Feb. 26, 1957 F. J. KENNEDY 2,782,743

CONTINUOUS TUBE MILL WITH TENSION COMPENSATOR

Filed Oct. 1, 1952

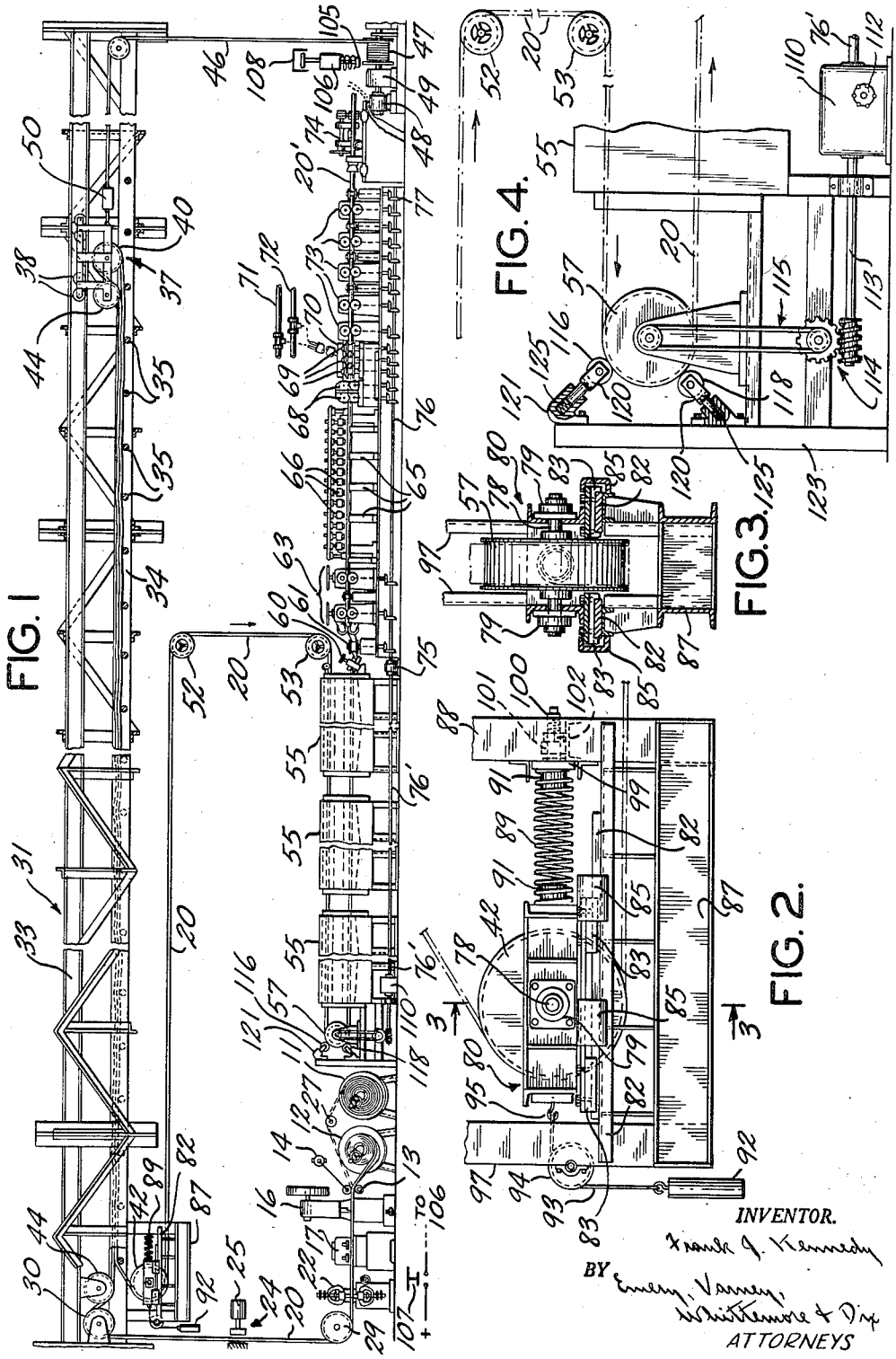


FIG. 1

FIG. 4.

FIG. 3.

FIG. 2.

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United States Patent Office 2,782,743 Patented Feb. 26, 1957

2,782,743

CONTINUOUS TUBE MILL WITH TENSION COMPENSATOR

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Application October 1, 1952, Serial No. 312,555

11 Claims. (Cl. 113—33)

This invention relates to the manufacture of pipe and tubing in a continuous mill. In order to enable a pipe mill to operate continuously, the skelp is taken from reels and a slack accumulator is used to supply skelp to the mill during the time which is required to connect the rearward end of an exhausted reel to the forward end of a new reel.

One object of the invention is to provide a feed for supplying skelp to a continuous mill by driving rolls that contact with the skelp preliminarily to forming the skelp so as to prevent variations in the tubing caused by changes in tension with repeated starting and stopping of the slack accumulator and the reels that supply the slack accumulator. In previous installations, where the roll passes of the mill have supplied all of the power for advancing the metal strip from the reels and through the slack accumulator, heating furnaces and mill, there have been substantial variations in tension which have impaired the uniformity of the product and limited the speed at which the tubing can be produced by the mill. The auxiliary feed rolls of this invention take out most of the variations in tension before such variations reach the main heating chambers of the furnace and the subsequent forming, guiding and welding roll passes.

It is another object of this invention to provide means for compensating variations in the tension of the strip during the operation of the mill. Unless some means are provided for reducing such variation, there are substantial changes in the pull on the skelp as the result of the stopping and starting of a long length of the strip in the accumulator, and the inertia of the other parts, such as the new reel and the carriage which holds the guide wheels for the slack accumulator.

The tension compensator of the invention yields in response to variations in the tension of the strip so that the peaks and valleys of the tension are smoothed out and substantial variations are eliminated. It is sometimes used without the feed rolls.

Another object is to reduce the variations in tension by preventing swinging of the skelp in the slack accumulator, since such swinging of long runs of strip is in itself a cause of variations in tension.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views;

Figure 1 is a diagrammatic side elevation of a tube mill and slack accumulator embodying this invention;

Figure 2 is a greatly enlarged side elevation of the tension compensator shown in Figure 1;

Figure 3 is a sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a diagrammatic, enlarged side elevation of the auxiliary feed rolls shown in Figure 1.

The apparatus shown in Figure 1 includes two stands 11 and 12 for holding reels of skelp.

The skelp is payed out, from the reel on stand 12, through power rolls 13, driven by an electric motor 14. The skelp is fed through a cutoff machine 16, similar to a punch press, and equipped with blades for shearing the skelp near each end of the reel to obtain a square or other straight transverse end for connecting with the next reel.

From the cutoff machine 16, the skelp passes to a welder 17, in which the forward end of the reel is clamped in a position adjacent to the rearward end of the preceding length of strip or skelp 20.

The welder 17 makes an electric weld which joins the skelps quickly and the skelp is then advanced to bring the weld into a dressing machine 22, which can be a miller or a grinder or other device for removing excess material from the weld so as to leave the weld with substantially the same thickness as the remainder of the strip.

When the entire length of the reel on the stand 12 has been used, the strip 20 is stopped by means of a clamp 24, operated by a fluid motor 25. The strip is stopped before its irregular rearward end reaches the cutoff machine 16, and this machine 16 is operated to shear the strip with a straight edge suitable for welding to the next reel of skelp. The strip 20 is then advanced until the rearward end is in proper position in the welder 17.

The forward end of the reel on the stand 11 is then led over a guide roll 27, to clear the stand 12, and through the feed rolls 13 to the cutoff machine 16. The forward end of the new reel is sheared off straight by the cutoff machine 16 to produce an end which will abut evenly with the rearward end of the strip 20 in the welder 17. The welder is operated to connect the strip 20 with the forward end of the new reel of skelp; and after the weld is made, it is advanced to the dressing machine 22 where it is reduced in thickness to that of the remainder of the strip, as previously described.

From the dressing machine 22, the strip 20 passes around a guide wheel 29 and then upward through the clamp 24 to the first guide wheel 30 of a slack accumulator 31. The power rolls 13 are not used except for advancing the forward end of a new reel first to the cutoff machine, then to the welding apparatus, and finally to the dressing machine 22.

The slack accumulator 31 includes a long frame extending for a substantial part of the length of the building in which the tube mill is housed. This frame includes a track 33, and lower supports 34 with a series of rollers 35 extending between them. The strip 20, after passing around the first guide wheel 30, extends along the line of the slack accumulator 31 to a carriage 37. This carriage 37 has wheels 38 which run along the track 33 and which support the carriage. The strip 20 passes around a guide wheel 40 which reverses the run of the strip, and after passing around the guide wheel 40, the strip 20 extends back along the accumulator to another guide wheel 42 near the beginning of the slack accumulator 31. This guide wheel 42 and its supporting structure comprise the tension compensator, as will be more fully described in connection with Figure 2.

The lower run of the strip between guide wheel 40 and the other guide wheel 42 rests upon the rollers 35. The run of the strip 20 between guide wheels 30 and 40 rests upon the run of the strip beneath it throughout most of the distance between the guide wheels 30 and 40. If nothing were provided to prevent it, the strip between guide wheels 30 and 40 would lift up from the strip beneath it along substantial portions of its length near the guide wheels 30 and 40, when the tension on the strip increased. At any time when the carriage 37 was close to the first guide wheel 30, the strip might extend from the guide wheel 30 to the guide wheel 40 with a moderate sag which was not sufficient to bring any part of this upper run of the strip into contact with the run of the strip resting on the roller 35. Such a sagging loop of strip has a tendency to whip and bounce with resulting variations in the tension of that run of the strip, and such variations in tension are transmitted to the strip beyond the guide wheels since the guide wheels are idlers.

In order to prevent the strip between guide wheels 30 and 40 from ever forming a sagging, unsupported loop, or from forming portions of such a loop adjacent to the guide wheels 30 and 40 when the carriage 37 is at a substantial distance from the beginning of the accumulator, two auxiliary guide wheels 44 are provided to hold the top run of the strip down on the lower run of strip beneath it. One of these auxiliary guide wheels 44 is attached to the frame of the accumulator just beyond the first guide wheel 30; and the other auxiliary guide wheel 44 is supported by the carriage 37 and located just ahead of the guide wheel 40.

The carriage 37 is moved toward the left along the track 33, by the pull of the strip 20, when one end of the strip is clamped by the clamp 24. The carriage 37 is moved in the opposite direction, toward the right along the track 33, by a cable 46 which wraps on a drum 47 driven by a motor 48 through reduction gearing 49. The cable 46 is connected to the carriage 37 by a resilient connection 50 containing springs.

The strip 20 passes around the guide wheel 42 and then forwardly under the slack accumulator 31 to another guide wheel 52 beyond which the strip passes downwardly to a guide wheel 53 adjacent to the entrance to a furnace 55. There are three furnaces 55 located in line with one another and constructed in such a way that the strip 20 can be fed first through the upper portions of each furnace where it comes into contact with the products of combustion from the main heating chamber of the furnace.

The strip 20 is thus preheated by passage through the upper portions of the furnaces 55; and after coming out of the end of the last furnace 55, the strip 20 passes around a wheel 57 which reverses the run of the strip so that it passes next through the main heating chambers of the furnaces 55. The wheel 57 is power-driven and comprises part of the auxiliary feed mechanism of the apparatus. Its construction and operation will be described in connection with Figure 4.

After passing through the main heating chambers of the furnaces 55, the strip 20 is directed downwardly through a guide 60 and then passes between the forming rolls 61, which bend the flat strip into an open seam tube.

A group of roll stands beyond the forming rolls 61 control the contour of the tube and maintain the seam at the top of the tube. These roll stands are indicated generally by the reference character 63.

The formed tube, indicated by the reference character 20', passes from the roll stands 63 across supporting guides 65 and under a relatively long series of heaters 66 which are preferably gas burners located directly over the seam of the tube for concentrating heat in the edge portions of the tube with a soaking heat which leaves relatively low temperature gradients immediately behind the edge faces of the seam. This makes the immediately subsequent welding operation less critical to minor variations in tube speed or gas pressure.

The welding block of the tube mill includes guide roll stands 68 and welding rolls 69 which control the seam cleft while the tube passes under a welding torch 70. The welding torch 70 is preferably an oxy-acetylene torch supplied with oxygen through a supply pipe 71 and with acetylene through a supply pipe 72.

Beyond the torch 70, the tube 20' passes through the roll passes of a group of sizing roll stands 73 which reduce the welded tube to an accurate pre-determined diameter. A flying saw 74, beyond the forming roll stands 73, operates at a coordinated speed with the rolls of the mill, to cut the tube 20' to pre-determined length.

The rolls of the sizing roll stands 73 are power driven, the power being supplied by an electric motor 75 through a drive shaft 76 and gearing 77. In the mill shown in the drawing, the welding rolls 69, and the guide rolls in the roll stands 63 and 68, as well as the forming rolls 61, are also driven by power from the same motor 75.

Figure 2 shows the tension compensator wheel 42 which has an axle 78 supported by bearings 79 on a carriage 80. This carriage 80 is free to slide along a bearing comprising rails 82, and the carriage has pads 83 which rest on the rails 82 and extend downwardly on each side of the rails, as best shown in Figure 3. There are guards 85 extending upwardly on both sides of the carriage at spaced regions along the length of the rails. These guards overlap the opposite edges of the carriage to prevent any possible over-turning of the carriage. The rails 82 are carried by a stationary frame 87 supported from the overhead frame of the slack accumulator. The guards 85 are also connected with the stationary frame 87 that supports the rails 82.

The carriage 80 is urged away from an end bracket 88 of the frame 87 by a coil spring 89 located between the carriage and the bracket 88. The spring 89 is held in position by studs 91, which extend into the first few convolutions at each end of the spring. The carriage 80 is also urged away from the bracket 88 by a weight 92 hanging from a flexible connector 93 which passes around a sheave 94 to a hook 95 secured to the back of the carriage 80. The sheave 94 is supported by an axle in bearings attached to a frame element 97 which supports one end of the frame 87.

Movement of the carriage 80 away from the end bracket 88 is limited by the frame element 97. The stud 91, which is nearer to the end bracket 88, has a flange 99 that contacts with the end of the spring 89 and behind this flange 99 there is an extension 100 threaded through a lug 101 attached to the frame 88. The flange 99 can be advanced toward the left by turning the extension 100 so as to screw it through the lug 101 in a direction toward the carriage 80. With this adjustment, the spring 89 can be used to push the carriage 80 into contact with the abutment provided by the frame element 97 and impart some initial tension to the spring 89, if desired.

Whenever the tension on the strip 20 increases sufficiently to overcome the spring 89, the carriage 80 moves toward the right in Figure 2, lifting the weight 92 and compressing the spring 89. As the tension is released, the weight 92 and spring 89 move the carriage 80 toward the left again. The spring 89 provides a yielding means having substantially no inertia and capable, therefore, of responding quickly to changes in the tension. The weight 92 yields more gradually and for changes in tension over periods of longer duration, since the force required to move the weight 92 quickly is greater than the force required to move it slowly.

This tension compensator can be made with a spring 89 of different strength in proportion to the mass of the weight 92, so as to obtain the most effective tension compensation for the particular installation with which it is intended to be used. For some conditions, spring tensioning alone may be desirable and in others, the weight tensioning can be used alone. One difference is that the spring provides a counter-force that increases progressively with the displacement, whereas the counter-force of the weight is constant.

With the slack accumulator illustrated in the drawing, the principal change in tension comes when a new reel has been attached to the strip and the movement of the carriage 37 is stopped so as to force the apparatus to start unwinding the new reel. At this time, the moving portion of the strip 20 must overcome the inertia of the length of stationary strip from the carriage 37 back around the guide wheels 30 and 29, and overcome also the inertia of the new reel, which must start turning on the stand 11 or 12 in order to unwind.

The magnitude of this pull can be decreased by stopping the carriage 37 slowly, and starting it in the other direction, toward the right along the track 33, with a gradual

acceleration. This is accomplished by providing a brake 105 on the reel 47, operated by a solenoid 106 with remote control from a control switch 107 at the attaching station near the welder 17. This same control switch 107 also supplies power to the clamp motor 25 and to the motor 48 for starting the carriage 37 in the opposite direction. A dash pot 108 or any other conventional time delay can be used for making the application of the brake 105 and the starting of the motor 48 more gradual.

Although the tension-compensator wheel 42 reduces the variations in the tension of the strip, by moving in a direction to compensate the variation, it will be evident that this tension-compensation wheel 42 can only take out the "peaks and valleys" of the tension variations. The amount of compensation which the wheel 42 can effect, depends upon the length of travel of the carriage 80 along its track.

If a substantially uniform tension in the strip, in the furnaces 55 and in the mill beyond the furnaces is to be maintained, feed rolls are used to drive the strip ahead of the furnace at a pre-determined speed, which is co-ordinated with the speed of the mill.

Figure 4 is a large-scale view showing the wheel 57, which co-operates with pressure rolls to provide power-driven feed rolls ahead of the furnaces, and this figure also shows the driving mechanism for the roll or wheel 57. This wheel is preferably driven from the same motor 75 that drives the roll stands of the mill. The motor has a drive shaft 76' extending along the length of the furnaces 55 to a transmission 110 which can be adjusted by a hand wheel 112, to vary the speed ratio between the input shaft 76' and an output shaft 113. Power is transmitted from the shaft 113 to the wheel 157 through worm gearing 114 and a belt-and-pulley connection 115.

The variable speed transmission 110 is not a necessary part of the apparatus if the power-driven roll passes of the mill are geared to advance the formed strip at a rate equal to or slightly greater than the lineal speed of the strip corresponding to the speed at which the strip is fed by the driving wheel 57; and slippage of the mill rollers on the strip and expansion of the strip when heated in the furnace compensate for speed differences.

The increase in the length of the strip in the furnaces 55 depends upon the temperature to which the metal is heated and this is not always the same. It is impractical, therefore, to try to maintain a strip speed at the wheel 57 which will exactly correspond, when compensation for temperature has been made, with the lineal speed at which the feed rolls of the mill are driven. In practice, the lineal speed of the strip on the wheel 57 is made slightly less than the corresponding speed of the feed rolls of the mill. Minor speed differences are easily compensated for by slight slipping of the rolls on the tube in the mill stands, and the tension maintained on the strip beyond the wheel 57 is substantially constant during any particular run.

The strip 20 is held against the face of the wheel 57, in order to maintain adequate frictional pressure, by rollers 116 and 118. These rollers 116 and 118 rotate on axles carried by brackets 120 which slide in supports 121 rigidly mounted on a fixed frame member 123.

The brackets 120 move substantially radially with respect to the axis of rotation of the wheel 57, and there are springs 125 which urge the brackets 120 toward the wheel 57 and thus maintain a pre-determined pressure, between the strip 20 and the surface of the wheel 57, to drive the strip.

The preferred embodiment of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. In tube making apparatus in which a strip from a supply reel splicing station, where the strip is stopped and started as required in connecting new lengths to the strip, is fed through a tube forming mill with continuous motion, the combination comprising heating means through which the strip passes and in which it is highly heated on its way to the tube mill, feed means beyond the heating means for advancing the strip, a slack accumulator between the supply reel splicing station and the heating means, said slack accumulator including a guide wheel around which the strip passes to change its direction of run, a carriage in which the guide wheel is supported, a track along which the carriage is movable to vary the slack in said accumulator, a second guide wheel around which the strip passes to change its direction of run at a location beyond the slack accumulator but ahead of the region where the strip is highly heated, a support on which the second guide wheel is movable to change the tension of the strip between the supply reel splicing station and the region at which the strip is highly heated, and resilient means urging the wheel support to move in a direction to increase the tension of the strip, the force of said resilient means being correlated with the average strip tension so as to successively yield and expand in response to sudden variations in the strip tension and thereby compensate such variations.

2. Tube making apparatus through which an endless strip passes with continuous motion, a slack accumulator including a track, a carriage movable along the track, a guide wheel supported by the carriage and around which the loop of skelp passes, and mechanism for moving the carriage in one direction to accumulate a larger loop of skelp, feed rolls for the strip beyond the slack accumulator, the carriage of the slack accumulator being movable in the other direction in response to the withdrawal of skelp from the accumulated loop of skelp by said feed rolls during times when one end of the strip is temporarily stopped for connection with a new length, and means for preventing sudden changes in tension of the strip at said feed rolls, said means including a second guide wheel located between the slack accumulator and the feed rolls, a movable support independent of the slack accumulator carriage and by which the second guide wheel is carried, a bearing independent of the slack accumulator carriage and along which the movable support reciprocates in response to variations in the tension of the skelp, and spring means urging the movable support in a direction to increase the tension of the skelp.

3. In a continuous tube mill of the class wherein the rearward end of each length of skelp is temporarily stopped at a supply reel station for connecting it with the forward end of a new length of skelp, and skelp is supplied to the mill from a slack accumulator while one end of the skelp is stopped for connection to a new length, and said slack accumulator includes a guide wheel around which the skelp passes to change its direction of run, a carriage in which the guide wheel is supported, and a track along which the carriage is movable to vary the slack in said accumulator as the skelp travels continuously on its way to forming and welding apparatus, the combination with said slack accumulator of a second guide wheel located between the slack accumulator and the mill and around which the skelp changes its direction of travel, a support independent of the slack accumulator carriage and by which the second guide wheel is carried, a bearing, independent of the slack accumulator carriage and track, and along which the support for the second guide wheel reciprocates to compensate for changes in the tension of the strip, resilient means urging the carriage in a direction to increase the tension, and power-driven feed rolls between which the strip passes, said power-driven feed rolls being located beyond the second guide wheel.

4. Slack accumulator means for supplying skelp to a continuously operating tube mill including, in combination, a track, a carriage movable along the track and supporting a guide wheel about which an accumulated loop of skelp reverses its run, power mechanism to pull

the carriage in one direction along the track to increase the skelp accumulation, other guide wheels around which the skelp passes, including a guide wheel from which the skelp passes toward the tube mill, at least one of said other guide wheels comprising a tension compensator for preventing sudden changes in the tension of the skelp, a movable support independent of said carriage and by which the tension compensator guide wheel is carried, a bearing independent of the carriage and along which the movable support reciprocates in response to variations in the tension of the skelp, the movable support being movable in one direction on said bearing by pull of the skelp, and spring means urging the movable support to move on said bearing in the other direction to increase the tension of the skelp when there is a slackening in the pull.

5. The slack accumulator described in claim 4, characterized by a brake for preventing movement of the carriage along the track in the direction to reduce the accumulated slack, and control means connected with the brake and movable into different positions to cause selectively an application or release of the brake, and further characterized by said spring means having stored energy that shifts the movable support in a direction to compensate for the reduced strip tension resulting from release of the carriage brake.

6. In a continuous mill, the combination comprising heating means that impart a high temperature to a continuously moving metal strip, forming means in which the heated strip is bent into a tube, roll stands beyond the heating means and through which the formed tube travels, power driving mechanism that operates the rolls in the roll stands to pull the strip and tube through the mill and heating means at substantially uniform speed, holders for supply reels from which the metal strip is intermittently fed through the heating means to the tube mill, a slack accumulator between the supply reel holders and the heating means and from which skelp is supplied to the mill when the skelp is temporarily stopped to connect the rearward end of the skelp from an exhausted reel to the forward end of the skelp of a new reel, guide wheels around which the strip passes and around which the strip changes its direction of travel at different locations between the supply reel holder and the heating means, at least one of said guide wheels around which the skelp changes its direction of travel being a tension compensator and having a movable carriage by which it is supported and resilient means holding the carriage in position and that yield as the carriage moves to eliminate sudden changes in the pull on the strip.

7. In the continuous tube mill described in claim 6, a combination having some of the guide wheels located in the slack accumulator, power mechanism that moves at least one of the guide wheels of the slack accumulator in a direction to increase the slack accumulation when a new supply reel is connected to the strip, retarding means for the movable guide wheel releasable to cause movement of the guide wheel in a direction to pay out slack when the end of the strip is stopped at the supply reel end for connecting to a new supply reel, the resilient means at the tension compensator guide wheel being operable to smooth out tension changes resulting from starting and stopping of the movement of the guide wheel that changes the slack accumulation.

8. In a continuous tube mill of the class wherein skelp is supplied to the mill through a skelp heating zone and there is a slack accumulator through which the skelp passes on its way to the heating zone, and there are feeding means beyond the heating zone for advancing the skelp, the slack accumulator comprising a track extending lengthwise of the mill, a carriage movable along the track, and there are clamping means for temporarily stopping the movement of the strip ahead of the slack accumulator and at the end remote from the mill for connection with a new length of strip, a brake that holds the carriage against movement along its track, power mechanism that moves the carriage along the track to increase the slack accumulation, and common control means for the clamp, brake and power mechanism, the combination with said slack accumulator of a tension compensator along the run of the skelp between the slack accumulator and the heating zone for compensating sudden tension variations in the strip caused by inertia changes resulting from the stopping and starting of the carriage and the portion of the strip beyond the carriage, said tension compensator comprising a wheel around which the strip passes to change its direction of travel, and resilient means urging the guide wheel in a direction to increase the tension of the strip.

9. In tube making apparatus, a slack accumulator for a loop of skelp between a supply reel station from which skelp is supplied intermittently and high temperature heating means through which an endless strip of skelp moves with continuous motion for supplying forming and welding apparatus beyond the heating means, feed means beyond the heating means for advancing the skelp, and a shock absorber for preventing sudden tension stresses from reaching the skelp operated upon by the high temperature heating means, said shock absorber comprising power driven feed rolls located ahead of the high temperature heating means but beyond the portions of the slack accumulator in which the velocity of the skelp changes.

10. In tube making apparatus, a slack accumulator for a loop of skelp between a supply reel station and high temperature heating means through which an endless strip of skelp travels with continuous motion, the slack accumulator comprising a generally horizontal track along which a loop of skelp extends, a carriage movable along the track, a guide wheel on the carriage about which the loop of skelp passes to change its direction of travel in the slack accumulator, another guide wheel around and across the top of which the skelp passes to enter the slack accumulator and from which the skelp travels to the top of the guide wheel on the carriage, supporting means for the run of skelp between said guide wheels, and other guide wheels near opposite ends of said run of skelp in position to hold the skelp down close to the underlying support so as to prevent the building up of a free hanging run of skelp with variable wave and sag which would produce variations in the tension of the strip.

11. In a continuous tube mill, the combination of a furnace having a main heating chamber and a secondary heating chamber through which the products of combustion from the main heating chamber pass, a guide wheel around which a skelp from the secondary heating chamber passes to reverse its run before entering the main heating chamber on its way to forming and welding apparatus including feed means located beyond the furnace and that pulls the skelp from the furnace, power mechanism that drives said guide wheel at a peripheral speed substantially equal to the speed at which said feed means pulls the skelp from the furnace, a second guide wheel located ahead of the furnace and around which the skelp changes its direction of travel, a support for the second guide wheel, a bearing on which the support for said second guide wheel is movable in response to changes in the tension of the strip on its way to the guide wheel that reverses the run of the skelp between the heating chambers of the furnace, and resilient means urging the support to move in a direction to increase the tension, said means being yieldable in response to sudden changes in the tension of the skelp for compensating such changes and maintaining a more uniform pull on the heated skelp in the furnace.

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