Dec. 19, 1944. G. R. ROEMER 2,365,216

ART OF ROLLING RODS

Filed Jan. 4, 1943 3 Sheets-Sheet 1

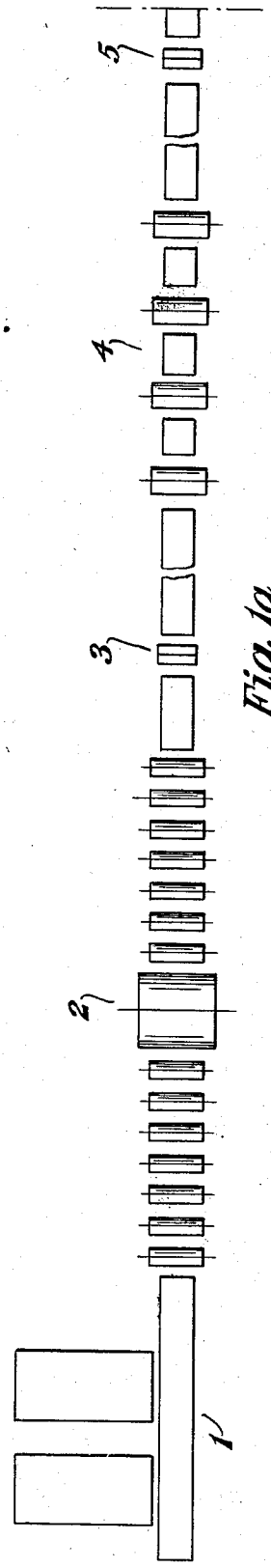

Fig. 1a

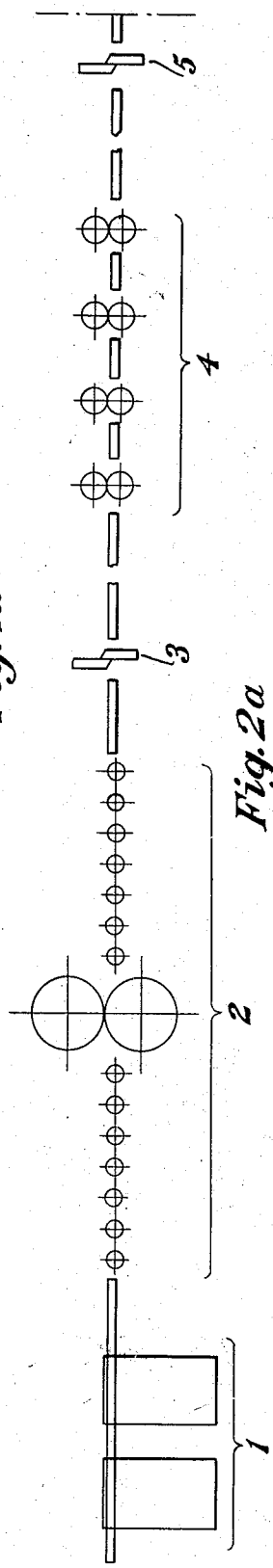

Fig. 2a

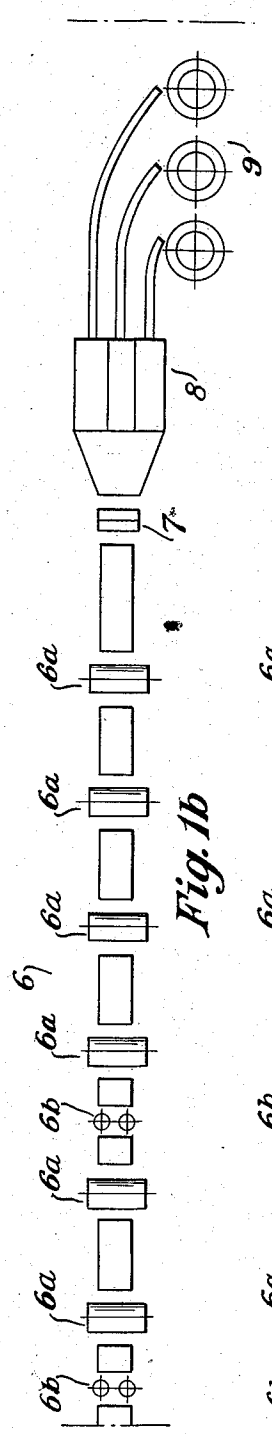

Fig. 1b

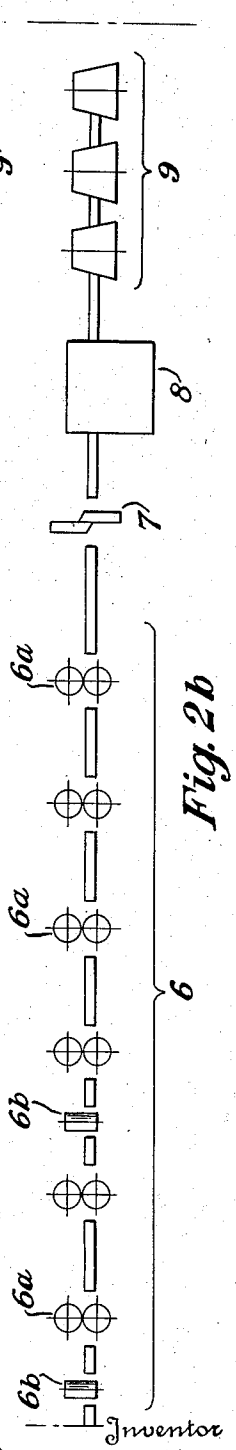

Fig. 2b

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Dec. 19, 1944. G. R. ROEMER 2,365,216

ART OF ROLLING RODS

Filed Jan. 4, 1943 3 Sheets-Sheet 2

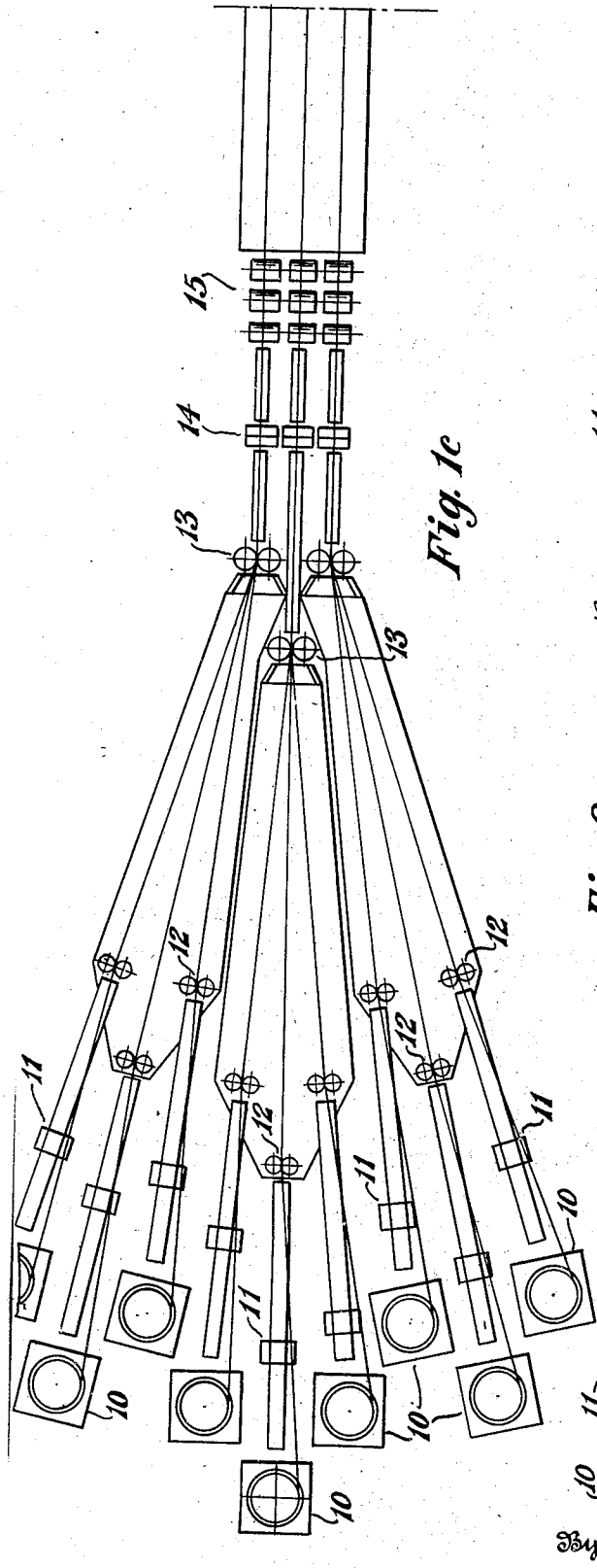

Fig. 1c

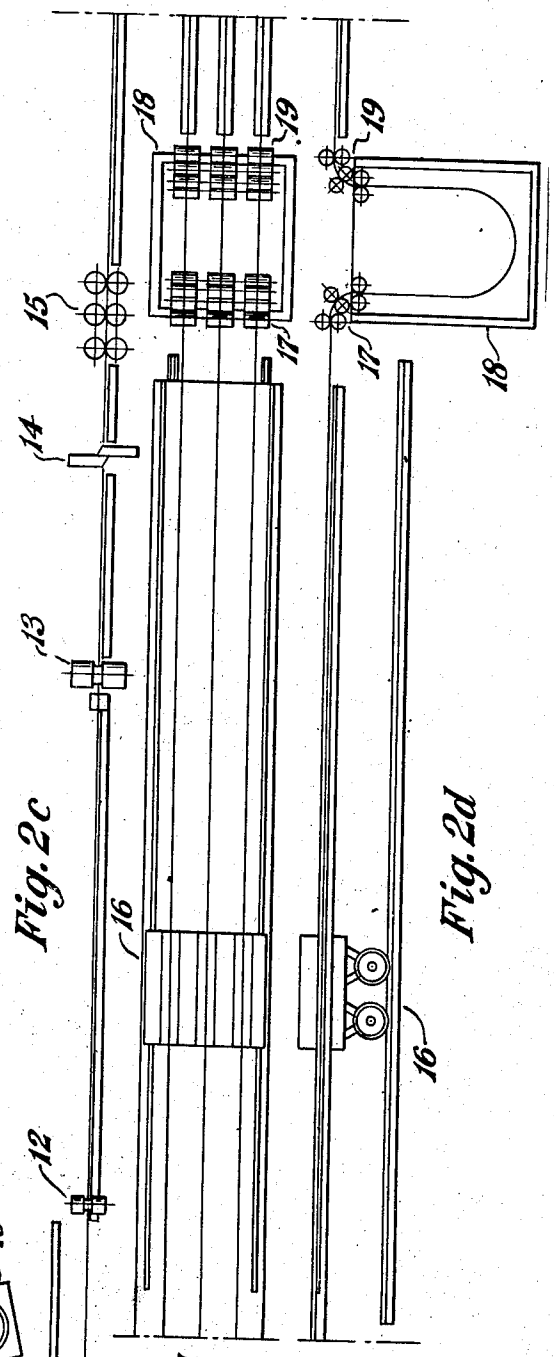

Fig. 2c

Fig. 2d

Fig. 1d

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Dec. 19, 1944. G. R. ROEMER 2,365,216

ART OF ROLLING RODS

Filed Jan. 4, 1943 3 Sheets-Sheet 3

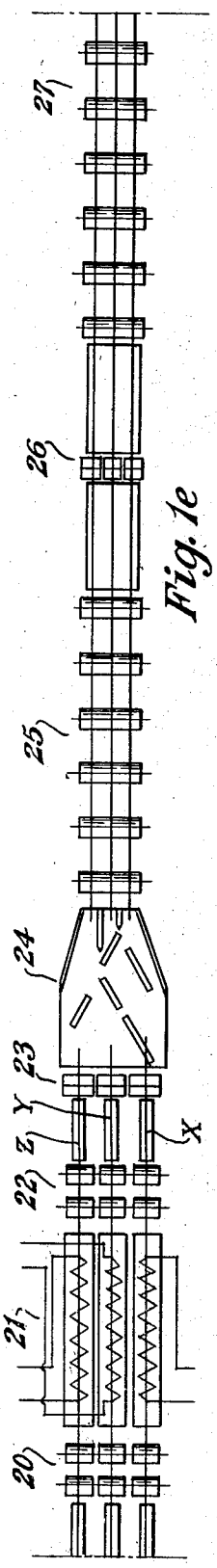

Fig. 1e

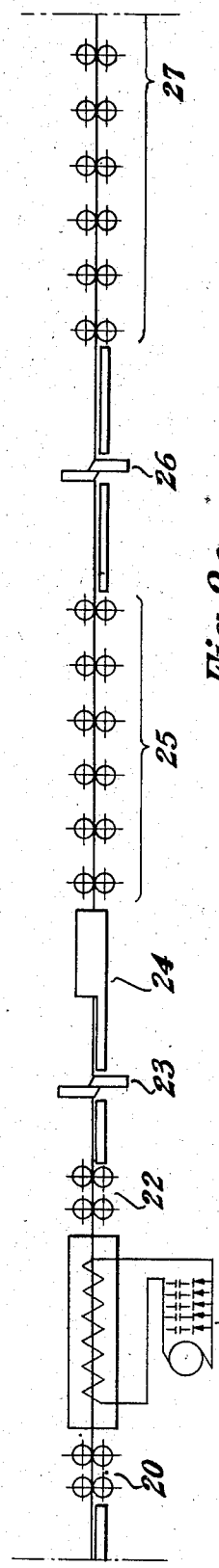

Fig. 2e

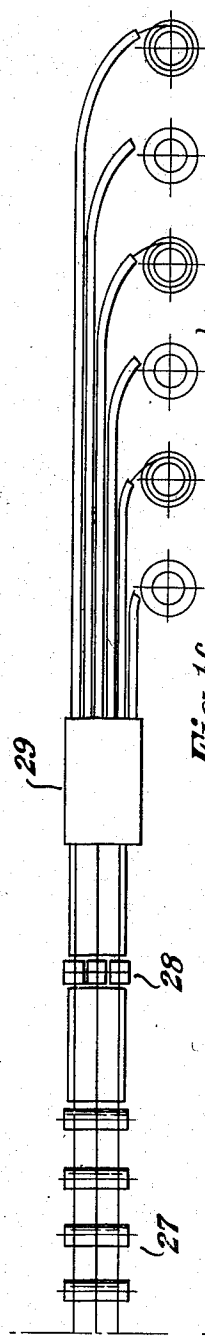

Fig. 1f

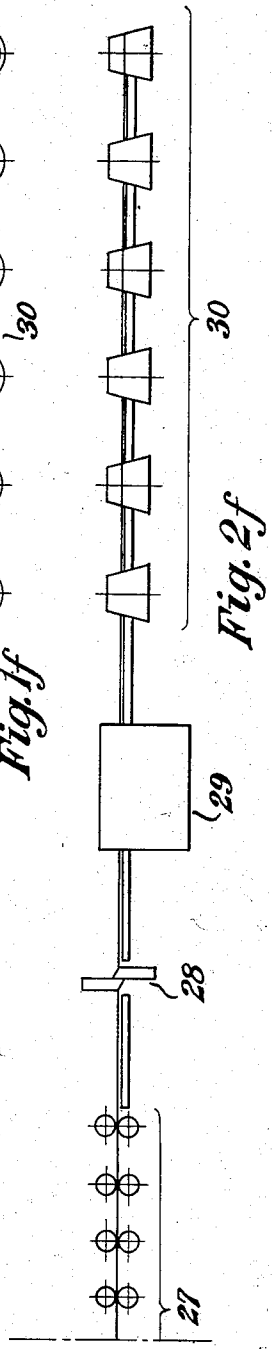

Fig. 2f

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2,365,216

UNITED STATES PATENT OFFICE

2,365,216

ART OF ROLLING RODS

George R. Roemer, Mount Lebanon, Pa.

Application January 4, 1943, Serial No. 471,243

13 Claims. (Cl. 80—63)

The invention relates generally to the art of rolling steel rods, and more particularly to a new method involving the production of coilable billets and the continuous heating and continuous rolling of such billets for producing an endless or continuous rod of small cross section, directly from ingots.

The art of rolling rod has not changed fundamentally, or in any essential steps, during the last forty to sixty years, when the Morgan continuous and the Garrett looping mills were introduced to and almost universally adopted by the art. Today the largest proportion of all rods produced for being drawn into wire for making galvanized wire, springs, rope, barbed wire, woven wire fence, nails and sundry other finished wire products, are rolled on continuous rod mills originally known as the Morgan type rod mill.

Such continuous rod mills consist essentially of a so-called continuous type bar heating furnace, in which billets from 1¾" to 2" square and 30 feet long are heated, the billets being charged and discharged mechanically; a roughing mill usually consisting of six stands, which receive and roll the billets as they are discharged from the furnace; a flying shear; a finishing mill usually of some ten stands from the last stand of which the material normally issue as a No. 5 rod; and a battery of automatic reels which coil the rod as it is delivered from the finishing mill in coils or bundles. The 1¾" to 2" square, 30 feet long billets weighing for 1¾" square billets 300 pounds each, are rolled in the conventional manner on blooming and billet mills.

This practice, as stated, is now in almost universal use in this country and has been accepted as standard for many years; although there are a number of recognized disadvantages and difficulties which are and have always been present.

First, each 30 foot, 300 pound billet passed through the mill and rolled to produce the 300 pound coil of No. 5 rod must be individually pushed from and fed to the continuous mill and a crop end is produced with each billet, which must be cut off, amounting to a loss in scrap of approximately 1½ per cent.

Second, as each 30 foot billet enters each stand of rolls in the series, there is a bump or impact upon the rolls which is transmitted to the roll neck bearings, with the result that these bearings must be replaced at frequent intervals.

Third, the finished rod, due to the continual bumping or pounding and for other reasons is off gauge in a portion of its front and rear ends; and if the finished rod is further reduced by wire drawing, the off gauge end portions cause considerable trouble in the first wire drawing operation where close tolerances are required.

Fourth, cobbles are quite prevalent in continuous rod mills, caused by the failure of the forward end of a 300 pound billet to enter a succeeding roll pass; such cobbles becoming scrap material.

Fifth, the 30 foot billets, while being heated in the so-called continuous bar or billet heating furnace, are stacked close together therein, and are often heated unevenly, which results in non-uniform sections from mill pass to mill pass and consequently produces finned rods, which have to be scrapped and returned to the open hearth furnace to be remelted.

Sixth, 300 pound coils or bundles are the product of the rod mill and in drawing wire therefrom these coils or bundles must be constantly handled and rehandled in subsequent pickling, washing, liming, baking and wire drawing operations. Larger coils could, if produced, be handled much more conveniently and economically. Similarly, relatively high handling costs are also involved in handling the 30 foot, 300 pounds billets from shearing at the billet mill until they reach the so-called continuous billet or bar heating furnace.

Seventh, there is considerable scale formed, and consequently a considerable scale loss, all along the line in the present practice of rolling rods, and particularly during the slow heating of 30 foot billets in the bar heating furnace.

Eighth, the foregoing difficulties or disadvantages, recognized in and inherent in the present conventional and substantially universally used continuous rod mill practice, result in scrap losses and increased costs. These scrap losses and increased costs materially reduce the yield of finished material, reduce the production of the rod mill from its rated capacity, and increase the cost of the material ultimately finished, whether it be coils or bundles of rods, or drawn wire, or fabricated wire products.

The Herman et al. Patent No. 1,901,514, proposed some years ago to eliminate some of these difficulties by welding the 30 foot billets end to end into a continuous piece, either before or after heating them, and in then heating the continuous piece and passing it through the continuous rod mill.

However, this proposal, while theoretically eliminating some of the above difficulties, actually introduces further difficulties or increased

expense. Thus, the heating means suggested is a 400 foot furnace, the use of which would be utterly impractical because of the space required, because of the inability to locate the same adjacent to existing continuous rod mill equipment, and because of the cost of installation and upkeep of such a furnace and the handling and conveying equipment therein.

Furthermore, a welding operation must be performed for every 30 foot billet at a relatively high cost. Moreover, the characteristics of the metal in the weld may be sufficiently different from the remainder of the material as to cause difficulties in subsequent wire drawing operations. Therefore, the welded zone in the rod produced, occurring once in every 300 pounds of material, may have to be cut out as scrap. In effect, although the end crop for every 30 foot 300 pound billet is presumably eliminated, it is actually present in the welded zone which must be cut out.

Perhaps for these reasons, but in any event, for some reason, these proposals have not been commercially used to my knowledge.

Apparently, these recognized and inherent difficulties and disadvantages which have always existed and which continue to exist in the accepted standard practice of rolling rods, have not been overcome or eliminated, because the correct approach has not been made to the problem. That is to say, the seat, source or root of the difficulties is in the use of 30 foot, 300 pound billets. There have been no attempts to eliminate the use of such material as the raw material for a rod mill, whether the rods are rolled in accordance with standard practice, or in accordance with the suggestions of Patent No. 1,901,514.

Perhaps no such attempts have been suggested or made because it has probably been taken for granted by those skilled in the art that material of billet section suitable for rolling into rods could only be made from ingots in a steel mill and conveniently supplied to a rod mill in the shape and form of round, flat or square billets, 1¾" to 2½" square, and 30 feet long, and weighing 300 pounds for 1¾" square billets.

However, in accordance with the present invention, by properly approaching the problem at its root, by eliminating the use of individual 300 pound, 30 foot billets as a raw material for rolling rods, by altering steel mill practice in order to supply a new type of material of billet section to the rod mill for avoiding rod mill difficulties, and by altering rod mill practice and procedure to handle the new type of material of billet section supplied by the steel mill, the problem can be solved, the described difficulties and disadvantages can be eliminated, and many new advantages and unexpected results are obtained.

It has never to my knowledge been suggested, or recognized that material of modified billet cross section could be rolled in one or not exceeding two pieces directly from an ingot and coiled and that such a coiled billet is adapted for uncoiling and for subsequently being heated to rod rolling temperature quickly. The usual 1¾" to 2½" square billets have cross sectional areas of from 3 to over 6 square inches. Material of this area and thickness or dimensions cannot be satisfactorily coiled, or if coiled, cannot be satisfactorily uncoiled, and cannot be reheated quickly to rod rolling temperature.

However, I have discovered that a billet section, which can be coiled hot and uncoiled cold or uncoiled without too much heating, can be readily rolled directly from an ingot in the usual blooming mill and a slightly modified billet mill in one or two pieces, depending upon the size of the ingot, if the finished billet section is symmetrical and has a cross sectional area of not over about 2.25 square inches, such as a 1½" square, or a 1 11/16" diameter round; or if the finished billet section is rectangular or oval and has a cross sectional area of not over 4 square inches with one dimension not over 1 inch, such as a ¾" x 3", or a ¾" x 4", or a 1" x 4" billet section.

The rolling of billets having such modified coilable sections may only require either a few extra passes while rolling the ingot in the blooming mill, or the addition of several stands to either or both of the roughing or finishing stands of the billet mill, or both.

Such billets having modified coilable sections can be readily and quickly continuously reheated, as hereinafter described, to rod rolling temperature because of their reduced cross sectional area or dimension one way.

Likewise, the usual existing continuous rod mills can, with slight modification of the roll passes, readily roll such billets having modified coilable sections, because such sections will not exceed 4 square inches in cross section, and most existing continuous rod mills are designed to roll a 2" x 2" billet which has a cross sectional area of 4 square inches.

Finally, because of the smaller cross sectional area of the modified coilable square or round billet sections, the existing continuous rod mills, with modified roll passes, can readily reduce the billet to a No. 7 rod rather than a No. 5 rod, if desired, and thus relieve the draw benches of considerable work in the further drawing of the rods to wire.

It has been stated that an ingot can be rolled in one or two pieces to produce one or two coiled billets of modified coilable section. Ingot weights in different plants vary from 4000 to 8500 pounds or more. The average ingot is about 6000 pounds. In accordance with the present invention, ingots up to 5000 to 6000 pounds should be rolled in one piece to produce a single coiled billet; and ingots over 6000 pounds should be sheared in half after blooming, and the two pieces further reduced on the billet mill to form to coiled billet coils.

Thus, the billet coils which may be supplied as the raw material for the rod mill, in accordance with the present invention, will each be in one piece and each weigh from something over 3000 pounds to upwards of 6000 pounds.

These coiled billets may then be uncoiled cold, or heated a few hundred degrees if necessary for uncoiling, and the billets of modified coilable section welded end to end. The continuous billet thus formed in accordance with the present invention with welded joints only say every 300 to 600 feet or more, depending upon the size of the original ingot, instead of every 30 feet in accordance with prior proposals, may then be passed through a high frequency induction heating furnace for heating the same up to rod rolling temperature of say 2200° F. Such a furnace is very short and can with little if any scale formation quickly heat the material of the modified coilable section to rolling temperature, because of its reduced cross sectional area.

The continuous heated billet is then passed through the continuous rod mill and may be re-

duced to a No. 5 rod with fewer passes, or to a No. 7 rod if desired, as explained above, and coiled on the automatic rod mill coilers. The coiled rod coil may have any desired weight selected for the most convenient and inexpensive subsequent handling say 1000 to 2000 pounds.

The following objects and new results of the present invention are now clearly understood from a consideration of the foregoing general statement of the problem existing in the art of rolling rods and of a solution of the problem in accordance with the present invention.

It is a primary and fundamental object of the present invention to eliminate the making and use of 30 foot billets in the manufacture of rods.

Also it is an object of the present invention to provide a billet of modified coilable section, and to provide for the manufacture of coiled billets in one or two coils directly from an ingot for further reduction into rods.

A further object of the present invention is to provide in connection with the manufacture of rods, a coiled billet rolled directly from an ingot weighing 3000 pounds or more, which may be uncoiled cold, or without too much heating.

Also it is an object of the present invention to eliminate the scrap loss resulting from end cropping for every 300 pounds of rod produced in accordance with present practice.

Also, it is an object of the present invention to eliminate the handling of separate 30 foot billets from a billet mill to a bar heating furnace, and the individual charging of such billets into the furnace and the pushing of the same individually from the furnace to a continuous rod mill.

Likewise, it is an object of the present invention to eliminate the wear and tear on continuous rod mill rolls and the bearings thereof resulting from the bumping, pounding and impact to which the rolls and bearings are subjected by passing individual 30 foot billets through the mill; and to thereby increase the life of the roll bearings and rolls and reduce shut down losses.

Likewise, it is an object of the present invention to eliminate off gauge portions in every 300 pounds of rod rolled on a continuous rod mill, and to provide for rolling a rod of uniform gauge throughout its entire length, thereby eliminating difficulties in subsequent wire drawing operations.

Additionally, it is an object of the present invention to eliminate mill cobbles and scrap losses resulting therefrom prevalent in the present practice of rolling rods on a continuous rod mill.

Likewise, it is an object of the present invention to provide for the uniform heating of material of billet section fed to a continuous rod mill so as to maintain a uniform rolling temperature, avoid non-uniform sections from mill pass to mill pass, and eliminate finned rods and the scrap resulting therefrom.

Moreover, it is an object of the present invention to greatly reduce scale losses in the rolling of rods.

Also it is an object of the present invention to provide rod coils of greater weight than are at present available for reducing the handling cost per ton of material handled in connection with subsequent pickling, washing, liming, baking and wire drawing operations.

Also it is an object of the present invention to provide a way of rolling a No. 5 rod with fewer passes, or a No. 7 rod with greater facility on existing continuous rod mills in order to reduce the cost of subsequent wire drawing, heat treating or patenting operations.

Furthermore, it is an object of the present invention to provide a continuous billet for being fed to a continuous rod mill, and to provide for heating the same uniformly to rolling temperature in a small space and short time.

Also it is an object of the present invention to provide a continuous billet for being fed to a continuous rod mill, with not more than an average of one welded joint for every 3000 or more pounds of material fed to the rod mill.

Also it is an object of the present invention to modify the present practice of rolling billets so as to produce from an ingot in one or two coils, a new type of billet of modified coilable section having a cross sectional area if symmetrical of not over about 2.25 square inches, or having a cross sectional area if rectangular or oval of not over 4 square inches with one dimension not over 1 inch; all without materially increasing the cost of production thereof over the present cost of producing the usual 30 foot billets.

Finally, it is an object of the present invention to materially increase the yield of finished material in making rods, wire or wire products; to increase the rate of production of rods on rod mills; and to reduce the unit cost of material ultimately finished, whether it be rod coils, drawn wire or fabricated wire products.

These and other objects may be obtained, and the foregoing and other beneficial results achieved, by the present invention heretofore generally set forth and now to be described in detail and hereinafter claimed.

In the drawings,

Figures 1*a*, 1*b*, 1*c* etc. are diagrammatic plan views of a continuous production line of equipment for rolling rods from an ingot to coiled rods in accordance with the present invention; and

Figs. 2*a*, 2*b*, 2*c* etc. are diagrammatic side elevations of the production line shown in Figs. 1*a*, 1*b*, 1*c* etc.

Similar numerals refer to similar parts through the drawings.

The following detailed description of the invention sets forth the manufacture of No. 5 (.218" diam.) and No. 7 (.187 diam.) rods, utilizing coiled steel billets 1½" square having a cross sectional area of 2.25 square inches, to which the invention is particularly directed. However, it is understood that square billets in coiled form, having an even smaller cross sectional area may be used; or that round billets in coiled form having diameters up to 1$\frac{1}{8}$" and cross sectional areas up to 2.25 square inches might be utilized. Such billets are termed herein and in the claims, "billets having symmetrical sections and cross sectional areas up to 2.25 square inches."

Also with slight modifications in the roll passes of the billet mill and continuous rod mill, coiled billets of oval or rectangular shape having cross sectional areas of up to 4 square inches and one dimension thereof not over 1 inch may be made, used and further reduced on the rod mill to form miscellaneous sections, hoop iron, cotton ties, narrow hot rolled strip, concrete bars and the like. Such oval or rectangular billets having generally rectangular sections are termed herein and in the claims, "billets having narrowed sections with cross sectional areas up to 4 inches and with the narrow dimension thereof not over 1 inch."

Moreover, the "billets having symmetrical sections and cross sectional areas up to 2.25 square inches" and the "billets having narrowed sections

with cross sectional areas up to 4 square inches and with the narrow dimension thereof not over 1 inch" are defined and termed herein and in the appended claims, collectively as "billets of modified coilable section," or "billets of coilable section."

Also, the rods, hoop iron, cotton ties, narrow hot rolled strip, concrete bars and other miscellaneous sections which may be rolled on a continuous rod mill with usual or modified passes from billets of modified coilable section, are termed herein and in the appended claims, "rods and the like."

It will be assumed for the purpose of the present description that ingots weighing from 8000 to 8500 pounds are available for rolling. These ingots are placed in the usual soaking pits 1 and heated and soaked therein to rolling temperature. The ingots are then withdrawn from the soaking pits and rolled on the blooming mill indicated diagrammatically at 2, which is illustrated as being a 2-high reversing blooming mill.

The bloom produced by the blooming operation in accordance with usual practice normally would be a 7" x 9" bloom. However, in accordance with the present invention a few extra passes may be given to the bloom on the blooming mill 2 in order to reduce the bloom to a smaller cross-sectional area such as a 6" x 8", or even smaller.

The bloom shear 3 is used for cropping the ends of the bloom, and may also be used for cutting the bloom in two pieces if the bloom weighs 6000 to 8500 pounds. In accordance with the present invention, if the ingot is approximately 6000 pounds or under, only one bloom will be ordinarily formed.

The bloom or blooms are then passed to the intermediate roughing stands of a continuous billet mill shown diagrammatically at 4, preferably including four roll stands on which the blooms may be rolled down to approximately a 4" x 4" section.

A swing shear is indicated at 5, which may be used if necessary for end cropping the intermediate billets. The shear 5 may also be used for cutting the billet in two in case it is desired to make two billets from an ingot and the bloom has not been cut in two at the bloom shear 3. The swing shear 5 may also be used to sever the billet if it cobbles in the following stands of the billet mill.

The 4" x 4" section intermediate billet then passes to the final or finishing stands of the continuous hot billet mill indicated generally at 6. The finishing stands of the billet mill 6 are shown diagrammatically as including six roll stands 6*a* with two sets of edge rolls 6*b*, one preceding the first roll stand 6*a* and one preceding the third roll stand 6*a*.

The final or finishing stands 6 of the billet mill reduce the billet to the modified coilable billet section of the present invention which for billets having symmetrical sections such as a square or a round will have cross-sectional areas up to 2¼ square inches such as a 1½ inch square or a 1 1/16 inches diameter round.

Another flying shear indicated at 7 follows the finishing stands 6 of the billet mill for cropping the ends of the billet of modified coilable section and for cutting the billet if it has not been previously cut by either the shear 3 or the shear 5 into pieces weighing 3000 pounds and upwards. As has been previously stated, if smaller ingots weighing from 5000 to 6000 pounds are used, only one billet will normally be made from the ingot.

The billet then passes through the automatic switching device 8 associated and coordinated with coilers 9, and the device 8 directs the billet to one of the coilers or reels 9. The billet of modified coilable section weighing 3000 pounds and upwards is thereupon coiled in one piece on one of the coilers 9. The switching device 8 feeds the billet to whichever coiler or reel 9 that is open or available for receiving the billet.

The coiled billets thus produced are in convenient form to facilitate subsequent handling, and the handling costs for such coiled billets will be materially less than the cost of handling a large number of 300 pound 30 foot billets such as are normally produced in accordance with standard practice on a billet mill when making material for rolling rods.

If the rods to be rolled are to have an exceptionally good surface finish, the coiled billets may be pickled in coil form at this point before further rolling. However, such a pickling operation will be the exception and not the rule.

The coiled billets are then taken to uncoilers 10, nine of which have been shown diagrammatically for supplying three lines to a continuous rod mill. The uncoilers 10 are preferably reels each mounted within a furnace which may be a top opening or top covered furnace to facilitate entry of the coils into the furnace and onto the uncoilers.

The coils may if desired be heated in the furnaces 10 a few hundred degrees, but not above a scaling temperature. The primary purposes of heating the billet coils in the uncoiler furnaces 10 is to facilitate uncoiling thereof. Thus the billet may be heated if the cross sectional area of the billet, though of coilable form, is from 2 to 4 square inches; such as in the larger sizes of billets having symmetrical sections and cross sectional areas up to 2¼ square inches, or such as in the larger sizes of billets having narrowed sections with cross sectional areas up to 4 square inches and with a narrow dimension of not over one inch.

Each uncoiler 10 is provided with a gripping device 11 for gripping the outside end of the coiled billet at the uncoiler 10 and for pulling it to and entering it between the pinch rolls 12 provided for each uncoiler 10.

The pinch rolls 12 are driven and are shown diagrammatically as being vertical pinch rolls, although either vertical or horizontal pinch rolls may be used. The pinch rolls 12 advance the end of each billet to the master pinch roll stand 13 which is also driven and is shown diagrammatically as including vertical rolls. The master pinch rolls 13 may also have either vertical or horizontal rolls.

Shears 14 are provided following master pinch rolls 13 for shearing the ends of the billets and for preparing the ends for subsequent welding end to end.

Following the shear 14 is a series of pinch and straightening rolls 15 for straightening the billet and for feeding it to the traveling welder 16 which is used to weld the billets end to end and form a continuous or endless billet for the following rod mill.

The billet then passes between driven pinch rolls 17 at the entrance of the looping pit 18 and out of the looping pit 18 between driven pinch rolls 19. The looping pit 18 is interposed at this point to deliver the material to the following rod mill at a substantially constant desired speed which in accordance with present accepted rod

mill practice is about 40 to 60 feet per minute at the first pass of the rod mill.

Present practice is based on square billets having a cross sectional area of approximately 4 square inches. However, in accordance with the present invention where the area of the modified billet section is less than 4 square inches, the speed of the continuous billet on entering the first pass of the rod mill may be greater than 40 to 60 feet per minute if it is desired to maintain the usual finishing speed on the rod mill of approximately 3600 feet per minute for a No. 5 rod.

The billet then passes through driven pinch rolls **20**, a high frequency induction heating furnace **21** and driven pinch rolls **22**. The billet is heated continuously as it passes through the induction heating furnace **21** to the usual rolling temperature of approximately 2200° F. One of the characteristics of the high frequency induction heating furnace is that material passing therethrough may be heated to the desired temperature quickly in a few seconds and at a much higher rate of heating than by any other means of heating.

Also, the induction heating furnace **21** occupies a relatively small amount of floor space and can accordingly be readily installed in connection with existing rod mills.

Another characteristic of the induction heating furnace **21** is that the heating occurs so quickly that there is little opportunity for the formation of scale; and if it is desired to insure against the formation of any scale incident to heating to rolling temperature, an inert gas or controlled atmosphere may be introduced into and maintained in the furnace **21**.

One of the functions of the pinch rolls **20** and **22** on either side of the induction heating furnace **21** is to maintain the material tensioned or taut as it passes through the furnace **21** so that the exact relationship between the material and the furnace is maintained to insure uniform heating. That is to say the material must pass through the central zone of the induction heating furnace in exact relationship with respect to the top, bottom and sides thereof in order to obtain uniform heating by the current induced therein.

Burners if desired may be placed in the looping pit **18** and along the path of advance of the material to the induction heating furnace **21** in order to reduce the amount of power consumed by heating in the induction furnace. However, the material should not be heated by such burners above scaling temperature without providing a suitable enclosure to prevent scaling.

Thus, in accordance with the present invention, an induction heating furnace is the preferred furnace for quickly heating the material, for preventing scaling and for conserving floor space.

A shear **23** is provided to take care of cobbles which may occur in originally entering the forward end of the continuous material in one of the roughing stands of the following rod mill. The shear **23** may also be used for transferring the material from one pass to another pass of the rod mill at the time when one series of grooves on the rod mill may wear out.

A selective multiple feed device **24** which may be built in accordance with the disclosure of the Morrison & Gehring Patent No. 2,290,443 may be provided after shear **23** in order to feed any one of the three lines of supply illustrated diagrammatically at X, Y and Z to any one of the rod mill passes. The rod mill as hereinafter stated may be provided with six grooves and the supply line X may normally be rolled on the No. 1 groove of the rod mill until it wears out, whereupon the device **24** is used to feed supply X to the No. 2 rod mill groove, or to any other groove open or available. Any other suitable feed device may be used in place of a feed device of the type shown in Patent No. 2,290,443.

The foregoing description of the supply of material from the uncoilers **10** to the rod mill has been based upon using a billet of symmetrical coilable section. In case coilable billets are used having narrowed sections, it may be necessary to interpose some means between furnace **10** and looping pit **18** to twist the material 90 degrees so that the wide dimension thereof is horizontal as it passes through the looping pit. Furthermore, a similar twisting device may be interposed preferably somewhere between the induction furnace **21** and the first stand of the rod mill in order to twist the material 90 degrees so that it enters the first stand of the rod mill with its wide dimension vertical.

The material then passes from the feed device **24** to the roughing stands **25** of a continuous rod mill. Six roughing stands are shown in accordance with usual practice and each stand may be provided with six grooves. If a billet of generally rectangular coilable section is used for rolling rods in accordance with the present invention, the passes of the six rod mill roughing stands are designed specially to produce a ½" x ½" or ⅝" x ⅝" section coming out of roughing stand No. 6.

In accordance with present practice, the material then passes to the finishing stands **27** of the rod mill, ten stands being diagrammatically shown. A shear **26** is interposed between the roughing stands **25** and finishing stands **27** in accordance with standard practice to take care of cropping the end of the first material coming through the mill and to take care of switching passes or grooves on the mill when one series of grooves wears out or requires redressing.

A flying rotary swing shear **28** is provided following the finishing stands of the rod mill, followed by a reel switching device **29** and a plurality of rod reels **30**. The flying shear **28** cuts the material and in coordination with the switching device **29** transfers the material from reel to reel when the desired weight of rod has been coiled on one reel. The operation of the reels **30**, the switching device **29** and the flying shears **28** is coordinated so that they operate to accomplish the severing and reeling of the material. The coiled rods are then removed from the reels **30** in the usual manner, and are ready for further treatment for making wire and the like.

As stated, the rod coils wound on rod reels **30** may be of any desired weight and this enables rods of absolutely uniform section to be provided in coil form at the rod reels **30** weighing as much as 1,000, 2,000 or 3,000 pounds each. Such larger coils materially reduce labor and handling costs in subsequent wire drawing or other operations for making wire and other finished products from the rods.

This is contrasted with the maximum weight limitation of 300 pounds for rod coils produced in accordance with present practice. Obviously, 300 pound rod coils can be made, if desired, as a final step of the improved method.

Normally billets having symmetrical sections and cross sectional areas up to 2.25 square inches will be used in accordance with the present in-

vention for rolling rods. Because of the materially reduced cross sectional area of such billets, a No. 7 rod may be finished on the rod mill with the same number of passes as is used in accordance with present practice in making a No. 5 rod; or a No. 5 rod may be made from the improved billets of coilable section if desired, with fewer passes on the rod mill.

The ability to roll a No. 7 rod with the usual equipment now required for rolling a No. 5 rod constitutes one of the new results of the present invention. This enables a substantial saving in the cost of finished products, by eliminating a number of wire drawing or other operations in the later fabrication of wire or the like from the rods.

It is quite apparent that the traveling welder 16, pinch rolls 17 and 19 and looping pit 18 may be omitted, if desired; and the billets fed from the master pinch rolls 13 and leveller pinch rolls 15 to induction furnace pinch rolls 20 and 22, through the induction furnace 21, and then through the rod mill, so that the coiled billets are rolled into rods individually and not as a continuous uninterrupted billet by welding successive billets end to end.

If this variation of the present method is used, some of the present day difficulties in rolling rods will still be present to a very minor degree, such as the possibility of cobbling, off gauge portions in the ends, and some wear and tear on roll neck bearings. However, the increased costs due to these difficulties will only be one-tenth or less as much as are at present encountered, because they will only occur once for every 3,000 or more pounds of billet, rather than once for every 300 pounds of billet.

Accordingly, the present invention entirely eliminates the use of individual 300 pound 30 foot billets as a raw material for rolling rods, thereby eliminating numerous difficulties at present encountered incident to the use of such material.

Moreover, the present invention eliminates the end crop produced with each 30 foot billet in accordance with present practice; eliminates the wear and tear on rod mill rolls and roll neck bearings, and the frequent replacement thereof incident to continually entering 30 foot billets into the rod mill passes; substantially or entirely eliminates off gauge portions in the rods produced by a rod mill, thereby eliminating difficulties in wire drawing operations where close tolerances are required; substantially eliminates cobbles, which frequently occur in the operation of a rod mill; eliminates the high handling costs involved in handling a large number of 300 pound pieces, either in billet or rod coil form; eliminates a considerable amount of scale loss; and materially reduces scrap losses and production and handling costs.

These results are obtained in accordance with the present invention by rolling an ingot directly in one or two pieces down to a coilable and coiled billet of modified section, which can be uncoiled cold or without heating above scaling temperature. The formation of such a modified coilable billet section of relatively small cross sectional area enables the billet to then be quickly and continuously heated without the formation of any scale and rolled continuously on a rod mill to form rod coils of substantially any desired weight.

Likewise, the formation of the billets of modified coilable section enables the use of a high frequency induction heating furnace for heating the billets to rolling temperature very quickly within a few seconds, say from 5 to 15 seconds, depending upon the cross sectional area of the billet.

And finally, the formation of billets of coilable section and the continuous heating thereof by high frequency induction heating reduces scrap and scale losses, reduces rod rolling and later finishing costs, and increases rod mill and wire drawing production.

Having described the problem existing in the art of rolling rods, a solution of the problem, the improved features of the present invention, the operation of preferred embodiments thereof, and the new and advantageous results attained by the improved method; the new and useful methods, steps, arrangements and coordination, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

I claim:

1. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing 3000 pounds and upwards and from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets in a single coil to facilitate handling, transferring said billet coils to a rod mill, uncoiling the billets at a temperature below scaling temperature, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature, and continuously rolling the heated billets to form rods and the like.

2. The method of making steel rods and the like including the steps of rolling billets weighing 3000 pounds and upwards of coilable section directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, uncoiling the billets, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., continuously rolling the heated billets to form rods and the like, coiling the rods, and severing the rods at intervals as they are being coiled to form from each billet a plurality of rod coils each weighing 300 pounds and upwards.

3. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing 3000 pounds and upwards and from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets in a single coil to facilitate handling, transferring said billet coils to a rod mill, uncoiling the billets at a temperature below scaling temperature, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., continuously rolling the heated billets to form rods and the like from 0.218 to 0.187 inches in diameter, coiling the rods, and severing the rods at intervals as they are being coiled to form from each billet a plurality of rod coils each weighing 300 pounds and upwards.

4. The method of making steel rods and the like including the steps of rolling an ingot weighing 4000 to 6000 pounds directly in one piece into a billet of coilable section, coiling the billet to facilitate handling, transferring the billet coil to a rod mill, uncoiling the billet, passing the billet

continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., continuously rolling the heated billet to form a rod, coiling the rod, and severing the rod at intervals as it is being coiled to form from said billet a plurality of rod coils each weighing 300 pounds and upwards.

5. The method of making steel rods and the like including the steps of rolling an ingot weighing 6000 pounds and upwards to form two billets of coilable section, coiling the billets to facilitate handling, transferring the billet coils to a rod mill, uncoiling the billets, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., continuously rolling the heated billets to form rods, coiling the rods, and severing the rods at intervals as they are being coiled to form from each billet a plurality of rod coils each weighing 300 pounds and upwards.

6. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing 3000 pounds and upwards and from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, uncoiling the billets at a temperature below scaling temperature, passing the billets continuously lengthwise through a heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., continuously rolling the heated billets to form rods and the like, coiling the rods, and severing the rods at intervals as they are being coiled to form from each billet a plurality of rod coils each weighing 300 pounds and upwards.

7. The method of making steel rods and the like including the steps of rolling ingots to form billets of coilable section each weighing 3000 pounds and upwards, coiling each of said billets to facilitate handling, transferring the billet coils to a rod mill, successively uncoiling the billets, welding successive billets end to end to form a continuous uninterrupted billet, passing said continuous billet through an induction heating furnace and quickly heating the same therein to rolling temperature, rolling the heated continuous billet to form a rod from 0.218 to 0.187 inches in diameter, coiling the rod, and severing the rod at intervals as it is being coiled to form a plurality of rod coils of desired weight.

8. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, heating the coiled billets to a temperature below scaling temperature to facilitate uncoiling, successively uncoiling the billets, welding successive billets end to end to form a continuous uninterrupted billet, passing said continuous billet through a heating furnace and quickly heating the same therein to a rolling temperature of about 2200° F., rolling the heated continuous billet to form a rod and the like, coiling the rod, and severing the rod at intervals as it is being coiled to form a plurality of rod coils of desired weight.

9. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, heating the coiled billets to a temperature below scaling temperature to facilitate uncoiling, uncoiling the billets, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature, and continuously rolling the heated billets to form rods and the like.

10. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, heating said billet coils to a temperature below scaling temperature to facilitate uncoiling, uncoiling the billets, roller straightening the billets, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., tensioning the billets as they are passed through the heating furnace to center the same therein and obtain uniform heating thereof, and continuously rolling the heated billets to form rods and the like.

11. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing from approximately one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, heating said billets to a temperature below scaling temperature to facilitate uncoiling, successively uncoiling the billets, roller straightening the billets, welding successive billets end to end to form a continuous uninterrupted billet, passing said continuous billet through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., tensioning the billet as it is passed through the heating furnace to center the same therein and obtain uniform heating thereof, and continuously rolling the heated billet to form rods and the like.

12. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing approximately from one-half to approximately the entire ingot weight directly from ingots, coiling each of said billets to facilitate handling, transferring said billet coils to a rod mill, heating the billet coils to a temperature below scaling temperature to facilitate uncoiling, uncoiling the billets, roller straightening the billets, passing the billets continuously lengthwise through an induction heating furnace and quickly heating the same therein to rolling temperature of about 2200° F., tensioning the billets as they are passed through the heating furnace to center the same therein and obtain uniform heating thereof, rolling the heated billets to form rods from 0.218 to 0.187 inches in diameter, coiling the rods, and severing the rods at intervals as they are being rolled to form from each billet a plurality of rod coils each weighing 300 pounds and upwards.

13. The method of making steel rods and the like including the steps of rolling billets of coilable section and each weighing from approximately one-half to approximately the entire ingot weight directly from ingots, calling each of said billets to facilitate handling, transferring

said billet coils to a rod mill, heating the billet coils to a temperature below scaling temperature to facilitate uncoiling, successively uncoiling the billets, roller straightening the billets, welding succesive billets end to end to form a continuous uninterrupted billet, passing said continuous billet through an induction heating furnace and heating the same therein in from 5 to 15 seconds to rolling temperature of about 2200° F., tensioning the continuous billet as it is being passed through the heating furnace to center the same therein and obtain uniform heating, rolling the heated continuous billet to form a rod from 0.218 to 0.187 inches in diameter, coiling the rod, and severing the rod at intervals as it is being coiled to form a plurality of rod coils of desired weight.

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