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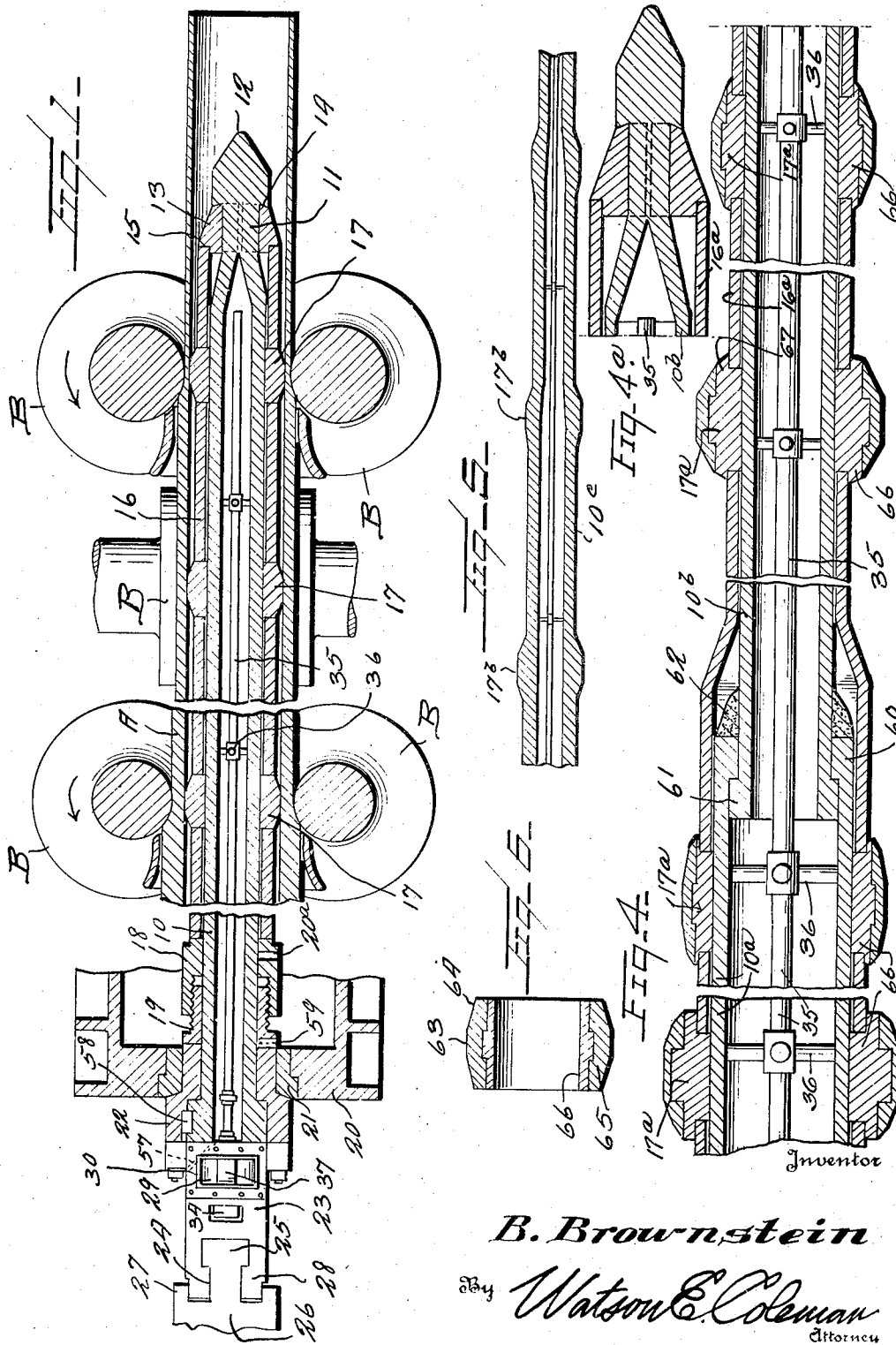
B. BROWNSTEIN

**2,025,439**

MANDREL BAR FOR CONTINUOUS TUBE ROLLING MILLS

Filed May 20, 1933

2 Sheets-Sheet 1



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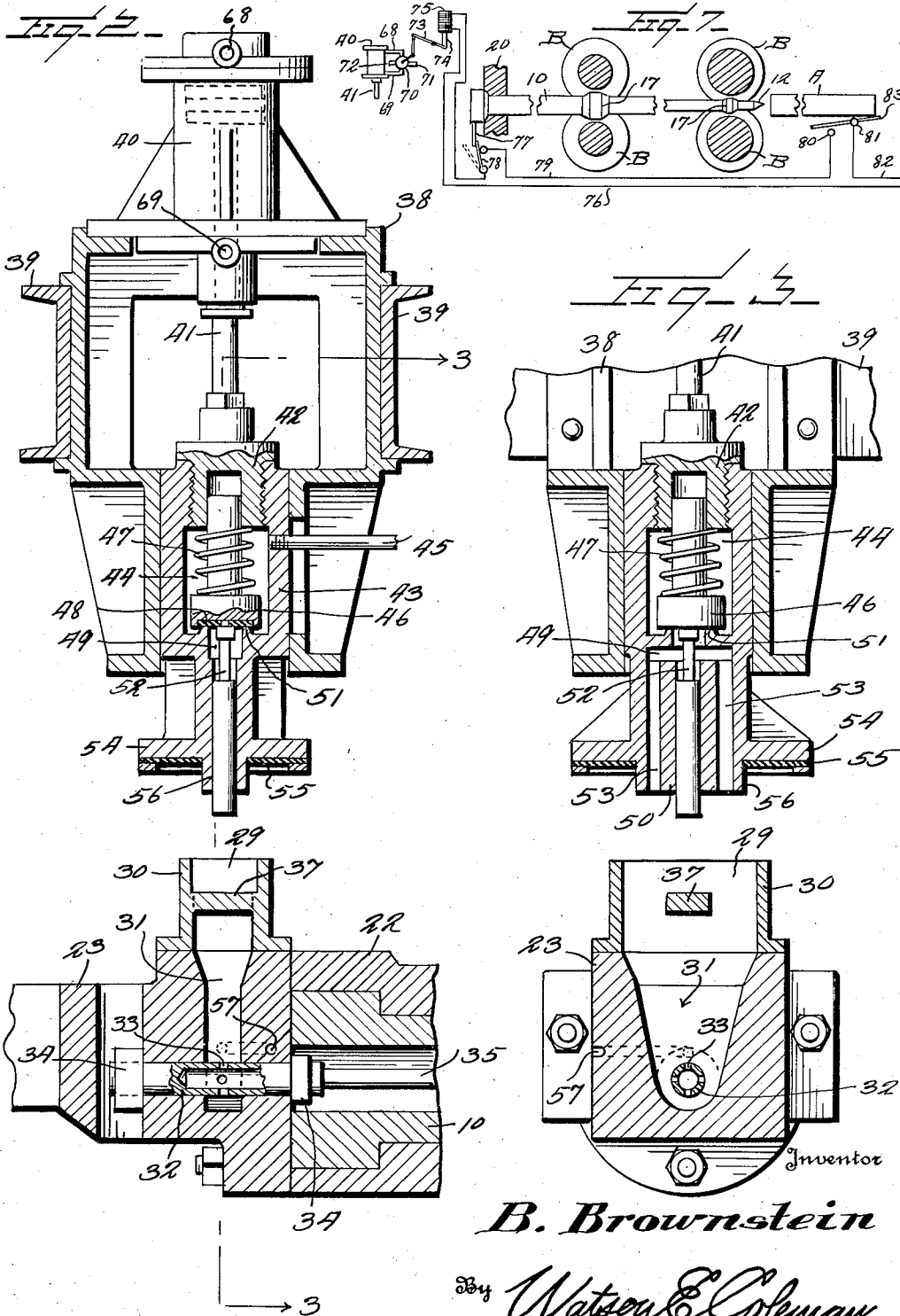
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## UNITED STATES PATENT OFFICE

2,025,439

MANDREL BAR FOR CONTINUOUS TUBE  
ROLLING MILLS

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Application May 20, 1933, Serial No. 672,075

13 Claims. (Cl. 80-11)

This invention relates to the art of rolling tubes in rolling mills and particularly to the mandrels therefore.

Continuous rolling mills for rolling different structural shapes, bar stocks and sheets are in operation in many steel plants but to my knowledge, there are no continuous tube rolling mills that roll on a mandrel bar and produce a tube of seventy-five feet or more in length due to the fact that there has never been produced, to my knowledge, a mandrel bar of one hundred and fifty feet to two hundred feet long which will safely withstand the enormous compressive force produced on the long mandrel bar by the rolling action of all rolls in the continuous rolling mill.

In the present practice, the total length of the mandrel bar must be equal to the length of the continuous rolling mill, which consists of five, six or more roll stands plus the length of the finished roll tube after leaving the rolling mill and reaching the mandrel bar support. Tubes of from fifty to fifty-two feet maximum finished length having an outside diameter of six inches or larger are produced in the present single stand tube rolling mill with a mandrel bar in compression, but the greatest length of the tube that can be produced under these circumstances is limited by the back stop which supports the end of the mandrel bar opposite the roll stands and this is limited to about sixty feet from the middle of the rolling mill. By the use of the best alloy steels obtainable and by heat treating the finished mandrel bar, a very high compressive strength is developed in the mandrel bar which makes it possible to use a mandrel bar sixty feet long but this is the safe limit of present practice.

The general object of the present invention is to provide a mandrel bar so constructed that it may be used in a continuous rolling mill having a plurality of roll stands, which bar will produce rolled tubes of any desired length due to the fact that the mandrel bar is in tension and because the tube being rolled, moves toward the free end of the mandrel bar during the rolling operation and away from the supported end of the mandrel bar so that there is nothing in the way of the tube being rolled to limit its length. A mandrel bar in tension eliminates a most troublesome weakness, that is, buckling, this buckling particularly occurring in and being the limiting factor of the present compression resisting mandrel bars.

A further object of this invention is to provide means whereby the mandrel bar may be water-cooled at all times and of such character that

notwithstanding the length of the mandrel, the free circulation of water will not be obstructed by the generation of steam and in this connection I provide means for supporting the water inlet pipe so that it will always remain in the center of the bore of the mandrel bar and cannot sag and rest upon the bottom of the bore as at present, thus preventing the inlet pipe from getting hot by direct contact with the body of the mandrel, thus avoiding the generation of steam in the inlet pipe and eliminating the choking off of incoming cooling water.

A further object is to provide means whereby, as soon as the mandrel is in position between the rolls, the inlet water pipe may be automatically connected to a water controlling valve, the construction being such as to entirely do away with the necessity of using long lengths of hose connected to the mandrel and having a length equal to the length of travel of the mandrel, which hose are connected to a main water line midway of the length of the mandrel bar travel, such hose being supported in loops above the mandrel bar and being a continuous source of trouble and danger to men working around these mills.

A further object of the invention is to improve upon the detailed construction of the mandrel bar and its connection to the cross head, this construction being such as to permit of the mandrel bar being readily coupled to or uncoupled from the cross head while the mandrel bar is being lowered into or lifted from the supporting trough.

A still further object in this connection is to improve upon the construction of the mandrel bar by the provision of a plurality of rolling plugs disposed in spaced relation upon the mandrel bar and in certain forms of my apparatus by the provision of rolling plugs which surround the core of the mandrel bar and are held in spaced relation to it by means of spacing sleeves, these plugs and the spacing sleeves being detachably mounted upon the core of the mandrel bar.

A further object is to provide plugs of this character having a relatively hard outer surface and a relatively soft inner body and provide a plug which is beveled or rounded from its entrance end upward toward the middle and is then approximately flat faced longitudinally for a certain distance and then beveled or rounded downward toward the mandrel.

Other objects will appear in the course of the following description.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a longitudinal section of one form of mandrel and a portion of the support therefor, the coupling between the mandrel and the cross head being shown in elevation, the roll stands being shown in section and the tube being shown in section;

Figure 2 is a vertical sectional view of the water inlet valve and the means for supporting it and of the adjacent portion of the mandrel;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is a fragmentary longitudinal section of a modified form of mandrel;

Figure 5 is a longitudinal fragmentary section of another form of mandrel;

Figure 6 is a sectional view through one form of mandrel plug;

Figure 7 is a diagrammatic view of electrically operated means for automatically raising or lowering the water supply valve.

Referring particularly to Figures 1, 2 and 3, 10 designates the core of the mandrel bar or mandrel bar proper. This may have any desired length and, of course, has a length greater than the length of the series of roll stands. At its forward end, this mandrel bar which is preferably tubular, as will be later explained, is reduced to form the neck 11 and the pointed or conical head 12 larger in diameter than the neck 11. Surrounding this neck 11 and bearing against the head 12 is a split locking sleeve 13. It will be seen that the portion 14 of the head 12 is reentrantly angled and that the forward end of the split locking sleeve 13 fits into this reentrant angle. The rear end of the split locking sleeve is also formed on its periphery with a projection or shoulder 15, the end wall of this shoulder being right angled. Disposed around the mandrel bar are a series of sleeves 16 and intermediate annular plugs 17. The rearmost sleeve is engaged by a locking nut 18 which in turn is engaged with a screw-threaded sleeve 19, this locking nut having openings 20<sup>a</sup> whereby a wrench bar may be inserted to rotate the locking nut and jam it against the adjacent sleeve 16 so as to force the sleeves and the plugs longitudinally along the core of the mandrel bar and the forwardmost sleeve into interlocking engagement with the split locking sleeve 13 and the sleeve 13 into engagement with the head 14. The adjacent sleeve and the undercut end of the head 14 prevent the split sleeve 13 from opening until the pressure against the sleeves of the locking nut 18 is removed.

It will be seen from Figure 1 that the plugs 17 have a diameter at the middle portions greater than the exterior diameter of the sleeve 16 but that the end portions of the plugs are tapered downward from this middle portion to a diameter equal to the diameter of the sleeve 16. The particular advantage of this construction of the plugs will be later adverted to.

The core 10 of the mandrel extends through an opening in the mandrel bar head supporting frame which is designated generally 20 and which may be of any suitable or usual construction. Within the frame 20 is disposed an annular bushing 21 which is interlocked with the frame 20 against forward movement and disposed within this bushing is the mandrel bar head 22.

Bolted to the rear end of the mandrel bar head 22 is a female coupler element 23, the rear end of which is formed with a vertical T-shaped

slot 24 for the reception of the T-shaped male element 25 of the cross head coupler 26. It is to be understood that the cross head coupler 26 is connected to a piston operating within the usual cylinder to project or retract the mandrel, the cylinder, piston and the cross head and allied parts having nothing to do with my present invention.

Attention is called to the fact, however, that the coupler 26 is formed on each side of the male element 25 with the longitudinally extending vertically disposed lugs 27 and that these engage exteriorly of the arms or sides 28 which define the T-shaped slot 24 so that when the rear end of the mandrel bar is moved downward to engage the coupler 28 with the coupler 26, that the two lugs 27 interlock with the portions 28 and hold these portions 28 in interlocked relation with the T-shaped head 25 and prevent this bifurcation or coupler fork from opening up under strain.

The forward end of the coupler 23 is provided with an opening 29 defined by an upstanding wall 30 as shown in Figures 2 and 3. This opening 29 extends downward to the center of the coupler as at 31. Extending through the coupler is a perforated pipe section 32 having a series of circumferential perforations 33, one end of the pipe section being closed and the forward end being open. The opened end of the pipe section 32 is formed with a collar 34<sup>a</sup> and the closed end carries the nut 34 bearing against the body of the coupler as shown in Figure 2. Connected to this pipe section 32 and extending longitudinally from it through the center of the mandrel bar is a water inlet pipe 35 shown clearly in Figure 1, this pipe extending the entire length of the mandrel bar and discharging adjacent the forward closed end of the mandrel bar. This inlet pipe 35 is supported at intervals by radially extending supports 36 as shown in Figure 1. These supports act to center the pipe 35 and prevent this pipe from sagging and so touching the mandrel bar at any point. This is a very important feature of my invention as will hereafter appear.

Referring again to Figures 2 and 3, it will be noted that the water inlet opening 29 is crossed by a transverse bar 37 which, as shown in Figure 3, is less in width than the width of the opening 29.

Disposed above the mandrel bar, when the mandrel bar has reached the position shown in Figure 1 within the rolls, is a water inlet controlling valve shown in the upper portion of Figures 2 and 3. This comprises a supporting frame or body 38 which is supported by the girders 39 or other suitable supports. Supported on this body 38 is a cylinder 40 having therein a piston (not shown) connected to a piston rod 41. This piston rod is operatively connected to a plug 42 which is screw-threaded and engaged with the upper end of a vertically shiftable valve body 43. The interior of this valve body is hollow as at 44 to provide a water chamber connected to a source of water supply by a pipe 45. Disposed within this chamber 44 or valve casing is a valve 46 which is urged downward by a spring 47, this valve having upon its under face a packing 48. The valve casing 43 at its lower end has a downwardly extending passage 49 within which is disposed an elongated spider 50 as shown in Figure 3. The upper end of this passage 49 has an upwardly extending valve seat 51 upon which the valve 46 rests. A stem 52 extends downward from the center of

this valve and extends downward through the passage 49 and normally projects below this passage in the position shown in Figures 2 and 3. It will be seen that water passages are provided exteriorly of the spider 50, these passages being designated 53. The lower end of the cylinder 43 is provided with an outwardly projecting annular flange 54 adapted to rest upon the wall 30 and carrying a packing 55 so that when this valve is lowered on to the wall 30, a water-tight joint is provided. The wall of the passage 53 extends down below this packing 54 to form a nozzle 56 so as to fit within the upstanding wall 30. It is to be noted that the opening 29 defined by the upstanding walls 30 is larger than the wall 56 of passages 53 and that the flange 54 with the gasket 55 below it extends out in all directions beyond the wall 30 to such an extent as to permit a slight difference of alinement between the part 56 and the opening 29. Thus in order for the valve to properly function, it is not necessary that the part 56 should be exactly concentric to the vertical center of the opening 29 but it may be to one side or the other of this center line. Thus it will be seen that my water valve construction, as regards the connection between the parts 30, 37, 55 and 56 is flexible and the alinement can vary as much as three inches or more in any direction and yet perfect contact can be made between the wall 30 and the gasket 55 and water-tight joint will result. The reason that it is necessary for me to have a flexible connection, that is, a connection in which the alinement may vary is because, as disclosed in my pending application, Serial No. 674,593 filed on the 6th of June, 1933, I use three or more mandrel bars arranged in parallel relation to each other and mounted on a common carriage that moves with the mandrel bars at right angles to the rolling pass so that any one of the mandrel bars may be brought in line with the rolling mill pass. It is impossible to operate the carriage so as to bring the outlet of the valve casing absolutely in accurate alinement with the inlet opening 29 of each of these mandrels and hence some provision for play must be allowed. Furthermore, in my invention, the mandrel bar when brought in pass alinement, is held in that position by the bushing 21 in Figure 1 and, as this bushing wears, the alinement of the mandrel bar is caused to vary or shift. With my variable connection between the water controlling valve and the part 29, the mandrel bar with the part 30 thereon can be moved in any horizontal direction and the valve will make perfect connection with 30 and produce a tight joint. The same structure may be used for supplying the mandrel bar with cooling water when it is not in operation but when it is out of the rolling mill and fully retracted. Due to the fact that the mandrel bar has a length from 75 to 150 ft. or more, the carriage upon which the mandrel bar or bars is or are mounted must also be made the same length and, therefore, the alinement or proper position of the part 30 on the mandrel bar in relation to the valve body disposed above the point of greatest retraction of the mandrel bar may vary considerably from the true position due to some possible defective condition or contraction or expansion of the long carriage.

Now when the mandrel has been forced into the position shown in Figure 1 within the roll stands, the coupler is brought into position immediately beneath the valve. The valve is then lowered, either automatically or by hand, by forcing fluid under pressure into the upper end of

the cylinder 40, thus forcing the valve chamber 43 downward and as the stem 52 strikes the cross bar 37, the stem is relatively lifted, that is, the stem is held stationary while the valve body moves downward and water immediately passes from chamber 44 downward through the passages 53 into the opening 29 into the pipe section 30 and thence by pipe 35 through the entire length of the mandrel, then out at the forward end of the mandrel back around the pipe 35 and out through a discharge outlet 57 shown in dotted lines in Figures 1, 2 and 3. When the pipe A has been completely rolled and has moved off the mandrel, then air or other pressure fluid is admitted beneath the piston in the cylinder 40, the water supply structure is immediately raised and the valve automatically closes to cut off the supply of water and then the cross head is run back to withdraw the mandrel to its initial position entirely out of the roll stands and in position to receive another pierced ingot or billet to be rolled.

It may also be desirable, when the mandrel has been fully withdrawn, to supply water to the mandrel to keep it cool and in that event an automatic valve structure such as shown in Figure 2 will be supported immediately above the rear end of the mandrel when the latter has been fully withdrawn and lowered into position as soon as the mandrel has reached its fully withdrawn position.

While I have referred to the water supplying means as being either operated by hand to raise or lower it or operated automatically, preferably I operate it automatically as will be later stated.

In Figure 1, the ordinary roll stands B are shown with three rolls disposed in the usual manner, but it is to be understood that this is purely illustrative and that any number of rolls may be used depending upon diameter of the pipe and the reduction to be made therein. It will also be seen that in Figure 1 I have illustrated a constant diameter mandrel bar and that the rolls are rotating in the direction of the arrows in Figure 1 so that the tube is being pulled away from the mandrel bar support and toward the free end of the mandrel and that thus the mandrel bar is under tension at all times. It will also be noticed that in this figure, the outside diameter of the rolling plugs is the same for all of the roll passes. Hence the inside diameter of the tube is constant at all roll passes. The mandrel bar during the rolling operation is held in a fixed position by the bushing 21 located in the supporting frame 20 and this takes care of the heavy pull produced on the mandrel bar. Of course, it will be understood that different sized bushings are used for different sizes of mandrel bars.

The mandrel bar head 22 is locked to the rear end of the mandrel bar by means of a key 58 and the sleeve 19 is also locked to the mandrel bar by a key 59, thus preventing the mandrel bar head and sleeve from turning on the mandrel bar body. The coupler with the valve connection attached to it is bolted to the mandrel bar head. The mandrel bar is then ready for use. To put the mandrel into operation, it is lowered into the trough (not shown) and coupled to the coupler 26 of the cross head or operating carriage as the mandrel bar is lowered into place and is then ready for operation, that is, to be forced forward with the tube upon it and into position between the roll stands.

In Figure 4, I illustrate a variable diameter mandrel bar which is similar to the constant di-

ameter mandrel bar except that the mandrel bar is either made of one piece with two or more different diameters forged or drawn thereon or made of several lengths in different diameters, the lengths being assembled and welded together, as shown in Figure 4.

In Figure 4, 10a designates one section of the mandrel bar and 10b a second section of less exterior and interior diameter. The section 10a is formed at its forward end with a head 60 and the section 10b at its rear end is formed with a head 61, the head 61 being disposed inward of and against the head 60. The head 60 is then welded to the section 10b as at 62. The plugs 17a may be of the character shown in Figure 1 or may be of a different character as illustrated in Figure 4 but these plugs are held in spaced relation upon the core of the mandrel bar by means of the spacing sleeves 16a. That one of the spacing sleeves which extends over the rear end of the section 10b and the forward end of the section 10a is enlarged in diameter at its rear end as shown in Figure 4.

While I have illustrated this variable diameter mandrel as being formed of sections, I do not wish to be limited thereto. The interior of the mandrel is provided with the water supply pipe 35 as previously described centered upon the supports 36.

With this mandrel bar, the inside diameter of the hollow ingot or tube is reduced at the same time that the outside diameter and wall thickness is reduced and thus the finished rolled tube has a smaller inside diameter than the original inside diameter of the hollow ingot or tube.

In Figure 5, I have illustrated a portion of a mandrel bar for small diameter tubes (4 in. O. D.) and smaller. This mandrel 10c is made of one piece with the plugs formed upon the exterior of the bar and may be made hollow for water cooling as illustrated in Figure 5 or solid and may be either of a constant or variable diameter. Such a mandrel bar does the same work as the mandrel bar shown in Figures 1 and 4 but is intended for tubes of small diameter.

The diameter of the mandrel bar body between the projecting rolling surfaces or plugs 17b is smaller than the diameter of the plugs in order to relieve these parts from doing any work and to reduce the resistance of the tube in its path between the rolls. The contour of the integral plug 17b is the same as the contour of the plug shown in Figures 1 and 4.

It will be seen that in all forms of my mandrel, the contour of the rolling plugs is essentially the same, that is, it is made up a central portion 63 of uniform diameter and on each side of this middle portion 63, the plug is tapered or rounded inward toward the ends of the mandrel as at 64 (see Fig. 6). This makes the rolling plug symmetrical about the center which is very necessary.

The conical ends 64 enable the rolled tube to advance over them without resistance until the tube meets the straight middle portion of the rolling plug and since this straight middle portion is correspondingly short and the travel of the end of the tube along the short surface before it reaches the rolls is shorter, the resistance of this middle portion need not be considered.

The rolling plug 17 shown in Figure 1 is made of one piece of material with flush ends while the plug shown in Figure 6 is made of two different kinds of materials and particularly made up of an outer shell 65 of a hard and heat-resisting alloy and an inner core 66 of soft steel,

the ends of this core in Figure 6, terminating flush with the ends of the outer shell. This outer shell is interlocked with the core 66 as shown in Figure 6.

The inner core 66 may, as shown in Figure 4, be formed with counter-bored ends as at 67 into which the ends of the separators extend to thereby anchor the ends of the separators within the rolling plug and prevent the separators from moving around. This construction assists also in making the mandrel bar a more rigid body.

While I have not illustrated this, it is obvious that for small diameter tubes, as stated before, the mandrel bar may be solid, this mandrel bar, however, carrying the rolling plugs either as shown in Fig. 5 or Figures 1, 4 and 6.

The general operation of this mandrel bar in connection with the rolling of pipe will be understood from what has gone before by those skilled in the art. This invention is particularly designed to be used in connection with the method and apparatus for piercing ingots shown in my pending applications for patent, Serial No. 584,234 and Serial No. 490,229, filed on the 31st day of December, 1931 and the 21st day of October, 1930, respectively, for Method of and apparatus for piercing ingots. In the application of this method, an ingot is poured and when the ingot is in such condition that the interior of the ingot is plastic, the ingot is pierced either entirely through the length of the ingot or partially through the length of the ingot. This ingot is then cropped or cut off and it is this ingot which, after reheating, is transferred to the rolling mill. The mandrel is then forced through the ingot and the ingot is brought into position in engagement with the first stand of rolls which, as shown in Figure 1, will act to reduce the exterior diameter of the ingot and draw the tube longitudinally over the mandrel until the forward end of the tube reaches the second stand of rolls, which in turn reduces it still further and so on until the completed tube is withdrawn entirely from the mandrel, the tube having been reduced in diameter either exteriorly or interiorly and exteriorly (by means of such a mandrel as shown in Figure 4) and the last pair of rolls drawing the tube entirely off of the mandrel.

It must be borne in mind that in making long lengths of tubes in a continuous rolling mill, all rolls come into action at the same time after the tube has reached the last roll pass and that at this time the pull on the mandrel is particularly great, the pull on the small mandrels being in the same relative proportion as the pull on large mandrels. The sudden heavy load cannot be applied to a mandrel without something very substantial to hold the mandrel under this tension. Furthermore, it must not be forgotten that this suddenly applied heavy load action is repeated a thousand or more times in a working turn of ten hours and such a pounding and strain upon the mandrel requires a rigid construction, not only as to the mandrel itself but as to the head or other means which holds the mandrel under this strain.

The design and construction of my mandrel bars are such that they embody strength, simplicity and rigidity and are easily disassembled or assembled in quick time and can be used for the manufacture of large or small tubes. It is reiterated that in my mechanism, the mandrel is not moved through the passes with the tube but is moved into position with the plugs disposed concentrically to the rolls and that it is the rolls themselves which act to draw out the tube along

the mandrel and eventually draw the tube off of the mandrel so that thus tubes of any desired length and any desired diameter may be readily made because the length of the tubes is not limited to the length of the mandrel as is the case where the billet is forced on to the free end of the mandrel and lengthened toward the fixed end of the mandrel where the length of the tube is thus limited by the back stop at the rear end of the mandrel.

In my construction, as will be obvious from Figure 1, the tension on the rolling plugs 17 which would tend to pull them toward the free end of the mandrel is resisted by the sleeves 16 and this in turn is resisted by the split collar 13 which bears against the head 12 so that the strain is transmitted as a tensional strain on the interior core 10 of the mandrel, this strain being carried back and being supported by the mandrel head engaging with the bushing 21 which in turn is supported against any movement by the mandrel bar head supporting frame 20 which, of course, is made very rigid and strong.

Attention is particularly called to the shape of the plugs 17, 17a or 17b, it being remembered that this mandrel is designed particularly for rolling hot tubes with large reductions per pass. Under these circumstances, the metal is soft and has not much resistance to maintain its form under pressure or, in other words, the metal cannot resist the crushing force of the rolls. With my rolling plug, the end of the tube as it enters the pass is gripped solidly in the roll grooves due to the wedging action produced by the inclined surfaces of the rolls and straight backing up surface of the plug, thus reducing the outside diameter of the tube and the wall thickness and causing the reduced tube to travel forward as it is being rolled into a reduced tube. The conical ends enable the rolled tube to advance over them without any resistance until the tube meets the straight part of the rolling plugs.

I am aware of the fact that a cooling water inlet pipe has been used in mandrels for rolling tubes but these installations have been open to two objections:—One of these is that the inlet pipe was not supported within the center of the mandrel and out of contact with the sides of the mandrel and that long lengths of hose were used which moved with the mandrel bar and which were a source of constant and great danger to operatives. The feeding of the cooling water to the mandrel bar is a very vital function of the mandrel bar and my cooling water valve and method of operation cannot be dispensed with when the mandrel bar is used for a continuous rolling mill. The fact must not be lost sight of that the mandrel bar has a large volume of metal and that the volume of the cooling water in the mandrel bar is small in comparison with the amount of heat it must absorb in its flow. Hence the flow must be swift and continuous in order that it will function properly and keep the temperature of the mandrel bar at a low degree. In other words, in order to accomplish this result, the water pipe must be kept centered with relation to the mandrel bar and the flow of water constantly maintained.

To the end that the water inlet pipe may function properly at all times, I provide supports which center this pipe and prevent the pipe resting on the bottom of the bore. By doing this, the inlet pipe is prevented from getting hot by direct contact with the body of the mandrel and this prevents the generation of steam and pre-

vents the choking off of the incoming cooling water. The necessity of doing this is apparent from the fact that 85% of the length of the mandrel bar is surrounded by the hot tube which is at a temperature of between 2,000 to 2,200 degrees F. and furthermore that portion of the mandrel bar which is located between the first and the last pass is cut off from all ventilation. Thus the mandrel bar will get extremely hot even though it be cooled with cooling water. Should, however, the cooling water feed line be interrupted from any cause whatsoever, the mandrel bar will be ruined in a very short time. While the mandrel bar used in a single stand rolling mill is surrounded by the hot tube, yet it has ventilation from both ends of the tube and is not confined very long in the hot tube but in a continuous tube rolling mill, the mandrel bar is confined in the hot tube five, six or more times as long as it is in a single roll stand (depending upon the number of roll stands in the mill). Hence the greater heating effect and the greater care which must be taken to keep the mandrel cool.

Preferably, the cooling water valve will be operated by the piston rod 41 having the piston operating within the cylinder 40 and air or other fluid will be admitted into this cylinder on one side or the other of the piston automatically by means of an electrically operated valve. Thus when the mandrel bar comes to a stop in its travel into the continuous tube rolling mill, the mandrel bar will make electrical contact which will operate the valve, permitting air to be admitted into the cylinder 40 above the piston and causing the downward movement of the valve casing 43 and when the finished rolled tube leaves the last roll pass, it will operate an electric contact which will reverse the electrically operated air valve so as to discharge air into the cylinder 40 on the under side of the piston, thus lifting the water valve casing 43 and disconnecting it from the mandrel bar.

Such a construction is shown diagrammatically in Fig. 7. In this figure, there is shown the cylinder 40 and the piston rod 41 of this cylinder, this piston being connected to the valve as shown in Figure 2. The cylinder is shown as having two pipes 68 and 69 extending to opposite ends of the cylinder and extending into a valve casing 70 having therein an oscillatable valve which when turning in one direction will connect the pipe 68 with the outlet pipe 71 and pipe 69 with the inlet pipe 72 or vice versa. This valve has an arm connected to a lever 73 in turn connected to the core 74 of a solenoid 75. This solenoid coil is connected to a line wire 76 on one side and on the other is connected to a switch blade 77. When the mandrel is forced in between the rolls and the head of the mandrel comes against the mandrel support 20, this blade 77 will be forced against a contact 78 connected to a line wire 79 in turn extending to a contact 80, disposed at a point adjacent the forward end of the tube A when the tube has entirely left the roll stands. Coacting with this contact 80 is a switch blade 81 pivotally connected to the line wire 82. This switch blade has an arm 83 extending forward. Starting with the mandrel bar out of the rolls, the switch blade 77 will be open and the switch blade 81 will be closed by gravity against the contact 80 and arm 83 is disposed in the path of movement of the completed tube A. The mandrel bar is then moved forward and on reaching the supporting frame where it is stopped as shown in Figure 1,

it closes the blade 77 against the contact 78 and thus, inasmuch as the switch blade 81 is closed, the circuit is completed, thus energizing the solenoid, causing the core thereof to move upward and opening the air valve, admitting air to the upper part of the cylinder, thus causing the piston within the cylinder to lower and lower the water valve to make connection with the mandrel bar and permit the flow of water into the mandrel bar. The parts remain in this position until the rear end of the tube A leaves the last rolls. The forward end of the tube A then comes at this time in contact with the arm 83 of the switch blade 81, opening a circuit and deenergizing the solenoid. The core of the solenoid then drops and reverses the air valve 70, admitting air to the lower part of the cylinder, which lifts the valve from the mandrel bar, thus cutting off the supply of water. The mandrel bar is then withdrawn from the mill, allowing switch blade 77 to open and the tube A continuing in its movement releases the arm 83 of switch 81, thus closing the switch and completing the cycle of operation.

It will be understood that a solenoid may be used in place of the cylinder 40 with its piston and this solenoid may be used for raising or lowering the air valve and the solenoid may be energized and deenergized automatically by the switches shown in Figure 7.

While I have described the valve casing 43 as being raised and lowered by means of a cylinder 40 into which compressed air or other motive fluid is introduced, I do not wish to be limited to this as it would be entirely possible to use a solenoid for the purpose of raising or lowering the cooling water valve.

I claim:—

1. A mandrel for use in continuous tube rolling mills including a central core having a head at one end, the opposite end of the core being reduced in diameter to form a neck and provided with a terminal head beyond the reduced portion, a series of annular rolling plugs disposed upon the core, spacing sleeves disposed between the plugs and holding the plugs in spaced relation on the mandrel, a split sleeve surrounding the neck at the forward end of the mandrel and engaging against the last sleeve of the series and against the terminal head at the forward end of the mandrel, and means at the other end of the mandrel adjustably bearing against the first sleeve of the series, the rolling plugs projecting outward beyond the sleeves.

2. A mandrel for use in continuous tube rolling mills including a longitudinally extending core, the forward end of the core being reduced in diameter to form a neck and a terminal head disposed beyond the neck, a series of rolling plugs mounted at intervals upon the core, a series of spacing sleeves disposed between said plugs, a split sleeve surrounding the neck of the core and bearing against the terminal head thereof, the rear end of the split sleeve having an annular shoulder to bear against the adjacent end of the last spacing sleeve of the series whereby to hold the split sleeve from opening, and a nut carried upon the rear end of the mandrel and bearing against the first sleeve of the series, the rolling plugs extending outward beyond the spacing sleeves.

3. A mandrel for use in continuous tube rolling mills including a core having a flanged rear end, a mandrel bar head surrounding the rear end of the core and fitting said flanged rear end and keyed thereto, a sleeve nut surrounding the core

and bearing against this head having an exteriorly screw-threaded shank, a coacting sleeve nut surrounding the core and having screw-threaded engagement with the first named nut, a series of rolling plugs mounted at intervals upon the core and loosely surrounding the core, a series of spacing sleeves disposed between the plugs, the forward end of the core being reduced in diameter and beyond this reduced portion being provided with a terminal head, a split sleeve surrounding the reduced portion and disposed to bear against said head, the rear face of the split sleeve being annularly shouldered to abut against the adjacent end of the adjacent spacing sleeve, the second named sleeve nut bearing against the rear end of the rearmost spacing sleeve whereby the sleeves and plugs may be locked upon the core of the mandrel.

4. A mandrel for use in continuous tube rolling mills including a core having successive portions thereon reduced in diameter from the butt end to the forward terminal end of the mandrel, and rolling plugs thereon successively less in exterior diameter from the rear end of the mandrel to the forward terminal end thereof and spacing sleeves disposed between the plugs and surrounding the core of the mandrel and holding the plugs in spaced relation to each other, and means for locking the spacing sleeves and plugs against movement on the core.

5. A mandrel for use in continuous tube rolling mills having a core, a series of plugs disposed on and surrounding the core, spacing sleeves spacing said plugs from each other and surrounding the core, the plugs having annular end recesses into which the extremities of the spacing sleeves extend, the outer walls of the recesses overhanging the ends of the adjacent sleeves and means for locking the spacing sleeves and the plugs on the core from longitudinal movement.

6. The combination with a continuous hot tube rolling mill having a series of roll stands, of a tubular mandrel insertible into the rolls with the tube section thereon, said rolls rotating in a direction to draw the tube section off of the mandrel, means at the rear end of the mandrel for holding it from movement with the tube being rolled, means for shifting the mandrel into or out of the rolls, a water supply pipe extending longitudinally through the interior of the mandrel from the rear end nearly to the forward end thereof, an element into which the rear end of the tube extends and having a water receiving chamber, a water supply valve casing disposed above the rear end of the mandrel when the mandrel is fully inserted within the rolls, the valve casing being vertically movable toward or from the rear end of the mandrel and into or out of coactive engagement with the walls of the water chamber, a valve carried by the valve casing and normally urged to a closed position but automatically opened when the valve casing is lowered into engagement with the walls of the water chamber, means for raising or lowering the valve casing and operatively connected thereto, means for automatically causing the operation of said first named means to lower the valve casing into engagement with the mandrel when the mandrel has come to a position of full insertion within the rolls, and means actuated by the tube being rolled as the rear end of said tube passes beyond the last roll stand acting to actuate said means to lift the water supply valve casing from its engagement with the mandrel.

7. A mandrel for use in continuous tube roll-

ing mills including a central tubular core formed of a plurality of sections successively decreasing in diameter, the adjacent ends of the sections having coacting interengaging shoulders and being welded to each other, a series of rolling plugs on the core sections, the plugs being of successively decreasing diameter, spacing sleeves disposed between the plugs and around the sections, the plugs projecting over the ends of the spacing sleeves, and means for locking the spacing sleeves in place upon the core.

8. In a continuous tube rolling mill, a mandrel having a head at one end, a supporting frame with which the head engages when the mandrel is disposed in position in the rolls, an element at the rear end of the mandrel and having a water inlet opening, a cooling water pipe extending longitudinally through the mandrel and receiving water from the element, a water supply valve casing supported for vertical movement above the element and connected to a source of water, a valve controlling the discharge from the water supply valve casing and having a stem, means disposed within the element engaging said stem and lifting it when the valve casing is lowered into engagement with said member, means for automatically closing the valve as the valve casing is lifted, air operated means for raising or lowering the valve casing including a controlling valve, and means for automatically shifting said controlling valve when the mandrel has been fully inserted between the rolls to cause the downward movement of the valve casing, and means for automatically shifting said valve to cause the upward movement of the valve casing when the tube has been discharged from the last pass of the rolling mill.

9. In a continuous tube rolling mill, a mandrel having a head at one end, a supporting frame with which the head engages when the mandrel is disposed in position in the rolls, a coupling element engaged with the rear end of the mandrel and having a water inlet opening, a cooling water pipe extending longitudinally through the mandrel and receiving water from the coupling, a water supply valve casing supported for vertical movement above the coupling element and connected to a source of water, a valve controlling the discharge from the water supply valve casing and having a stem, means disposed within the coupling element engaging said stem and lifting it when the valve casing is lowered into engagement with said member, means for automatically closing the valve as the valve casing is lifted, air operated means for raising or lowering the valve casing including a controlling valve, and means for automatically shifting said controlling valve when the mandrel has been fully inserted between the rolls to cause the downward movement of the valve casing, and means for automatically shifting said valve to cause the upward movement of the valve casing when the tube has been discharged from the last pass of the rolling mill, including a solenoid for shifting said valve and having a core operatively connected thereto, the solenoid being connected in circuit with a source of power, a normally open switch disposed to be operatively engaged by the head of the mandrel and shifted to a closed position when the mandrel is fully inserted between the rolls, and a normally closed switch disposed in the path of movement of the tube when it has passed the last roll stand, the switch being shifted to its open position by engagement with the tube.

10. A reciprocable tube mandrel for use with

a series of roll stands, the mandrel being insertible into the rolls with the tube thereon, the mandrel having rolling plugs at intervals, a head at its rear end, a fixed supporting frame through which the mandrel is insertible into the rolls or withdrawable therefrom, a bushing disposed in said supporting frame and against which the head of the mandrel bears when the mandrel is fully inserted, the frame and bushing holding the mandrel from further movement toward the rolls, a reciprocating cross head disposed behind the supporting frame, and bushing, and means detachably connecting the head of the mandrel to the cross head, the bushing and frame holding the mandrel against the pull exerted by the rolls on the mandrel in withdrawing the tube from the mandrel.

11. A tube mandrel for use with a series of roll stands, the mandrel being insertible into the rolls with the tube thereon, the mandrel having a core provided with heads at its opposite ends, a series of rolling plugs mounted at intervals upon the core, sleeves surrounding the core and disposed between the rolling plugs, a mandrel bar head surrounding the rear head of the mandrel core and having a reduced portion, an exteriorly screw-threaded sleeve surrounding the core and bearing against the mandrel bar head, a nut engaging the screw-threaded sleeve and bearing against the rearmost sleeve of the series of sleeves disposed between the plugs, the head of the core and the mandrel bar head being keyed to each other, a coupling element bearing against the rear end of the core and bolted to the mandrel bar head, a fixed supporting frame through which the mandrel is insertible into the rolls, a bushing within the frame and engaging the reduced portion of the mandrel bar head, the frame and bushing holding the mandrel bar head and the mandrel from movement toward the rolls.

12. The combination with a mandrel having movement in a horizontal plane, the mandrel being tubular and closed at its forward end, an element engaged rigidly with the rear end of the mandrel for movement therewith and having a water inlet chamber and having an outlet passage from the interior of the mandrel, and a water supply pipe extending longitudinally through the mandrel, the rear end of the supply pipe extending and opening into said element and having openings to the water chamber of the element, of a water supply valve casing mounted entirely above the element and separate from the mandrel and element and free from normal engagement therewith, the casing being vertically shiftable bodily into or out of engagement with the element when the mandrel and element are in a predetermined position, the casing having a valve automatically opened when the casing is lowered into engagement with the element to permit the flow of water from the valve casing into said element and thus into the mandrel, the valve being automatically closed when the valve casing is raised, and manually controllable means for raising or lowering the valve casing.

13. The combination with a reciprocable mandrel having movement in a horizontal plane, the mandrel being closed at its forward end, the rear end of the mandrel having a water chamber rigid therewith and movable with the mandrel, a water supply pipe extending from said water chamber longitudinally through the mandrel and opening into the water chamber, the water chamber having an inlet opening in its upper surface, of a water supply valve casing

mounted on a level above the mandrel out of normal engagement therewith and movable entirely independent of the mandrel, means for supporting the water supply valve casing but permitting it to have vertical bodily movement toward and from the mandrel, the casing having a discharge nozzle insertible into the opening of the water chamber when the valve casing is lowered, and a valve in said nozzle automatically opening when the valve casing is lowered into operative engagement with the chamber to permit the discharge of water into said water chamber of the mandrel, and means for automatically closing the valve as the valve casing is lifted out of operative relation to the mandrel.

14. In a rolling mill, a tubular mandrel having movement in a horizontal plane closed at its forward end, a member constituting the rear end of the mandrel and having a water chamber rigidly engaged therewith for common movement, the chamber opening upon the upper face of said member and having upwardly extending walls, and a cross bar extending across the opening defined by said walls, a water supply pipe extending longitudinally through the mandrel nearly to the forward end thereof and communicating with the interior of said water chamber, the member having a water outlet communicating with the interior of the mandrel, a valve casing operatively supported normally above the mandrel and guided for vertical bodily movement entirely independent of the mandrel toward or from the water chamber when the mandrel is in a predetermined position, the valve casing having a water inlet and a discharge outlet defined by a nozzle, the nozzle being insertible in the opening defined by said upstanding walls when the valve chamber is lowered and having an outwardly extending gasketed flange adapted to have water-tight engagement with the upper edges of the upstanding walls when the valve casing is lowered into operative engagement with the member, a valve controlling the flow of water from the outlet of the valve casing having a stem normally projecting below the nozzle but engaged by said cross bar when the valve casing is lowered, and permitting the flow of water from the valve casing into the inlet opening of the chamber, and means for lowering or raising the valve casing.

15. In a rolling mill, a tubular mandrel closed at its forward end having movement in a horizontal plane, a member constituting the rear end of the mandrel, rigidly engaged with the mandrel for common movement therewith and having a water chamber, the water chamber opening upon the upper surface of the mandrel and having upstanding walls defining said opening, and a cross bar across the opening, a water supply pipe extending from said water chamber longitudinally through the mandrel and communicating with the water chamber, said member having a water outlet duct, a supporting frame disposed above and spaced from the path of movement of the mandrel, a valve casing mounted for vertical movement in said frame entirely independent of the movement of the mandrel, the valve casing having an interior valve seat, and a discharge nozzle extending toward the mandrel, the extremity of said nozzle being adapted to be inserted into the inlet opening of the water chamber, the nozzle having an outwardly extending gasketed flange adapted to bear against the upstanding walls constituting the inlet opening of the water chamber, a vertically movable valve disposed within the valve casing and resiliently urged against

said seat, the valve having a stem projecting below the lower end of the nozzle when the valve is closed and adapted, as the valve casing is lowered, to engage the cross bar and be lifted thereby to lift the valve from its seat and permit the flow of water from the valve casing to said chamber, the interior of the valve casing being connected to a source of water, and means for raising or lowering the valve casing.

16. In a rolling mill, a tubular mandrel closed at its forward end and movable in a horizontal plane, a member rigidly engaged with and constituting the rear end of the mandrel and having a water chamber, the water chamber opening upon the upper surface of the mandrel and having upstanding walls defining said opening, and a cross bar across the opening, a water supply pipe extending from said water chamber longitudinally through the mandrel and communicating with the water chamber, said member having a water outlet duct, a supporting frame disposed above and spaced from the path of movement of the mandrel, a valve casing mounted for vertical movement in said frame entirely independent of the movement of the mandrel, the valve casing having an interior valve seat, and a discharge nozzle extending toward the mandrel, the extremity of said nozzle being adapted to be inserted into the inlet opening of the water chamber, the nozzle having an outwardly extending gasketed flange adapted to bear against the upstanding walls constituting the inlet opening of the water chamber, a vertically movable valve disposed within the valve casing and resiliently urged against said seat, the valve having a stem projecting below the lower end of the nozzle when the valve is closed and adapted, as the valve casing is lowered, to engage the cross bar and be lifted thereby to lift the valve from its seat and permit the flow of water from the valve casing to said chamber, the interior of the valve casing being connected to a source of water, and fluid pressure operated means for raising or lowering the valve casing.

17. In a rolling mill, a tubular mandrel closed at its forward end and movable in a horizontal plane, a member rigidly engaged with and constituting the rear end of the mandrel and having a water chamber, the water chamber having an inlet defined by upstanding walls, there being a cross bar extending across the inlet opening, a water supply pipe extending longitudinally through the mandrel and discharging therein to and communicating at its rear end with said water chamber, the member having an outlet duct leading from the interior of the mandrel, a supporting frame disposed entirely above and spaced from the path of movement of the mandrel, a valve casing mounted for vertical movement in the supporting frame entirely independent of the movement of the mandrel and having a water supply pipe opening therein to, the valve casing having a downwardly extending nozzle adapted to be inserted within the upstanding walls defining the opening of the water chamber, the nozzle being less in cross sectional area than the cross sectional area of said opening, the nozzle above its lower end having an outstanding flange greater in area than the cross sectional area of the opening of the water chamber and its walls, the flange being provided on its under face with a gasket, a valve within the valve casing and having a stem extending downward through the nozzle and normally projecting beyond the same and

adapted when the valve casing is lowered to engage the cross bar of the opening to thereby lift the valve from its seat and permit the flow of water into the water chamber, means urging the valve to its seat, and means whereby the valve casing may be raised or lowered in its frame to bring it out of or into operative relation with the inlet of the water chamber.

18. In a rolling mill, a tubular mandrel closed at its forward end having movement in a horizontal plane, a member constituting the rear end of the mandrel rigidly engaged with the mandrel and having a water chamber opening upon the upper face of the member and defined by up-standing walls, there being a cross bar extending across the opening defined by said walls, a water supply pipe extending from said water chamber longitudinally through the mandrel and discharging thereinto, the member having an outlet duct communicating with the interior of the mandrel, a water supply valve casing disposed entirely above the mandrel and mounted for vertical

movement entirely independent of the mandrel, the valve casing having a water supply pipe, and having a vertically extending discharge nozzle formed to provide a central passage and two lateral passages, the valve casing above the passages being formed with a valve seat, a valve resiliently urged against said seat and having a stem extending downward through the central passage and normally projecting below the lower end of the passage and adapted to be engaged by the cross bar when the casing is lowered to thereby lift the valve from its seat, the nozzle having a cross sectional area less than the cross sectional area of the opening defined by said walls and having an outwardly extending flange projecting in all directions beyond the walls defining the inlet opening of the chamber and having a gasket on the under face of the flange, and means for lowering or raising the valve casing to bring it into or out of co-operative relation to the inlet opening of the water chamber.

BENJAMIN BROWNSTEIN.