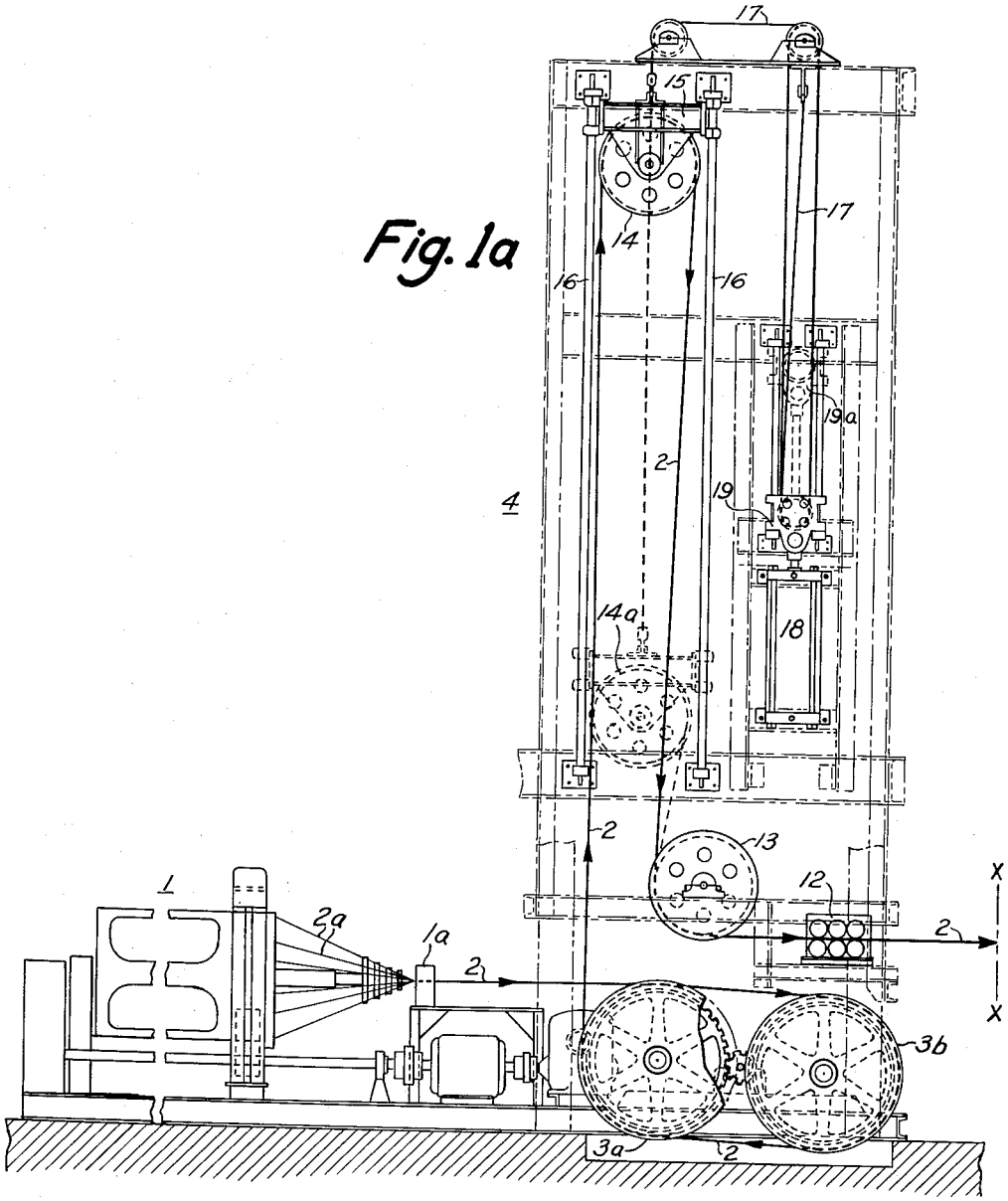
July 17, 1962 L. G. COSCIA ET AL 3,045,094

HEAT TREATMENT OF CONTINUOUS STRAND

Filed Jan. 30, 1959

2 Sheets-Sheet 1

Fig. 1a



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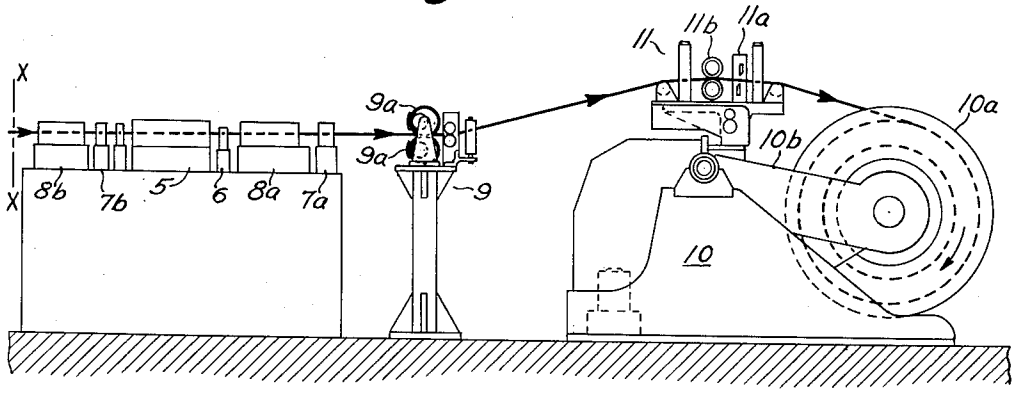
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HEAT TREATMENT OF CONTINUOUS STRAND

Filed Jan. 30, 1959 2 Sheets-Sheet 2

Fig. 1b



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3,045,094

Patented July 17, 1962

3,045,094

HEAT TREATMENT OF CONTINUOUS STRAND

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Filed Jan. 30, 1959, Ser. No. 790,283
9 Claims. (Cl. 219—10.41)

This invention relates to an improved method and apparatus for treating linear material. More particularly this invention relates to a method and apparatus for treating all portions of an extensive length of linear material to obtain uniform properties in a discontinuous in line operation.

The invention is useful in operations where extended linear material such as strand or strip must be passed through a treating line at a minimum rate of speed to enable correct treating to take place, but where the said treating line, on the other hand, is subject to frequent stops, which stops and subsequent restarts cannot be made substantially instantaneously because of the momentum or inertia of the linear material or the machinery of the treating line.

For instance, in stress relief heat treating of continuous wire strand by induction coil means it has been found that it is quite impractical because of certain unsolved technical considerations to control the power input to the induction coil so as to maintain a uniform temperature in the strand passing through the coil when the speed of the strand drops below approximately 25 feet per minute. If the power is left on at speeds below 25 feet per minute the strand may be under or overheated and may have to be scrapped while if the power to the coil is cut off when strand speed drops below 25 feet per minute then a portion of the strand will be completely untreated and usually will have to be removed and discarded. This not only is an economic waste but also means that it is often difficult if not impossible to manufacture a continuous long length of fully and uniformly treated material by any heretofore practical means.

Since the operation of a conventional strand spinning machine is inherently a start-stop operation to allow the bobbins to be replaced and since the strander has considerable momentum it follows that the strand will be traveling at speeds below 25 feet per minute for appreciable periods of time during starting and stopping. Likewise since the strand take-up reel must be changed from time to time sub-critical speed will occur for an interval when the line must be halted for this operation. A certain amount of strand will thus pass through the induction coil at a speed below 25 feet per minute during every stop and start of the line. This strand may not be properly treated. Since there are numerous starts and stops of the line a large amount of scrap may be produced.

An object of the present invention therefore is the provision of an improved method of operating a treating line for extended linear material when the said line must operate at a minimum speed during treating, whereby the operation of the said treating line although operated discontinuously will result in extended linear material having uniform properties in all portions.

A further object is the provision of means whereby a discontinuously operated treating line may be arranged to retract from the treating zone after stopping a predetermined length of linear material which will include all the untreated linear material which passes through said treating apparatus during deceleration to a stop plus an amount of already treated material at least equal to the amount of linear material which must pass through the said treating apparatus below said minimum critical speed during acceleration from a stop, and which means will act to pay out the said retracted material through the treating zone again upon restarting.

A more specific object is the provision of a looping tower adapted to retract extended linear material from an induction heat treating zone after the line containing the said induction zone is stopped when power to the induction heating means has been cut off after the line has decelerated to a minimum critical speed but before completely halting, which looping tower will store the retracted material which passed through the induction heating zone while the said zone was inoperative plus enough retracted treated material to enable the line to accelerate to said minimum critical speed, when power may again be applied to the induction means, before the stored untreated material again passes into the treating zone.

Further objects and advantages of the invention will be clear from the following description and claims, together with the drawing.

FIGURES 1*a* and 1*b* taken together illustrate diagrammatically a linear strand forming and heat treating line including an induction stress relief heating furnace and an associated retracting tower.

While the present invention may be applied to a line treating in various ways any extended linear material such as strip, strand, wire, etc., which for some reason must be treated while traveling at some minimum speed, we have found that the invention is particularly useful at the present time in the practice of stress relief heat treatment of wire strand by induction heating. We have therefore selected this use of the apparatus and method as the embodiment of our invention with which we shall illustrate and explain our invention.

In the accompanying dawing **1** indicates a conventional strand spinning machine consisting of a rotating barrel with internal mountings, not shown, to cradle bobbins of wire. Wire strand formed by the barrel strander is indicated at several points by numeral 2. Individual wires **2***a* pass from the barrel strander **1** as it rotates and pass to die **1***a* in line with the barrel strander where they are formed into the strand **2**. Two capstan sheaves **3***a* and **3***b* around which strand **2** is passed pull the wires **2***a* from the barrel strander **1** through the die **1***a* to form strand **2**. Immediately over capstan sheaves **3***a* and **3***b* is located a retracting tower **4** to which strand **2** passes after passing around capstan sheaves **3***a* and **3***b*.

Numeral **5** indicates an induction furnace for heating the wire strand **2** as said strand passes through said furnace. A pyrometer temperature indicator **6** is shown adjacent the exit end of the furnace. High pressure air coolers and driers are indicated at **7***a* and **7***b*. Water quenches are shown at **8***a* and **8***b*.

A strand guide and clamping stand incorporating eccentric clamping rolls **9***a* is indicated at **9**.

A constant tension variable drive take-up reel unit is indicated at 10. 10*a* is a take-up reel and 10*b* is a take-up reel carrier arm which supports reel 10*a*. A strand feed and shear mounted upon take-up reel unit 10 is indicated at 11. Shear blades are shown at 11*a* and strand feed rollers are shown at 11*b*.

At 12 is indicated a tachometer generator which controls the power input to the induction coil of induction furnace 5. As the strand speeds up, more power is supplied to the induction coil of induction furnace 5 to maintain a preset strand temperature. As the strand is slowed down less power is supplied.

A sheave 13 is fixed to the lower framework of retracting tower 4 to guide strand 2 to induction furnace 5. A movable take-up sheave 14 is arranged so that it may move up and down retracting tower 4 on a sliding carriage 15 which is supported on guide rods 16. The sliding carriage 15 is moved and supported through the agency of cable 17 which is connected at one end to a pneumatic air cylinder and piston assembly 18 and at the other end to carriage 15.

A crosshead and take-up block assembly shown at 19 guides the piston of said cylinder and piston assembly 18 and also provides the connecting link between cable 17 and cylinder and piston assembly 18. Crosshead and take-up block assembly 19 is shown in normal operating position at 19*a* by means of dotted lines.

Strand 2 passes from capstan 3*a* over sheave 14, down to and under sheave 13 and thence to the induction furnace 5. Sheave 14 is shown in normal operating position as indicated at 14*a* in dotted lines, and in elevated or retracted position in full lines. When the strander is stopped, the sheave automatically moves up tower 4, for a distance of 11 feet, retracting about 22 feet of strand from the take-up reel. Upon restarting the take-up reel and strander, the sheave slowly descends back to the normal position. Any suitable control means may be used to cause the operation of cylinder and piston assembly 18 in order to move sheave 14 up and down tower 4 when stopping and restarting the line or if desired the operation may be manually controlled.

The operation of the present embodiment of our invention will now be explained.

In the operation of the stranding line tachometer generator 12 controls the power input to the coils of the induction furnace 5 through control apparatus, not shown, so as to heat all sections of the strand to a certain uniform temperature as the strand passes through the induction coil. If the speed at which strand 2 is passing through the induction coil increases the power input to the induction coil is increased and if the speed of the strand decreases the power input to the induction coil is decreased accordingly. These increases and decreases of speed are typical of the operation of a line such as this.

According to the present invention the power to the induction coil will be off when the speed of the line is below a certain critical speed such as 25 feet per minute either in starting or stopping. Thus in stopping, as the strand speed diminishes the temperature of strand 2 is controlled and maintained to a speed of substantially 25 feet per minute. At this speed the power to the induction coil 5 is cut off. It takes approximately 7 to 8 feet more of strand travel before the line stops. These 7 or 8 feet will be unheated strand. Immediately upon the strand's stopping, the take-up sheave 14 together with its carriage 15 is moved up the retracting tower 4 by the operation of the pneumatic air cylinder and piston assembly 18 which may be automatically controlled by means not shown. The movement of the take-up sheave 14 up retracting tower 4 draws back or retracts through the induction coil furnace 5 about 22 feet of strand 2. During this back-up or retracting operation, the left hand air and water quenches 7*b* and 8*b* are in operation.

When the said 22 feet of strand 2 including the 7 or 8 feet of unheated strand has been retracted, assuming that it is desired to replace the take-up reel 10*a*, eccentric clamping rolls 9*a* of clamp 9 are closed maintaining the strand tension. Feed rolls 11*b* are energized to retract an additional 8 feet of strand which forms a loop between strand feed and shear 11 and the clamping and guide strand 9. The shear blades 11*a* then cut the wire and the loose strand end is fastened to the full reel.

A new reel 10*a* is placed in take-up reel carrier arm 10*b*. Feed rolls 11*b* are energized in the opposite direction to remove the 8 foot loop. The strand end is fastened to the new reel and the excess given about one wrap around the reel drum.

The take-up reel unit 10 and the strander 1 are started and the line is brought up to operating speed. Preferably the take-up reel 10 and the strander 1 are electrically or otherwise interconnected so that they may both be started and run in coordination with each other. When a speed of 25 feet per minute is attained the induction coil is energized preferably by some suitable automatic means. Normally about 8 feet of strand will have passed through the induction coil 5 before this speed is reached. This 8 foot length of strand had previously been heated before the machine stopped. The next 6 feet of strand which passes through the coil after the critical speed is attained and power reapplied had also been previously heated at least in part, some of this 6 feet being the portion of the strand which was in the induction furnace when said furnace was deenergized and which strand thus may be only partly treated. This section is heated a second time as a precaution so that an overlapping of the previously completely heated and subsequently completely heated sections will occur and no unheated portions may accidentally be left due to variations in the acceleration or deceleration of the line or other variations of operation which may occur. A second heating does no damage to the mechanical properties of the strand. The exact amount of strand which passes through the induction coil during acceleration or deceleration of the line is, of course, proportional to the said acceleration or deceleration and the relative proportions passing through are dependent upon the relative rates of acceleration and deceleration. The next 8 feet or so of strand which passes through the induction coil after said 6 feet of previously heated strand is the unheated portion of strand which previously passed through the coil during deceleration, but was untreated or unheated because the strand was moving at a speed less than 25 feet per minute and the power to the coil was shut off. The remainder of the strand from this point, of course, has also not previously passed through the induction coil and is therefore untreated. As this strand passes through the line and is treated the sheave 14 will be caused to gradually descend to its normal position as shown in FIGURE 1*a* in dotted lines and the excess 22 feet of strand stored on tower 4 is gradually removed and passed through induction coil 5 to take-up reel 10*a*. Tower 4 thus will be empty and ready to retract another 22 feet of strand during the next halting of the line.

It may be arranged that tower 4 will start to discharge its stored 22 feet of strand at any time after the line has reached and passed the critical speed of 25 feet per minute, or the tower may be arranged to begin discharging its stored strand immediately upon starting the line if desired, provided the discharge is not so fast as to cause a large difference in speed between the take-up reel 10*a* and the strander 1. It will be seen that the strander must reach a speed of 25 feet per minute or more before all the retracted strand is paid out for the effective operation of the line.

It is preferable to provide some suitable automatic control means to coordinate the speeds of the take-up reel 10*a*, the strander 1 and the movement of the sheave 14 up and down the tower 4, however, these factors may all be controlled manually.

By the use of the procedure described above, every foot of strand is assured the proper temperature treatment and no scrap is produced.

Although we have thus described our invention hereinabove in considerable detail, we do not wish to be limited narrowly to the exact and specific particulars disclosed, but we may also use such substitutes, modifications or equivalents as are included within the scope and spirit of the invention or pointed out in the appended claims.

We claim:

1. An improved method of uniformly heating wire strand by induction heating means in an intermittently operating treating line which comprises cutting off the power to deenergize said induction heating means when the speed of the line decreases below a critical control point during the stopping of the treating apparatus, retracting the resulting unheated strand, which passed through the unpowered heating means during stopping of the treating line, together with an amount of already heated strand, back through the induction heating means and subsequently restarting said treating line, repassing said already heated strand back through said unenergized induction heating means while the speed of the strand material is accelerating to said critical control point, and when the speed has reached said critical control point, reenergizing said induction heating means whereby all of the unheated strand material is heated.

2. A method of uniformly heating portions of substantially continuous strand material by induction means during stopping and starting of a stranding line in which induction heating is performed which comprises shutting off power to the induction means when speed of the line falls below a critical control speed, then, upon halting of the strand line, retracting through the induction heating means all of the unheated strand and some of the heated strand which passed through said induction heating means during deceleration of the line after power was cut off from said heating means and during starting of the line, repassing the said retracted portions of strand through said heating means and reapplying power to said heating means when the line reaches said critical control speed whereby all of the strand is heated at least once.

3. A method of uniformly heat treating a continuous extended length of linear material in an induction coil furnace which comprises directly varying the power input to said induction coil furnace in a predetermined manner according to the speed at which the linear material passes through the said furnace above a predetermined minimum speed, cutting off the power input to the said furnace coil during any time intervals at which the linear material is moving at less than the said predetermined minimum speed during the deceleration or acceleration of the said linear material to or from a complete stop, and upon a complete stop retracting back through the induction coil furnace by means of a retracting tower all the linear material which may have passed into or through the induction coil furnace while the power input to said furnace was cut off plus an amount of linear material which passed through the said furnace while the power input thereto was still applied at least equal to the amount of linear material which will, upon restarting of the linear material's movement, pass through the said furnace during the period of acceleration of the said linear material to the said predetermined minimum speed at which time the power input to the said furnace will be reapplied thereto, and subsequently upon restarting of the movement of the linear material first paying out through the said induction coil furnace all of the linear material which has been retracted upon the said retracting tower.

4. In a method for treating long lengths of strand material in which said material is passed through a treating means and the material is intermittently stopped and started, the improvement which comprises shutting off said treating means when the speed of the material falls below a certain rate during deceleration, thereafter retracting through the treating means untreated material which has passed beyond the treating means during deceleration together with previously treated material, thereafter restarting the treatment means when the speed of the material reaches a predetermined rate and repassing through the treatment means the material previously retracted therethrough.

5. In a treating means for treating linear material, a treating means, means for supplying linear material to the treating means, means for taking up material which has passed through the treating means, means for stopping and starting said supply means and takeup means, means for deactivating said treating means when the speed of the material therethrough is less than a predetermined rate and for reactivating said treating means when the speed of the material therethrough exceeds a predetermined rate, means for retracting material which has passed through the treating means during its deactivation, whereby on reactivating said treating means the material so retracted will be repassed through the treating means and treated therein.

6. Apparatus for heat treating linear material comprising an induction furnace, a supply means for supplying linear material to said furnace, a takeup means for taking up material which has passed through said furnace, means for starting, stopping and controlling the speed of said supply means and takeup means, means for cutting off the power to said furnace when the speed of the material is less than a predetermined speed and for supplying power to said furnace when the speed of the material exceeds a predetermined speed, a looping tower between the supply means and the furnace, means for actuating said looping tower on stopping of the line to retract material which has passed through the furnace while the power has been cut off whereby, on restarting the line said material will be repassed through the furnace and heat treated therein.

7. A method of uniformly heat treating linear material in an induction furnace which comprises applying power to said furnace when the speed of said material therethrough exceeds a predetermined minimum, varying the power input to said induction furnace in a predetermined manner according to the speed at which the linear material passes through the said furnace above said predetermined minimum speed, intermittently decelerating the speed of said material, cutting off the power input to the said furnace during any time intervals at which the linear material is moving at less than the said predetermined minimum speed, and upon the cutting off of said power input retracting through the induction furnace all the linear material which has passed through the induction furnace while the power input to said furnace was cut off plus an amount of linear material which passed through the said furnace while the power input thereto was still applied at least equal to the amount of linear material which will, upon acceleration of the linear material's movement, pass through the said furnace during the period of acceleration of the said linear material to the said predetermined minimum speed, and subsequently reaccelerating the speed of said material and paying out through the said induction furnace all of the linear material which has been retracted.

8. Apparatus for heat treating linear material comprising a heating means, a supply means for supplying linear material to said heating means, a take-up means for taking up material which has passed through the heating means, means for controlling the speed of said supply means and take-up means, means for deactivating the heating means when the speed of the material is less than a predetermined speed and for activating the said heating means when the speed of the material exceeds a predetermined speed, linear material retracting means between the supply means and the heating means, means for actuating said retracting means upon halting the movement of the linear material through the heating means to retract material which has passed beyond the

heating means while the heating means has been deactivated whereby, on restarting the normal forward movement of the linear material said material will be repassed through the heating means and heat treated therein.

9. Apparatus for heat treating strand comprising a payoff device and a take-up device for said strand, a heat treatment apparatus through which said strand passes from the payoff device to the take-up device, means for slowing and stopping the payoff and take-up devices, means for deactivating the treatment apparatus when the speed of the strand therethrough falls below a predetermined minimum, means for retracting through the treatment apparatus strand which has been passed therethrough subsequent to such deactivation plus an additional amount of previously treated strand, means for restarting the payoff and take-up devices, means for reactivating the treatment apparatus when the speed of the strand reaches a predetermined minimum, and means for repassing through the treatment apparatus the retracted material whereby all of the material passing through the treatment apparatus will be treated therein.

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