May 24, 1960 J. C. BONGIOVANNI 2,937,431

METHOD AND MECHANISM FOR PROCESSING ELONGATED METAL ARTICLES

Filed June 7, 1955 4 Sheets-Sheet 1

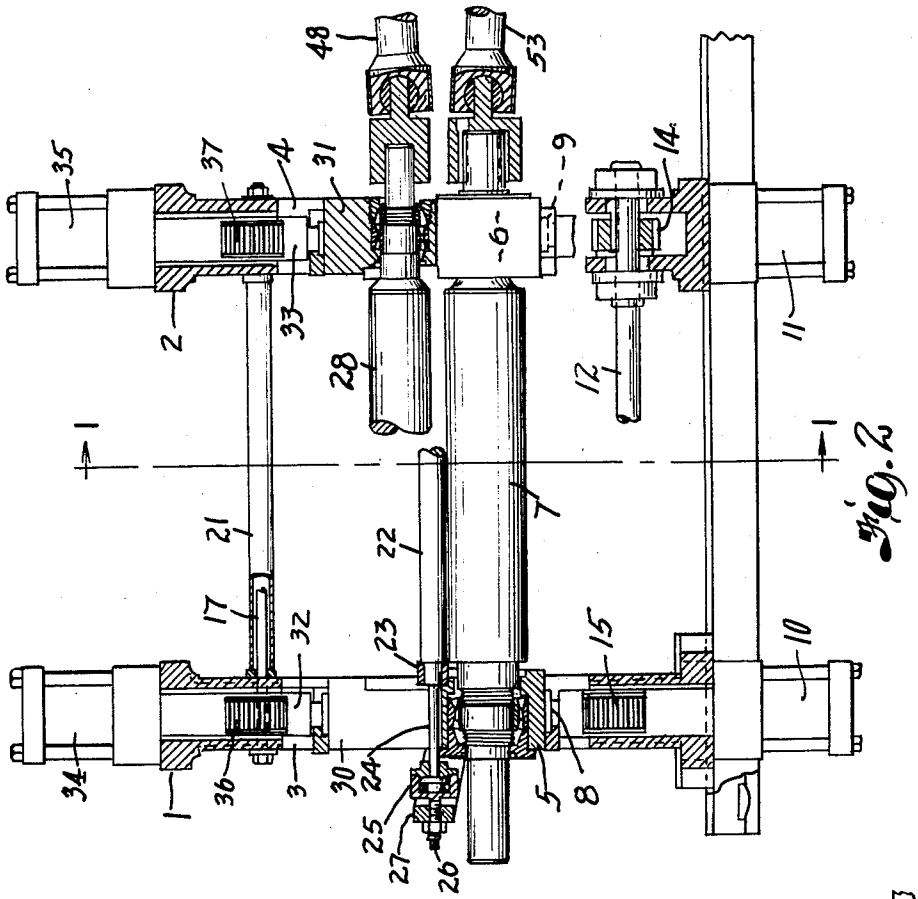


Fig. 2

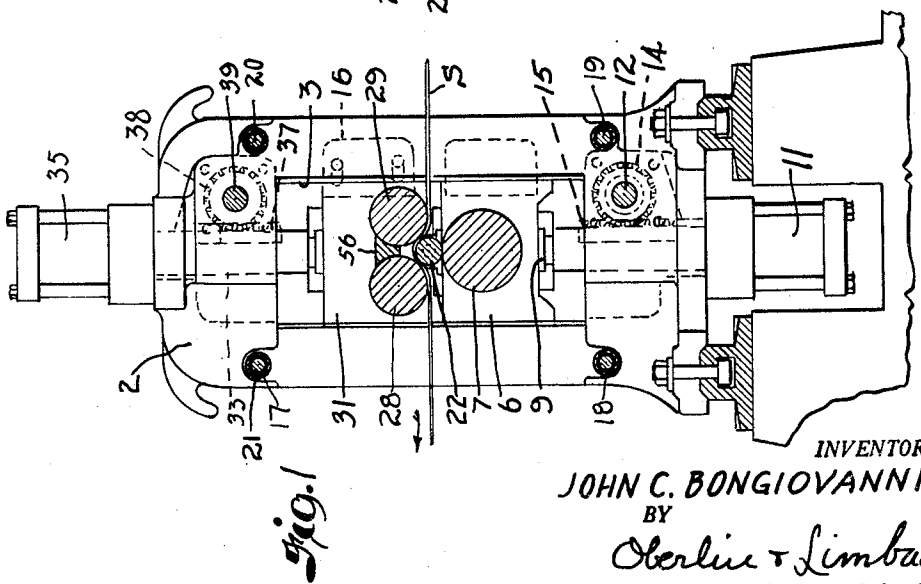


Fig. 1

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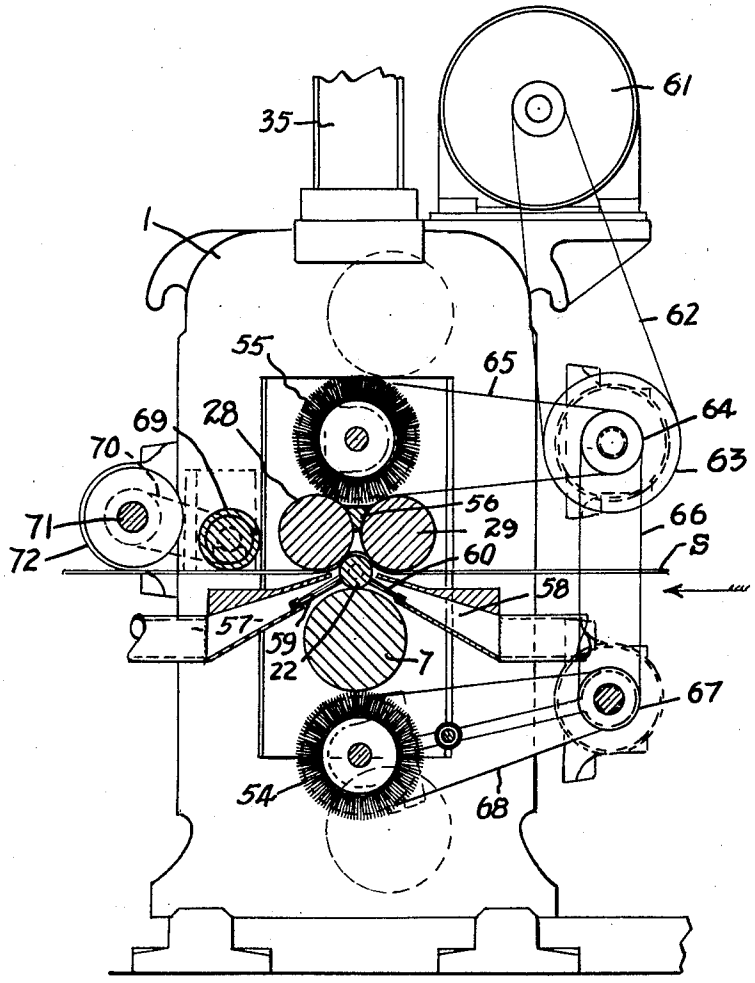


Fig. 3

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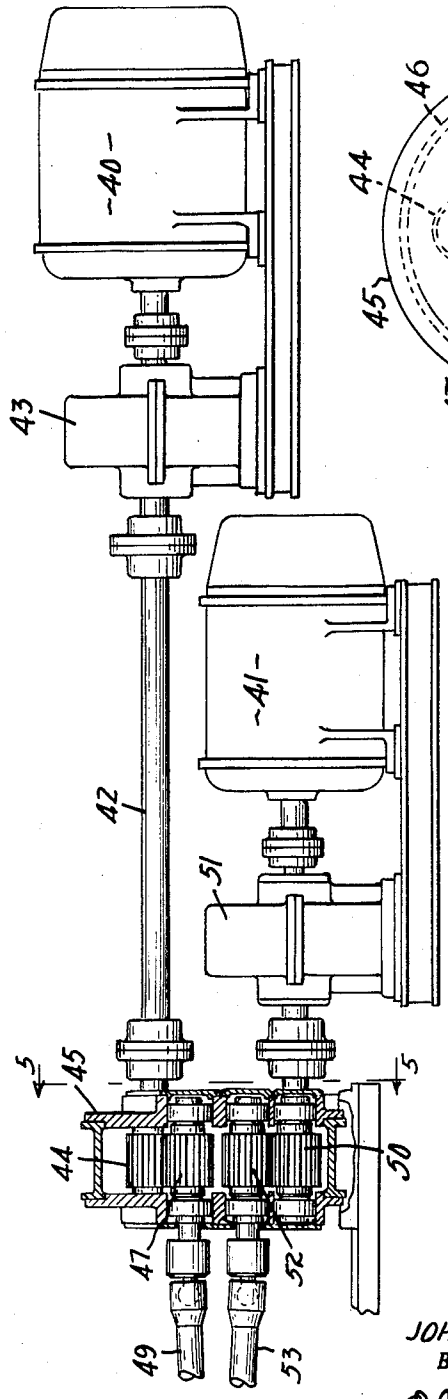


Fig. 4

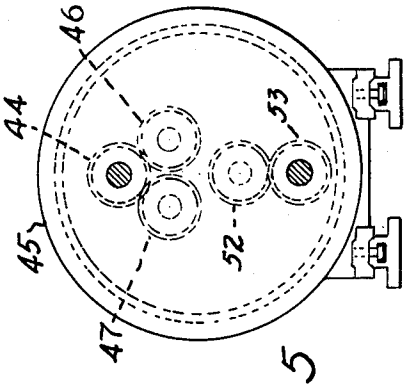


Fig. 5

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METHOD AND MECHANISM FOR PROCESSING ELONGATED METAL ARTICLES

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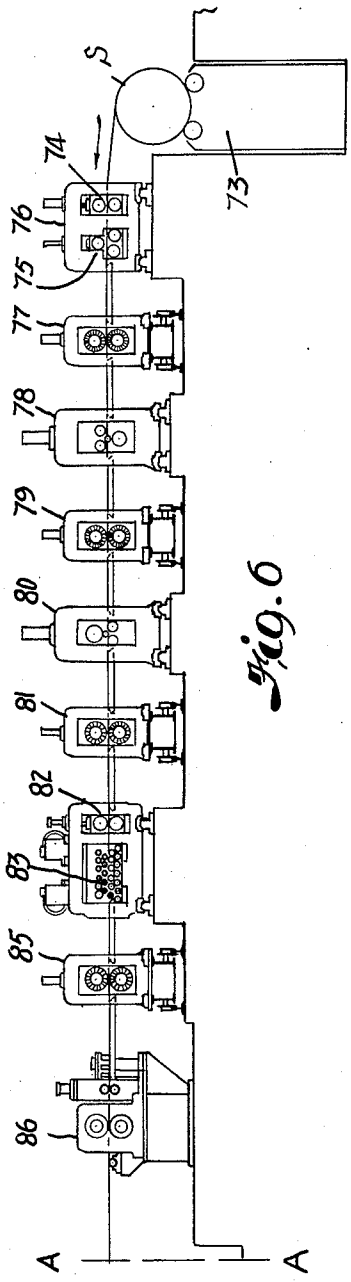


Fig. 6

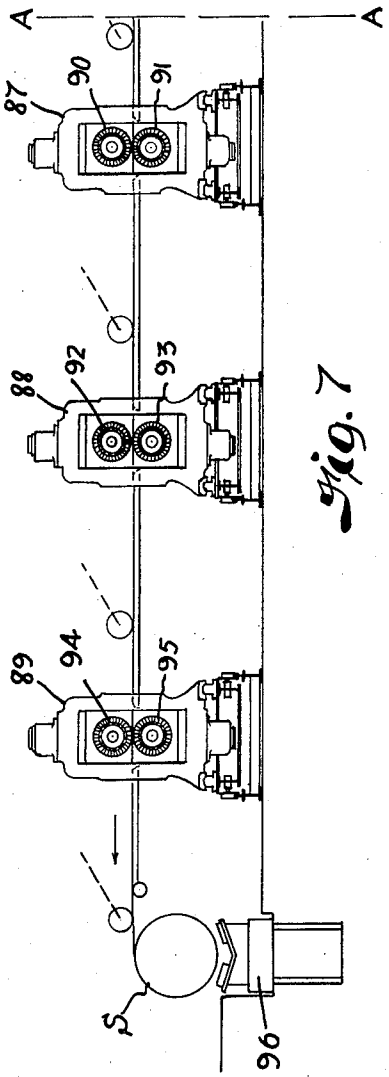


Fig. 7

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United States Patent Office 2,937,431 Patented May 24, 1960

2,937,431

METHOD AND MECHANISM FOR PROCESSING ELONGATED METAL ARTICLES

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Filed June 7, 1955, Ser. No. 513,641

14 Claims. (Cl. 29—81)

This invention relates as indicated to a novel method and mechanism for processing elongated metal articles, and more particularly to a method of regularizing and surface beneficiating steel strip, sheet and the like.

The steel industry with its present hot rolling practice is confronted with a difficult problem of scale removal from the hot rolled steel before the latter can be further cold rolled or processed. Such scale or oxide on the usual low carbon hot rolled steel comprises three principal layers. The layer next to the steel is chiefly FeO or mixture of Fe and Fe_3O_4; the outer layer is composed chiefly of Fe_2O_3; and the intermediate layer which is relatively thick and not usually substanitally attacked by sulphuric acid during pickling is composed chiefly of Fe_3O_4. The scale as a whole, however, after fracturing is not impervious to acid, and the present conventional practice for removing scale from hot rolled steel strip, rod and the like is pickling in sulphuric acid which is effective to penetrate to the parent metal underlying the oxide layers. It has long been recognized that such pickling operations are expensive, time- and space-consuming, and wasteful of materials. With the increasing strictness of anti-pollution laws, there is also increasing difficulty in disposing of the spent liquor.

Numerous efforts have been made in the past to remove scale by other methods including shot blasting and by power brushing. In Pecsok Patent 2,335,196 there is disclosed a method of scale removal wherein the steel strip is first passed between breaker rolls and subjected to a strong water spray before passing in engagement with power driven rotary brushes adapted to engage each side of the strip. This and certain other methods have been found effective to a degree in the removal of oxide scale from steel but the practical difficulty has resided in the fact that any method of scale removal to be adopted as regular steel mill practice, eliminating employment of pickling tanks entirely, must be substantially 100% reliable. In other words, it is not sufficient that a substitute method will remove a very large proportion of the scale or even all of the scale in certain special cases. Before the enormous advantages to be derived from elimination of the pickling process are to be realized, it is essential that the new mode of treatment be at least equally reliable in the removal of the scale. Power brushing represents an extremely attractive mechanical operation for employment in a scale removal line inasmuch as such brushing operation, when properly controlled and regulated, may also be utilized to beneficiate the metal surface in other respects and thereby afford a superior product. In order for such brushes to be fully effective in scale removal, however, it is necessary that means be provided effective preliminarily to fracture, loosen and otherwise prepare the scale for complete removal by the brush or brushes. The employment of scale breakers as suggested in the aforesaid Pecsok Patent 2,335,196 is obvious for such purpose, but unfortunately those previously known and used in steel mills have not proven fully adequate for the purpose. It is accordingly a principal object of my invention to provide novel mechanical means for flexing hot rolled steel strip and the like in a manner effective to prepare the same for complete removal of oxide scale therefrom by the subsequent action of properly selected and arranged power driven rotary brushes.

A further object is to provide a novel roll stand for flexing the work about a relatively small radius, the rolls being mounted, driven and continuously acted upon in a manner to maintain their uniformly effective cooperative action on the strip.

Still another object is to provide such method and mechanism whereby the scale being fractured is subjected both to tension and to compression strains.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 is an end elevational view of a roll stand incorporating mechanism embodying my new invention;

Fig. 2 is a longitudinal section through such stand with portions of the mechanism further broken away better to illustrate the manner of assembly;

Fig. 3 is a transverse sectional view through the rolls of such stand and illustrating auxiliary brush means acting upon the several rolls to prevent build-up of scale particles thereon;

Fig. 4 is a side elevational view of the roll drive mechanism;

Fig. 5 is an end elevational view of the pinion stand of such mechanism; and

Figs. 6 and 7 show in semi-diagrammatic manner the passage of a length of strip through a scale removal line utilizing the scale fracturing means of the present invention.

Referring now more particularly to said drawing and especially Figs. 1–5 thereof, a metal processing mechanism embodying the principles of my invention is there illustrated comprising two spaced stands **1** and **2** having windows **3** and **4** therein within which are mounted slides **5** and **6** respectively journaling a large lower back-up roll **7**. Such slides or bearing blocks **5** and **6** are carried by the pistons **8** and **9** of double-acting hydraulic cylinders **10** and **11**, such reciprocation of the bearing blocks being synchronized through the action of torsion bar **12** having pinions **13** and **14** keyed thereto and engaging racks such as **15** on such pistons. Roll **7**, as well as the rolls described below, may be of SAE–52110 hardened alloy steel, for example, mounted in totally enclosed bearings provided with grease lubrication and having neoprene or equivalent grease seals. Keeper plates such as **16** retain the bearing blocks or slides in place and may be shifted to permit endwise removal of such bearings and associated rolls when required.

Four tie rods **17**, **18**, **19** and **20** connect the two stands **1** and **2** under tension, such tie rods being enclosed within tubular spacer members such as **21**.

A small diameter work roll **22** is mounted to rest upon the upper surface of lower back-up roll **7**, the ends of such work roll being journaled in bronze bearings such as **23** fitting in recesses in the upper surfaces of main slides or bearing mounts **5** and **6** whereby a degree of vertical movement of such work roll relative to back-up roll **7** may be obtained. The respective ends of the work roll are engaged by thrust bearings such as **24** terminating in outer housings **25**. Screws such as **26** threaded in brackets

or bridges 27 carried on slides 5 and 6 are adjustable to shift such thrust bearings properly to locate work roll 22. It will accordingly be apparent that such work roll is precisely positioned axially but is mounted to float vertically. Roll 22 has no drive of its own and is rotated only through its engagement with back-up roll 7 and the travel of the work as later described.

A pair of upper work rolls 28 and 29 are journaled in upper slides or bearing blocks 30 and 31 adapted to be reciprocated vertically within windows or slideways 3 and 4 respectively. Such slides or bearing blocks are carried by pistons 32 and 33 respectively, adapted to be reciprocated by double-acting cylinders 34 and 35, synchronism of such reciprocation being assured by racks 36 and 37 on such pistons adapted to engage pinions such as 38 on a pinion shaft 39 journaled in the respective stands in the same manner as pinion shaft 12. It is accordingly obvious that through reciprocation of bearing slides 30 and 31, rolls 28 and 29 may be forced downwardly toward work roll 22, the latter being supported by large back-up roll 7. Work rolls 28 and 29 are much larger than work roll 22 and are asymmetrically disposed relative to the latter with the axes of rolls 28 and 29 lying in a horizontal plane. As shown in Figs. 1 and 3, the work such as steel strip S is threaded between lower work roll 22 and upper work rolls 28 and 29, the latter being operative to enforce conformance of such strip to a portion of the arcuate surface of small roll 22.

Referring now more especially to Figs. 4 and 5 of the drawing, it will be seen that upper work rolls 28 and 29 are driven in unison from electric motor 40 whereas lower back-up roll 7 is independently driven from electric motor 41. Motor 40 drives shaft 42 through gear reduction unit 43, and such shaft drives upper pinion 44 in pinion stand 45. Such pinion in turn engages and drives pinions 46 and 47 which drives shafts 48 and 49 coupled to rolls 28 and 29 respectively. Motor 41 drives lower pinion 50 through gear reduction unit 51, and such pinion in turn drives pinion 52 and shaft 53 coupled to lower back-up roll 7. It is accordingly possible to vary the rotation of roll 7 relative to that of rolls 28 and 29.

In order to prevent the build-up of scale particles on the several rolls, I provide a cylindrical power driven rotary brush 54 mounted to engage the underside of back-up roll 7 and a similar brush 55 mounted to engage the upper surfaces of rolls 28 and 29. A bronze bar 56 is interposed between the upper portions of rolls 28 and 29 shaped to conform to the arcuate surfaces of the same and also to the outer peripheral surface of brush 55. Such bar is recessed sufficiently to permit brush 55 to engage rolls 28 and 29 but is effective substantially to prevent scale particles dislodged by the brush from dropping downwardly between rolls 28 and 29 onto the upper surface of strip S. It will preferably be firmly secured to the end slides to serve an additional purpose as explained below.

Suction nozzles 57 and 58 extending the length of work roll 22 are interposed between roll 28 and roll 7, and between roll 29 and roll 7 respectively to remove scale particles from the surface of roll 22. Lengths of brush strip 59 and 60 mounted in such nozzles and engaging roll 22 assist further in cleaning the roll and reducing transfer of such particles from roll 22 to back-up roll 7.

Rotary brush 55 is driven from electric motor 61 through belt 62, pulley 63, pulley 64 and belt 65. Brush 54 is similarly driven through an extension of such drive means including belt 66, pulley 67 and belt 68. Brushes 54 and 55 may desirably be carried on swinging arms (not shown) to permit their being conveniently swung out of the way when it is desired to inspect the rolls, etc.

I very much prefer that two roll stands of the type described above be employed in sequence to process the traveling strip, the rolls of the second stand being inverted relative to the rolls of the first stand so that the work will be flexed in the opposite direction. A dancing roll 69 may be carried by pivotally mounted arms 70 keyed to shaft 71 connected to hydromotor 72 whereby a selected rotative force may be applied to such shaft in a clockwise direction as viewed in Fig. 3 to force roll 69 downwardly upon the upper surface of the strip S. Such roll 69 is effective largely to eliminate the upward curling tendency of the strip as it leaves the stand and consequently to assist threading of the strip through the next stand which, as above indicated, will ordinarily preferably include an identical roll assembly which is, however, inverted relative to that of the first stand. When the strip has been threaded through the line, it is ordinarily unnecessary thereafter to maintain downward pressure on the dancing roll 69.

In Figs. 6 and 7 I show a continuous strip processing line incorporating my new roll stand and effective both to remove scale from the traveling metal strip and also to surface beneficiate the same. The metal strip S is taken from the coil resting on uncoiler 73, and the leading end of the strip is first threaded between pinch rolls 74 and feeder rolls 75 in stand 76, whence it passes between power driven cylindrical rotary brushes in duster stand 77 to remove any loose scale, dirt, etc., on the upper and lower surfaces of the strip. The strip is next conducted through a stand 78 of the type illustrated in Figs. 1 and 3 and described above, between upper and lower power driven rotary brushes in duster stand 79, and then through a second roll stand 80 similar to stand 78 except that the arrangement of the rolls therein is inverted to flex the strip in the opposite direction. After passing through another duster stand 81 to remove any loose particles adhering to the surface of the strip, the latter passes between pinch rolls 82 and then between the rolls of a leveler (which may, for example, have 11 rolls engaging the work) before passing through another duster stand 85 and slitter 86. The slit strip may thereafter be conducted through power brushing stands 87, 88 and 89 of the type disclosed in co-pending application Serial No. 491,992 of Ruben O. Peterson filed March 3, 1955, entitled, "Reciprocating Surface-Finishing Mechanism and Method." The brushes 90, 91, 92, 93, 94 and 95 of such latter stands are effective to remove burs from the slit strip edges and to surface beneficiate such strip so that when wound on coiler 96 the strip will have been completely de-scaled, cleaned, slit and finished in a single continuous line.

My new strip flexing and working apparatus is of particular utility in preparing low carbon and alloy steel strip for further treatment by high speed power driven rotary brushes. The strip will ordinarily be caused to travel at a speed of from 30 to 200 feet per minute and the scale removal brushes may be driven at about 8300 surface feet per minute, for example. Hard crimped steel wire brush bristle material will usually be employed for this purpose, wire of .0118 inch diameter being suitable. Granular abrasive may be fed to the brushes either externally or internally as described in Peterson Patent 2,680,938, for example. The use of such abrasive, e.g. "Aloxite" (aluminum oxide), "Carborundum," and the like, is especially advantageous when brushing titanium strip which tends to adsorb hydrogen, nitrogen and oxygen during its formation to produce a hard superficial layer desirably removed by my new treatment. Aluminum and high carbon steel strip also often may be much improved by such treatment.

The brush stands 87, 88 and 89 will desirably be mounted on rails for reciprocation transversely of the path of travel of the strip being treated, and the brushes utilized will be at least slightly longer than the width of the widest strip to be handled by the line. The reciprocation of the brush supporting carriages will be regulated to cause the ends of each brush closely to approach the corresponding side edges of the strip being brushed at the inner limits of such reciprocation. Some or all of such brush stands may desirably be disposed at angles to the path of travel of the work and also at angles to

each other so that each area of the work surface will be power brushed in at least three different directions. This arrangement considerably enhances the effectiveness of the brushing operation and affords a superior finish with pits and other minor surface irregularities blended and smoothed. The diagonal placement of the power driven rotary brushes is also helpful and effective in removing edge burs produced by a slitting operation and in blending the sharp surface junctures at such edges to form desirably rounded corners.

In some cases, the brushes **90**, **91**, **92**, **93**, **94** and **95** may be driven at high speeds of rotation on the order of about 6,000 or even 9,000 surface feet per minute, whereas reciprocation of the brush supporting carriages transversely of the path of travel of the strip is so slow as to be wholly inconsequential insofar as any modification of the brushing action is concerned. Such reciprocation may, for example, be at the rate of only three complete return reciprocations per minute although such reciprocation may also be at a somewhat greater rate if desired, without appreciably affecting the action of the brush bristles upon the work.

Various types of brush drive means may be utilized, including fluid motors, and it will be desirable periodically to reverse the direction of rotation of the brushes to maintain the sharpness of the bristle ends. The brush bristle material employed will ordinarily be relatively hard crimped steel wire which may, for example, have a thin coating of nylon or other plastic thereon, and unless extremely hard wire is employed the bristle ends tend to become rounded and dulled on the sides first engaging the work, considerably reducing their effectiveness. This difficulty may be substantially avoided by periodically reversing the direction of rotation of the brushes, and for this reason the drive means may desirably be reversible electric motors or fluid motors as above indicated. If a sufficient number of brushing stands are utilized, the brushes of one stand at a time may be temporarily retracted out of contact with the work in order that they may be stopped and their direction of rotation thus reversed. Also, the brushes of an extra stand which have last been driven in one direction and have since been retracted from contact with the work may now be brought into operation again in the opposite direction to replace brushes of another stand due to be retracted and reversed, the newly retracted brushes becoming extras for similar subsequent employment. In some cases, however, it is quite satisfactory thus to reverse the rotation of the brushes while still in contact with the work or with contact pressure slightly reduced inasmuch as this can be achieved in a very short period of time. It is also often feasible to time such brush reversal in synchronism with changes in speed of travel of the work and the passage of strip ends, for example.

The apparatus and method described above have numerous advantages over conventional pickling methods ordinarily employed in the removal of scale from strip and the like including the fact that there is little or no loss of virgin metal by brushing as compared with from ½% to as much as 2% metal loss often experienced during pickling. A brushing line of the general type illustrated and described will ordinarily occupy somewhat less than one-half the space required by a pickling line. The pickling acid fumes are highly corrosive in the building and associated equipment and also make for unhealthful working conditions. Whereas the brushing line may be continuously maintained with only very brief periods of down time, a pickling line must periodically be completely shut down for relatively long periods to permit substantial replacements and repairs. The cost of the pickling acids, commonly sulphuric acid, has in the past fluctuated considerably more than has been the case with suitable brushing materials. Not only is the supply of sulphuric acid sometimes a problem, but also

the large quantities of water necessary are becoming steadily more difficult to obtain, especially reasonably clean water which will not leave objectionable residues. Whereas the waste disposal problem of a pickling line is serious and becoming steadily more so due to the imposition of anti-pollution laws, the scale removed by a brushing line is easily salvaged and becomes a valuable source of powdered metal for use in powder metallurgy. It is also useful as an abrasive and as a chemical. The installation cost of a scale removal line of the general type disclosed herein may be as low as approximately one-third that of a continuous pickling line having the same production capacity.

Not only are there very important operating advantages arising from the employment of my new apparatus and process, but also the finished work is much superior to that obtainable from a conventional pickling line. More particularly, the brushing action, properly controlled, serves to beneficiate the metal surface by removal of minute splinters, the blending of sharp edges of pits, other surface irregularities and strip margins, and the production of a very clean, dry finish which does not tend to rust quickly. Despite the washing steps employed after acid pickling, it is not practical to remove all minute traces of acid, salts and water-borne dirt from the metal surface, and consequently the pickled surface is not clean and is highly susceptible to rusting. The pickling process actually tends to produce and accentuate objectionable pits in the surface in which salts collect and a certain amount of hydrogen may be absorbed by the metal surface with consequent local weaknesses and embrittlement.

The brushing stands fit in well with other high speed equipment such as slitters, for example, and the brushing operations may, of course, be selected not only to remove scale but also to afford an improved finish to the metal surface, to remove edge burs, and generally to eliminate the need for further elaborate finishing operations at a later period. In contrast thereto, the pickling line is often a bottleneck in a steel mill.

Referring now to Fig. 1 of the drawing, in a usual installation embodying the principles of my invention, the upper work rolls **28** and **29** may be 6 inches in diameter or somewhat larger if a relatively wide strip is to be processed necessitating unusually long rolls. Lower work roll **22** will normally range from 1½ to 3 inches in diameter depending upon the thickness of the steel strip to be processed. Thus, if the strip is between .060 and .080 inch thick, roll **22** may be approximately 1½ inches in diameter; if the strip is from .080 to .100 inch thick, such roll may be 1¾ inches in diameter; if the strip is .100 to .187 inch thick, then such roll may be 2½ inches in diameter; and if such strip is .187 to .250 inch thick, then such roll may be 3 inches in diameter.

As shown in Figs. 1 and 3 of the drawing, the strip may be caused to conform to an arcuate portion of the periphery of roll **22** of selected diameter as explained above. This does not require that rolls **28** and **29** form true nips with roll **22** and they may preferably be spaced from the latter distances somewhat greater than the thickness of the strip being processed. The less the strip thickness, the smaller should be the diameter of work roll **22**. There is, however, a method of avoiding the necessity of employing very small diameter work rolls **22** or of avoiding the necessity of changing from a larger to a smaller work roll **22** when strip of thinner gauge is to be processed. I have unexpectedly discovered that when the rate of travel of the strip through the machine is very considerably increased (as from 35 feet per minute to 130 feet per minute in one case) the strip no longer conforms exactly to the upper surface of small roll **22** but leaves such upper surface in an abrupt hump or buckle, thereby causing the concave surface to be flexed on a smaller radius than that of roll **22** itself. This has proven very effective in fracturing and loosening

scale, and I am enabled actually to detach from 25 to 50 percent of the scale from such strip surface at this stage in the process and prior to the subsequent brushing operations. Of course, the strip will also be flexed in a similar manner but in the opposite direction in stand 80 (Fig. 6) so that the scale on both sides of the strip will have been subjected to very substantial and forceful compression. Bar 56 will desirably extend downwardly as far as the center line of rolls 28, 29 to serve as a bumper or deflector limiting the extent to which the strip is thus permitted to buckle or bulge. The degree of bulge may also be controlled by regulating the pressure of the small work roll against the strip, the greater the pressure the greater being the tendency to bulge.

I have found that the work rolls 28 and 29 and back-up roll 7 should be very slightly crowned to ensure proper tracking of the strip and to prevent strip wobble. The upper work roll 28 (on the strip exit side of the machine) should rotate at a slightly greater speed (surface feet per minute) than roll 29 inasmuch as sufficient scale will have been removed by the time the strip reaches roll 28 slightly to lessen the effective gauge of such strip. This may desirably be achieved by driving rolls 28 and 29 at the same rate of rotation from motor 40 through pinion stand 45 but making roll 28 of very slightly greater diameter than roll 29 so that its surface speed will be about 1 to 2 percent greater. Back-up roll 7 will be driven at a rate to drive small work roll 22 at the same speed as roll 29. Roll 22, of course, has no positive drive means of its own and is mounted so as to be quickly and conveniently removable. When roll 22 is changed to one of a different diameter as explained above, it is not necessary to change rolls 7 or 28 and 29.

In addition to removing a large portion of the scale, the abrupt reverse bending of the strip regularizes the metal structure to a considerable extent and superficially work-hardens the strip a little although not enough to prevent the metal from still drawing well. Not only does such abrupt reverse bending exert large edgewise compressive forces on the scale layers, but it also serves to cause minute slivers in the surface to stand up in a manner rendering them more amenable to the subsequent brushing operation.

The roller leveler 83 considerably facilitates the subsequent brushing operations and a leveler utilizing a large number of small diameter rollers is desirable.

The power driven rotary brushes 54 and 55 are of considerable importance in preventing the build-up of scale particles on the rolls. Such build-up may otherwise be quite detrimental to the operation of my new machine and may cause the fractured hard scale particles to be driven into the surface of the bend being processed with permanent damage to the latter. Brushes 59 and 60 combined with suction nozzles 57 and 58 serve substantially to clean small work roll 22 (Fig. 3) and any particles transferred to the surface of large back-up roll 7 are, of course, removed by power driven cylindrical rotary brush 54. The bronze shoe 56 fitting between rolls 28 and 29 both prevents particles dislodged by brush 55 from dropping down between rolls 28 and 29 upon strip S, and also serves somewhat as a scraper. The greater quantity of scale particles is, of course, dislodged from the underside of the strip in the Fig. 3 embodiment inasmuch as it is such underside which is subjected to compressive forces. The tensioning of the upper surface is also somewhat effective but to a less degree.

The employment of my new process preliminary to the power brushing of the strip wherein I flex the strip about a radius of 1½ inches or less (by traversing the strip at sufficiently high speed the strip may be caused to buckle about smaller radii than those indicated by the listed diameters of work roll 22 given above) so uniformly and effectively fractures and loosens the scale from the metal surface that a subsequent brushing operation properly carried out, as explained herein, is effective to remove 100 percent of the scale from the strip surface and also to produce a regularized and much improved metal surface. The multitudinous objections to the usual pickling operation are entirely avoided.

The small work roll will ordinarily be driven at substantially the same rate of surface feet per minute as the opposed larger work rolls, it being recalled that the larger work roll on the exit side will be turning at a slightly greater surface f.p.m. rate than the other work roll. The larger work rolls serve to deflect the strip about the smaller roll but preferably do not act to pinch or reduce the strip. They are arranged asymmetrically of the smaller work roll and back-up roll assembly. The exact diameter of the back-up roll is not critical but may, for example, be 8 inches when the smaller work roll is 1½ to 3 inches in diameter and the rolls are approximately 36 inches long. The rolls should, of course, be longer than the width of the strip processed. If non-flat rod is to be processed, the rolls may be appropriately grooved to receive and guide the same.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

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

1. Mechanism for sharply flexing metal strip and the like comprising a stand, a back-up roll journalled in said stand, power means operative to drive said roll at a predetermined rate of speed, a parallel smaller diameter work roll freely rotatably journalled in said stand and mounted for ready removal therefrom, said work roll contacting said back-up roll, a pair of parallel larger work rolls slightly spaced from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, power means separate from said first-named power means operative to rotate said two larger work rolls in unison together at a predetermined rate of rotation, and means operative to shift said larger work rolls toward and away from said smaller work roll.

2. Mechanism for sharply flexing metal strip and the like comprising a stand, a back-up roll journalled in said stand, power means operative to drive said roll at a predetermined rate of speed, a parallel smaller diameter work roll freely rotatably journalled in said stand, said work roll contacting said back-up roll, a pair of parallel larger work rolls slightly spaced from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, power means separate from said first-named power means operative to rotate said two larger work rolls at predetermined rates of rotation, and means operative to shift said larger work rolls relative to said smaller work roll.

3. The mechanism of claim 2, wherein said smaller work roll has a diameter of from 1½ to 3 inches.

4. The mechanism of claim 2, wherein the said larger work roller at the exit side of the stand is driven at the same rate of rotation as the other said larger work roll but is of slightly greater diameter than the other said roll.

5. The mechanism of claim 2, including slides mounted in said stand journalling said larger work rolls for reciprocation toward and away from said smaller work roll, and power means operative thus to reciprocate said slides.

6. The mechanism of claim 2, including slides mounted in said stand journalling said larger work rolls for reciprocation toward and away from said smaller work roll, power means operative thus to reciprocate said slides, and means interconnecting said slides to ensure precise reciprocation in unison.

7. The mechanism of claim 2, including slides mounted in said stand journalling said larger work rolls for reciprocation toward and away from said smaller work roll, slides in said stand journalling said back-up roll for

reciprocation in a direction toward and away from said smaller work roll, and power means operative thus to reciprocate said slides.

8. The mechanism of claim 2, including power driven rotary brushes engaging said back-up roll and said two larger work rolls effective to prevent accumulation of material on their surfaces.

9. In mechanism for sharply flexing metal strip and the like, a stand, a back-up roll journalled in said stand, power means operative to drive said roll, a parallel smaller diameter work roll freely rotatably supported against said back-up roll, a pair of parallel larger work rolls slightly spaced from said smaller work roll sufficiently to avoid reduction of the work therebetween asymmetrically of said smaller work roll and back-up roll assembly, and power means operative to drive said larger work rolls.

10. The method of loosening scale on metal strip which comprises deforming such strip by flexing the same about a small diameter roll, and continuously advancing such strip at such a high rate of speed that it bulges away from the surface of such small roll in reaction to the force of deformation and is consequently abruptly flexed about a smaller radius than that of such roll.

11. Mechanism for flexing metal strip and the like comprising a stand, a back-up roll journalled in said stand, power means operative to drive said roll at a predetermined rate of speed, a paralleled smaller diameter work roll freely rotatably journalled in said stand, said work roll contacting said back-up roll, a pair of parallel larger work rolls slightly spaced from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, and means intergearing said larger work rolls for rotation at the same rate, said larger work roll on the exit side of the stand being of slightly greater diameter than the larger work roll on the entering side of the stand.

12. Mechanism for flexing metal strip and the like comprising a stand, spaced slides mounted for parallel reciprocation in said stand, a back-up roll journalled in said slides, power means operative to drive said roll at a predetermined rate of speed, a parallel smaller diameter work roll freely rotatably supported against said back-up roll, a pair of parallel larger work rolls journalled in spaced slides in said stand for reciprocation toward and away from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, drive means for said larger work rolls, means operative to reciprocate said slides in said stand, pinion-bearing torsion bars and racks on said stand and slide reciprocating means respectively intergeared to ensure that said slides at opposite ends of each said roll are reciprocated exactly in unison.

13. Mechanism for flexing metal strip and the like comprising a stand, a back-up roll journalled in said stand, power means operative to drive said roll at a predetermined rate of speed, a parallel smaller diameter work roll freely rotatably journalled in said stand, said work roll contacting said back-up roll, a pair of parallel larger work rolls slightly spaced from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, said back-up roll being beneath said smaller work roll and said larger work rolls being thereabove, drive means for said larger work rolls, a single cylindrical power driven rotary brush mounted to engage the upper surfaces of both said larger work rolls to clean their surfaces and prevent build-up of material thereon, and a shoe interposed between said larger work rolls and closely fitting the same to prevent particles dislodged by said brush from dropping down therebetween onto the upper surface of the work.

14. Mechanism for flexing metal strip and the like comprising a stand, spaced slides mounted for parallel reciprocation in said stand, a back-up roll journalled in said slides, power means operative to drive said roll at a predetermined rate of speed, a parallel smaller diameter work roll freely rotatably supported against said back-up roll, journals for said smaller work roll releasably supported in said slides, a pair of parallel larger work rolls journalled in spaced slides in said stand for reciprocation toward and away from said smaller work roll asymmetrically of said smaller work roll and back-up roll assembly, drive means for said larger work rolls, and means operative to reciprocate said slides in said stand.

References Cited in the file of this patent

UNITED STATES PATENTS

1,047,335	Thurston	Dec. 17, 1912
1,984,762	Roberts	Dec. 18, 1934
2,004,596	Biggert	June 11, 1935
2,226,500	Matthews	Dec. 24, 1940
2,234,153	Herbert	Mar. 4, 1941
2,256,520	Johansen	Sept. 23, 1941
2,282,770	Sarver	May 12, 1942
2,318,432	Stanier et al.	May 4, 1943
2,335,196	Pecsok	Nov. 23, 1943
2,391,499	Yoder	Dec. 25, 1945
2,403,374	Kalmar	July 2, 1946
2,680,938	Peterson	June 15, 1954
2,790,229	Hellstrom	Apr. 30, 1957

FOREIGN PATENTS

619,820	Germany	Oct. 7, 1935
1,071,352	France	Mar. 3, 1954