May 31, 1966 J. FRANEK 3,253,445

APPARATUS FOR ROLLING STRIP METAL

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Fig. 1.

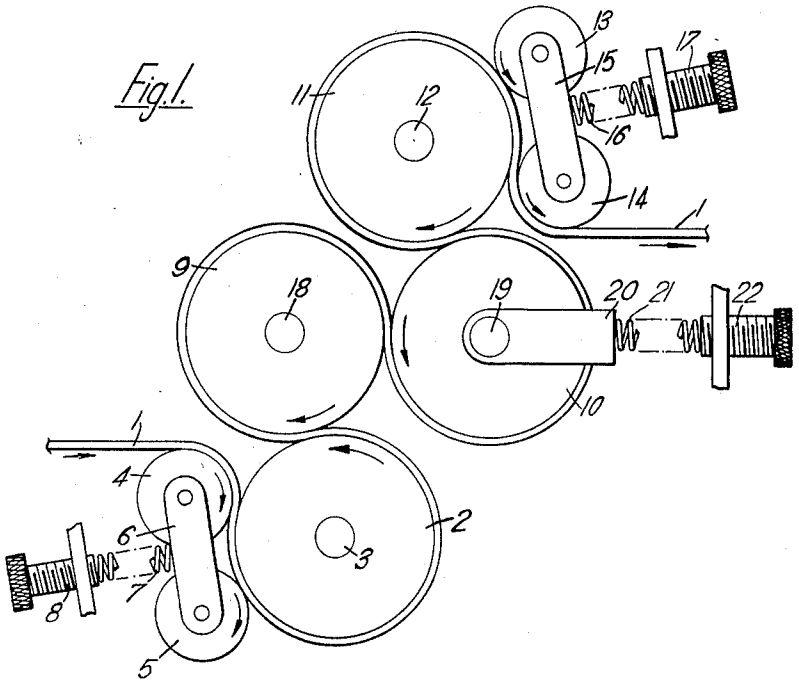
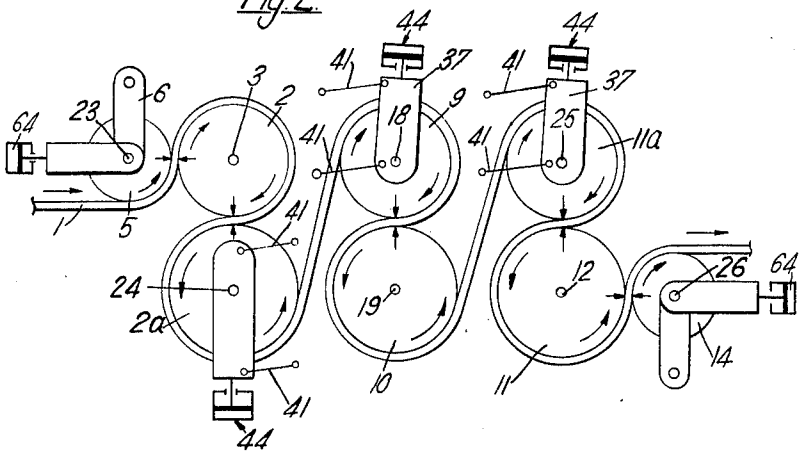


Fig. 2



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Fig. 3.

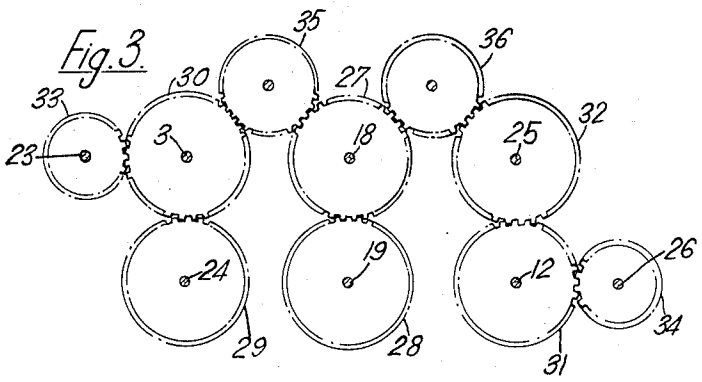
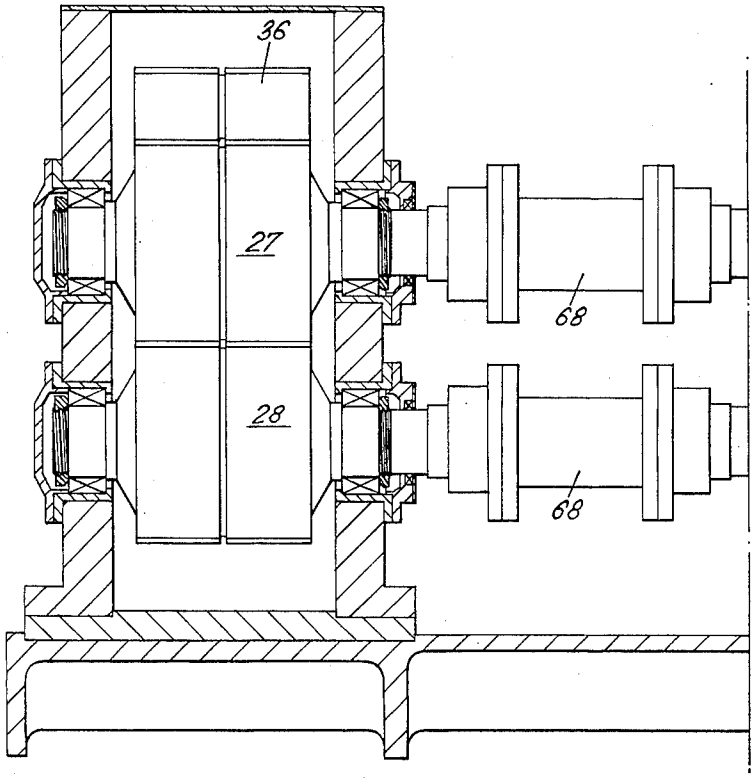


Fig. 4A.



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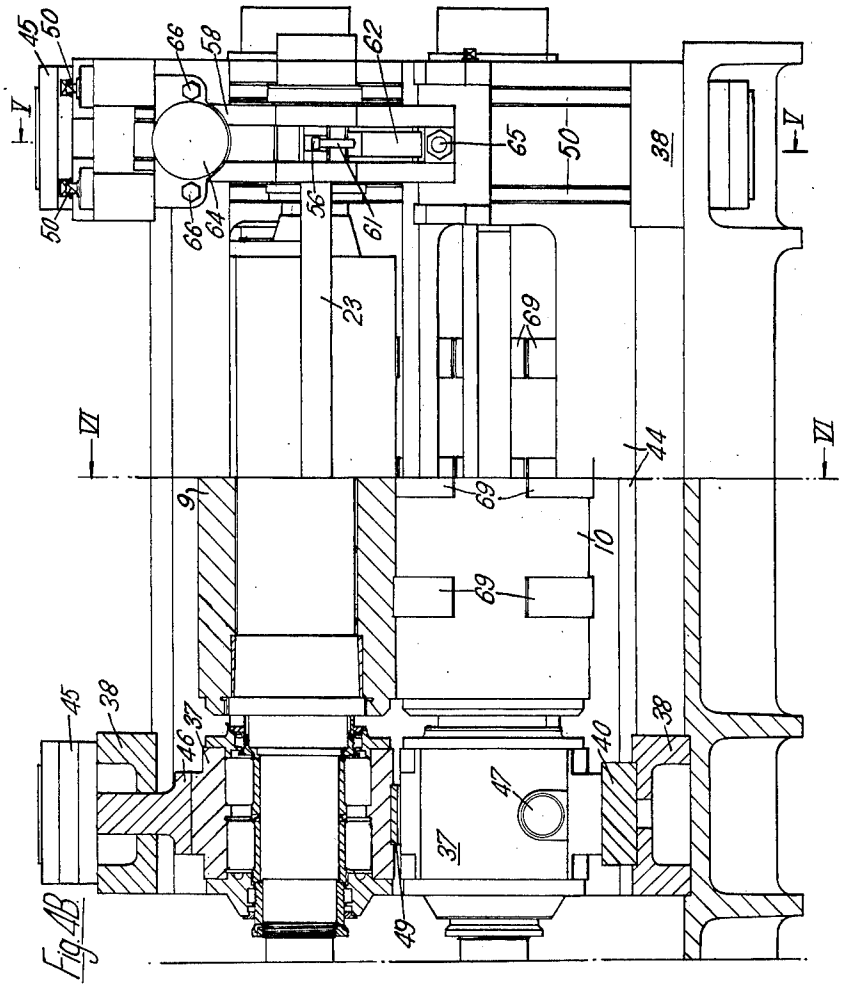


Fig 4B

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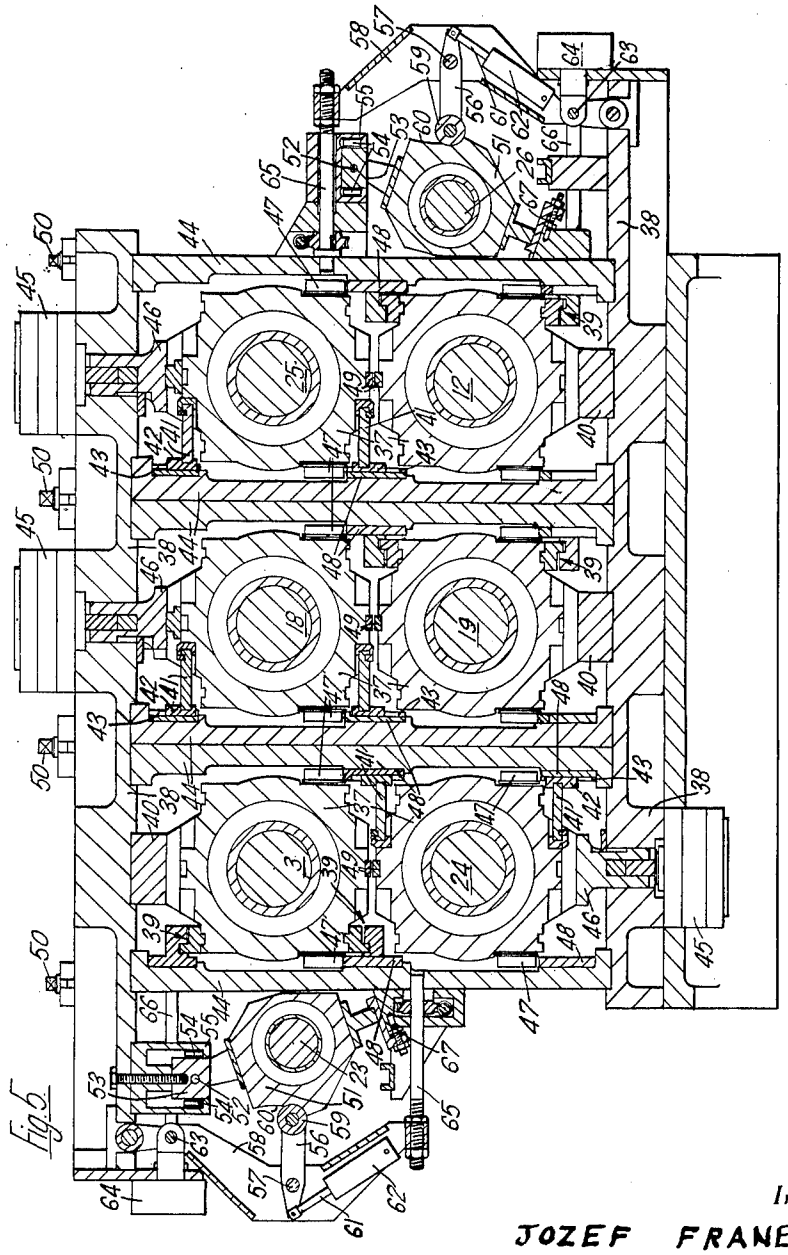


Fig. 5

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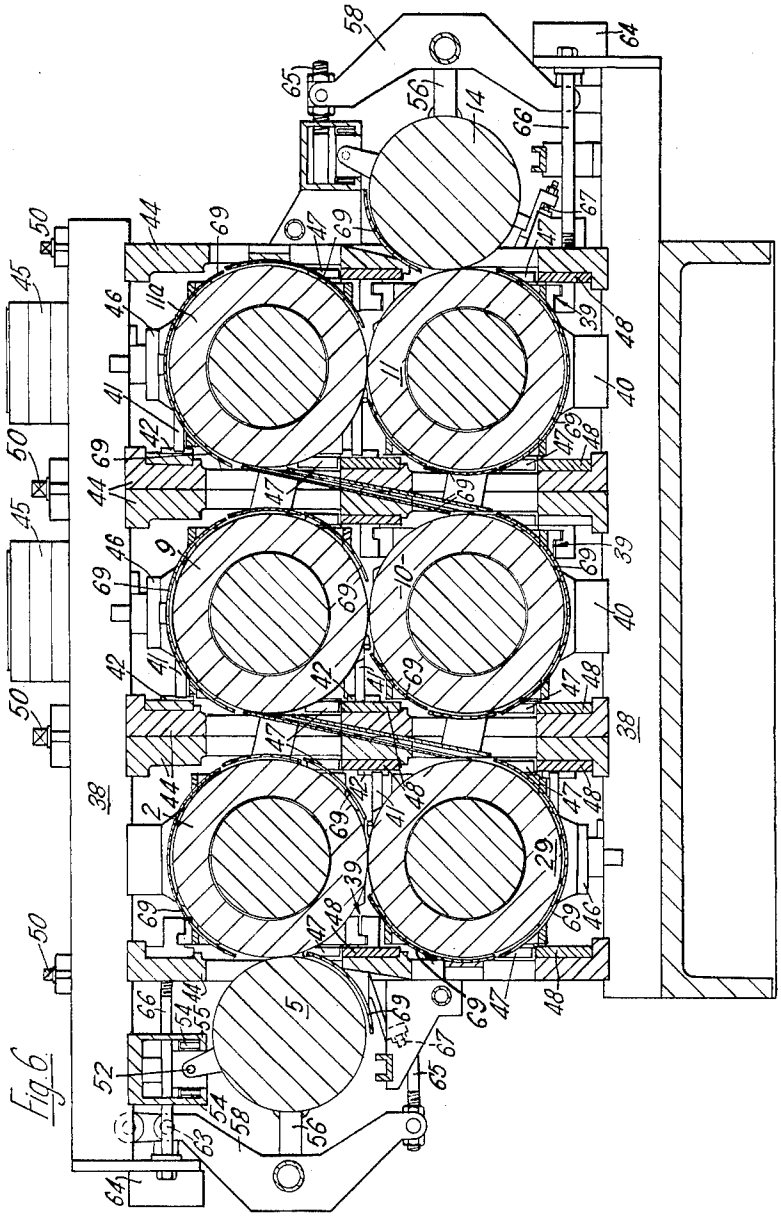


Fig. 6

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APPARATUS FOR ROLLING STRIP METAL

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Claims priority, application Great Britain, July 9, 1962, 26,317/62
10 Claims. (Cl. 72—164)

This invention relates to the treatment of strip metal of ferrous or non-ferrous base, as well as ferrous base metal having a protective coating for example of tinplate, which is rolled to a predetermined thickness which may be of the order of 0.010 inch or more or may be a foil.

As is understood in the art, metal which is rolled to a thickness of up to about 0.01 inch to form a long strip may suffer to a lesser or greater extent from a number of defects in the geometry thereof such defects being known in the art as:

(a) Camber or edge wander, which is the greatest deviation of the longitudinal edges of the strip from a straight line and which does not permit the cutting from the strip of sheets with right angles,

(b) Wavy edges, which are due to compressive stresses near the edges of the strip and tensile stresses in the centre of the strip, and which cause sheets cut from the strip not to be flat so that difficulty occurs in feeding the sheets during printing, lacquering, and stamping thereof,

(c) Buckle or blisters in the centre of the strip, which are usually caused by the presence of compressive stresses in the middle of the strip and tensile stresses near the longitudinal edges of the strip,

(d) Seaweed effect, which is a combination of defects (a), (b), and (c),

(e) Buckled edge, which is usually due to damage by engagement of the strip with guide elements, and

(f) Dents or creases, which are usually caused by damage to the strip after coiling thereof.

Besides the above defects, change in some physical properties may occur due to aging. This can be detected by subjecting a specimen of the strip material to the tensile test. The aged strip can be identified by the presence of the yield point discontinuity on the stress-strain curve. Strip suffering from such a defect in the physical properties cannot be deformed plastically in a uniform manner with complete success. For example when aged tinplate is employed for the manufacture of an open top can body, a condition known in the art as "fluting or panelling" will often occur and the cylinder may be polygonal instead of smoothly circular. Can ends made from aged tinplate may have stretcher strain marks (known as Leuder bands) which indicate a return of yield point discontinuity and a decrease in the formability. Such can ends will be geometrically imperfect and dimensionally unstable, especially when deep drawing, or irregular or non-circular shapes are involved.

Normally in strip metal manufacture "skin passing" and "temper rolling" are employed as corrective operations to reduce physical defects and to mask the yield point discontinuity. This is done largely by high compression stresses imparted by the rolls and moderate strip tension, resulting in a characteristic stress pattern within the thickness of the strip which is in compression near the surfaces and tension in the middle. The strip usually undergoes further corrective treatment by a roller leveller before being cut into sheets.

The stress pattern in temper rolled strip is upset by aging and while the known methods of roller levelling applied to the strip immediately before cutting thereof into sheets may correct the stress pattern if the roll diameter is small enough it is found, particularly in the case of

tinplate used in the manufacture of open top cans, and which has a thickness less than 0.010 inch, that the effect of the roller levelling is negligible in correcting the defects in the geometry of the strip and in the physical properties thereof.

It is one object of the present invention to provide apparatus for effecting a predetermined plastic tensile strain combined with compression which permits correction of the geometrical defects of a metal strip and imparts the desired physical properties to the strip in a controlled manner. According to the amount of the predetermined tensile strain and compression applied to the strip the strip will be subjected either to temper stretch levelling or to temper rolling.

According to the invention there is provided apparatus for stretching strip metal, comprising rotatable entrance and exit bridle rollers supported for rotation at positions spaced apart along the path of a strip to be stretched and around which the strip is passed, rotatable pinch rollers operable to press the strip against the bridle rollers, first and second rotatable tensioning rollers around which the strip passes during movement thereof from the entrance bridle roller to the exit bridle roller and between which the strip is gripped, said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, adjustable pressure-applying means co-operating with the first tensioning roller to apply to the strip a predetermined local compressive stress lower than the yield stress of the strip while the strip is subjected to local longitudinal tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

In order that the invention may be clearly understood some embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 illustrates diagrammatically one form of apparatus for carrying the invention into effect,

FIGURE 2 illustrates diagrammatically a second form of apparatus for carrying the invention into effect,

FIGURE 3 illustrates a train of gears for driving rollers employed in the apparatus of FIGURE 2,

FIGURES 4A and 4B together are an elevation, partly in section, of a part of a machine embodying the apparatus shown diagrammatically in FIGURES 2 and 3,

FIGURE 5 is a section on line V—V, FIGURE 4B, and

FIGURE 6 is a section on line VI—VI, FIGURE 4B.

In the drawings like reference numerals refer to like or similar parts.

Referring to FIGURE 1, temper stretch levelling of a strip 1 of metal is effected by moving the strip lengthwise and at a predetermined position along the path of the strip longitudinally tensioning the strip gradually round bridle rollers and locally increasing the linear speed thereof to impart a permanent tensile strain to the strip while compressing the strip from opposite sides thereof to avoid the formation of undesired stretcher strain marks on the strip and to transfer the required finish of temper rolls on to the surface of the strip.

The strip 1 at the said predetermined position enters between an entrance bridle roller 2, rotatable with a shaft 3, and a first pair of pinch rollers 4, 5 which are carried by a carrier 6 and press the strip against the bridle roller 2. The pinching force exerted by the pinch rollers 4, 5 may be applied by hydraulic or mechanical means and as illustrated in FIGURE 1 is applied by means of a compression spring 7 and adjusting screw 8.

On leaving the bridle roller 2 the strip 1 is wrapped round a first tensioning roller 9 and then in turn round

a second tensioning roller **10** and a second, or exit, bridle roller **11**, rotatable with a shaft **12**, against which it is pressed by a second pair of pinch rollers **13**, **14** carried by a carrier **15** provided with a compression spring **16** and adjusting screw **17**. The roller **9** is rotatable with a shaft **18** and roller **10** is rotatable with a shaft **19** carried by a carrier **20** provided with suitable means arranged to permit roller **10** to be moved towards and away from roller **9**. While passing between rollers **9** and **10** the strip **1** is subjected to a local compressive stress lower than the yield stress but high enough to prevent the formation of stretcher strain marks (Lueder bands) and the pressure is exerted through the carrier **20** by hydraulic or mechanical means. As shown in FIGURE 1 the pressure is exerted by a compression spring **21** and an adjusting screw **22**. The strip **1** while being locally compressed between rollers **9** and **10** is subjected to a local stretching or tensioning strain by means of a difference between the circumferential velocities of the rollers **9**, **10**, the circumferential velocity of roller **10** being greater than that of roller **9**.

In the embodiment of the invention being described the rollers **2**, **9**, **10** and **11** are each of 20 inches nominal diameter and the pinch rollers **4**, **5** and **13**, **14** each have a diameter of 12 inches. The rollers are positively rotated by a train of gears, not shown, the pinch rollers **4**, **5**, **13** and **14** having a circumferential speed equal to that of the bridle rollers **2** and **11**. The rollers **2**, **9** are geared in 1:1 ratio and similarly the rollers **10**, **11** may be also geared in 1:1 ratio to maintain equal angular velocities.

The diameters of the tensioning rollers **9**, **10** and the gearing between them is selected in a manner such as to result in the desired difference between the circumferential velocities of the rollers, this difference, being between 0.5% and 5%. If the strip is to be subjected only to a slight degree of stretch the ratio of the gears driving rollers **9** and **10** may be 1:1 and the difference in circumferential velocity of the rollers obtained by making the diameter of roller **10** greater than that of roller **9**. On the other hand, if a greater degree of stretch is required this will be obtained by selecting a suitable ratio for the gears rotating the rollers **9**, **10** and by making the diameter of roller **10** greater than that of roller **9**. When the apparatus is used for effecting a temper stretch levelling process the strip is subjected to a tensile strain below 2% combined with the above-mentioned local compressive stress less than the yield stress, but when the apparatus is used for effecting a temper stretch rolling process the strip is subjected to a tensile strain of 2% or more up to about 5% combined with the above-mentioned compressive stress less than the yield stress. The strip **1** while being locally compressed between the rollers **9**, **10** undergoes a predetermined plastic tensile strain due to the greater circumferential velocity of the roller **10** as compared with that of roller **9**.

To ensure uniform processing of the strip **1** the tensioning rollers **9**, **10** and the pinch rollers are crowned to compensate for deflection but as the process is mainly a stretching process the rolling forces are small and crowning will be small and dependent on the width and material of the strip and the dimensions of the rolls. For example, the crowning of the pinch rolls **4**, **5** and **13**, **14** may be of the order of 0.030 inch and that of the tensioning rolls may be of the order of 0.006 inch.

The diameter of the first tensioning roller **9** is slightly greater, about 0.05% greater, than that of the entrance bridle roller **2** and the diameter of the second tensioning roller **10** is slightly greater than that of the exit bridle roller **11** to compensate for the gradually increasing elastic tensile strain in the strip **1** caused by the action of the bridles.

Referring to FIGURES 2 to 6, the apparatus therein illustrated operates in a manner similar to that of the apparatus described with reference to FIGURE 1 but is designed to meet the conditions of low coefficient of friction which occurs in the case of lubricated strip material fed at high linear speed to highly finished rolls. Such conditions are likely to occur when levelling tinplate strip fed at a velocity of about 900 ft./min.

In this embodiment of the invention the strip **1** approaches the single pinch roller **5** substantially horizontally and is wrapped round it for about 90% to pass between the pinch roller **5** and entrance bridle roller **2** and between the bridle roller **2** and an auxiliary entrance bridle roller **2***a*. After leaving roller **2***a* the strip is passed round and between the tensioning rollers **9**, **10** and is subjected to the above-mentioned local compressive stress and local stretching or tensioning strain and then passes round an auxiliary exit bridle roller **11***a*, the exit bridle roller **11**, and a single pinch roller **14**.

The rollers **5**, **2***a*, **11***a* and **14** are respectively rotatable with shafts **23**, **24**, **25** and **26** and FIGURE 3 illustrates the train of gears for rotating the various rollers. From FIGURE 3 it will be seen that the tensioning rollers **9**, **10** are rotated by meshing gears **27**, **28**; rollers **2** and **2***a* by meshing gears **29**, **30**; rollers **11**, **11***a* by meshing gears **31**, **32**; rollers **5** and **14** by gears **33**, **34** meshing respectively with gears **30** and **31**; and idler gears **35**, **36** mesh respectively with the gears **27**, **30** and **27**, **32**.

The rollers **2**, **2***a*, **9**, **10**, **11***a* and **11** have a nominal diameter of 20 inches but the rollers **2**, **2***a* and **9** are of lesser diameter than that of the nominal diameter to permit the predetermined stretch of the strip as described above. The pinch rollers **5** and **14** have a nominal diameter of 16 inches. The diameters of the individual rollers are corrected according to the elastic strain in the strip so as to minimise slip between the strip and the highly finished surfaces of the rollers.

The number of teeth of the gears **33** and **34** is proportional to the diameters of the pinch rollers **5** and **14** and the gears **30**, **29** and **27** respectively have the same number of teeth proportional to the diameters of the rollers **2**, **2***a* and **9**. The gears **28**, **31**, **32** may have the same number of teeth as gears **30**, **29** and **27** when the increased circumferential velocity of roller **10** is achieved by the diameter of the roller **10** being greater than that of roller **9**. When, however, a greater degree of stretch is required the number of teeth on the gears **28**, **31**, **32** will be less than that of the gears **30**, **29**, **27**. The idler gears **35**, **36** transfer the drive between the bridle rollers and the tensioning rollers.

FIGURES 4 to 6 illustrate a part of a machine embodying the apparatus illustrated diagrammatically in FIGURES 2 and 3.

From FIGURE 5 is will be seen that the shafts **3**, **12**, **18**, **19**, **24** and **25**, are supported in identical bearing chocks **37** mounted between top and bottom machine frame elements **38**. A chock **37**, shown in FIGS. 4B and 5 but not visible in FIG. 6, is provided for each end of the shaft for each roller. The chocks **37** for the rollers **2**, **10**, **4** and **11** are positively attached to the frame elements by gibs **39** and adjustable distance blocks **40**. The chocks **37** for the rollers **2***a*, **9** and **11***a* are connected to pairs of parallel links **41** supported by blocks **42** located in grooves **43** in side frame elements **44**, and the rollers **2***a*, **9** and **11**a carried by these chocks are urged towards their opposing rollers **2**, **10**, and **11** by hydraulic devices **45**, known as load cells, acting through distance blocks **46**. The parallel links **41** act to take up the side thrust or horizontal component of the strip tension reaction of the strip being processed. To facilitate the easy withdrawal of the roller assemblies the bearing chocks are provided with wheels **47** which run on rails **48** carried by the frame elements **44**.

From FIGURES 2 and 6 it will be seen that the tensioning rollers **9**, **10** are superimposed one on the other and are located between the pairs **2**, **2***a*; **11**, **11***a* of bridle rollers.

To prevent damage of the hardened surfaces of the rollers each chock **37** is provided with adjustable distance

wedges 49. The side frame elements 44 locate the roller assemblies sideways and the elements 44 are located between the top and bottom frame elements 38 which are clamped together by bolts 50 which resist the rolling forces exerted by the load cells 45.

The pinch rollers 5, 14 are carried by bearing chocks 51 pivoted at 52 to carriages 53 having wheels 54 which run on a rail track 55 carried, see FIGURE 5, one by the top frame 38 and one by an end side frame 44. This method of mounting the chocks 51 facilitates the easy withdrawal of the pinch roller units from the frames. The pinch force is applied by links 56 pivoted at 57 in yokes 58 and carrying a roller 59 which engages a contoured portion 60 of the chock 51. The links 56 are operated by the piston rod 61 of a hydraulic cylinder 62. At one end thereof the yoke 58 is mounted on a pivot 63 and is loaded by load cells 64. The other end of the yoke 58 is attached to an adjustable tension bolt 65 which shares the pinch roll reaction force with non-adjustable bolts 66, FIGS. 4B and 6. Adjustable stops 67 are provided to prevent damage to the hardened surfaces of the pinch rollers 5, 14 and bridle rollers 2*a*, 11*a*.

The gears 29, 30; 27, 28; and 31, 32 are all driven through connecting gear coupling arrangements, two of which are indicated at 68, FIGURE 4A, which provide the drive to the rollers which may vary in diameter and thus in the distance between the centres thereof.

To facilitate threading of the strip 1 through the apparaus guides 69, FIGURE 6, are provided.

When the apparatus is employed for temper stretch levelling the strip is subjected by the tensioning rollers 9, 10 to a local predetermined tensile strain less than 2% combined with a local compressive stress lower than the yield stress but high enough to prevent the formation of stretcher strain marks (Lueder bands).

When the apparatus is employed for temper stretch rolling the strip is subjected by the tensioning rollers 9, 10 to a local predetermined tensile stress of between 2% and 5% combined with a local compressive stress lower than the yield stress but high enough to prevent the formation of stretcher strain marks (Lueder bands).

It is found when effecting temper stretch leveling or temper stretch rolling by the apparatus according to the invention that not only is the formation of stretcher strain marks (Lueder bands) prevented but that a preferred pattern of stresses within the thickness of the strip is returned or imparted, the yield point discontinuity is masked, and the temper of the strip is imparted or corrected and in some instances is slightly increased. The ductility of the strip is improved as is evident by the absence of stretcher strain marks in stampings made from the treated strip. Furthermore, the surface of the strip is treated by the degree of finish of the tensioning rollers 9, 10 and in many instances this results in an improvement in the surface appearance of the treated strip even when, prior to treating, the strip is severely dented or creased.

It will be understood that in each of the forms of apparatus described herein due to the extreme tensions in the strip equal to the yield stress and multiplied by the area of the cross-section of the strip, the exit bridle has to provide a large amount of work because the strip tension acts opposite to the direction of strip movement. A high percentage of the work is, however, returned to the apparatus by the entrance bridle because both strip tension and movement are in the same direction. The work is transferred by the gears, and the driving motor, not shown, supplies the necessary work for stretching.

I claim:

1. Apparatus for temper stretch levelling or temper stretch rolling strip metal, comprising rotatable entrance and exit bridle rollers supported for rotation at positions spaced apart along the path of a strip and around which the strip is passed, rotatable pinch rollers operable to press the strip against the bridle entrance bridle roller to the exit bridle roller and between which the strip is gripped, said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, adjustable pressure-applying means co-operating with the first tensioning roller to apply to the strip a predetermined local compressive stress lower than the yield stress of the strip while the strip is subjected to local tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

2. Apparatus for temper stretch levelling or temper stretch rolling strip metal, comprising rotatable entrance and exit bridle rollers supported for rotation at positions spaced apart along the path of a strip and around which the strip is passed, rotatable pinch rollers operable to press the strip against the bridle rollers, first and second contra-rotatable tensioning rollers around which the strip passes during movement thereof from the entrance bridle roller to the exit bridle roller and between which the strip is gripped, said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, one of said tensioning rollers being rotatable in fixed bearings and the other in movable bearings permitting movement of said other tensioning roller towards and away from said one tensioning roller, adjustable pressure-applying means operable to urge said other tensioning roller towards said one tensioning roller to apply to the strip a local predetermined compressive stress lower than the yield stress of the strip while the strip is subjected to local tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

3. Apparatus according to claim 2 in which said movable bearings are carried by parallel links supported by stationary frame elements to accommodate the horizontal component of the strip tension reaction.

4. Apparatus according to claim 2 in which each pinch roller is rotatable in pinch roller bearings supported for pivotal movement towards and away from the bridle roller associated therewith and including for each pinch roller a stationary yoke, links pivotally connected to said yoke, a roller carried by said links and engaging contoured portions of the pinch roller bearings, and a hydraulic cylinder having a piston rod connected with said links to effect rocking of the pinch roller bearings about the pivots therefor by co-operation between the roller carried by the links and said contoured portions of the pinch roller bearings.

5. Apparatus for temper stretch levelling or temper stretch rolling strip metal, comprising rotatable entrance and exit bridle rollers supported for rotation at positions spaced apart along the path of a strip and around which the strip is passed, rotatable pinch rollers operable to press the strip against the bridle rollers, said pinch rollers being peripherally crowned, first and second rotatable tensioning rollers around which the strip passes during movement thereof from the entrance bridle roller to the exit bridle roller and between which the strip is gripped, said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, adjustable pressure-applying means co-operating with the first tensioning roller to apply to the strip a predetermined local compressive stress lower than the yield stress of the strip while the strip is subjected to local tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

6. Apparatus for temper stretch levelling or temper stretch rolling strip metal, comprising rotatable entrance and exit bridle rollers supported for rotation at positions

spaced apart along the path of a strip and around which the strip is passed, rotatable pinch rollers operable to press the strip against the bridle rollers, first and second rotatable tensioning rollers around which the strip passes during movement thereof from the entrance bridle roller to the exit bridle roller and between which the strip is gripped, said first tensioning roller being peripherally crowned to compensate for deflection of the tensioning rollers and said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, adjustable pressure-applying means co-operating with the first tensioning roller to apply to the strip a predetermined local compressive stress lower than the yield stress of the strip while the strip is subjected to local tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

7. Apparatus for temper stretch levelling or temper stretch rolling strip metal, comprising an entrance bridle roller and an auxiliary entrance bridle roller supported for rotation in superimposed co-operating relation, an exit bridle roller and an auxiliary exit bridle roller supported for rotation in superimposed co-operating relation, said entrance and exit bridle rollers being located at positions spaced apart along the path of a strip and the strip being passed around and between the paired rollers, fixed bearings in which the entrance and exit bridle rollers are rotatable, movable bearings in which the auxiliary entrance and exit bridle rollers are rotatable, said movable bearings permitting movement of the auxiliary rollers towards and away from the entrance and exit bridle rollers with which they respectively co-operate, pressure-applying means co-operating with said movable bearings to urge the auxiliary bridle rollers towards the entrance and exit bridle rollers to effect pinching of the strip between the paired rollers, first and second contra-rotating tensioning rollers around which the strip passes during movement thereof from the entrance bridle roller to the exit bridle roller and between which the strip is gripped, said second tensioning roller being rotatable with a circumferential velocity greater than that of the first tensioning roller thereby locally to increase the linear speed of the strip to impart a permanent tensile strain thereto, one of said tensioning rollers being rotatable in fixed tensioning-roller bearings and the other in movable tensioning-roller bearings permitting movement of said other tensioning roller towards and away from said one adjustable tensioning roller, tensioning-roller pressure-applying means operable to urge said other tensioning roller towards said one tensioning roller to apply to the strip a local compressive stress lower than the yield stress of the strip while the strip is subjected to local tensioning by the first and second tensioning rollers, and a train of gears operable to effect simultaneous rotation of all of said rollers.

8. Apparatus according to claim 7 in which said movable tensioning-roller bearings are carried by parallel links supported by stationary frame elements to accommodate the horizontal component of the strip tension reaction.

9. Apparatus according to claim 7 in which each pinch roller is rotatable in pinch roller bearings supported for pivotal movement towards and away from the bridle roller associated therewith and including for each pinch roller a stationary yoke, links pivotally connected to said yoke, a roller carried by said links and engaging contoured portions of the pinch roller bearings, and a hydraulic cylinder having a piston rod connected with said links to effect rocking of the pinch roller bearings about the pivots therefor by co-operation between the roller carried by the links and said contoured portions of the pinch roller bearings.

10. Apparatus according to claim 8 in which said pinch roller is rotatable in pinch roller bearings supported for pivotal movement towards and away from the bridle roller associated therewith and including for each pinch roller a stationary yoke, links pivotally connected to said yoke, a roller carried by said links and engaging contoured portions of the pinch roller bearings, and a hydraulic cylinder having a piston rod connected with said links to effect rocking of the pinch roller bearings about the pivots therefor by co-operation between the roller carried by the links and said contoured portions of the pinch roller bearings.

References Cited by the Examiner

UNITED STATES PATENTS

2,163,504	6/1939	Thomas	72—205
2,166,418	7/1939	McBain	80—60
2,178,674	11/1939	Simons	72—205
2,332,796	10/1943	Hume	72—205
2,392,323	1/1946	Koss	72—205
2,526,296	10/1950	Stone	80—35
2,567,770	9/1951	Heller	72—164
2,735,474	2/1956	Sherwood	72—378
2,742,949	4/1956	Nilsson	72—161
2,857,655	10/1958	Greenberger	72—205
3,153,696	10/1964	Blanchard	72—378

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