Oct. 30, 1962 E. SPENLE 3,060,945

APPARATUS FOR INTRODUCING WIDE METAL STRIP INTO A PICKLING DEVICE

Filed Jan. 3, 1961 3 Sheets-Sheet 1

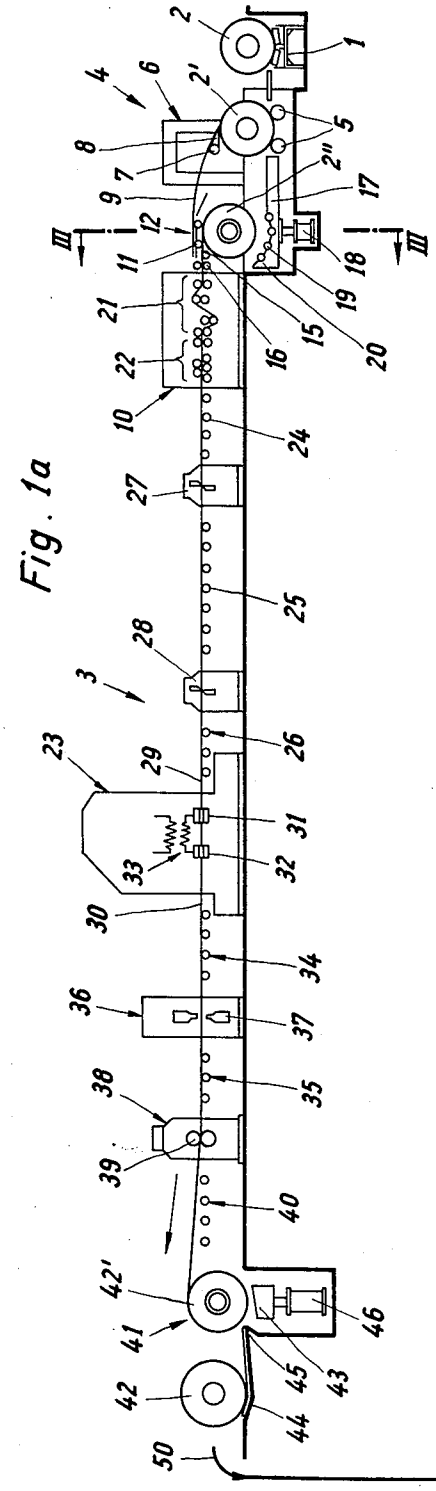


Fig. 1a

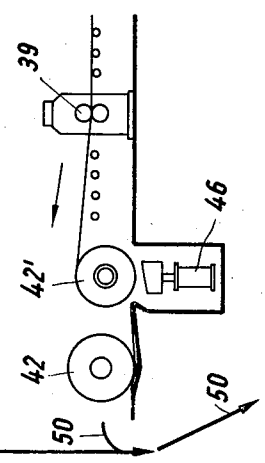


Fig. 1b

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APPARATUS FOR INTRODUCING WIDE METAL STRIP INTO A PICKLING DEVICE

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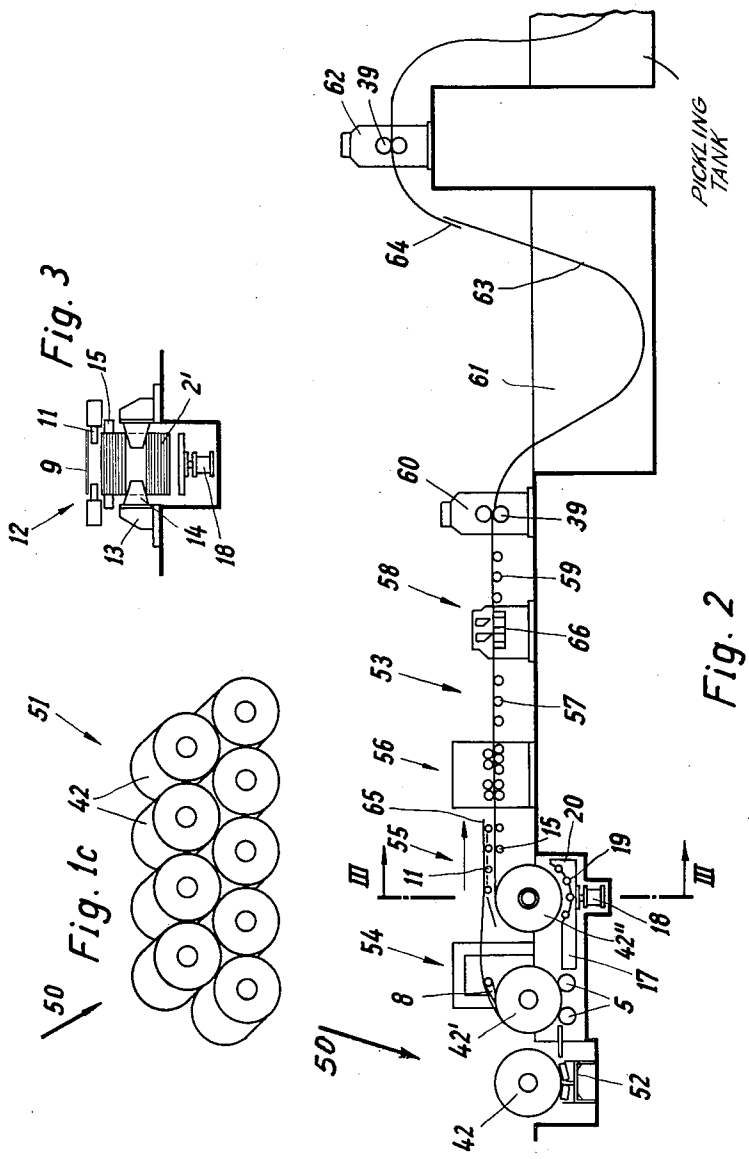


Fig. 2

Fig. 3

Fig. 1c

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APPARATUS FOR INTRODUCING WIDE METAL STRIP INTO A PICKLING DEVICE
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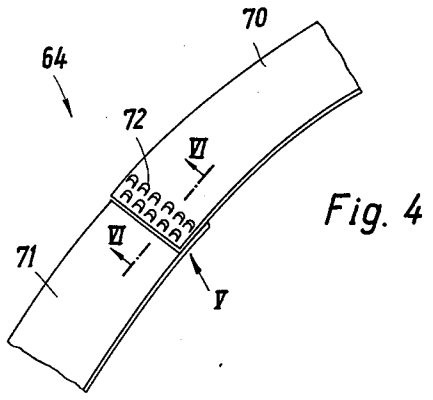


Fig. 4

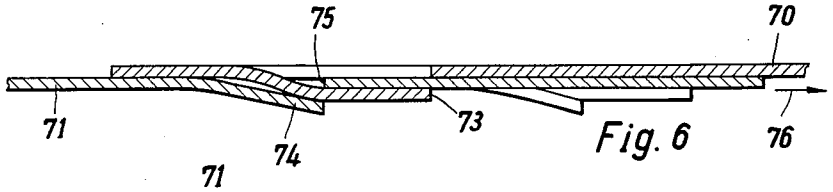


Fig. 6

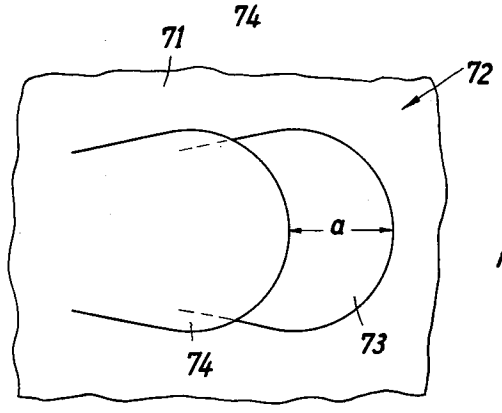


Fig. 5

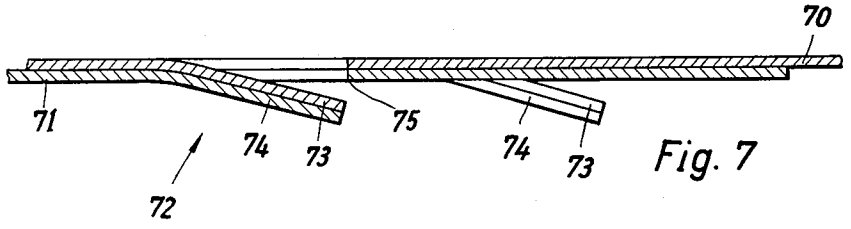


Fig. 7

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3,060,945

APPARATUS FOR INTRODUCING WIDE METAL STRIP INTO A PICKLING DEVICE

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Claims priority, application Germany Jan. 5, 1960
8 Claims. (Cl. 134—63)

The present invention relates to an apparatus for introducing wide metal strip into a pickling device, and more particularly the present invention is concerned with the preparation of hot rolled metal coils, steel coils, for introduction into the pickling device.

Thus, the present invention is primarily concerned with the method and apparatus which are to be used up to the point where the hot rolled wide steel band or the like enters the pickling device.

In this preparatory portion of the entire installation, wide steel band which is received as hot rolled coils from a hot rolling mill is welded together so that the steel band of a plurality of hot rolled coils will form a continuous band. This continuous band which has a length or weight equal to the length or weight of several hot rolled coils, will remain intact throughout the entire pickling process and, after leaving the pickling device, the heavy continuous steel band is wound up into a coil which will have a weight equal to several times the weight of the individual coils received from the hot rolling mill. This is desirable because the cold rolling mill through which the pickled steel band is passed thereafter, operates at optimum conditions when the wide band of the pickled steel which is introduced into the same has the greatest possible continuous length. In order to operate the pickling device in a continuous manner, the welded hot rolled steel band, i.e. the heavy intermediate coil formed by welding together several of the initial hot rolled coils, will be unwound and one end thereof will be stitched or otherwise temporarily adhered to an end portion of a subsequent similar intermediate coil. In this manner, the elongated steel bands of considerable length which were formed by welding together the steel bands of several hot rolled coils, will be temporarily connected so as to form a continuous band for the purpose of passage through the pickling device. After the continuous band has passed through the pickling device, the same is separated at the temporarily stitched or locked portions thereof so that a series of the above-described elongated bands will be formed, each of which is then wound up into a coil having approximately the same weight as the previously described intermediate coil.

Such preparatory arrangements for the pickling device up to now were formed of a single track for unwinding the coil of hot rolled steel and for passing the same into the pickling device. Along such track, a welding device, a stitching device and a descaling device are arranged, as well as a loop pit for taking up the slack in forward movement of the metal band which is caused during welding together of adjacent end portion of successive unrolled hot rolled metal coils. Such loop pit is a conventional device, essentially a loop forming device. During forward movement of the welded band from the welding device to the pickling device, loops of the welded band will be formed in the intermediate loop pit and the forward end of the loops will be passed at a continuous speed to the subsequent arranged pickling device. When, during the welding together of adjacent end portions of individual unrolled coils, forward movement of the band from the welding device towards the loop pit is stopped, nevertheless, feeding of metal band into the pickling device will continue at the same speed by taking up portions of the loops which were previously stored in the loop pit. Prior to exhausting the steel band portion which is stored in the form of accumulated loops in the loop pit, the welding will be completed and forward movement of the welded steel band from the welding device towards the loop pit and thus the formation of new loops in the loop pit will have been resumed.

However, the above-described arrangement is subject to considerable disadvantages. These are due to the difference in the optimum speed at which the various individual devices may be operated. It is desirable to operate the pickling device (and also subsequently arranged cold rolling devices) at a speed which is far greater than the continuous speed which can be maintained as described above. The slack caused by welding together the adjacent ends of individual unrolled coils expressed in length of metal band, will become proportionately greater with increased speed of forward movement or feeding of the metal band into the pickling device. Thus, in order to take up such slack at greater speed, the loop pit would have to be unduly enlarged. This does not only cause practical problems and in fact it becomes a practical impossibility, but it would also tend to cause damage to the steel band, if the same has to be arranged in too large a number of superposed loops. Thus, it was not possible up to now to run the pickling device, and particularly the subsequently arranged cold rolling mill at maximum desirable speed, since an even feed of steel band to these devices could not be assured at such greater speed.

It is therefore an object of the present invention to overcome the above discussed difficulties and disadvantages in the introduction of a wide steel band into a pickling device and particularly in the operation of the preparatory devices which are employed in transforming the hot rolled coils of steel or the like into a continuous band suitable for feeding into and through a pickling device.

It is another object of the present invention to provide an apparatus for feeding a continuous wide metal strip such as a steel band into a pickling device, which can be arranged and operated in a simple and economical manner and furthermore so that the continuous steel band or the like can be fed into the pickling device at a greater speed than was hitherto possible.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention comprises in a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, the introduction means including preparatory track means comprising means for unrolling hot rolled metal coils and for welding adjacent end portions of successive unrolled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of the plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of the plurality of hot rolled metal coils, feeding track means including means for unrolling the intermediate coil and for temporarily adhering adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, and for continuously feeding the continuous metal band at a substantially even speed into the pickling device, and means for transporting the intermediate coils from the preparatory track to the feeding track.

The present invention is also concerned with a method

of pickling hot rolled wide metal strip which comprises the steps of successively unrolling a plurality of hot rolled metal coils, welding together adjacent end portions of successively unrolled coils of the plurality of hot rolled coils so as to form of the plurality of hot rolled coils an elongated metal band, winding the thus formed elongated metal band into an intermediate coil, successively unwinding a plurality of the intermediate coils, temporarily adhering to each other adjacent end portions of the thus unwound intermediate coils so as to form thereof a continuous metal band, and passing the thus formed continuous metal band through a pickling device.

Thus, according to the present invention, the introduction means introducing a continuous wide band of steel or the like into the pickling bath are subdivided into a feeding track for the actual introduction of the wide metal band into the pickling bath, and into one or more preparatory tracks. The stitching device is located in the feeding track, while the welding device for welding the steel band from the individual hot rolled coils together, is located in the preparatory track or tracks. Each preparatory track ends in a winding device for winding the welded elongated metal band into an intermediary coil which will contain the steel band or the like from several hot rolled coils and consequently will have several times the weight of the individual hot rolled coils. The size of the intermediary coils is so chosen as to be equal to or correspond to the weight of the cold rolled coils which are eventually produced from the pickled steed band.

Surprisingly, it has been found that by separating the introduction means for introducing the wide metal strip into the pickling device into one or more preparatory tracks and one feeding track, and notwithstanding the greater initial cost of the arrangement according to the present invention, very great advantages are achieved by the same. Initial expense, larger space requirements and the need of forming an intermediary coil represent relatively small disadvantages compared with the very great advantages which are achieved thereby. It is now possible to pass the metal band along the preparatory track at a relatively low speed so that welding and checking operations, including the cutting out of any portion of the metal band which does not pass inspection, can be carried out in the most careful manner. Furthermore, it is no longer necessary according to the present invention to provide the conventional loop pit in which up to 20 loops of steel band were superposed upon each other.

However, of even greater importance and giving surprisingly advantageous results are the following advantages of the present invention:

a. The cold rolling mill is capable of cold rolling the elongated band which has been passed into and through a pickling bath in accordance with the present invention, with an even and very high speed, including the weld portions of such elongated band.

b. Due to the high pickling speed which can be maintained in accordance with the present invention, the metal band leaving the pickling device may be immediately introduced into the cold rolling mill without requiring an intermediate winding into coils.

c. The effectiveness and yield of the pickling device will be increased according to the present invention by about 70% while the increase in the costs of the introduction means, including maintenance and operation, will be only between about 10 and 20%.

In order to fully utilize the above-mentioned advantages of the present invention, it is preferred to incorporate in the preparatory track a descaling device through which the metal band has to pass prior to reaching the welding device. Thereby, it is avoided that the weld seam will be exposed to the bending and stress to which the band is subjected by passing through the preliminary descaling device.

Furthermore, the welding device may include in addition to the actual welding installation and the weld trimming device, also an inspection track which is limited by two cutting devices or scissors for cutting out defective portions of the steel band before the same reaches the actual welding device. This is particularly important in order to obtain a maximum performance of the cold rolling mill. For this purpose it is necessary to introduce into the cold rolling mill an elongated band with perfect welding seams and terminal band portions welded together, which terminal band portions are free of pipings, slag inclusions and the like.

With respect to the feeding track according to the present invention, it is preferred to incorporate in the same a stitching machine of the type which is capable to punch out simultaneously two rows of stitch portions. This type of stitching machine operates very fast and thus, notwithstanding the relatively great forward speed of the band passing along the feeding track, only a very short length of slack due to reduction of speed by the stitching operation will have to be taken up in order to be able to feed the continuous band at an even and high speed into the pickling bath. It is even possible to arrange the stitching device in such a manner that no stoppage of the steel band is required. This is accomplished by arranging the stitching machine movable in the direction of passage of the steel band so that the stitching machine during stitching together the adjacent ends of successive metal bands will move at the same speed and in the same direction as the metal bands. Of course, the stitching device will then again return to its initial position to be ready for stitching the next following band end portions together.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1*c* is a schematic perspective illustration of the tory track according to the present invention;

FIG. 1*b* is an abbreviated schematic elevational view of a second preparatory track coordinated and cooperating with the preparatory track of FIG. 1*a*;

FIG. 1*a* is a schematic perspective illustration of the storage of intermediate coils obtained from the preparatory tracks of FIGS. 1*a* and 1*b*;

FIG. 2 is a schematic elevational view of a feeding track according to the present invention;

FIG. 3 is a cross-sectional view taken along lines III—III of FIG. 2 and particularly illustrating the unwinding device of the feeding track;

FIG. 4 is a perspective view of the stitched end portions of adjacent metal bands as obtained during the operation of the feeding track illustrated in FIG. 2;

FIG. 5 is a greatly enlarged view of a segment of the stitched end portion illustrated in FIG. 4 and seen from below as indicated by arrow V in FIG. 4;

FIG. 6 is a cross-sectional view taken along line VI—VI of FIG. 4 and also shown on a greatly enlarged scale; and

FIG. 7 is a cross-sectional view taken along line VI—VI of FIG. 4, however showing the band ends which are being stitched together in an intermediate stage of the stitching process.

Referring now to the drawing and particularly to FIG. 1*a*, hot rolled coil **2** is seen as it comes from a hot rolling train (not shown), resting on roller bed **1** and awaiting introduction into the preparatory track. Hot rolled coil **2**, for instance, may have a weight of 6,000 kilograms, a diameter of 1,100 millimeters and a width of 1,500 millimeters. The thickness of the coiled band may be 2 millimeters and scale formation is apparent on the surface of the coiled metal band. The two ends of the

coiled band 2 are tongue-shaped and irregular and contain slag inclusions, pipings and other irregularities.

At the entrance portion of preparatory track 3, another hot rolled coil 2' is located in a conventional coil opening device 4 which includes two driven rollers 5 which support coil 2' and a schematically shown wedge opening device 6. Device 6 includes two wedges 8 pivotally arranged upon axis 7, so that each of the two wedges 8 will contact one of the lateral edge portions of the coil for a distance of about 30 centimeters. As illustrated, coil 2' already has been opened. The tongue-shaped front end portion 9 of coil 2' is supported by rollers 11 in a position just prior to being introduced into the preliminary descaling and straightening device 10. Roller pin 11 forms part of the coil unwinding device 12 which is shown in more detail in FIG. 3. Hot rolled coil 2'' is supported by rotatable conical studs 14 which are loosely supported by frame 13. Thus, hot rolled coil 2'' is loosely turnable. The metal band which is being unwound from coil 2'' rests on loosely supported roller 15 and is firmly gripped between driving rollers 16 which pass the metal band to the descaling and straightening device 10. Unwinding device 12 includes table 17 which is reciprocally movable in vertical direction and which is located underneath coil 2''. Table 17 extends towards coil opener 4 and is provided with hydraulic means 18 for effecting the vertical movement of table 17. The portion of table 17 which is located underneath coil 2'' is trough-shaped and formed with turnable supporting rollers 18, and with an upwardly extending end portion or barrier 20.

The metal band, upon introduction into the descaling device 21, will be subjected to severe bending in upward and then in downward direction so that the band is forced to move along an S-shaped path. Additional rollers are provided (not shown in the schematic drawing) which force the metal band along this path. The rollers of the straightening portion 22 are driven so as to cause movement of the metal band along the preparatory track.

The band leaving straightening portion 22, while moving towards welding device 23, passes over roller table 24, 25 and 26 and the two cutting devices 27 and 28 which serve for cutting off the tongue-shaped front and end portion of the unwound coil. The length of the thus cut off band portion is so chosen that the remaining portion of the band will be free of the defects which are characteristic for the coil end portions. According to FIG. 1*a*, the then remaining front end portion of the metal band from coil 2' reaches into welding device 23 into close proximity with the rear end portion of the preceding metal band 30. The two metal band end portions located in welding device 23 are gripped by the two pairs of jaws 31 and 32 which are attached to the secondary winding of a welding current transformer 33. The rear end portion of the preceding metal band is supported by roller tables 34 and 35 and passes between the same through the trimming device 36. Trimming device 36 is provided with two horizontally acting shearing means 37 for shearing-off of the protruding upper and lower portions of the welding seam, the forward movement of the steel band is temporarily stopped. The shearing tool then is moved transverse to the longitudinal extension of the band. Forward movement of the band is resumed after completion of the shearing operation, actuated by driving means 38 which include a driven pair of rollers 39. During the initial stages of coiling the thus welded elongated metal band, the same will be supported by a roller table 40.

Preparatory track 3 terminates in a coil forming device 41. As illustrated, intermediary coil 42' is shown in the stage of being wound. Intermediate coil 42' is supported in coil forming device 41 in a manner similar to the supporting of coil 2' according to FIG. 3. However coiling device 41, contrary to unwinding device 12, includes a cylindrical shaft, supported and driven at one end, in place of conical studs 14 of unwinding device 12. The cyindrical shaft is formed with a longitudinally extending slot into which the bent front end portion of the steel band is inserted in a manner similar to the insertion of a film end portion into the slot of a spool of a photographic camera. Bending rolls (not illustrated) are arranged in contact with the metal band shortly before the same is wound about studs 14 of coiling device 41 in order to prebend the metal band so that the individual windings of the coil will remain prestressed in contact with each other when the finished coil 42' is removed from coiling device 41. Underneath the intermediate coil 42, a table 43 is arranged as an upwardly and downwardly movable platform and provided with hydraulic lifting means 46. The illustration of the coil winding device is to serve only as a schematic illustration of devices of this kind which, per se, are known in the art, although the conventional devices differ in various details from the device discussed hereinabove.

Intermediate coil 42 has been previously formed in the same manner as discussed in connection with intermediate coil 41. Intermediate coil 42 is located in a trough ready for removal from preparatory track 3. Intermediate coil 42, for instance may have a width of 1,500 millimeters, a diameter of about 2,000 millimeters and a weight of about 18,000 kilograms. Intermediate coil 42 is formed from the metal band contained in three hot rolled coils such as coil 2 and, consequently, includes two welding seams. The two end portions of intermediate coil 42 are cleanly cut and thus, intermediate coil 42 does no longer include tongue-shape end portions. The surface of the metal band of coil 42 has been descaled. The number of hot rolled coils 2 which may be welded together to an intermediate coil such as coil 42 depends to some extent on the width and thickness of the metal band. In case of relatively thin and narrow metal bands and consequently a greater length of the band contained in one hot rolled coil such as coil 2, it may suffice to weld only two hot rolled coils 2 together. However, in the case of wider and thicker bands, several hot rolled coils 2, for instance five such coils 2 may be welded together to form one intermediate coil 42.

FIG. 1*b* is a fragmentary illustration of a preparatory track similar to the one illustrated in and discussed with respect to FIG. 1*a*. It is the main purpose of FIG. 1*b* to illustrate that more than one preparatory track 3 may be included in the introduction means of the present invention.

As illustrated in FIGS. 1*a* and 1*b*, the steel band is at rest in the preparatory track means. In operating the device, contact jaws 31 and 32 are now closed and a welding current emanating from transformer 33 passes through the same. In this manner, the adjacent ends of the steel bands are heated to melting temperature and as soon as melting temperature has been reached, the adjacent ends are energetically pushed against each other by means of a driving device (not shown) for contact jaws 31 and 32. Thereby, the thus contacting steel band end portions will be brought into engagement with each other and welded together. The thus formed weld possesses bulging portions extending outwardly on both sides of the welded band. After the weld has cooled, the driving roller pairs 16 and 39, straightening device 22 and coiling device 41 are started so that the bulging portions of the weldment will pass trimming device 36. The band is stopped for a short period of time while being trimmed so as to remove the bulging portions of the weld and then continues its forward movement. During the forward movement of the band, the portion thereof which is in contact with the descaling device 21 will be descaled. The sharp bends of the S-shaped track will cause a large portion of the scale to separate and fall off the band. The residual scale which may remain on the band will be cracked and thus will allow the acid of the pickling bath to penetrate the residual scale portions. The intermediate coil 42' which as illustrated includes already the steel

band from two hot rolled coils 2, will be completed by winding thereon hot rolled coil 2'. After thus completing intermediate coil 42', table 43 will be raised by hydraulic means 44 so as to support coil 42', and the cylindrical shaft of coil winding device 41 will be removed from coil 42', or table 43 with coil 42' supported by the same will be moved laterally so as to withdraw the coil from the shaft. Upon further raising of table 43, the coil will slowly roll about rim 45 and will come to rest in trough 44. The intermediate coil which previously has been located in trough 44 has previously been removed therefrom by a suitable lifting device or crane.

In the meantime, studs 11 of unwinding device 12 have been moved laterally in opposite direction so that the tongue-shaped front end portion of hot rolled coil 2' will drop onto roller 15. The pair of wedges 8 have been previously removed laterally so that no further contact with coil 2' will exist. Thereafter, rollers 5 are actuated for a short period of time in order to introduce the hot rolled coil tongue 9 into the pair of driven rollers 16, which grip the tongue portion 9 and lead the same into the descaling and straightening device 10. Once the tongue portion 9 is located between cutting devices or scissors 27 and 28, the forward movement is stopped. It is now determined in conventional manner up to which point of the tongue portion the same is defective and from which point on the band will be free of pipings, slag inclusions and the like. Should it be found that the point from which on the steel band is of the desired fault-free quality is still located at roller table 24, then the former movement is resumed for a very short period of time until this point at which the tongue is to be cut off is located underneath scissor 27. On the other hand, if this point at which the band is to be cut is found to be located already on roller table 25, then forward movement is resumed until this point of the band is located underneath or within cutting device 28. Should subsequent rechecking show that unexpectedly faulty portions still occur in the new front portion of the steel band which was formed by cutting off of the tongue portion, then cutting device 28 is used for cutting off one or more additional strips of the steel band until a completely satisfactory cut is obtained. Thereafter, the front end of the band is driven to the remaining portion of the preparatory track, bent and inserted into the slot of the shaft of coil winding device 41. Thereafter, the balance of coil 2' with the exception of the rear end tongue portion is quickly passed through the preparatory track and wound into the core portion of the intermediary coil in coil winding device 41. Thereafter rollers 5, are firmly braked in order to achieve that the residue of coil 2' will roll from rollers 5, over the left one of rollers 5, onto table 17 and into the trough formed by rollers 19 thereon. The rim portion 20 of table 17 prevents further rolling of coil 2'. Simultaneously, hydraulic device 18 is operated to raise table 17 on which the coil has already started to rotate, until the center of the coil is sufficiently high to allow insertion of studs 14, as illustrated in FIG. 3. Once coil 2' has reached the position which in FIG. 1*a* is occupied by coil 2'', and is fully supported by studs 14, table 17 is again moved downwardly out of contact with the coil. In order to assure continuity of the operation, simultaneously coil 2 is raised and introduced into the coil opening device, into the position which in FIG. 1*a* is occupied by coil 2'. Thus coil 2 will then be supported by rollers 5 and rollers 5 will force the tongue shaped front end portion of the steel band of coil 2 into the opening device. In other words, wedges 8 will now operate to unwind the steel band from the coil. The front end of the newly unwound coil will now rest on rollers 11 and will remain there until the previously unwound coil has been completely unwound. Now, conical studs 14 and roller studs 11 are laterally moved apart. Tongue portion 9 drops to roller 15 and passes into the descaling and straightening device 10 as has been described further above. The preparatory track is immobilized prior to repeating the operation of devices 4 and 12 in connection with the subsequent coil. As described further above, cutting devices 27 and 28 are used once or several times, until the cut surface is free of any faults. Finally, the rear end portion of the preceding band is firmly gripped by jaws 32 and remains therein until, as described further above, the front end portion 29 of the subsequent steel band reaches the pair of jaws 31. Now, the adjacent end portions in jaws 31 and 32 are welded together and the band moves on to removal of the abutting portions of the weldment and further to being coiled as part of an intermediate coil such as coil 42'. The steel band of additional coils 2 is similarly opened, unwound, descaled, and welded onto the rear end of the preceding steel band, as has been fully described above.

Intermediate coils 42 once they have been completed, i.e. once they have reached the desired weight, are transported by conventional means in the direction of arrows 50 and are stored in an intermediate storage device 51 (FIG. 1*c*).

Referring now to FIG. 2, it will be seen that intermediate coils 42 coming from intermediate storage means 51 are placed on a roller track 52, preparatory to being introduced into the feeding track means which start with a coil opener 54 corresponding to the coil opener 4 of FIG. 1*a*. Similarly, unwinding device 55 corresponds to unwinding device 12 of FIG. 1*a*. After unwinding device 55, follows straightening device 56. Descaling means need not, but may, be included in the feeding track means. Such descaling means, generally are included when the feeding track is destined not only for feeding intermediary coils to the pickling device, but is also to be capable of the feeding hot rolled coils such as coil 2. However, the feeding track does not include a welding device. This is essential, because the advantages of the present invention can be achieved only when the feeding of the metal band to the pickling device can be carried out without the interruption or reduction in speed which would be caused by the inclusion of a welding device in the feeding track means. Roller table 57 leads to a mechanical stitcher 58, the operation of which will be described further below. Replacement of the stitching device with a spot welding apparatus is not desirable because such spot welding apparatus is incapable to unite or temporarily adhere end portions of the steel bands to each other with a speed comparable to the speed of operation of the stitching machine. A further roller table 59 leads to a driving device 60 which corresponds to driving device 38 of FIG. 1*a*. Then follows loop pit 61 of relatively small dimension. The steel band then passes from loop pit 61 through driving device 62 and from there into the pickling device (not shown).

FIG. 2 illustrates the device while the steel band is wound off coil 42'', however, it is to be noted that at this point, when the unwinding starts and the stitched portion 64 is still in the introductory track, the loop 63 actually would not yet have been formed or at least would not yet have been developed to its full size. However, loop 63 is shown in its full size as it exists shortly prior to operation of the stitching device for stitching together the rear end portion of coil 42'' and the front end portion of coil 42'. Loop 63 need not reach its full development until shortly before the actual stitching and thus stopping of the forward movement of the steel band takes place. Development of loop 63 is controlled in a simple and automatic manner by arranging a forward movement of the steel band in driving means 60 at a somewhat greater speed than forward movement of the steel band in driving means 62.

As soon as coil 42'' has been completely unwound, conical studs 14 and roller studs 11 are laterally separated so that the front end 65 of opened coil 42' will drop onto rollers 15, driven by rollers 5, front end 65 will follow the rear end of coil 42' which is just disappearing in straightening device 56. The two adjacent steel band

end portions and thus the entire feeding track will be quickly stopped while the driving means **62** continue to move the steel band with full and unchanged speed. By means of auxiliary devices which are conventional and not shown in the drawing, upon stopping of the feeding track, the adjacent ends of the two steel bands which are to be connected will be located in overlapping position in stitching device **58** underneath the two pairs of punching devices **66** which are now operated immediately, so as to connect the overlapping steel band end portions.

Immediately after completion of stitching, the feeding device is started again, first by operating only driving means **60** and after a short delay also by operating straightening device **56**. The delay between the starting of driving means **60** and of the straightening device **56** serves to create tension in the stitched portion which is necessary for completing the stitching, as will be more fully described below. Roller pair **39** will allow the punched portions to pass therethrough, however during such passage, the outwardly extending punched portions will be rolled flat and thus stitching will be completed. The entire period during which the feeding device is to be stopped for the purpose of stitching adjacent band end portions to each other, amounts only to about 10 seconds. Assuming that during such stitching the forward speed of the steel band passing through driving means **62** remains at 150 meters per minute, it thus is necessary prior to stopping the feeding device to introduce a loop into loop pit **61** which must be sufficient to allow driving means **62** to withdraw 25 meters before the again moving driving means **60**, etc., will again supply subsequent portions of the steel band.

At the front end of feeding track **53**, additional coils replace unwound coil **42'** or **42''** in a manner similar as described in connection with coils **2**, **2'** and **2''** in FIG. 1*a*. Coil **42'** rolls under the force of the withdrawing steel band onto table **17** and comes to rest in trough **19**, is raised by raising table **17** and is then held by introduction of conical studs **14**. The space which thus has been freed in coil opening device **54** is then occupied by coil **42**, and the front end of opened coil **42** (now in the position of coil **42'**) is resting on rollers **11** until coil **42''** has been completed unrolled.

After passing through driving means **62**, the steel band enters a conventional pickling device and passes from there in conventional manner through a cutting device and then onto a coil winding apparatus. The coil winding apparatus serves to wind coils of such dimensions as are used for introduction into the cold rolling mill, i.e. for winding coils of dimensions similar to those of intermediate coils **42**. The cutting device which is arranged after the pickling device will cut off from the continuous band, the stitched portions which were formed in apparatus **58**. The rear end portion of the thus cut and pickled band forms now the front end of the respective cold rolling mill coil.

FIG. 4 is a perspective view of the stitched seam **64** of FIG. 2. The band end portions **70** and **71** overlap each other and the stitching is formed by two rows of stitched portions **72**. The two pairs of punching devices **66** of stitcher **58** cut simultaneously in known manner into the two superposed band ends so that all stitching portions **72**, each having the form of a spoon, will be formed at the same time. The punched portions extend downwardly and are not cut off. After the punching device has been removed, the punched portions have a configuration as illustrated in FIG. 7. By placing the band under tension, punched portion **73** will be separated from punched portion **74** by the distance *a* as shown in FIG. 5, and will come in contact with the edge **75** of band end portion **71**, thereby forming a locking connection. While passing through driving means **60** of FIG. 2 and being exposed to the pressure of yielding rollers **39**, the free ends of the spoon-shaped portions **73** and **74** will be flattened and, thereby, the stitched seam is secured against separation of the bands in the direction opposite to that of arrow **76**, as shown more fully in FIG. 6. The load carrying active traction corresponds to the direction of arrow **76**.

It is of course not required that two preparatory tracks are always coordinated with one feeding track. For instance a 50% improvement in the yield of the pickling device can be achieved already by combining two feeding tracks and thus two pickling devices with three preparatory tracks, so that one and one-half preparatory tracks are available for supplying steel band to one pickling device.

Certain advantages of the arrangement according to the present invention have been described further above in paragraphs *a*, *b* and *c*. With respect to these advantages, and with particular reference to the drawings and to the detailed description above, it is also important to note that (with reference to *a*) the welded portions interfered with the cold rolling of welded coils. The otherwise unchanged cold rolling speed of between 1,000 and 1,500 meters per minute had to be reduced in the final passes of the cold rolling mill to about 300 meters per minute whenever a welded portion reached such final passes. The area of the weld or of the welded portion, measured at the finished cold rolled band includes about 30 meters of the length of the band. This area generally was of imperfect structure due to the failure of carrying out the material control and inspection immediately before the welding of the hot rolled coils. Thus, this area had to be cold rolled at reduced speed in order to avoid tearing of the band. Furthermore, this area had to be cut out of the finished cold rolled band due to its inferior characteristics. Furthermore, it was necessary up to now to cut out of the cold rolled band those areas which were damaged by sharp bends in the prior art loop pit in which a great number of loops were superposed upon each other. According to the present invention, these difficulties and band imperfections are overcome since no sharp bending of the band takes place in the loop pit according to the present invention and since the welding seam and the band end portions in the vicinity of the welding seam can be produced with such a degree of faultlessness, that it is no longer necessary to carry out special precautions when passing these weld seam portions of the steel band through the cold rolling mill. Consequently, in accordance with the present invention, it is possible to cold roll the pickled intermediate coils at full and even speed such as a speed of between 1,000 and 1,500 meters per minute.

With respect to *b* above, it is important to note that the conventional pickling devices for wide steel bands are arranged in such a manner that the same can be operated at an average speed of considerably more than 150 meters per minute. However, due to the limited storage space in the loop pit on the one hand and also because it is desirable to pass the steel band at an even speed through the pickling device, it was not possible up until now to use the pickling devices to their full capacity. It has been tried to reduce the time required for welding of the steel band and thus the time of stoppage of the band which has to be taken up by the loop pit. However, any substantial reduction in the welding time resulted in inferior quality of the weld seam. According to the present invention, these difficulties are overcome, the welding and inspection can be carried out as slowly and carefully as desired, and nevertheless, it is possible to operate the pickling device at a constant even speed of passage of the steel band which without difficulties may reach for instance 300 meters per minute. 300 meters per minute, however, corresponds to the speed with which modern cold rolling mills in tandem arrangement receive the steel band. Consequently, by utilizing the present invention, the cold rolling mill may be arranged immediately after the pickling device without requiring an intermediate winding of the pickled steel band into cold rolling mill coils.

With respect to *c*, reference is made to the statement hereinabove, that constant pickling speeds of about 300 meters per minute can be easily obtained in accordance with the present invention. Assuming that the average speed of passage of the band is increased only from 150 meters per minute to 250 meters per minute, this would already represent an increase in capacity of about 70%. Compared therewith, the additional costs of the arrangement of the present invention which includes preparatory tracks and a feeding track, are only between 10 and 20% higher than those of conventional installations.

Theoretically, advantages more or less similar to those described above could be achieved if it were possible to produce very heavy coils of steel band for cold rolling of the same without having to weld relatively smaller hot rolled bands to each other. Such heavy cold rolling mill coils are not available. It has been tried to produce such heavy cold rolling mill coils and attempts have been made to produce correspondingly constructed hot rolling mills. However, even if such attempts should eventually be successful, they would still be limited in their application since it is not possible to produce from unkilned deep drawing steels ingots of such great weight as would be required for operation of such hot rolling mills capable of producing hot rolled coils of a size commensurate to the size of the coils which are to be received by the cold rolling mill. Thus, whenever unkilned deep drawing steels are used for forming wide steel bands, it will be necessary to combine several relatively short hot rolled coils by welding into coils of a size adapted to be introduced into the cold rolling mill. Presently, wide steel bands, hot and subsequently cold rolled of unkilned deep drawing steel, represent about 40% of the total consumption of such steel bands. Irrespective of the size of hot rolled coils which future hot rolling mills may be capable to produce, the advantages of the present invention will remain unimpaired with respect to the portion of the entire production of wide steel bands which will continue to be based on ingots of unkilned deep drawing steel.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pickling arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in devices for preparation of hot rolled metal coils for subsequent pickling of the same, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptions should and are intended to be comprehended within the means and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including preparatory track means comprising means for unrolling hot rolled metal coils and for welding adjacent end portions of successive unrolled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for temporarily adhering adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, and for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

2. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including preparatory track means comprising means for unrolling hot rolled metal coils and for welding adjacent end portions of successive unrolled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for temporarily adhering adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, said feeding track means also including means for taking up the slack in forward speed of the unrolled intermediate coils caused by temporarily adhering the same to each other, and means for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

3. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including preparatory track means comprising means for unrolling hot rolled metal coils, means for descaling the thus unrolled metal coils and means for welding adjacent end portions of successive unrolled descaled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for temporarily adhering adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, said feeding track means also including means for taking up the slack in forward speed of the unrolled intermediate coils caused by temporarily adhering the same to each other, and means for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

4. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including preparatory track means comprising means for unrolling hot rolled metal coils, means for descaling the thus unrolled metal coils and means for welding adjacent end portions of successive unrolled descaled hot rolled metal coils to each

other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including inspection means including means for cutting off and removing faulty metal strip portions after descaling and prior to welding together of said successive unrolled hot rolled metal coils, and winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for temporarily adhering adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, said feeding track means also including means for taking up the slack in forward speed of the unrolled intermediate coils caused by temporarily adhering the same to each other, and means for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

5. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including at least one preparatory track means comprising means for unrolling hot rolled metal coils and for welding adjacent end portions of successive unrolled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for stitching adjacent end portions of successive unrolled intermediate coils to each other so as to form a continuous metal band, and for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

6. In a pickling arrangement for the continuous pickling of wide metal strip, in combination, introduction means for introducing wide metal strip into a pickling device, said introduction means including preparatory track means comprising means for unrolling hot rolled metal coils and for welding adjacent end portions of successive unrolled hot rolled metal coils to each other so as to form of a plurality of hot rolled metal coils an elongated metal band having a length substantially equal to the combined lengths of said plurality of hot rolled metal coils, and also including winding means for winding the thus formed elongated metal band into a single intermediate coil having a weight substantially equal to the combined weight of said plurality of hot rolled metal coils; storage means for sequentially receiving and simultaneously storing a plurality of said intermediate coils; and feeding track means sequentially receiving intermediate coils from said storage means and including means for unrolling said sequentially received intermediate coils and for releasably locking together adjacent end portions of successive unrolled intermediate coils so as to form a continuous metal band, and for continuously feeding said continuous metal band at a substantially even speed into said pickling device.

7. A pickling arrangement as defined in claim 6 wherein said means for releasably locking together end portions of successive unrolled intermediate coils include a stitching device adapted to form simultaneously two rows of interlocked portions in the superposed adjacent end portions of said successive unrolled intermediate coils.

8. A pickling arrangement as defined in claim 7 wherein said means for releasably locking together end portions of successive unrolled intermediate coils include moving means for moving said stitching device during operation of the same from a first position in the direction and with the speed of movement of said unrolled intermediate coils, and for thereafter returning said stitching device to said first position.

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