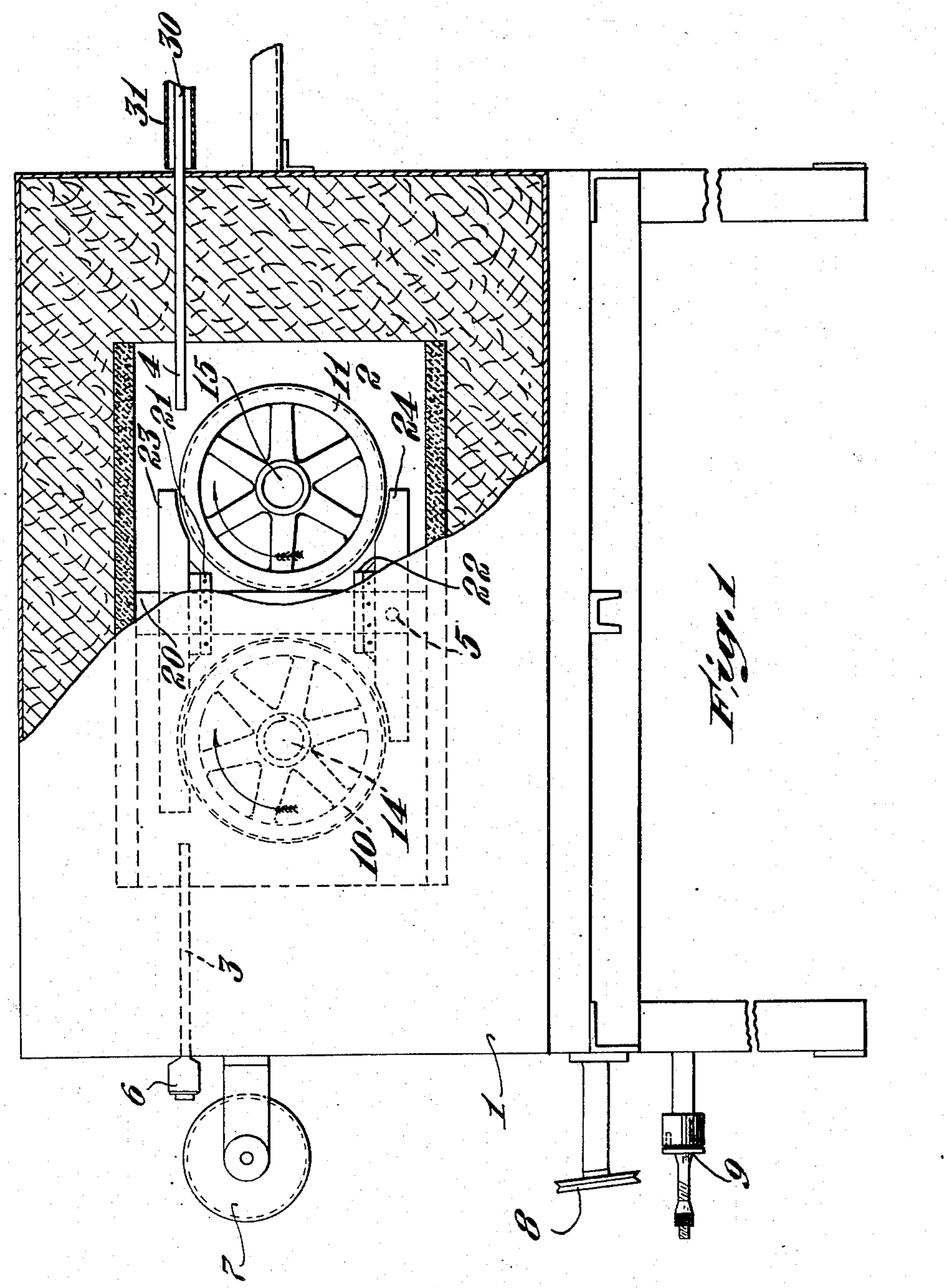
June 11, 1940. J. E. DOESCHER 2,203,946

HEAT-TREATING WIRE

Filed July 6, 1939 3 Sheets-Sheet 1



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HEAT-TREATING WIRE

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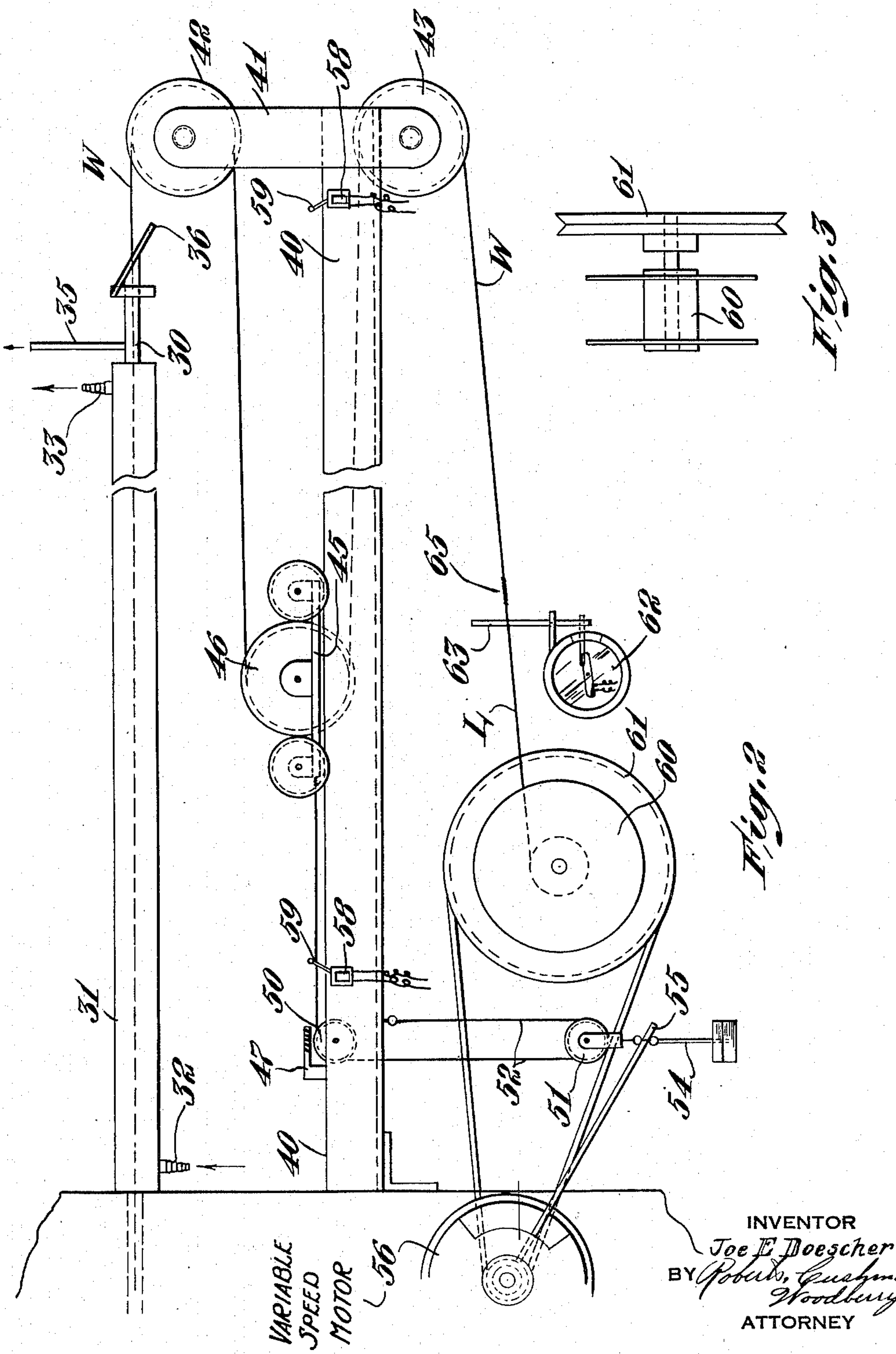

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HEAT-TREATING WIRE

Filed July 6, 1939 3 Sheets-Sheet 3

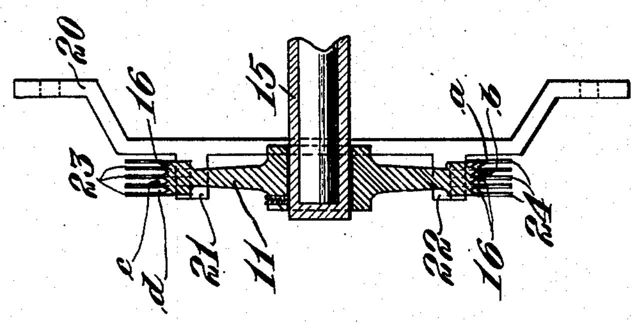

Fig. 5

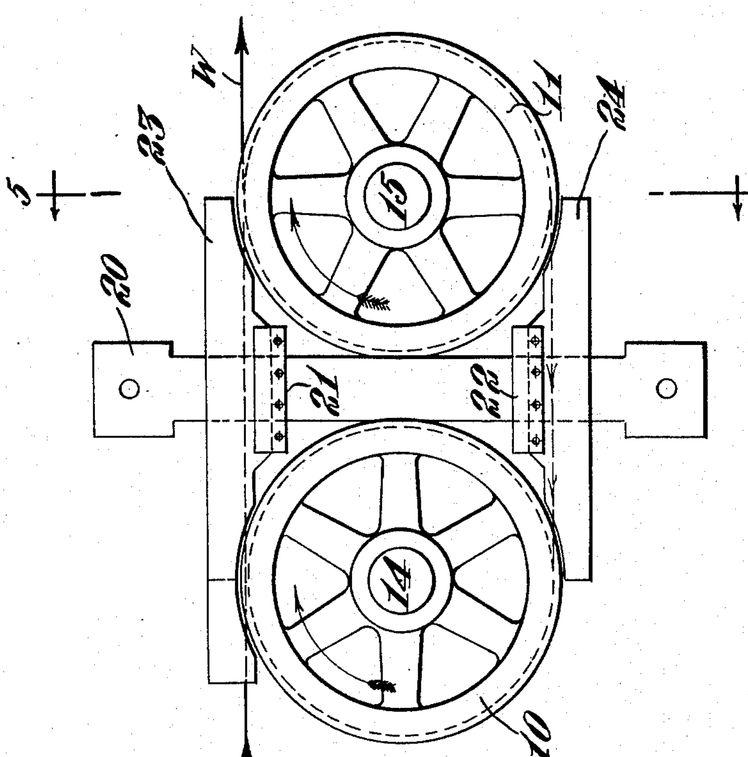

Fig. 4

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HEAT-TREATING WIRE

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3 Claims. (Cl. 242—45)

This invention relates to a method of and means for heat-treating metallic strand material, and as illustrative of its utility is here shown as applied to the continuous annealing of wire.

In heat-treating wire and like strand material in accordance with conventional practices, one or more coils are placed within a furnace heated to the proper temperature and the batch is permitted to remain for a period of time sufficient to insure a substantially thorough heating, after which the batch is removed for further processing, if necessary. The annealing of wire in accordance with such practices is generally unsatisfactory since the time required for the heat to penetrate and thoroughly anneal the center of the coil is considerably greater than the time required to bring the outer strands up to annealing temperature. Hence, the outer strands are usually over-annealed, or the inner strands under-annealed, and in any case the best that can be accomplished is a compromise condition. Moreover, the batch method of heat-treating invariably requires a large size furnace to accommodate a number of coils and also a number of heating elements, controls, etc., to maintain the desired temperature conditions.

The principal objects of the present invention are to overcome the aforementioned difficulties and to provide an efficient and reliable method of uniformly annealing wire under conditions which can be readily duplicated, thereby to insure uniform production; to provide an apparatus having a heating zone of minimum size in relation to its output, and which is provided with mechanism for conducting one or more strands through the heating zone at a constant rate of speed and under a substantially uniform tension; to provide an apparatus capable of automatic operation and which is provided with control mechanism by means of which the rate of travel and the tension on the wire being treated may be accurately adjusted so as to attain the optimum operating conditions for the production of a uniform product; to provide an apparatus equipped with controls which are automatically operative in response to breakage or completion of the run of material under treatment to stop the operation; to provide an apparatus wherein plated strand material may be continuously conducted through the different zones and wound up in such a manner as to minimize, if not avoid, scratches and abrasions; and to provide a compact apparatus constructed so that the operating mechanism is readily accessible and which permits observation of the heat-treating zone during operation.

Further objects will be apparent from consideration of the following description and accompanying drawings, wherein

Fig. 1 is a side elevation, with parts broken away and shown in section, of a heat-treating furnace constructed in accordance with the present invention;

Fig. 2 is a side elevation of the spooling mechanism and associated parts which adjoin the exit end of the furnace;

Fig. 3 is a detail of the spooler and associated driving pulley;

Fig. 4 is a side elevation of the drums and associated parts; and

Fig. 5 is a section on the line 5—5 of Fig. 4.

In accordance with the present invention, one or more wires or like metallic strand material to be annealed or heat-treated may be drawn from a supply roll and fed into the heat-treating zone of a furnace, conducted about the periphery of one or more drums rotatably mounted therein and heated to the desired temperature, and thence out of the furnace to a cooling zone or chamber, after which the wire is wound up. The heating drums may be of any material capable of withstanding a high degree of heat, and their peripheries are preferably formed with a plurality of grooves, so that the wire may travel back and forth from the grooves of one drum to those of the other. Although the drums may be heated either by means of built-in heating elements or by direct radiation from heating elements built into or otherwise secured to the walls of the heating chamber, the wire under treatment is heated primarily by direct contact with the peripheries of the drums. The size of the drums, the number of grooves, and the relative position of the drums within the heating zone, as well as the speed at which the drums are driven, may vary, depending upon the character of the wire to be treated, the type of treatment desired, etc., but in any case the period of contact between the wire and the periphery of the drums should be sufficient to insure a thorough and uniform heating of the wire, and the drums should be driven at a constant speed so that every section of the wire is treated for the same period of time and under substantially identical operating conditions, thus insuring uniformity of production.

The method may be carried out in an economical and efficient manner, using a conventional heat-treating furnace having a heating chamber or zone large enough to accommodate a pair of spaced rotary drums which are driven by a motor preferably equipped with a variable speed control. Means are also provided for guiding the wire from the supply roll to the drums and from the latter to the cooling zone, and thence to an automatic spooler or winding mechanism operative not only to take up slack, but also to maintain the wire under a uniform tension, thus preventing the formation of kinks and bends. In addition to the foregoing, the furnace may be provided with means for maintaining either an oxidizing or a reducing atmosphere, and also controls for maintaining predetermined temperature conditions.

Referring to the drawings which show what is now considered a preferred form of apparatus, the numeral 1 designates a heat-treating furnace which may be of conventional construction, having a heat-treating zone 2 provided with an inlet duct 3 at one end, an outlet duct 4 at its opposite end, and a centrally disposed inlet port 5 for the admission of gas to control the character of the atmosphere of the heating zone 2. The ducts 3 and 4 are of a size and shape to accommodate one or more wires or like strand material to be treated, and the outer end of the duct 3 may be provided with a suitable gas check valve 6. The furnace may be heated in any conventional manner and the usual temperature indicators, controls, etc., may be provided so as to maintain the desired atmosphere and predetermined temperature conditions.

At the forward end of the furnace there is mounted an idler guide 7 aligned with the inlet duct 3 and an idler guide 8 positioned to cooperate with a brake spindle 9 adapted to hold a coil of stock to be treated, the construction and arrangement of parts being such that wire drawn from the supply coil (not shown) is guided by the idler 8 to the idler 7 and thence through the gas check 6 and inlet duct 3 into the heating zone 2.

Mounted within the zone 2 is a pair of spaced drums 10 and 11 which may be of any suitable heat-resisting material, and these drums are fixed to hollow drive shafts 14 and 15 which are suitably journaled in bearings mounted in the side wall of the furnace. The outer ends of the drive shafts 14 and 15 extend outwardly beyond the exterior wall of the furnace and are driven by a variable speed motor (not shown). The periphery of each drum is formed with a plurality of grooves 16 (Fig. 5) and the two drums are positioned so that their corresponding grooves align with each other. The position of the drums within the furnace is such that one of the outer grooves of the drum 10 is in alignment with the inlet duct 3 and the opposite outer groove of the drum 11 is in alignment with the outlet duct 4.

A vertically extending bracket 20 (Figs. 4 and 5) is mounted on the wall of the zone 2 between the drums 10 and 11 and this bracket is formed adjacent to its opposite ends with inwardly projecting arms 21 and 22 which support a plurality of stationary guide fins 23 and 24, as shown in Fig. 5. The upper guide fins 23 are arranged so as to define a direct line of travel between the corresponding grooves of the two drums, and the lower guide fins 24 are positioned at a slight angle relative to the upper fins so as to define a line of travel from the first set of grooves to the next set of grooves. For example, where, as here shown, each drum is formed with four grooves *a, b, c* and *d*, the upper fins 23 define a line of travel between corresponding grooves *a—a, b—b*, etc., while the lower fins 24 define a line of travel between grooves *a, b* and *c* of drum 11 and grooves *b, c* and *d* of drum 10, respectively.

The outlet duct 4 is provided with an extension 30 which projects rearwardly from the end of the furnace and is surrounded by a water jacket 31, thus providing an elongate cooling zone, as shown in Fig. 2. The water jacket is provided with inlet and outlet ports 32 and 33 so that water may be continually circulated therethrough so as to maintain substantially uniform temperature conditions within the duct 30. Adjacent to its outer end the extension 30 is provided with a vent 35 through which gases circulating through the heating zone 2 and ducts 4 and 30 may escape, and the outer end of the extension 30 is provided with a gas check 36 which may be of conventionel design.

A pair of tracks 40 is mounted in any suitable manner beneath the cooling zone and the outer ends of the tracks support a pair of vertically disposed brackets 41 in which guide pulleys 42 and 43 are journaled. A carriage 45 is mounted on the tracks 40 and supports a guide pulley 46 coplanar with the pulleys 42 and 43. Adjacent to the inner end of the tracks is a bumper 47 which serves to limit the inward travel of the carriage 45, the outward travel of the carriage being limited by the inner edge of the brackets 41. A block and fall is supported adjacent to the inner end of the tracks and comprises a stationary pulley 50 journaled in openings in the tracks 40 and a movable pulley 51 supported by a cable 52, one end of which is fixed to one of the tracks and its opposite end to the carriage 45, as shown in Fig. 2.

Suspended from the pulley 51 is a counterpoise 54 which is connected with the free end of a control lever 55. The opposite end of the control lever is operatively associated with the speed control mechanism of a variable speed electric motor 56, the construction and arrangement of parts being such that as the pulley 51 drops in response to inward movement of the carriage 45, the lever 55 operates to increase the speed of the motor 56, and as the pulley 51 rises in response to outward movement of the carriage 45, the lever 55 operates to decrease the speed of the motor.

Adjacent to each end of the tracks 40 is a switch 58 having an operating lever 59 which projects into the path of the carriage 45 so as to be operated thereby. Each switch is connected in series in the circuit (not shown) feeding the motor driving the drums 10 and 11 and the motor 56 so that upon actuation of either switch 58 by the carriage 45 the current is shut off, thus stopping both motors.

A spooler or winder 60, supported in any suitable manner beneath the tracks 40, is provided with a pulley 61 which is driven by the motor 56, and located between the spooler 60 and the pulley 43 is a trigger switch 62 having an operating lever 63 adapted to be actuated by a trailer wire connection or other projection 65 carried by the wire W. The switch 62 is connected in series in the aforementioned circuit so as to shut off the motors when actuated by the projection 65.

The operation of the apparatus is as follows: Assuming that the brake spindle 9 supports a coil of wire to be annealed, that the heating zone 2 has been brought to the desired annealing temperature, that a regulated flow of reducing gas, such as hydrogen, enters the heating zone 2 through the port 5 and that excess gas is being discharged through the vent opening

35, that a leader L (Fig. 2) consisting of a heat-resistant alloy such as "Inconel" has been drawn through the duct 3 into the heating zone 2 and about the drums 10 and 11 in the manner previously described, and that such leader passes through the cooling zone and about the pulleys 42, 46 and 43 to the spooler 60—the wire W to be treated is first connected to the trailing end of the leader and any slack in the system is then taken up by adjusting the position of the carriage 45 and the weights on the counterpoise 54 so as to produce a predetermined tension. With the leader thus adjusted, the motors operating the drums 10 and 11 and the spooler 60 are turned on and adjusted to the proper speed. The wire W is drawn through the check valve 5, thence about the drums 10 and 11, passing successively from a groove *a* of drum 10 to groove *a* of drum 11, thence to groove *b* of drum 10, etc. During the passage of the wire about the drums, the guide fins 23 and 24 maintain the wire in the proper grooves and prevent jumping. The wire W is thus continuously conducted at a uniform speed in a helical path about the peripheries of the drums 10 and 11, and during its passage through the heating zone it is uniformly heated to annealing temperature primarily by direct contact with the drums 10 and 11 which are maintained at a predetermined temperature by radiation from the walls of the zone.

As the wire leaves the drum 11 it is conducted through the outlet duct 4 into the cooling zone where it is cooled sufficiently to prevent oxidation on exposure to air. On emerging from the cooling zone, the wire passes through the check valve 36, about the pulleys 42, 46 and 43 and thence to the spooler 60, as shown in Fig. 2. As the wire is wound upon the spooler the peripheral speed of the coil increases and hence pulls the carriage outwardly. As a result of the outward movement of the carriage the block and fall operate the control lever 55 so as to effect a reduction in the speed of the motor 56, it being noted that since the tension on the wire is governed by the counterpoise 54, variations in the winding speed of the spooler do not materially affect the tension so long as the carriage is free to move between the bumper 47 and brackets 41.

In the event the speed of the motor 56 is reduced too much, the carriage is pulled rearwardly and causes the lowering of the block and fall, which operates the lever 55 so as to effect an increase in the speed of the motor 56. In the course of normal operation, the carriage 45 and associated parts are thus effective not only to compensate for the increasing winding speed of the spooled wire, but also to maintain a substantially constant rate of travel of and tension on the wire W.

In event the wire breaks during the annealing operation, the tension thereon is released and hence the counterpoise 54 operates to pull the carriage rearwardly, thus causing it to operate the switch 58 to shut off the motors. If the speed of the control mechanism associated with the motor 56 fails properly to function, the tension on the wire would either be increased or decreased to an extent sufficient to cause the carriage to travel either to one end of the track or the other, and in any event the carriage would operate one of the switches 58 and thus shut off the motors.

The end of each length of wire is spliced or otherwise connected with a trailer of heat-resisting wire in such a manner as to provide a projection 65, and at the completion of the run this projection operates the trip lever 63 of the switch 62, stopping the motors, but leaving the apparatus "laced up" with the trailer which may be used as the leader for another coil of wire to be annealed. After having connected this wire with the outer end of an untreated coil, the motors may again be started and the operation repeated.

It will be noted that in a heat treating apparatus constructed in accordance with the present invention, the drums 10 and 11 support a fixed length of wire, and as they are rotated at a constant speed, every section of the wire is subjected to identical operating conditions for the same period of time, thus insuring uniformity of production. If desired, the temperature of the heating zone and the atmospheric conditions therein, the time of treatment, and the tension on the wire may be varied in accordance with the character of the wire to be treated, and as all such operating factors are capable of exact determination, the desired operating conditions may be duplicated at any time and hence variation in the quality of production may be eliminated.

It will also be noted that the manner of conducting the wire through the furnace and to the spooler is such as to minimize the danger of causing scratches and abrasions which are especially harmful to precious-metal-plated stock, and, as above pointed out, if the apparatus should fail to function properly, the controls automatically operate to shut off the motors.

A further feature of the apparatus is that the process is continuous and hence indefinite lengths of wire of varying cross-sectional shape may be heat-treated without necessitating structural changes, rearrangement or substitution of parts. Accordingly, the size of the furnace in relation to its output or capacity is reduced to a minimum and is considerably smaller than that of a furnace of comparable output used in batch operations.

While I have shown and described one desirable embodiment of the invention, it is to be understood that the present disclosure is for the purpose of illustration and that various changes in shape, proportion, and arrangement of parts, as well as the substitution of equivalent elements for those herein shown and described, may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In apparatus for heat-treating wire and like strand material, control means for maintaining the wire under substantially uniform tension, comprising guiding means for the wire as it emerges from the heat-treating zone, a spooler on which the heat-treated wire is wound, variable speed driving means for said spooler, a carriage interposed between the guiding means and spooler and having means for engaging the wire and exerting a predetermined tension thereon, said carriage being movable back and forth along a fixed path so as to vary the length of wire traveling from said guiding means to said spooler, and speed control means operatively associated with said driving means and actuated by said carriage so as to effect a change of speed of said spooler in accordance with the position of said carriage.

2. In apparatus for heat-treating wire and like strand material, control means for main-

taining the wire under substantially uniform tension, comprising guiding means for the wire as it emerges from the heat-treating zone, a spooler on which the heat-treated wire is wound, variable speed driving means for said spooler, a carriage interposed between the guiding means and spooler and having means for engaging the wire and exerting a predetermined tension thereon, said carriage being movable back and forth along a fixed path so as to vary the length of wire traveling from said guiding means to said spooler, and speed control means actuated by said carriage for controlling said driving means, the control means being effective to increase the speed of said spooler as said carriage travels toward one end of said path and being effective to decrease the speed of said spooler as said carriage travels toward the opposite end of said path.

3. In apparatus for heat-treating wire and like strand material, control means for maintaining the wire under substantially uniform tension, comprising guiding means for the wire as it emerges from the heat-treating zone, a spooler on which the heat-treated wire is wound, variable speed driving means for said spooler, a track interposed between the guiding means and spooler, a carriage mounted on said track and having means for engaging and exerting a predetermined tension on said wire, said carriage being movable back and forth along said track so as to vary the length of wire traveling from said guiding means to said spooler, and speed control means opeartively connected with said carriage so as to be actuated thereby to vary the speed of said driving means in accordance with the position of said carriage.

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