headstock, comprising a rotary driving shaft having a pinion keyed thereon in engagement with a gear wheel fixed on said arbor, a worm wheel loose on said shaft, a stationary rack engaging the worm wheel, and a sliding clutch adapted to engage said worm wheel and cause the same to rotate with the shaft, substantially as described.

21. In combination with the rotating head and arbor carrying the exterior and interior reducing rolls, respectively, and the screw-feed shafts and gearing connected therewith so as to rotate said head and arbor in opposite directions, the pushers movably mounted on suitable guide-ways and provided with means for grasping the stock, and friction gearing connecting the pushers with said screw-feed-shafts, substantially as and for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM HECKERT.

Witnesses:

LAURA A. HECKERT,

CLARENCE E. FLEMING.