June 13, 1939. C. H. MANION 2,162,407

METHOD AND APPARATUS FOR MANUFACTURING METALLIC STRIP

Filed Sept. 11, 1937 3 Sheets-Sheet 1

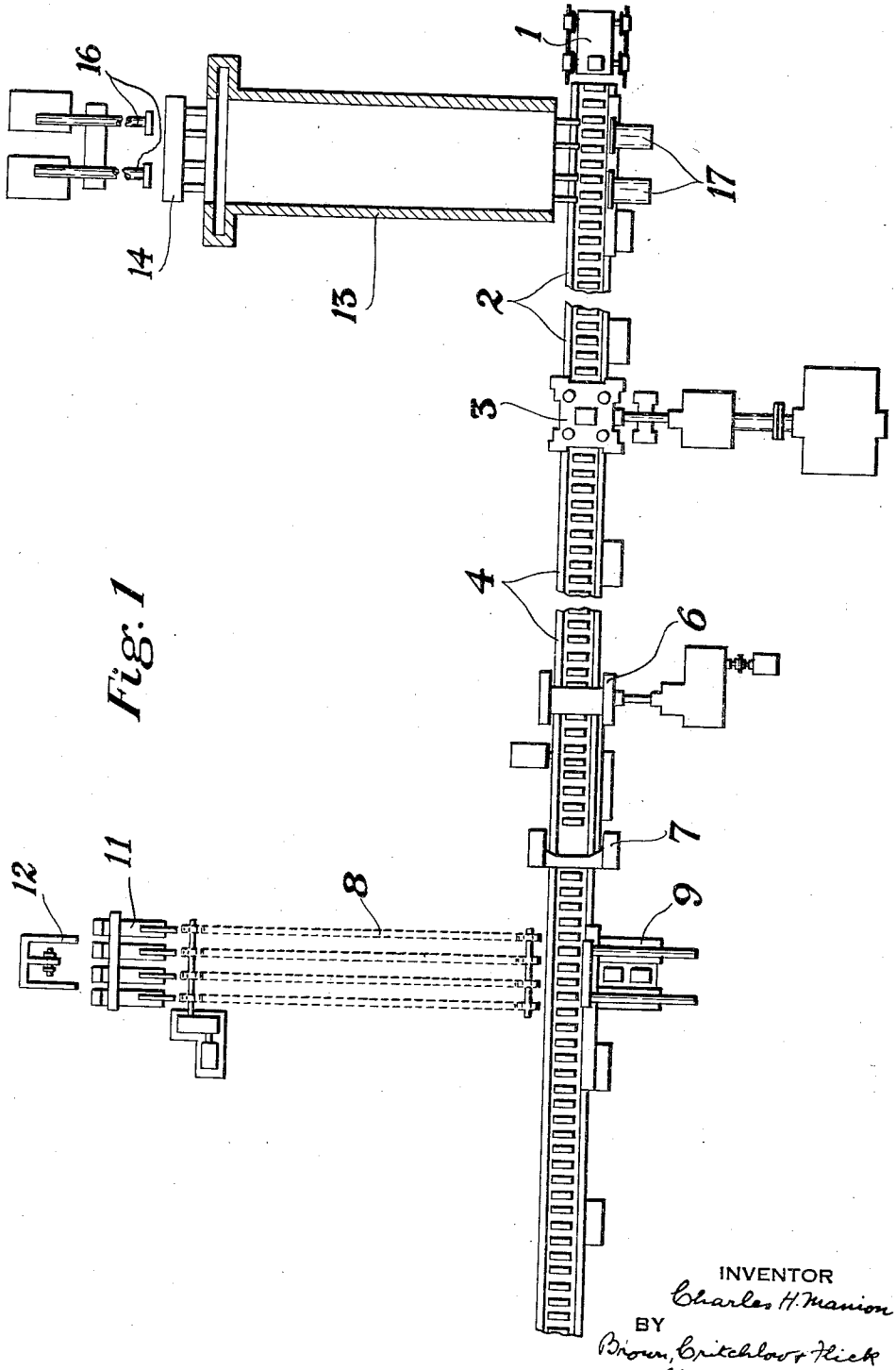


Fig. 1

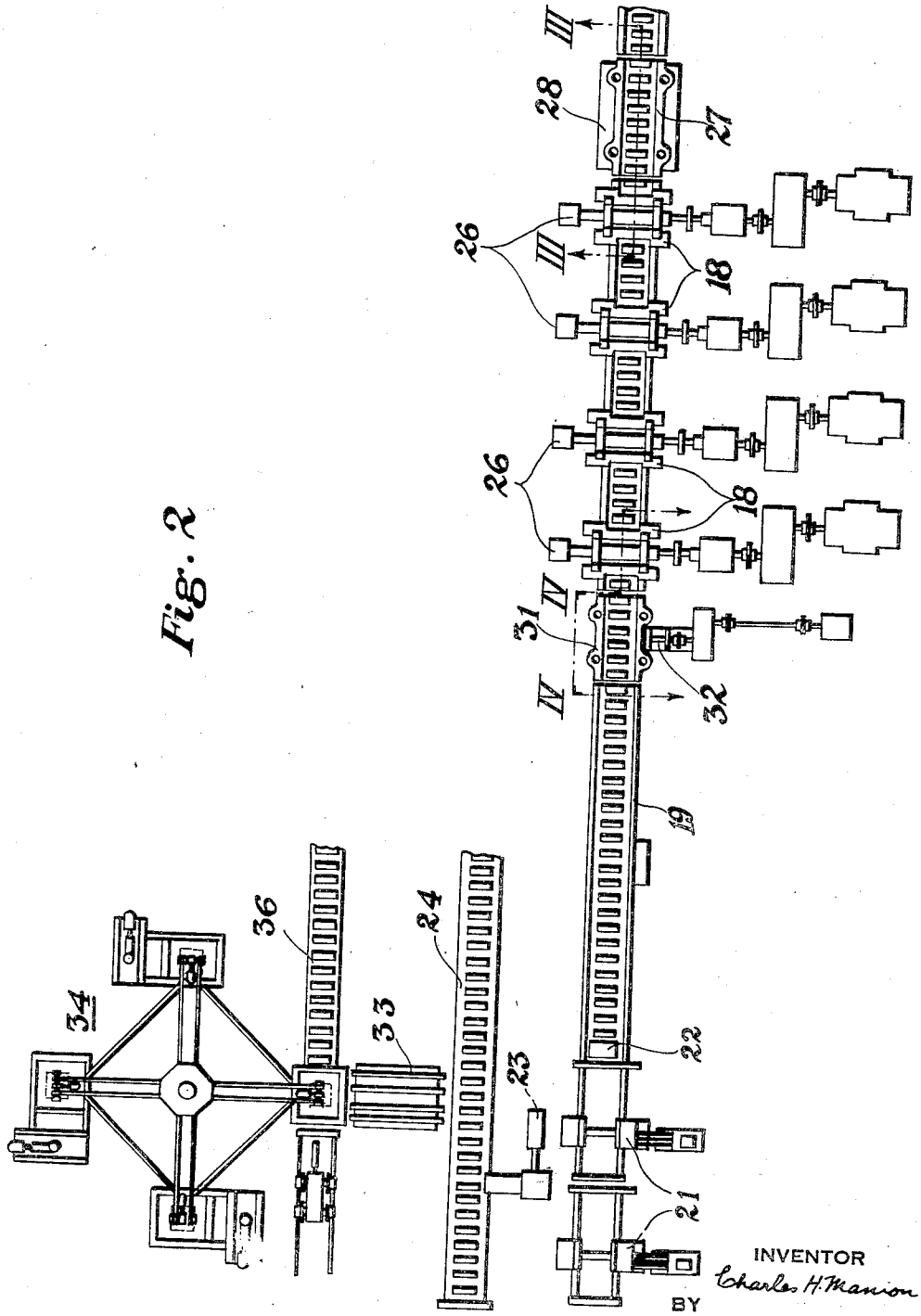
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Fig. 2



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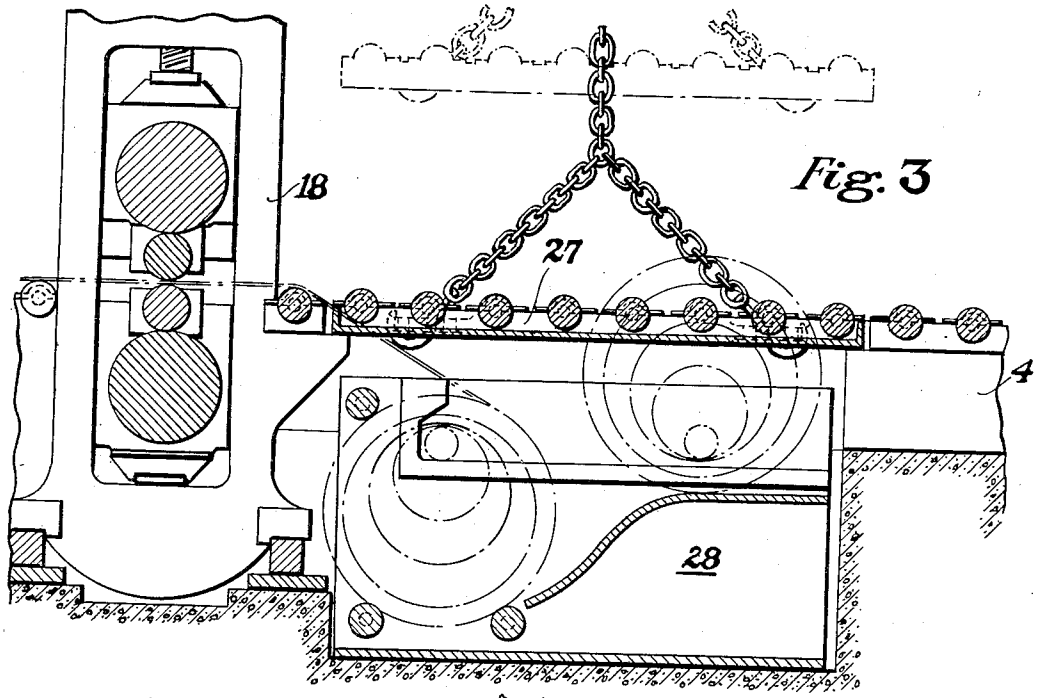


Fig. 3

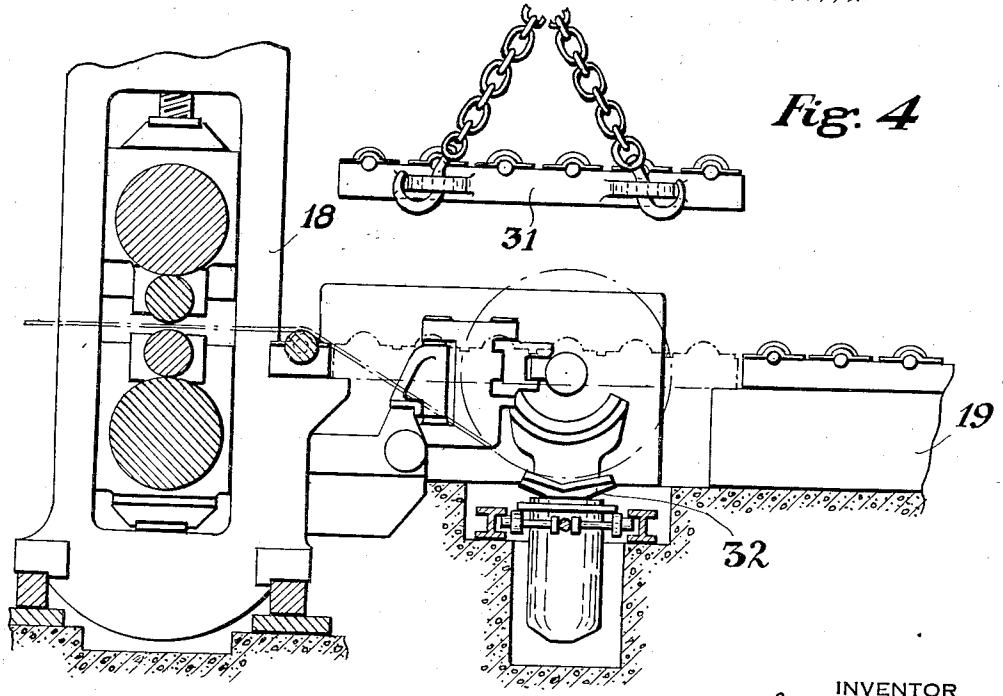


Fig. 4

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UNITED STATES PATENT OFFICE

2,162,407

METHOD AND APPARATUS FOR MANUFACTURING METALLIC STRIP

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Application September 11, 1937, Serial No. 163,359

17 Claims. (Cl. 80—31.1)

This invention relates to a method and apparatus for reducing hot ingots to cold rolled strip steel, and more particularly to a mill arrangement or layout for this purpose and to a method of rolling practiced in connection therewith.

The customary practice in producing cold rolled metal strip from hot ingots is to roll the hot ingots into slabs in a blooming or slabbing mill, shear the slabs, and transfer them to a reheating furnace. Thereafter the slabs are further reduced in a hot roughing mill which may comprise several separate sets of roll stands. Next the ends of the resultant strip are cropped and the strip then hot rolled in a hot strip mill which also comprises several separate sets of roll stands. After the strip leaves the hot mill, it may be pickled and then cold rolled in a cold rolling mill which, like the hot mill, may comprise several separate sets of roll stands. Large tonnage can be produced with such a method and apparatus, but it will be appreciated that very great initial and operating costs are involved because so many different types of mills and drives and auxiliaries are required, so much space is required for the equipment, and such a relatively large number of men are required to control the operations of the various machines.

Due to these exceedingly high initial and operating costs and the large investment necessitated thereby, small companies that do not require a large tonnage of strip steel are discouraged or prevented from rolling strip cold, or find it necessary to have other companies do part of the work, such as produce the slabs or even the hot strip. In some cases it is possible to get along with less equipment by arranging it so that some of it serves a dual purpose, but this saving is largely lost by the increased cost of production resulting from the fact that while part of the equipment is serving its dual purpose other parts must stand idle while waiting for the material being processed. Money invested in expensive mill equipment which is not used at all during a large part of the strip-forming operation adds greatly to production costs.

It is among the objects of this invention to provide for reducing ingots to cold rolled strip by apparatus the initial cost of which is materially reduced relative to the cost of apparatus used for this purpose heretofore, by apparatus substantially all of which is maintained in continuous operation while rolling is progressing so as to hold production costs down to a reasonable level, and by apparatus for which a minimum of operators and floor space is required. Another object is to provide a method of hot and cold rolling by which fulfillment of the above-mentioned objects is made possible.

In accordance with this invention hot ingots are reduced to slabs in the same mill that is later used as a roughing stand for reducing the slabs to rough strips or bars after the former have been sheared and reheated. It is preferred to use a reversing universal mill for this purpose, and to remove the slabs from its run-out table after they have been sheared so as to deliver them to a slab yard through which they are subsequently charged into a reheating furnace located beside the mill's entry table. As fast as bars are rolled in the universal mill they are cropped by the slab shear and conveyed by the run-out table directly to a hot strip mill, preferably of the continuous type, in which they are further reduced to strips which are coiled for storage to be followed at the proper time by pickling, if desired. The strip mill is adapted to have its rolls for hot strip rolling removed and replaced by rolls suitable for cold rolling (hereinafter referred to as hot and cold rolls, respectively), and similarly its strip guiding equipment is changeable to guiding equipment suitable for cold strip rolling. The same mill is also operatively connected with an uncoiler and one or more strip reels. The uncoiler and the strip reels may be arranged in any manner which is suitable to secure cooperation with the strip mill, but I prefer, for the sake of simplicity, that arrangement in which they are located below displaceable sections of the conveyor tables at the entry and delivery ends of the strip mill.

After all of the slabs that were produced by the universal mill have been rolled into bars and the bars have been rolled into hot strip, cold rolls are substituted for the hot rolls of the strip mill, the strip guiding equipment between the stands is changed to that suitable for cold strip, and the removable table sections are removed to uncover the uncoiler and reel. The coils of hot rolled strip, which have cooled with self-annealing if desired, and which may have been pickled in the meantime, are then placed in the uncoiler and the strip is cold rolled in the strip mill and removed as coils from the reel.

While the cold rolling is proceeding in the strip mill, the universal still continues in uninterrupted operation rolling another supply of ingots into additional slabs that are fed into the reheating furnace, and as soon as the cold rolling is finished and the hot rolling equipment and table sections are replaced, these slabs, like the

preceding supply, are reduced in the universal mill to bars which are carried by the run-out table directly to the strip mill where they are hot rolled into strip. This cycle of operation is repeated over and over again as long as ingots are available, and it will therefore be apparent that both mills as well as the rest of the equipment operate substantially all of the time with no prolonged and costly periods during which part of the apparatus must necessarily stand idle. By rolling metal with this apparatus and according to this method, sufficient tonnage of cold rolled strip can be produced in a given period of time to prevent production costs from becoming excessive.

The preferred embodiment of the invention is illustrated in the accompanying drawings in which Fig. 1 is a fragmentary and somewhat diagrammatic plan view of part of the apparatus constructed and laid out in accordance with this invention; Fig. 2 is a continuation of Fig. 1 showing the rest of the apparatus; Fig. 3 is an enlarged side view of the uncoiler and associated parts taken on the line III—III of Fig. 2; and Fig. 4 is a side view, similar to Fig. 3, of the cold strip reel taken on the line IV—IV of Fig. 2.

Referring to Fig. 1 of the drawings, an ingot buggy 1 or other suitable device is adapted to deliver hot ingots to one end of a driven entry table 2 at the opposite end of which there is a mill 3 in which the ingots are reduced to slabs. As it is an object of this invention to provide as little rolling equipment as possible, a single reversing universal mill is used because its vertical rolls make it unnecessary to provide for ingot-turning apparatus. At the delivery side of the mill there is a driven run-out table 4 on which the slabs are conveyed through a shear 6 by which they are cut into suitable lengths with the help of a shear gauge 7. As the slabs leave the shear they are pushed laterally off the run-out table and onto transfer apparatus 8 by means of a reciprocable slab pusher 9 mounted on the opposite side of the table. The transfer apparatus is of any suitable form, such as an endless chain conveyor disposed substantially at right angles to the table, and transports the slabs from the table to a piler 11.

As soon as a sizable pile of slabs has been formed in this manner, the slabs are transferred to the slab yard where they are inspected, processed and stored; and from storage they are delivered by any suitable means, such as crane hook 12, to an unpiler disposed at one end of a reheating furnace 13, the opposite end of which is positioned adjacent one side of entry table 2. The unpiler preferably comprises an elevatable support 14 for the pile of slabs, and reciprocable arms 16 for pushing the top slab from the pile into the furnace. Each time the arms are retracted the support is elevated to bring the top slab into the path of the arms. As the slabs are pushed through the reheating furnace in this manner the foremost one is pushed out onto entry table 2 where its lateral movement is arrested by stops 17 mounted on the opposite side of the table. Delivery of ingots from the soaking pit to mill 3 is then discontinued and the rolling of slabs delivered from the furnace 13 then takes place.

In accordance with this invention, each successive hot slab is rolled back and forth through the reversible universal mill until reduced to a size suitable for rolling into strip. Stock that has been thus reduced is referred to herein as bars. The bars are carried by run-out table 4 through shear 6, where their ends are cropped, and past slab transfer apparatus 8 to a strip mill 18, of which four stands are shown in Fig. 2 of the drawings. Each bar is reduced in the strip mill, which is preferably a continuous mill, to hot strip steel that moves over a delivery table 19 to a hot coiler 21. Preferably, two coilers are provided, each in line with the mill with the usual gate 22 in front of the first one for guiding the hot strip into either one of the coilers. Each coil thus formed is removed from its coiler by any suitable means, such as the coil unloader 23 shown in Patent No. 2,092,539, and deposited on a conveyor 24 by which it is conveyed to a storage area from which it may later be taken to be pickled. When in storage the coils cool off slowly because of the closely wrapped convolutions of the strip and the result is a self-annealing of the strip which is often advantageous.

It will thus be seen that with a minimum of apparatus ingots are reduced to hot strips which are coiled and stored; the universal mill, shear, and entry and run-out tables being used for the dual purpose of forming slabs from ingots and bars from the slabs. It follows that a minimum of floor space and a reduced number of operators are required for this apparatus.

In keeping with the foregoing, it is a feature of this invention that the strip mill 18 is convertible into a hot or cold mill whereby substantially one strip mill and its operators are eliminated, and full use is made of strip mill 18 and its operators. That is, strip is cold rolled in this mill after all of the bars have been reduced, whereby shutting down of the strip mill while more slabs are being made is avoided. Accordingly, the strip mill is adapted to receive either hot or cold rolls, i. e., rolls suitable for hot rolling and rolls designed for cold rolling, to receive strip-guiding equipment for either type of rolling, and the mill drives are suitable for both hot and cold rolling. Roll-changing apparatus 26, preferably of the type shown in Buente Patent No. 2,037,210, is therefore disposed besides each stand of the strip mill in readiness for quickly changing the rolls to form either a hot mill or a cold mill. Furthermore, the run-out delivery tables 4 and 19 are provided adjacent the strip mill with removable sections, by which is meant sections that can be lifted out of place by a crane or otherwise moved out of the way when desired. As shown in Fig. 3, under the removable run-out table section 27 there is an uncoiler 28, and, as shown in Fig. 4, under the removable delivery table section 31 there is a cold strip reel 32 preferably adapted to exert tension on strip connected to it.

If it is desired to pickle the coiled strip before placing it in the uncoiler uncovered by table section 27, a coil of the hot rolled strip is taken from storage by a crane, which may be the same one that delivers slab piles to the reheating furnace and lifts the removable table sections, and placed on skids 33 down which it rolls to the loading station of picking apparatus 34 which is desirably of the type disclosed in Biggert and Buente patent application Serial No. 82,542, filed May 29, 1936. The coil is successively immersed in pickling, washing and rinsing tanks after which it runs endwise down an inclined table 36 from whence it is transported by the crane or other means to uncoiler 28. Strip from this

pickled coil is fed through the strip mill in which cold rolls have been substituted for the hot rolls, and is connected to reel 32 from above which table section 31 has been removed. As soon as a coil of cold rolled strip is formed on the reel it is removed therefrom for storage, shipment, or further processing.

While the cold rolling is being carried on, another supply of ingots is fed over entry table 2 to the universal mill by which they are formed into slabs that are removed from the side of the run-out table and piled preparatory to reheating. As soon as all of the pickled coils have been cold rolled the removable table sections are replaced, the cold rolls are removed from the strip mill and the hot rolls replaced therein by roll-changing apparatus 26, and the strip-guiding equipment is changed by suitable apparatus, not shown. The strip mill is then ready to perform hot rolling again, so the slabs that were formed during the period of cold strip rolling are pushed out of the reheating furnace and reduced by the universal mill to bars which are conveyed by the run-out table to the hot mill in order to repeat the cycle of operation just described.

It will be observed that in practicing the method contemplated by this invention hot bars are produced by the same mill that forms the slabs from which they are made, the bars are fed directly from that mill to a hot strip mill that reduces them to strips that are formed into coils, additional ingots are rolled into slabs by the first mill after the hot strip rolling is finished, cold rolls are substituted for the hot rolls of the strip mill, the coils of strip may be pickled and the strip is then rolled in the cold mill just formed while slabs are being produced in the other mill, and the hot strip rolling equipment is operatively reassembled in the strip mill after cold rolling therein is finished in order to reduce to hot strips the bars that are then formed by the first mill from the slabs previously produced thereby. In short, hot strip rolling is carried on in the strip mill while the universal mill is forming slabs into bars, and the universal mill forms ingots into slabs while cold strip rolling is being carried on in the strip mill. Consequently, all of the apparatus is kept in operation substantially all the time so that there are no prolonged periods during which parts of it are shut down which would raise production costs. In addition to requiring a comparatively small investment in apparatus, the layout of the apparatus is compact, especially when the furnace, slab transfer, roll-changer and pickler are all disposed on the same side of the mills as is preferred.

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

I claim:

1. The method of rolling metal comprising rolling ingots or the like in a mill to form slabs, reheating the slabs, rolling the slabs in the same mill to form bars, conveying the bars from said mill directly to a hot strip mill to reduce them to strip, coiling the hot strip, again rolling ingots in said first mill to form slabs after said hot strip rolling is finished, exchanging the strip mill equipment necessary for hot rolling for that needed for cold rolling, cold rolling the hot rolled strip in the cold strip mill thus formed while slabs are being produced by said first mill, returning said hot rolling equipment to the strip mill after said cold rolling is finished, and repeating this cycle of rolling whereby substantially all of the apparatus is maintained in substantially continuous operation.

2. The method of rolling metal comprising rolling ingots in a mill to form slabs, shearing the slabs in a shear, reheating the slabs, rolling the slabs in the same mill to form bars, shearing the bars in the same shear, conveying the bars from said shear directly to a hot strip mill to reduce them to strip, coiling the hot strip, again rolling ingots in said first mill to form slabs after said hot strip rolling is finished, exchanging the strip mill equipment necessary for hot rolling for that needed for cold rolling, cold rolling the hot rolled strip in the cold strip mill thus formed while slabs are being produced from ingots by said first mill, returning said hot rolling equipment to the strip mill after said cold rolling is finished, and repeating this cycle of rolling whereby substantially all of the apparatus is maintained in substantially continuous operation.

3. Apparatus for hot and cold rolling metal, comprising a mill for rolling ingots into slabs, means for reheating said slabs, means for returning the reheated slabs to said mill for reduction to bars therein, means for delivering said bars from said mill to a hot strip mill for reduction to hot strip therein, means for changing the rolls of said strip mill to cold rolls, and means for feeding said hot rolled strip to the cold strip mill thus formed for cold rolling therein.

4. Apparatus for hot and cold rolling metal, comprising a mill for rolling ingots into slabs, means for reheating said slabs, means for returning the reheated slabs to said mill for reduction to bars therein, means for delivering said bars from said mill to a hot strip mill for reduction to hot strip therein, means for forming the hot strip into coils, means for changing the rolls of said strip mill to cold rolls to form a cold rolling mill, an uncoiler at one end of the strip mill, and a reel at the opposite end of the strip mill, whereby hot rolled strip from said coils disposed in said uncoiler is rolled in said cold rolling mill and wound on said reel.

5. Apparatus for hot and cold rolling metal, comprising a mill for rolling ingots into slabs, means for reheating said slabs, means for returning the reheated slabs to said mill for reduction to bars therein, a table for feeding said bars from said mill to a hot strip mill, a delivery table for receiving hot strip from said strip mill, each of said tables having a removable section adjacent the strip mill, an uncoiler mounted below said removable feed table section, a cold reel mounted below said removable delivery table section, a hot coiler at the opposite end of said delivery table, means for changing the rolls of the strip mill to cold rolls to form a cold rolling mill, and means for removing said table sections and for delivering coils of said hot rolled strip to said uncoiler for cold rolling in said cold rolling mill.

6. Apparatus for hot and cold rolling metal, comprising a mill for rolling ingots into slabs, a shear for said slabs, means for reheating the sheared slabs, means for returning the reheated slabs to said mill for reduction to bars therein, said shear being adapted to shear said bars,

hot rolled strip to the cold strip mill thus formed for cold rolling therein.

15. Apparatus for hot and cold rolling metal, comprising an entry table, means for delivering ingots thereto, a reheating furnace beside the table, a reversing universal mill at the delivery end of the table for reducing the ingots to slabs, a run-out table for the slabs, a shear associated with the run-out table for shearing the slabs, transfer means beside said run-out table for removing sheared slabs therefrom, means for conveying the removed slabs to said furnace to reheat them before returning them to said entry table for reduction to bars in said universal mill, said shear being adapted to shear the bars, a strip mill at the delivery end of the run-out table for rolling said bars into hot strip, said strip mill having interchangeable hot and cold rolls, the delivery end of said run-out table being provided with a removable section, an uncoiler mounted below said table section, a coiler for receiving said hot strip from said strip mill, a delivery table extending from the strip mill to the coiler and having a removable section adjacent the mill, a cold reel mounted below said delivery table section, and means for conveying coils of said hot rolled strip to said uncoiler when said table sections are removed and cold rolls are substituted for the hot rolls of the strip mill whereby to cold roll the strip.

16. Apparatus for hot and cold rolling metal, comprising an entry table, means for delivering ingots thereto, a reheating furnace in cooperative relationship with the table, a reversing universal mill at the delivery end of the table for reducing the ingots to slabs, a run-out table for the slabs, a shear associated with the run-out table, transfer means beside said run-out table for removing sheared slabs therefrom, a slab piler receiving slabs from said transfer means, means for conveying piles of slabs from the piler to a position adjacent said furnace, means for feeding the slabs into the furnace to reheat them before returning them to said entry table for reduction to bars in said universal mill, a strip mill at the delivery end of the run-out table for rolling said bars into hot strip, said strip mill having interchangeable equipment for hot and cold rolling, the delivery end of said run-out table being provided with a removable section, an uncoiler mounted below said table section, a coiler for receiving said hot strip from said strip mill, a delivery table extending from the strip mill to the coiler and having a removable section adjacent the mill, a cold reel mounted below said delivery table section, pickling apparatus, and means for conveying coils of strip from the coiler to the pickling apparatus and for conveying pickled coils to said uncoiler when said table sections are removed and cold rolling equipment is substituted for the hot rolling equipment of the strip mill whereby to cold roll the strip.

17. The method of rolling metal comprising rolling blanks in a mill to form work pieces, conveying work pieces while hot from said mill directly to a hot strip mill to reduce them to strip, coiling the hot strip, continuing the rolling of blanks in said first mill after said hot strip rolling is finished, exchanging the strip mill equipment necessary for hot rolling for that needed for cold rolling, cold rolling the hot rolled strip in the cold strip mill thus formed while blanks are being rolled in said first mill, returning said hot rolling equipment to the strip mill after said cold rolling is finished, and repeating this cycle of rolling whereby substantially all of the apparatus is maintained in substantially continuous operation.

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