Aug. 29, 1944. B. BANNISTER 2,356,734

TUBE MILL

Filed Aug. 14, 1941 3 Sheets-Sheet 1

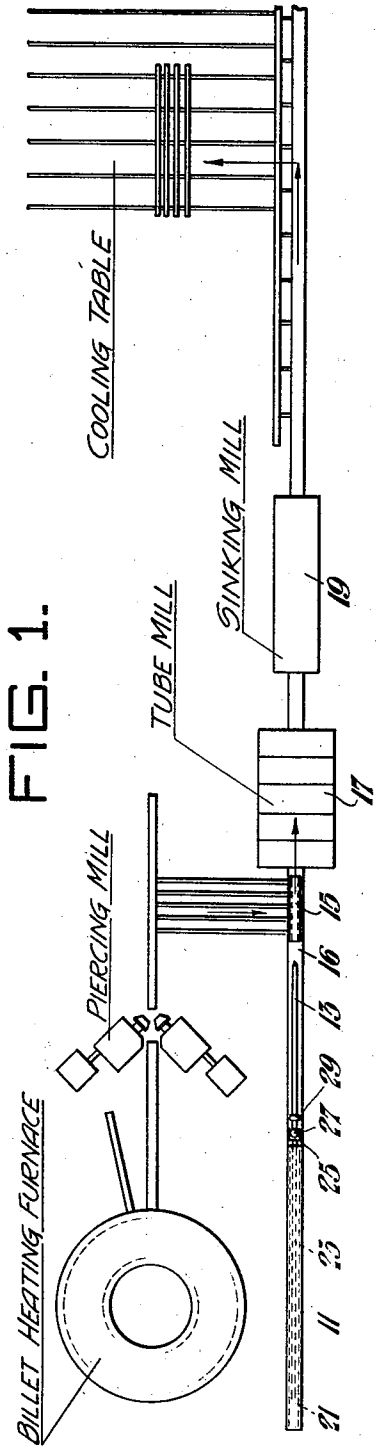


FIG. 1.

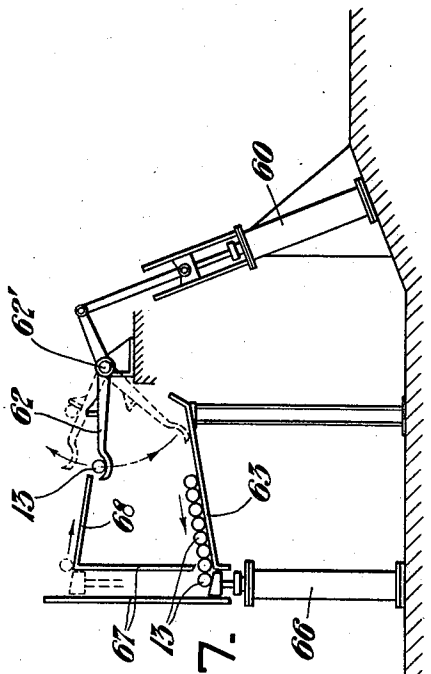


FIG. 7.

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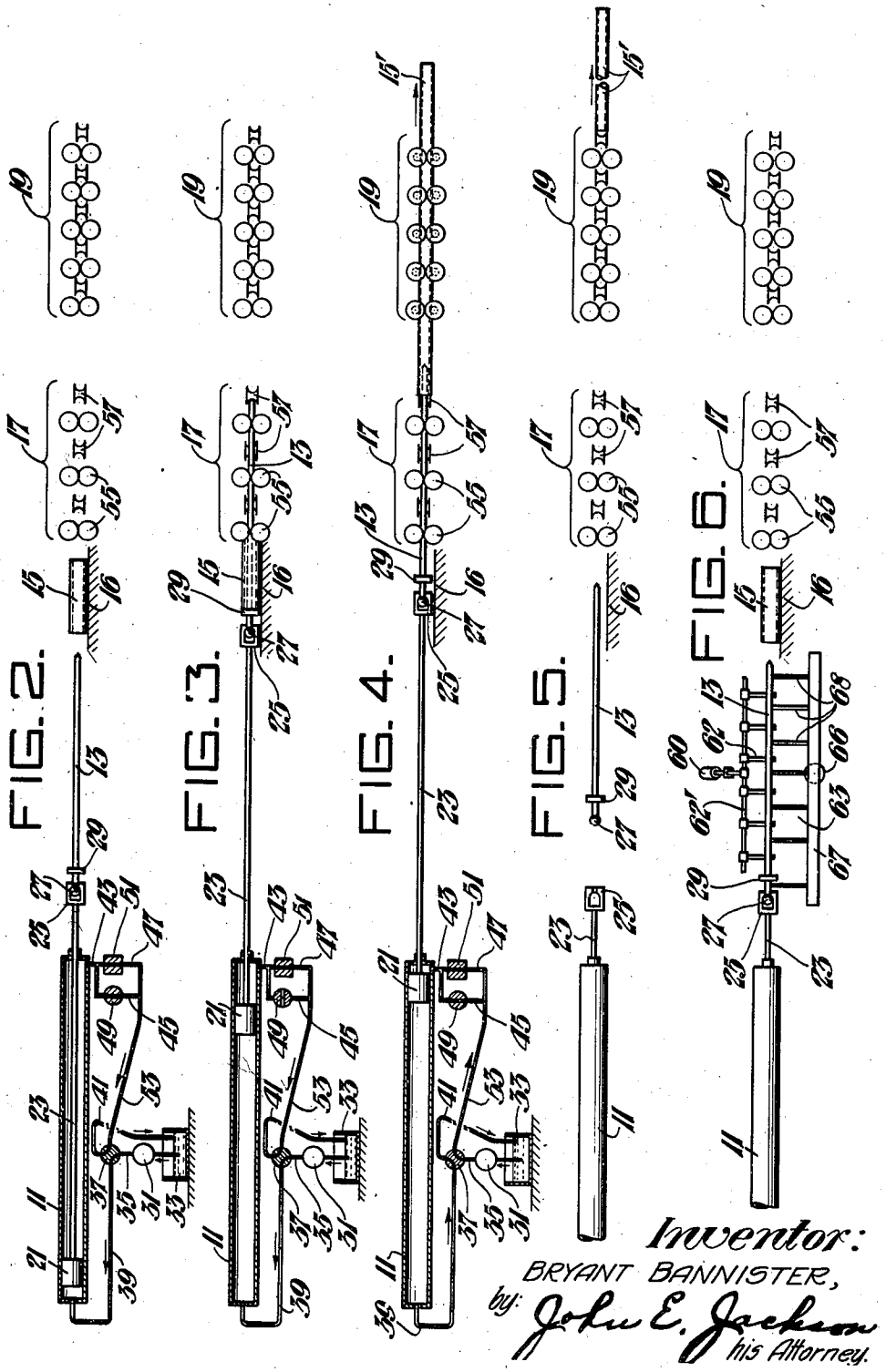


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

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TUBE MILL

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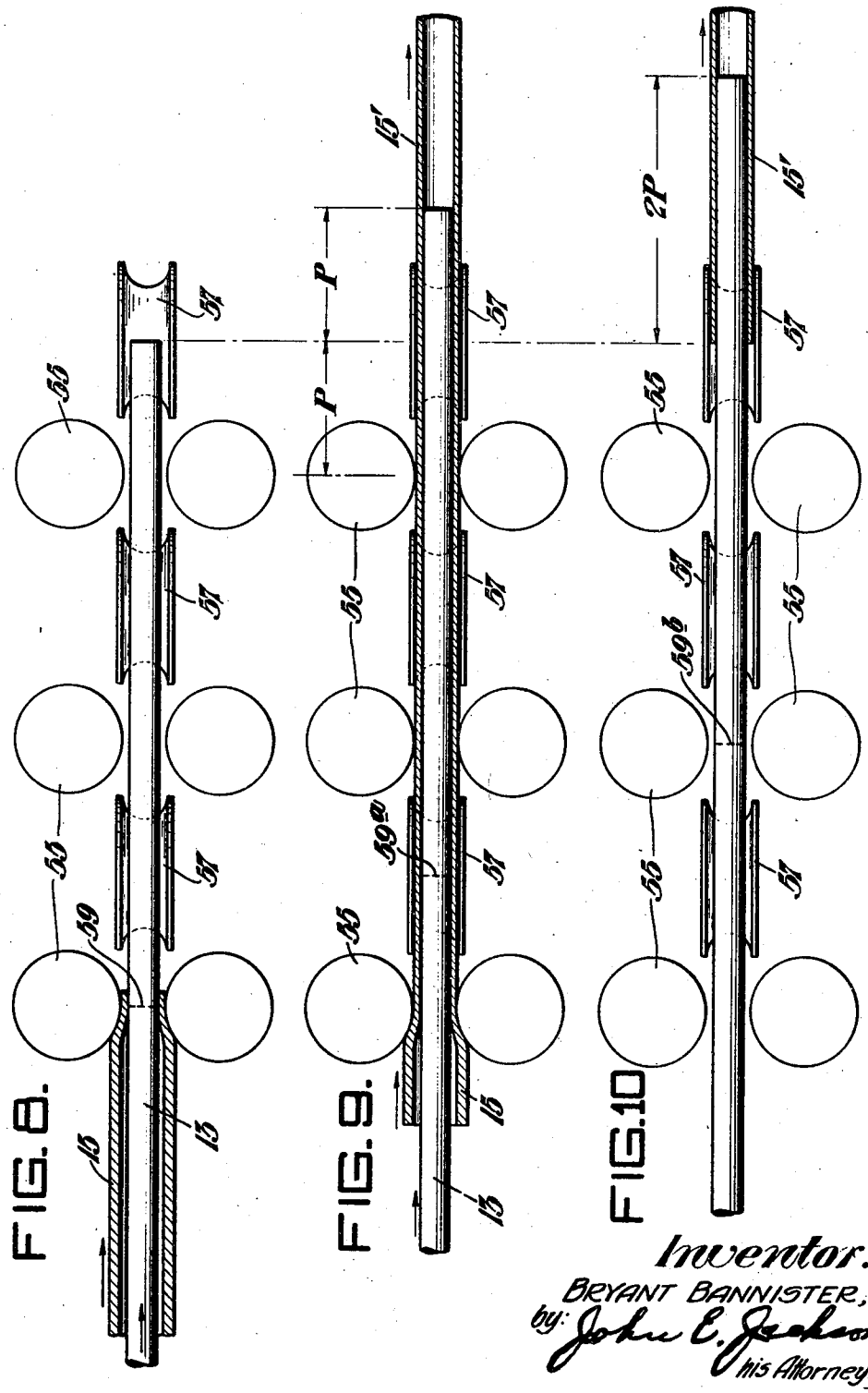


FIG. 8.

FIG. 9.

FIG. 10

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TUBE MILL

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Application August 14, 1941, Serial No. 406,894

9 Claims. (Cl. 80—11)

The present invention relates to a tube-mill layout for the manufacture of seamless pipe.

The manufacture of seamless pipe comprises, in general, the steps of piercing a solid cylindrical billet, reducing the wall and elongating the pierced billet, and finally planishing and sizing the pipe so produced, to the desired dimensions. One specific method which is employed comprises piercing the billet, rolling the billet in a continuous-type mill wherein a series of grooved rolls compress the metal against a mandrel which "floats" through the mill with the billet, stripping the rolled tube from the mandrel, and reheating the tube, after which it is reduced to final size.

The mandrel referred to above forms an internal support for the tube, and it is not mounted nor attached to anything. Consequently, it is said to "float" through the mill.

One object of the present invention is to simplify very greatly the production of seamless tubes by eliminating many of the operations now employed, thereby effecting a substantial reduction in operating costs, as well as a reduction in the cost of installation required to produce pipe.

Another object of the invention is to improve the quality of the pipe produced, by the elimination of reheating with its consequent tendency to pit the surfaces, and the avoidance of variable temperatures in the pipe during processing, which variable temperatures cause irregularities in diameter and wall thickness.

In accordance with the practice which has become accepted as being standard, after the pipe has been rolled on the floating mandrel through the continuous mill, it is necessary to employ a stripping die or other means to effect the stripping of the rolled pipe from the mandrel. Following this operation, the stripped pipe has cooled to such an extent that it is necessary to reheat the pipe before it is sent to the sizing mill or to the sinking-sizing mill, where it is brought to substantially final dimensions. This procedure increases the installation and operating costs quite substantially.

Furthermore, there is required considerably more handling than is necessary to produce the desired results, as it is not practicable to arrange the units of the equipment is alignment with each other, which may be stated to be a further object and advantage of the present improved system.

Generally speaking, in the practice of the present invention, there are employed a billet-heating furnace, a continuous-type rolling mill and a continuous-type sizing or sinking mill immediately following the continuous mill. In order to employ only this limited equipment, thereby eliminating a bar-stripper, reheating furnace, and extensive tables, conveyors and the like, there is employed, in accordance with the present invention, a mandrel in conjunction with the continuous rolling mill, which mandrel is inserted through the pierced billet, and on which the billet is rolled, but which is restrained or held from floating freely through the mill. The mandrel, however, is permitted to move forward, during the rolling of the tube, a distance approximating twice the distance between adjacent roll centers in the continuous mill. Since the alternate roll stands are disposed with their rolling planes at right angles to each other, this limited mandrel movement precludes the rolling of the pipe on any one position of the mandrel more than once.

This mandrel control arrangement permits the continuous mill to strip the rolled tube from the mandrel, thus projecting the forward end of the tube into the tandem sinking mill which then continues to strip the tube from the mandrel after the back end has passed the last stand of the continuous rolling mill, thus rendering unnecessary an extra roll stand to round up the tube which has been rolled by the mill into an oval shape, which has been caused by the action of the rolls of the mill as the wall-thickness of the pipe has been reduced. The extra rounding stand is essential when the mandrel floats through the mill with the pipe.

The present invention permits the placement of a sizing or sinking mill immediately in line with, and only a few feet removed from, the last stand of the continuous mill. As this continuous mill is operated at high roll speed, the tube enters the sizing mill at a temperature sufficiently high, without recourse to reheating, to permit sizing or sinking to a much smaller diameter. The pipe then proceeds to the cooling table and thence to the finishing department.

In practicing the present invention, the mandrel bar is reciprocated by a chain, cylinder, or similar device in line with the continuous mill, the mandrel being withdrawn far enough to permit the pierced billet to be dropped into the charging trough just ahead of the mill. The mandrel then is advanced toward the mill, passing through the pierced billet and into the roll passes of the mill. As the mandrel advances, a collar on the rear end of the mandrel engages the billet, pushing it forward to enter the mill.

The movements are controlled so that, as the billet enters the first roll stand, the forward end of the bar or mandrel is at the last roll stand of the mill. At this point, the rolls grip the pierced billet and draw it into the mill. At this stage, the forward movement of the mandrel is restricted so that it moves forward slowly, traveling only a few feet while the billet is being rolled.

Where the mill is producing small diameter pipe, the mandrels are small and several are employed in rotation. While one mandrel bar is being rolled upon, others are circulated through a cooling bath and returned one at a time to the mill. Large mills are able to employ one mandrel, which is water-cooled, such a mandrel remaining in service until wear necessitates its removal.

With the foregoing considerations in mind, attention may be given to the accompanying drawings which illustrate diagrammatically the foregoing considerations.

In the accompanying drawings:

Figure 1 is a general arrangement of a tube mill;

Figure 2 illustrates the apparatus in starting position, with a pierced billet ready to receive the mandrel, and with the mandrel control mechanism in starting position for beginning the operation;

Figure 3 illustrates the condition when the billet is just entering the continuous mill, the mandrel being almost at the end of its rapid forward travel;

Figure 4 illustrates the conditions when the rolled tube is just leaving the continuous mill and is passing through the sizing or sinking mill, with the mandrel being in its fully extended position, and being shown as having moved forward only a short distance during the passage of the tube-billet through the continuous mill;

Figure 5 shows the sized tube just leaving the sizing mill, the mandrel bar having returned to its retracted position and released;

Figure 6 is similar to Figure 1, completing the operating cycle, with a new billet ready to be run through the mills and a new mandrel bar in position. The view shows, also, means for releasing and replacing the mandrel bars;

Figure 7 is a diagrammatic detail of the mandrel bar handling mechanism; and

Figures 8, 9, and 10 are successive diagrammatic views of the rolling of the tube, the views showing the relative movement between the mandrel bar and tube during the rolling operation.

Referring more particularly to the drawings, the reference numeral 11 represents a means for actuating a mandrel bar 13 for pushing a pierced billet 15 through a continuous reduction mill 17, the resulting tube passing through a sinking mill 19, the respective mills being disposed in tandem alignment.

It will be understood that the actuating means 11 may be any one of several types, as has been pointed out above herein, and the control which will be described hereinafter likewise is intended to illustrate simply a control which will be operative to serve the intended purpose.

In the illustrated embodiment of the invention, the actuating device is a cylinder containing a hydraulic piston which is made up of a piston head 21 and a piston rod 23, the rod 23 terminating in a socket 25 for receiving the ball end 27 of the mandrel bar 13. The mandrel bar 13 has a push collar 29 adjacent to the ball 27.

The control system is illustrated as comprising a pump 31, which draws fluid from a sump 33, and delivers the fluid through a pipe 35 into a four-way valve 37. A pipe 39 connects the valve 37 to the cylinder 11, and enters the cylinder in front of the piston head 21. A pipe 41 connects the valve to the sump 33.

The cylinder 11 opens at its rear end into a pipe 43, which branches into two lines 45 and 47. Branch 45 contains a quick-acting valve 49, and branch 47 includes a constant volume valve 51, the orifice of which is small compared with that of the valve 49, so that flow of fluid is largely through valve 49, unless this valve is closed. The branches 45 and 47 connect through pipe 53, which leads to the sump when valve 37 is in the position shown in Figs. 2 and 3.

The operation becomes clear from Figures 2 through 6.

As shown in Figure 2, at the start of the operations, the valve 37 is open so that fluid is being delivered from the sump 33 through the pipe 39 and into the cylinder 11 in front of the piston head 21. The valve 49 is open so as to relieve pressure behind the piston head 21. Therefore, the pressure of the fluid entering the cylinder 11 through pipe 39 moves the piston head back through the cylinder 11, forcing the fluid behind it out through pipe 43 and branches 45 and 47, valves 49 and 31, and back to the sump through pipe 53.

This action thrusts the mandrel bar 13 through the pierced billet 15 and when the collar 29 in the mandrel 13 engages the billet and brings it to the first stand of rolls in the continuous mill 17, the valve 49 is closed and the fluid passes through the small orifice of the constant volume valve 51. See Fig. 3.

This retards the outward movement of the mandrel 13 which is secured at one end by the socket 25. The result is that the forward movement of the mandrel 13 is much less in its speed than is the movement of the billet 15 through the mill. This results in the mill 17 stripping the now elongated billet from the mandrel, the forward movement of which mandrel is controlled so that it reaches its maximum extension just as the end of the tube is leaving the continuous mill. It will be observed that the tube enters the sinking mill 19 before it entirely leaves the continuous mill 17, and it will be noted that the mandrel 13 having reached its farthest point of extension beyond the mill 17, the tube will be supported substantially throughout its entire length as it moves through the mill 19.

When the tube has cleared the last stand of the continuous mill 17, the valve 37 is turned so as to connect the pipe 39 with the sump, and pipe 53 with the pump 31. Simultaneously valve 49 is opened so that the pump 31 now forces fluid into the cylinder 11 behind the piston head 21 so as to retract quickly the mandrel 13. See Fig. 4. The return of this mandrel, as well as its outward movement, is in line with the center line of the mill 17. As the bar 13 returns to starting position, it is quickly disconnected from the socket 25 by suitable means, which means may be such as those shown in Figure 7. It will be seen that a suitable lifting means 60, which may be a suitable lifting cylinder operates lifting arms 62, which are mounted on a common shaft 62'. These arms act to lift the mandrel bar 13 out of its connection and to transfer it to a cooling bosh 63, which is adapted to contain a plurality of similar mandrel bars ready for use.

When the operation is to be resumed, a lifting

cylinder 66 is actuated, which lifts a mandrel 13 up between guides 67 onto an incline 68, which drops the bar into place in socket 25. Referring to Figures 8, 9 and 10, it will be noted that the continuous mill 17 is made up of a plurality of stands of rolls, each stand being positioned at 90° with respect to the preceding and succeeding stands, so that the billet will be rolled on substantially perpendicular axes. The vertical stands of rolls are indicated at 55, and the horizontal rolls at 57.

Each pair of rolls form a slightly oval pass so that the metal of the billet is reduced in thickness on diametrically opposite arcs of approximately 100° each. The metal in the 90° disposed plane occupies the long diameter of the oval and does not contact the mandrel 13.

Figures 8, 9, and 10 show clearly the relative movement of the billet and mandrel bar during passage through the mill. As the billet 15 enters the first stand of rolls 55, the mandrel bar 13 has passed a considerable distance through the mill. The billet 15 as it enters the mill is pressed against the mandrel bar 13, as shown at contact 59. When this first contact has been made, the further forward movement of the mandrel bar 13 is controlled so that no portion of this bar shall move a distance greater than twice the distance between the center lines of sequential stands of vertical rolls. That is to say, in Figure 9, when the billet 15 has been rolled to form the tube 15', the original contact line 59 will have moved only to the designated location at 59a, and when the tube 15' is leaving the last stand of rolls, the original contact line 59 has reached only the location indicated by 59b. That is to say, the bar has moved a distance not quite equal to that between the center lines of adjacent horizontal roll stands, it being understood that the roll stands are equally spaced. Consequently, this limited mandrel movement precludes the rolling of the billet 15 into the tube 15' on any one portion of the mandrel more than once.

From the foregoing, it will be seen that after the tube has been rolled completely in the continuous mill the sinking mill continues to strip the rolled tube from a portion of the mandrel projecting beyond the last stand of continuous mill rolls.

It will be seen, accordingly, that the present invention permits the arrangement of the continuous rolling mill and the sinking mill to be placed in tandem alignment, and that the movement of the mandrel bar likewise is in alignment with the mills. It will be seen further that the arrangement of the present invention eliminates reheating the work, and eliminates also the customary stripping stand which has been necessary heretofore. The immediate and direct passage of the tube from the continuous mill to the sinking mill prevents substantial loss of heat from the work during such passage; and because the work enters the sinking mill before it entirely leaves the continuous mill, and since the mandrel bar is not withdrawn until substantially the rear end of the work is ready to enter the sinking mill, the work is supported during substantially its entire course of travel through the mills. However, it will be evident that it is not essential that the rolled tube be supported by the mandrel after it has cleared the continuous mill, since a supporting trough normally is provided between the continuous mill and sinking mill for this purpose. Also, the control mechanism for the mandrel acts to start the mandrel bar retracting just as soon as the back end of the tube has cleared the last stand of rolls in the continuous mill, so that the sinking mill is pulling the tube in one direction while the control mechanism is pulling the mandrel in the opposite direction. When this retraction is rapid, and the sinking mill operates relatively slower, then a substantial portion of the back end of the continuous rolled tube yet has to enter the sinking mill after the mandrel bar has been withdrawn, this requiring the use of the supporting troughs referred to above.

Also, the control mechanism for the mandrel limits the forward motion of the mandrel so that it cannot at any time enter the first stand of rolls in the sinking mill.

It will be apparent that as the pierced billet is rolled into a tube in the continuous mill, the mandrel bar functions as an internal anvil upon which the metal of the billet is compressed by the rolls of the continuous mill.

The billets 15 are supported in a suitable trough in alignment with the mandrel bar 13 and continuous mill 17, it having been received in the said trough, which is designated at 16 on the drawings, from the piercing mill, preferably without reheating; although, if desired, the pierced billets may be reheated in a suitable furnace before being handled in accordance with the present invention.

I claim:

1. Apparatus for making seamless tubes, which comprises, in combination, a continuous mill, a sinking mill, and means for delivering a pierced billet into the continuous mill, the mills and delivering means being in alignment, the said delivery means including a semi-floating mandrel bar adapted to enter the billet and support the same during its conversion into a tube in the continuous mill, the mandrel continuing its forward movement during working of the billet in the continuous mill, and means for retarding forward movement of the mandrel relative to the tube in the continuous mill, thereby causing the tube to be stripped from the mandrel in the mill, the said continuous mill and sinking mill being positioned sufficiently closely together to enable the tube to pass substantially and with continuous movement into the sinking mill before it has entirely cleared the continuous mill, and the said mandrel forming a support for the tube after it has cleared the continuous mill until substantially all of the tube has passed through the sinking mill, there being no interruption to continuity of movement of the tube between the continuous mill and the sinking mill.

2. Apparatus for producing seamless tubes, which comprises, in combination, aligned continuous and sinking mills and means in alignment with the said mills for delivering a pierced billet thereto, the said means including a semi-floating mandrel bar adapted to push the said billet into the continuous mill and to support the resulting tube as it is formed in the mill through its entire passage through the mill, and means for controlling the forward movement of the mandrel to effect a differential in speed between the forward motion of the bar and the billet, and to prevent the rolling of the tube on any one portion of the mandrel bar more than once, the sinking mill being adapted to receive the resulting tube from the continuous mill before the tube has entirely cleared the continuous mill, and mechanism for retracting the mandrel bar from the resulting continuous rolled billet

when the billet has entered the sizing mill, the tube entering and passing through the sinking mill without interruption to movement of the tube between the continuous mill and the sinking mill.

3. Mechanism for producing seamless tubes, which comprises a continuous mill and a sinking mill in closely adjacent and aligned relationship, means for introducing the pierced billet into the continuous mill and for supporting the billet through the mill as it is rolled into a tube, and controlling mechanism for the said means for limiting forward movement of the said means during actual rolling of the billet to a distance not more than twice the distance between the center lines of adjacent stands in the mill, the sinking mill being adapted to receive the resulting tube substantially immediately as it emerges from the continuous mill.

4. Apparatus for making seamless tubes, which comprises, in combination, a continuous mill, a sinking mill in tandem alignment with the continuous mill, means for delivering a pierced billet into the continuous mill, the delivering means being in tandem alignment with the mills, the said delivery means including an internal anvil for the pierced billet defining an internal support for the billet against which the metal of the billet is compressed during rolling, the continuous mill and the sinking mill being positioned sufficiently closely together to enable the tube to pass substantially into the sinking mill before it has cleared entirely the continuous mill and means for retracting the said internal anvil from the thus-rolled tube as the sinking mill acts upon the tube to draw the tube through the said sinking mill, the tube passing with a continuous and uninterrupted movement through the said mills.

5. Apparatus for making seamless tubes, which comprises, in combination, a continuous mill, a sinking mill, and mechanism for feeding a pierced billet therethrough, all of the foregoing units being in tandem alignment, the feeding means comprising a mandrel, an actuating bar for the mandrel, a connection between the mandrel and the bar, the said connection holding the mandrel in a semi-floating condition, operating mechanism for the bar for causing the mandrel to move into a pierced billet for feeding into the continuous mill and for continuing forward movement of the mandrel as the billet moves through the continuous mill and is formed into a tube therein and control mechanism for retarding the forward movement of the mandrel as the billet passes through the continuous mill thereby effecting a speed differential between the mandrel and the billet to allow the resulting tube to be stripped as formed from the mandrel, while the mandrel continues its forward movement to a point beyond the continuous mill and intermediate the continuous mill and the sinking mill, the sinking mill being sufficiently close to the continuous mill to allow direct and continuous passage of the resulting tube from the continuous mill to the sinking mill, the said mandrel defining a support for the tube until substantially the entire length of the tube has entered the sinking mill.

6. Apparatus for producing seamless tubes, which comprises, in combination, aligned continuous and sinking mills and means in alignment with the said mills for delivering a pierced billet thereto, the said means including a semi-floating mandrel bar adapted to push the said billet into the continuous mill and to support the resulting tube as it is formed in the mill through its entire passage through the mill, actuating instrumentalities for the mandrel, mechanism for operating the actuating instrumentalities for selectively advancing and retracting the mandrel, means removably interconnecting the mandrel and actuating instrumentalities and mechanism for removing a mandrel from the actuating instrumentalities at completion of each cycle of passage of the billet and mandrel through the continuous mills and for replacing the said mandrel with a new mandrel for the next succeeding passage through the mills.

7. Apparatus for producing seamless tubes, which comprises, in combination, aligned continuous and sinking mills and means in alignment with the said mills for delivering a pierced billet thereto, the said means including a semi-floating mandrel bar adapted to push the said billet into the continuous mill and to support the resulting tube as it is formed in the mill continuous through its entire passage through the mill, actuating instrumentalities for the mandrel, mechanism for operating the actuating instrumentalities for selectively advancing and retracting the mandrel, means removably interconnecting the mandrel and actuating instrumentalities, and mandrel-handling mechanism for removing a mandrel from the actuating instrumentalities at completion of each cycle of passage of the billet and mandrel through the continuous mills and for replacing the said mandrel with a new mandrel for the next succeeding passage through the mills, the said mandrel-handling mechanism being positioned intermediate the mandrel-actuating instrumentalities and the pierced billet in alignment with the mills.

8. Apparatus for producing seamless tubes, which comprises, in combination, aligned continuous and sinking mills and means in alignment with the said mills for delivering a pierced billet thereto, the said means including a semi-floating mandrel bar adapted to push the said billet into the continuous mill and to support the resulting tube as it is formed in the mills through its entire passage through the continuous mill, actuating instrumentalities for the mandrel, mechanism for operating the mandrel-actuating instrumentalities for selectively advancing and retracting the mandrel, means removably interconnecting the mandrel and mandrel-actuating instrumentalities, and mandrel-handling mechanism for removing the mandrel from the mandrel-actuating instrumentalities at completion of each cycle of passage of the billet and mandrel through the mills and for replacing the said mandrel with a new mandrel for the next succeeding passage through the mills, the mandrel-handling mechanism including a stand for receiving a plurality of mandrels, rocker-arm instrumentalities for receiving a mandrel, actuating means for the rocker-arm instrumentalities, whereby operation of the actuating means causes a lifting of the said rocker-arm instrumentalities to enable the rocker-arm instrumentalities to pick up a mandrel out of its interconnection with the mandrel-actuating instrumentalities, while reverse operation of the actuating means deposits the removed mandrel onto the said stand, and instrumentalities for placing successive fresh mandrels from the stand onto the rocker-arm instrumentalities for replacement of the said successive

mandrels into interconnection with the mandrel-actuating instrumentalities.

9. Apparatus for producing seamless tubes, which comprises, in combination, aligned continuous and sizing mills and means in alignment with the said mills for delivering a pierced billet thereto, the said means including a semi-floating mandrel bar adapted to push the said billet into the said continuous mill and to support the resulting tube as it is formed in the mills through its entire passage through the mills, actuating instrumentalities for the mandrel, mechanism for operating the actuating instrumentalities for selectively advancing and retracting the mandrel, means removably interconnecting the mandrel and actuating instrumentalities, and mandrel-handling mechanism for removing the mandrel from the actuating instrumentalities at completion of each cycle of passage of the billet and mandrel through the mills and for replacing the said mandrel with a new mandrel for the next succeeding passage through the mills, the mandrel-handling mechanism including a stand for receiving a plurality of mandrels, rocker-arm instrumentalities for receiving a mandrel, actuating means for the rocker-arm instrumentalities, whereby operation of the actuating means to cause a lifting of the said rocker-arm instrumentalities to enable the said rocker-arm instrumentalities to pick up a mandrel out of the interconnection with the actuating instrumentalities, while reverse operation of the actuating means deposits the removed mandrel onto the said stand, lifting means for lifting successive fresh mandrels from the stand, and a gravity feed for shifting each lifted mandrel from the lifting means to the rocker-arm instrumentalities for placement into the interconnection with the mandrel-actuating instrumentalities.

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