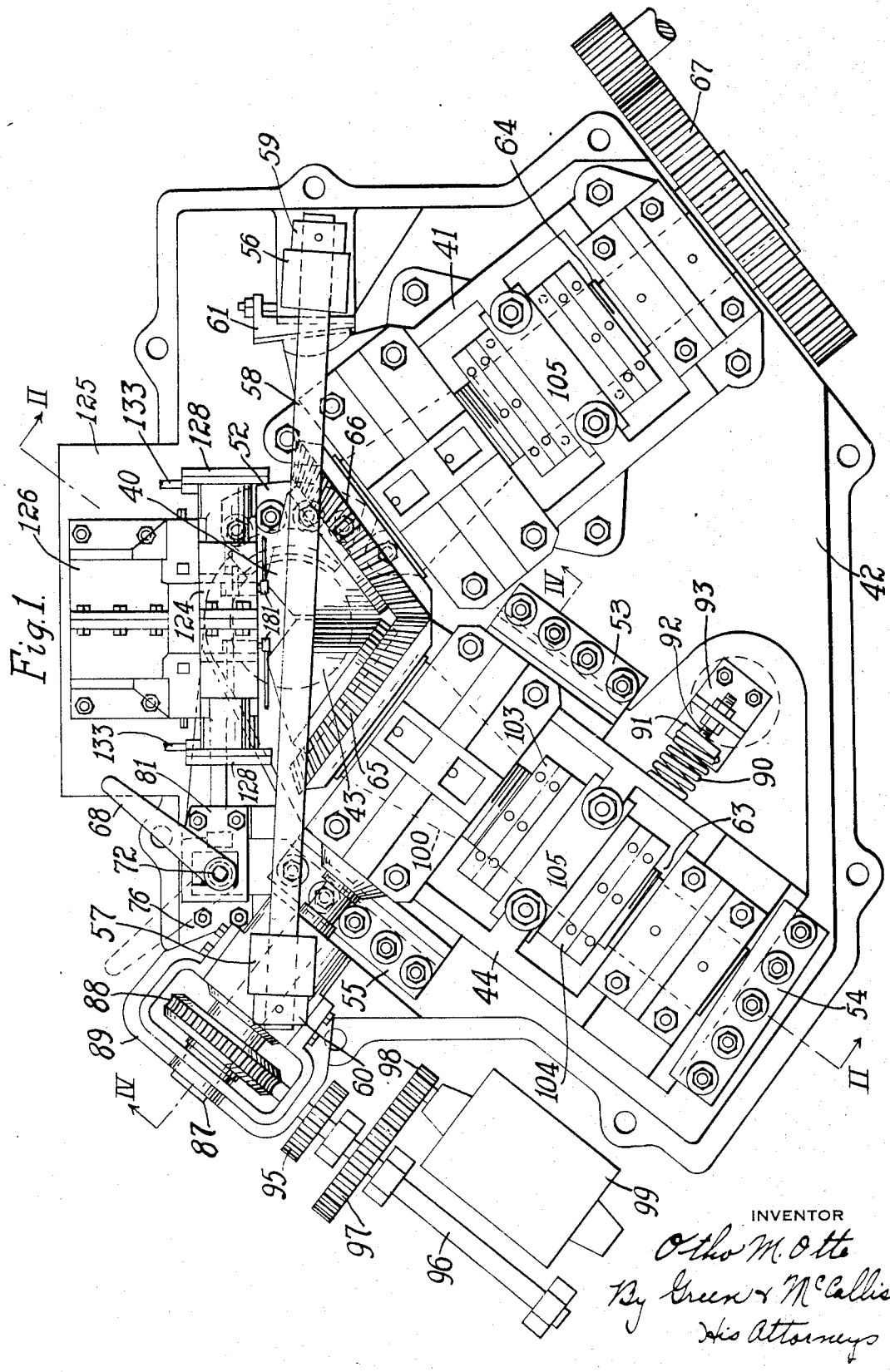
Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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Fig. 1.



INVENTOR

Otho M. Otte

By Green & McCallister

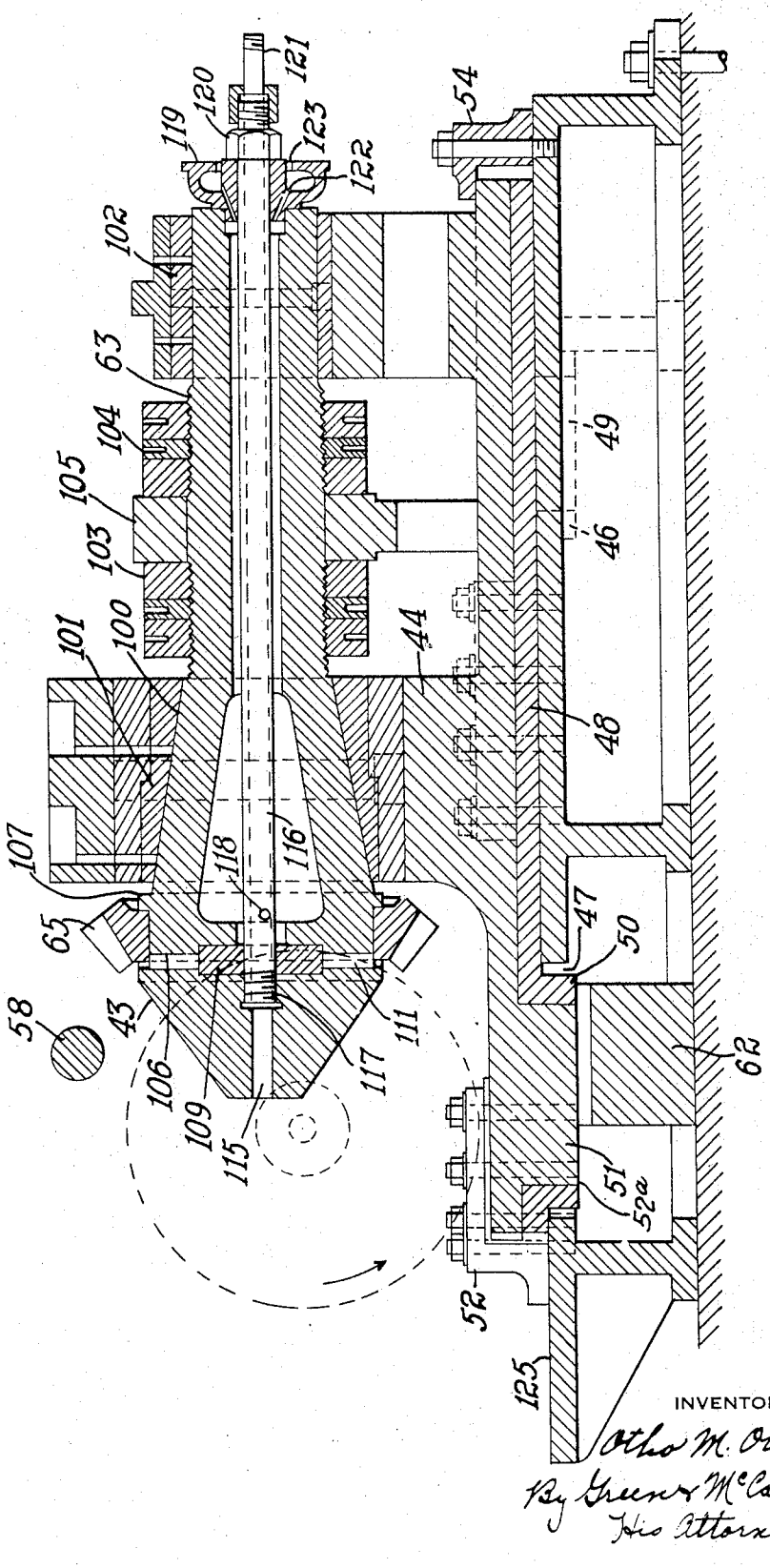
His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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Fig. 2.



INVENTOR
Otho M. Otte
By Greene & McCallister
His Attorneys

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METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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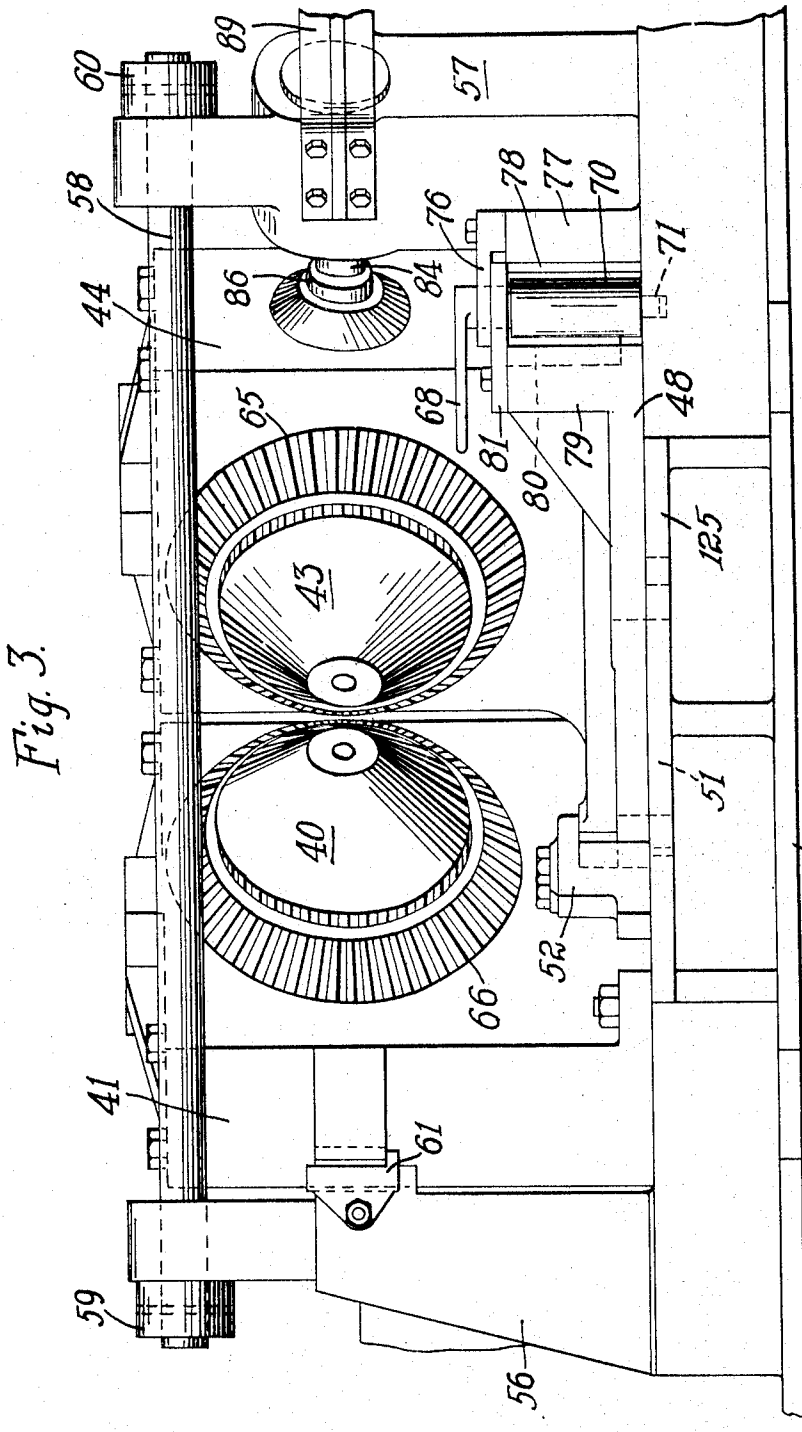


Fig. 3.

INVENTOR

Otho M. Otte

By Greenr McCallister

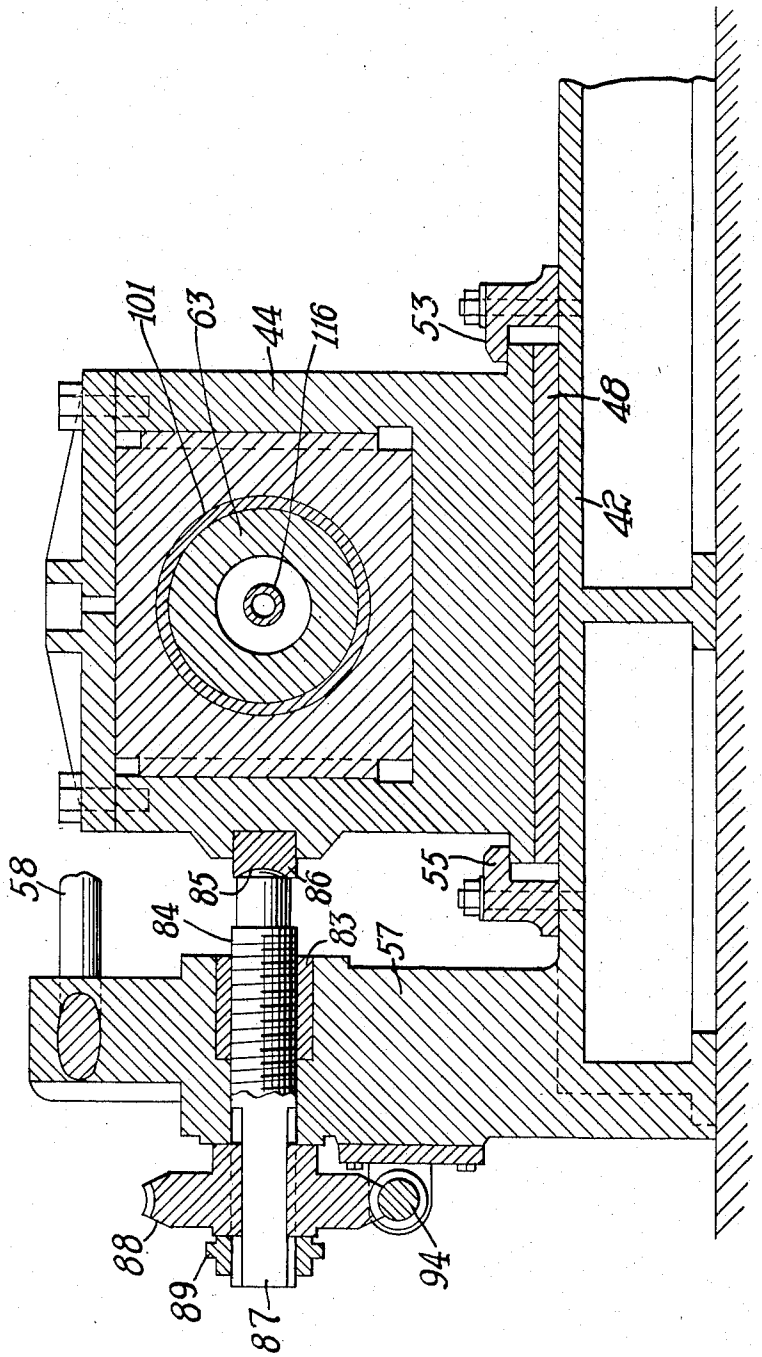
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Aug. 22, 1933. O. M. OTTE 1,923,389

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Fig. 4.



INVENTOR

Otho M. Otte

By Green & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

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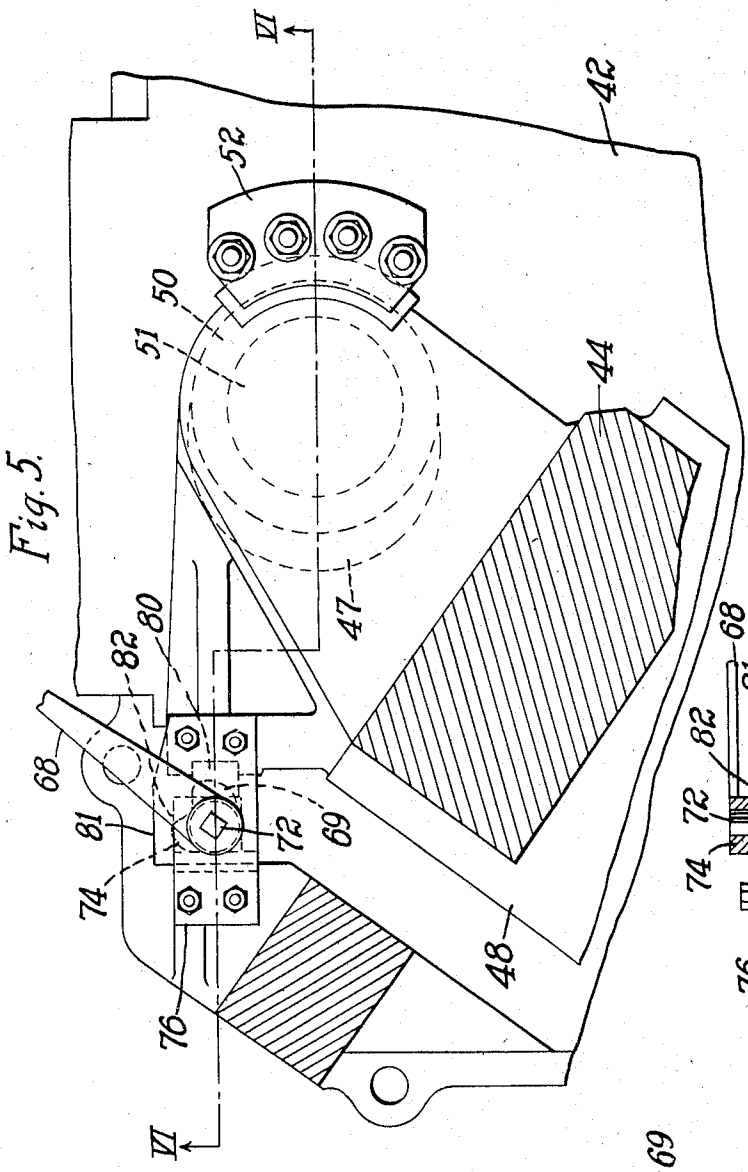


Fig. 5.

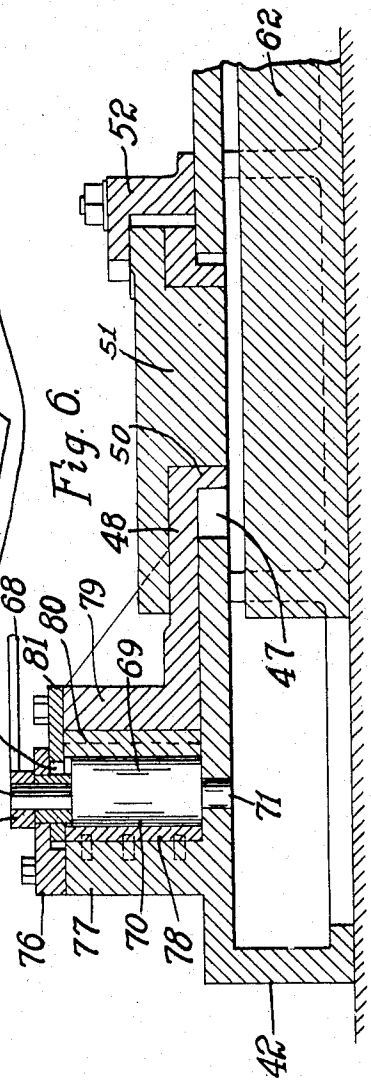


Fig. 6.

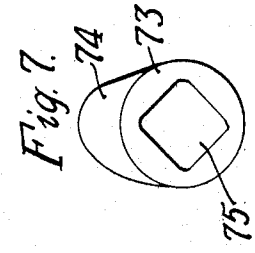


Fig. 7.

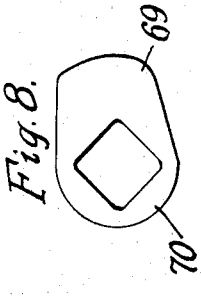


Fig. 8.

INVENTOR

Otho M. Otte

By Greene & McCallister

His Attorneys

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METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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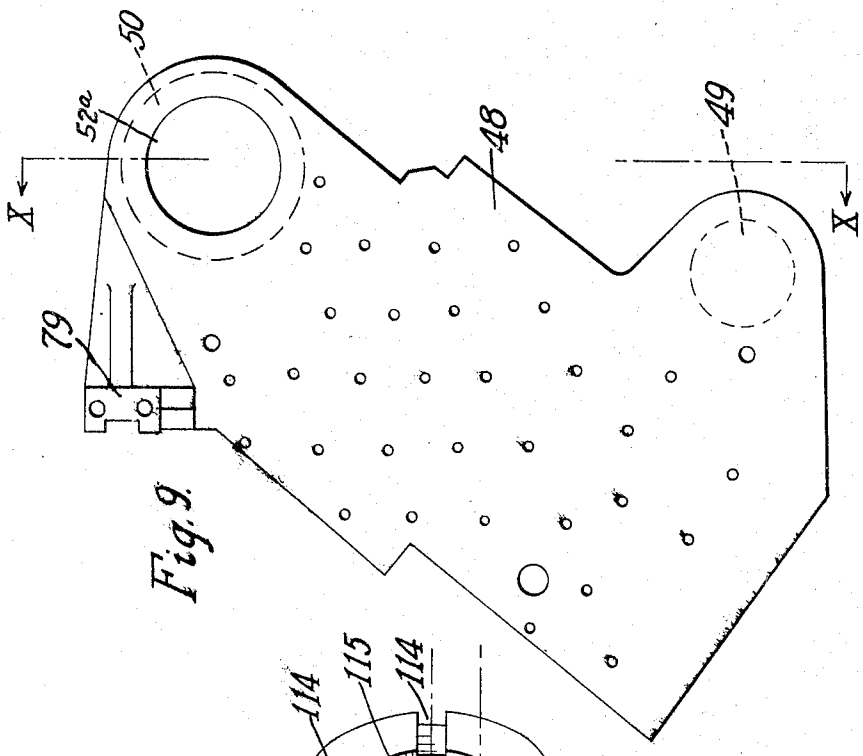


Fig. 9.

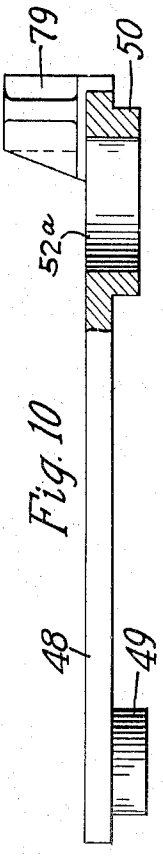


Fig. 10

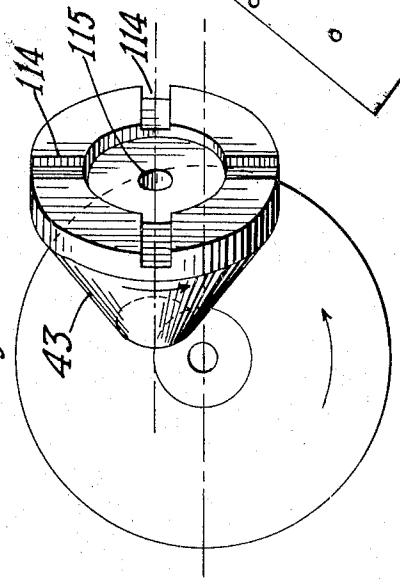


Fig. 32.

INVENTOR

Otho M. Otte

By Green & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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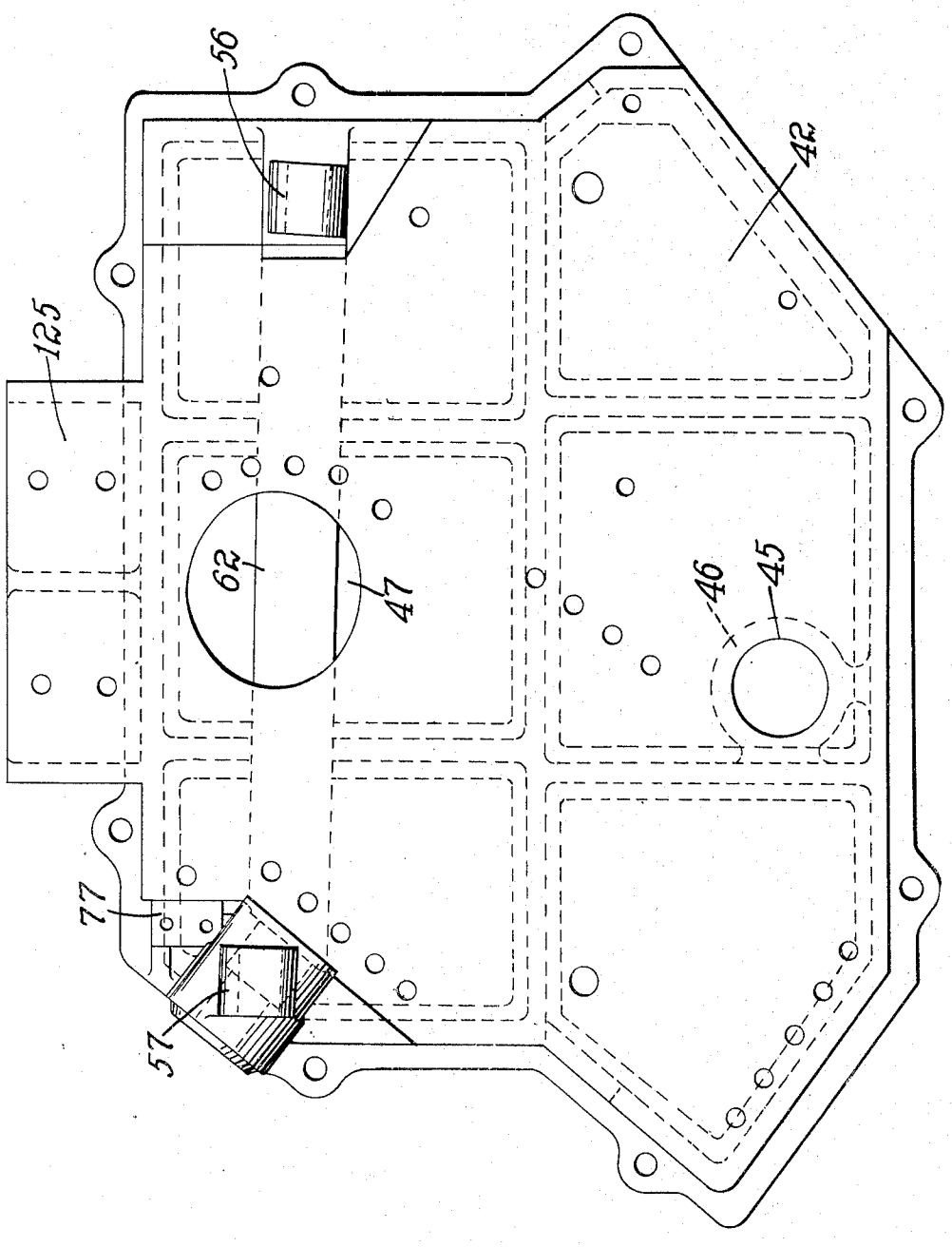


Fig. 11

INVENTOR

Otho M. Otte

By Greene & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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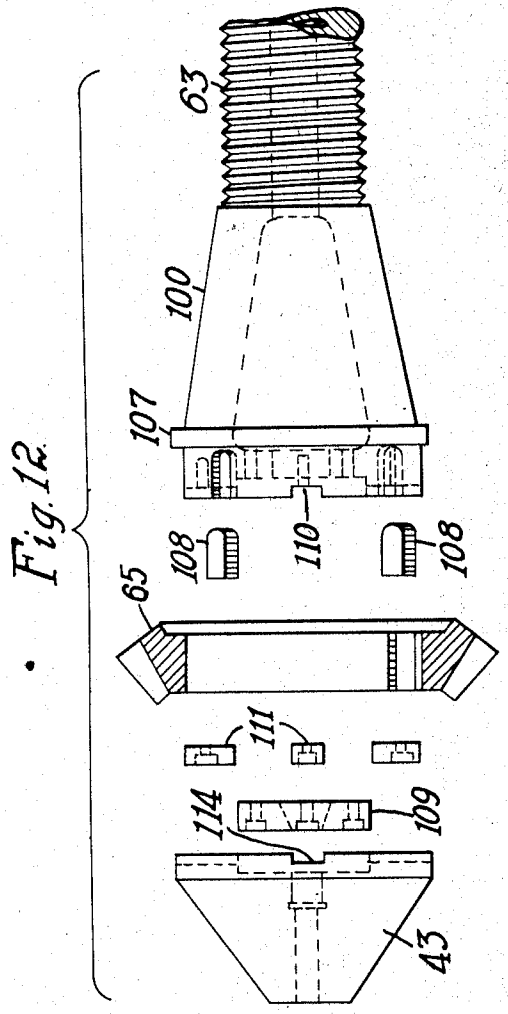


Fig. 12.

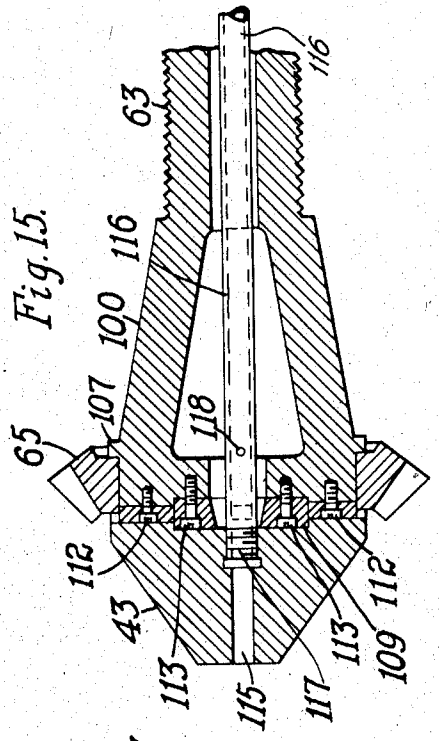


Fig. 15.

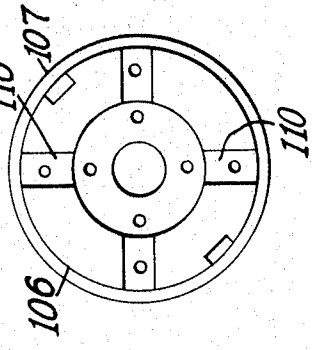


Fig. 14.

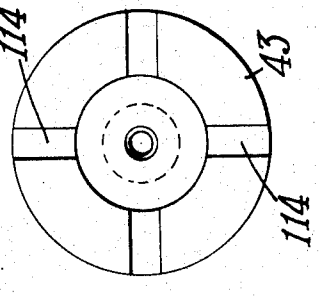


Fig. 13.

INVENTOR

Otho M. Otte

By Green & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

Original Filed Aug. 21, 1923 14 Sheets-Sheet 9

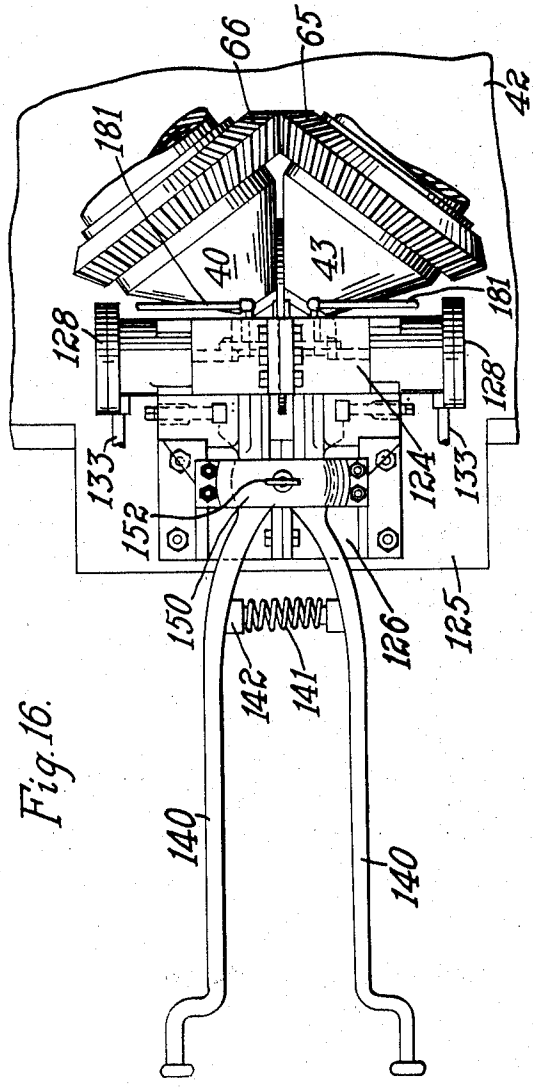


Fig. 16.

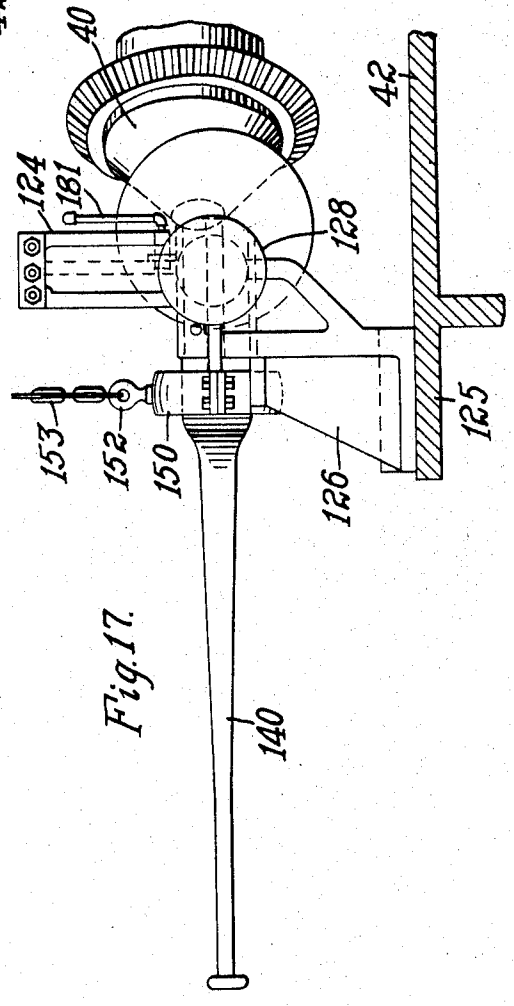


Fig. 17.

INVENTOR

Otho M. Otte

By Green & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

Original Filed Aug. 21, 1923 14 Sheets-Sheet 10

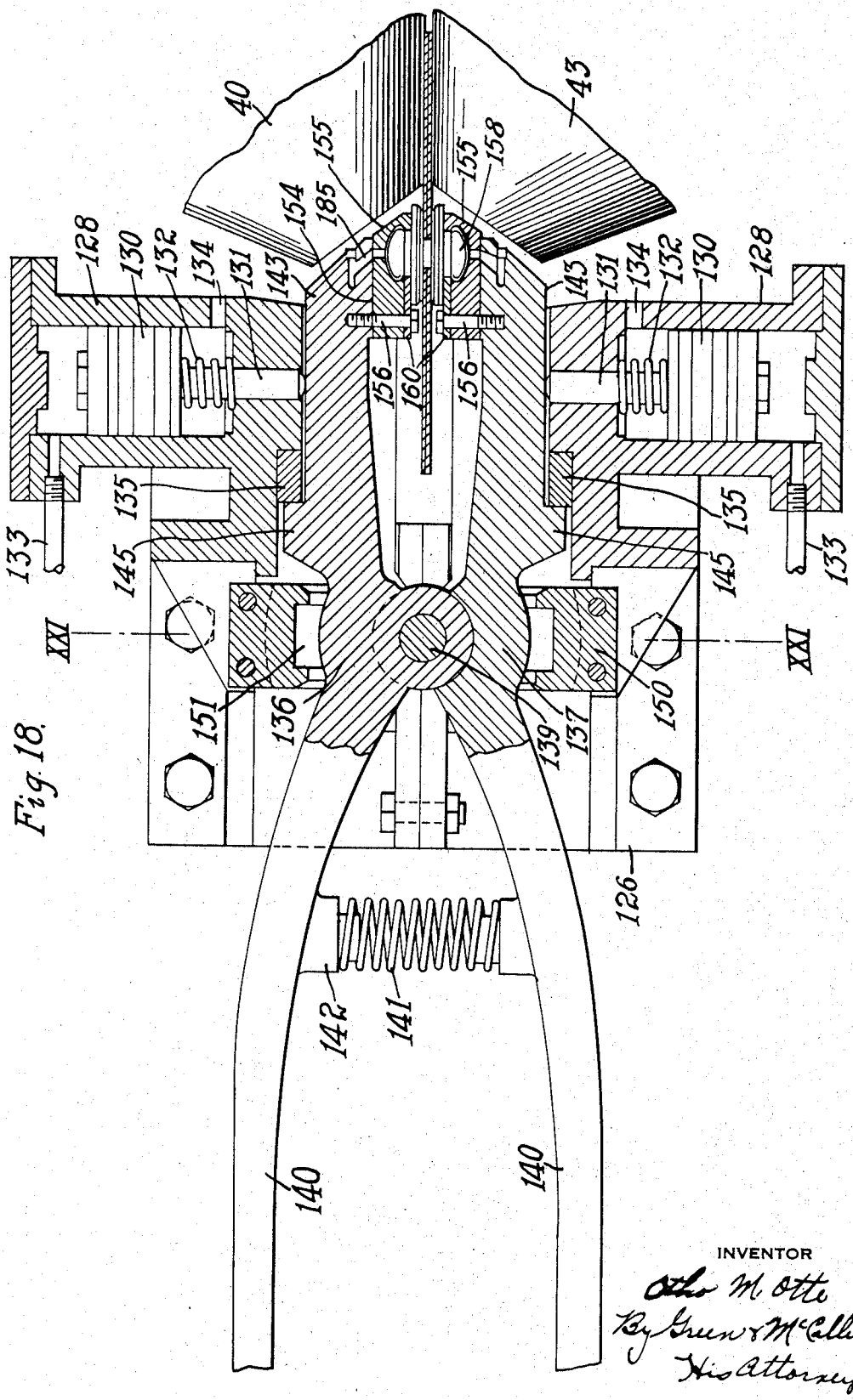


Fig. 18.

INVENTOR
Otho M. Otte
By Green & McCallister
His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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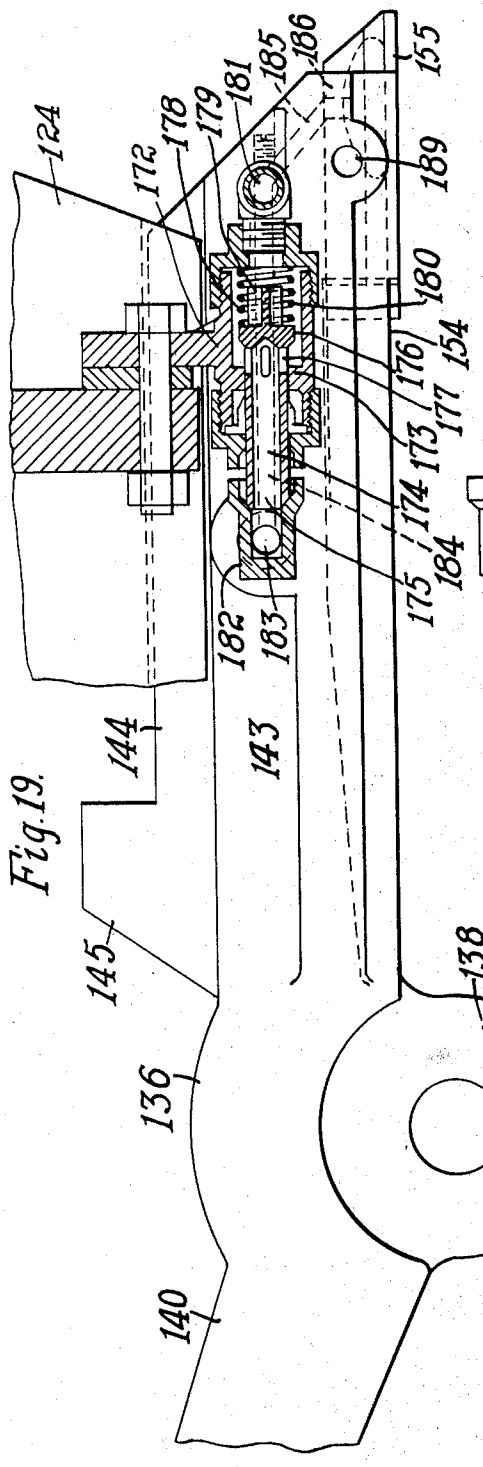


Fig. 19.

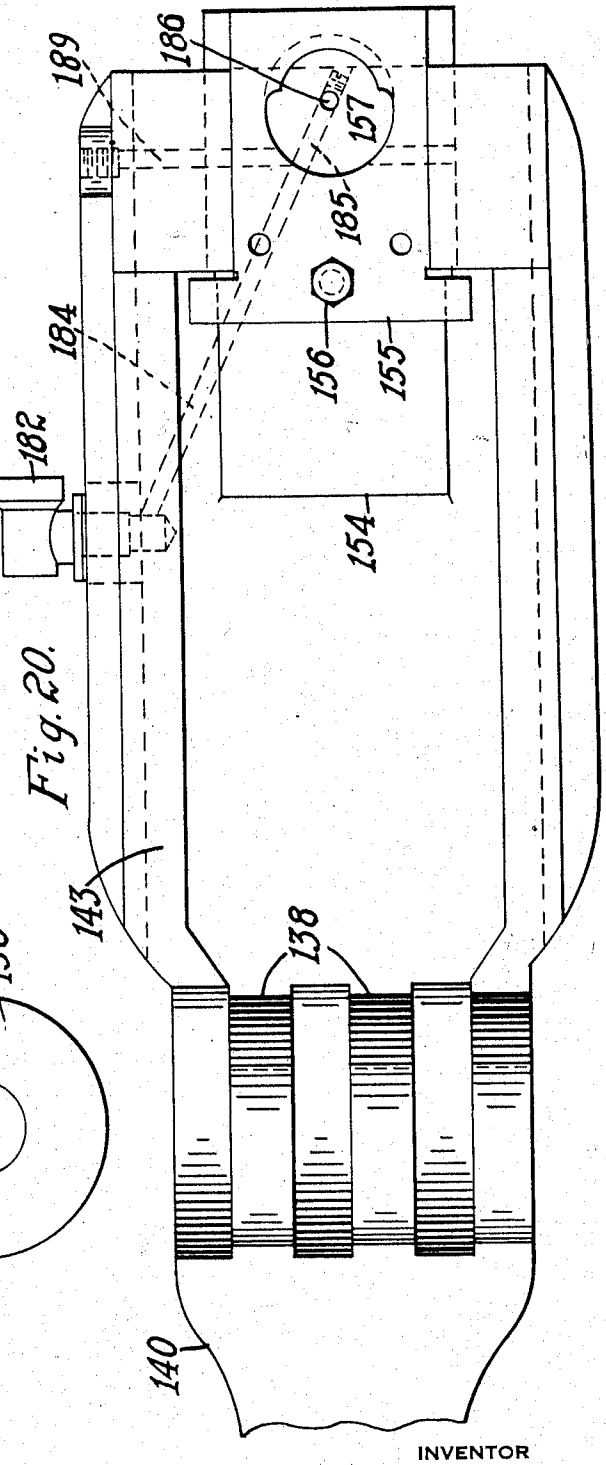


Fig. 20.

INVENTOR

Otho M. Otte

By Grant McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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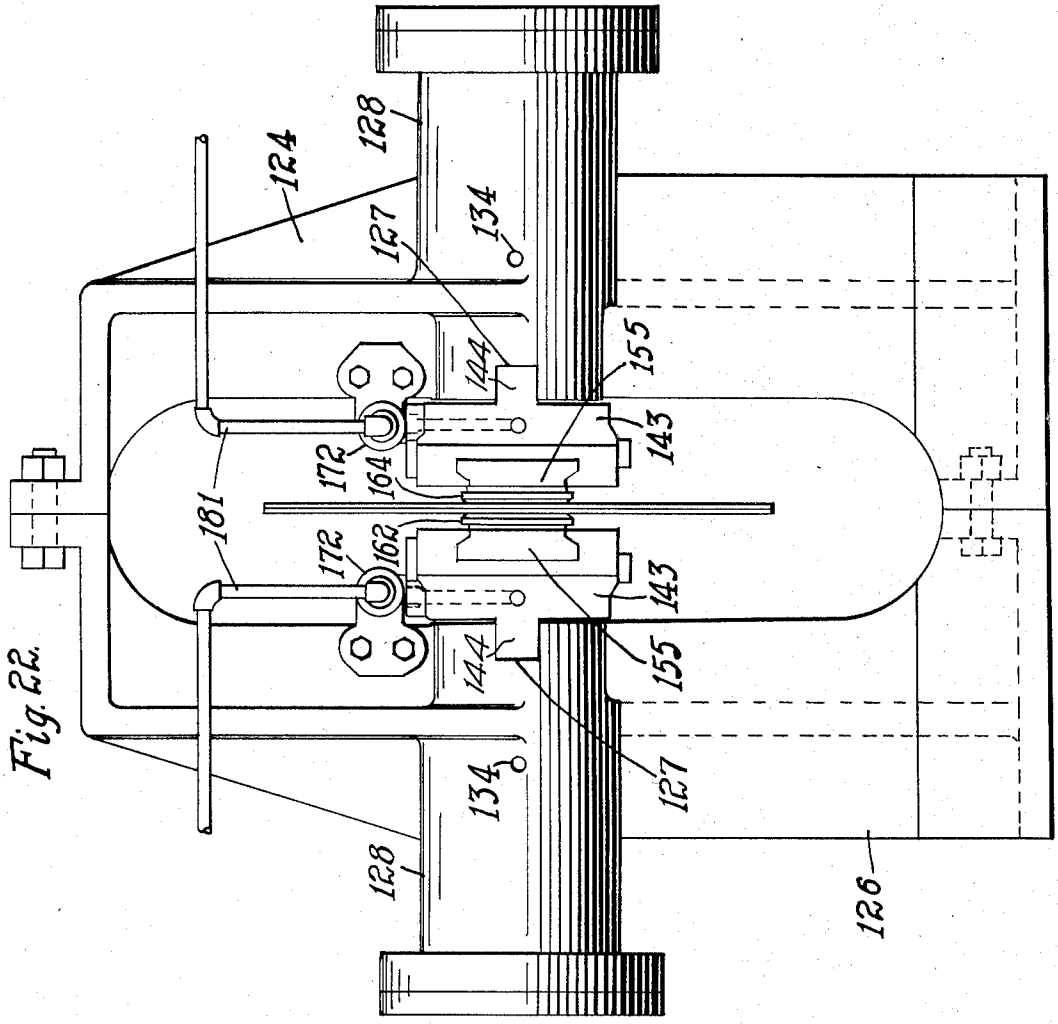


Fig. 22.

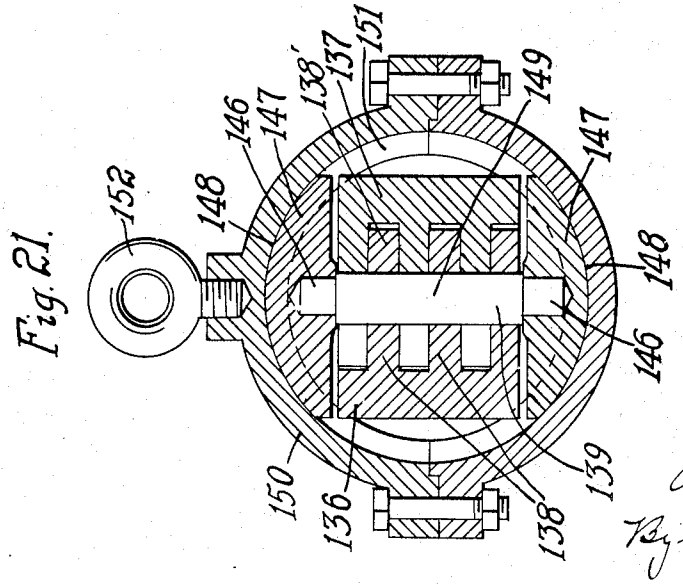


Fig. 21.

INVENTOR

Otho M. Otte

By Grosvenor McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

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Fig. 23.

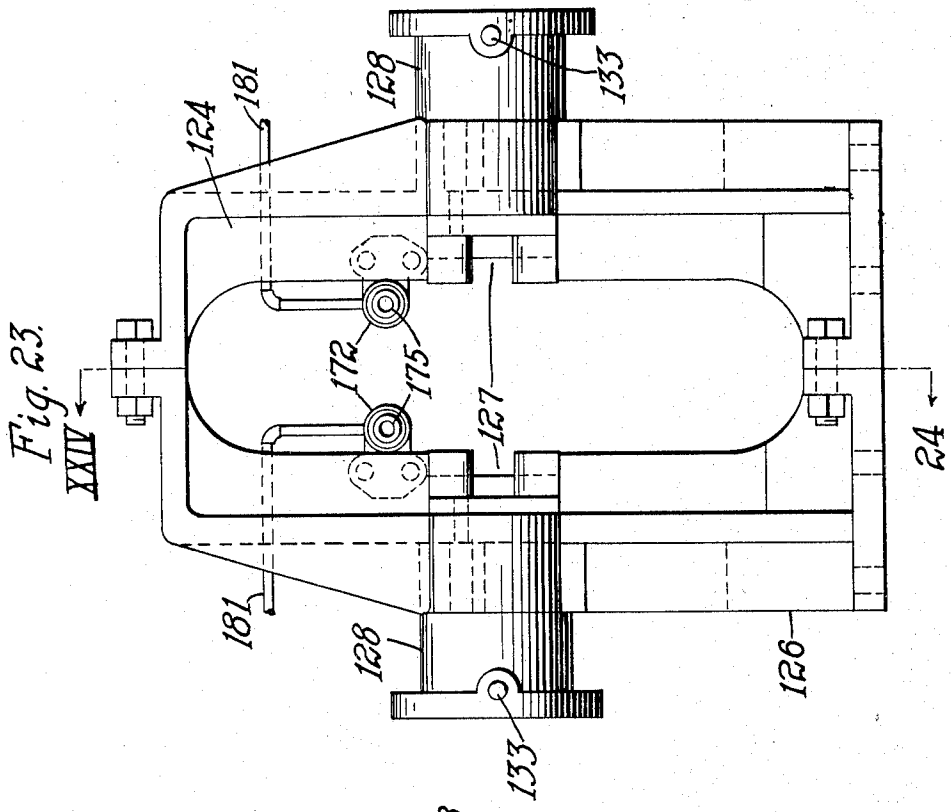
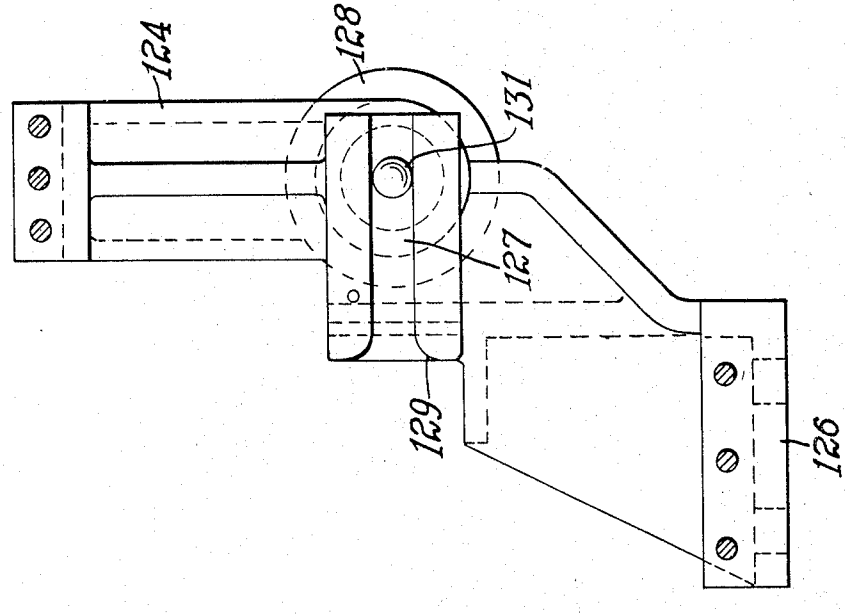


Fig. 24.



INVENTOR

Otho M. Otte

By Greene & McCallister

His Attorneys

Aug. 22, 1933. O. M. OTTE 1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

Original Filed Aug. 21, 1923 14 Sheets-Sheet 14

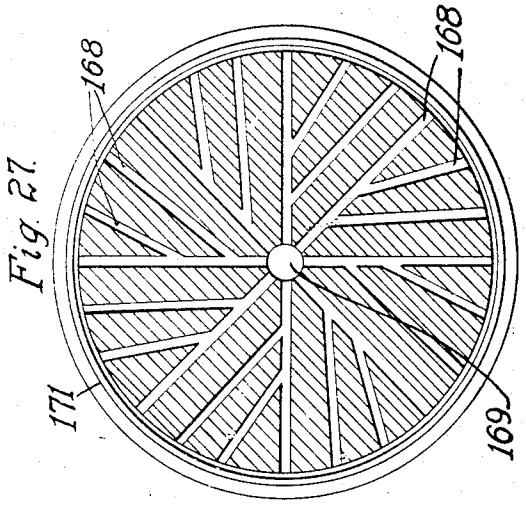


Fig. 27.

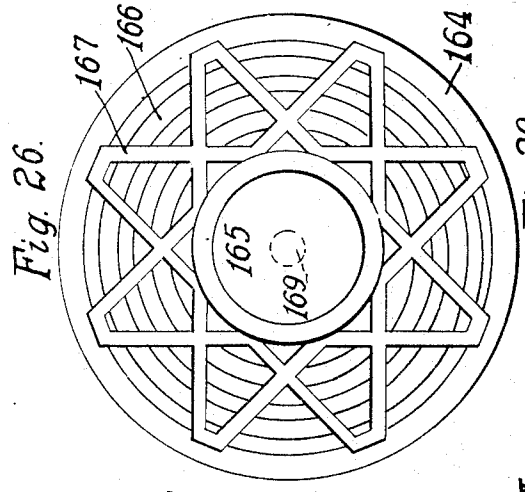


Fig. 26.

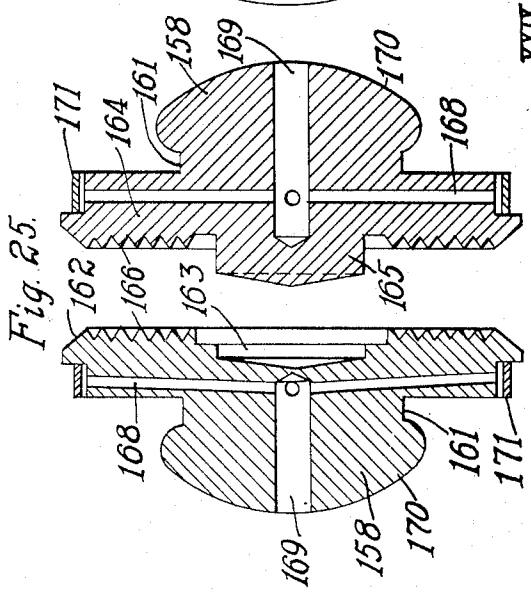


Fig. 25.

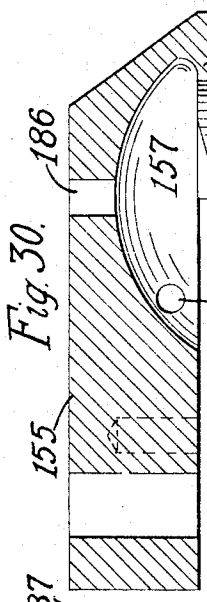


Fig. 30.

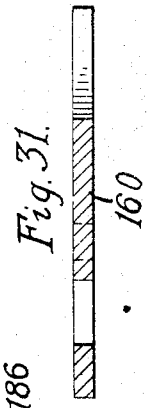


Fig. 31.

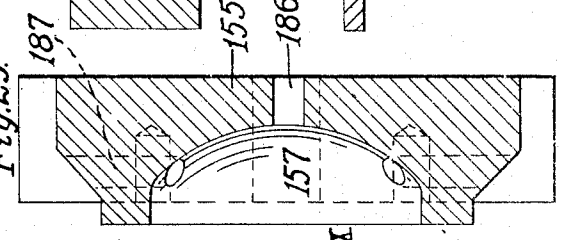


Fig. 29.

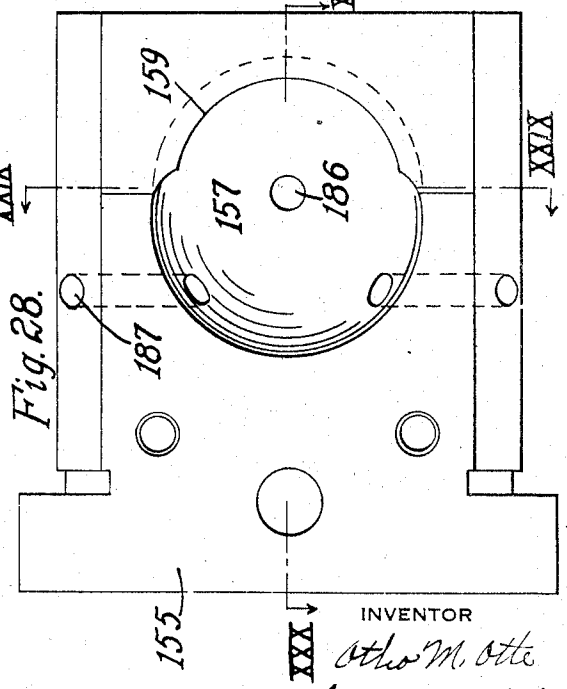


Fig. 28.

INVENTOR

Otho M. Otte

By Green & McCallister

His Attorneys

Patented Aug. 22, 1933 1,923,389

UNITED STATES PATENT OFFICE

1,923,389

METHOD OF HOT ROLLING RADIALLY TAPERED DISKS

Otho M. Otte, Tarentum, Pa., assignor, by mesne assignments, to Budd Wheel Company, a Corporation of Pennsylvania

Original application August 21, 1923, Serial No. 658,541. Divided and this application June 14, 1928. Serial No. 285,266

24 Claims. (Cl. 80—60)

This invention relates to radially tapered metal disks such as used in the fabrication of disk wheels for motor vehicles and more particularly to a method of hot rolling such disks.

This application is a divisional application of an application Serial No. 658,541, filed by me August 21, 1923 which has resulted in Patent No. 1,708,800 of April 9, 1929.

In a pending application for United States Letters Patent filed by me September 3, 1921 and Serially Numbered 498,350, I have disclosed one method of and mill for rolling such disks.

An object of this invention is to improve the method of said former application.

In a general way, the method of said former application resembles the method of this application, but in certain important particulars the method of this application differs materially from the method of the former application.

In the present method as in the former, the blanks are rolled off center and the roll contact line or line of rolling is ahead of the center about which the blanks are caused to rotate during rolling. The finished disks are flat on one side and on the other side are radially tapered uniformly on a straight taper from a circular central flat area to the disk's outer periphery. The disks, therefore, resemble relatively flat truncated cones.

Since the blanks are rolled off center, it is necessary to have the active face of the roll which contacts with the tapered face of the blank when finished, concaved or incurved, so as to conform to the surface of the finished disk along the line of rolling. When two blanks are rolled simultaneously the active faces of both rolls must be incurved.

In the present method as in the former, one of the rolls during rolling is tilted toward the other about a point between the center of the blank and its periphery. In the mill for carrying out the present method, the rolls are conical or more truly, are truncated cones and the point about which one roll swings or tilts during rolling is located in the periphery of the small end of the roll or in other words in the roll contact line or line of rolling.

In said former applications, the roll having its active face incurved from end to end to conform to the surface of the finished disk along the line of rolling is tilted during rolling about a point in the axis of said roll between the center of the blank and its periphery instead of about a point in the roll contact line.

The mill of the former applications is of the ordinary type in which the rolls have bearings at each end and in said mill, the roll axes are disposed in the same vertical plane and the blanks during rolling rotate about a vertical axis. In the present mill, the roll axes are arranged in the same horizontal plane and the disks during rolling rotate about a horizontal axis located below the plane including the roll axes. In the former mill, the angle between the roll axes is progressively increased during rolling, while in the present mill, the angle between the roll axes is progressively decreased.

In the former mill, as well as in the present mill, the rolls are separated beyond normal position for the purpose of inserting the blanks and for removing the finished disks.

In the present mill, the position of the blanks with relation to the rolls during rolling allows the scale as it is cracked and loosened by the rolls to fall away from the rolls.

Since the active face of each roll along the line of rolling is a hyperbolic curve conforming to the disk surface along such line and since the angularity of the rolls is progressively changed during rolling, one face of each blank is rolled into convex form, and as the rolling progresses, the convexity of said face is reduced until final reduction of the blank occurs when this face takes the form of a truncated cone having straight sides.

Metal disks such as those made in accordance with this invention are applicable for use in the manufacture of metal disk wheels for motor vehicles and in the fabrication of one disk wheel with which I am familiar, a steel disk 28½" in diameter, flat on one side and on the other tapered radially from a central flat area 8¼" in diameter is used. The central area is .197" in thickness and the disk from the edge of this central area tapers to .057" in thickness at the disk's outer periphery.

For the purpose of rolling radially tapered disks of the dimensions given, I take for example, a pair of circular blanks each .197" in thickness 22.125" in diameter and having a circular hole punched at its center. The blanks are heated to proper rolling temperature, placed face to face in superposed relation and held for rotation so that their common axis is 3.5" below and therefore ahead of the plane including the roll axes.

As will be noted from the drawings, and particularly, from Figures 2 and 18, each blank is held in such a manner that its axis is below the horizontal plane common to the rolls 40

and 43; and, since these rolls are positioned in such a manner that they have a common point of intersection for the projections of their respective axial planes, the blank may be said to be held in an offset relation to this point of intersection. Then too, it is also seen that the blank or superposed blanks are independently disposed and held at the center within the space formed between the ends of the rolls and the intersection of plane projections of the outer faces of the rolls, and that the plane of roll contact line, as well as their common axial plane, is offset from or outside of and substantially parallel to the plane of the axis of the blank.

During rolling one of the rolls is moved horizontally in such manner that it is tilted toward the other about a point in its active face. The tilting movement is progressive and is regulated in accordance with the amount of reduction desired in the blank and the degree of taper desired in the finished disk.

After the proper reduction has been obtained, further tilting of the roll is stopped and the disks are subjected to a number of dead passes for the purpose of planishing the disks and stretching the same level. The roll axes are angularly disposed in the same horizontal plane and one roll is mounted in a stationary housing, while the other is mounted in a housing which is capable of being moved horizontally in order to separate the rolls for the introduction and removal of the work. After the blanks are introduced the movable roll is moved into contact with the blanks and during rolling this roll is swung or tilted toward the other roll about a point in the roll contact line located in the periphery of the small end of the roll. In this way the small end of the roll describes the circular flat area on the side of the blank to be tapered.

The blank support is so constructed and arranged that the axis about which the blanks rotate during rolling is approximately 3.5'' below the plane including the roll axes. The blank holding means resists movement of the blanks through the rolls.

The blank holder is formed in part by a supporting frame secured to the bed plate of the mill and in part by a novel form of tongs for gripping the blanks. The gripping jaws are constructed so as to rotate with the blanks and are water cooled; the water cooling arrangement being such that when the blanks are shoved into place between the rolls, the water for cooling is automatically turned on and in like manner is automatically turned off when the finished disks are removed from the rolls.

The clamping jaws are held in contact with the blanks by air pressure under the control of the roller.

The gears connecting the rolls are so formed that they always remain in mesh even during movement of the movable roll and its housing bodily away from the fixed or stationary roll.

In the drawings accompanying and forming part of this application Figure 1 is a top plan view of the mill proper.

Fig. 2 is a vertical section through a portion of the mill taken on line 2—2 of Fig. 1. Fig. 3 is a front view in elevation of the mill looking toward the roll faces. In this view as well as in Fig. 2, the device for holding the blanks during rolling, together with its associated parts, has been removed. Fig. 4 is a vertical section taken on line 4—4 of Fig. 1 through the shiftable roll housing. Fig. 5 is a view partially in top plan and partially in section of a portion of the mill and illustrates the mechanism for moving the shiftable roll toward and from the stationary roll in order to enter and remove the work. Fig. 6 is a vertical section taken on line 6—6 of Fig. 5. Figs. 7 and 8 are views of cam elements utilized in the mechanism for shifting the movable roll housing on its supporting element. Fig. 9 is a plan view of the pivot table or element which directly supports the housing for the shiftable roll. Fig. 10 is a side view taken on line 10—10 of Fig. 9. Fig. 11 is a top plan view of the bed plate of the mill. Fig. 12 is a side view partially in section and partially in elevation of the roll end of one of the roll spindles with its associated gear. Fig. 13 is an end view in elevation of the large end of one of the rolls. Fig. 14 is an end view of the roll end of the spindle. Fig. 15 is an assembled view in sectional elevation of one of the rolls, its associated gear and the roll end of the spindle. Fig. 16 is a top plan view of the blank holding device and in this view the ends of the rolls are shown in top plan. Fig. 17 is a view in side elevation of the parts shown in Fig. 16. Fig. 18 is an enlarged view partially in plan and partially in section of the parts shown in Figs. 16 and 17. Fig. 19 is a view partially in plan and partially in section of a portion of the blank holding means. Fig. 20 is a view in side elevation of the portion of the device shown in Fig. 19. Fig. 21 is a sectional view taken on line 21—21 of Fig. 18. Fig. 22 is a view in elevation of the frame or support member for supporting the blanks in position during rolling. This view is taken from the roll side. Fig. 23 is a front view in elevation of the supporting frame or member shown in Fig. 22. Fig. 24 is a side sectional view of one-half of the support member shown in Fig. 23 and is taken on line 24—24 of Fig. 23. Fig. 25 is a view in side sectional elevation of the cooperating clamping jaws used in the make-up of the disk holding device. Fig. 26 illustrates the grooves milled in the clamping faces of the cooperating jaws. Fig. 27 is a view in cross section of one of the clamping jaws and illustrates the channels for distributing cooling water from a point adjacent the axis of the jaw periphery. Fig. 28 is a view in side elevation of one of the jaw holders. Fig 29 is a view in section taken on line 29—29 of Fig. 28. Fig. 30 is a sectional view of the jaw holder taken on line 30—30 of Fig. 28. Fig. 31 is a sectional view of a locking plate used with the jaws. Fig. 32 is a diagrammatic view which illustrates the method of rolling the blanks off center.

The mill proper

A roll 40 which I term the stationary or fixed roll is mounted for rotation in bearings carried in a housing 41 rigidly bolted to the bed plate 42 of the mill, and a roll 43, which I term the movable, tilting or swinging roll is mounted for rotation in bearings carried in housing 44 which is capable of being oscillated horizontally, first for the purpose of separating the rolls beyond normal rolling position for entering and removing the work, and second, for the purpose of swinging the movable roll toward the fixed roll about a point in the roll contact line.

The bed plate of the mill (shown in detail

in Fig. 11) is provided with a circular opening 45 having a depending annular bearing flange 46 (Fig. 2) and an elliptical opening 47.

A pivot table 48 provided with a depending circular boss 49 is supported for movement upon the bed plate about the vertical axis of circular boss 49 (see Fig. 10) as its center of oscillation. The pivot table 48 is provided with a depending annular flange 50 which lies within elliptical opening 47 in the bed plate and the oscillations of the pivot table are thus limited by the walls of elliptical opening 47.

Housing 44 for the movable roll is provided with a depending circular boss or lug 51 which snugly fits a circular opening 52a in the pivot table and this lug extends through the bed plate and is concentric with annular flange 50. From this, it will be seen that roll housing 44 is capable of horizontal oscillation, first, about the vertical axis of lug or boss 49 of the pivot table and second about the vertical axis of lug or boss 51 of the roll housing 44. Movement about the axis of lug 49 of the pivot table limited by the elliptical opening 47 in the bed plate provides the movement of the movable roll bodily toward and from the fixed roll for the purpose of entering and removing the work and for moving the movable roll into contact with the roll preparatory to rolling. The second movement or that about the vertical axis of lug 51 of the roll housing 44 is utilized in swinging the movable roll toward the fixed roll to decrease the distance between the rolls during rolling, and, since the movable roll is swung or tilted during rolling about a point in the roll contact line, or, in other words about a point in the surface of the blank with which the movable roll contacts, the position of the vertical axis of lug 51 is determined by the total thickness of the superposed blanks entered between the rolls.

The movable roll housing and the pivot table are held in place against vertical movement by means of hold-down clamps 52, 53, 54 and 55 which are bolted to the bed plate and overlie bearing flangers formed on and which project outwardly from the base of the movable roll housing.

The bed plate on opposite sides is provided with upwardly extending posts 56 and 57 and a tie rod 58 extends through openings in the upper ends of said posts and is securely held in place by means of stop collars 59 and 60 and a wedge device 61. A stiffening member 62 formed integral with the bed plate, extends below and across the bed plate between posts 56 and 57. The tie member 58 and the stiffening member 62 co-operate to prevent distortion of the bed plate during rolling.

The rolls, or more properly, the roll spindles 63 and 64, are geared together adjacent the rolls 40 and 43 by means of bevel gears 65 and 66. These gears are formed so as to remain in mesh during the entire movement of roll 43 away from roll 40, limited as it is by the walls of elliptical opening 47.

Spindle 64 of the fixed roll 40 is driven by a suitable electric motor (not shown) through gearing 67.

The roll swinging mechanism

The housing for the movable roll is oscillated about the axis of lug 49 of the pivot table by means of two cams adapted to be operated by the roller and by means of a hand lever 68 positioned on the entrance side of the mill. The cams are shown in detail in Figs. 5–8 inclusive. Cam 69 which is the closing cam or the cam for moving the roll housing 44 toward roll housing 41 is formed with a semi-cylindrical body portion 70 and is provided with a downwardly extending stub shaft 71 which is journaled within a bearing opening formed in the bed plate. The cam is provided with a squared shaft 72 which projects upwardly above the body portion and an opening cam 73 having a cam member 74 is provided with a squared opening 75 which snugly fits squared shaft 72 of cam member 70. The body of cam member 73 is cylindrical and this cylindrical body is journaled within a bearing plate 76 bolted to the top of a cam post 77 formed integral with the bed plate. This cam post is provided with a wear plate 78 secured thereto and which has its inner bearing surface curved to conform to the body portion 70 of cam 69. A post 79 which projects upwardly from the pivot table 48 carries a wear plate 80 against which cam 69 bears during closing movement of roll 43 toward fixed roll 40. A cam plate 81 bolted to the top of post 79 is provided with an opening 82 which embraces the opening cam 74 by means of which roll 43 is moved away from fixed roll 40. Opening 82 is rectangular as shown in Fig. 5.

Both the top and bottom of the pivot table as well as the bottom of roll housing 44 and the top of the bed plate are machined, and are provided with suitable oil grooves and oil pockets to ensure relatively easy sliding of the roll housing on the pivot table and the pivot table on the bed plate.

Post 57 of the bed plate is drilled through from side to side in such manner as to provide two bores within the larger of which an internally threaded bushing 83 is located. A screw 84 threaded into bushing 83 is provided at its inner end with a curved face 85 which bears against a correspondingly curved face on a bearing block 86 secured to the outer side of housing 44 for the movable roll. The other end 87 of screw 84 is squared and a worm wheel 88 provided with a squared hole is mounted on this squared end of the shaft so that as screw 84 is turned in against bearing block 86 by the worm wheel 88, the shaft will slide within the worm wheel. A yoke member 89 bolted to opposite sides of post 57 as shown in Fig. 1, surrounds worm wheel 88 and the outer end 87 of the screw 84 and holds the worm wheel in place when the screw 84 is backed out of bushing 83.

Roll housing 44 and therefore, roll 43 is moved by screw 84 about the vertical axis of lug 51 of the roll housing during rolling and returned to normal or starting position when this screw is backed out by reversing the motor 99 by means of a relatively stiff coil spring 90 which is positioned between the inner side of roll housing 44 and a spring abutment member 91 adjustably carried on a screw 92 which is threaded through a support member 93 carried by pivot table 48 adjacent depending lug or boss 49. Worm wheel 88 meshes with worm gear 94 the shaft of which carries a pinion which meshes with a gear 95. The shaft 96 upon which gear 95 is mounted, carries a gear 97 with which the pinion 98 of the electric motor 99 meshes. The operation of motor 99 is under the control of the roller and the control mechanism for this motor (not shown) is positioned adjacent lever 68.

The methods employed for changing the an-

gular position of the roll 43 will be briefly explained: When the work or material is positioned or inserted between the rolls or removed therefrom, for a quick and positive change of position of the roll 43, the hand lever 68 is employed. The lever 68 by means of its lug 74 cooperating with a grooved opening 82 cut in the cam plate 81 and, additionally, by means of the lug 69 cooperating with its irregularly formed seat, causes the bearing plate 76 and the pivot table 48 to which it is secured, to oscillate on the lug 49 about the elliptical opening 47 (see Figs. 1, 5, 6, 9, 10, and 11). As seen from Fig. 6, the operation of the hand lever is entirely independent of the operation of the worm mechanism 88 timed to the rotation of the rolls.

But, when the pivot table 48 is locked in a given position by the hand lever 68 and the material is in position for rolling and the rolls are set in rotative operation, then, the worm gear mechanism 88 (see Figs. 1 and 4), driving the screw 84, slowly pushes the housing 44 about the circular lug or box 51 in timed relation to the rotative speed of the rolls. To return the housing 44 to its original position, the motor can be reversed, as will be explained.

Roll and spindle construction

The two rolls and the two spindles of the mill are substantially identical and are shown in detail in Figs. 1, 2 and 12–15 inclusive. The movable roll and its spindle is illustrated in Fig. 2 and this, therefore, will be described. The spindle is hollow and at the roll end is enlarged in diameter. The enlarged diameter is provided with a tapered bearing surface 100 which is journaled within a tapered bearing 101 carried in the roll housing. The opposite end of the spindle from the roll is provided with a cylindrical bearing journaled within a bearing (see Fig. 2) member 102 carried in the roll housing. Thrust bearings 103 and 104 secured to the spindle are positioned on opposite sides of an abutment member 105 formed as a part of the roll housing. The thrust bearings will preferably be of the tapered roller type and these will be so adjusted as to prevent tapered bearing face 100 of the spindle from contacting with tapered bearing 101. The tapered bearing serves more as a steadying member and holds the roll in position. Both the tapered bearing of the spindle as well as the cylindrical bearing are flooded with oil as are also the thrust bearings.

The spindle at the roll end is provided with a cylindrical seat 106 to receive gear 65. The gear abuts against a stop shoulder 107 and is keyed to the spindle by means of keys 108 as shown in Fig. 12.

The end face of the spindle at the roll end is bored out at its center to provide a circular recess for the reception of a centering plug or disk 109 which lies within the recess and projects outwardly therefrom. This spindle end face is also provided with 4 key ways 110 for the reception of keys 111, (Figs. 12, 14 and 15), which are held in place in their key ways by screws 112. Centering plug 109 is also secured within its recess by means of screws 113.

Roll 43 in its larger end is provided with a central circular recess adapted to fit centering plug 109 and with key ways 114 corresponding to the key ways in the end face of the spindle. These fit keys 111.

The roll is drilled through from end to end as shown at 115 and the inner end of the bore thus formed is threaded to receive the threaded end of a pipe 116 which extends outwardly through the hollow spindle and beyond the outer end thereof. The inner end 117 of this pipe is plugged and the pipe is provided with one or more openings 118. The outer end of pipe 116 is centered and supported by means of a centering and supporting member 119 through which the pipe passes. The outer end of the pipe is threaded and a nut 120 screwed onto the pipe against member 119 holds the roll 43 in position on the spindle.

Water from any suitable source is admitted to pipe 116 through a water connection 121. The water flowing in through the pipe passes out through holes 118 into the hollow spindle surrounding the pipe and flows out of the spindle through channels 122 and 123 formed in the centering member 119.

Blank holding mechanism

The blanks (two or more in superposed relation) raised to proper rolling temperature are gripped by the helper with a pair of tongs of peculiar construction which are suspended and counterbalanced as is now common. The tongs are entered within guide ways in a supporting frame or structure and shoved to position against stops.

The tongs are provided with gripping jaws which securely grip the blanks and which are free to rotate with the blanks during rolling. The supporting frame or member is provided with air cylinder arranged on opposite sides of the tongs in line with the gripping jaws. When the blanks have been moved to position, the roller admits air to the air cylinders by means of a three way valve (not shown) and the gripping jaws with their blanks are locked in position.

The gripping jaws are water cooled and provision is made so that when the tongs have been shoved to position against the stops, a water connection is automatically made so that the cooling water is immediately forced into the gripping jaws.

When the disks are finished, the roller, by means of said valve releases the air from the air cylinders and the helper removes the tongs with the finished disks. The act of removing the tongs from the support member automatically cuts off the water supply to the gripping jaws.

The tongs support frame or member 124 is made up of bilaterally symmetrical halves bolted together as shown in Figs. 23 and 24 and is rigidly bolted to the projecting portion 125 of the bed plate in front of the rolls. The support overhangs its base member 126 on the roll side as shown in Fig. 24. Guide ways 127—127 for the tongs are provided and air cylinders 128—128 are located in line with the guide ways. At the entrance end the guide ways are rounded off as shown at 129 in order to provide an easy entrance opening.

Each air cylinder is provided with a piston 130 which has a stem 131 secured thereto and which projects through a hole drilled through the frame of the support member in line with the guides 127. A coil spring 132 forces the piston to inoperative position when air line 133 is exhausted by means of the three way valve under the control of the roller. Each air cylinder 128 is provided with an atmospheric vent 134 on the spring side of the piston. Each

guide way adjacent the air cylinder on its side of the support member is provided with a stop 135 for limiting the movement of the tongs toward the rolls.

The tongs

The tongs consist of two levers 136 and 137 formed with cooperating hinge jaws 138 and 138'. The levers are connected together by means of a hinge pin 139. (See Figs. 18, 19, 20 and 21). The long ends 140 of the levers form the handles for the tongs and these are held in separated position by means of a coiled spring 141 positioned on suitable abutments 142 formed on the long ends of the levers. The short ends 143 of the levers are provided with gripping jaws for the blanks and these are shown in detail in Figs. 25 to 31 inclusive.

Each end 143 of the levers is provided with a rectangular rib or fin 144 formed to slide within its guide way 127 of the tongs support frame. Each member 143 is also provided with a shoulder 145 adapted to contact with stop block 135. This limits the inward movement of the tongs toward the rolls.

The hinge pin extends above and below the levers 136 and 137, and loosely mounted on each extension 146 of the pin is a bearing block 147 the outer surface 148 of which is struck on the arc of a circle having point 149 (the center of hinge pin 139) as its center. A support ring 150 formed in halves and interiorly provided with a circular guide way 151 embraces the bearing blocks 147 and holds them in place on the hinge pin ends. The upper half of ring 150 is provided with a support eye 152 adapted to be connected to the jib or trolley by a chain 153 whereby the blanks may be conveyed by the helper from the heating furnace to the mill and carried therefrom when finished to the point of discharge.

The construction above described provides for universal movement of the tongs about the center 149 of the hinge pin.

Tong gripping jaws

The inner face 154 of the outer end of each tong arm 143 is machined to receive a gripping-jaw bearing-block 155 which is secured to member 143 by means of machine bolts 156. Each of these bearing-blocks is provided with a concave bearing surface 157 formed as a segment of a sphere and adapted to receive a knob-like member 158 formed integral with one of the gripping plates used in the make-up of the gripping jaws of the tongs. The head of the knob-like member is formed on the segment of a sphere corresponding to the surface 157 of the jaw bearing block 155.

Each bearing block 155 is provided with a lip 159 which overlies a part of concave bearing surface 157. The knob-like members lie within the cavities formed by the concave bearing surfaces 157 and partially overlap the knob members. The knob members are secured in place by means of locking plates 160 which are secured to the bearing-blocks 155 on the opposite sides from lips 159 and overlie the surfaces 161 of the knob-like members 158.

In this manner the gripping jaws are secured to the tong levers and the desired amount of universal movement is provided.

The gripping jaws are circular as shown in Figs. 26 and 27, and one jaw 162 is formed with a central recess 163. The other jaw 164 is formed with a central cylindrical boss 165 which enters recess 163 when the jaws are in gripping position. The length of boss 165 is such that it will enter recess 163 when two blanks are in position between the gripping jaws. As before said, each blank has a circular hole punched at its center and these holes are of such size as to snugly fit boss 165. The gripping face of each jaw (illustrated in Figs. 25 and 26) is provided with a series of annular V grooves 166 and a series of cross grooves 167 in order that the jaws may be sunk into the hot metal plates to prevent them from turning relatively to the jaws and from pulling away from boss 165 during rolling.

Each jaw is drilled inwardly from its periphery to provide water distributing channels 168 which connect with a centrally located channel 169 drilled in the knob portion of each gripping jaw from its convex face 170.

The water distributing channels 168 terminate at the periphery of the gripping jaw which at this point is cylindrical. Each gripping jaw carries a loose ring 171 which acts as a baffle ring for the water discharged outwardly through the water distributing channels 168. The water passes laterally through the space between the ring and the periphery of the gripping jaw and falls by gravity to the bed plate of the mill.

The tongs support frame on each side above the guide way 127 for that side, carries a cooling water distributing valve device shown in detail in Fig. 19. This consists of a valve housing 172 having an inwardly projecting diaphragm partition 173 provided with a centrally located circular opening for the reception of a valve member 174. The valve member 174 is hollow and open at its outer end 175. The inner end of the valve member is closed by means of a head 176 and is provided with a series of ports 177. A coil spring 178 which surrounds a projection 179 formed on the outer side of head 176 normally holds the valve member in closed position with the ports 177 out of communication with valve chamber 180. Valve chamber 180 by means of suitable piping 181 (Fig. 22) is connected to a suitable source of water supply. Each arm 143 of the tongs is provided with a cupped connector member 182 which is adapted to contact with valve member 174 when the tongs are shoved to position in guide ways 127 of the tongs support frame. The interior 183 of cupped member 182 connects with a channel 184 drilled in its arm 143 of the tongs. A cross channel 185 connects channel 184 with a channel 186 drilled in the bearing block 155. The channel 186 at all times connects with channel 169 drilled in the knob-like portion 158 of the gripping jaw.

From this construction it will be seen that as the tongs are shoved to rolling position, the valve device 172 will admit water to the gripping jaws and when the tongs are removed from rolling position, the flow of water to the gripping jaws will be cut off.

Each bearing block 155 is drilled through from side to side to provide an oil or grease channel 187. This channel intercepts the concave bearing surface 157 to form an oil opening 188. The channel 187 registers with an oil channel 189 drilled in the tong member 143. This allows a suitable supply of oil or grease to be fed to the bearing surface 157. Unless otherwise limited, the term "a blank" as employed in the claims

includes a single blank as well as a plurality of superposed blanks.

Having thus described my invention, what I claim is:—

1. The method of making radially tapered discs which consists in roller forging a blank between a pair of rolls, the axes of which lie in a common horizontal plane, and in timed relation to the rolling, in progressively varying the angle between the roll axes during rolling by tilting one of said rolls toward the other about a point in the roll contact line.

2. The method of making radially tapered discs which consist in roller forging a blank between a pair of rolls, the angle between the axes of which is varied on their common horizontal plane during rolling, in timed relation thereto, by tilting one of said rolls toward the other about a point in the roll contact line.

3. The method of making radially tapered discs, which consists in entering a blank between rolls, the axes of which lie in a common horizontal plane and holding the center of the blank outside the plane of the roll axes, in giving unity of rotation to said rolls and simultaneously therewith in tilting one of said rolls toward the other about a point located in the roll contact line.

4. The method of making radially tapered discs, which consists in entering a metal blank between rolls the axes of which lie in a common horizontal plane, in holding the center of the blank outside of the plane including the roll axes, in giving unity of rotation to said rolls and simultaneously therewith in decreasing the angle between the axes of said rolls.

5. The method of making radially tapered discs, which consists in entering a metal blank between rolls the axes of which lie in a common horizontal plane, in holding the center of the blank below the plane of the roll axes, in giving unity of rotation to said rolls and simultaneously therewith in constantly decreasing the angle between the axes of said rolls.

6. The method of making radially tapered discs, which consists in entering a blank between a pair of rolls, locating the axes of the rolls so as to be in a common plane above the center of the blank, in giving unity of rotation to said rolls and simultaneously therewith in progressively varying the angle between the roll axes by tilting one of said rolls toward the other about a point located in the roll contact line.

7. The method of making radially tapered discs, which consists in entering a metal blank between a pair of rolls, in holding the center of the blank below the plane including the roll axes, in giving unity of rotation to said rolls and simultaneously therewith in tilting one of said rolls toward the other about a point located in the roll contact line so as to decrease the angle between the roll axes.

8. The method of making radially tapered disks which consists in forging a blank between a pair of rolls, and in independently holding the center of said blank within the space formed between the ends of the rolls and the intersection of plane projections of the outer faces of the rolls, and in constantly decreasing the angle between the roll axes during rolling.

9. The method of making radially tapered disks which consists in entering a blank between a pair of rolls, in revolving said rolls, and simultaneously therewith in timed relation thereto, in tilting one of said rollers toward the other about a point in the roll contact line.

10. The method of making radially tapered disks which consists in forging a blank between a pair of rolls, in holding the center of the blank outside the plane including the roll axes, and in revolving said rolls, and simultaneously therewith in timed relation thereto, in tilting one of said rolls toward the other about a point in the roll contact line.

11. The method of making radially tapered disks which consists in forging a blank between a pair of rolls, in separately supporting the center of said blank within the space formed between the ends of the rolls and the intersection of plane projections of the outer faces of the rolls, and in revolving said rolls, and simultaneously therewith in timed relation thereto, in tilting one of said rollers toward a point in the roll contact line.

12. The method of making radially tapered disks which consists in forging a blank between rolls, the angle between the axes of which is varied during rolling by tilting one of said rolls toward the other about a point in the roll contact line, and in holding the center of said blank within the space formed between the ends of the rolls and the intersection of plane projections of the outer surface faces of the rolls, and also in holding the axis of said blank in a plane outside of the plane including the roll axes.

13. The method of making radially tapered disks which consists in so supporting a blank for rotation between a pair of rolls that the roll contact line is above the center about which the blank rotates during rolling, and in tilting one of said rolls toward the other to decrease the angle between the roll axes during rolling.

14. The method of making radially tapered disks which includes entering a blank between rolls having a common axial plane, holding the center of the blank offsetly from and substantially parallel to the common plane of the rolls, revolving said rolls, and simultaneously therewith, varying the angle between said rolls about a point located in the roll contact line.

15. The method of making radially tapered disks which includes entering a blank between a pair of rolls, the axes of which lie on a common plane, holding the center of said rolls offsetly from and substantially parallel to the plane of the roll axes, and progressively varying the angle between the roll axes during rolling by tilting one roll toward the other about a point in the roll contact line.

16. The method of making radially tapered disks which includes entering a blank between rolls, the axes of which lie on a common plane, holding the center of the blank outside of and substantially parallel to the plane including the roll axes, revolving said rolls, and simultaneously therewith, tilting one of said rolls towards the other about a point in the roll contact line.

17. The method of making radially tapered disks which includes entering a metal blank between the rolls having a common axial plane, holding the center of the blank offsetly from and substantially parallel to the common plane, revolving said rolls, and simultaneously therewith, decreasing the angle between said rolls.

18. The method of making radially tapered disks which includes entering a metal blank between rolls, the axes of which lie in a common plane, holding the center of the blank outside of and substantially parallel to the plane

including the roll axes, revolving said rolls, and simultaneously therewith, constantly decreasing the angle between the axes of said rolls.

19. The method of making radially tapered disks which includes entering a blank between rolls, holding the center of the blank offsetly from and substantially parallel to the plane including the roll axes, revolving said rolls, and simultaneously therewith, decreasing the angle between the roll axes by tilting one of said rolls toward the other about a point in the roll contact line.

20. The method of making radially tapered disks which includes entering a metal blank between rolls, holding the center of the blank offsetly from the plane including the roll axes, revolving said rolls, and simultaneously therewith, tilting one of said rolls about a point located in the roll contact line and decreasing the angle between the roll axes.

21. The method of making radially tapered disks which includes entering a blank between rolls, holding the center of said blank offsetly from the center of the roll axes, giving unity of rotation to the said rolls, and simultaneously therewith, in tilting one of said rolls toward the other about a point located in the roll contact line.

22. The method of making radially tapered disks which includes entering a blank between rolls, the axes of which lie on a common plane, holding the center of said blank offsetly from the common plane of the roll axes, giving unity of rotation to said rolls, and simultaneously therewith in timed relation thereto, tilting one of said rolls towards the other about a point located in the roll contact line and decreasing the angle between the roll axes.

23. The method of making radially tapered disks which includes entering a metal blank between rolls, holding the center of the blank outside of the plane including the roll axes, revolving said rolls, and simultaneously therewith, tilting one of said rolls towards the other about the point of intersection of their axial planes.

24. The method of making radially tapered disks which includes roller forging a blank between a pair of rolls, holding the center of the blank outside of the plane including the roll axes, revolving said rolls, tilting one of said rolls toward the other about the point of intersection of their axial planes, and in timed relation therewith and simultaneously therewith, giving unity of rotation to said rolls.

OTHO M. OTTE.