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(54) Tension leveller.

(57) A tension leveller, particularly for use in a tandem cold strip mill, has each of its staggered work rolls (A-D) nested in, and supported by, two back-up rolls (F-H and J-L), each of which has a diameter at least 1.1/4 times greater than the diameter of the work rolls.

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TENSION LEVELLER

This invention relates to a tension leveller for metal strip in elongate form. Tension levellers are used to improve the shape, that is the flatness, of the product.

A tension leveller has two sets of work rolls which are staggered and which cause the strip to pass through the leveller along a sinusoidal path and to be flexed under tension in opposite directions alternately. It is of course important that no bending of any of the leveller work rolls should occur, since if bending occurs the flatness of the product suffers. Therefore, where circumstances allow, either very large work rolls are used which are stiff enough to support the applied loads without deflection, or, if small work rolls have to be used, these require to be supported by back-up rolls.

Normally the strip speed through a stretch leveller is low, e.g. 5 metres/second, compared with the speed through a tandem strip mill (up to 20 metres/second). At the lower speed, the bearings for the leveller rolls are well able to transmit the loading applied to the work rolls by the strip.

It has been proposed to employ a leveller between two consecutive stands of a tandem hot mill, but in a hot mill work hardening does not occur and the leveller may be theoretically capable of operating with relatively large work rolls, with consequential large bearings and low rotational speeds so that the bearings are again able to operate satisfactorily. There are however serious problems

in employing a leveller in a tandem cold mill. Firstly, the strip speed is far greater than the normal speed for levelling lines and, secondly, the hardness of the strip, due to the work hardening in the mill, necessitates the use of small diameter, backed-up, work rolls. Those two characteristics result in a high rotational speed of the work rolls and, because the back-up rolls are restricted in size by the required spacing of the work rolls, the back-up rolls also run at high speeds which are greater than the safe value for the load transmitted.

Furthermore, in a conventional leveller line, the small diameter forced upon the back-up rolls by the space restriction necessitate the use of composite back-up rolls, each comprising a series of short barrel length rolls along the length of the work roll, each with its own bearing arrangement carried in saddles from a stiff beam. While such an arrangement may be satisfactory in a leveller line, it is not acceptable in a cold tandem mill, where the equipment is submerged in quantities of roll coolant and rolling lubricant which are detrimental to the operation of the bearings.

For those reasons and others, it has not been possible to employ a roller leveller within a cold strip mill, although it would be clearly advantageous to do so, in order to improve the shape of the strip leaving the mill, and to effect a strip reduction, additional to that performed by the mill itself. Thus, by using a leveller, either the

reduction can be increased, or the same reduction effected with fewer stands.

An object of the present invention is to provide a construction of leveller which, although usable in other applications, may be employed in a cold tandem rolling mill.

A tension leveller for metal strip in elongate form comprises according to the present invention two sets of work rolls which, in each set, are spaced apart in the direction of the strip path, the work rolls of one set being staggered relative to the work rolls of the other set so that, in use, the strip is constrained to a sinusoidal path by contact with successive work rolls, characterised in that each work roll is engaged and supported by two back-up rolls so that the bearings of the work rolls are relieved of significant loading both transversely of, and normal to, the mean pass-line of the strip through the leveller, and in that each of the back-up rolls has a diameter at least one and a quarter times the diameter of the work rolls.

Preferably the ratio of the diameter of the back-up rolls to the diameter of the work rolls is at least 1.5. Advantageously, that ratio is between 1.25 and 2 and the diameter of the work rolls is between 80 mm and 180 mm.

The invention is based on an appreciation of the fact that the work roll spacing in a tension leveller may be greater than that usual in leveller lines and that consequentially the restriction on the diameter of the back-up rolls need not be as severe as previously thought

necessary. Thus, although the diameter of the work rolls can be small, the diameter of the back-up rolls can be increased in order to accommodate the strip speed in a tandem mill whilst keeping the speed of the back-up rolls within the safe load bearing limits for the bearings. At the same time, because each work roll is nested in, and supported by, two back-up rolls, the work roll bearings are subject only to insignificant loading and can therefore operate at the high speeds resulting from the high strip speed and the small diameter of the work roll.

Preferably, each back-up roll extends over the entire barrel length of the work rolls with which it is in contact. The use of long barrel length back-up rolls is made possible by their increased diameter and results in the reduction of the number of bearings to a minimum of two per back-up roll. Consequently, the problems resulting from the presence of roll coolant and rolling lubricant is reduced to tolerable levels.

In another aspect, the invention provides the combination of a tandem cold strip mill and a tension leveller as described above, arranged between two consecutive stands of the mill. Advantageously, the upper set of work rolls of the leveller with its back-up rolls is movable away from the lower set for threading of the strip through the mill and the lower set of work rolls are arranged to guide the strip along a designated pass-line between the consecutive stands for threading. There may be

further provided deflector rolls which, when the work rolls are in operative position, guide the strip into and out of the leveller along that pass-line.

The invention will be more readily understood by way of example from the following description of a tension leveller and of a cold tandem mill incoporating such a leveller. Reference is made to the accompanying drawings in which:

Figure 1 shows schematically a part of a cold tandem mill, and

Figure 2 shows the leveller in greater detail.

In Figure 1, the cold tandem mill is represented by the rolls of two consecutive stands 1 and 2, which may in fact be stands 4 and 5 of the mill. The strip 3 leaving stand 1 passes over a tensiometer 4, through a tension leveller 5, and is led into stand 2 by an entry guide 6.

Tension leveller 5, shown in greater detail in Figure 2, is so mounted as to be removable from the mill line transversely to the passline, e.g. on slides as illustrated in the drawing at 12, or on wheels. In Figure 2, the tensiometer deflector roll of tensiometer 4 is indicated at 13.

The leveller has a framework 15 which can slide on the slides 12 and which carries the bearings for four leveller work rolls A to D and entry deflector roll E, eight back-up rolls F to L, and an exit deflector roll M. As will be observed, each of the work rolls A to D is nested between, and in contact with, two of the back-up rolls F to L.

Consequently, each work roll is restrained from bending both in the direction normal to the passline and in the direction of the passline. The work roll bearings are therefore relieved of the need to transmit any significant part of the rolling load, which is taken by the back-up rolls F to L. The spacing of the work rolls along the passline is larger than is customary in leveller lines.

Each of the backup rolls F to L has a relatively large diameter, which is made possible by the wide spacing of the work rolls, and which is at least one and a quarter times the diameter of the work rolls A to D and preferably at least one and a half times the latter diameter. Advantageously, the ratio of the diameter of the back-up rolls to the diameter of the work rolls is between 1.1/2 and 2 and the diameter of the workrolls is between 80 and 180 mm. Because of the larger diameter of the back-up rolls, their rotational speed is relatively low, thus enabling their bearings to operate at the high loading. Because of the large diameter of each back-up roll, it is subject to little bending under the rolling loads and can be made to extend over the full barrel length of the work rolls with which it is in contact. Accordingly, each back-up roll has only two bearings which can be readily sealed and serviced.

As will be observed, the entry deflector roll E, which ensures the correct angle of wrap of the strip around work roll D is similar to the work rolls and is supported by the back-up rolls H and I.

The upper set of rolls - the work rolls A and B, deflector roll E, and back-up rolls F to I are carried in a sub-housing 16 which can be raised in the framework 15 as by a hydraulic piston and cylinder arrangement 14. By displacing the upper set of rolls vertically away from the lower set, the leveller can be opened to facilitate threading of the strip through the mill at start-up. When the leveller is open, the passline through the leveller defined by the rolls 13 D, C and M coincide with the defined mill passline between deflector roll 13 and the downstream stand 2. When the mill has been threaded and the upper set of leveller rolls has been returned to the operative position shown in Figure 2, the positions of the roll 13 and the exit deflector roll M ensure that the strip enters and leaves the leveller along the same passline whilst the entry deflector roll 13 further ensures a correct angle of wrap of material around roll D. This arrangement ensuring that the passline is unaffected is necessary because of the close juxtaposition of various items of mill equipment to the leveller and their requirement for a constant passline. As space between consecutive stands of the mill is at a premium, it is desirable that the passline be maintained within the confines of the leveller itself.

It will be appreciated that the arrangement of rolls shown in the drawing is for one particular application only and the number of rolls and their arrangement may be altered to suit special circumstances.

CLAIMS

1. A tension leveller for metal strip in elongate form comprising two sets of work rolls (A,B and C,D) which, in each set, are spaced apart in the direction of the strip path, the work rolls (A,B) of one set being staggered relative to the work rolls (C,D) of the other set so that, in use, the strip is constrained to a sinusoidal path by contact with successive work rolls, characterised in that each work roll (A-D) is engaged and supported by two back-up rolls (F-H and J-L) so that the bearings of the work rolls are relieved of significant loading both transversely of, and normal to, the mean pass-line of the strip through the leveller, and in that each of the back-up rolls (F-H and J-L) has a diameter at least one and a quarter times the diameter of the work rolls (A-D).

2. A tension leveller according to claim 1, in which the ratio of the diameter of the back-up rolls (F-H and J-L) to the diameter of the work rolls (A-D) is at least 1.1/2.

3. A tension leveller according to claim 1, in which the ratio of the diameter of the back-up rolls (J-H and J-L) to the diameter of the work rolls (A-D) is between 1.1/4 and 2.

4. A tension leveller according to any one of the preceding claims, in which the diameter of the work rolls

(A-D) is between 80mm and 180mm.

5. A tension leveller according to any one of the preceding claims, in which at least one (G,K) of the back-up rolls of each set engages two work rolls of the corresponding set (A,B and C,D).

6. A tension leveller according to any one of the preceding claims, in which each back-up roll (F-H and J-L) extends over the entire barrel length of the work roll or work rolls with which it is in contact.

7. The combination of a tension leveller according to any one of the preceding claims and a tandem cold strip mill, with the tension leveller located between two consecutive stands of the mill.

8. The combination according to claim 7, in which each set of work rolls (A,B and C,D) is supported independently of the other set, and the upper set (A,B) is movable away from the lower set (C,D) for threading of the strip through the mill, the lower set of work rolls (C,D) being arranged to guide the strip along the designated pass-line between the consecutive stands between which the leveller is located.

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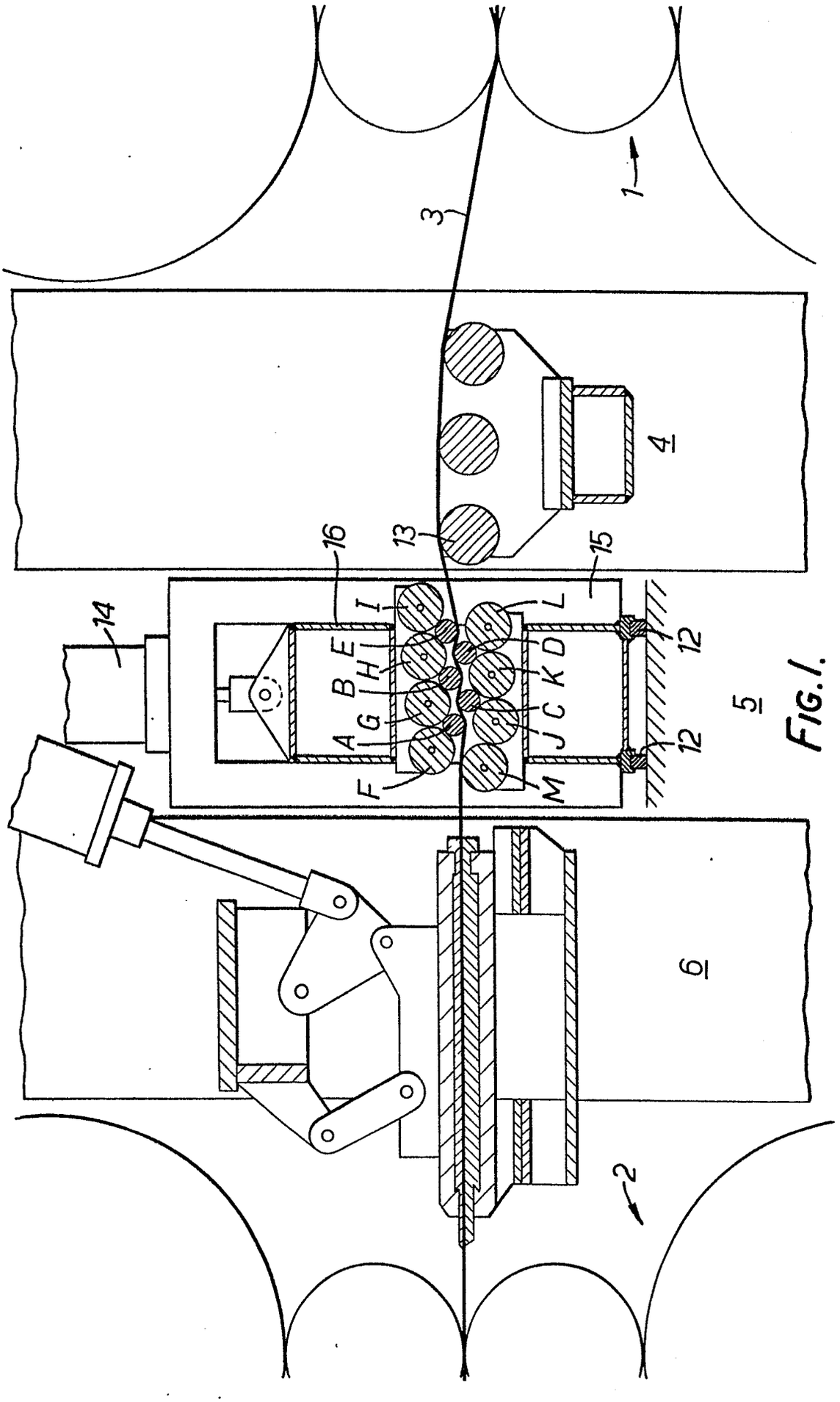

FIG. 1.

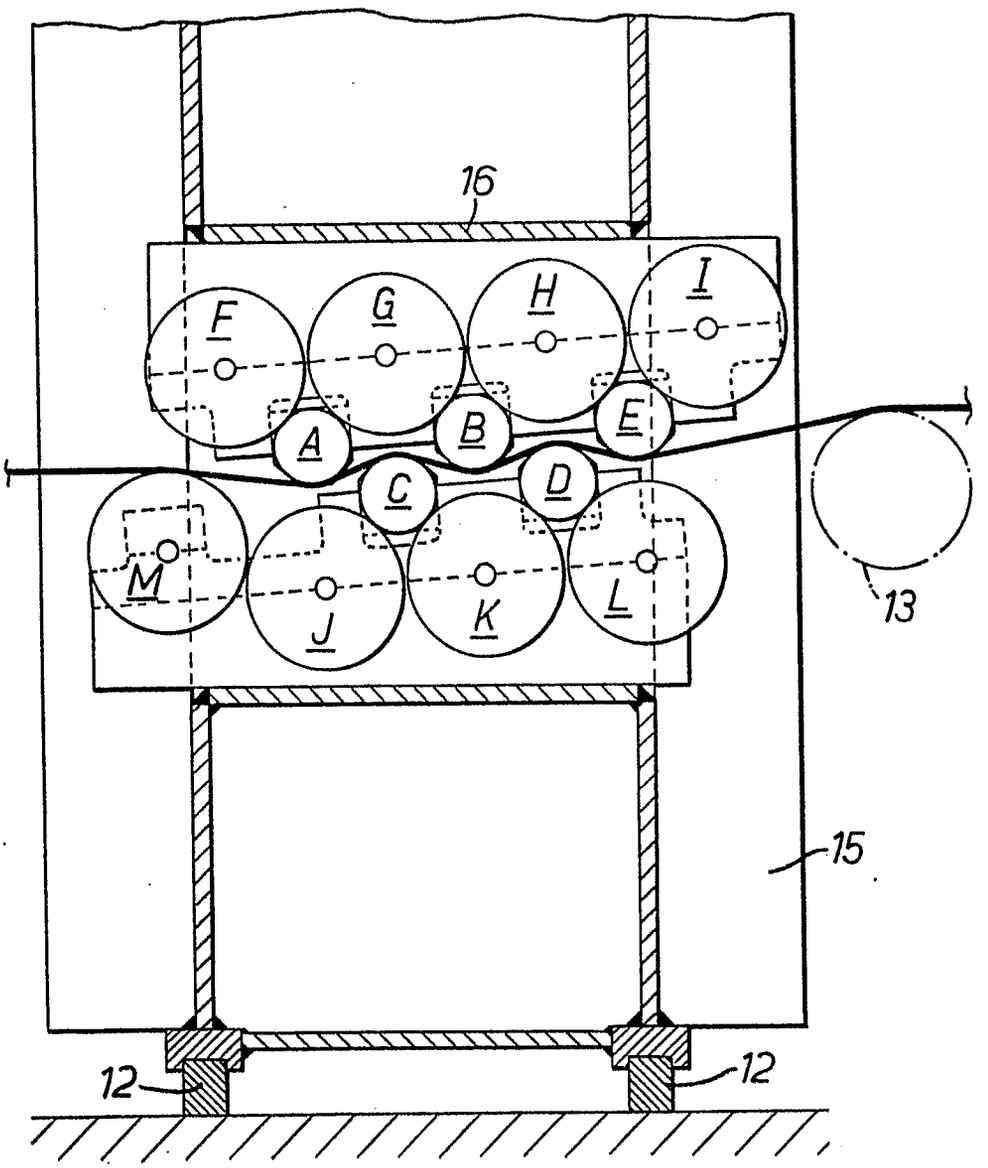

FIG. 2.