April 21, 1925. 1,534,860

A. MARTIN

MILL FOR ROLLING TAPERED DISKS

Original Filed May 26, 1922 4 Sheets-Sheet 1

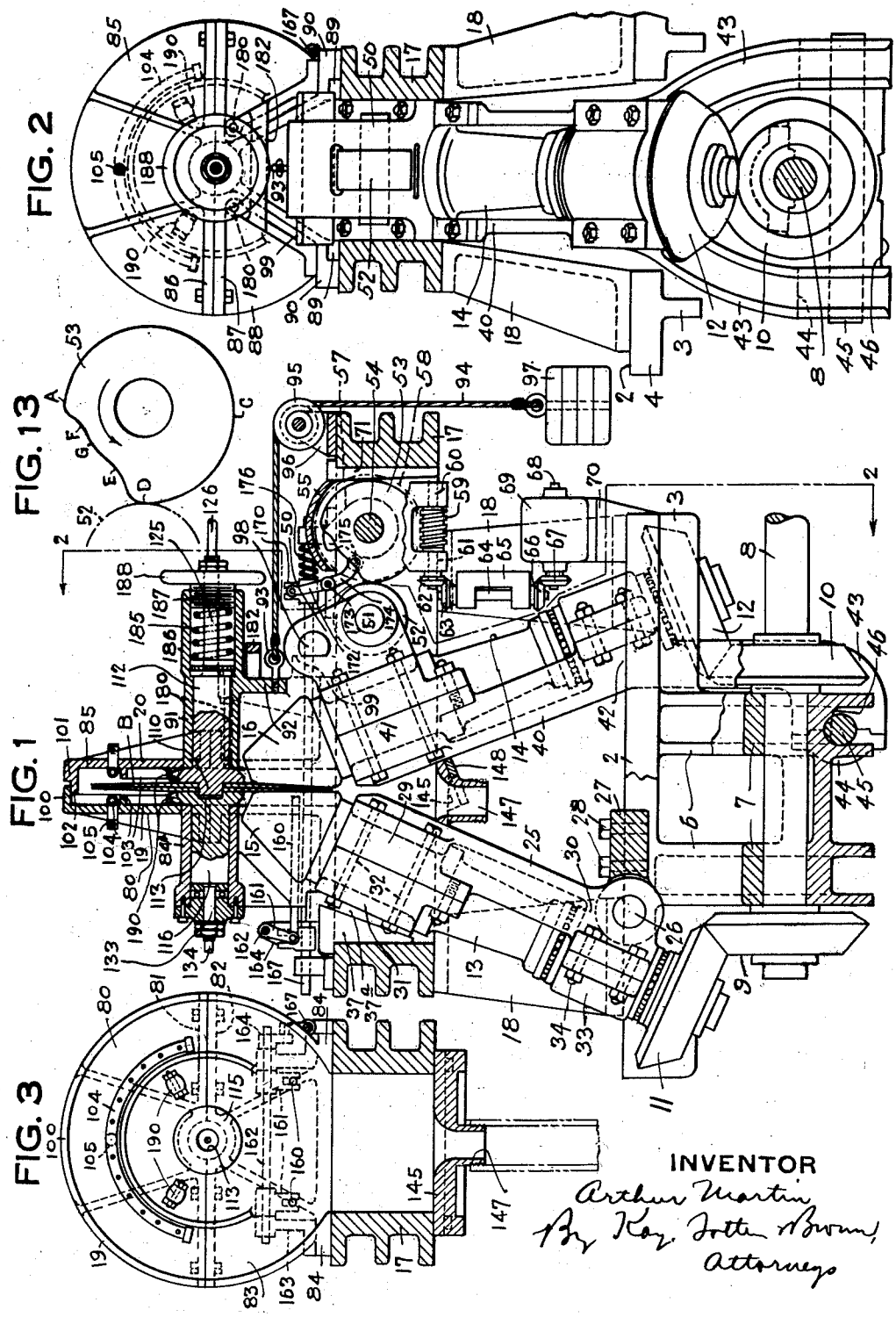


FIG. 2

FIG. 13

FIG. 1

FIG. 3

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FIG. 4

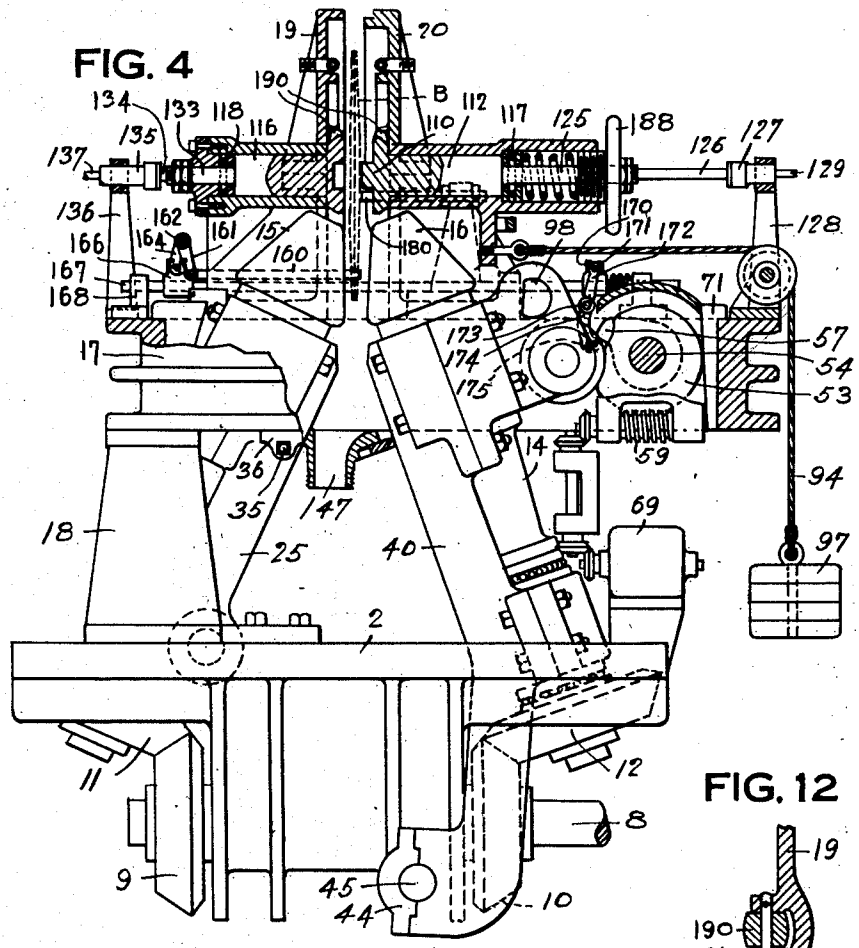


FIG. 12

FIG. 11

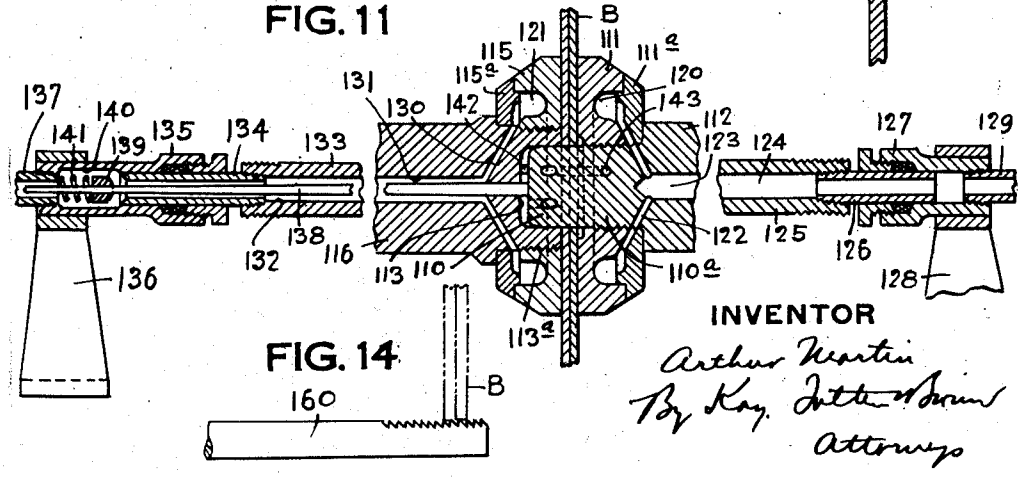


FIG. 14

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FIG. 5

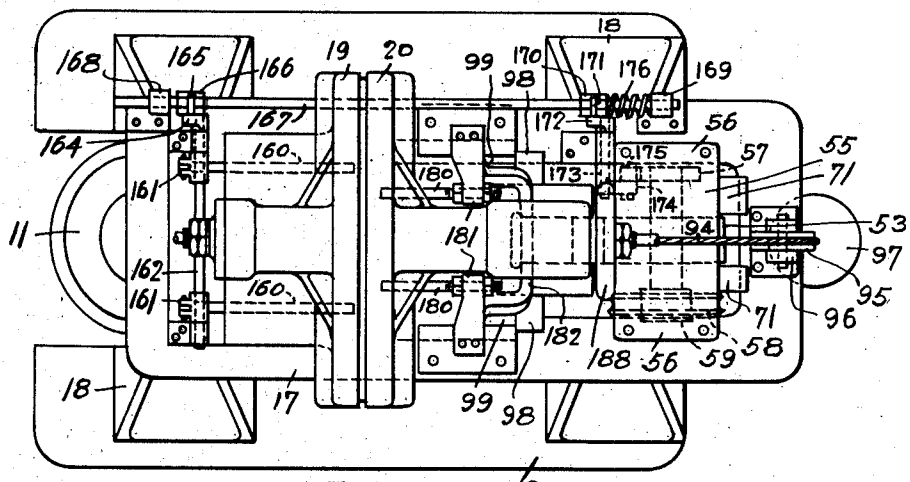


FIG. 6

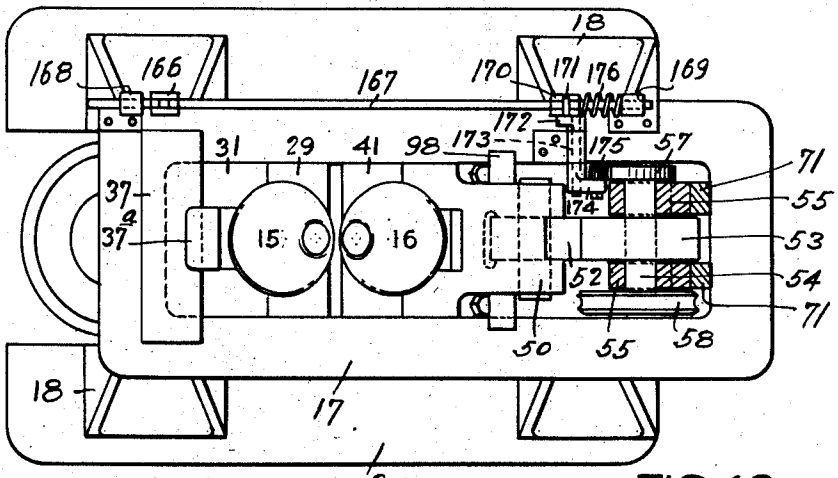


FIG. 7

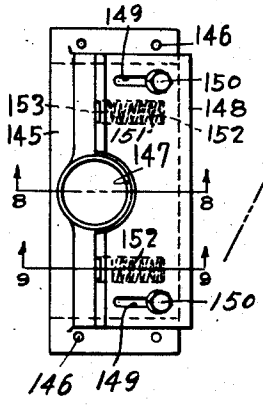


FIG. 8

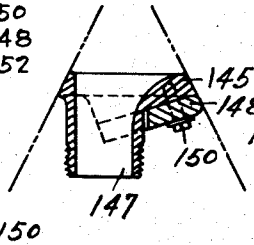


FIG. 9

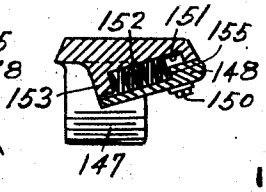
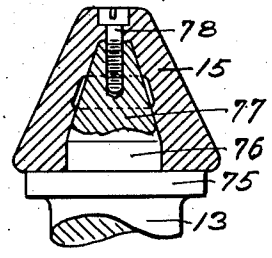


FIG. 10



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FIG. 15

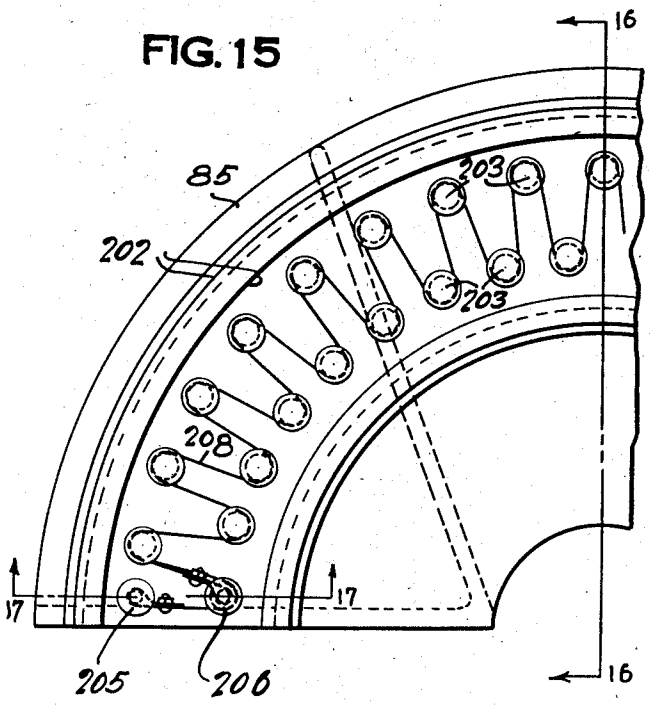


FIG. 16

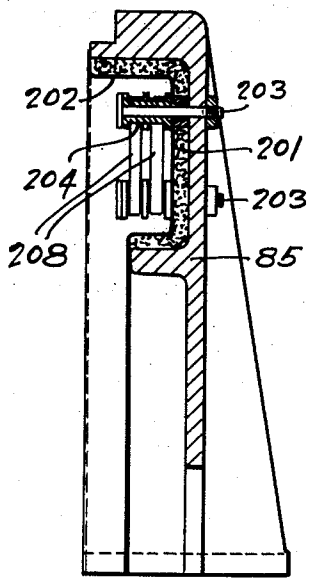
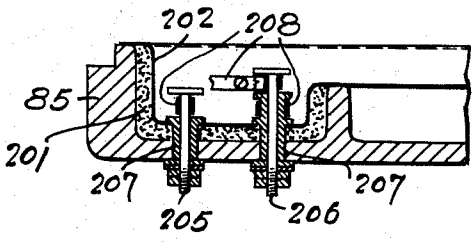


FIG. 17



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Patented Apr. 21, 1925. 1,534,860

UNITED STATES PATENT OFFICE.

ARTHUR MARTIN, OF PITTSBURGH, PENNSYLVANIA.

MILL FOR ROLLING TAPERED DISKS.

Original application filed May 26, 1922, Serial No. 563,877. Divided and this application filed June 21, 1923. Serial No. 646,860.

To all whom it may concern:

Be it known that I, ARTHUR MARTIN, a citizen of the United States, and resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Mills for Rolling Tapered Disks; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the art of rolling metal, and it has special reference to the manufacture of tapered disks for automobile wheels and for other purposes.

Another object of my invention is to provide a rolling mill for tapered disks which shall be of simple and rugged construction, and shall employ frusto-conical rolls mounted and operated in an improved manner.

My improved rolling mill consists of two frusto-conical rolls mounted on shafts which preferably are mounted upright with their axes of rotation in a common vertical plane, and having cam-operated means for feeding one of the rolls toward the other during the rolling operation. The movable roll is mounted in a novel manner for rocking upon an axis which is so arranged that the rocking movement of the roll shaft causes the movable roll to approach and recede from the fixed roll in a substantially straight path. The upper roll bearings and the cam mechanism for feeding the movable roll are all mounted in a rigid yoke of novel construction. The blank to be rolled is mounted on a mandrel within a housing which opens to receive and discharge the blanks, and is closed during the rolling operation, and I provide means for exhausting the air from the interior of the housing, and also, if desired, for heating the interior of the housing near the periphery of the blank so as to produce non-oxidizing conditions within the housing, and also to heat the edge of the blank which is the portion which cools most rapidly.

The general features just mentioned, together with other novel devices which contribute to the perfect operation of the machine, are shown in the accompanying drawing, in which Fig. 1 is a side view, partly in elevation and partly in section, of a complete rolling mill constructed in accordance with my invention, showing the blank housing closed and a pair of blanks at the end of the rolling operation; Fig. 2 is an end elevational view of the same machine, partly in section on the line 2—2, Fig. 1; Fig. 3 is a view, partly in elevation and partly in section, of one-half of the blank housing; Fig. 4 is a side elevational view of the machine, with parts in section, showing the blank housing open; Fig. 5 is a plan view of the machine; Fig. 6 is another plan view, with the blank housing and its attachments removed; Fig. 7 is a bottom plan view of the bottom closure plate for the blank housing; Fig. 8 is a detail vertical sectional view taken substantially on the line 8—8, Fig. 7; Fig. 9 is another detail vertical section taken substantially on the line 9—9, Fig. 7; Fig. 10 is a longitudinal sectional view taken axially through one of the rolls, showing the manner in which the roll is attached to its shaft; Fig. 11 is a longitudinal sectional view taken axially through the blank-supporting mandrel and its attachments; Fig. 12 is a fragmentary sectional view showing one of the blank guide rollers; Fig. 13 is a diagrammatic side view of the roll-operating cam and the cam-roller; Fig. 14 is a detail view of one of the blank-positioning rods; Fig. 15 is a fragmentary elevational view showing a modified form of heating device, and Figs. 16 and 17 are sectional views taken on the lines 16—16 and 17—17, respectively.

In the drawing, the numeral 2 indicates a rectangular base frame having depending ribs 3 which are spaced from the edges of the base 2 to form flanges 4 upon which the mill may be supported upon a floor or other stationary support. Hangers 6 are formed beneath the base 2 and support bearings 7 for a drive shaft 8 which is driven from any suitable source of power, not shown, and which carries bevel gear wheels 9 and 10 meshing with bevel gear wheels 11 and 12 that are secured to the lower ends of inclined roll shafts 13 and 14 to the upper ends of which are secured frusto-conical rolls 15 and 16.

A rigid yoke 17, suitably made of cast iron, or cast steel, and formed in one piece, is supported upon four standards 18 carried by the base 2. The yoke 17 guides and supports the rolls with their operating mechanism, and also supports a housing composed of separable sections 19 and 20 in which the blanks are enclosed while being rolled.

The roll shaft 13 is mounted in a bearing block 25 which is supported on a pivot pin 26 carried by a slide 27 that is movable for adjustment on suitable ways formed in the base 2 and may be secured in its adjusted position by means of bolts 28. The bearing block 25 is formed at its upper end with a half-bearing 29 which is constructed like one-half of a mill-bearing of ordinary construction, and is also formed near its lower end with a half-bearing 30 which forms one-half of a roller thrust bearing. The mill bearing at the upper end of this shaft is completed by a removable half-bearing 31 which is secured to the half-bearing 29 by means of bolts 32. The roller thrust bearing at the lower end of the shaft is similarly completed by means of a removable half bearing 33 secured to the bearing 30 by means of bolts 34. The angular position of the bearing block 25 is fixed by means of set-screws 35, Fig. 4, which extend through projections 36 formed on opposite sides of the yoke 17 and which bear against the sides of the bearing block 25.

The sliding movement of the slide 27, and the angular movement of the bearing block 25 around its pivot 26, permits the roll shaft 13 to be adjusted at the beginning of a rolling operation, after which this roll shaft is fixed in position by means of the bolts 28 and the set screws 35. Wedges 37 and 37ª are provided to give a fine adjustment of the angle of inclination of the roll shaft 13.

The roll shaft 14 is mounted in a bearing block 40 which, like the bearing block 25, is provided with an upper mill bearing 41 and a lower roller thrust bearing 42. The bearing block 40 is supported upon a forked yoke 43 in the lower ends of which are formed bearings 44 which receive the ends of a pivot shaft 45 which is supported in bearings 46 carried by one of the hangers 6 of the frame. By this construction the roll shaft 14 and the roll 16 are permitted to swing around the axis of the pin 45, and since this axis is disposed a considerable distance directly below the roll 16 this roll moves toward and away from the roll 15 in a path which is nearly a straight line.

The upper mill bearings of the roller shafts 13 and 14 are rectangular and fit within the rigid yoke 17, as best shown on Fig. 6. For the purpose of feeding the movable roll 16 toward the fixed roll 15 and for moving the roll 16 away from the roll 15 after the rolling operation is completed, the bearing 41 of the movable roll 16 is provided with two extensions 50 in which is journaled a heavy pivot pin 51 carrying a roller 52 which engages the periphery of a cam 53 mounted on a shaft 54 that is supported in bearings in a block 55 having flanges 56 which project over and are bolted upon the upper surface of the yoke 17. The cam shaft 54 also carries a smaller cam 5ª for a purpose to be described below, and a worm wheel 58 for rotating the cam shaft 54 to produce the proper feed of the roll 16. The worm wheel 58 meshes with a worm 59 carried by a shaft 60 which is mounted in bearings 61 on the under side of the block 55. The shaft 60 also carries a bevel gear 62 meshing with a bevel gear 63 on the upper end of a vertical shaft 64 which is mounted in fixed bearings 65 supported upon one of the standards 18, and carries at its lower end a bevel gear 66 meshing with a bevel pinion 67 on the armature shaft 68 of an electric motor 69 which is mounted on a fixed bracket 70.

An adjustable wedge 71 is interposed between the block 55 and the end of the rigid yoke 17. It will thus be observed that when the rolls 15 and 16 are operating to roll blanks between them, all of the horizontal rolling thrust is taken up by the ends of the rigid yoke 17, and that this yoke, in addition, prevents lateral displacement of the rolls through the close fit of the upper roll bearings in the yoke.

Fig. 10 shows the manner in which the rolls 15 and 16 are attached to the upper ends of their respective shafts. As shown in this figure, the upper end of the shaft 13 is provided with a flange 75 above which is a squared portion 76 of reduced area at the base of a conically tapered end portion 77 which is tapped to receive a stud bolt 78. The roll 15 fits over the squared and conical portions 76 and 77 and is provided with a countersunk opening to receive the stud bolt 78.

The housing which encloses the blanks during the rolling operation is composed, as stated above, of separable sections 19 and 20. The section 19 is composed of a semi-circular casting 80 having horizontal flanges 81 which are bolted to corresponding flanges 82 carried by an arched casting 83, the lower ends of which are provided with flanges 84 which rest upon and are bolted to the opposite sides of the yoke 17. The casting 83 also carries a tubular mandrel bearing 84ª.

The movable housing section 20, like the fixed section 19, is composed of a semi-circular casting 85 having horizontal flanges 86 which are bolted to similar flanges 87 extending from the upper end of an arched casting 88. The lower ends of the arched casting 88 are formed into flanges 89 which are slidably received beneath gibs 90 that are secured to the upper surface of the yoke 17. The casting 88 also carries a tubular mandrel bearing 91. Beneath the mandrel bearing 91 the end of the hollow casting 88 is closed by means of a web 92 in which is secured an I-bolt 93 to which is attached a wire rope 94, or other suitable flexible connector, which extends over a fixed pulley

95 mounted in bearings 96 and serves to suspend a weight 97 which tends to draw the movable housing section 20 away from the fixed section 19. When the cam 53 permits such movement to occur, the movable roll 16 is caused to move with the housing section 20. For this purpose the extension 50 from the upper roll bearing 41 is provided with a pin 98, the ends of which project beyond the bearing extension 50 and are flattened to rest against a flat plate 99 which is carried by the sliding casting 88.

The housings 19 and 20 cooperate to form a circular space which encloses the blanks B while the blanks are being rolled. For this purpose the housing sections 19 and 20 are provided with opposed flanges 100 and 101, respectively, and the flange 101 is provided with an extension 102 which telescopes within the flange 100. Opposed ribs 103 are formed on the inner sides of the housing sections 19 and 20 and cooperate with the flanges 100 and 101 to form a heating chamber within which are disposed two curved burners 104 which are supplied with fuel gas or oil, and with air for combustion, through pipe connections 105. The flanges 103 retain most of the heat from the burners 104 at the peripheral portions of the blanks and prevent overheating of the hub portions and of the mandrel on which the blanks are supported.

As shown in the drawing, two or more of the blanks B are rolled simultaneously, but while this is the most economical method the blanks may evidently be rolled one at a time, if desired. During the rolling operation the blank or pair of blanks is supported on a mandrel 110, the details of construction of which are omitted from the general views 1 and 4 for the sake of clearness. As shown in Fig. 11, the mandrel 110 is formed on the end of a screw-threaded extension 110^a from a shaft 112 which is mounted in the tubular bearing 91 of the movable housing section 20. A mandrel hub 111 is screwed upon the threaded shaft extension 110^a and rests against a plate 111^a. The mandrel 110 moves horizontally with the housing section 20, and when in the working position shown on Figs. 1 and 11 extends into a recess 113 formed in the end of a screw-threaded extension 113^a from a shaft 116 which is received in the tubular bearing 84^a carried by the fixed housing section 19. A mandrel hub 115 is screwed upon the threaded shaft extension 113^a and rests against a plate 115^a. The shafts 112 and 116 are provided with ball bearings or roller bearings 117 and 118 respectively, and are rotated by the blank B as the blank is turned through its engagement between the rolls 15 and 16.

For the purpose of cooling the mandrel hubs 111 and 115, these hubs are provided with annular chambers 120 and 121, respectively. The annular chamber 120 communicates through passages 122 with a horizontal passage 123 formed in the shaft 112 and communicating with a similar passage 124 formed in a reduced extension 125 from the shaft 112. A tube 126 is screwed into the end of the reduced shaft section 125 and extends rotatably through a gland 127 which is supported in a fixed standard 128 and is provided with a tapped opening to which a pipe 129 is attached for supplying or removing cooling fluid.

The chamber 121 in the mandrel hub 115 communicates through inclined passages 130 with a horizontal passage 131 formed in the shaft 116 and communicating with a similar passage 132 in a reduced extension 133 of the shaft 116. A tube 134 is screwed into the end of the reduced shaft section 133 and extends rotatably through a gland 135 which is carried by a fixed standard 136 and is provided with a tapped opening to which a pipe 137 is connected for supplying or removing fluid. A sliding rod 138 extends through the openings 131 and 132 and through the tube 134 and projects into the recess 113 adjacent to the mandrel 110. This rod carries a valve member 139 which is contained in a recess 140 formed in the gland 135 and which is adapted to close the end of the tube 134. A spring 141 tends to force the valve member 139 against the end of the tube 134 and thus prevents fluid from flowing through the cooling system except when the rod 138 is moved to the left, Fig. 11, by the mandrel 110. Such movement of the rod 138 carries the valve member 139 to the left against the compression of the spring 141 and opens the tube 134 for the flow of cooling fluid.

Communication between the cooling chambers 120 and 121 is effected by means of passages 142 and 143. The passages 142 place the chamber 121 in communication with the recess 113 which is made deeper than the mandrel 110, while the passages 143 place the annular chamber 120 in communication with the recess 113. If the pipe 137 is connected to a source of water or other cooling fluid, the water cannot flow past the valve member 139 until the mandrel 110 pushes the rod 138 and the valve member 139 to the left, whereupon the water flows through the tube 134, the openings 132, 131 and passages 130 to the annular chamber 131 and thence through the passages 142 to the recess 113 and from this recess through the passages 143 to the annular chamber 120. From the chamber 120 the water flows through the passages 122, 123, 124 and the tube 126 to the outlet pipe 129.

The housing sections 19 and 20 cooperate with each other and with the roll shaft bearings to form a substantially air-tight enclosure, the bottom of which is closed by

means of a plate 145, Figs. 1, 4, 7, 8 and 9. The plate 145 is bolted to the under side of the casting 17 by means of bolts which extend through openings 146 shown in Fig. 7, and is provided with a screw-threaded tubular outlet 147 which may be connected to a blower or other suitable suction means for exhausting the air from the housing while the metal is being rolled. The suction thus applied also draws away any scale or dirt that may be dislodged from the metal during rolling, and thus prevents fouling of the gears or the other operating mechanism. In order to keep the lower portion of the housing closed while the rolls are separated, the plate 145 carries a slide 148, the right-hand edge of which bears against the under side of the movable bearing block 40. As shown in Fig. 7, the slide 148 is provided with parallel slots 149 through which extend stud bolts 150 received in the plate 145. The plate 145 and the slide 148 are provided with semi-circular recesses forming spring seats 151 in which are received compression springs 152. The rear or lower ends of the springs 152, as shown in Fig. 9, rest against projections 153 which are carried by the plate 145 and which are received in extensions from the spring-seat recesses in the slide 148. The upper or forward end of each spring 152 rests against a shoulder 155 formed in the sliding plate 148. The springs 152 thus tend to force the slide to the right as seen in the drawing, and when the bearing block 40 is rocked around the axis 45 to withdraw the roll 16 from the roll 15, the slide 148 follows the bearing block and keeps the under side of the blank housing closed.

For the purpose of properly positioning the blanks with respect to the mandrel 110, I provide two rods 160 which extend slidably through openings in the rear of the housing casting 83 and are attached to levers 161 which depend from a rock shaft 162 that is mounted in fixed bearings 163. One end of the rock shaft 162 carries a lever 164 which is provided with a pin 165 received in a fork 166 which is rigidly secured to a horizontal rod 167 slidably mounted in fixed bearings 168 and 169. The rod 167 also carries a forked member 170 in which is received a pin 171 carried by a lever 172 which is secured to a rock shaft 173 that also carries a lever 174. The lever 174 carries a cam roller 175 running upon the periphery of the small cam 57 which, as stated above, is secured to the shaft 54 which carries the main roll-operating cam 53. A spring 176 surrounds the rod 167 between the bearing 169 and the fork 170, and tends to move the shaft 167 to the left, as seen in the drawings, against the action of the cam 57. When the cam 57 moves the cam roller 175 to the left, Fig. 1, this movement is communicated through the lever 174, the rock shaft 173, the lever 172, and the pin 171 to move the rod 167 to the right, Fig. 1, compressing the spring 176. This movement is communicated through the fork 166, lever 164, rock shaft 162 and levers 161 to move the rods 160 to the right, Fig. 1, thus bringing the inner ends of these rods into position to receive the next blank or pair of blanks that is to be rolled. The inner ends of the rods 160 are provided with notches in order to engage the edges of the blanks, as shown in Fig. 14, and are so positioned that when the blank or pair of blanks rests upon the two rods 160 the central opening in the blank or pair of blanks is in proper position to admit the mandrel 110.

For the purpose of removing the finished disks from the mandrel 110 after the rolling operation, I provide two stationary pins 180 which are adjustably carried by fixed standards 181 that are bolted to the gibs 90, as shown in Fig. 2, and are connected by means of a stirrup 182. These rods 180 extend through openings in the movable housing section 20 in proper position to engage the disks and prevent them from moving further with the mandrel 110 as the mandrel moves to the right in the drawing.

The mandrel shaft 112, with its roller bearing 117, is so arranged as to slide to a limited extent within the tubular bearing casting 91, and is normally forced to the left by means of a compression spring 185 which is contained within an enlarged extension 186 of the tubular bearing 91. One end of the spring 185 rests against the end of the mandrel roller bearing 117 and the other end of the spring 185 is adjustably compressed by means of a plug 187 which is screwed into the end of the bearing extension 186 and is provided with a hand wheel 188. The plug is suitably bored to receive the water-cooling attachments shown in Fig. 11. By turning the hand wheel 188 the compression of the spring 185 may be varied with corresponding variation in the pressure with which the mandrel 110 is forced to the left. When the mandrel hub 111 is closed upon the blanks B the mandrel shaft 112 moves slightly to the right within its bearing, and this movement is cushioned by the spring 185. The spring 185 also provides an adjustment for differences in the diameter of the rolls when the rolls are returned from time to time.

In order to avoid marring the blanks when the blanks are placed upon the receiving rods 160, and also to avoid marring the finished disks when the disks are removed from the machine, I provide guide rolls 190 mounted on pins 191 which are loosely carried in bearings formed on the inner walls of the housing sections 19 and 20, as shown in Figs. 2, 3 and 12.

When the machine described above is to be operated to roll disk from circular blanks, the blanks are heated in a suitable furnace and are delivered from the furnace, either by automatic feeding means or by hand, and placed singly or in pairs upon the receiving rods 160 which, at this time, have been moved by the cam 57 and the connections described above into the receiving position shown in Fig. 4. At this time the housing section 20 is separated from the housing section 19 and the roll 16 is separated from the roll 15. The continued rotation of the cam shaft 54 in a counter-clockwise direction, Fig. 4, brings the enlarged portion of the cam 53 into contact with the roller 52 and thus rocks the bearing block 40 of the roll 16 around the pivot shaft 45, thus moving the roll 16 in a substantially straight line toward the roll 15 until the blank is gripped between the rolls. This movement is communicated through the pin 98 to the sliding housing section 20, and the housing is thus closed around the blank and the mandrel 110 is caused to pass through the central opening in the blank. Thereupon the cam 57 operates to withdraw the rods 160 from beneath the blank, leaving the blank free to increase in diameter as the rolling operation proceeds. As soon as the housing is closed around the blank the suction means connected to the outlet 147 operates to exhaust the air from the interior of the housing. The flames of the burners 104 help to remove oxygen from within the housing and a non-oxidizing atmosphere is quickly established therein, which prevents, or at least greatly reduces, the formation of scale on the blanks during the rolling operation. Any scale which may be formed and which may be dislodged is carried away through the outlet 147.

It will be observed that the heat of the burners 104 is mainly confined to the periphery of the blanks which are the parts most quickly cooled when circular blanks are rolled in the open air, while at the same time the hub portions of the blanks are not overheated. This is particularly important when the finished disks are to be used as vehicle wheels, since overheating of the center portion of the disk would permit the center portion to be distorted by the rolling forces. The cooling of the mandrel hubs 111 and 115 also contributes to keep the center portion of the disk from overheating.

The cam 53 is formed with a continuously increasing radius forming a spiral curve from the point A to about the point C, Fig. 13, and while this portion of the cam is in contact with the roller 52 the roll 16 is fed gradually toward the roll 15. Between the point C and the point D the periphery of the cam is concentric so that the roll 16 pauses at the end of its feeding movement. Between the points D and A the periphery of the cam is formed with a sudden drop E and a sudden rise F separated by a concentric portion G, so that when the point D reaches the roller 52 the entire sliding structure, including the housing section 20, the roll 16 and the bearing block 40, is permitted to withdraw to the right, under the influence of the weight 97, to the position shown in Fig. 4. After a pause while the roller 52 is in contact with the concentric portion G of the cam, the rising portion F again causes the sliding system to move to the left. Between these sliding movements the finished blank is removed from the machine and a fresh blank or pair of blanks is placed upon the rods 160, which meanwhile have been moved by the cam 55 into their blank-receiving position.

That portion of my invention which relates to the working of metal in a non-oxidizing atmosphere, or in a partial vacuum, is not restricted to the rolling of circular disks, and it will be understood that this method may be employed in many other metal working operations. It will also be understood that the non-oxidizing atmosphere surrounding the metal during working may be produced by simple suction, by suction in combination with reducing flames, as in the embodiment described above, or by surrounding the metal with non-oxidizing gas, such as nitrogen or carbon dioxide.

The casing within which the metal is worked may be heated by means of electric heating elements instead of by means of gas flames. One arrangement of heating elements and connections therefore is shown in Figs. 15, 16 and 17, the housing or casting 85 is provided in its channel portion with insulation material 201 upon which is placed retaining sheet 202 that may be of sheet metal. A plurality of bolts 203 surrounded by insulating bushings 204 are supported by the member 85.

Two bolts 205 and 206 provided with insulating bushings 207 are also supported by the member 85 and serve as terminals to the outer ends of which electrical conductors are connected. The inner ends of the bolts 203 serve as a support for a ribbon of a resistance material 208, such as nichrome, that is passed around the insulating bushings 204 in the manner shown in Figs. 15 and 16, the opposite ends of the resistance ribbon or wire being connected to the terminal bolts 205 and 207. The casting 80 may be provided with similar heating elements. This application is a division of my copending application for Letters Patent filed May 26, 1922, Serial No. 563,877.

The structural details shown and described herein may be varied in many respects without departing from my invention,

the scope of which is indicated in the appended claims.

I claim as my invention:

1. A mill for rolling disks comprising two shafts each of which carries at its end a conically tapered roll cooperating with a similar roll carried by the other shaft, a beveled gear wheel mounted at the opposite end of one of the shafts, a beveled driving pinion therefor, a pivotal support for said shaft disposed intermediate the ends thereof and having an axis extending transversely to the shaft, and means for adjusting said pivotal support in a direction parallel to the axis of said pinion.

2. A mill for rolling disks comprising two cooperating and conically tapered rolls, shafts supporting said rolls and having converging axes, a beveled gear wheel carried by one of the shafts, a cooperating beveled drive gear for said gear wheel, and means for mounting one of said shafts for pivotal movement about an axis transverse to and remote from the axis thereof.

3. A mill for rolling disks comprising two cooperating and conically tapered rolls, a shaft for supporting one of said rolls, a slidable pivotal support for said shaft whereby it may be moved toward and from the other roll and is tiltable about an axis disposed transversely thereof, a shaft for supporting the second named roll, a beveled gear wheel carried by the last named shaft, a cooperating beveled drive gear for said wheel, and means for mounting said shaft for pivotal movement about an axis transverse to and remote from the axis thereof, the said shafts being rotatable about converging axes.

4. A mill for rolling disks comprising two cooperating and conically tapered rolls having their axes of rotation in a common vertical plane, inclined shafts supporting said rolls, and means for mounting one of said shafts for pivotal movement around a horizontal axis beneath and substantially in vertical line with said movable roll, whereby said movable roll approaches and recedes from the other roll in a substantially straight line.

5. A mill for rolling disks comprising two cooperating and conically tapered rolls having their axes of rotation in a common vertical plane, inclined shafts supporting said rolls, means for adjusting one of said shafts toward and from the other and for varying the inclination of said shaft, and means for mounting the other roll for pivotal movement around a horizontal axis disposed beneath and substantially in vertical line with said second roll, whereby said second roll approaches and recedes from said first roll in a substantially straight line.

6. A mill for rolling disks comprising two cooperating rolls, shafts supporting said rolls and having converging axes, bearings for said shafts adjacent to said rolls, a rigid yoke or frame surrounding said bearings, and cam-operated means carried by said yoke for reciprocating one of said rolls toward and from the other roll.

7. A mill for rolling disks comprising two cooperating rolls, shafts supporting said rolls and having converging axes, bearings for said shafts adjacent to said rolls, a rigid yoke or frame surrounding said bearings, a roller carried by one of said bearings, a cam carried by said yoke and operable through said roller to move said bearing and its roll toward the other roll, and means for withdrawing said bearing and roll in opposition to the movement imparted by said cam.

8. A mill for rolling disks comprising two cooperating rolls, shafts supporting said rolls and having converging axes, bearings for said shafts adjacent to said rolls, a rigid yoke or frame surrounding said bearings, said bearings fitting within said yoke and being slidably movable toward and from each other, a roller carried by one of said bearings, a cam carried by said yoke and operating through said roller to move one of said bearings toward the other, means for moving said movable bearing in opposition to the movement produced by said cam, and means for transmitting rolling thrusts from said rolls to the ends of said yoke.

9. A mill for rolling disks comprising two cooperating rolls, a housing surrounding said rolls and composed of two separable sections, means for moving one of said rolls toward and away from the other, and means for closing and opening said housing in timed relation to the movement of said rolls.

10. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls and having converging axes, bearings for said shafts adjacent to said rolls, a rigid yoke surrounding said bearings, cam-operated means carried by said yoke for reciprocating one of said bearings toward and from the other, a housing carried by said yoke and composed of a fixed section and a movable section mounted upon said yoke and slidable toward and from said fixed section, and means for causing said sliding section to move with said movable shaft bearing, whereby said housing is closed when the movable roll is moved toward the fixed roll, and is opened when the movable roll is moved away from said fixed roll.

11. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls having converging axes, bearings for said shafts adjacent to said rolls, a yoke surrounding said bearings, means carried by said yoke for moving one of said bearings toward and from the other, a housing surrounding said rolls and resting upon said yoke, said housing being com-

posed of a fixed section and a slidably movable section, a member carried by said movable bearing and resting against the portion of said sliding housing section, and a weight connected to said housing section and tending to move said section away from said fixed housing section.

12. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls having converging axes, bearings for said shafts adjacent to said rolls, a yoke surrounding said bearings, means carried by said yoke for moving one of said bearings toward and away from the other, a housing surrounding said rolls and comprising two circularly curved sections, one of said sections being fixed and the other section being slidably movable to open and close said housing, a mandrel composed of a separable section carried by each of said housing sections.

13. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls having converging axes, bearings for said shafts adjacent to said rolls, a yoke surrounding said bearings, means carried by said yoke for moving one of said bearings toward and away from the other, a housing surrounding said rolls and comprising two circularly curved sections, one of said sections being fixed and the other section being slidably movable to open and close said housing, a mandrel composed of a separable section carried by each of said housing sections, and means for circulating cooling fluid through said mandrel.

14. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls having converging axes, bearings for said shafts adjacent to said rolls, a yoke surrounding said bearings, means carried by said yoke for moving one of said bearings toward and away from the other, a housing surrounding said rolls and comprising two circularly curved sections, one of said sections being fixed and the other section being slidably movable to open and close said housing, a mandrel composed of a separable section carried by each of said housing sections, rods for supporting blanks in position to be received upon said mandrel, and means for reciprocating said rods to and from blank-receiving position in timed relation to the movement of said movable roll.

15. A mill for rolling tapered disks comprising two cooperating rolls, shafts supporting said rolls having converging axes, bearings for said shafts adjacent to said rolls, a yoke surrounding said bearings, means carried by said yoke for moving one of said bearings toward and away from the other, a housing surrounding said rolls and comprising two circularly curved sections, one of said sections being fixed and the other section being slidably movable to open and close said housing, a mandrel composed of a separable section carried by each of said housing sections, and means operable when said movable housing section is withdrawn from said fixed section for removing finished disks from said mandrel.

16. A mill for rolling tapered disks comprising two cooperating and converging tapered rolls having their axes of rotation in a common vertical plane, shafts supporting said rolls, bearings for said shafts adjacent to said rolls, thrust bearings supporting the lower ends of said shafts, means for simultaneously driving said shafts, means for adjusting one of said rolls toward and from the other and for varying the angular position of said roll, means for mounting the other roll for pivotal movement around a horizontal axis disposed below said movable roll, whereby said movable roll may approach and recede from the first-named roll in a substantially straight line, a continuously rigid yoke surrounding the upper bearings of said roll shafts, a cam roller carried by the upper bearing of said movable roll, a cam carried by said yoke and operating through said cam roller to move said movable roll toward the other roll, means for transmitting rolling thrust through said rolls to the ends of said yoke, a housing carried by said yoke and composed of a fixed section and a slidable section, a member carried by the upper bearing of said movable roll and engaging a portion of said slidable housing section, a weight connected to said slidable section and tending to move said slidable section away from said fixed section, and also tending to move said movable roll away from said fixed roll, a burner within said housing, means for confining most of the heat from said burner to the outer portion of said housing, means for positioning blanks within said housing, a separable mandrel carried by the sections of said housing, means for carrying cooling fluid through said mandrel, means for exhausting air from said housing, and means for detaching finished disks from said mandrel when said housing is opened.

In testimony whereof I, the said ARTHUR MARTIN, have hereunto set my hand.

ARTHUR MARTIN.