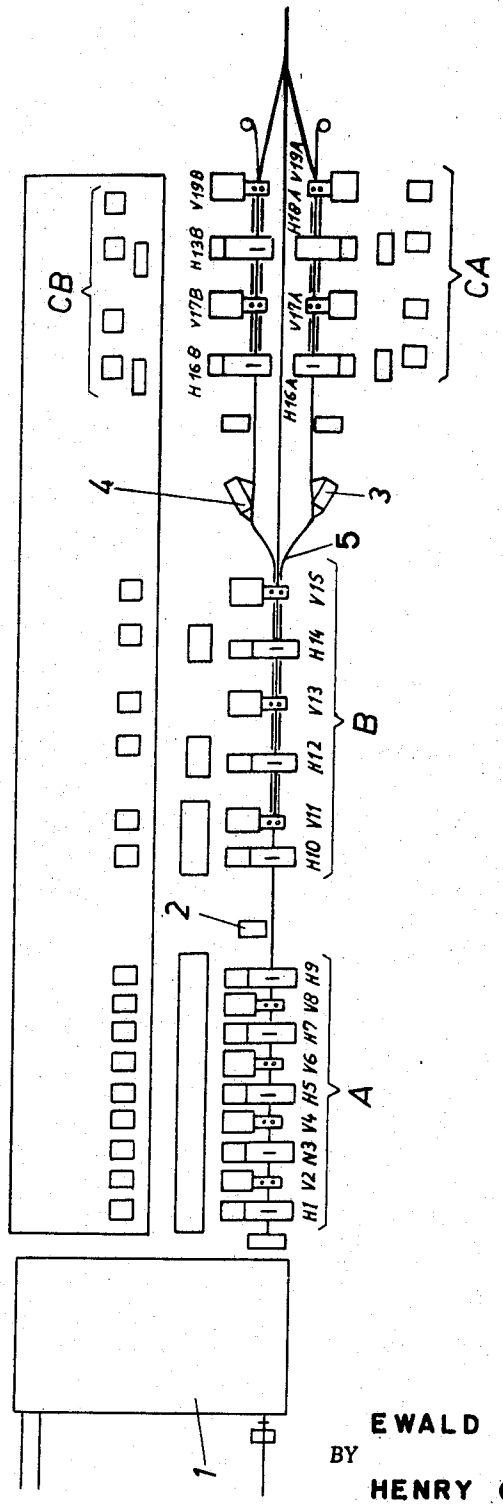
Dec. 30, 1969 E. HEIN 3,486,359

ROLLING MILL ARRANGEMENT

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FIG. 1

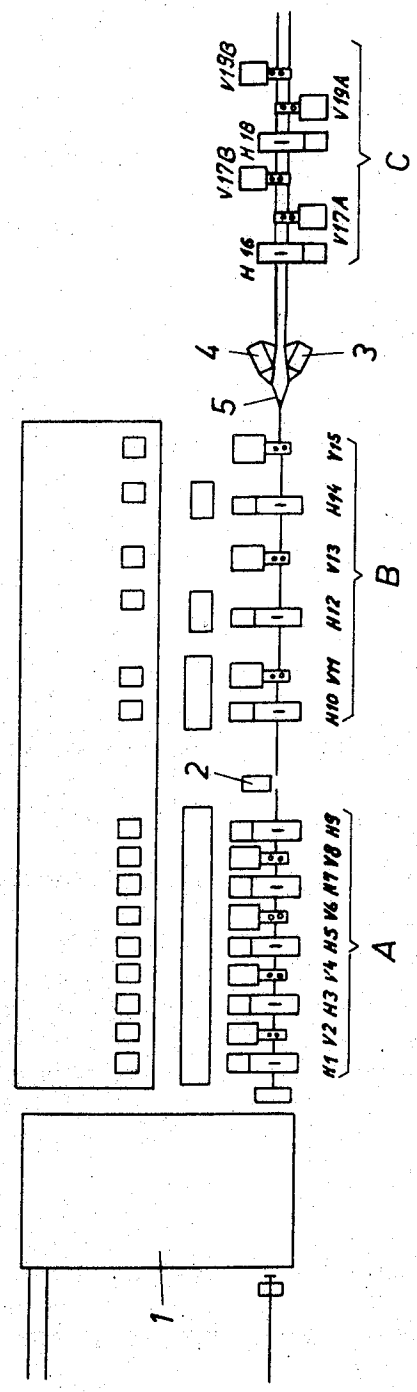


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FIG. 2



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ROLLING MILL ARRANGEMENT

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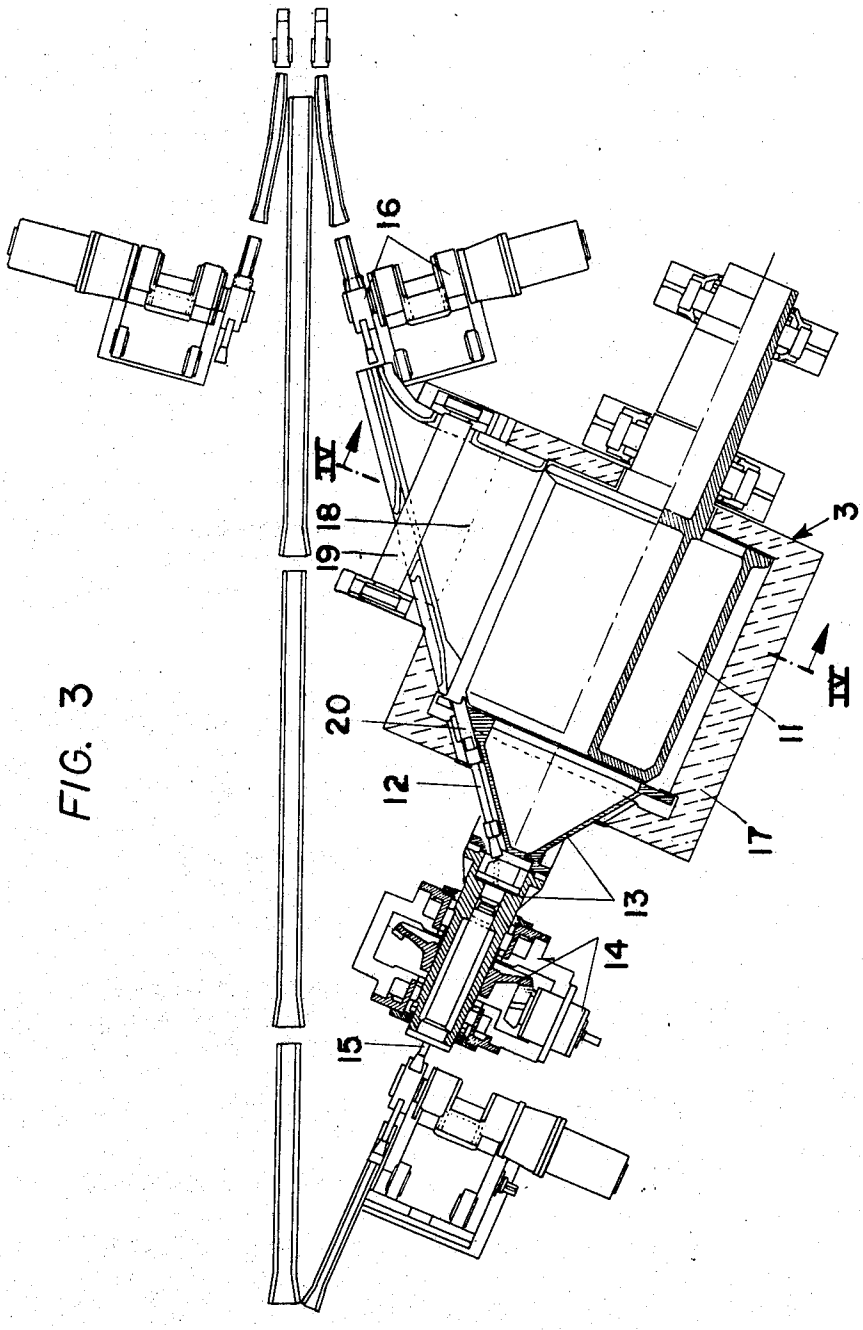


FIG. 3

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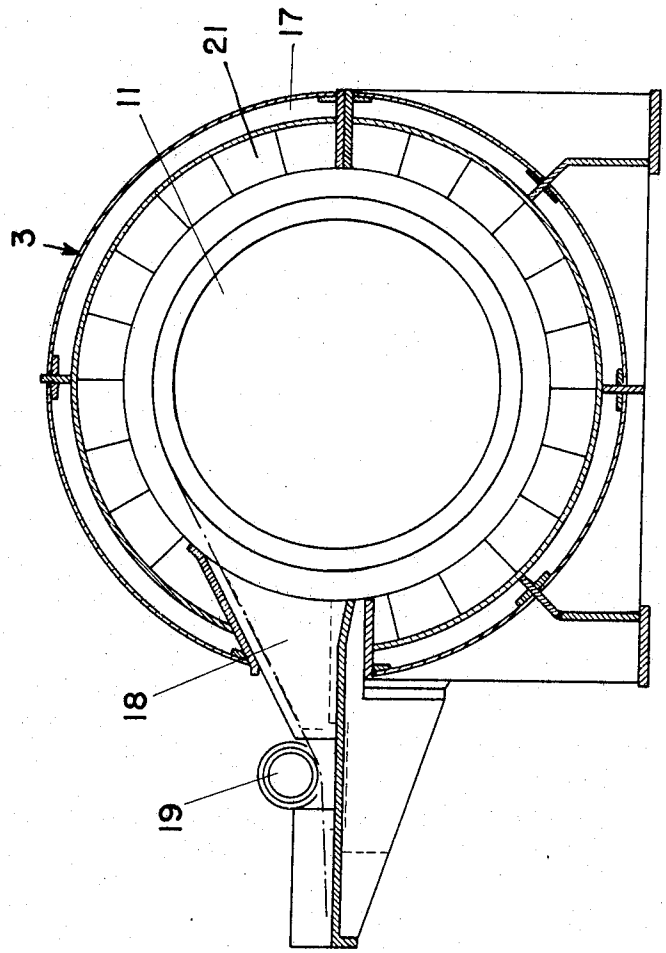


FIG. 4

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United States Patent Office 3,486,359 Patented Dec. 30, 1969

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ROLLING MILL ARRANGEMENT

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Filed Nov. 21, 1967, Ser. No. 684,848
Int. Cl. B21b 27/06, 41/04, 39/20
U.S. Cl. 72—200 7 Claims

ABSTRACT OF THE DISCLOSURE

A small continuous rolling mill arrangement having sequentially disposed a furnace, a roughing mill train, an intermediate mill train and a finishing mill train. The mill trains consists substantially of alternately arranged horizontal and vertical rolling mill stands. The roughing and intermediate mill trains are designed for single strand operation, while the finishing mill train is designed for multi-strand operation. Preceding the finishing mill train there is provided a differential speed buffer in the form of a storage reel for each strand of the finishing mill which reels alternatively receive the single strand issuing from the intermediate mill train. The reels are constructed and arranged to simultaneously coil and uncoil a strand of workpiece at different relative speeds. The reels also include furnaces for heating or equalizing the temperature of the strand before entering the finishing mill train.

BACKGROUND OF THE INVENTION

In a small section rolling mill arrangement, it is a well known practice to design the furnace to have a workpiece heating capacity consistent with the production capacity of the rolling mill when processing medium size workpieces. If, for example, a rolling mill arrangement is designed to receive round workpieces within the range of 5 and 40 mm. in diameter, maximum production is obtained from the arrangement when 16 mm. diameter workpieces are heated in the furnace and processed in a single strand rolling mill. When larger workpieces are processed, the furnace production will lag behind relative to the designed capacity of the rolling mill, while when processing small workpieces, both the furnace and the rolling mill must be operated below their designed capacities. In the former instance the furnace cannot heat workpieces at the same rate the rolling mill can process them, and in the latter instance the furnace output volume of workpieces cannot be processed in the rolling mill because, for example, of speed limitations on the mechanical equipment.

It is a known and accepted practice when processing large workpieces of a designated range that the furnace output lags behind the rolling mill capacity. Since, however, the principal product produced by small section rolling mill arrangements is mainly rolled stock within the small range of workpieces, it is particularly undesirable that neither the rolling mill capacity, nor the furnace capacity are fully utilized and, therefore, the rolling mill arrangement is uneconomical. In order to better utilize the designed capacity of both the furnace and rolling mill, it is a known practice to design the mill stands of the rolling mill for two-strand operation, when processing small workpieces within the designated size range, and for large workpieces of the size range, the mill stands are employed for single-strand operation. To provide a good workpiece surface and accurate dimension tolerances of the rolled workpiece, particularly with respect to quality and high-grade steel products, it is the present day practice to use rolling mill trains consisting of alternating horizontal and vertical mill stands, to thereby eliminate the conventional practice of twisting the workpiece between successive mill stands. When such rolling mills are designed for two-strand operation, the horizontal mill stands can be conveniently employed, while separate vertical stands must be provided for each strand, such that in a given mill train two vertical mill stands are arranged in a staggered relation between horizontal mill stands. Such a train of rolling mills represents a large capital investment and presents certain operational difficulties. One such difficulty is that each strand of workpiece must be dimensioned to conform with the particular speed of each mill stand in the mill arrangement.

It is further known in the art with respect to continuous rolling mill arrangements, in particular rod and wire rolling mills, that the cross sectional size of the initial workpiece, the rolling speed, and the cross sectional size of the finished workpiece are all a function of each other. It may be that initial cross sectional dimension of the workpieces are very large because of the method of producing the initial material. This necessitates a slow entering speed of the workpiece into the roughing mill train and brings about a long period of contact with the rolls, with the result that heavy cooling of the workpiece takes place during the rolling process. If the workpiece entering speed is increased, this requires, particularly in the production of thin wire, that the rolling speed in the finished mill train becomes higher than is desirable from the operational standpoint and further that excessive demands are placed on the mechanical equipment of the rolling mill arrangement.

The present invention provides a continuous rolling mill arrangement designed to more fully utilize the production capacities of the components of the mill arrangement which is designed to represent a lower investment and overcome the disadvantages inherent in known rolling mill arrangements.

The present invention further provides a continuous rolling mill arrangement consisting of a furnace, a roughing mill train, an intermediate mill train, and a finishing mill train, which are designed so that the roughing and intermediate mill trains have a rolling speed consistent with the maximum furnace output when rolling small workpieces of a given range of workpiece sizes. The principal feature of the present invention resides in designing the roughing and intermediate mill trains for one-strand operation, designing the finishing mill train for multi-strand operation, and providing a speed differential buffer means preceding each strand of the finished mill whereby the buffer means are alternately fed from strand from the intermediate mill.

With a rolling mill arrangement having the foregoing characteristics it is possible to operate the single-strand roughing and the intermediate mill trains at double speed, which is independent of the maximum final speed of the two-strand finishing mill train. This has the further advantage that considerably lower capital investment is required than if the entire rolling mill arrangement were designed for two-strand operation.

According to the present invention, the aforesaid speed differential buffer means takes the form of workpiece heating furnaces incorporating built-in reels which are employed to buffer the workpiece speed and optionally to re-heat rolled workpieces to the most favorable rolling temperature, as well as to equalize temperature differences in the workpiece. A further feature of the present invention consists in the fact that the winding storage units can be employed optionally via a switch.

The present invention provides that the roughing mill and intermediate mill trains have rolling speeds independent of the finishing mill train and that winding storage reels form a speed buffer for the finishing mill train. This is provided by constructing the reels whereby the speed of charging and discharging a workpiece is different and preferably variable within definite limits.

The winding storage reels according to the present invention each include a rotating winding arm located in an adjacent coaxial relation with a receiving drum which incorporates a tangential stock discharge, the construction being such that the winding arm and the receiving arm rotate in opposite senses of rotation. By this construction a strand of workpiece laid by the winding arm about the periphery of the receiving drum continually migrates toward the outer periphery thereof by reason of the tangential stock discharge. This changing of the stock position within the drum brings about a uniform effect of an intermediate treatment such as heating, cooling, and/or temperature equalization of the strand workpiece.

The present invention will be better understood when the following description is read with the accompanying drawings of which:

FIGURE 1 is a schematic view illustrating one embodiment of rolling mill arrangement incorporating the features of the present invention.

FIGURE 2 is a view similar to FIGURE 1 and illustrating a second embodiment of the present invention.

FIGURE 3 is a plan view partly in section illustrating one form of the buffer storage reel built according to the present invention and

FIGURE 4 is a sectional elevational view taken along lines IV—IV of FIGURE 3.

Turning first to FIGURES 1 and 2 of the drawing, it will be noted that the two illustrated rolling mill arrangements according to the present invention are identical with respect to the design and construction of the roughing mill train A and the intermediate mill train B and that differences exist only in the design and the construction of the finishing mill train C.

As illustrated in FIGURES 1 and 2 there is provided a billet heating furnace **1**, which is constructed in a manner well known in the art, such as for example, a lift-beam furnace. Following the furnace is a roughing mill train A designed for single-strand rolling operation and made up of horizontal rolling mill stands **H1**, **H3**, **H5**, **H7**, and **H9**, and the vertical rolling mill stands **V2**, **V4**, **V6**, and **V8**. Following the roughing mill train there is provided a rotary shear **2** also constructed in a manner well known in the art. Following the shear there is provided an intermediate mill train B also designed for single-strand operation and consisting of horizontal rolling stands **H10**, **H12**, **H14** and vertical rolling stands **V11**, **V13**, and **V15**.

The intermediate mill train B is followed by a finishing mill train designed for two-strand operation. In the embodiment illustrated in FIGURE 1 two finishing mill trains CA and CB are provided. The finishing mill train CA consists of the horizontal rolling mill stands **H16A** and **H18A** and vertical rolling mill stands **V17A** and **V19A**, and the finishing mill train CB consists of horizontal rolling mill stands **H16B** and **H18B** and vertical rolling mill stands **V17B** and **V19B**.

In the embodiment illustrated in FIGURE 2 the two-strand finishing mill C consists of horizontal rolling mill stands **H16** and **H18** which are common to both strands of the finishing train. Finishing train C further includes vertical rolling mill stands **V17A** and **V19A** for one strand and **V17B** and **V19B** for the other strand.

Referring again to the embodiments illustrated in FIGURES 1 and 2, between the intermediate mill train and the finishing mill train there is provided two winding storage reels **3** and **4**, which are operated as speed differential buffers.

The storage reels **3** and **4** are fed alternately by a switch **5** with a strand of workpiece issuing from the intermediate mill train B. The strand coiled by reels **3** or **4** is then simultaneously uncoiled for processing it in the finishing mill train. This makes possible high speed operation of the roughing mill train A and the intermediate mill train B such that the output of the furnace **1** can be utilized completely even when processing workpieces having small final cross section. Stating the foregoing in another manner, the storage reel **3** delivers to the finishing mill train CA a previously accumulated partial length of coiled workpiece at the same time the storage reel **4** coils the next workpiece delivered from the intermediate mill B, and simultaneously uncoils it for processing in the finishing mill line C–B.

As previously mentioned, the finishing mill train is employed as a two-strand only when rolling workpieces having final cross sections lying within the lower cross section range.

When the entire rolling mill arrangement is employed for single-strand operation, e.g. when rolling workpieces having large cross sections of a given range of workpieces, only the finishing mill train CA is employed with respect to the embodiment illustrated in FIGURE 1 and in the FIGURE 2 embodiment, the finishing mill train C is arranged for single-strand operation and consists of mill stands **H16**, **H18**, **V17** and **V19**.

The rolling mill arrangement illustrated in FIGURE 2 differs from the arrangement illustrated in FIGURE 1 only by the fact that in the FIGURE 2 arrangement the finishing mill C has horizontal rolling mill stands **H16** and **H18** which are common to the two strands and separate vertical rolling mill stands **V17A**, **V19A**, and **V17B** and **V19B** respectively process the two strands. It will be apparent to those skilled in the art that the finishing mill train shown in the FIGURE 2 embodiment eliminates the need for two horizontal mill stands over the finishing mill embodiment shown in FIGURE 1. However, the mode of operation of the rolling mill arrangements illustrated in FIGURES 1 and 2 is in principle the same.

Referring now to FIGURES 3 and 4 of the drawings, the buffer storage reels **3** and **4** each comprise a workpiece receiving drum **11** supported for rotating about a horizontal axis. Associated with the drum **11** is a winding arm **12** secured to a winding head **13** that is in turn connected to a drive **14** for rotating the arm **12** in coaxial alignment with the drum **11**. A central guide tube **15** is employed to feed a workpiece strand to the winding arm **12**. The head **13** is formed in the shape of a cone having a base diameter corresponding approximately to the diameter of the receiving drum **11**. The discharge end of the winding arm **12** extends adjacent to one end of the receiving drum so that rotation of winding arm **12** continually deposits a strand of workpiece in a helix form in the receiving drum **11**. It is pointed out that before the winding arm **12** is rotated with respect to the receiving drum **11**, the leading end of a workpiece is transferred from the winding arm **12** to a position between driven pinch rollers **16**, thereby assuring that the workpiece to be coiled can be uncoiled any time from the receiving drum **11** without affecting the speed at which the workpiece enters the receiving drum during coiling. The strand of workpiece is fed from the drum by operating the driven pinch rollers to withdraw the coiled strand, which causes the drum to rotate. For example, it is possible to coil a workpiece by depositing it in the receiving drum **11** by the winding arm **12** in helical windings at considerably higher speed than the workpiece is discharged from the receiving drum **11**. The receiving drum **11** thus, in effect, forms a continual workpiece speed buffer in which the entering speed of the workpiece and the discharge speed of the workpiece determine the volume of workpiece that is temporarily stored in the drum. The receiving drum **11** is preferably constructed such that it can accommodate the entire length of a given workpiece fed to it when the pinch rollers **16** are not actuated.

The pinch rollers **16** are driven in a manner such that their speed can be regulated from stopped to the maximum entry speed of the strand by the winding arm **12** thereby to control the desired amount or length of workpiece within the receiving drum.

As best shown in FIGURES 3 and 4, a housing **17** partly encloses the receiving drum **11** and the winding head **13** with the winding arm **12**. The housing **17** is formed with a workpiece discharge opening **18** which extends the length of the drum so that the workpiece can be discharged by the pinch rolls **16** at any point along the length of the drum at its periphery. The discharge opening **18** adjacent the end of the winding arm **12** is inclined to correspond to the inclination of the winding arm **12**, while the opening **18** at the end of the drum opposite the winding arm **12** extends approximately parallel to the bottom of the receiving drum **11**. A discharge roller **19** is, like the receiving drum **11**, supported in a freely rotatable manner to assure an unimpeded discharge of the workpiece strand from the drum **11** to the pinch rollers **16**. A roller **20** is associated with the winding arm **12** and supports the leading end of a workpiece as it passes into the discharge opening **18** and enters the pinch rollers **16**.

Clearly shown in FIGURE 4 is the discharge of the strand of workpiece from the periphery of the receiving drum **11**, which causes it to rotate.

As heretofore indicated, it is a feature of the present invention to incorporate with the storage reel a workpiece heating furnace. To accomplish this, the housing **17** is constructed and arranged to incorporate a chamber of a heating furnace generally indicated at **21** in FIGURE 4, which also includes a heat-producing source not shown. By this construction a workpiece stored by the receiving drum **11** is heated before it is discharged from the receiving drum **11** for further processing in a consecutively arranged finishing mill train shown in FIGURES 1 and 2.

The present invention also contemplates instead of a heating furnace the employement of the chamber **21** for cooling and/or equalizing the temperature of the rolled stock stored by the receiving drum **11**. It is further within the scope of this invention to provide drive means connected to the drum **11** for rotating it to uncoil the stored workpiece either separately or in conjunction with the pinch rollers **16**.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise that as specifically illustrated and described.

I claim:

1. A method of processing workpieces in a rolling mill arrangement which comprises, in sequence, a workpiece heating furnace, a roughing mill train, an intermediate mill train, at least two independently operable and separate winding storage means and a finishing mill having at least two separate finishing mill trains; the steps comprising:

heating the workpieces in said furnace to a desired rolling temperature;

rolling the heated workpieces individually in sequence in said roughing mill train and said intermediate mill train;

coiling separately and in sequence the workpieces in said winding storage means after rolling in said intermediate rolling mill train;

uncoiling the workpieces separately and in sequence from said winding storage means prior to completely coiling each workpiece; and

rolling each uncoiled workpiece in one of said separate finishing mill stands.

2. A method of processing workpieces according to claim **1** comprising the additional step of:

reheating the coiled portion of each workpiece in said winding storage means after said coiling and prior to said uncoiling.

3. A method of processing workpieces according to claim **1** comprising the additional step of:

forming a differential speed buffer between said intermediate mill train and said finishing mill trains with said winding storage means by coiling each workpiece at a speed independent of the speed at which the workpiece is uncoiled.

4. A rolling mill arrangement for processing small section workpieces comprising:

a furnace for heating successive workpieces;

a single-strand mill train for rolling the heated workpieces in sequence;

a finishing mill having at least two finishing mill trains for rolling workpieces after rolling in said single-strand mill train;

said mill trains substantially consisting of alternately arranged horizontal and vertical roll stands;

a winding storage means preceding each of said finishing mill trains for coiling and uncoiling workpieces rolled in said single-strand mill train; and

means for alternately feeding successive workpieces from said single strand mill train to said winding storage means.

5. A rolling mill arrangement according to claim **4**, wherein each of said winding storage means comprises a workpiece heating furnace;

a workpiece storage reel supported in said furnace whereby the temperature of the portion of workpiece coiled on said reel is equalized or elevated by heating.

6. A rolling mill arrangement according to claim **4**, wherein said single-strand mill train comprises a roughing mill train and an intermediate mill train constructed and arranged for rolling a single strand of workpiece;

said winding storage means each comprise a reel supported for rotation about an axis;

feeding means for coiling a workpiece in said reel;

a first drive adopted to drive said feeding means;

uncoiling means including a second drive means for delivering a coiled workpiece from said reel;

said first and second drive means are constructed and arranged for varying the relative speed of a workpiece between coiling and uncoiling.

7. A rolling mill unit according to claim **4**, wherein said two finishing mill trains comprise horizontal rolling mill stands and vertical rolling mill stands wherein pairs of said vertical rolling mill stands are arranged in a side by side relation between pairs of said horizontal rolling mill stands.

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U.S. Cl. X.R.

72—228, 250