CROSS-ROLL STRAIGHTENER

Filed March 10, 1958 3 Sheets-Sheet 1

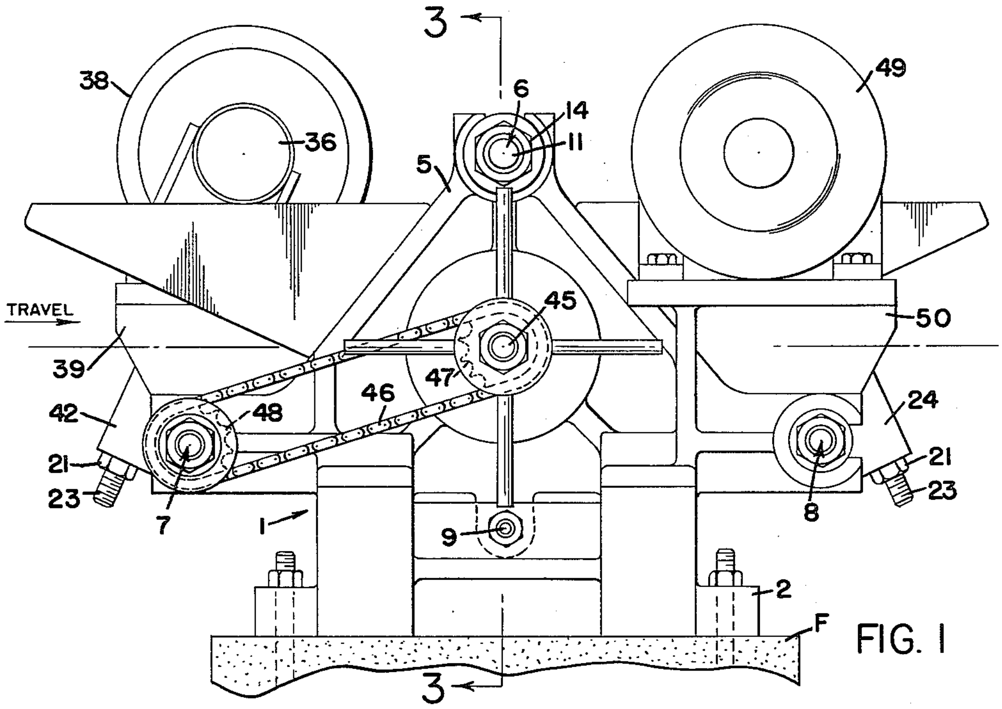

FIG. 1

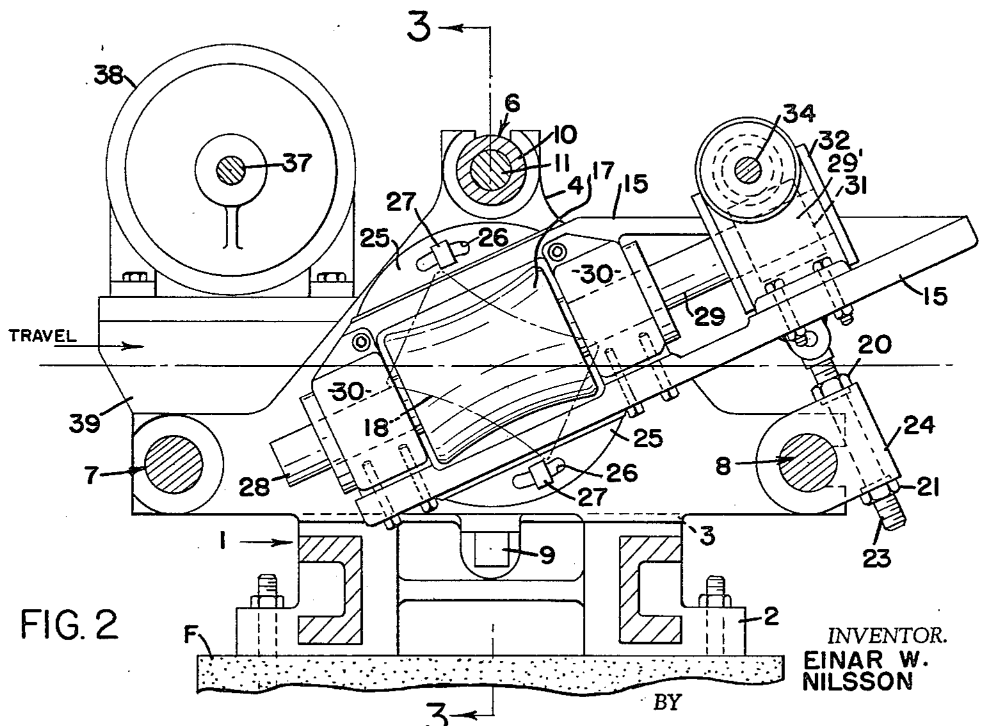

FIG. 2

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CROSS-ROLL STRAIGHTENER

Filed March 10, 1958 3 Sheets-Sheet 2

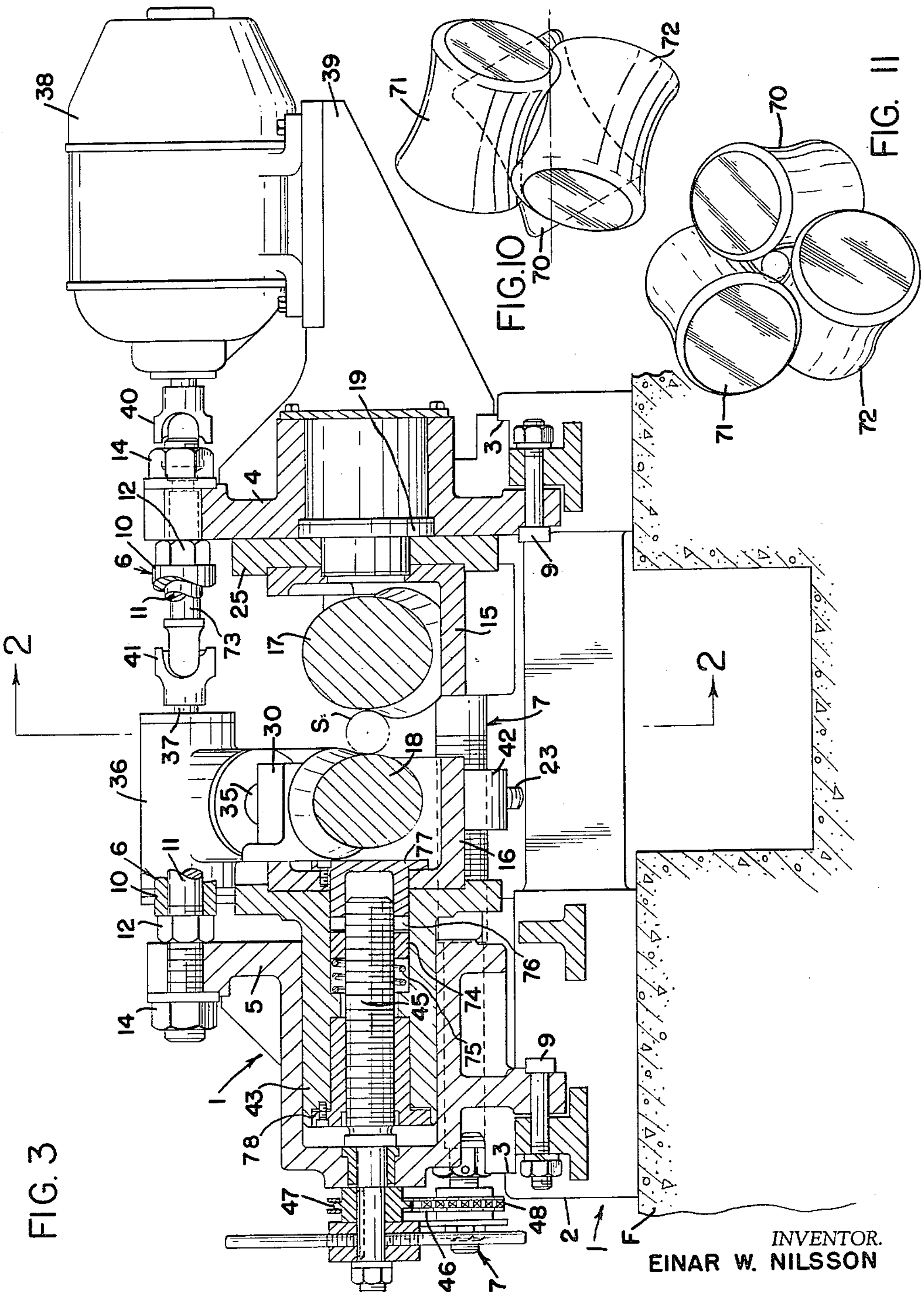

FIG. 3

FIG. 10

FIG. 11

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CROSS-ROLL STRAIGHTENER

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FIG. 4

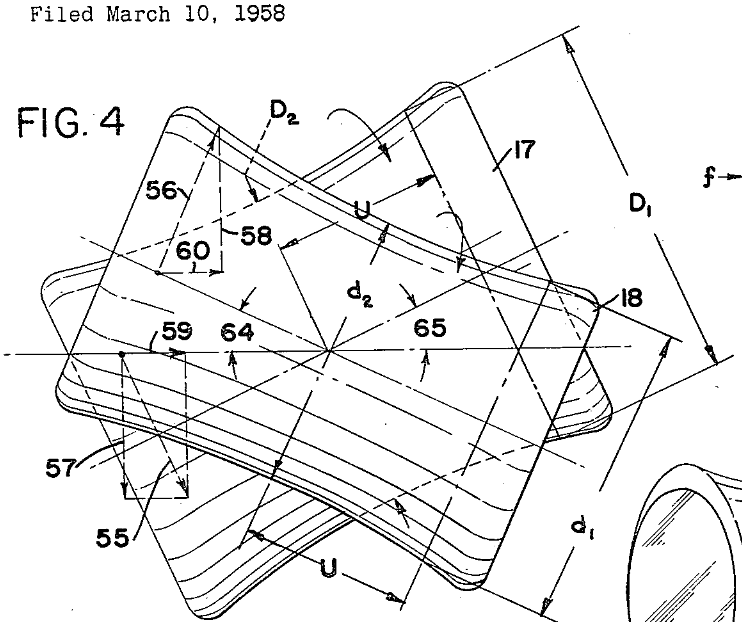


FIG. 5

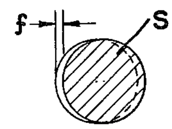


FIG. 6

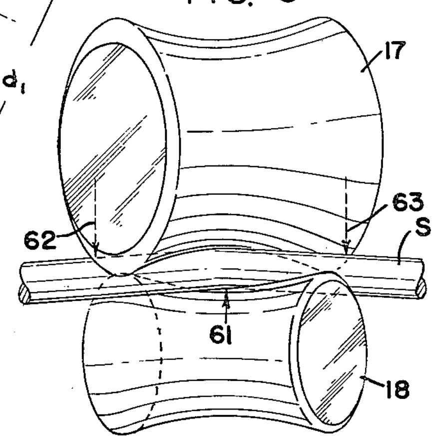
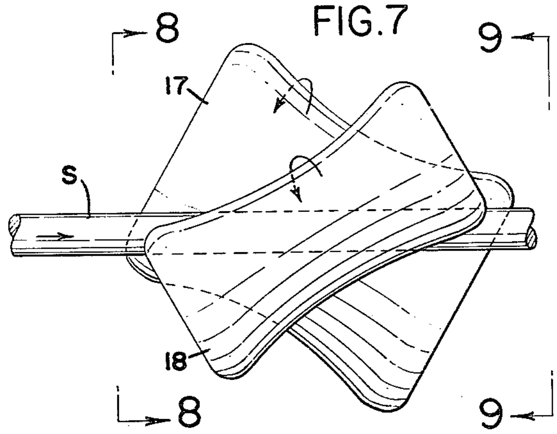


FIG. 7



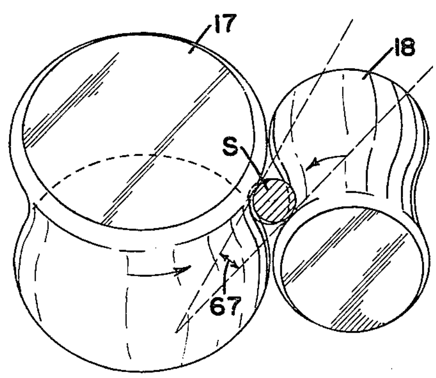
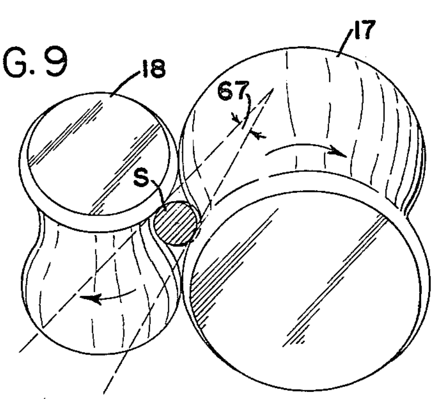


FIG. 8

FIG. 9



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3,047,046

Patented July 31, 1962

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3,047,046
CROSS-ROLL STRAIGHTENER

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Filed Mar. 10, 1958, Ser. No. 720,454
17 Claims. (Cl. 153—103)

The present invention relates generally as indicated to a cross-roll straightener, and more particularly, to a cross-roll straightener in which round stock (wire, rod, bar, tube, etc.) is straightened thereby as the stock is flexed to longitudinally curved form, and is rotated about and advanced along its longitudinal axis through one or more curved passes defined between a set or sets of cross-rolls.

Hitherto, and as well-known in the art, it has been proposed to straighten round stock by advancing the same through a curved pass formed between a set of cross-rolls one of which is straight and the other of which is concavely contoured, the former roll serving as the male roll to deform the stock against the latter or female roll. The female roll may be contoured to make contact with the curved or flexed stock along an approximately helical line. It also has been proposed to provide successive sets of straight-pass cross-rolls that are laterally offset with respect to the longitudinal axis of the stock so as to cause flexing thereof as it advances from one set of cross-rolls to the next.

In the use of curved pass machines of the character indicated, the round stock has a tendency of moving laterally of its axis, or of assuming a position parallel to the axis of one or the other of the cross-rolls whereby working pressure of the rolls on the stock is lessened unless complex guides capable of handling considerable forces are employed to maintain the axis of the stock coincident with the axis of the roll pass. The variation in the speeds on both sides of the pass in conventional curved pass straighteners has reduced the efficiency of such machines considerably. In addition to friction losses in the rolls themselves, the pressure on the guides, both top and bottom have reduced the efficiency of these machines over multiple roll, straight pass straighteners besides limiting the straightening speed because of the guides. The constant adjustment of the guides, due to considerable wear and frequent replacement of guides and rolls, due to excessive wear have limited these machines and have reduced the overall efficiency as compared to straight pass straighteners where symmetrical rolls and speeds are obtainable. By employing several such symmetrical, straight pass, concave rolls, set at rather steep angles and providing for adjustment of the roll speed on both sides of the pass it has been possible to straighten tubes without guides. Such straighteners have the drawback, however, that the stock must engage all rolls before full flexure is obtained, and every portion of the stock will not be straightened evenly, such as in the case of a two roll, curved pass cross roll straightener. The multiple roll straightener of my U.S. Patent No. 2,655,194 also provides the extra guidance of roll sets skewed in relation to each other, but all multiple roll machines are more complex, are more difficult to set up and are also, as a rule, more expensive.

Accordingly, it is a principal object of this invention to provide a set of curved pass cross-rolls that are contoured to define a curved pass having rotating speeds substantially equalized at opposite contact points throughout the pass.

It is another object of this invention to provide cross-rolls that are contoured so that a curved pass as above is defined therebetween (thereby necessitating cross-rolls of different diameters), and so that the ratios of the diameters at the ends of the pass to the minimum working contour diameter of the large roll (the female roll) and of

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the diameters at the ends of the pass to the minimum working contour diameter of the small roll (the male roll) are substantially equal.

It is another object of this invention to provide a cross-roll straightener of the curved pass type where the stock is contacted on substantially equal lengths on both sides of the pass, by rolls of substantially equal lengths but of unequal mean diameters so that the male roll forces the stock into wedged supports formed by both rolls at the entering and leaving ends of the pass.

It is another object of this invention to provide cross-rolls of unequal mean diameters that contact flexed stock at the ends of the pass and in the middle, where the ratio between the diameters at the ends of the pass to the diameters in the middle of the pass are approximately equal for the respective opposed ends of the pass. Between these contacts the contour of the rolls may be relieved from contact with the stock so that more concentrated pressure may be had, particularly in the middle of the pass, for polishing bar stock and perhaps reduce the same in size and yet be able to provide good efficiency as to the speeds in planes normal to the stock axis within said contact zones.

It is another object of this invention to provide a cross-roll straightener of the curved pass type in which the small and large (male and female) cross-rolls are driven, or at least the small (male) rolls are driven to achieve wedging or self-guiding action.

It is another object of this invention to provide a cross-roll straightener in which the cross-rolls are mounted for easy and quick replacement.

It is another object of this invention to provide a cross-roll straightener in which the cross-roll mounting frame is pre-loaded in such manner as to minimize the effects of shock loads and to favorably distribute loads for efficient straightening without marring the stock.

It is another object of this invention to provide a cross-roll straightener in which the cross-rolls are angularly adjustably mounted.

It is another object of this invention to provide a cross-roll straightener in which the cross-rolls are relatively adjustable transversely toward and away from one another to vary the width of the pass therebetween to work on round stock of different diameters, and to provide a pre-loaded adjusting screw for making such adjustments.

It is an other object of this invention to provide a cross-roll straightener in which the cross-roll drive motor is fixedly mounted on the base or frame of the straightener and in which the cross-roll driven thereby is journalled in an adjustable mount and is coupled to the motor through a flexible power transmission that permits adjusting movements of the mount.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the 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 a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a side elevation view of a cross-roll straightener embodying the present invention;

FIG. 2 is a cross-section view in a vertical plane passing through the longitudinal working axis of the straightener, such section having been taken along line 2—2, FIG. 3;

FIG. 3 is a transverse cross-section view taken along line 3—3, FIGS. 1 and 2;

FIG. 4 is a side elevation view of a set of curved pass cross-rolls according to the present invention;

FIG. 5 is a cross-section view of round stock taken at the middle of its curved pass between the cross-rolls of FIG. 4;

FIGS. 6, 7, 8, and 9 are respectively top plan (FIG. 6), side elevation (FIG. 7), stock entering end elevation (FIG. 8 as viewed along line 8—8, FIG. 7), and stock emerging end elevation views (FIG. 9 as viewed along line 9—9, FIG. 7) of curved pass cross rolls; and

FIGS. 10 and 11 are respectively side and end elevation views of a set of three cross-rolls that form a curved pass therebetween.

Referring now in detail to the drawings and first to FIGS. 1, 2, and 3, the cross-roll straightener herein shown comprises a frame assembly **1** which includes a rugged generally rectangular base **2** which is adapted to be bolted to a solid foundation F as shown. Fitted in guides **3** formed on the top of base **2** are upstanding plates **4** and **5**, the plates **4** and **5** being joined together by three tie rods **6**, **7**, and **8** and being secured to the base **2** by bolts **9** which, as is apparent, are effective when tightened to tend to bow the plates **4** and **5** between the tie rods **7** and **8** and/or machined surfaces **3** in the base **2**. Vertical bolts, not shown, may be used to further secure plates **4** and **5** to the base **2**.

The tie rod **6** preferably is pre-stressed in tension and comprises a tube or hollow member **10** through which the rod **11** extends, the rod **11** being slipped in the tube **10** in heated condition and the nuts **12** being tightened against the tube ends. Thus when the rod **11** cools to the same temperature as tube **10**, the rod will tend to become shorter in length, thereby creating tensile stress therein. As seen in FIG. 3, the rod **11** is held in this pre-stressed condition by nuts **12** which are tightened against the tube **10** before the rod cools. Accordingly, the upper ends of the plates **4** and **5** will be held against separation until the separating force exceeds the preload of the tie rod **6**. Nuts **14** serve to clamp the tie rod ends in place in the slots at upper ends of plates **4** and **5**. If desired, the other tie rods **7** and **8** may be of the same general type as tie rod **6**. Tube **10** may be dowelled to rod **11** and the latter keyed to one of the plates **4** or **5**. A structure for holding a top safety guide may be welded to said tube **10** before the preloading thereby providing for an easily removable support for such a safety guide. A similar structure for supporting a bottom safety guide may be mounted on bolts **7** and **8**.

The plates **4** and **5** carry the angularly adjustable cross-roll mounts **15** and **16** for the cross-rolls **17** and **18**. The mount **15** has a transverse shaft **19** that is rotatable in plate **4** and angular adjustment is made by turning the nuts **20** and **21** on the bolt **23** that is pivotally connected to the mount, the nuts being formed with cylindrical portions fitted in counterbores in the opposite sides of the block **24** that is fitted on tie rod **8**. The mount **15** has a circular flange **25** formed with arcuate slots **26** for bolts **27** by which the mount is locked against plate **4** in its angularly adjusted position.

The cross-roll **17** has integral oppositely extending shaft portions **28** and **29** extending through bearings **30** bolted onto both legs of angle mount **15** (these fasteners also may be conventional swing bolts for quick removal when regrinding the rolls or replacing them) and the shaft portion **29** is splined to non-rotatably fit in the worm wheel **31** of the angle drive unit **32**, the unit **32** also being bolted on the mount **15** as best shown in FIG. 2 and being adapted to be retracted and temporarily fastened in retracted position, the shaft **29** and worm wheel **31** thus having a slidably detachable driving engagement as shown at **29'**. The worm shaft **34** is adapted to be motor driven in a manner presently to be explained.

The cross-roll **18** is journalled in bearings **30** on mount **16** in the same way as just described with reference to

cross-roll **17** and the upper shaft portion **35** is driven through another angle drive unit **36**. The worm (not shown) of unit **36** has a splined drive connection to motor **38** by means of spindle **73** and universal joints or couplings **40** and **41** to enable shifting of mount **16** and cross-roll **18** toward and away from mount **15** and cross-roll **17** as required when straightening stocks S of different diameters. Shaft **37** is driven by electric motor **38** mounted on a fixed bracket **39** of plate **4**, there being two universal joints **40** and **41** through which power is transmitted from the motor **38** to the cross-roll **18**. As evident, the universal joints **40** and **41** and the splined sliding fit in spindle **73** permit angular adjustment of mount **16**, such adjustment being effected in the same manner as described in connection with mount **15** except that the block **42** preferably has threaded engagement with tie rod **7** for a reason to be explained.

The mount **16** has a shaft portion **43** that is rotatably fitted in plate **5** and in order to adjustably move the mount **16** toward or away from mount **15**, said shaft portion **43** has threaded engagement with an axially fixed adjusting screw **45**. To prevent skewing or cocking of the upper end portion of the mount **16** on which angle drive unit **36** is mounted the block **42** has threaded engagement with tie rod **7**, the tie rod threads being of the same pitch as the threads of adjusting screw **45**. The tie rod **7** is axially fixed, but rotatable, in plates **4** and **5** and is rotated in unison with adjusting screw **45** through the interconnecting chain **46** that is trained over sprockets **47** and **48** on screw **45** and tie rod **7**.

Referring now to the drive for cross-roll **17** the input shaft **34** of the angle drive unit **32** will be coupled to the electric drive motor **49** through universal joints and splined spindle the same as universal joints **40** and **41** and splined spindle **73**, the motor **49** being mounted on the fixed bracket **50** on plate **5**.

In the present case, the cross-rolls **17** and **18** are driven by separate motors **49** and **38** and are contoured as best shown in FIGS. 4 to 9 to define a curved pass therebetween for the round stock S to be straightened. To form such curved pass where the rolls are inclined at approximately equal angles to the stock (see FIG. 4) and both rolls are of a concave contour (much exaggerated in FIG. 6), one roll **17** must be larger in diameter than the other roll **18**, and in order to equalize the peripheral speeds for every section normal to the centerline of the stock S throughout the pass, the contours of the cross-rolls **17** and **18** should have the same ratio of maximum to minimum working contour diameters.

One or both of the drive motors **38** and **49** are of the variable speed type so that the speeds of the rolls **18** and **17** may be equalized in any plane normal to the axis of the stock S, regardless of smaller variations in the angular positions of the two opposed rolls. If both of said motors are of the variable speed type their adjustment means may be interconnected so that once the suitable relative speeds for the opposed rolls have been found, for a certain set-up, both motor speeds may be increased or decreased, simultaneously, by a single adjustment. The peripheral speeds of the rolls **17** and **18** at their respective maximum diameters are represented by the vectors **55** and **56** respectively in FIG. 4 and, obviously, if the vectors **55** and **56** are equal then so will the vertical components **57** and **58** and the horizontal components **59** and **60** be equal to one another.

While the peripheral speed vectors will change in magnitude toward the throats or necks of the respective rolls **17** and **18**, they will remain equal to each other in any vertical plane normal to the axis of the stock. The corresponding changes in the magnitude of the equal vertical vectors will not however produce any tendency to shift the stock either up or down as it is moved through the pass defined by the rolls **17** and **18**. The change in the equal horizontal vectors will cause some horizontal slippage between the rolls **17** and **18** and the stock S.

With the rolls 17 and 18 contoured as hereinabove explained, the middle portion of the small roll 18 (the male roll) will flex the stock S at the point 61, FIG. 6 into the throat of the large roll 17 (the female roll) and the ends of the working length of roll 17 will support the stock S at the points 62 and 63 for flexing in the middle. It will, of course, be understood that reference to roll length herein refers to roll working lengths rather than to overall lengths since one roll may be longer than the opposed roll and yet have the same effective working length. By proper contouring of the rolls 17 and 18 i.e. by maintaining the maximum to minimum diameter ratios equal to one another and by proper adjustment of the relative motor speed the speed vectors may be equalized in any plane normal to the stock axis, throughout the pass. The angles of inclination, 64 and 65, may be varied somewhat in order to obtain a more or less abrupt flexure; but by adjusting the motor speeds accordingly, small variations in said angles may be compensated for.

A decided advantage of the present curved pass cross-roll arrangement is that stock guides may be dispensed with except for mere safety or for facilitating starting of the stock S. The reason for that is most clearly shown in FIGS. 8 and 9 wherein the tangent lines from the points of contact of the rolls 17 and 18 with the stock S define oppositely disposed wedge angles 67 at the ends of the rolls.

When but one cross-roll is to be driven it should be the smaller one 18 for better entering driving action on the stock S and only one guide (not shown) needs be provided but such guide would hardly be subject to wear since the elasticity of the stock S tends to force the stock into the wedge angles 67. Aside from the obvious advantage that the small roll requires less driving torque, the stock can be supported only by force 61 (FIG. 6) and the opposed wedge supports at both ends of the pass as soon as the larger roll assumes full rotation by the frictional engagement of the stock with both rolls. If the larger roll alone is driven the stock will then be forced toward any guide used particularly on the entering side, making the ratio of the roll diameters a liability rather than an asset.

By reason of the preloading of the frame assembly 1, less deformation thereof will occur when stock S enters between the cross-rolls 17 and 18 whereby the entering end of the stock S will not be damaged and moreover the stock S will enter easily. In the present straightener the changing of the cross-rolls 17 and 18 is easily and quickly accomplished. Also, because the shaft portions of the rolls 17 and 18 are of the same size, the large roll 17, when worn, may be ground down to serve as the small roll 18 with a new roll 17.

Referring now to FIGS. 10 and 11 there is shown therein a set of three cross-rolls 70, 71, 72 of which the roll 70 is the small or male roll and of which the rolls 71 and 72 together constitute the larger or female rolls to accommodate flexing of the stock S by the male roll 70. Because of the angular relationship of rolls 71 and 72 with reference to the deflection of the stock S the difference in diameters of rolls 71 and 72 from roll 70 is not of the same proportion as in FIGS. 4 to 9 while the maximum and minimum diameter ratios are maintained substantially equal. It is to be understood that two equal diameter rolls may constitute the male rolls while the third and the largest roll may constitute the female roll.

The preloading of the adjusting screw 45 is accomplished by threading a nut 74, FIG. 3, onto screw 45 while spring 75 is being compressed during the assembly. Spring 75 will thus force mount 16 and shaft 43 with its nut 78 back on the screw so as to prevent a recoil of the latter when the stock leaves the pass, thereby maintaining the pass opening while new stock enters the pass. Nut 74 is prevented from rotating on the screw by means of radial tongue and groove 76 in nut 74 and retainer 77.

It must be borne in mind that rolls proportioned according to the teachings of this invention may also be employed in groups of three or more. They not only will guide the stock better in two-roll machines or multiple-roll machines where one or more roll sets define curved passes, but will provide for the most efficient rolls possible wherever rolls are employed to flex the stock in a curved pass, whether the pass is defined by two cross-rolls or three or more cross-rolls in a group.

The flexing of the stock S herein is in the approximate form of a parabola. Whereas curved pass cross-roll straighteners heretofore designed with one straight roll and one concave roll effect flexing of the stock in the manner of a simple beam with a load concentrated at the middle, the present straightener employs cross-rolls that form a curved pass like that of a uniformly loaded beam, i.e., in which

$$f=\frac{5wl^4}{384EI}$$

where

"w" is the load per unit length,
"l" is the length of the curved pass,
"E" is the modules of elasticity of the stock,
"I" is the inertia, and
"f" is the deflection or maximum deviation from a straight line through the axis at both ends of the pass.

Additional pressure caused by narrowing the opening between the cross-rolls slightly under the stock diameter will be distributed over the faces of said cross-rolls. This is quite important in the case of tube straightening, particularly thin wall tubing.

It is within the scope of this invention to provide a pass, curved similar to the elastic line of a uniformly loaded simple beam, as it would be preferable in the case of thin wall tubing in order to avoid concentrated forces, but it is also within the scope of this invention to provide a pass curved similar to the elastic line of a simple beam with one load applied in the center. The latter may be preferable in the case of heavy wall tubing and solid round bars. It is also within the scope of this invention to provide cross-rolls that will contact curved stock at one or more places in addition to contacting the same at the throat of the rolls (or the minimum diameter); the rolls being proportioned in such a manner that the ratio of the diameters at these contact points to the minimum diameter, for the respective rolls, will assure the best efficiency possible according to the teachings of the formula given on page 12. This will then include rolls in a group of three, and rolls which contact the stock only in the middle and at each end of the pass. It will include rolls which form a pass formed according to the curvature of a simple beam uniformly loaded as well as the curvature of a simple beam with a single load.

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. A cross-roll straightener and the like comprising a frame assembly including a pair of upstanding spaced apart frame members; opposed cross-roll mounts carried by the respective frame members, cross-rolls journalled on the respective mounts and forming therebetween a pass through which elongated round stock is adapted to be lineally fed and rotated while in contact with said cross-rolls; drive means operatively connected to at least one of said cross-rolls to drive the same; and at least one preloaded tie rod extending between said frame members to reduce deformations due to loads caused by stock entering the pass between said cross-rolls, said rod being prestressed in a hollow member and secured to said member in such prestressed condition, and means to mount said

rod in such prestressed condition in said frame assembly.

2. A cross-roll straightener comprising a frame assembly; a set of concavely contoured cross-rolls journalled in said assembly and defining therebetween a generally parabolic curved pass of substantially uniform size throughout substantially the entire working lengths of said cross-rolls through which curved pass elongated round stock is adapted to be lineally fed while flexed substantially in the form of a parabola and rotated; and drive means operative to drive said rolls at speeds that are substantially equal in any plane normal to the axis of the stock in said curved pass, said cross-rolls being of substantially the same length, at least one of said rolls having a smaller mean diameter, the ratios of the respective diameters of said rolls being substantially the same throughout the axial length thereof.

3. A cross-roll straightener comprising a frame assembly; a set of concavely contoured cross-rolls of substantially equal length journalled in said assembly and defining therebetween a curved pass through which elongated round stock is adapted to be lineally fed while flexed and rotated; and drive means operative to drive at least one of said cross-rolls, and said cross-rolls having different mean diameters but having the ratios of the diameters at the ends of the pass equal to the ratio of the minimum diameters.

4. A cross-roll straightener comprising a frame assembly including a pair of upstanding spaced apart frame members; opposed cross-roll mounts carried by the respective frame members, cross-rolls of substantially equal working lengths journalled on the respective mounts and defining therebetween a curved pass of substantially uniform size throughout substantial axially opposed lengths of said cross-rolls both at the center and at the ends of said pass through which elongated round stock is adapted to be lineally fed while flexed to the general form of said curved pass and rotated; and drive means operatively connected to at least one of said cross-rolls to drive the same, at least one of said rolls having a smaller mean diameter, the ratios of the respective diameters of said rolls being substantially the same throughout the axial working length thereof.

5. A set of cross-rolls for a cross-roll straightener comprising at least two concavely contoured cross-rolls of different mean diameters and of approximately equal working lengths, the ratios of the diameters at the end of the working pass to minimum diameters of the respective cross-rolls being substantially equal so as to define a curved pass therebetween through which elongated round stock is adapted to be lineally fed and rotated while flexed between substantially the entire working lengths of said cross-rolls.

6. A cross-roll mount for a cross-roll straightener apparatus comprising a drive unit on said mount; spaced apart, coaxial bearings on said mount, a cross-roll having oppositely extending shaft portions journalled in said bearings, one shaft portion having slidably detachable driving engagement with said drive unit, said bearings being detachably secured on said mount whereby said cross-roll and bearings may be removed from said mount for replacement.

7. A pair of opposed male and female concave cross-rolls of substantially equal working lengths forming therebetween a curved pass for flexing round stock by advancing and rotating the same therebetween, the mean diameter of the male roll being smaller than the mean diameter of the female roll so that the pressure from the male roll will force the stock into wedged supports formed by both of said rolls at the entering and leaving ends of the pass.

8. A set of cross-rolls for a cross-roll straightener, said set comprising at least two concavely contoured male and female cross-rolls of substantially the same length positioned so as to define a curved pass therebetween through which elongated round stock is adapted to be lineally fed and rotated while contacting substantial lengths on said rolls, the male roll defining one side in said pass being substantially smaller in diameter throughout the length of said pass than such female roll defining an opposite side in said pass and at least the male roll being driven.

9. A cross-roll straightener as set forth in claim 1 wherein said preloaded tie-rod is maintained in its preloaded condition by a pair of nuts threaded on each end of the tie-rod and tightened against the ends of said hollow member surrounding said rod.

10. A cross-roll straightener comprising a frame assembly; a set of cross-rolls journalled in said assembly and defining a curved pass therebetween through which elongated round stock is adapted to be lineally fed while flexed and rotated upon driving of at least one of said rolls; and drive means operative to drive at least one of said rolls; said rolls being shaped so that each one has line contact with the flexed portion of the stock on opposite sides of the latter, said cross-rolls being concavely contoured and being of different mean diameters but having the ratios of the diameters at the ends of the pass to the minimum diameters thereof substantially equal.

11. A cross-roll straightener comprising a set of concavely contoured cross-rolls journalled in said assembly and defining therebetween a curved pass through which elongated round stock is adapted to be lineally fed, the axis of said curved pass conforming substantially to the elastic curve of a uniformly loaded simple beam, the maximum deflection of which is in the order of

$$f=\frac{5wl^4}{384EI}$$

where "w" equals load per unit length, "l" is the length of the pass, "E" is the modulus of elasticity and "I" is the inertia, and "f" is the maximum deviation from a straight line through the axis at both ends of the pass, said cross-rolls being of substantially the same length, and at least one of said cross-rolls having a smaller mean diameter, the ratios of the diameters of the rolls at the ends of the pass to the minimum diameters thereof being substantially equal.

12. A cross-roll straightener comprising a frame assembly, a set of concavely contoured cross-rolls journalled in said frame assembly and forming a curved pass through which round stock is adapted to be fed and rotated, the axes of such cross-rolls being inclined to each other and inclined to the axis of such stock adapted to pass therebetween, said rolls being of unequal mean diameters and contoured to form regions of contact with said stock on opposed sides thereof, both at the central portion of such curved pass and at the respective ends thereof.

13. A machine for processing round stock having cross-rolls forming a pass through which such round stock is adapted to be fed and rotated, a power driven drive shaft for at least one of said rolls, a roll shaft for said one roll, and means angularly to adjust the axis of said roll shaft in a plane normal to the axis of said drive shaft about a center line offset from the axis of said drive shaft whereby no angular acceleration is imparted to said one roll as the result of adjustment of said roll shaft.

14. A machine for processing round stock having cross-rolls forming a pass through which such round stock is adapted to be fed and rotated, a power driven drive shaft for at least one of said rolls, a roll shaft for said one roll, and means angularly to adjust the axis of said roll shaft in a plane normal to the axis of said drive shaft whereby no angular acceleration is imparted to said one roll as the result of adjustment of said roll shaft, said means comprising an angle drive for said roll shaft and universal joints operatively interconnecting said drive shaft and angle drive.

15. In a machine for processing round stock; cross-rolls for feeding and rotating such round stock, the tangent lines from the points of contact of the rolls with such stock defining a wedge angle at the entering end of the rolls; driving means for at least one of said rolls

for forcing such stock into said wedge angle formed thereby as such stock enters therebetween.

16. In a machine of the character described including a pair of spaced apart frame members; at least one preloaded tie rod extending between said frame members to reduce deflections due to loads on said frame members, said rod being prestressed in a hollow member and secured to said member in such prestressed condition, and means to mount said rod in such prestressed condition in said frame assembly.

17. In an apparatus having opposed male and female rolls forming a curved pass for flexing elongated round stock by advancing and rotating the same therethrough; at least two said opposed rolls having unequal mean diameters, the opposed diameters of said two rolls being of the same ratio adjacent at least one end as in the center thereof.

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