Jan. 24, 1933. P. F. WILSON 1,895,303

METHOD AND APPARATUS FOR METAL ROLLING

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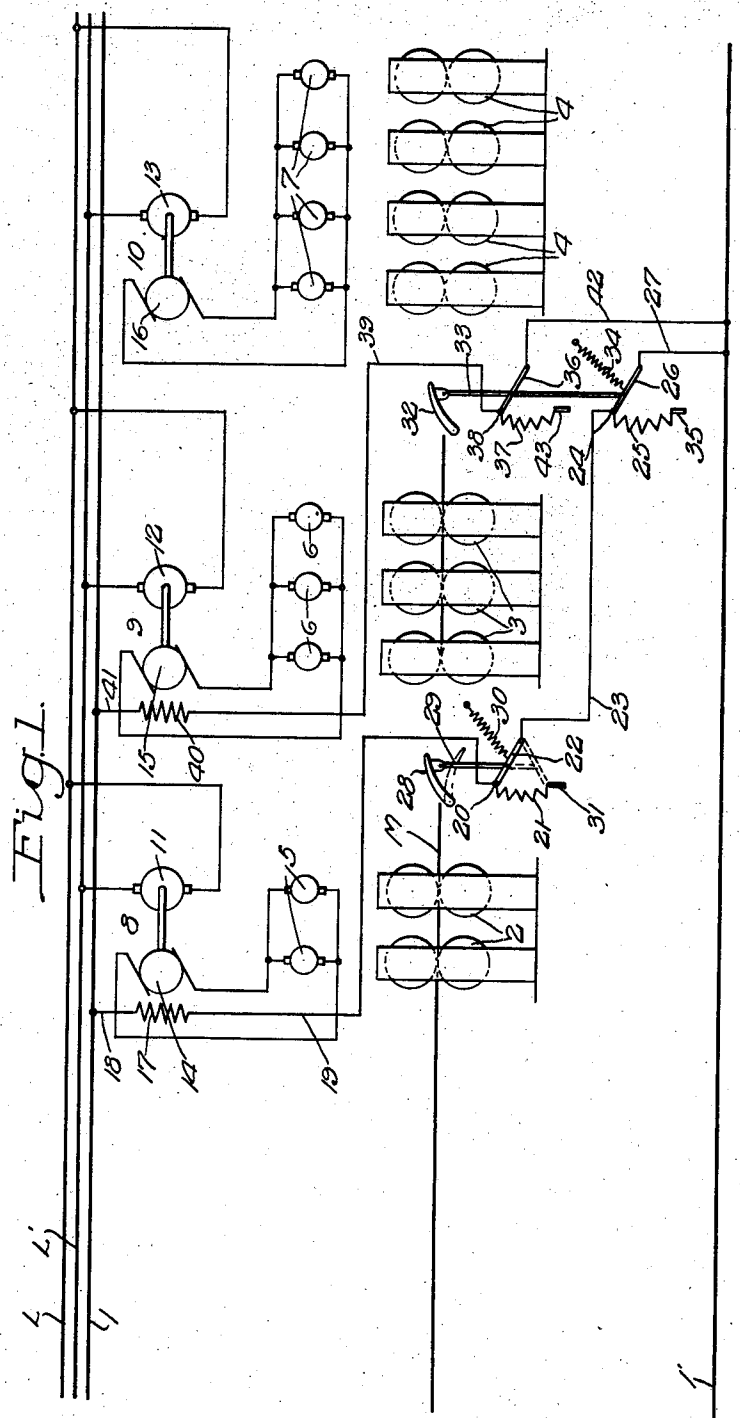


Fig. 1.

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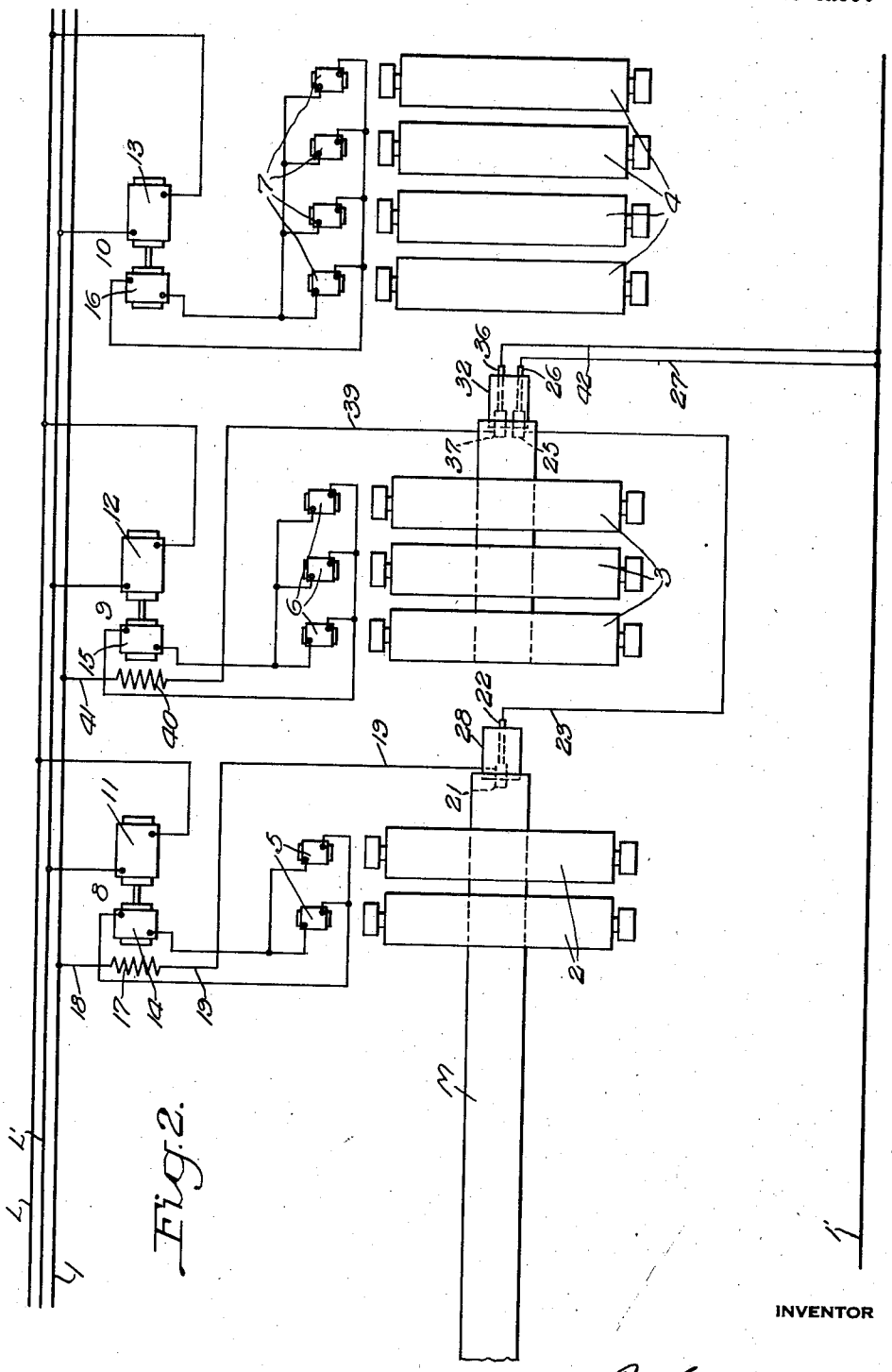


Fig. 2.

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR METAL ROLLING

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The present invention relates broadly to the art of metal rolling, and more particularly to the art of so-called continuous mills or continuous strip rolling in which a given piece of material at certain times is being simultaneously operated upon by two or more mills.

In the art of continuous rolling as commercially practiced at the present time, it is customary to feed an ingot, slab or billet, which for purposes of convenience will hereinafter be referred to as a billet, into one or more breakdown or roughing mills from which it passes into one or more intermediate mills which further reduce the thickness of the metal and effect an elongation thereof. After leaving the intermediate mill or mills, the material reduced in thickness and increased in length, is passed into one or more finishing mills which are so set as to reduce the thickness of the metal to the required point, and effect further elongation thereof.

Depending upon the characteristics of the material which it is desired to produce, there may be utilized mills either of the two-high, four-high, or cluster type, the present invention not being limited with respect to the characteristics or construction of the mills being utilized. For purposes of illustration, however, I have diagrammatically shown the invention as practiced with two-high mills, it being understood that the utility of the invention is not limited in this respect.

In accordance with present day operation, it is customary to provide separate driving motors for each of the various mills, these motors in turn being energized by a motor generator set. Each motor is in turn so regulated by a suitable field control that the mills will cooperate to deliver material at a speed at which it can be effectively handled. It is apparent, therefore, that the delivery speed of the finishing mills determines the speed of operation of the roughing or breakdown mill or mills. Inasmuch as there is a maximum delivery speed above which material cannot be satisfactorily or efficiently handled, there is necessarily a maximum entry speed for the material, which speed from a practical standpoint must not be exceeded.

It may be assumed for purposes of example that a given continuous mill installation is effective for producing a reduction of from 10 inches to 10/100ths of an inch, with a corresponding elongation of from 10 feet to 1000 feet. In the average installation it is not possible to handle material delivered at speeds much above 2500 feet a minute.

This being true, it is obviously necessary to so adjust the speed of the various mills that there will be an entering speed of but 25 feet a minute under the above conditions. This being true, it will be apparent to those skilled in the art that the speed at the entering end of the mill represents but a small fraction, namely approximately 1%, of the speed at the delivery end of the mill. This necessarily means that considerable time is lost in passing the material through the roughing or breakdown mill or mills. This time interval, however, is required in order to insure a speed of operation of the intermediate and finishing mills such that when the material leaves these mills they will be traveling at the proper relative speed to efficiently act upon and further reduce and elongate the material.

The present invention contemplates an improved mill installation and system of operation whereby the time ordinarily lost in passing material through the roughing and/or intermediate mills is conserved without effecting any increase in the delivery speed.

In the accompanying drawings, I have shown more or less diagrammatically, for purposes of illustration only, a preferred embodiment of the present invention.

In the drawings:—

Figure 1 is a diagrammatic side elevational view of a typical installation embodying roughing mills, intermediate mills, and finishing mills, together with an improved system of control for such mills; and

Figure 2 is a diagrammatic top plan view of the installation illustrated in Figure 1.

While the present invention contemplates not only the use of any preferred type of

mill, as hereinbefore referred to, but also contemplates the use of any desired number of mills in sequence, I have herein illustrated the invention as comprising a pair of roughing or breakdown mills 2; three intermediate mills 3; and four finishing mills 4.

The roughing mills are driven by individual direct current motors 5; the intermediate mills by similar motors 6; and the finishing mills by motors 7. The driving motors 5 for the roughing mills are controlled by a motor generator set 8; the motors 6 by a second motor generator set 9; and the motors 7 by a third motor generator set 10.

The motor 11 of the motor generator set 8; the motor 12 of the motor generator set 9; and the motor 13 of the motor generator set 10, are connected through suitable leads, as indicated, to the line wires L and L', whereby they are operated at a substantially constant speed.

The generator 14 of the motor generator set 8 is connected to the driving motors 5, for the roughing mills 2. The generator 15 of the motor generator set 9 is similarly connected to the driving motors 6 for the intermediate mills 3; while the generator 16 is connected to the driving motors 7 for the finishing mills 4.

The generator 14 is provided with a separately excited field 17, one terminal of which has a connection 18 to a direct current bus line 1. The opposite terminal has a connection 19 to one terminal 20 of a rheostat 21. Cooperating with the rheostat 21 is a contact arm 22, having a connection 23 to one terminal 24 of a second rheostat 25. Cooperating with the rheostat 25 is a contact arm 26, having a connection 27 to a D. C. bus line 1'.

For actuating the contact arm 22, there is provided a flag 28, operatively connected to one end of a link 29, the opposite end of which is in turn connected to the contact arm. The flag 28 is so located as to be in the path of the material M being operated upon, whereby when the material engages the flag it will be depressed in such manner as to rotate the contact arm 22 against the action of its returning spring 30, in a counter-clockwise direction, as indicated in Figure 1. This movement of the flag will be effective for moving the contact arm from its full line position of Figure 1, to its dotted line position in contact with the terminal 31, whereby the resistance of the rheostat 21 will be thrown into series with the exciting field 17 of the generator 14, thereby correspondingly reducing the voltage generated by the motor generator set 8 and proportionately decreasing the speed of the driving motors 5.

Assuming the parts to be in full line position illustrated in Figure 1, the generator 14 will have impressed thereon the maximum voltage of the exciting coil 17, whereby the motors 5 will be operated at their maximum speed. This speed will be initially predetermined so that under conditions of operation as previously referred to by way of example only, the mills 2 will be operated at a speed, for example, ten times greater than the permissible speed in ordinary installations, assuming the permissible speed to be that determined by the delivery speed of the finishing mills. This means that these mills instead of effecting a material travel of 25 feet a minute, will effect a speed of travel of approximately 250 feet a minute, so that the time required for the passage of material through the roughing mills will be cut down to $\frac{1}{10}$ of that ordinarily required.

At a predetermined point in its travel, the material which has passed through the roughing mills will engage the flag 28 and depress the same, thereby throwing the resistance of the rheostat 21 into series with the exciting coil 17 and correspondingly reducing the exciting effect of this coil. This in turn will decrease the voltage output of the generator and thereby reduce the speed of operation of the motors 5. The resistance of the rheostat 21 will initially be so selected that the speed reduction of the motors 5 will be such as to properly correlate the speed of operation of the roughing mills 2 to the speed of operation of the intermediate mills 3. In other words, the operation of the flag 28 will effect a slowing down of the speed of operation of the roughing mills to a point where the material may be effectively operated upon by the intermediate mills.

This reduced speed condition will continue until such time as the material reaches a point where it will be effective for engaging a second flag 32, similar to the flag 28. The flag 32 has a pivotal connection to one end of a link 33, the opposite end of which is pivotally connected to contact arm 26. Depression of the flag 32 will be effective in the manner described for rotating the contact arm 26 in a counter-clockwise direction against action of its returning spring 34 to move the contact arm from engagement with the terminal 24 into engagement with the terminal 35. This operation will place the resistance of the rheostat 25 in series with the resistance of the rheostat 21, both of these resistances being in series with the exciting coil 17. This will further reduce the voltage output of the generator 14 and effect a further decrease in the speed of operation of the motors 5.

The flag 32 also has an operative connection through the link 33 with the contact arm 36 of a third rheostat 37. One terminal 38 of the rheostat 37 has an operative connection 39 to one terminal of an exciting coil 40 for the generator 15 of the motor generator set 9, the opposite terminal of the exciting coil having a connection 41 to

the bus line 1. The contact arm 36 in turn has a connection 42 to the bus line 1'.

By reason of the construction just described, movement of the flag 32 effective for throwing the resistance of the rheostat 25 into series with the exciting coil 17, will also be effective for moving the contact arm 36 from engagement with the terminal 38 into engagement with the terminal 43 of the rheostat 37, and thus throw its resistance into series with the exciting coil 40 for the generator 15.

This, in turn, will be effective for decreasing the generating voltage of the motor generator set 9, and thereby reducing the speed of operation of the motors 6. The resistance of the rheostat 37 will be initially so selected that the speed reduction effected in the motors 6 will be such as to properly correlate the speed of operation of the intermediate mills at this time to the reduced speed of operation of the roughing mills, the speed of operation of both of these sets of mills being also correlated to the speed of operation of the finishing mills.

It will now be apparent to those skilled in the art that the present invention provides a rolling mill installation which may embody one or more mills in advance of a finishing mill or mills. Where more than two mills are provided in advance of the finishing mill, the speed of such mills may be progressively and selectively decreased. This construction makes it possible to initially operate one of the mills, for example, the roughing mill, at a speed materially higher than present day conditions of operation and without regard to the delivery speed desired from the finishing mills. This enables the material being rolled to pass through the roughing mill or mills in a much smaller time interval than that heretofore required. Similarly, when the material has advanced to a point where it is ready to be engaged by the intermediate mill or mills, automatic speed control effects a reduction in the speed of operation of the roughing mill such that the roughing mill and intermediate mill have a properly related speed.

This speed is, however, above the normal operating speed of present installations, thereby effecting a reduction in the time required for the material to travel through the intermediate mill.

The material after passage through the intermediate mill, is effective for producing a further speed reduction in both the roughing mill and intermediate mill, such that their speed of operation will be properly related to the speed of operation of the finishing mill.

This successive reduction in speed of operation of two or more successive mills or groups of mills provides a continuous mill installation in which the elapsed time from the entry of a piece of material into the roughing mill to the time of its discharge from the finishing mill is materially reduced without at any time increasing the speed of operation or delivery speed of such finishing mill. In this manner, there may be maintained at all times a delivery speed commensurate with present day delivery speeds, and such that the material as delivered may be efficiently handled.

On the other hand, this involves the possibility of a greater total reduction with one heating than that heretofore permitted, by a proper increase in the number and arrangement of the mills. In any case, the invention makes it possible to operate a continuous mill either without any reheating between any of the successive rolls or with a considerable reduction in the amount of such reheating.

Such decrease in the elapsed time further results in a considerable increase in the length of life of the roughing and intermediate rolls. It is a well-known fact that these rolls are subject to very appreciable fire-cracking due to the length of time during which the hot metal is in contact therewith. By reducing this time of contact, the amount of fire-cracking is correspondingly reduced, and hence the length of life of the rolls correspondingly increased.

In addition to the various advantages referred to, the present invention has the further advantage inherent therein of enabling the operator by a proper choice of speeds and consequently by a proper selection of elapsed time intervals, to control and widely vary the metallurgical characteristics of the material being rolled, regardless of whether that material be a shape or a strip, it being apparent that certain features of the present invention are adaptable to either.

The present invention, of course, contemplates the use of driving motors of usual characteristics with their individual speed control in accordance with present day practice, whereby the initial speed is definitely controlled by the operator. In addition to this, the various rheostats 21, 25 and 37 instead of being of the fixed resistance type, may be of the variable resistance type under the control of the operator, whereby if the operator wishes to finish a given piece of material at a higher temperature, he will throw in relatively less resistance and thereby increase the speed of rolling throughout. On the other hand, if he wishes to finish at a lower temperature, the reverse operation will be resorted to.

It will also be apparent to those skilled in the art that while I have herein illustrated the flags as being so arranged that they effect a speed variation before the material has passed from one roll stand into the succeeding roll stand, the arrangement may be such

that the effective reduction in speed does not occur until the material has actually entered or approximately entered a succeeding roll stand. In other words, the exact time at which the speed control is effected is not essential, and the type of control utilized, and its position, may be such that this variation in speed will occur either before or after a succeeding roll stand comes into operation.

It is also understood that the present invention is not limited with respect to the characteristics or structural shape of the material being rolled, it being applicable to a wide variety of different shapes and sections.

While I have herein illustrated and described one preferred embodiment of the present invention, other and further embodiments and modifications may be made without departing either from the spirit of the present invention or the scope of my broader claims.

I claim:

1. In the method of continuous rolling, the steps comprising operating a mill at a speed higher than that determined by the delivery speed of a succeeding mill, and thereafter reducing the speed of operation of said first-mentioned mill, the reduction in speed being effected while the material being rolled is out of contact with said succeeding mill.

2. In the method of continuous rolling, the steps comprising operating a plurality of mills at a speed higher than that determined by the delivery speed of a succeeding mill, and thereafter reducing the speed of operation of said first-mentioned mills, the reduction in speed being effected while the material being rolled is out of contact with said succeeding mill.

3. In the method of continuous rolling, the steps comprising operating a plurality of mills at a speed higher than that determined by the delivery speed of a succeeding mill, and subsequently sequentially reducing the speed of operation of said mills to correspond to the speed of said succeeding mill, the first of said sequential speed reductions being effected while the material being rolled is out of contact with the second of said plurality of mills, the second of said sequential speed reductions being effected while the material being rolled is out of contact with said succeeding mill.

4. In the continuous rolling of sheets and the like, the steps comprising changing the speed of at least one of the mills during the rolling process, the change in speed being effected while the material being rolled is in contact with the mill the speed of which is changed, but before contact of the material with the succeeding mill.

5. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled through at least one mill, and thereafter reducing the speed of said mill to correlate its speed with the speed of the next succeeding mill, the change in speed being effected while the material is in contact with said first mentioned mill but before contact with said succeeding mill.

6. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled between at least one mill, and thereafter decreasing the speed of said mill to correlate its speed with the speed of succeeding mills, the change in speed being effected while the material is still in contact with said first mentioned mill but before contact of the material with said succeeding mills.

7. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled through a mill at a speed higher than that corresponding to the speed of a succeeding mill, and thereafter decreasing the speed of said first-mentioned mill to correspond to the speed of said succeeding mill, the reduction in speed being effected while the material being rolled is out of contact with said succeeding mill.

8. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled through at least one mill at a speed higher than that corresponding to the speed of succeeding mills, and thereafter decreasing the speed of said first mentioned mill to correspond to the speed of said succeeding mills, the change of speed being effected while the material is in contact with said first mentioned mill but before contact with said succeeding mills.

9. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled through a roughing mill at a speed higher than that corresponding to the speed of a finishing mill, and thereafter decreasing the speed of the roughing mill to correspond to the speed of the finishing mill, the reduction in speed being effected while the material being rolled is out of contact with said finishing mill.

10. In the continuous rolling of sheets and the like wherein a roughing mill, an intermediate mill and a finishing mill are employed, the steps comprising passing the material to be rolled through at least one roughing mill at a speed higher than that corresponding to the speed of the intermediate mill, decreasing the speed of the roughing mill to correspond to the speed of the intermediate mill while the material is in contact with the roughing mill but before contact with the intermediate mill, and thereafter decreasing the speed of the intermediate mill to correspond to the speed of the finishing mill while the material is in contact with the intermediate mill but before contact with the finishing mill.

11. In a continuous rolling mill, a roughing mill, a finishing mill, means for rotating the roughing mill at a speed higher than that

corresponding to the speed of the finishing mill, and means controlled by the passage of the material through the mills for reducing the speed of the roughing mill during the rolling operation to correspond to the speed of the finishing mill before the material being rolled enters the finishing mill.

12. In a continuous rolling mill, a roughing mill, a finishing mill, separate motors for operating the mills, means for operating the roughing mill at a speed higher than that corresponding to the speed of the finishing mill, and means controlled by the passage of the material between the roughing and finishing mills for reducing the speed of the roughing mill during the rolling operation to correspond to the speed of the finishing mill before the material being rolled enters the finishing mill.

13. In a continuous rolling mill, a roughing mill, a finishing mill, separate motors for the mills, means for rotating the roughing mill at a speed higher than that corresponding to the speed of the finishing mill, a flag arranged between the roughing and finishing mills in the path of the material being rolled, and connections between the flag and the motor of the roughing mill for reducing the speed of the roughing mill to correspond to the speed of the finishing mill before the material enters the finishing mill.

14. In a continuous rolling mill, a roughing mill, a finishing mill, separate motors for the mills each connected to separate motor generator sets, means for rotating the roughing mill at a speed higher than that corresponding to the speed of the finishing mill, a flag between the roughing and finishing mills in the path of the material being rolled, and connections between the flag and the motor of the motor generator set for the roughing mill for reducing the speed of the roughing mill to correspond with the speed of the finishing mill before the material enters the finishing mill.

15. In a continuous rolling mill, a roughing mill, an intermediate mill, a finishing mill, separate motors for the mills, means for rotating the intermediate mill at a higher speed than that corresponding to the speed of the finishing mill, means for rotating the roughing mill at a speed higher than that corresponding to the speed of the intermediate mill, a flag between the roughing and intermediate mills in the path of the material being rolled, a second flag between the intermediate mill and the finishing mill, connections between the first mentioned flag and the roughing mill to reduce the speed of the roughing mill to correspond to the speed of the intermediate mill before the material enters the intermediate mill, and connections between the second mentioned flag and both the roughing and intermediate mills to reduce their speeds to correspond to the speed of the finishing mill before the sheet enters the finishing mill.

16. In the continuous rolling of sheets and the like, the steps comprising passing the material to be rolled through at least one mill, and thereafter reducing the speed of said mill to correlate its speed with the speed of the next succeeding mill, the change in speed being effected while the material is in contact with said first mentioned mill but before it has been acted upon to a substantial extent by said succeeding mill.

17. In a continuous rolling mill, a roughing mill, a finishing mill, means for rotating the roughing mill at a speed higher than that corresponding to the speed of the finishing mill, and means for reducing the speed of the roughing mill during the rolling operation to correspond to the speed of the finishing mill before the material being rolled has been acted upon to a substantial extent by the finishing mill.

In testimony whereof I have hereunto set my hand.

PARKER F. WILSON.