June 18, 1940. R. M. FENTON 2,204,984

METHOD OF AND APPARATUS FOR MAKING SHEETS

Filed March 20, 1936 4 Sheets-Sheet 1

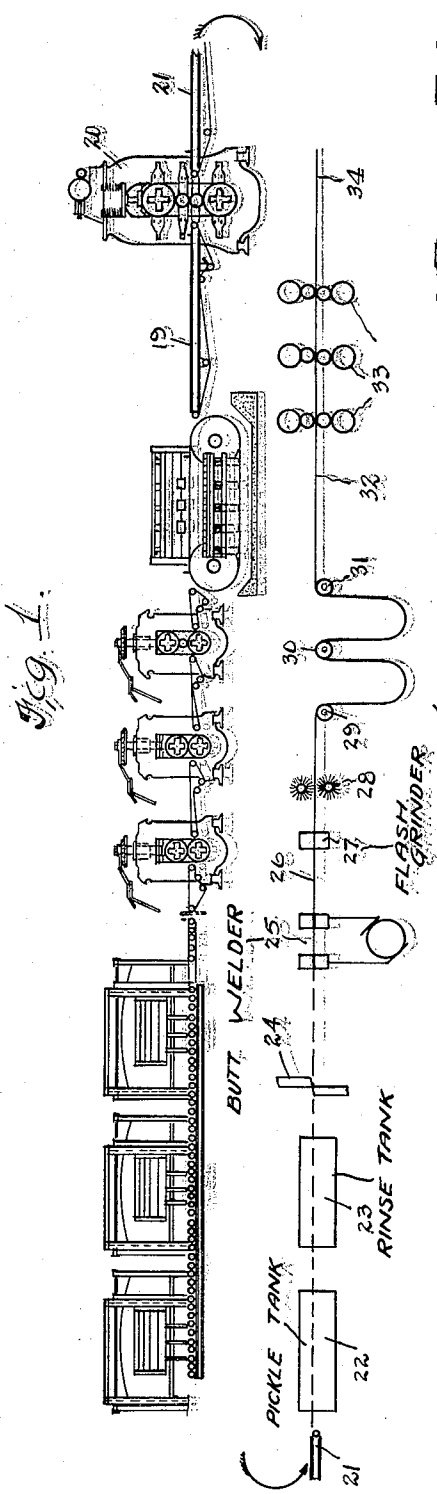


Fig. 1.

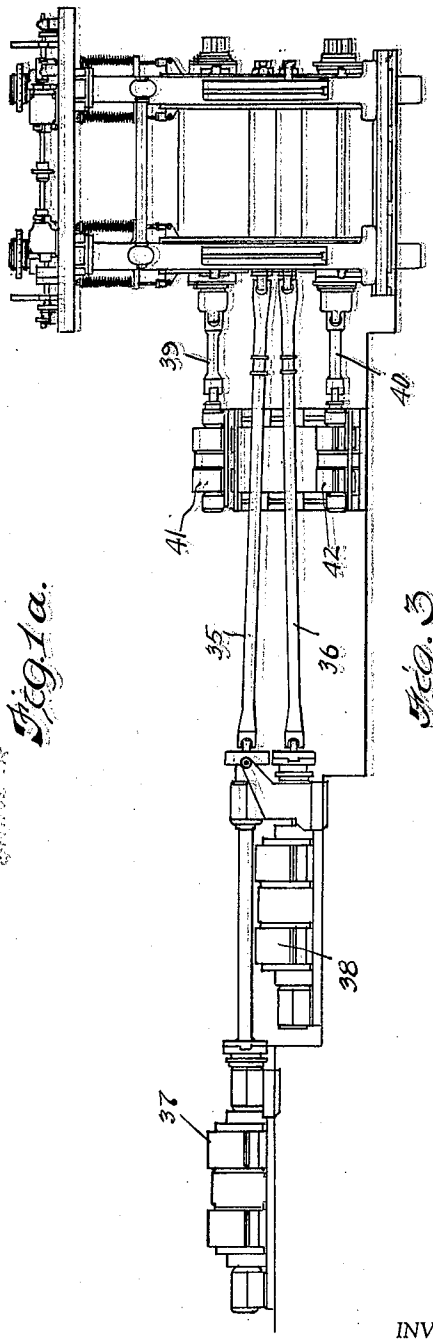


Fig. 3

Fig. 1a.

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METHOD OF AND APPARATUS FOR MAKING SHEETS

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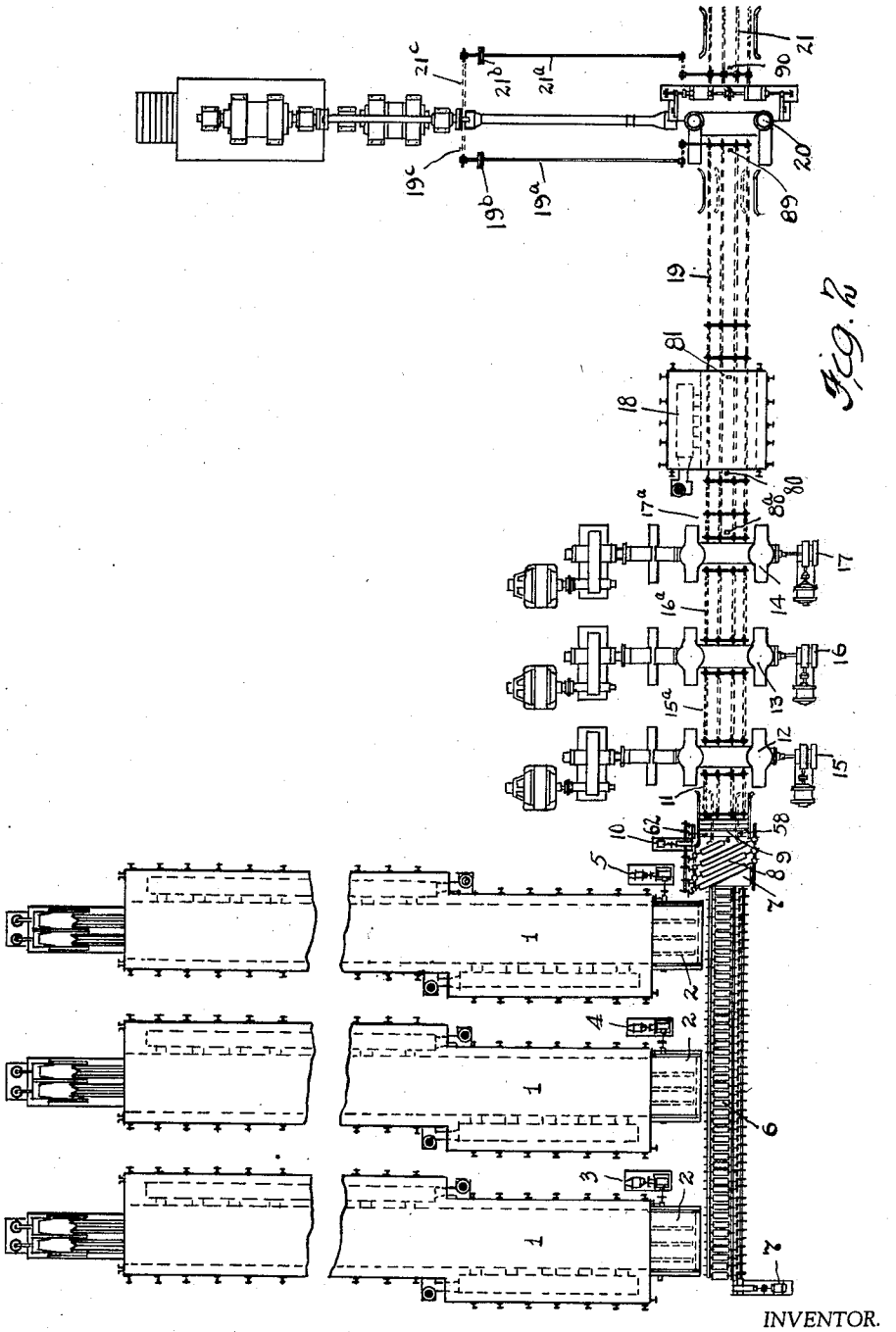


Fig. 2

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METHOD OF AND APPARATUS FOR MAKING SHEETS

Filed March 20, 1936 4 Sheets-Sheet 3

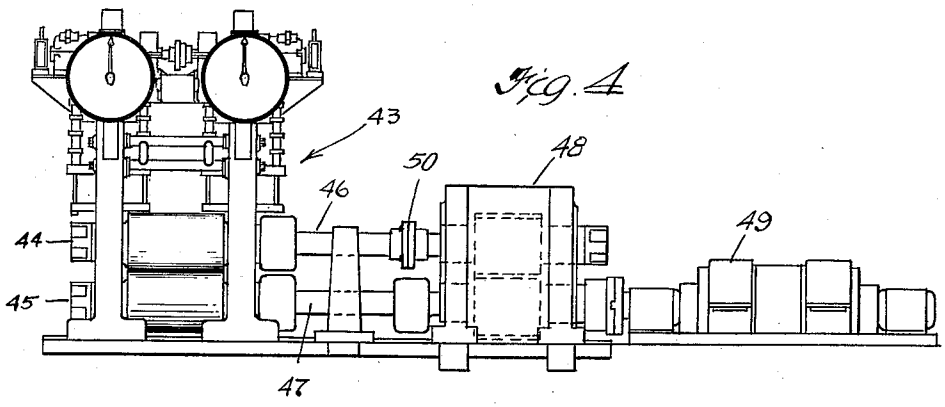


Fig. 4

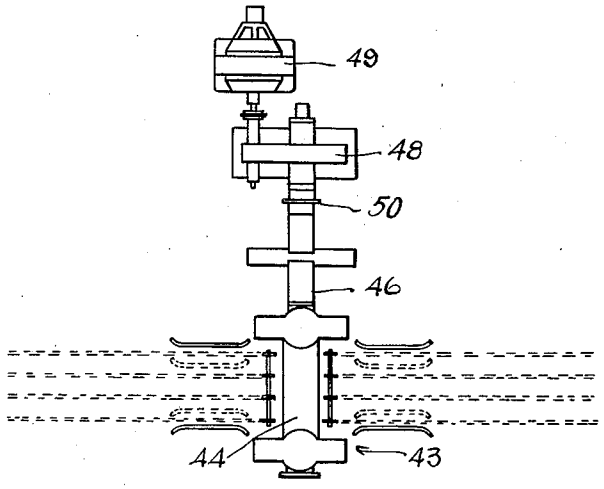


Fig. 5

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METHOD OF AND APPARATUS FOR MAKING SHEETS

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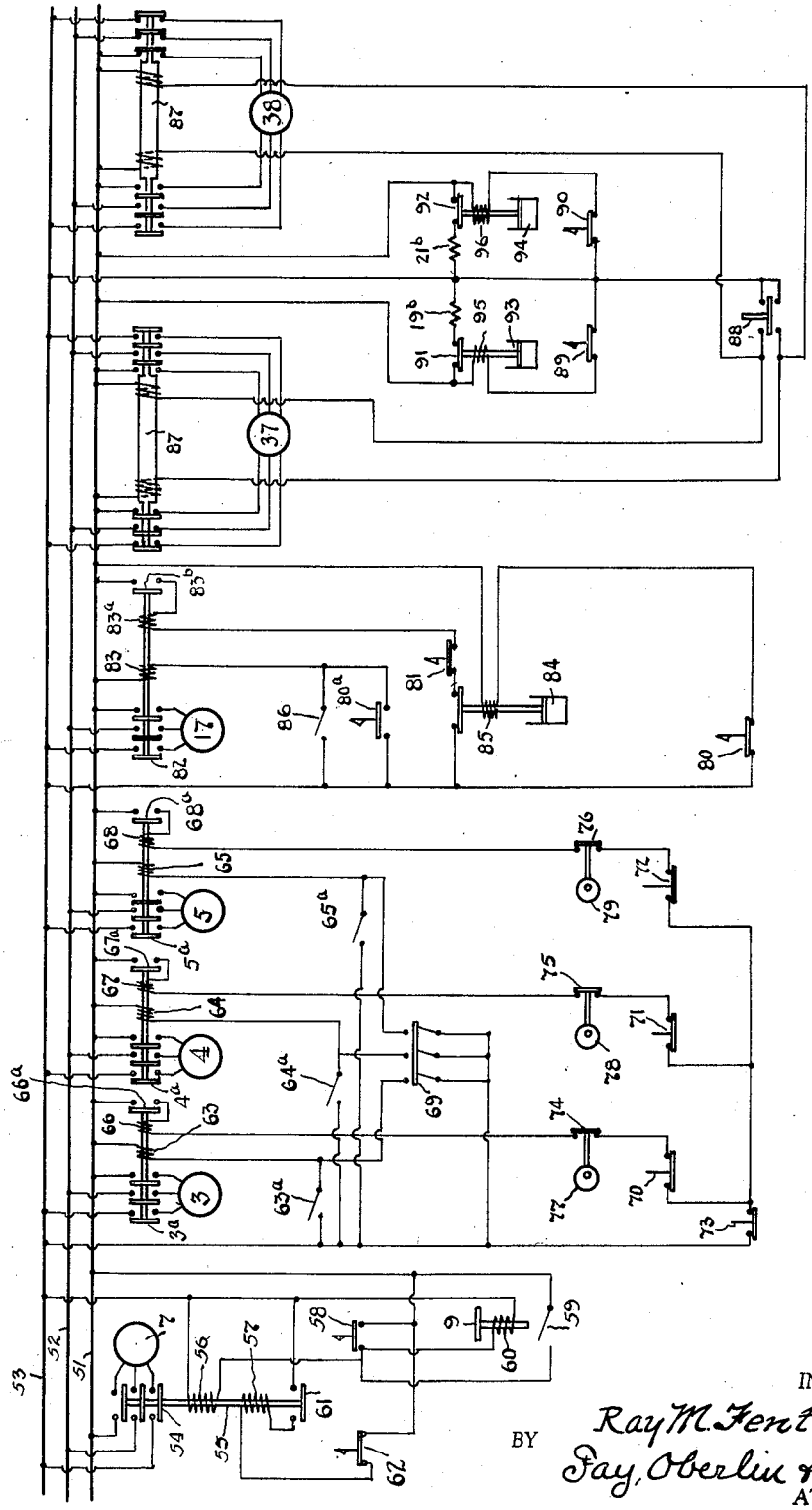


Fig. 6

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UNITED STATES PATENT OFFICE

2,204,984

METHOD OF AND APPARATUS FOR MAKING SHEETS

Ray M. Fenton, Youngstown, Ohio

Application March 20, 1936, Serial No. 69,937

5 Claims. (Cl. 29—17)

This invention relates as indicated to the method of and apparatus for making sheets and more particularly to a rolling mill system and a mode of operation thereof whereby the production of a uniform grade of rolled metallic sheets is made possible at a lower cost as based on the amount of capital and labor invested.

It is a further object of my invention to provide a method of and apparatus for the production of individual sheets having all of the desirable characteristics of so-called continuous strip but without requiring the expensive apparatus necessary in the production of such strip.

More specifically, it is a further object of my invention to provide a method of and apparatus for the production of rolled sheets in which a plurality of individual sheet bars are successively operated upon to the ultimate production of a continuous strip which is then severed into appropriate lengths for the production of flat sheets having the desirable characteristics as to uniformity in gauge and contour usually associated with continuous strip steel.

It is a further object of my invention to provide a method of and apparatus whereby a plurality of sheet bars in excess of the number usually worked together may be treated as a batch and successively subjected to various rolling operations whereby there is produced a batch of sheets of substantially identical form and with a marked saving in the cost of such production.

It is a further object of my invention to provide a particular apparatus capable of efficiently and economically producing the above enumerated results.

To the accomplishment of the foregoing and related ends, said invention, then consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawings and the following description setting forth in detail certain means and one mode illustrating, however, but one of the various ways in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a side elevational view, showing part of the apparatus constructed and arranged in accordance with the principles of my invention and capable of carrying out the process comprising this invention; Fig. 1*a* is a schematic side elevational view of the remainder of my said apparatus; Fig. 2 is a plan view of the part of the apparatus shown in Fig. 1; Fig. 3 is a side elevational view of the rolling mill and its associated drive shown at the upper righthand end of Fig. 1; Fig. 4 is a side elevational view of an alternative form of construction of the apparatus illustrated in Fig 3; Fig. 5 is a plan view of the mill shown in Fig. 4 and Fig. 6 is a schematic wiring diagram of the control circuit for the apparatus illustrated in the previous figures, particularly Figs. 1 and 2.

The methods whereby metallic sheets or strips have been rolled in the past may for purposes of the present consideration be divided into two general classes: first, the method wherein individual relatively small sheet bars are rolled into individual sheets, in which method the principal manipulation of the work pieces was originally performed manually and in recent years supplemented by mechanical apparatus such as feeders, catchers and conveyors; second, the method which is generally referred to as the continuous strip process wherein a relatively large billet or bar is successively rolled down to the production of a so-called continuous strip which, due to its great length, as compared to its width, is usually coiled after finishing in order to place the same in the form for convenient shipment. In this last-named process the apparatus necessary to produce the long strip has been of necessity very expensive to the end that there are but few complete installations of this character in this country at the present time.

My invention, as previously explained, contemplates a process which may be conveniently referred to as a combination of certain features of the previously described processes retaining the flexibility and low equipment cost of the sheet process with the desirable characteristics, so far as the finished product is concerned, of the so-called strip process.

Referring now more specifically to the drawings and more especially to Figs. 1 and 2, the apparatus herein illustrated so arranged as to be capable of performing the method comprising my invention consists of a plurality of bar heating furnaces generally indicated at 1 of which three in number have been illustrated. Any convenient number of furnaces such as 1 may be employed; however, it has been found that when three such furnaces of the usual capacity are used, they are ample to supply the heated bars necessary for a continuous operation of the apparatus associated therewith and in accordance with the method presently to be explained.

Each of the furnaces 1 is provided with a conveyor 2 extending preferably therethrough and arranged to carry the work bars on edge through

the furnace in the manner generally indicated in my prior Patent No. 2,023,318, dated December 3, 1935. The furnaces 1 or more particularly the work conveyors associated therewith are provided with drive motors 3, 4 and 5 which are energized and controlled in the manner hereinafter more fully explained.

Positioned adjacent the discharge ends of the conveyors 2 and extending transversely thereof is a roller conveyor generally indicated at 6 which is driven by means of a suitable motor such as 7.

Adjacent the right hand or discharge end of the conveyor 6 there is positioned a straightening or aligning table, generally indicated at 7, which is provided with a plurality of driven rollers 8 arranged at an angle to the longitudinal axis of the conveyor 6 so that when a sheet bar is delivered endwise fashion from the conveyor 6 to the table 8, the bar will be rotated in a counter-clockwise direction as viewed in Fig. 2 until the same moves against the matching stop 9 with its long axis arranged at right angles to the longitudinal axis of the conveyor 6, i. e., the bar is arranged in position to be presented to the mills.

The straightening table 8, or more particularly the rollers thereof are preferably continuously driven by some suitable means such as a motor 10 which may also be employed for the purpose of continuously driving the conveyor 11 which extends from the matching stop 9 to the mills.

In the preferred form of my invention I provide two 2-high roughing mills generally indicated at 12 and 13 which mills are arranged in tandem with each other and with a 3-high roughing mill generally indicated at 14. The employment of the 3-high roughing mill for the last roughing pass is preferred since it results in the production of a breakdown having a more uniform cross section than when the last roughing pass is through a 2-high mill. The motor shown at 15 may be employed for the purpose of continuously driving the conveyor 15*a*. The motor 16 may be employed for the purpose of continuously driving the conveyor 16*a* and the motor 17 may be employed for the purpose of driving the conveyor 17*a* in the particular manner hereinafter more fully explained.

Positioned in alignment with the conveyor 17*a* is a holding furnace 18 of conventional construction and design and arranged to receive a plurality of work units issuing from the mills 12, 13 and 14 and to maintain such work pieces at a predetermined temperature or to heat the same to such temperature preliminary to their being subjected to a further rolling operation.

Leading from the discharge end of the furnace 18 is a conveyor 19 which is in reality a combined feeding and catching device associated with the mill generally indicated at 20, the construction and mode or operation of which will likewise be explained in detail.

The mill 20 also has a catcher-feeder table generally indicated at 21 associated therewith. The tables 19 and 21 are employed as hereinafter more fully explained for the purpose of passing and re-passing a plurality of work pieces arranged and treated as a batch through the mill 20 until they have been reduced and accordingly elongated to the desired extent.

The conveyor chains on tables 19 and 21 are respectively driven by means of spindles 19*a* and 21*a* through magnetic clutches 19*b* and 21*b* and are coupled for a source of power by means of sprocket chains 19*c* and 21*c* to one of the driving pinions for the mill 20.

In accordance with the method comprising my invention the work pieces after the conclusion of the rolling operation in the mill 20 are discharged into a pickling tank generally indicated at 22 from which they pass into a wash tank generally indicated at 23 in order to remove therefrom all foreign material such as dirt, scale and the like. The cleaning tank 23, it should be noted, may be constructed in accordance with the principles disclosed in my co-pending application Serial No. 62,304, filed February 4, 1936, so that a continuous line of individual sheets is discharged from the cleaning tank whereupon they pass through an end shears generally indicated at 24 which crops forward and rear ends of the sheet along the lines normal to their longitudinal axes. The end-sheared sheets then pass through a resistance welder generally indicated at 25 which momentarily arrests the sheets and by means of the resistance flash welding process welds the forward end of a rearward sheet to the rearward end of a forward sheet to the production of a continuous strip generally indicated at 26. The strip thus formed passes through a grinder of any conventional design generally indicated at 27 which is employed for the purpose of grinding off the flash formed on the sheets by the welder. After the grinding operation has been completed the strip passes through a pair of opposed brushes 28 which finally clean the sheet of all adhering foreign material and after which the sheet or strip passes over the rollers such as 29, 30 and 31 between which the sheet is permitted to loop so that it may be drawn at a continuous rate as at 32 through one or more stands of 4-high finishing mills generally indicated at 33.

After the strip thus rolled in a continuous fashion and comprising a plurality of individual components joined together by weld areas is discharged as at 34 from the finishing mills 33, the same will preferably be severed into individual units along the lines at which the sheets were originally welded to the production of a plurality of flat sheets in which substantially the entire body thereof is uniform both as to structure and cross section.

The mill 20 illustrated as being of usual 4-high design so far as the rolls thereof are concerned, is, however, novel with respect to the means which have been provided for driving the same and the manner in which the same is driven and controlled. The upper and lower work rolls are respectively driven through spindles 35 and 36 by means of independent reversable electric motors 37 and 38 and the backing up rolls are connected by means of spindles 39 and 40 to small electric motors 41 and 42 respectively. The primary or work motors 37 and 38 are as previously indicated of the reversible type and while forming no part of this invention are so constructed as to be capable of being brought up to speed in a relatively short time such as approximately one second and brought to a stop from full speed in an approximately equivalent length of time. The motors 41 and 42 are employed primarily for the purpose of overcoming the inertia of the large backing up rolls. That is, when the power is cut off of the motors 37 and 38 for the purpose of bringing the mill to a standstill preliminary to its reversal, the motors 41 and 42 are energized so as to act as a magnetic brake for the rotating backing up rolls and thereafter to assist in bringing the backing up rolls to full

speed in the opposite direction. If the small diameter work rolls were relied upon entirely for this purpose undesirable relative movement between such work rolls and the backing up rolls might occur. It is believed novel to provide this type of drive for a reversing 4-high mill, i. e., where reversing motors are employed for the purpose of driving the work rolls in opposite directions and individual motors are employed for the purpose of driving the backing up rolls in opposite direction during the reversal stage so as to overcome the inertia of the large mass rolls. It will be understood that the degree of energization which the motors 41 and 42 are subjected to, i. e., the amount of driving which such motors exert upon the backing up rolls with which the same are associated, is not materially relied upon during the rolling operation to assist in driving the mill but are primarily relied upon to reverse the backing up rolls in the manner explained.

Instead of employing a 4-high mill at 20 as above explained, I may prefer to employ a reversing 2-high mill generally indicated at 43 in Figs. 4 and 5. The upper and lower rolls 44 and 45 respectively of the 2-high mill are connected by means of spindles 46 and 47 respectively through a gear housing generally indicated at 48 to a single prime mover such as the electric motor 49. The spindle 46 has interposed therein between the roll 44 and the driving gear on the spindle a slip clutch generally indicated at 50 which is employed for substantially the same purpose as are the motors 41 and 42 in the 4-high mill. In other words, the slip clutch 50 will be so adjusted that the amount of torque capable of transmittal thereby to the upper roll 44 is sufficient to overcome the momentum and inertia of the roll during a stopping and starting in reverse direction of the mill but insufficient to drive the roll 44 at a speed different from that at which the lower work roll 45 is driven. The provision of the slip clutch 50 makes possible, therefore, the driving of both upper and lower rolls of the 2-high mills from a single source of power which is essential during the reversal of the mill without, however, in any way interfering with the normal operation of the 2-high mill which requires that only one roll be driven since if both rolls were driven at a constant speed, variations in diameter of the two rolls would result in relative movement between their peripheral surfaces and a consequent scratching of the work and loss of power.

The operation of the above described apparatus may best be understood by having reference to the schematic wiring diagram illustrated in Fig. 6 wherein the controls for the various units are shown.

The power lines from which the primary power from the mill, as well as the power for the control circuits are derived, are shown at 51, 52 and 53.

The motor 7 which is employed to drive the conveyor 6 has a magnetically actuated starting switch, generally indicated at 54 associated therewith, the armature 55 of which carries a pull-in coil 56 and a holding coil 57. The pull-in coil 56 may be connected across lines 51 and 53 either by means of the flag switch 58 or the manually operable switch 59. Connected parallel with the pull-in coil 56 and simultaneously connected across the power lines by the flag switch 58 is the actuating coil 60 of the matching stop 9 on the straightening or aligning table 7. The holding coil is connected across the power lines by means of the back contactor 61, the circuit through which is completed through the flag switch 62. The flag switches 62 and 58 are arranged adjacent the opposite ends of the matching stop 9 at its forward face with the flag switch 62 arranged to be engaged by the forward end of the bar being handled and the rear end of the bar being handled engaging the flag switch 58.

Each of the motors 3, 4 and 5 is provided with a magnetic starting switch 3*a*, 4*a* and 5*a* respectively, the armatures of which are provided with pull-in coils 63, 64 and 65 and also holding coils 66, 67 and 68. The pull-in coils 63, 64 and 65 may be connected across the power lines 51 and 53, either independently by means of the individual start buttons 63*a*, 64*a* and 65*a* or simultaneously by means of the common starting switch 69. The circuit for the holding coils from the main power lines is completed through the back contactors 66*a*, 67*a* and 68*a*, the individual stop buttons 70, 71 and 72 and the common stop button 73. Stop switches 74, 75 and 76 are also included in the lines to the holding coils 66, 67 and 68 and are adapted to be energized by cams 77, 78 and 79 respectively, which cams are connected in any suitable manner to the respective conveyors 2 or the motors driving the same so that when the conveyor, after energization, has advanced a predetermined distance sufficient to discharge one bar from its furnace, the cam such as 77 will engage the stop switch 74 deenergizing the holding coil 66, opening the switch 3*a* and deenergizing the motor 3 and stopping the conveyor. The holding furnace 18, as previously indicated, has a conveyor 17*a* associated therewith and also as illustrated in Figs. 2 and 6, flag switches 80 and 81. Motor 17 which is employed to drive the conveyor 17*a* in the holding furnace is energized by means of a magnetic starting switch 82 which is actuated on energization of the coil 83. The circuit across the power line to the coil 83 may be completed either by means of the manually operated switch 86 or the flag switch 80*a*. The flag switch 81 and a time delay relay generally indicated at 84, the energization coil 85 of which is connected across the power line through the flag switch 80, control the energization of the holding coil 83*a*.

The motors 37 and 38 which are employed to drive the work rolls of the mill 20 in opposite directions are connected in any suitable manner such as is illustrated in Fig. 6 across the power lines so as to be capable of energization for rotation in opposite directions. For example, a double throw armature 87 adapted to selectively close one or the other of two switches controlled thereby may be employed with separate coils on each such armature, one each of which may be selectively connected across the power lines by a central control switch such as 88. Depending upon the position of the switch 88, the motors 37 and 38 will be driven in either one direction or the other.

Since the conveyors 19 and 21 are connected by means of spindles 19*a* and 21*a* and magnetic clutches 19*b* and 21*b* respectively with one or the other of the spindles of the motors 37 and 38, the direction of movement when energized of such tables will always be in the direction of the work movement through the mill. Some means must be provided, however, for insuring that the tables 19 or 20 will not, upon elongation of the work pieces carried thereby during the rolling operation, cause such work pieces to terminally overlap. To this end flag switches 89

and 90 positioned on opposite sides of the mill are provided and interconnected with the magnetic clutches 19b and 21b respectively in the manner illustrated in Fig. 6.

The magnetic clutches are arranged to be connected across the power lines by means of switches such as 91 and 92 which are respectively connected with time delay switches 93 and 94, the energization coils 95 and 96 of the time delay switches being in series with the flag switches 89 and 90 respectively.

Let it be assumed that there is no work in the mill and the operator thereof desires to initiate the passage of work bars from the furnaces 1 through the mill. The operator will first close the common start switch 69 for the three motors 3, 4 and 5 which respectively drive the conveyors of the three furnaces. Immediately such switch is closed, it may be reopened by the operator since the holding coils 66, 67 and 68 will maintain the switches 3a, 4a and 5a in closed position until the conveyors have advanced sufficiently to discharge one bar from each of the furnaces, whereupon cams 77, 78 and 79 by a deenergization of the holding coils 66, 67 and 68 will cause the motors 3, 4 and 5 to be deenergized. Three bars have thus been discharged onto conveyor 6, whereupon the operator by a closing of switch 59 causes the motor 7 to be energized to advance the bar farthest on the right as viewed in Fig. 1 to move onto the straightening table 7. The forward end of such bar will strike the flag switch 62, deenergizing the holding coil 57, opening the switch 2 and deenergizing the motor 7, thus stopping conveyor 6. As the bar is rotated in a counterclockwise direction until its forward edge engages flag switch 58 closing the latter, the coil 60 of the matching stop will be energized, lowering the matching stop out of the path of the bar and simultaneously reenergizing the motor 7 through the pull-in coil 56, thus restarting the conveyor 6 which will continue until the bar which was discharged from the center furnace strikes the flag switch 62, whereupon the above outlined procedure will be repeated.

As soon as the matching stop 9 has been depressed, i. e., moved out of the path of the first bar, it will proceed on the conveyor 11 successively through the mills 12, 13 and 14 onto conveyor 17a. Immediately upon its being discharged from the mill, the bar will strike the flag switch 80a which will energize the pull-in coil 83, closing the switch 82, energizing motor 17, causing conveyor 17a to carry the bar towards the holding furnace. As the bar approaches the holding furnace it engages the flag switch 80 which is in series with the time delay switch 84, which controls the energization of the holding coil 83a. The effect of the time delay switch 84 is to maintain the circuit through the holding coil 83a closed for a predetermined length of time after the bar trips the flag switch 80. This length of time is just sufficient for the bar to move into the heating zone of the furnace whereupon the relay 84 will drop out, deenergizing the holding coil 83a and opening the switch 82. The next bar that issues out of the mill 14 will by energization of the flag switch 80a re-start the motor 17 to carry such second bar through the same sequence of events just described in connection with the description of the movement of the first bar.

This operation of filling the holding furnace will continue until the first bar engages the flag switch 81 whereupon the holding coil will be deenergized so that no more bars can be fed into the furnace.

With the holding furnace filled or containing a sufficient number of bars to comprise a batch for rolling on the mill 20, the operator will, by closing switch 18a and manually maintaining the same closed, cause a predetermined number of bars to be discharged from the holding furnace onto the table 19. With the mill 20 being driven in the proper direction, the table 19 will progressively move such predetermined number of bars through the mill 20. After all of the bars have moved through the mill 20, the operator will reverse the switch 88, causing the motors 37 and 38 and the tables 19 and 21 to be driven in the opposite direction to effect a re-rolling of the batch of bars through the mill 20.

The magnetic clutches 19b and 21b are provided, as previously indicated, for the purpose of preventing the bars due to elongation from terminally overlapping on the tables 19 and 21 and the operation of such magnetic clutches is briefly as follows:

A flag switch 89 at the forward side of the mill is connected with the power lines, so that when closed, it will maintain energized the winding 95 of the time delay switch 93 by means of which latter switch, the winding 19b of the magnetic clutch is energized. Assuming that the work is progressing from left to right, as viewed in Fig. 2, the forward end of the first bar strikes the flag switch 89, causing the same to be opened. The switch 93 will maintain the magnetic clutch 19b energized for a length of time sufficient for the first bar to enter the bite of the mill, at the expiration of which time the magnetic clutch 19b will be deenergized and the conveyor 19 stopped until the rear end of the first bar has passed over the flag switch 89, whereupon the magnetic clutch 19b will be re-energized to start the conveyor 19 and feed the next bar into the mill. Thus, the successive bars passing through the mill are at all times spaced approximately the distance between the flag switch 89 and the bite of the mill. In a similar manner the flag switch 90 operates as the work is moving from right to left as viewed in Fig. 2 to maintain the same spacing between the work pieces during such directional movement. At this point, it should be noted that the flag switches 89 and 90 are so constructed that the switch 89 will open the line to the magnetic clutch 19b only when the work moves such switch from left to right and the flag switch 90 is constructed to open the line to the magnetic clutch 21b only when the work moves such switch from right to left.

No provision need be made to insure spacing of the work pieces on the conveyor at the discharge side of the mill since the speed of such conveyor is always substantially the same as the rate at which the mill is driven and the work is discharged from the mill.

The previously described method of manipulation of the apparatus, it will be noted, results in the simultaneous working of a single mill through a plurality of work pieces which is essential if such work pieces are to be joined together in the production of a continuous strip for the rolling in a continuous fashion through a plurality of finishing mills. In other words, it is essential, when joining together a plurality of individual sheets to roll the same thereafter in strip fashion, that the contour of all of such individual components be substantially identical in order that the contour of the rolls of the finishing mill may

be fitted in a measure at least to the contour of the work being operated upon. In other words, it is essential that there be some relationship between the contour of the rolls of the mill **20** and the contour of the rolls of the mills **33**, so that when the strip is finished in the last-named mills, the metal of the strip will flow in a uniform fashion throughout the width of the strip which is essential in the production of a first class sheet.

Other forms may be employed embodying the features of my invention instead of the one herein explained, change being made as regards the means and the steps herein disclosed, provided the elements stated by any of the following claims or the equivalent of such stated elements be employed, whether produced by my preferred method or by others embodying steps equivalent to those stated in the following claims.

I therefore particularly point out and distinctly claim as my invention:

1. In a method of producing steel sheets, uniform as to gauge and having similar characteristics, the steps of hot rolling sheet bars by single passes through a plurality of breakdown mills in tandem; semi-finishing the batch of sheets so produced by passing and repassing as a batch through a reversing mill; butt-welding the several pieces of such batch in end to end relation into a single work-piece; full finishing such work-piece on a continuous finishing mill; and separating the several sheets along the lines of the several welds.

2. A method of producing cold-rolled sheet steel, comprising the steps of hot rolling a plurality of sheet bars by single passes through successive stands of roughing rolls in tandem; semi-finishing by repeated passes in batches on a reversing mill whereby a plurality of semi-finished sheets are produced having similar cross-sections; joining the semi-finished sheets by butt-welding the ends, whereby a work-piece is produced; and finishing the work-piece by cold rolling on a continuous mill.

3. A method of producing cold-rolled steel sheets, comprising the steps of hot rolling a plurality of sheet bars by single passes through a plurality of roll stands, whereby work units of similar cross-section are secured; semi-finishing a batch of such work units of substantially uniform temperature by passing and repassing as a batch through a reversing mill; uniting the work units of such batch into a single work-piece by butt-welding the ends, whereby a work-piece is produced; and finishing the work-piece by cold rolling on a continuous mill; and separating the sheet along the lines of the welds.

4. A method of producing a work-piece for cold finishing on a continuous mill, comprising the steps of hot rolling a plurality of sheet bars by single passes on successive stands of rolls; semi-finishing a batch of sheet bars so rolled by repeated reductions of same as a batch on a reversing mill, whereby a plurality of semi-finished sheets of similar cross-section are produced; and joining the semi-finished sheets by butt-welding the adjoining ends thereof.

5. In the formation of a work-piece suitable for full-finishing on a continuous cold roll mill, the steps of forming breakdowns by rolling a plurality of work-pieces on a tandem mill comprising a plurality of two-high stands; semi-finishing said breakdowns by reversing passes on a finishing mill; and uniting the semi-finished sheets by butt-welding into a single work-piece.

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