Feb. 26, 1963 C. S. SHUMAKER ET AL 3,078,748

ROLLING MILL

Filed Feb. 3, 1960 2 Sheets-Sheet 1

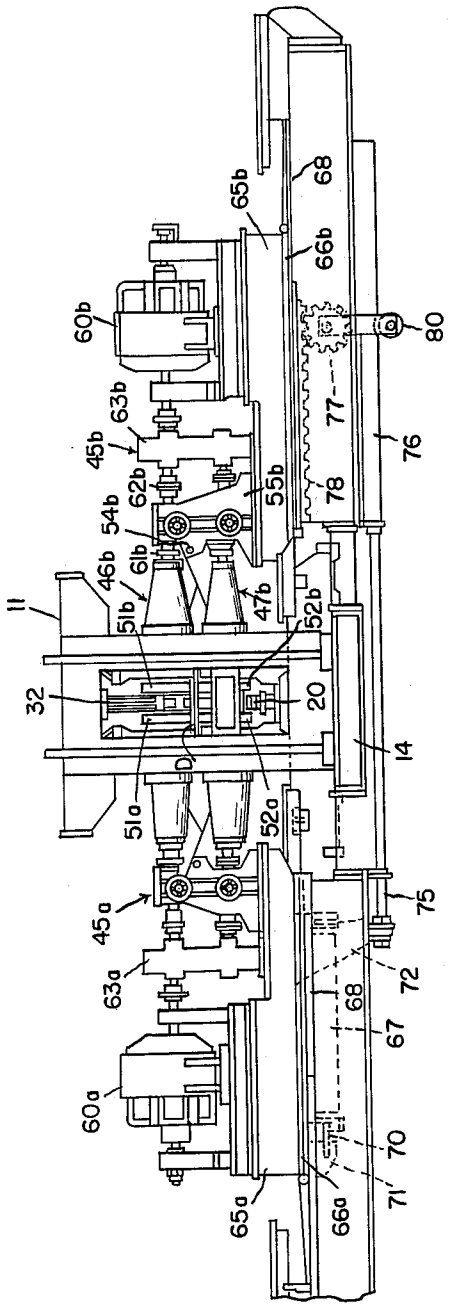


FIG. 1.

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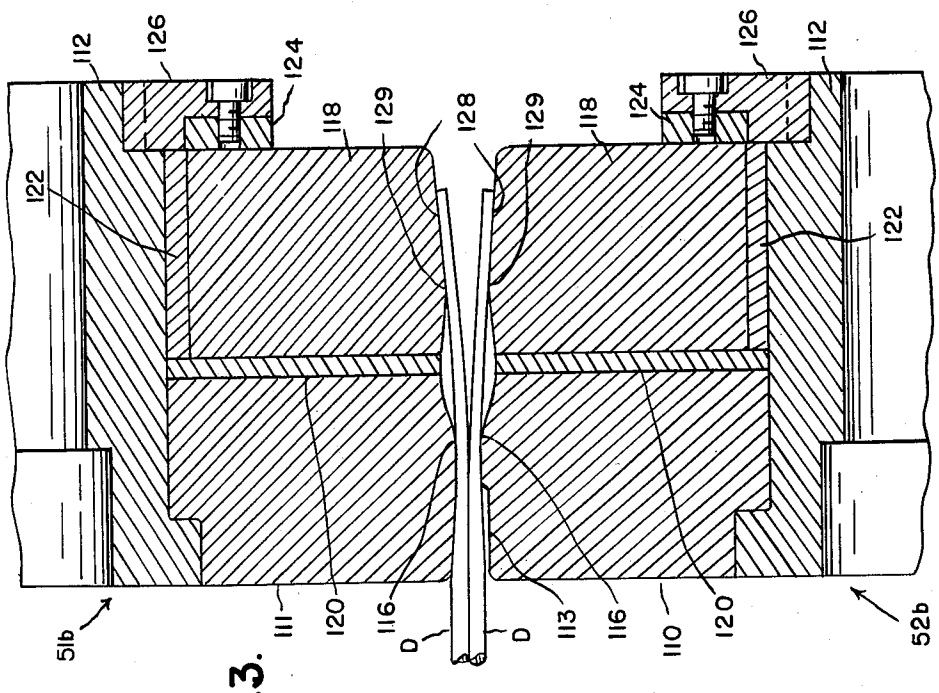


FIG. 3.

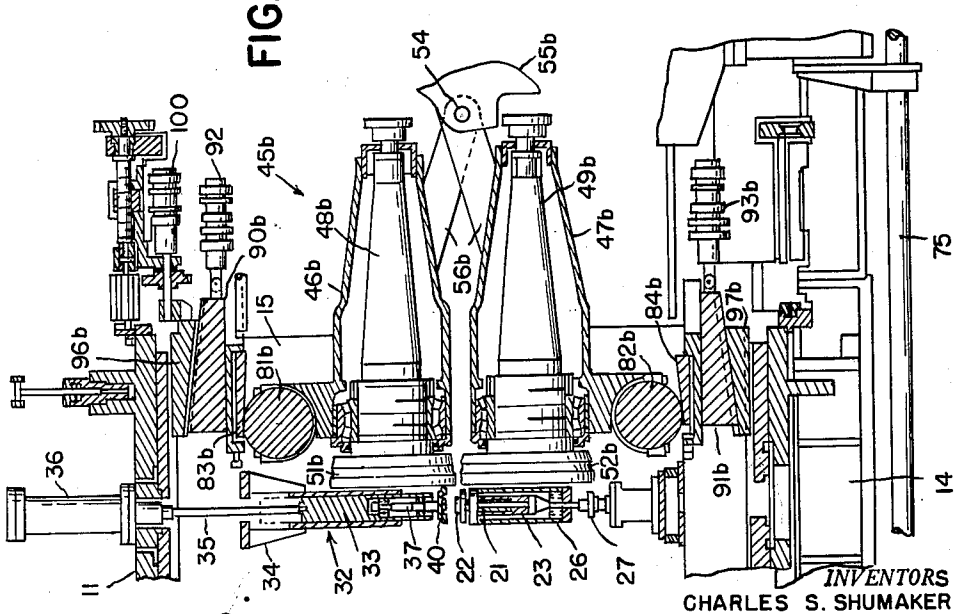


FIG. 2.

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3,078,748

ROLLING MILL

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1 Claim. (Cl. 80—58)

This invention relates to disk rolling machines and refers more particularly to apparatus having a special roll construction for rolling circular disks to a tapered contour for use in the manufacture of vehicle wheels.

The invention has for one of its objects to provide apparatus for forming contoured disks in a highly efficient and economical manner.

The invention has for another object to provide apparatus for forming contoured disks by employing rolls arranged to impose a rolling pressure on opposite sides of the disks, the rolls having their axes extending radially relative to the disks and being movable radially outwardly to apply a rolling pressure along a spiral path of gradually increasing radius.

The invention has for a further object to provide rolling apparatus as described in the preceding paragraph in which the rolls have rolling portions which actually apply a reducing pressure on the disk and confining portions which prevent cupping of the radially outer unrolled portions of the disk, said confining portions constraining the unrolled portions to stretch or elongate thus effecting a partial reduction of the unrolled portions prior to the application thereto of the reducing pressure, and in which the confining portions of the rolls are freely rotatable relative to the rolling portions thereof to preclude scuffing of the unrolled portions of the disk.

The invention has for still another object to provide rolling apparatus as described above for forming two disks at a time by rolling them simultaneously while in back-to-back relation to each other.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating a preferred embodiment of the invention, wherein:

FIG. 1 is a side elevational view of a rolling mill embodying the invention;

FIG. 2 is an enlarged view of a portion of FIG. 1, partly in section; and

FIG. 3 is an enlarged view of a portion of FIG. 2 showing the roll contour and construction.

Referring now more particularly to the drawings and especially to FIGS. 1 and 2 thereof, there is illustrated a mill for rolling tapered disks which includes a housing 11 supported on and secured to the bed plates 14. The end walls of the housing are formed with openings 15 for receiving the mill rolls as will appear more fully hereinafter.

The mill is designed to simultaneously roll a pair of circular metal disks D placed back to back on the vertical work support or spindle assembly 20 which is disposed centrally within the housing on the vertical center line of the mill.

The work support or spindle assembly 20 comprises a vertical stem 21 having a flanged element 22 secured to the upper end thereof on which the disks rest. The central hub of the element 22 receives the central opening in the disks. The stem 21 is received within a cartridge 23 and is keyed thereto for rotation with the cartridge as a unit. The cartridge is rotatably received within a sleeve 26 secured to housing 11, and the lower end of the cartridge 23 extends beneath the sleeve and is connected

by a coupling 27 through a gear unit 28 to a suitable source of power (not shown) for rotating the cartridge and hence the disks D.

A hold-down assembly 32 is provided which is mounted above and coaxial with the spindle assembly. The assembly 32 comprises a plunger 33 vertically slidable in a bracket 34 and having secured to its upper end a piston rod 35 extending downwardly from the piston of a double acting cylinder 36 mounted on top of housng 11. A hold-down shaft 37 is rotatably carried by the plunger 33 and has a cup-like shoe 40 at the lower end engageable with the disks on the spindle assembly. The hold-down shaft is movable vertically as a unit with plunger 33 and therefore is raised and lowered by the action of cylinder 36.

When a pair of disk blanks are positioned on the spindle assembly and the hold-down shoe 40 engages the disks, the disks may be rapidly accelerated to the proper speed for rolling, after which the disks may be rapidly decelerated with the aid of the hold-down assembly. The cylinder 36 clamps the disks between the spindle assembly and the hold-down shoe under sufficient pressure to enable a rapid acceleration or deceleration of the disks.

The disks are rolled by the rolling units 45*a* and 45*b* respectively disposed at opposite ends of the housing 11 and adapted to extend into the housing through the openings 15. The various elements of the two rolling units are exactly the same and hence only the unit to the right in FIG. 1 will be described. The unit to the left has its parts identified by the same reference numerals followed by the letter "*a*" whereas the identifying numerals for the righthand unit are followed by the letter "*b*."

The unit 45*b* includes a pair of roll heads 46*b* and 47*b* which are disposed one above the other in the same vertical plane and have roll shafts 48*b* and 49*b* therewithin. The roll shafts are supported within the heads for axial rotation by suitable bearings and respectively carry rolls 51*b*, 52*b* at their inner ends. The vertical plane of the heads 46*b* and 47*b* contains the spindle and hold-down assemblies 20 and 32, and the rolls 51*b* and 52*b* cooperate to roll the pair of disks to a predetermined taper by engagement with the upper and lower sides of the pair.

The heads 46*b* and 47*b* pivot toward and away from each other about a stub shaft 54*b* secured to the roll support stand 55*b*. The heads have mounting extensions 56*b* supported on the pivot shaft 54*b*. The heads may thus be moved with respect to the axis of the pivot shaft 54*b* so as to move the rolls 51*b* and 52*b* toward or away from each other to roll the disks to the desired contour. The shafts 48*b*, 49*b* extend through the outboard ends of the heads and are driven by a motor 60*b*. The outboard ends of the shafts 48*b* and 49*b* are connected by universal couplings 61*b* through the spindles 62*b* to the output side of the common gear drive 63*b* driven by the motor 60*b*. The rolls 51*b*, 52*b* are driven at the same speed to impart a rotation to the disks during rolling.

The two roll units 45*a* and 45*b* are supported for movement toward and away from the spindle support, and means are provided for assuring a simultaneous equal movement thereof. Each unit is mounted on a platform 65*a*, 65*b* supported for longitudinal sliding movement on suitable guides 66*a*, 66*b* which extend longitudinally of the apparatus. A double acting piston-cylinder assembly 67 is secured to a fixed sub-platform 68 and disposed longitudinally of the paths of the rolling units, and the piston rod 70 is secured by a bracket 71 to the platform 65*a*. Beneath the platform 65*a* and secured to a bracket 72 thereof is an equalizer tension rod 75 which passes beneath the mill toward the other unit 45*b*. A rack 76 is secured to the other end of a rod 75 and has teeth on the upper side in mesh with a gear 77 secured to the fixed sub-platform 68. A rack 78 secured to the platform 65*b*

also meshes with gear 77 thus assuring a simultaneous equal movement of the roll units in directions toward and away from the work supporting spindle assembly 20. The roller 80 depending from the fixed sub-platform 68 provides an anti-friction support for the tension rod.

By moving the roll units simultaneously and equally away from the work support, and at the same time controlling the position of the rolls of each unit with respect to each other, the pair of disks may be rolled to a predetermined contour, such as a uniform taper, and the rolls of both units will engage the same portion of the disks during rolling. The roll units 45*a* and 45*b* are longitudinally movable from an inner limit adjacent to the spindle support to an outer limit beyond the periphery of the disks. Hence the rolls will apply a rolling pressure to the disks along a spiral path of gradually increasing radius. The disks will of course rotate with the driven rolls due to the pressure of engagement therewith. The rapid acceleration of the disks by the spindle assembly takes place before rolling commences so that the disks will attain the speed of the rolls prior to engagement thereby, and the disks are rapidly decelerated after rolling to facilitate subsequent handling and removal.

The movement of the roll heads of each unit toward and away from each other is controlled by suitable structure shown in FIG. 2. The heads 46*b* and 47*b* carry cam rollers or followers 81*b*, 82*b*, the axes of which are at right angles to the axes of the roll shafts. These cam rollers engage the wedge-shaped cams 83*b*, 84*b*. These cams are suitably inclined to define the movement of the roll shafts toward and away from each other during the outward movement of the roll units, and thereby determine the rolled contour of the disks. The cams can move vertically only, being held from transverse or longitudinal movement by suitable vertical guides on the housing 11. Wedges 90*b*, 91*b* engage the cams and cylinders 92*b*, 93*b* move the wedges and hence the cams between roll open and roll closed positions. The wedges 96*b*, 97*b* engageable with the wedges 90*b*, 91*b* are provided to determine the amount of reduction or thickness after rolling. The lower wedge 97*b* is fixed and the upper wedge 96*b* is controlled by cylinder 100.

Referring now more particularly to FIG. 3, the rolls 51*b*, 52*b* are shown on an enlarged scale so that the contour and construction thereof will be readily apparent. The rolls 51*a* and 52*b* are of exactly the same construction as are rolls 52*a* and 51*b*. Rolls 51*a*, 52*b* differ from rolls 52*a*, 51*b* only in the contour of the work ring, as will appear more fully hereinafter. Each roll comprises a circular work roll fixedly secured to the roll hub 112 on the roll shaft. Work roll 110 of roll 52*b* differs from work roll 111 of roll 51*b* in that the former has a relieved peripheral surface portion 113. Otherwise the work rolls 110 and 111 are identical. The work roll thus rotates as a unit with its roll shaft and cooperates with the work roll of the opposed roll in applying a rolling pressure to opposite sides of the pair of disks supported by the spindle assembly sufficient to reduce the cross-section of the disks. The work rolls have circular portions 116 of enlarged diameter where the rolling or reducing pressure is most highly concentrated. Outwardly of the enlarged portion 116, the roll contour is curved on an arc to provide a lead in.

Each roll also includes a free-running ring 118. The ring 118 is circular, of the same thickness or axial dimension as the working ring, and is supported for free rotation on the roll shaft 112. Secured to the outer face of the work ring is a disk-shaped bushing 120 and secured to the roll hub is a cylindrical bushing 122. The free running ring 118 encircles the bushing 122 and is axially confined by a bushing 124 in cooperation with the bushing 120. Bushing 124 is secured to a clamping ring 126 on the roll hub.

The free running rings 118 define circular peripheral disk confining portions 128 which do not actually impose

a rolling pressure on the disks but serve to confine the disks and retain the unrolled portions thereof close to each other and to prevent the tendency of the disks to cup or curl at their outer margins. The confining portions 128 are of greatest diameter at the point 129 and from there flare outwardly as shown. Hence, maximum confining is at point 129. The maximum diameter of the confining portions 128 is slightly less than the maximum diameter of the work rolls and the angle of the flare is small, and not greater than about 6°.

The rolling pressure imposed upon the disks by the work rolls 110 and 111 has the effect of causing the radially outer unrolled portions of the disks to cup. This is undesirable since very often the two disks will cup in the same direction with the result that the outer margins will curl together and interlock with the further result that one disk may be reduced more than the other at the outer periphery. Another disadvantage of cupping is that additional friction occurs and more power is required to uncurl or straighten the cupped portions.

The confining portions of the free runing rings 118 not only serve to prevent curling but actually cause the radial compressive forces incident to the rolling action of the work rolls 110 and 111 to so act upon the disks that the portions between the free running rings is reduced by elongation. In other words, the metal displaced or squeezed by the work rolls flows outwardly, and since the disks cannot cup or curl the result is a circumferential stretching and hence a radial elongation of the disks in advance of the actual application of rolling pressure thereto, thereby reducing the thickness of the unrolled portions of the disks.

By reason of the fact that there is an actual reduction of an outer portion of the disks prior to actual contact with the work rolls of the rolls, the entry of the metal into the bite of the work rolls will be quite gradual, resulting in a smooth gentle rolling action which would not be the case if the disks were unrestrained and permitted to curl to their fullest extent during rolling. Since this relationship is maintained throughout the rolling cycle, as the blanks are progressively reduced in thickness by an actual rolling action of the work rolls, there is a corresponding progressive reduction in thickness of the metal outwardly of the area being rolled. The unrolled outer portions of the disks thus reduced by elongation or stretching are of course subsequently rolled by the work rolls as the rolls move outwardly. Hence, the action of the rolls in the final reduction of the disks reaches a maximum in efficiency by consistency of bite and thus consistency of final gauge.

The disks are rotated by the rolls by reason of the pressure engagement of the work rolls with the disks. However, the linear velocity of the portion of the disks engaged by the work rolls is substantially less than the linear velocity of the portion of the disks engaging the free running rings. This is due to the difference in radius between the disk portions actually subjected to high rolling pressure and the disk portions constrained or confined against cupping by the free running rings. It is for this reason that the confining rings are free running and therefore free to be rotated by and at the same speed as the portions of the disks engaged thereby. If the work rolls 110 and 111 and the confining rings 118 rolled as a unit and at the same speed, scuffing of the disks by the confining rings would result.

What we claim as our invention is:

A roll for use in reducing a flat circular blank of a substantially uniform thickness to form a flat disk of a given contour in which there is included a rolling portion for contacting and reducing said blank, and a back-up portion freely rotatable relative to said rolling portion for preventing cupping of that section of said blank in advance of the section reduced by rolling, said back-up portion being at the axially outer side of said rolling portion and of substantially the same axial dimension as

said rolling portion, said back-up portion being of a maximum diameter adjacent its axially inner end closely approximating although slightly less than the maximum diameter of said rolling portion, the periphery of said back-up portion axially outwardly of the point of maximum diameter being substantially flat in radial section and extending from said point of maximum diameter at an angle to the roll axis not greater than about 6°, said rolling portion and said back-up portion being so contoured that said back-up portion engages a greater area of said blank than the area engaged by said rolling portion thereby confining said greater area to provide for circumferential and radial stretching of that section of said blank in advance of the section engaged by said rolling portion.

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