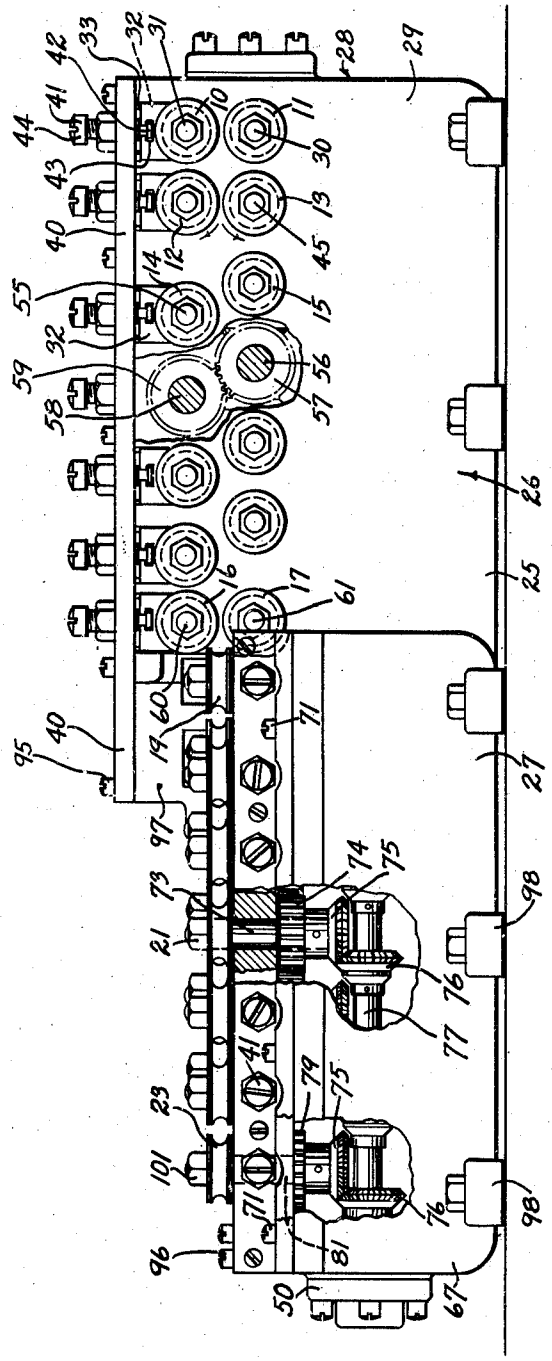
Aug. 18, 1942. J. MASON 2,293,156

STRAIGHTENING APPARATUS

Filed Aug. 7, 1941 3 Sheets-Sheet 1

FIG. 1



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Filed Aug. 7, 1941 3 Sheets-Sheet 2

FIG. 2

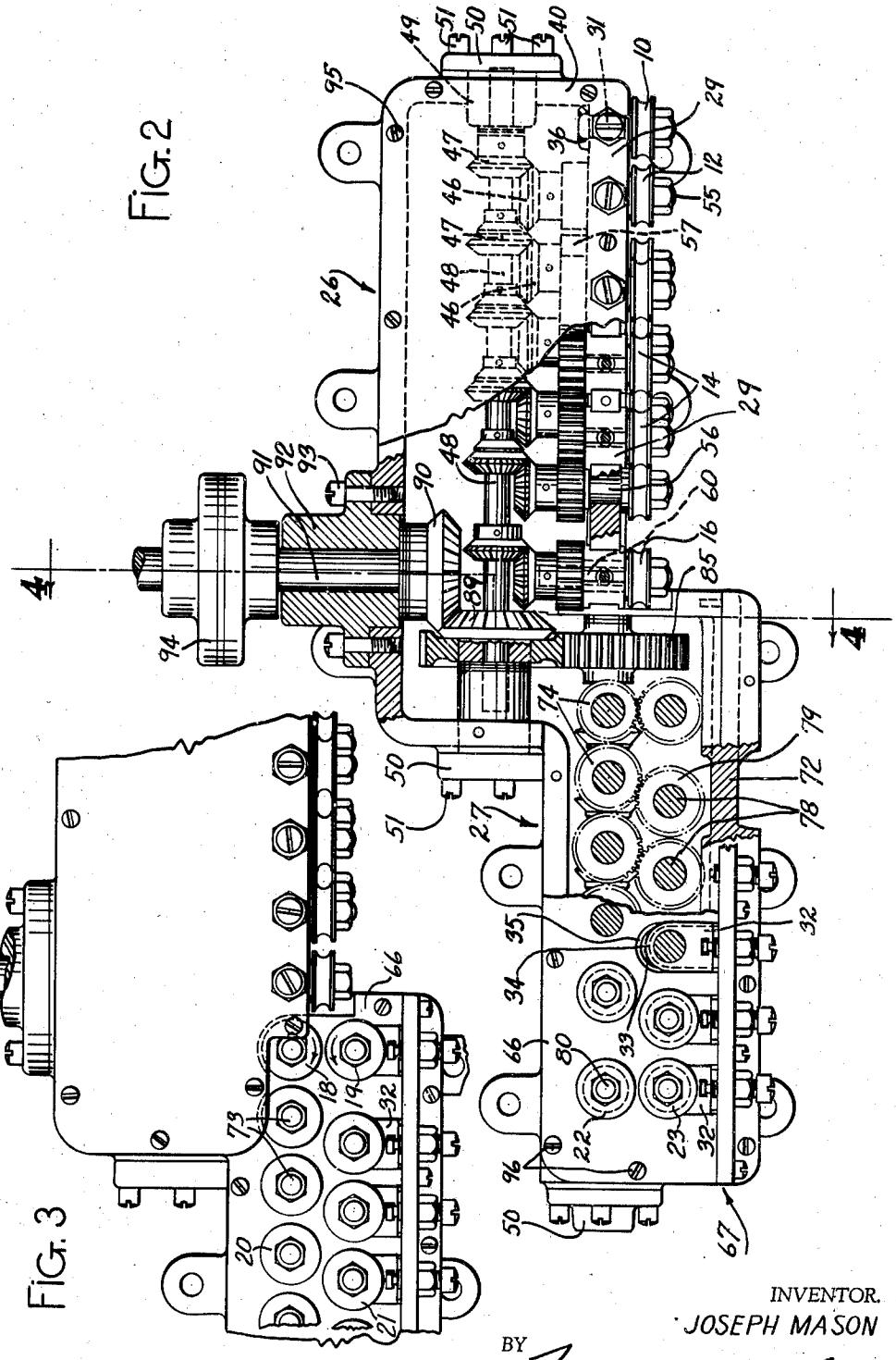

FIG. 3

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Aug. 18, 1942. J. MASON 2,293,156

STRAIGHTENING APPARATUS

Filed Aug. 7, 1941 3 Sheets-Sheet 3

FIG. 5

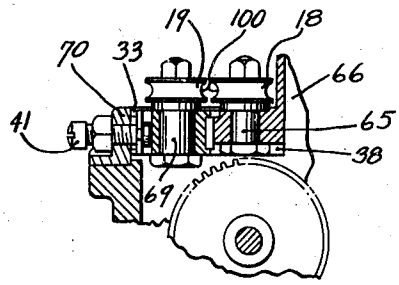
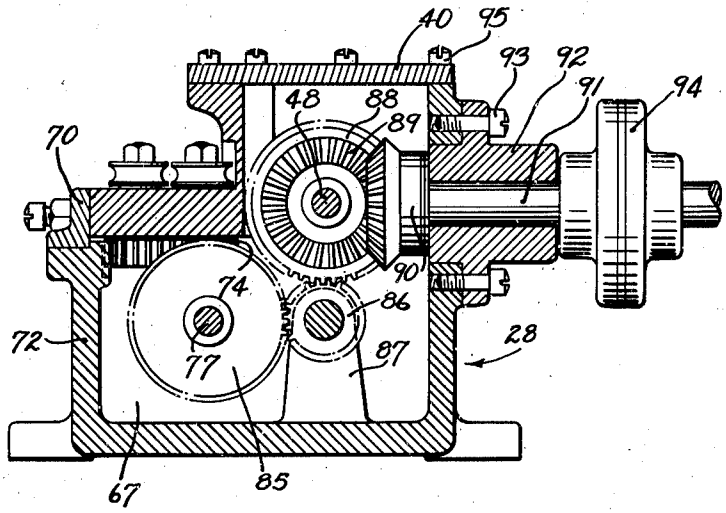


FIG. 4



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UNITED STATES PATENT OFFICE

2,293,156

STRAIGHTENING APPARATUS

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Application August 7, 1941, Serial No. 405,747

4 Claims. (Cl. 153—54)

This invention relates to apparatus for straightening metal tubes and the like, and is of the type in which each tube is passed endwise between a series of staggered opposed rolls arranged in one plane, and then between a similar series of rolls in a plane at right angles to the first.

A general purpose of the invention is to provide straightening apparatus of this type in the form of a compact enclosed unit which can be conveniently mounted, driven and operated. A further purpose is to improve the arrangement and drive of the straightening rolls, and particularly to provide positive drive of the rolls on both sides of the tube path without appreciable backlash or gear play.

In apparatus of this type the straightening rolls project alternately into the tube path from opposite sides to an extent sufficient to bend the tube alternately in opposite directions as it travels along the path between the rolls. The extent of such bending is an important factor in obtaining efficient straightening without undue deformation or damage to the tubes. For this purpose provision is made for adjusting certain of the rolls in a direction transverse to the path in order to obtain the correct amount of bend under given conditions. When the adjustable rolls are positively driven, the combination of suitable drive connections and adjusting means presents a problem which has heretofore been met by providing intermediate connections such as idler gears. Such an arrangement adds materially to the complication of the mechanism, the space required and the power demand. A feature of the invention is the provision of an arrangement in which the adjustable gears are positively driven without the use of intermediate gearing.

An improved construction for guiding and feeding the tubes to the straightening rolls and for transferring the tubes from one set of rolls to the other has been devised. The invention also includes improvements in the construction and arrangement of the supporting and enclosing structure. In the preferred form a single housing is provided in which the mechanism is arranged for ready assembly, accessibility and removal of parts for inspection and repair without extensive disassembling.

The preferred form of the apparatus has been developed particularly for straightening small metal tubes having thin walls, of the type used in fabricating engine radiators. Such tubes must be handled with substantial care and accuracy in order to prevent deformation. The invention includes features of construction which are especially adapted for straightening tubes of this type.

Other objects and advantages will appear from the following description considered in connection with the accompanying drawings in which

Fig. 1 is a front elevation of the straightening apparatus with parts broken away;

Fig. 2 is a top plan view of the apparatus with the upper part of the central portion broken away;

Fig. 3 is a fragmentary top plan view of such central portion of the apparatus;

Fig. 4 is a transverse section on line 4—4 of Fig. 2;

Fig. 5 is a detail vertical section through a pair of idler guide rolls.

The tubes pass through the apparatus from right to left as viewed in Figs. 1 to 3, entering between guide rolls 10 and 11, thence passing between feed rolls 12 and 13 and a series of pairs of offset straightening rolls 14 and 15 to discharge rolls 16 and 17, all of said rolls being arranged in the same vertical plane. For convenience of description herein the parts will be referred to in their vertical and horizontal relationships as shown in the figures; but it is understood that these terms are intended to indicate only the relationship of the parts, as the apparatus may be operated in any desired position.

From rolls 10 to 17, which constitute the first or vertical series, the tubes are passed to the second or horizontal series of rolls consisting of guide rolls 18 and 19, pairs of offset straightening rolls 20 and 21, and discharge rolls 22 and 23.

The rolls and the drive mechanism are mounted on a suitable support or frame. For this purpose a unitary casing 25 has been provided, including a vertical section 26 carrying the vertical guide rolls 10 to 17 and a horizontal section 27 carrying the horizontal rolls 18 to 23. In the form disclosed vertical section 26 includes a body 28 on which the rolls and drive mechanism of the first series are mounted. Lower guide roll 11 is mounted on shaft 30 journaled in the front wall 29 of body 28 and held against axial movement, as by a suitable retaining nut on the inner side of wall 29. Upper guide roll 10 is similarly mounted on shaft 31 journaled in a bearing block 32 slidably fitting in a vertical guideway 33 in wall 29, block 32 being provided with retaining flanges 34 fitting recesses 35 in opposite faces of wall 29. A similar retaining nut 36 on the rear

end of shaft 31 holds the latter against endwise movement.

Guide rolls 10 and 11 are arranged in vertical alignment; and means is provided for shifting block 32 to adjust the spacing of roll 10 from roll 11. The disclosed construction for this purpose is mounted on cover plate 40 for body 28, and comprises an adjusting screw 41 threaded through plate 40 and provided with an inner head 42 fitting into a horizontal T-slot 43 in the upper end of bearing block 32. Lock nut 44 on screw 41 retains the roll 10 in vertically adjusted position.

Roll 13 is arranged immediately adjacent roll 11 in horizontal alignment therewith, and is mounted on shaft 45 journaled in wall 29, carrying on its inner end a miter gear 46 meshing with miter gear 47 on gear shaft 48 extending lengthwise of body 28 and journaled at its ends in said body. For convenience in removing shaft 48 the ends of the shaft may be journaled in bearings 49 carried by bearing caps 50 removably mounted on the ends of body 28 by screws 51 and overlying openings in said body of sufficient size to permit removal of shaft 48 with gears thereon.

Roll 12 is mounted on shaft 55 journaled in a second bearing block 32, the mounting and adjusting arrangement for which is identical with that heretofore described, and is in vertical alignment with roll 13.

A series of lower straightening rolls 15 is mounted in horizontal alignment with rolls 11 and 13, each roll 15 being fixed to a shaft 56 journaled in wall 29 and carrying a pinion 57 adjacent the rear face of wall 29 as well as a miter gear 46 at the inner end of shaft 56 meshing with a miter gear 47 on shaft 48. Located above and a short distance to one side of each of the lower straightening rolls 15 is an upper straightening roll 14 mounted on a shaft 58 journaled in a bearing block 32 which is mounted and adjusted in the manner already described. A pinion 59 fixed to the inner end of each shaft 58 meshes with pinion 57 on the adjacent lower straightening roll shaft 56, whereby each roll 14 is positively driven from shaft 48.

As heretofore stated, it is desirable to provide a positive drive for both the upper straightening rolls 14 and the lower straightening rolls 15 as well as transverse adjustment of the relative position of these rolls. This is accomplished most conveniently by driving the upper rolls directly from the lower roll drive; but such an arrangement involves the difficulty of maintaining proper meshing of the gears. In order to maintain efficient operation of intermeshing gears, their pitch circles must either coincide or at least must not be spaced by more than a very limited distance, which is substantially less than the desirable range of transverse adjustment of the upper rolls. Intermediate gear trains heretofore employed to avoid this difficulty involve complication of the mechanism, loss of power and increased backlash.

An arrangement has been provided which permits the efficient use of a pinion fixed to a lower roll meshing with a pinion fixed to the upper roll and maintaining efficient driving engagement throughout the range of adjustment of the upper roll. This is accomplished by properly controlling the extent to which the driven upper roll is offset along the article path from the driving lower roll, since an increase in the extent or angle of such offset will substantially reduce the relative movement of the pitch circles of the intermeshing gears caused by a given transverse adjustment of one of the rolls. On the other hand, an increase in such offset will also reduce the extent to which the article is flexed during straightening, and, therefore, is limited by the necessity for maintaining sufficient flexing of the article to straighten it. It has been found, however, that the rolls connected to the intermeshing gears may be offset sufficiently to permit the necessary transverse adjustment while maintaining efficiency of gear operation, without preventing the maintenance of proper flexing, a fact which it is believed has not heretofore been recognized.

For instance, it has been found that if the axis of shaft 58 is offset so that when in normal position it is at an angle of approximately 31.5° from the vertical at the axis of shaft 56, an adjustment which brings rolls 14 and 15 a tenth of an inch closer together vertically will produce a displacement of only .0063 inch in the pitch circles of pinions 57 and 59. It has also been found that when rolls 14 are thus positioned, they are sufficiently offset from rolls 15 to provide the necessary bending of the tubes.

The discharge rolls 16 and 17 are similarly mounted, roll 16 on shaft 60 in bearing block 32 and carrying pinion 59, and roll 17 on shaft 61 carrying pinion 57 and miter gear 46 meshing with a miter gear 47 on shaft 48. Shafts 60 and 61, however, are in vertical alignment.

The guide rolls 18 and 19 on the horizontal section 27 of the casing are arranged in horizontal alignment in register with the path of the tubes, in position to receive a tube discharged from rolls 16 and 17, being advantageously located immediately adjacent the latter rolls, preferably so that the distance between the bite of rolls 16 and 17 and that of rolls 18 and 19 is less than the diameter of a roll. In the form illustrated roll 18 is mounted on a shaft 65 journaled in the cover 66 of body 67 of the horizontal section 27 of the casing, and is held against axial movement by a suitable retaining nut 38 on its inner end, as illustrated in Fig. 5. Roll 19 is fixed to shaft 69 journaled in a bearing block 32 fitting in a suitable guideway 33 in cover 66 and adjusted by screw 41, the general construction and operation of this adjustable mounting being the same as that already described. Rolls 18 and 19 are idlers; and in order to maintain continuous propulsion of the articles the distance between the discharge rolls 16 and 17, and the initial straightening rolls 20 and 21 of the second series, will be substantially less than the length of the article to be straightened.

It has been found advantageous to provide a mounting bar 70 in the form of an angle having a vertical flange fitting against the front edge of cover 66 and detachably mounted thereon as by screws 71, adjusting screws 41 being threaded through bar 70. The lower flange of bar 70 is detachably connected as by screws to the upper edge of the front wall 72 of body 67, which may be suitably flanged and recessed to fit the bar.

A series of straightening rolls 20 are arranged in alignment with guide roll 18, each mounted on a shaft 73 journaled in cover 66. A pinion 74 just below the cover is fixed to each shaft 73 which carries at its lower end a miter gear 75 meshing with a miter gear 76 fixed to gear shaft 77 extending longitudinally of body 67 and journaled at its ends in the body, the left-hand end

of shaft 77 being advantageously mounted in a removable bearing cap 50 in the end of body 67 constructed and arranged in the manner already described.

A straightening roll 21 is mounted adjacent each straightening roll 20 and offset therefrom in the manner already described in connection with rolls 14 and 15, each roll 21 being mounted on a shaft 78 journaled in a bearing block 32 constructed and mounted for adjustment in cover 66 as already set forth, the lower end of each shaft 78 carrying a pinion 79 meshing with pinion 74 and designed to retain effective driving engagement therewith throughout the range of normal adjustment in the manner heretofore indicated.

Rear discharge roll 22 is mounted on shaft 80 journaled in cover 66 and carrying a pinion 74 and miter gear 75 meshing with a miter gear 76 on shaft 77, the front discharge roll 23 being mounted on shaft 81 journaled in a bearing block 32 and carrying pinion 79 meshing with pinion 74 on shaft 80, the construction being the same as that described for each pair of related straightening rolls 20 and 21, except that rolls 22 and 23 are in transverse alignment relative to the path of the tubes.

A suitable arrangement is provided for driving gear shafts 48 and 77; and for this purpose the sections 26 and 27 of the casing are arranged in overlapping relation with the ends of shafts 48 and 77 in register to facilitate a compact and simple gear drive construction. In the illustrated embodiment this comprises a drive pinion 85 fixed to the right-hand end portion of shaft 77 and meshing with an intermediate pinion 86 journaled in a suitable standard 87 (Fig. 4) in the body 28. A drive pinion 88 fixed to gear shaft 48 adjacent its left-hand end meshes with intermediate pinion 86 and carries a coaxial miter gear 89 meshing with miter gear 90 on the end of drive shaft 91 which extends rearwardly through the casing body 28 and is journaled therein. This is conveniently accomplished by providing a bearing cap 92 fitting over a suitable aperture in the body 28 of sufficient size for access to the adjacent portions of the drive mechanism, cap 92 being detachably mounted on the body 28 as by screws 93. Shaft 91 may carry at its outer end any suitable drive means or drive connection, such as coupling 94.

The described arrangement of rolls and roll drive mechanism is arranged so that it may be carried by a unitary casing 25 comprising section bodies 28 and 67 which are formed integrally from a single casting or the like. Cover plate 40 for the vertical section 26 is detachably mounted as by screws 95 engaging edges of body 28, and the cover plate 66 for the horizontal section 27 is similarly detachably mounted on body 67 by screws 96. Cover plate 66 is advantageously provided with an upwardly extending wall 97 at its rear right-hand margin, the wall fitting against the bottom of cover plate 40 and the vertical margins of body 28 in the regions where the body extends above the overlapping portion of horizontal section 27. This arrangement fully exposes the drive gearing when cover plates 40 and 66 are removed, and simplifies the construction of the casing body. The latter may be provided with suitable supports or mounting means, such as the mounting ears 98.

The disclosed construction has been particularly designed to straighten small tubes; and therefore all of the rolls numbered 10 through 23 are advantageously provided with grooved tube-engaging faces 100, the curvature of which may correspond with reasonable closeness to that of the tubes to be straightened. Where tubes of a different diameter are to be straightened, the rolls may be replaced, which is facilitated by detachbly mounting each roll on its respective shaft as by nut 101. The adjustment of bearing block 32 likewise permits accurate adjustment of the machine to different sizes of tubes.

In the disclosed arrangement all of the tube-engaging rolls are positively driven except guide rolls 10 and 11 at the feed end of the machine and guide rolls 18 and 19 at the beginning of the horizontal section 27. This arrangement assures positive flexing of the tubes and the elimination of any possible slippage on idler rolls located in the flexing zone. The provision of the transversely aligned idler guide rolls 10 and 11 in register with and juxtapositioned to the transversely aligned positively driven feed rolls 12 and 13 facilitates the rapid and accurate introduction of the forward end of each tube between the straightening rolls 14 and 15. Likewise the provision of positively driven transversely aligned discharge rolls 16 and 17 at the end of the vertical series in alignment with the idler guide rolls 18 and 19 at the beginning of the horizontal series assures accurate and positive transfer of each tube from the first to the second series of rolls. Similarly, the provision of transversely aligned discharge rolls 22 and 23 not only assures uniform discharge but also the complete straightening of the tube.

The described construction is particularly convenient in providing accessibility of the parts for inspection, lubrication, repair or the like. The removal of cover plate 40 of the vertical section, carrying with it all of the upper rolls and pinions, fully exposes the lower pinions and gear shaft connections. The removal of cover plate 66 with mounting bar 70 exposes the gear shaft, and also the roll drive pinions and gears mounted on the cover 66. The front rolls and pinions mounted on bearing blocks 32 may be likewise removed as a unit by detaching the mounting bar 70.

The principles controlling the relative position of the offset rolls in order to straighten elongated articles by successive undulant bending in two planes at right angles to each other are generally recognized; and while the present arrangement has been designed to provide such bending in accordance with the best practice, an explanation of the previous positioning of the various rolls for this purpose is unnecessary. It is noted, however, that the provision of transverse adjustment for one roll of each pair of straightening rolls makes it possible to set the machine for tubes having varying characteristics, requiring various degrees of bending at different stages in the straightening operation. Moreover, the adjustment of one roll of each pair of transversely aligned rolls assured proper engagement with each tube without slipping or binding.

I claim:

1. Straightening apparatus comprising a series of rolls arranged on opposite sides of the path of an article to be straightened to provide an undulating path, a roll drive comprising a plurality of pairs of intermeshing pinions, the pinions of each pair being rigidly connected to rolls on opposite sides of the path, and a plurality of adjusting devices each arranged to shift a roll

and connected pinion transversely to said path, the pinions of each pair being offset longitudinally of said path by a distance sufficient to maintain the spacing of the pitch circles of said pinions within the limits of effective driving engagement throughout the range of adjustment of a roll connected to one of the pinions.

2. In an apparatus for straightening a workpiece, a support, a plurality of means on said support for forming a work path, including a first roller rotatably mounted on one side of said work path, a first pinion, means mounting said first pinion on said support for coaxial rotation with said first roller, a work engaging element on said one side of said path and spaced from said first roller, bearing guide means on said support, said bearing guide means forming a slideway with the length thereof extending substantially transverse to the length of the work path between said first roller and said element, and on the other side of said work path, a second roller, a second pinion rotating coaxially with said second roller and meshing with the first pinion, bearing means for rotatably supporting said second roller and pinion, and means adjustably mounting said bearing means in the slideway of said bearing guide means whereby said second roller and pinion may be adjusted transversely to said work path with comparatively little relative change between the pitch circles of said pinions.

3. In an apparatus for straightening a workpiece, a first set of rollers rotatably mounted on said support in spaced relation to one another so as to define one side of a work path, means for rotating said rollers, a first plurality of pinions rotatably mounted on said support for coaxial rotation with said rollers, respectively, another roller for adjustably defining the other side of said work path, another pinion rotating with and adjustable with said other roller, the said other pinion meshing with one of said first pinions, a guideway in said support extending transverse to said work path, and movable bearing means in said guideway rotatably supporting said other roller and pinion on the other side of said work path with the said other pinion offset along the length of said work path from the said one pinion with which it meshes, whereby the other roller may be adjusted transversely of the work path with comparatively little relative change between the pitch circles of the intermeshing pinions.

4. In an apparatus for straightening a workpiece, an elongated hollow rectangular box-like support including side walls, a line of fixed bearings extending transversely through one of said side walls and spaced from one edge thereof, shafts rotatably mounted in said fixed bearings, gears on the inner ends of said shafts for driving the same, rollers affixed on the outer end of said shafts and lying adjacent the outer side of said one side wall, pinions affixed on said shafts intermediate the ends thereof and lying adjacent the inner side of said side wall, said side wall having a plurality of slots extending inwardly from said one edge at right angles to the line of fixed bearings, and being staggered with respect to said fixed bearings, the side wall adjacent said one edge comprising a plate having a series of openings therethrough registering with said slots, a plurality of bearing blocks slidable in said slots, threaded means engaged through said openings and engaging said bearing blocks for adjustably holding said bearing blocks, axles rotatably mounted in said bearing blocks, rollers affixed on the outer ends of the last-mentioned axles and lying adjacent said one side wall for cooperating with the first-mentioned rollers, and pinions on the inner ends of the last-mentioned axles and respectively meshing with the first-mentioned pinions.

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