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Bald

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[54] **PROCESS AND MECHANISM FOR THE OPERATING OF A ROLLING MILL**

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[51] **Int. Cl.** **B21b 37/00**

[58] **Field of Search** 72/8, 9, 10, 11, 72/19, 21, 245, 14

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[57] **ABSTRACT**

The disclosure of this invention relates to a method and apparatus for operating a tandem rolling mill, wherein one or more of the stands thereof can be operated as a soft stand in order to reduce the workpiece more or less uniformly across its width to aid in entrance of the front end of the strip into the next stand or coil forming reel, after which the stand can be converted to a hard stand to roll to a desired gauge.

8 Claims, 4 Drawing Figures

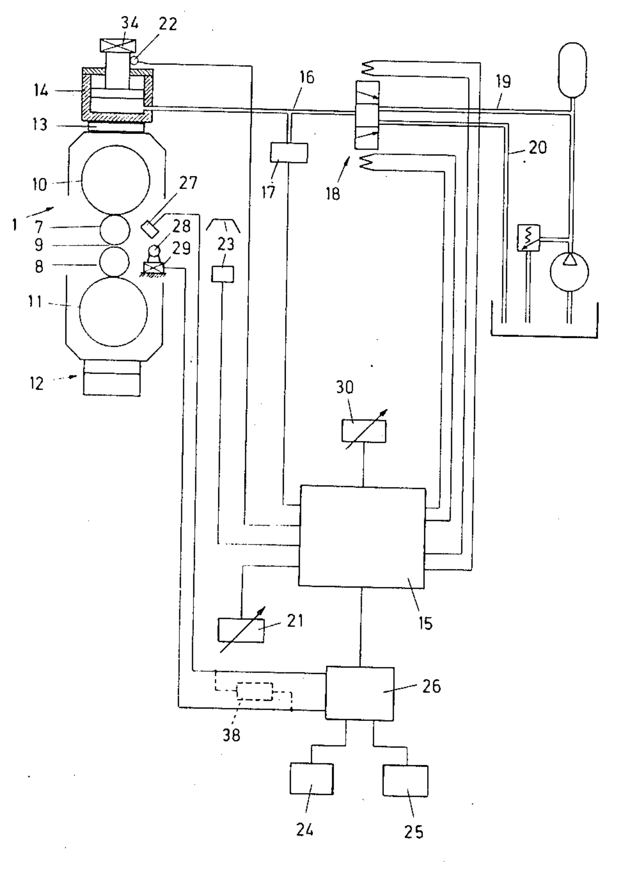


Fig. 1

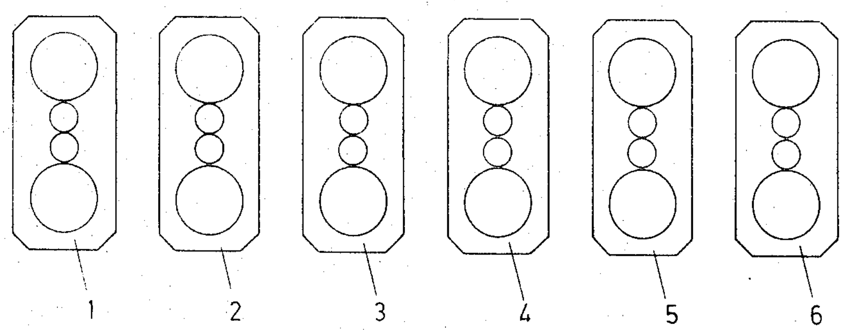


Fig. 3

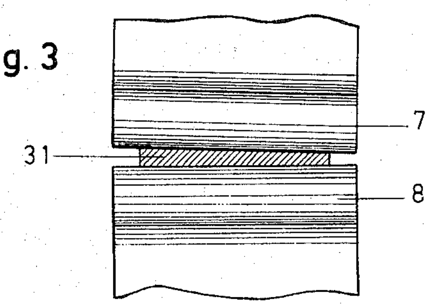
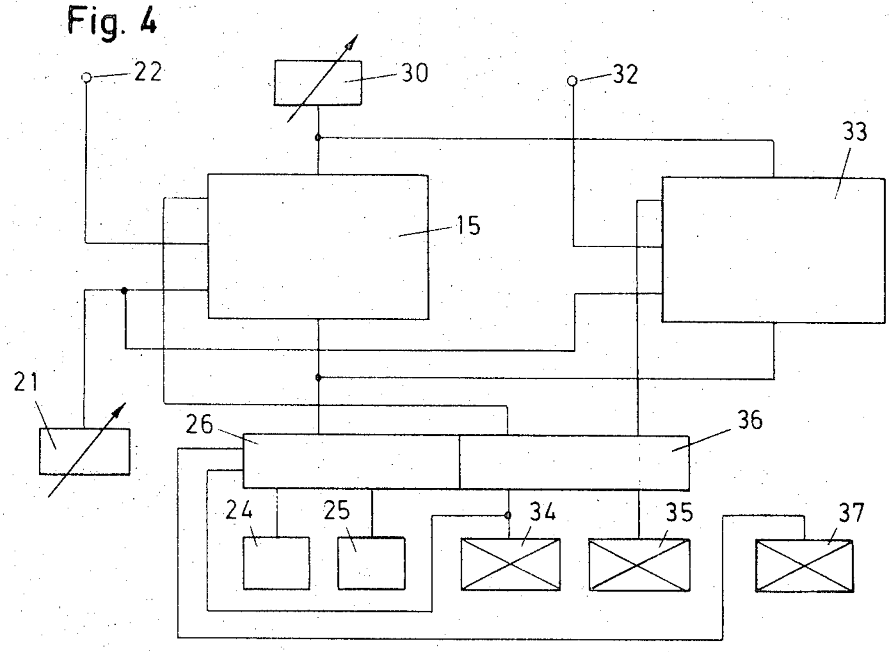


Fig. 4



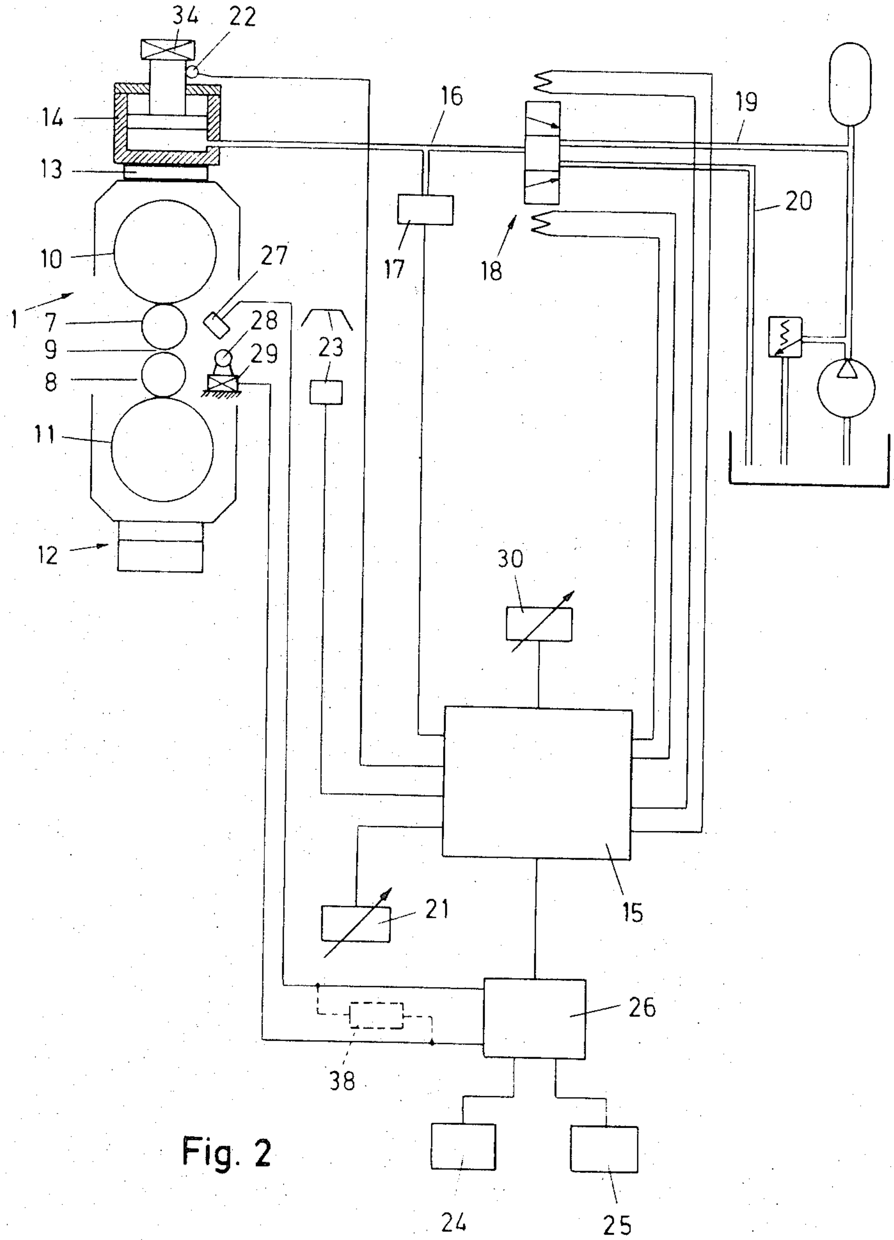

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Fig. 2

PROCESS AND MECHANISM FOR THE OPERATING OF A ROLLING MILL

The invention refers to a process for the operation of a rolling mill stand and/or a mill train formed by several rolling mill stands as well as a mechanism for the execution of the process. The invention refers especially to a process, as well as a mechanism, for the alleviation of the frequent difficulties in the entrance of the leading end of a strip, especially rolled steel strip into the stands, and the frequent difficulties experienced in the strip leaving the stand or stands.

In order to obtain close tolerances of rolled stock, it is known to equip single stands or one or more of the several stands of mill trains with regulating systems for the adjustment of the roll gap, by means of which an adjustment of the rolled stock is effected to obtain constant gauge. For common, non-regulated stands, and especially for regulated stands, it turned out that special problems occur at the initial pass of a rolled stock. The greatest problems result at the initial pass of a rolled stock when the stock is asymmetrical in cross-section. In the case of a strip entering the roll gap with a slight trapezoidal profile, the strip is stretched to a greater extent on its thicker side while passing through the roll gap, so that it approaches the following unit, which could either be a stand or a coiling device, in the shape of a circular arc being slightly laterally bent.

Due to this deviation from the desired rolling axis, the strip does not stay within the prescribed path of travel. Instead, the strip tends to move laterally in which its edge is forced against adjacent stationary equipment causing it to buckle requiring that the rolling operation be interrupted and and the strip be removed. It is true that the next stand or coiling device is generally preceded by lateral guides, but the guides cannot on the tendency of the lateral displacement of the strip away from the rolling axis correct the advancing rolled stock to center it in the direction of the rolling axis. The purpose of the guides is rather to lead the end issuing from the stand and to advance it along the rolling axis to the next stand or coiling device. In a number of cases, the leading end of the rolled stock is therefore not picked up correctly or not picked up at all by the next stand or coiling device, so that the stand must be shut down until the stock is removed.

The present invention has for its object a method for the operation of a rolling mill stand, in which, after a strip enters the pass, the rolls can adapt themselves to the actual profile of the strip in which the strip is engaged above its entire width and, accordingly, is stretched to the same extent over its width so that it can be advanced above a desired rolling axis.

This is attained with roll stands of the described type in that from a point of time, which lies between the delivery of a strip from a stand and the entry of the next strip into this stand, a regulating mechanism assigned to the stand is operated during a given period of the advance of the leading end of the next strip to effect an increase of the swelling or stretch of the stand. Due to the increase of the stand swelling which corresponds to a decrease of the stand modulus, there is attained a more uniform reduction of the profile and, connected therewith, a more uniform stretching of the rolled strip independent of the fact that the strip entering the stand may not have a rectangular profile. The leading end of the strip leaving the stand is thus kept from laterally bending, i.e., tending to take a ring sectional shape condition by asymmetrical stretching, and advances straight and symmetrically in the direction towards the next stand or coiling device.

The period of advance of the strip leading end with the decreased stand modulus condition can be determined to be a specified time interval of the period of advance. In one form arrangements can be made to terminate the time interval for the advance of the leading end of the strip as soon as it entered the next stand, or a coiling device. In another arrangement the time interval of the advance of the leading end can be made to terminate upon the building up of a tension in the strip delivered by the roll stand because such tension is a very definite sign of the reception of the leading end of the strip by the next unit.

For the practice of the method of the present invention it has proven advantageous to utilize stands whose housings are equipped with a control means and a means for adjusting the rolls as well as establishing a given stand modulus. In accordance with the invention, the control means include a switching means which makes effective one of at least two variable values of stand modulus. Sensors are also included which monitor the delivery of strip as well as its entry and which determine the operating position of the switching means.

The sensor may take the form of a feeler roll arranged with its periphery projecting into the path of the rolled stock with a low contact angle between the roll and the underside of the strip and adapted to be rotated by the passing strip; thereby monitoring the passing strip. The feeler roll may be supported by a pressure cell acting as a sensor, or the feeler roll may be assigned to a switch operated by its movement, for example, the angle of traverse of a lever supporting the roll. Further, light barriers can be employed as sensors to monitor the path of the strip and in many cases there can be utilized instead of the light barrier a simple photoelectric cell reacting to red or infrared light responsive to passing red-hot strip. Furthermore, the sensor can be constructed as electrical measuring and/or controlling devices, which may be located in the armature current circuits of the drive motors for the stands and which allow for the detection of the entry of the rolled strip as well as the building up of tension therein as a function of variations of the armature current. Also, pressure cells associated with the housings can be utilized as sensors and be connected to one or more switching mechanisms.

Sensors can act directly upon the switching device so that through activating one or two sensors there can be effected a two-position operation of the switch device. For this, there can be provided separate sensors for operating the switching device as well as for a resetting mechanism therefor, and it may be desirable to connect only one sensor with the switching mechanism and to determine its switching position in accordance with its own activation. As an example, when utilizing feeler rolls it can be brought about that the higher stand modulus is only effective if a passing strip is under tension, so that the entry as well as the delivery of the strip is effected at a preselected stand modulus. With the utilization of two sensors, the loading or release of one of them can effect the switching and that of the other, can effect the reverse switching. In case of emergency the effect of one of the sensors, preferably that for the reverse switching, can be given prominence. On the other hand, it is possible to provide timing relays between the sensor and the switching mechanism which transmit an operating signal on a delayed basis so that the required time can be given to allow the building up of the strip tension, especially for the last stand of a mill train, at which interval the housing modulus is to be changed after the entry of a strip. In this case the sensor can determine the moment of switching of the switching mechanism; and the same operating signal belonging to it can effect reverse switching, delayed by means of a timing circuit. Such timing circuits can also be provided for the bridging of the path differences of other stands.

Sensors can also be utilized, especially in mill trains, for the activating of the switching mechanisms of two stands, i.e., of a preceding as well as of a following stand; thus, the switching process can be effected by means of one of the sensors assigned to the preceding stand and the reverse switching can be effected through activating one of the sensors of the following stand.

Generally, the expenditures can be reduced if a common switching mechanism is assigned to each controlling device of the housings of a stand. In one form the switching mechanism, during the period of advance of the leading end of the strip, separate control mechanisms are connected with separate housing pressure measuring devices and receive a different load signal. In this case, subsequent to the reverse switching of the switching mechanisms, the separate control mechanisms of a housing receive signals of the same actual value of the load, which is determined through the formation of the sums of the loads of the pressure cells of both housings.

The above features and advantages of the present invention will be better understood when the following description is read along with the accompanying drawings, of which:

FIG. 1 is a schematic view of a six-stand tandem train incorporating the features of the present invention;

FIG. 2 is a schematic view of one of the four-high stands of the tandem train shown in FIG. 1 with mechanical and hydraulic screwdown devices represented in the form of block diagrams as well as control device assigned to the latter;

FIG. 3 is a schematic sectional view cut through a strip passing between the working rolls of a stand; and

FIG. 4 is a second block diagram of dual control devices with separate switching devices associated with them.

FIG. 1 shows schematically a tandem train with six four-high stands **1** to **6**. It is customary for the reducing of the tolerances of the rolled strip by the tandem train to operate stands of such trains with control devices in order to increase the stand modulus and, thereby, the rigidity of the stands.

FIG. 2 shows as an enlarged representation one of two identical housings of stand **1** of FIG. 1. The working rolls **7** and **8** form between them a roll gap **9** and are supported by backing rolls **10** and **11** whose lower chocks rest upon mechanical screwdown mechanisms formed by adjustable wedges **12**; whereas, the upper chock is subject by being in contact with a filler plate **13** to the force of a hydraulic cylinder provided as a hydraulic screwdown mechanism **14**.

The operating pressure of the hydraulic cylinder **14** is effected by means of a control device **15**; FIG. 2 illustrating only the device for one of the two housings of the roll stand **1**. The corresponding load of the stand results from the pressure occurring in the hydraulic cylinder. The pressure is fed by piping **16** to a pressure transformer **17** which supplies to the pressure analagous values of the control device **15**. Associated with the control device **15** there is a servovalve **18**, which connects the line **16** with a pressure line **19** and a return line **20**. The return line **20** returns the pressure medium, such as, oil supplied to it, to a supply sump wherefrom it is carried into a pressure reservoir by means of a pressure pump. This reservoir feeds the pressure line **19**. By this arrangement it is possible by connecting the line **16** with the return line **20** to reduce the amount of the pressure medium in the hydraulic cylinder **14**, while pressure medium can be fed into the hydraulic cylinder by connecting the line **16** with the pressure line **19**.

For the adjustment of the desired roll gap, the control device is provided with a setting means **21** for the desired opening of the roll gap and the actually resulting roll gap is controlled by the actual-value indicator **22**. Such actual-value indicators, e.g., constructed as transductors, can be assigned to the chocks of the rolls or, as in the form of the construction illustrated, to the hydraulic cylinder **14** itself. But, it is also possible to provide a monitor **23** as an actual-value indicator or additionally to another actual-value indicator, which controls the gauge of the delivered roll strip.

The regulating characteristic is determined by two indicators **24** and **25**, each of which is connected to the control device **15** by means of a switching mechanism **26**. The specific switching position of the switching mechanism **26** is determined by sensors associated with it. In the form of the construction illustrated there are provided as sensors a photoelectric cell **27** reacting to red or infrared light, as well as a pressure cell **29** activated by a feeler roll **28**, the cell and roll being located in the path of travel of the strip.

Before the commencing of the rolling operation, the adjustable portions of the wedges **12** of the stands **1** to **6** are shifted in such a manner that the tops of the lower working rolls are brought to a predetermined pass line. In now referring to only one of the stands, through an adequate selection of filler plates **13**, which are kept on hand in different thicknesses, it can be assured that during rolling the hydraulic cylinders **14** will remain within their desired working range which, in this case, can be chosen relatively narrow. Now, the rolls can be subject by means of the line **16** to a pressure which corresponds with the anticipated rolling force. The latter is sent to the corresponding control devices **15** by means of an adjustable selsyn **30**. In this way, during the slow rotating of the rolls, the working rolls can be pressed strongly against each other and the position indicator **22**, in the form, for example of the abovementioned transductors, can be set, i.e., adjusted to a zero setting. Subsequently, the hydraulic cylinders **14** will be un-loaded so as to position the upper rolls in the unloaded condition that will produce the desired roll gaps when the strip enters the stands and the housings stretch under the rolling loads.

If now a roll strip, e.g. a hot strip, is fed to a mill, for example, stand **1**, the indicator **24** is first made active by means of the switching mechanism **26**; thus causing the control device **15**, pursuant to its regulating characteristic, to set the initial desired stand modulus through operation of the cylinders **14**. This initial stand modulus is of such a nature that the natural rigidity of the stand is not increased by the control device as normally would happen, but, instead, it is rather considerably decreased. Thus, there is practically effected a "negative" adjustment in which for an increasing rolling force oil is allowed to escape the hydraulic cylinders; whereas, the cylinders are supplied with oil under a decreasing rolling force. Such a yielding stand allows, firstly, a more gently entry of the strip into the roll gap. But more importantly, it provides that the entry of the strip is improved considerably in the event, as shown in FIG. 3, the profile of the strip 31 is not exactly rectangular, but, for example, somewhat trapezoidal.

In customary roll stands, due to the rigidity or the high stand modulus, the thickness of such strip is not reduced proportionally to the strength distribution over the width or, at least, over a constant value over the width; but the trapezoidal profile is rolled down to a more or less rectangular one, so that there is effected an increased lengthening of the original thicker side of the strip. The strip delivered from the roll gap is therefore more lengthened on the original thicker side than on the opposite side, which slightly bends the strip in a ring-like shape. Consequently, the strip is laterally displaced from the vertical plane of symmetry of the mill train and with a curvature so that there exists the danger that it may not enter the next stand, but instead, piles up between the stands requiring with much effort that it be removed. This can be avoided by means of the control devices 15, due to the low stand modulus attained through the activity of the selsyn 30, the natural rigidity of the stand is not, as customary for roll gap adjustments, increased; but rather considerably decreased so that the rolls 7 and 8 can adapt themselves to the profile of the roll strip 31. In this event the advance of the strip is effected by means of the engagement of the rolls over the entire width and, simultaneously, the strip is reduced over the entire width by an equal amount or an amount proportional to the respective thickness or in amounts lying between these two conditions, so that the tendency for the formation of a ring section shape does not exist. Thus, the strip will take a straight course and will not deviate from the vertical plane of symmetry of the tandem train, so that it will reach the next stand safely and in a symmetrical predetermined position.

During the advancement of the strip, subsequent to leaving a stand, it passes over the feeler roll 28 located immediately after the stand. Because this feeler roll reaches only slightly into the path of the strip, it is passed over and, after having passed the feeler roll, the leading end of the strip lowers itself in the direction of the guides of the following stand. Only when the leading end of the strip is caught securely by the rolls of the following stand, will there occur a tension in the strip between both stands, which due to the engagement of the feeler roll even with only a low circumferential angle, placing a load on its supporting element. This load, when absorbed by the pressure cell 29, will cause the cell to produce a signal which is fed to the switching mechanism 26 and which effects operation of the switching mechanism. As a result, the indicator 24 is disconnected from the control device 15 of FIG. 2 and the indicator 25 will be connected with it. The indicator 25 is adjusted to another rigidity and effects a considerably different stand modulus than indicator 24. The normal rigidity of the stands is now increased to the extent as required by the gauge adjustment of the strip during the rolling operation. Special concern about the entry of the succeeding portion of the strip, especially the possibility of the off-track feeding of strip whose profile deviates from the rectangular shape, no longer has to be considered because the leading end of the strip will have been gripped by the next stand to subject the strip to a guiding tension.

In relating the invention to a tandem train, let it be assumed that a cold strip is to be rolled. The stands 1 to 6 are similarly constructed and also present the same delivery stand modulus of approximately 550 ton/mm., that is to say, an increase of the rolling force of approximately 550 tons results in an expansion or stretch of 1 mm. During the entry of the strip under the influence of the indicator 24, each of the stands will be brought to a reduced stand modulus of 50 ton/mm; thus, the stands are brought to approximately one tenth of their normal rigidity due to the adjustment. After the corresponding advancement of the leading end of the strip, the switching mechanisms 26 are activated, which disconnect the indicators 24 and connect the indicators 25. Consequently, the stands again receive a higher rigidity. It may be desirable to use an extreme rigidity corresponding to a high stand modulus in the present form of construction only for the stands 1 and 2. In this case stands 3, 4 and 5 can be adjusted to magnitudes which correspond to the normal stand modulus which is established by the mechanical stiffness of the mill, that is to say, the modulus of a similar stand without a control device. The last stand 6 can be brought to a stand modulus corresponding to approximately one-half of the normal stand modulus.

The invention is not limited to cold rolling nor the utilization of six stands. Among others, it can be applied to hot mills, cold mills and double cold reduction mills as well as to individual stands. The application of the invention is also not dependent of the type of adjustment. It can be utilized in combination with the customary, purely mechanical adjustments in which the corresponding stand load is established only by pressure cells. Disadvantages to be observed in such adjustment devices and control mechanisms are found in their slow response time in effecting a roll gap adjustment.

Correspondingly, the controlling mechanism itself can be altered. In the form of construction illustrated, the desired roll gap is established by a setting means 21 and the actually adjusted roll gap is controlled by a monitor 23, which is located after the stand and gives the actual value of the roll gap. In the described setting process, the position indicators 22 are adjusted to the zero position upon the pressurization of the hydraulic cylinders 14. Such position indicators can be located between the chocks, if desired. In the form of construction shown in the drawing the position indicators 22 are assigned to the hydraulic cylinders 14 and, adjusted in the initial position in which they not only indicate the movement of the pistons relative to the hydraulic cylinders, but, simultaneously, also the position of the rolls and serve as an indicator of actual value of the roll gap.

The time of switching of the switching mechanism 26 can also be altered. Thus, at the delivery of a strip from a stand, the stand can be converted to the soft or low stand modulus condition by the switching mechanism 26 activating the indicator 24. Such switching over at or shortly after the unloading of the preceding stand avoids the tendency of a lateral deviation of the tail end of the strip. In the same manner it is also possible to switch over the stands simultaneously to the lower of the modulus of both stands, but only after the delivery of the rolled stock from the train. to assure effective grasping of the leading end of the strip in the stand, it can be advantageous to effect the switching over only at the moment the leading end of the strip enters the roll gap. The stand will continue to operate at the low modulus condition only during the subsequent short interval, which ends with the grasping of the leading end of the strip by the next stand and the buildup of tension in the strip between the two stands.

In hot rolling the passing of the leading end of the strip can be determined by means of the photo-electric cell **27**, connected immediately after the stand and reacting to red or infrared light, to effect the switching over of the switching mechanism **26**. The reversal to the high modulus operating condition can be executed by a second photo-electric cell associated with the following stand or through the load on the pressure cell **29**. It is also possible to divert the switching over processes only from the pressure cells. For example, as soon as one of the pressure cells **29** is under load, the switching mechanism **29** of the associated stand can be switched to the high modulus condition, while the switching mechanism of the next stand in the direction of travel of the strip can be switched to the lower modulus condition.

A still further arrangement would be to effect the switching over automatically by providing the circuits of the mill motors for the stands with measuring devices having terminals, for example, current relays capable of triggering the entry switching processes as a function of the occurrence of maxima or minima current. During the entry of the strip the drives will operate under an idle condition at the beginning; but then they are loaded when the leading end condition of a strip is grasped, so that the current used by the motors will be considerably increased. When the leading end of the strip enters the following stand due to the tension occurring in the strip, the latter takes charge of a part of the power to be applied so that the current used by the driving motors of the preceding stand is again lowered. Therefore, the corresponding switching mechanism **26** will be switched over to the switching position corresponding to the lower stand modulus at the earliest during the idling period of the driving motor and at the latest during the great increase of the current during the entry of the strip, and during the renewed slight decrease of the current it will be switched over again to the high modulus operating condition. If desired, only the switching over to the low stand modulus can be effected by means of current relays or similar devices, while the switching over to the higher modulus can be effected by the pressure cell **29** or the photo-electric cell **27** of the following stand.

Turning now to the embodiment illustrated in FIG. **4**, in the block diagram of FIG. **2**, it was represented that for the control devices **15** of both housings of the roll stand **1** there is provided a single switching mechanism **26**. In the form of construction of FIG. **4** there is represented that at least for certain distinct values to be sent to the control devices of a stand, there are provided two switching elements.

In FIG. **4** the actual value indicators **22** and **32** of both housings of a stand are connected to separate control devices **15** and **33**, respectively, each assigned to one of the housings of the stand **1**. The load to be expected during the rolling operation to be given either manually or by means of data carriers is adjustable through a selsyn **30**, whose delivery signal is sent to both control devices. Likewise, the setting means **21** determining the thickness of the roll gap acts upon both control devices. However, the corresponding desired outputs of the regulatory signals and the corresponding loads of the housings are fed to the control devices **15** and **33** over special switching mechanisms. The switching mechanism **26** presents two inputs for the indicators **24** and **25** which correspond to those of FIG. **2** and are provided in common for both control devices **15** and **33**. The outlet of the switching mechanism **26** assigned to them is therefore connected with the control device **15** as well as with the corresponding inlet of the control device **33**.

The switching mechanism **26** is completed with further switching mechanism **36** jointly connected with it. To inlets of the switching mechanism **36** are connected pressure cells **34** and **35** assigned to a different one of the housings, indicating the corresponding loads of housings. The switching mechanism **36** continuously produces signals representing the existing loads which are sent to the control devices **15** and **33**. These control devices are constructed in such a manner that they can effect adjustment movements in dependence of the given roll gap as setting means and of the adjustment movement corresponding to the predetermined elasticity behavior of the stand. The desirable full compensation of the swelling or stretch and, therefore, the approach to an unlimited rigid stand is consciously avoided in the adjustment effected by the control devices. For practical purposes an additional automatic control system can effect correction with a large time constant and be superimposed on the control. Such a system can monitor the actual gauge by means of another measuring device, for example, the monitor **23** of FIG. **2**, which is omitted in FIG. **4** due to its particular diagrammatic representation.

As soon as the strip enters the roll gap there is attained a variation of loads by the pressure cells **34** and **35**. The pressure cell **34** feeds a signal to the switching mechanism **26** and switches it over to bring the indicator **24** into effect. The pressure cell **34** is also connected with the corresponding inlet of the control device **15** and the pressure cell **35** is connected with the corresponding inlet of the control device **33**. In these switching positions one works with a soft stand and the loads of the housings are correspondingly transferred to the control device of the pertinent housing. In this way the control device can control the pressure in the different piston cylinders **14** associated with the different housings, assuring that the strip will be uniformly reduced during the period the stand is operating under the soft modulus condition.

When the strip now enters the following stand, a pressure cell **37** associated therewith experiences a considerable load variation, and the switching mechanism **26** is reversed and also sets back the switching mechanism **36** similar to what occurs in the aforesaid switching over operation. In this case the indicator **25** becomes active by means of the switching mechanism **26** and the rigidity of the housings is increased through a corresponding adjustment of the control devices **15** and **33**. Within the switching step **36**, the pressure cells

34 and 35 are connected with a summation switching device which determines the sum from both their individual loads. A signal proportional to one of these sums, that is to say, a signal corresponding to the arithmetical average of both housing loads, is now fed to both inlets running to the controls so that they receive the actual value of the loads during the rolling operation and react based upon the arithmetical average of the housing loads as with customary control devices. FIG. 4 describes also how the switching over process can be effected through sensors of a given stand and how the reverse switching can be effected by means of sensors of the following stand.

A further arrangement for the switching over and reverse switching of the switching mechanism **26** as well as the switching mechanism **36** is shown in FIG. **2.** A photo-electric cell **27** can again be utilized as a sensor in this case or, if it is exposed to a large extent to danger of fouling by the strip, or if it should not be possible to position such a photo-electric cell close enough to the roll gap, there can be provided in its place a current relay for the driving motor, a pressure cell **34** or a pressure transformer **17.** In the given example, the switching over of the switching mechanism **26** will be effected by actuation of the photo-electric cell **27** wired directly to the switching mechanism **26.** The same signal can pass a time delay relay **38,** only after a time interval determined by it and reach the second or reversing inlet of the switching mechanism **26.** Also, several variants can be introduced without deviating from the invention, e.g., the switching over can be effected by a considerable load variation of the pressure cell **34,** while the reverse switching by means of the photo-electric cell **27** which activates a current limiting device or similar device in conjunction with a time delay relay **38.** When operating essentially only with current relays, the current impulse resulting in the initial pass can effect the switching over to effect a soft stand condition while the slight current drop after the lowering of load of the drive due to the occurrence of tension in the strip can be utilized for the reverse switching. For the protection against the effects of further variations of voltage the current relays can be attached to time relays, which allow the decline of the current only during a determined, relatively short-time interval and which will release a control signal effecting automatically the reverse switching, if a determinable decline after the predetermied period fails to appear.

In any case the entry of a strip is considerably facilitated and the desired automatization is accomplished since, during the entry operation, the corresponding stands are operated with a low stand modulus, that is to say, under a soft modulus condition with considerable housing swelling so that the rolls are capable of adapting themselves to the strip shape. Consequent lateral deviation of the strip from the plane of symmetry of the train is prevented. By means of the ability to automatically switch over to a soft mill condition after the predetermined advance or period of advance, a leading end of the strip not true to size is limited to a small length and, yet, during the actual rolling process the ideal rolling conditions can be maintained.

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.

I claim:

1. A method of operating a rolling mill for rolling strip, said mill having means for adjusting the roll gap of the mill, the steps of:

passing the leading end of the strip to said mill,

operating the roll gap adjusting means of said mill to cause said mill to operate at a low modulus condition during the time the leading end portion of the strip is being rolled by said mill to produce a substantially uniform reduction across the width of said strip portion,

after the leading end of the strip has been so rolled by said mill subjecting said leading end portion to tension between said mill and a tension means, and once said strip tensioning is created operating said roll gap adjusting means of said mill to permit said mill to be operated at a higher modulus condition to roll the remaining portion of the strip to a desired longitudinal gauge.

2. A method of operating a rolling mill for rolling strip, said mill formed by at least two tandemly arranged mill stands and having means for adjusting the roll gaps of the stands, the steps of:

passing the leading end of the strip to a preceding stand of said mill,

operating the roll gap adjusting means of said preceding stand to cause said stand to operate at a low modulus condition during the time the leading end portion of the strip is being rolled by said stand to produce a substantially uniform reduction across the width of said strip portion,

after the leading end of the strip has been so rolled by said preceding stand subjecting said leading end portion to tension between said preceding stand and a tension means, and

once said strip tensioning is created operating said roll gap adjusting means of said preceding stand to permit said preceding stand to be operated at a higher modulus condition to roll the remaining portion of the strip to a desired longitudinal gauge.

3. In a method according to claim **2,** characterizing in that said tensioning is created by a succeeding stand of said mill.

4. In a method according to claim **3,** the further step of operating said roll gap adjusting means of said succeeding stand of said mill to cause said succeeding stand to operate at a low modulus condition during the time the leading end portion of the strip is being rolled by said succeeding stand to create said tension condition and to produce a substantially uniform reduction across the width of said strip portion, and

immediately after said rolling commences by said succeeding stand changing the operation of said preceding stand from its low modulus condition to its higher modulus condition.

5. In a rolling mill for rolling strip,

said mill including means for adjusting the roll gap of the mill,

a control means for said roll gap adjusting means including means for establishing at least two different values of mill modulus,

means for causing said roll gap adjusting means to operate said mill at a low modulus condition during the time the leading end portion of the strip is being rolled to produce a substantially uniform reduction across the width of said strip portion,

means for subjecting the portion of the strip issuing from the mill to tension, and said control means including means for operating said roll gap adjusting means to cause said mill to operate at a higher modulus condition to roll the remaining portion of the strip to a desired longitudinal gauge.

6. In a rolling mill for rolling strip,

said mill made up of at least two mill stands tandemly arranged and including means for adjusting the roll gaps of the stands,

a control means for said roll gap adjusting means including means for establishing at least two different values of mill modulus for each stand,

means for causing said roll gap adjusting means of a preceding stand of said mill to cause said preceding stand to operate at a low modulus condition during the time the leading end portion of the strip is being rolled by said preceding stand to produce a substantially uniform reduction across the width of said strip portion,

means for subjecting the portion of the strip issuing from said preceding stand to tension, and

said control means including means for operating said roll gap adjusting means of said preceding stand to cause said stand to be operated at a higher modulus condition to roll the remaining portion of the strip to a desired longitudinal gauge.

7. In a rolling mill according to claim 6, characterized in that said tensioning means comprises a succeeding stand of said mill.

8. In a rolling mill according to claim 7, wherein said control includes means for operating said roll gap adjusting means of said succeeding stand of said mill to cause said stand to operate at a low modulus condition during the time the leading end portion of the strip is being rolled by said succeeding stand to create said tension condition and to produce a substantially uniform reduction across the width of said strip portion, and

said control also including means after said rolling commences by said succeeding stand to change the operation of said preceding stand from its low modulus condition to its higher modulus condition.

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