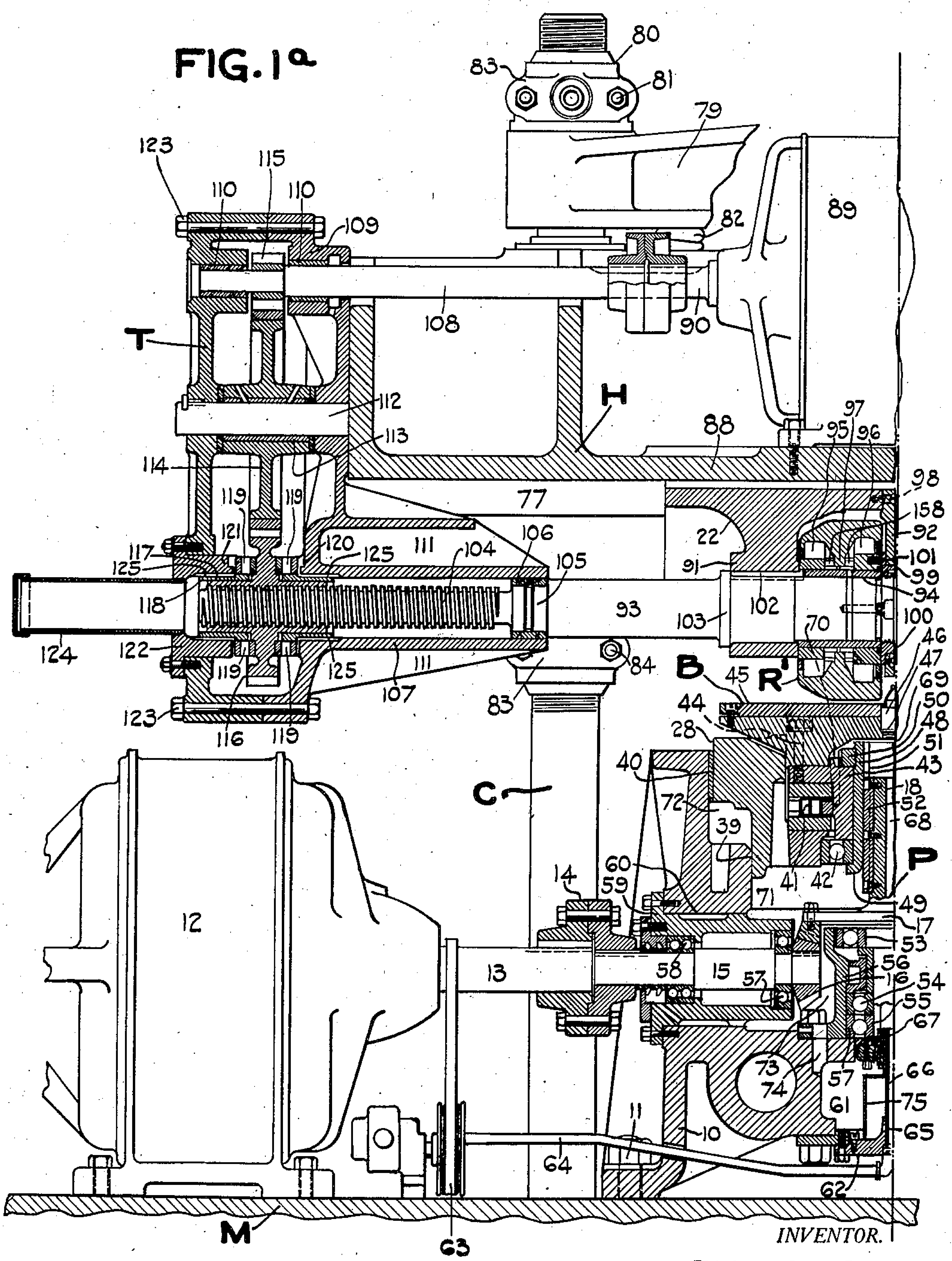
Sept. 4, 1928. **1,683,368**

E. A. NELSON

MACHINE FOR ROLLING WHEEL DISKS

Filed April 9, 1925 6 Sheets-Sheet 1

FIG. 1a



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Filed April 9, 1925 6 Sheets-Sheet 2

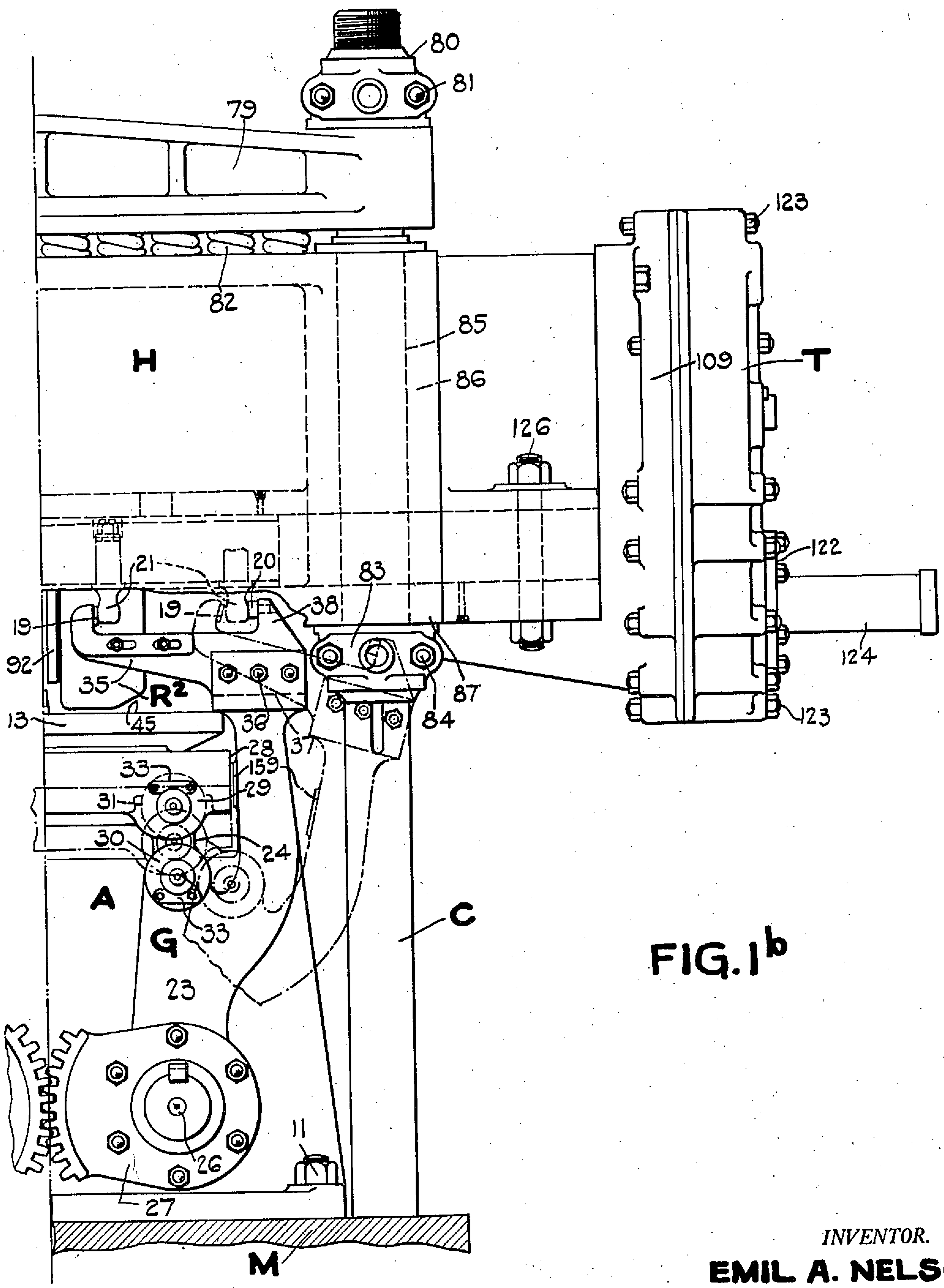

FIG. 1b

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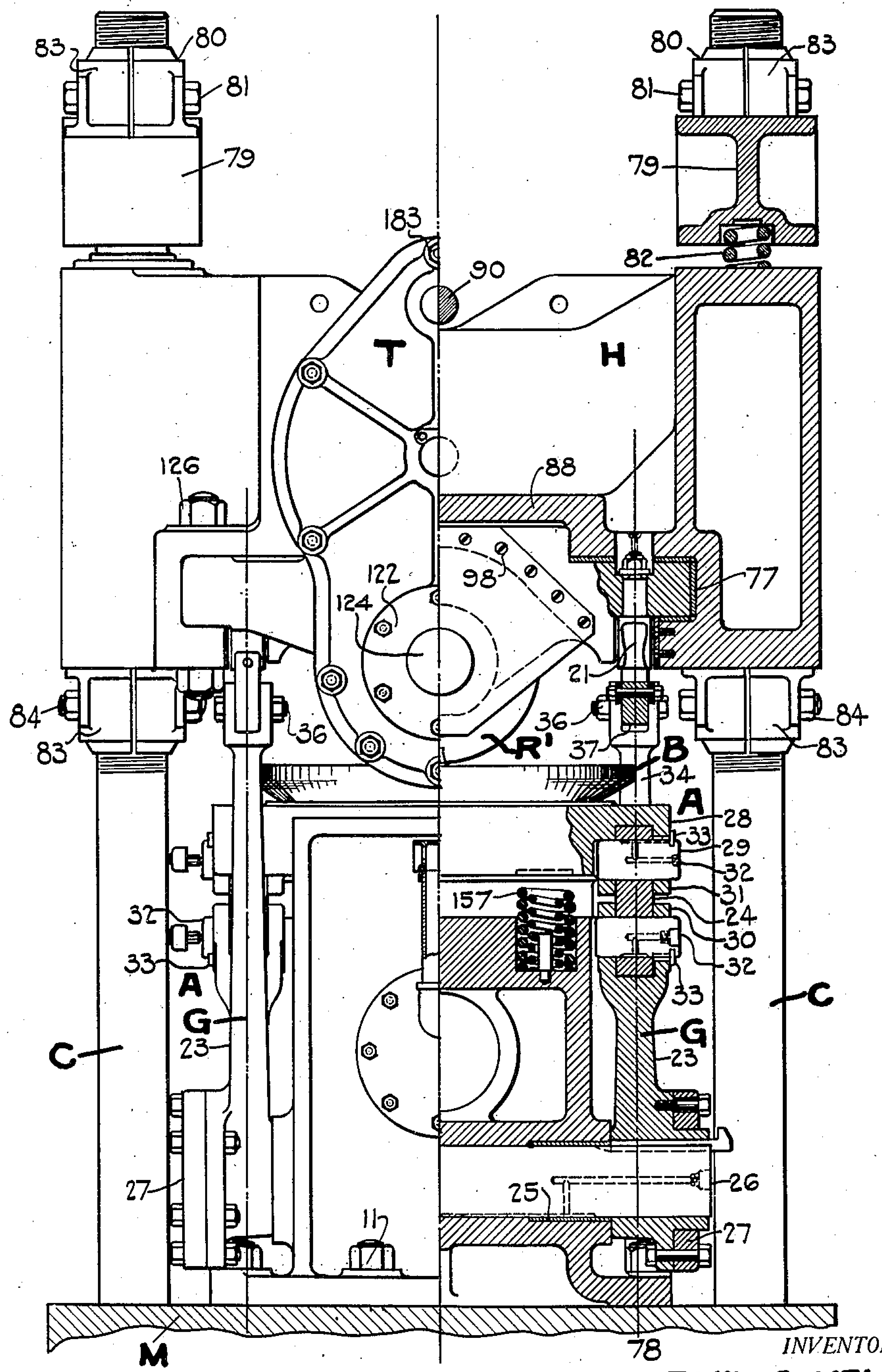

FIG. 2

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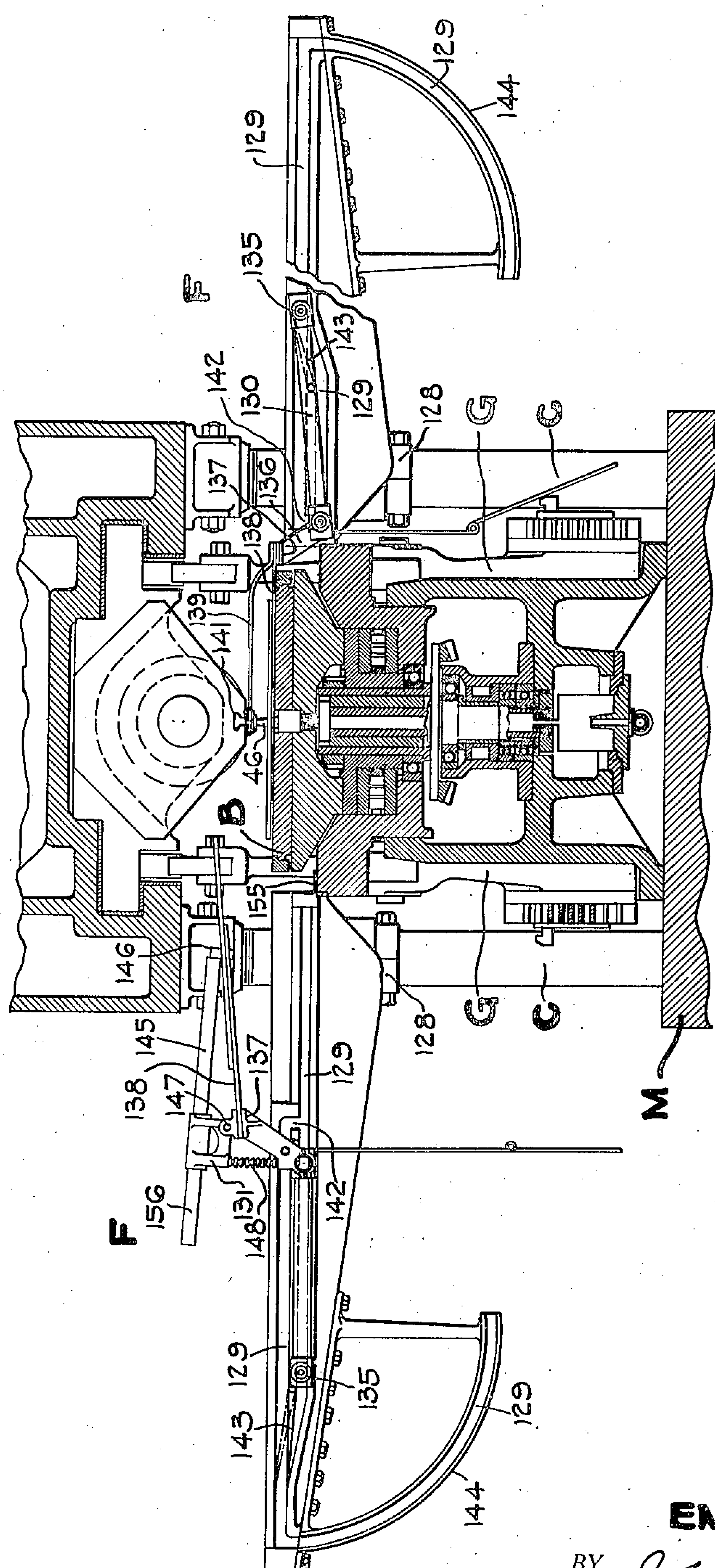

FIG. 3

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MACHINE FOR ROLLING WHEEL DISKS

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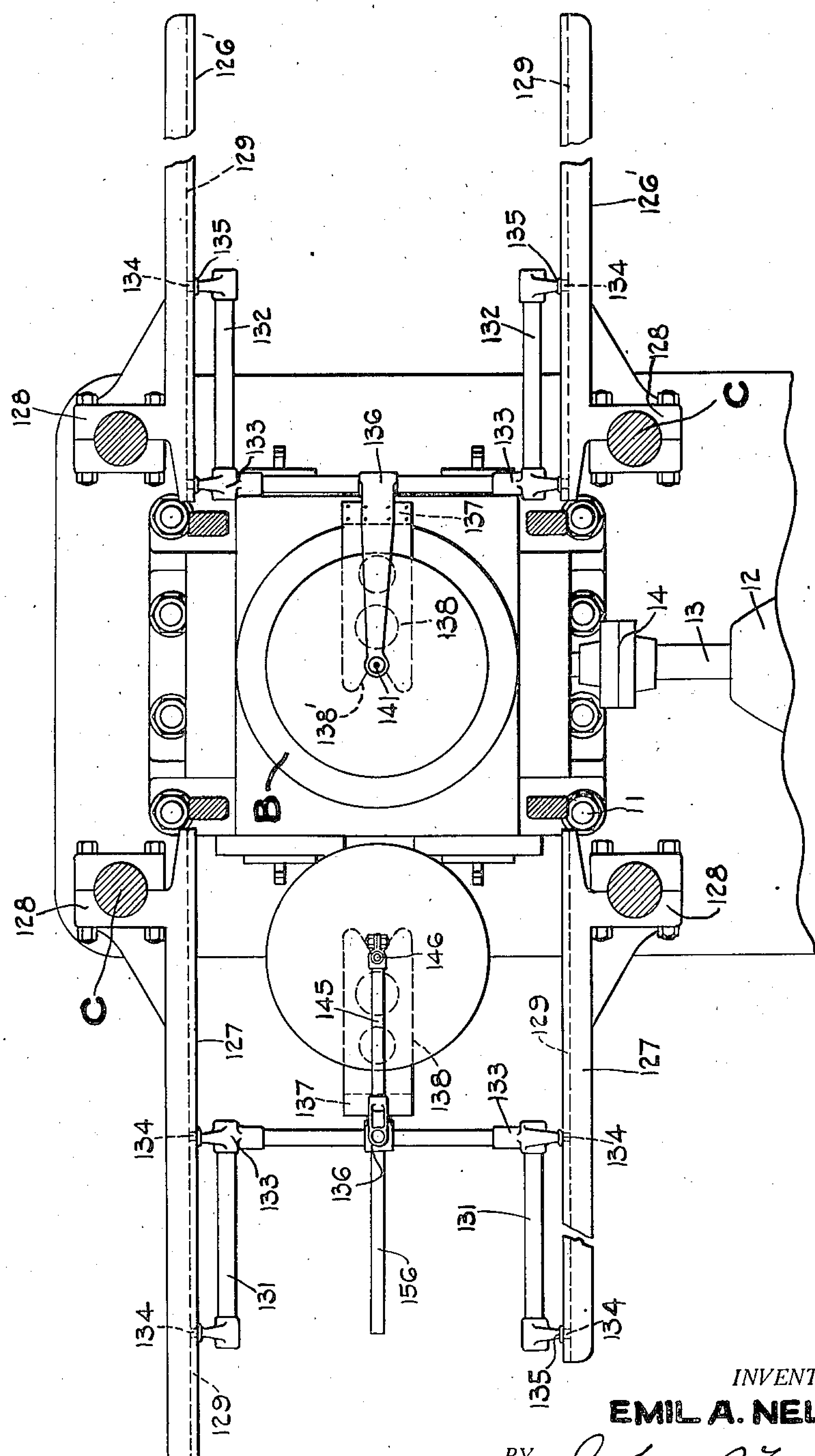
FIG. 4



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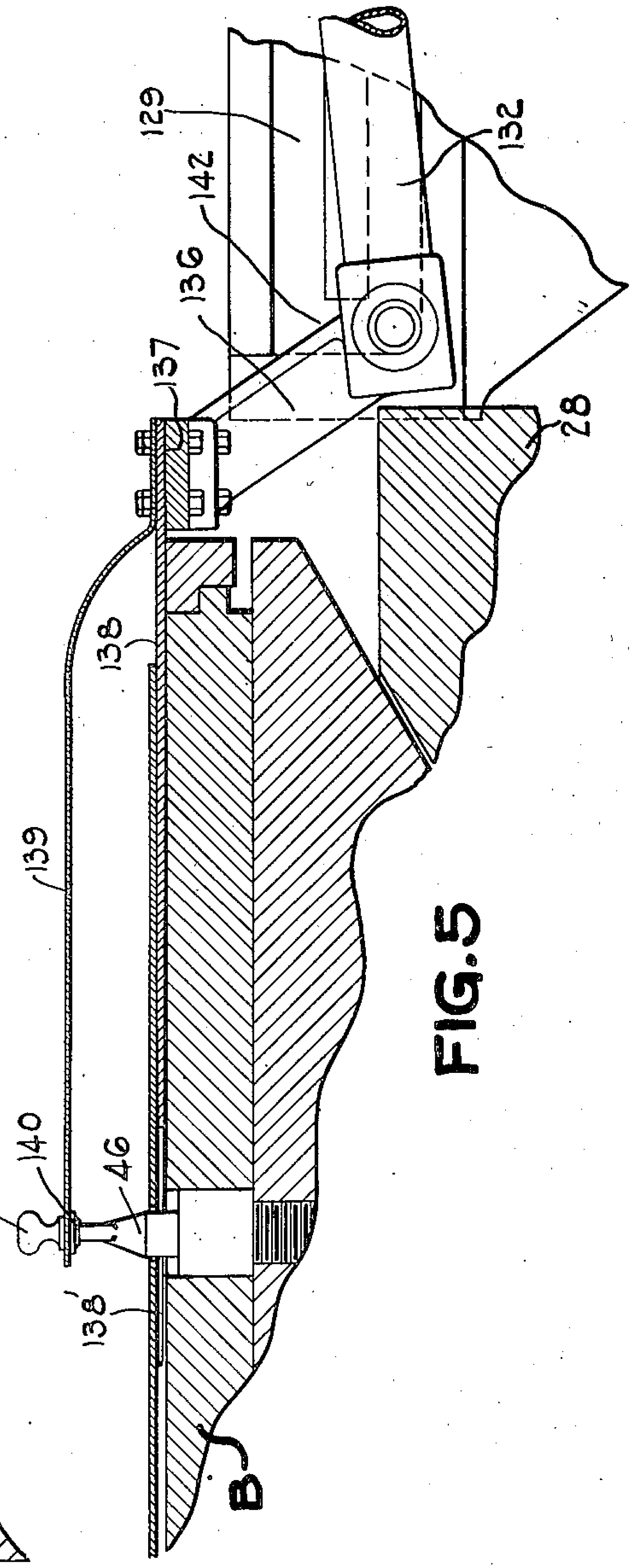

FIG.5

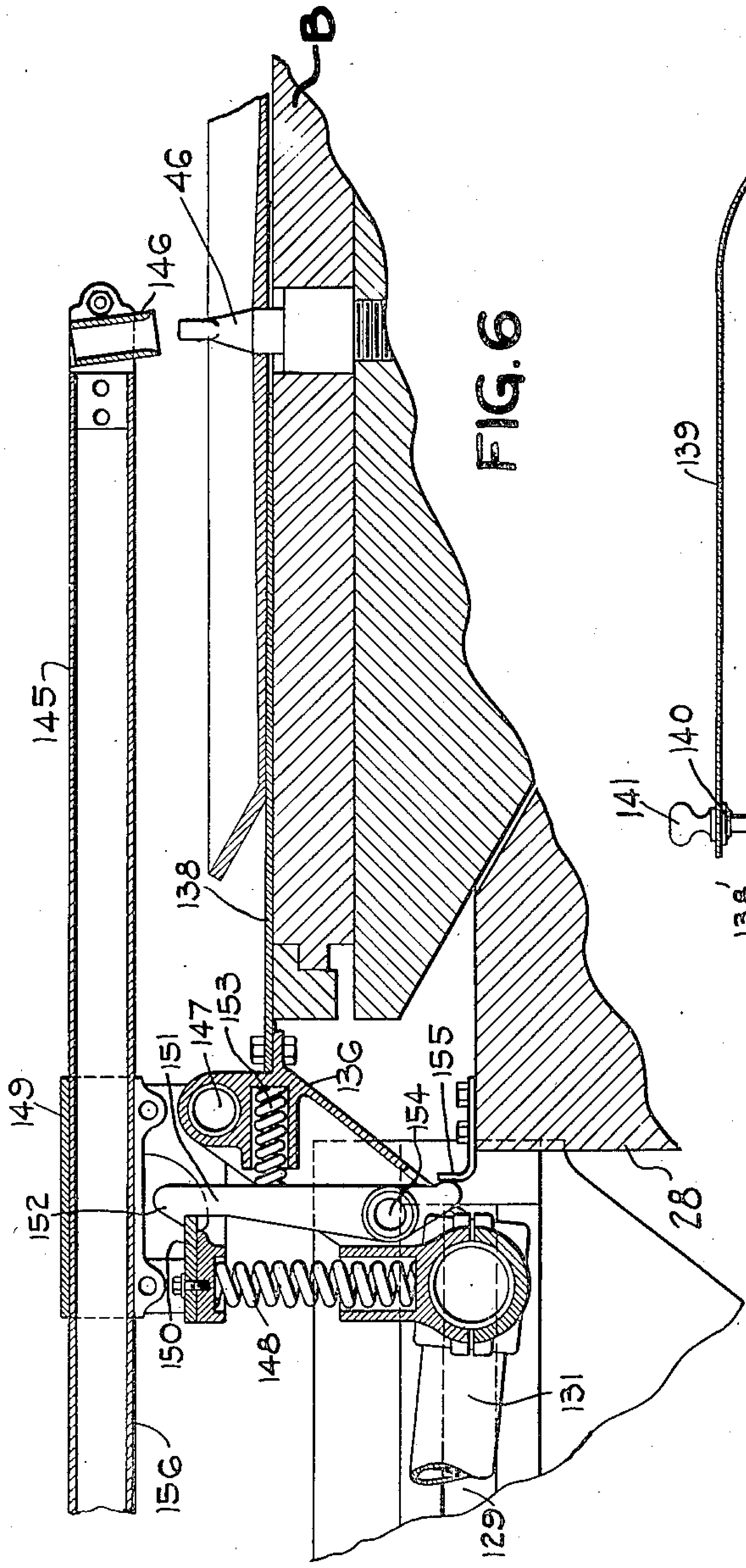

FIG.6

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Patented Sept. 4, 1928. 1,683,368

UNITED STATES PATENT OFFICE.

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MACHINE FOR ROLLING WHEEL DISKS.

Application filed April 9, 1925. Serial No. 21,797.

My invention relates to machines for rolling tapered wheel disks, especially to that class of machines developed very recently, and the subject of an application for Letters Patent filed in the name of John W. Smth, Serial No. 414,848, forging machines, filed October 5, 1920, and in the name of Emil A. Nelson, Serial No. 666,122, filed October 2, 1923, machines for rolling metallic disks. The prime object of my invention is the development of an improved type of this class of machines.

In general, the machines of this class which have heretofore been built have comprised a rotating blank holder in the form of a platen having a cross section corresponding in taper of working surface to the taper it is desired to give the related disk. A pair of diametrically opposed traversing rolls having a rectilinear traverse radially outward on a blank engaging line in converging relation to the radial tapered surface of the platen engage a blank upon the platen during the outward traversing movement in a combined spinning and rolling action. The work is thereby done on the blank along a spiral path progressing outwardly from the central area of the worked blank.

The types of machines heretofore developed have embodied constructional arrangements inherently weak, and affecting the application of the working pressures along lines other than straight lines and in a multiple number of angular directions, arrangements which at once invite lost motion, weaving, misalignment, undue wear of working parts, etc. These types have moreover been relatively difficult to adjust, equally difficult to retain in adjustment, difficult to repair, and operated at a relatively low speed of production.

As aforesaid, the prime object of my invention is to achieve an especially practical type of machine, one in which inherent simplicity of parts and straight-forward constructional combinations are utilized in a manner to enable those skilled in the art to practice good engineering design and to effectually eliminate in such designs most if not all of the working troubles heretofore experienced. From another angle it is my object to produce a type of machine at once strong, sturdy and reliable, a machine which will stand up for a long period of time under the extremely heavy duty in which it operates.

To produce such a type of machine having a general accessibility of parts and at the same time easy to knock down and assemble is another object. There results not only a facility in repair, but facility in manufacture and shipment of this large and heavy machine.

To produce a type of machine economical in power under this heavy duty is likewise an object.

An object, too, is the production of a machine which can be used to make tapered disks of either hot or cold blanks.

And an important object is the production of a type of machine having a decidedly increased rate of production, one sufficiently high to decidedly improve commercial economy of operation.

In the attainment of these objects I have invented a machine characterized among other things by the application of the approach and separation mechanism through which the approach and separation of the blank support and the working roll are effected, to the blank support rather than to the roll support or roll-carrying head, as has been commonly done heretofore. This in itself greatly increases the rate of production of the machine, since the roll-carrying head, the associated working rolls, and the traversing mechanism and its prime mover constitute a very heavy mass which prevents by its inertia the attainment of high speed production. I am moreover able to reduce the complexity of these portions of the machine by removing from association with them the approach and separation mechanism, and thereby to effect a great deal of the simplicity and straightforward construction which is my aim. Unburdened by these parts the roll-carrying head may be made more rugged.

My invention is characterized further by a concentration of the working strains on straight lines grouped as nearly as possible to the work being done, concentrated in fact largely within the working zone of the parts, which is to say within the cross sectional area of the machine occupied by the blank being worked upon. The approach and separation mechanism not only flanks the blank supporting structure at large, but actually underlies the blank support itself, giving force reactions on straight lines substantially parallel to the axis of rotation of the blank support. The approach and separation mechanism is in the form of toggles symmetrically disposed with respect to the axis of the blank support, and derives its power directly from the traversing mechanism of the working rolls. Thus the common prime mover supplies power for both the traversing and the approach and separation movements.

The blank support itself is connected with the approach and separation mechanism through the intermediary of a cradle in which it is mounted, and with respect to which it partakes of its rotating movement. The cradle itself, while borne in generous cylindrical guideways and having free axial movement in response to the approach and separation mechanism, is supported against rotative movement, enabling the most effectual journaling of the blank support to be attained.

The blank support and its cradle are mounted on a sub base anchored to the main base. The sub base is flanked by the approach and separation mechanism and the approach and separation mechanism is in turn flanked by a series of columns anchored to the main base of the machine and extending well beyond the blank support where they carry the roll carrying head in relatively fixed position as respects the base of the machine. Through this very arrangement I am able not only to yieldingly mount the head, but to effectually adjust it.

The head is a very deep structure having a hollow interior and a flooring on the side adjoining the blank support. The working rolls are mounted upon it for traversing movement between the flooring and the blank support. The prime mover for the working rolls is carried within the hollow of the head and geared directly to the working rolls beneath.

Finally, the type of the machine is characterized in general by symmetry of parts and by unit constructions as applied to its several mechanisms.

Of the drawings,

Fig. 1^A and Fig. 1^B depict the machine in side elevation, Fig. 1^A being partially a view in central longitudinal section while Fig. 1^B is the opposite half of the machine in full elevation.

Fig. 2 is an end elevation of the machine showing one-half of the machine in full elevation and the other half in transverse sectional elevation.

Fig. 3 is a central vertical longitudinal section of the machine with portions of the top and bottom broken away and designed to show in longitudinal section the work feeding mechanism.

Fig. 4 is a plan view taken in a horizontal plane just above the rotating blank support and the work feeding mechanism as shown in Fig. 3.

Fig. 5 is a vertical longitudinal section of the blank-placing portion of the feeding mechanism, and

Fig. 6 is a similar section of the blank-removing portion of such mechanism.

The blank supporting and rotating structure in general is designated B, the approach and separation mechanism by the letter A, the main base of the machine by the letter M, the columns severally by the letter C, the roll-carrying head generally by the letter H, and the traversing mechanism carried by it and supported from it, and through which the working rolls R^1 and R^2 are driven, in general by the letter T, while the feeding mechanism is designated generally by the letter F.

The blank support B is carried rotatably at the upper ends of a sub base 10, anchored by bolts 11 in the extended heavy and rigid main base M. It is rotated by a prime mover 12 anchored to the main base M to one side of the machine. This prime mover 12 has a horizontally-extending drive shaft 13 connected by detachable coupling 14 with the horizontal drive shaft 15, journaled in the sub base 10. Drive shaft 15, through beveled gears 16, 17, drives a vertical shaft 18 to which the blank support B is connected for rotation, through the intermediary of several elements presently to be described.

The approach and separation mechanism A flanks the sub base 10 and comprises four toggles designated generally G. These toggles are arranged in pairs on opposite sides of the base and each pair lies in a longitudinal vertical plane which intersects the perimeter of the blank holder B, as clearly appears in Fig. 2. In fact the toggles actually underlie the area of the blank support B and exert their pressures on a straight line passing through this area, and in direct opposition to the working rolls traversing the face of the blank support. Associated with these toggles are dogs 19 and 20 engaging with coacting dogs 21 mounted upon roll-carrying frames 22, by means of which rolls R^1 and R^2 are supported from the head H. Through interengagement with these dogs, the approach and separation mechanism is directly operated through the traversing movement of the rolls. As appears in Fig. 2, these dogs are located in the same longitudinal vertical plane as the toggles themselves, and this plane intersects the bodies of the frames 22 by means of which traversing rolls are supported. When the traversing rolls are moved, the engagement of dogs 21 at the outer extreme of movement unlocks the toggles and causes a quick movement of separation. When dogs 21 engage dogs 19 upon the inner traversing movement, the toggles are gradually raised to their locked positions in which the extreme of approach of the blank support B to the rolls R^1, R^2 is established.

Toggles G comprise in each case a lower arm 23 and an upper arm 24. Lower arms of corresponding toggles on opposite sides of the machine are keyed in common to transverse shafts 24′ of generous proportions journaled in anti-friction bearings 25 transversely of the foot of the sub base of the machine. Lubricant is supplied these bearings 25 by forcing through conduit 26 provided in the body of the shaft. Corresponding pairs of toggles on the same side of the machine, however, are, as shown clearly in Fig. 1 and Fig. 2, geared together by segmental gears 27 bolted to arms 23 surrounding shafts 24′. The arrangement is such that the arms 23, and consequently the toggles G at large, operate in unison toward and from the central vertical transverse plane through the axis of the machine. The upper arms 24 of toggles G connect with the cradle structure 28 bearing the blank support B, and through which structure the toggles move the blank support B to effect its approach and separation movement with respect to the rolls R^1 and R^2. Connection is made, respectively, with the lower arms 23 and with this cradle 28 by means of heavy bearing pins 29 passed through the forked projections 30 and 31, respectively, and the intervened upper arm itself. Lubrication is supplied to the generous bearing surfaces through channel 32 provided in the pins. The pins are retained in place by means of retaining bolts 33, or any equivalent device.

An extension 34 is formed integrally with the lower arm 23. This extension projects first laterally to clear the vertical projection of the blank support B (Fig. 1^B), then substantially vertically upward past the blank support B. It is here provided with an inwardly extending upper end 35. This upper end is in the form of a horizontally extending arm projecting inwardly of the machine. It is removably secured by bolts 36 in the socket 37 in the upper end of extension 34 whereby it may be bodily removed. At its inner end this arm 35 carries adjustably and removably the dog 19 which is of angle shape secured to the arm by its horizontal extension and engages dog 21 by its vertical extension. At its outer end, arm 35 has an integral vertical extension 38 provided with a removable pin 20 which constitutes the other dog of the pair engaging dog 21.

The cradle 28 is journaled within the body of the sub base 10 on substantially cylindrical bearings 39 (Fig. 1^A). Such bearings are very easily formed by boring or turning, and can be fitted with great accuracy. It is the lower portion of the cradle which is borne in these extended bearings. The upper portion is provided, as shown in Fig. 1^A, and in the plan view shown in Fig. 4, with a rectangular exterior, the opposite ends of which are borne between plane bearings 40 in the upper portion of the sub base. Cradle 28 is supported against rotation by these bearings 40, yet it may move freely in an axial direction. Supported both in these bearings and in the cylindrical main bearings 39, it is so moved axially when the toggles G are made and broken.

This cradle 28 supports the blank holder B jointly by means of the anti-friction thrust bearing 41 of relatively large diameter, and the radial anti-friction bearing 42 of relatively small diameter. The raceways of these bearings associated with the blank support B are borne by a blank support hub member 43 to which the blank support B is removably bolted, as at 44. The blank support is provided with the usual removable facing 45. Blank centering pin 46, adapted to pass through an aperture in the blank to center the same, passes freely through this facing 45 and is screwed home against a shoulder 47 formed in the center of the blank support B.

The hub 43 is free to rotate within the cradle 28 so that its rotation exerts no more than the torque imposed by the anti-friction bearings in a tendency to rotate the cradle. Interiorly it is bored out to receive the splined sleeve 48 through which it is keyed to the driving shaft 18 from which power is supplied to the rotating platen. This sleeve 48 fits snugly within the central bore of the hub member 43, and on its lower end is provided with a shoulder 49 between which and the hub is confined the inner raceway of the anti-friction bearing 42. Its upper end is screw threaded and receives the clamping ring 50 by means of which the anti-friction bearing 42 and hub 43 are clamped firmly upon it. Interiorly it is provided with the spline 51. This spline receives key 52 which is removably secured to the hollow drive shaft 18. Thus the rotating blank support is effectually coupled to its drive shaft, yet its cradle does not rotate but is free to partake of the approach and separation movement without disturbing the coupled relation, the key 52 sliding freely in the keyway 51. At the same time the cradle supports it anti-frictionally both against the tremendous working thrust through the anti-friction bearings 41 of large diameter, and against radial thrust through the anti-friction bearings 42.

The hollow driving shaft 18 is extended downwardly below gear 17 and there provided with a triple series of anti-friction radial thrust bearings 53, 54 and 55, the raceways of which are mounted in a vertically-extended sleeve or bearing casing 56 bolted or otherwise secured to the body of the sub base 10. The bearings are provided with suitable spacers, the one 53 being located at the top just beneath the gear 17, and two of them being located at the bottom, the bottom most seated upon shoulder 57′ of the sub-base 10. The entire series is removable simply by removing the mounting casing 56.

The horizontally-extending drive shaft 15 is likewise supported by anti-friction bearings at its inward and outward ends, these bearings being designated 57 and 58, respectively. These bearings are carried in a mounting sleeve 59 removably centered in a transverse bore 60 in the side of the sub base 10. The diameter of bore 60 is greater than that of the interior gear 16 whereby both shaft 15 and gear 16 may be bodily removed along with the bearing mounting sleeve 59 and the bearings, given access to them and to the interior of the casing.

The entire blank supporting and rotating construction just described is lubricated by a system of conduits formed in the parts commencing with the bottom of the sub base 10. This bottom is provided with a central chamber 61 immediately underlying the lower ends of the hollow shaft 18. Its lower end is closed by a removable flanged plate 62. Oil is introduced to the chamber from a circulating pump 63 by a conduit 64 entering the center of the flanged plate 62. This central entrance is through a projecting nozzle 65 formed integrally with the flanged plate 62. Interconnecting the nozzle and the hollow interior of shaft 18 is a section of tubing 66 having an oil-packed joint 67 with the lower end of shaft 18. Lubricant thus passes through the hollow 68 of the shaft to the top where it emerges within the recess 69 in the under side of the blank support B. Thence, it passes downwardly through and over the various bearings and guideways just described. It lubricates the spline connection 51, 52, passes down through the dotted line channel 70 to the thrust and radial bearings 41 and 42 entering the recess 71 below the cradle 28. There it lubricates the mounting bearings 39 and 40 of the cradle itself, working up slightly through the recess 72 to the bearing 40. Passing in bulk downwardly, it lubricates gears 16 and 17, the series of radial bearings 53, 54, 55, the series of horizontal bearings 57, 58, and, finally, passes through spaces 73 and channel 74 into the hollow chamber 61 through which it originally entered by way of tubing 66. Chamber 61 is of sufficient dimension to act as a sump if desired. However, another and larger reservoir may be provided for this purpose. Chamber 61 surrounding tubing 66 is provided with strainer 75 through which the lubricant passes from the body of the chamber to the suction conduit (not shown) through which it returns to the circulating pump 63.

The columns C are arranged in pairs symmetrical with respect to the vertical center of the machine. Their lower ends are anchored in a manner (not shown) rigidly in the extended rigid and heavy main base M. They are spaced from the blank supporting structure B and the approach and separation mechanism A sufficiently to allow free play of the parts of the latter mechanism in the space between the supporting structure E and the columns. Their extended upper ends support the roll-carrying head H approximately at its four corners. Within the columns on its under side, the roll-carrying head H is provided with the undercut guideways 77 overlying the approach and separation mechanisms A, and mounting and guiding in their traversing movements the frames 22 supporting the traversing rolls R^1, R^2. These guideways 77 in general are located in substantially the same vertical plane as the approach and separation mechanisms A. The line designating this plane in Fig. 2 is marked 78, and these planes are parallel to the longitudinal plane of symmetry of the machine. By virtue of these constructions, planes 78 are drawn close in to the longitudinal plane of symmetry, so close that they substantially intersect the working zone of the blank support B and the supporting cradle 28, and make feasible not only that direct mechanism interconnection between the approach and separation mechanisms A and the traversing frames 22 of the working rolls, but the application of supporting the working pressures along essentially straight lines, and the application of the force of reaction in direct opposition to the forces of working. Yet by reason also of the constructions recited, the actual working movements and the generous supporting bearings of the blank support B are in no wise impaired.

The tops of the columns are interconnected in longitudinally-extending pairs by bridges 79 in the form of heavy I-beams, as appears in Fig. 2. The columns pass upwardly freely through the ends of these bridges, and their upper ends are threaded. Split nuts 80 on these threaded ends are arranged to adjust the bridges 79 up and down within the limits of the threaded column ends. Having been adjusted, the nuts may be clamped in position by clamping bolts 81, through which its parts are firmly drawn together and about the ends of the column. Between the bridges 79 and the roll-carrying head H are arranged a series of heavy spiral springs 82 borne in sockets formed, respectively, on the under side of the bridge and the upper side of the roll head. These springs collectively exert sufficient pressure to bear the roll head H upon the work with the designed working pressures of spinning and rolling. The tension of these springs is adjusted to a determinate value such that normally the rolls R^1 and R^2 perform their work without give of the roll head H, but if the normal working pressures are exceeded, the roll head H gives upwardly against this yielding series of springs 82. This pressure may be exceeded upon the initial impact of the rolls with the work at the close of the approach movement of the blank support B and the roll, but only momentarily. It may be exceeded, too, should the rolls accidently, due to any misalignment of parts or overtraverse of the rolls in case of the use of blank support B of extra large diameter, come within working contact, not with an intervened blank, but with the hardened face of the blank support itself. The springs 82 would function also in case the rolls should encounter any abnormally hard mass in the blank being rolled, or any foreign substance between the blank and themselves. In other words they function as a safety device preventing the building up of destructive forces or they may be so set, if desired, as to cushion the rolling operation to as great extent as may be desired under any given working conditions.

Also mounted on the columns C, but in this case below the roll-carrying head H, are a second group of adjusting nuts 83, likewise threaded on the columns, and likewise clamped in adjusted positions, in this case by clamping bolts 84. These nuts constitute limit stops beneath the roll-carrying head H by the adjustment of which the limit of proximity of the working faces of rolls R^1 and R^2 to the working face of the blank support B may be set. By such setting, the thickness of the forged blank is adjusted. Normally these limit stops 83 support the weight of the roll head H and its pertinent mechanisms, and also counteract the normal pressure of springs 82 or equivalent means by means of which the rolls R^1 and R^2 are held to the work. Furthermore, by relative individual adjustment they coact with the bodies of the columns upon which the roll-carrying head is aligned, to adjust the alignment of the roll-carrying head.

The roll-carrying head itself is a heavy and deep casting of substantial rectangular horizontal cross section. In each of its four corners it is provided with extended bearings 85 through which the columns C project, and by means of which the roll-carrying head H is accurately borne and guided upon the columns in its adjustments. The columns, C, through their firm anchorage in the main base M, and their generous cross section, are themselves rigid and possess considerable resistance to bending and weaving movements. An accurate fitting of bearings 85, and the amassing of the metal 86 of the casting about the bearings, serves to further increase this resistance to bending and weaving. The under faces 87 surrounding the bearings are accurately machined, and the top faces of nuts 83 complementally machined whereby these effects are abetted and the horizontality of the roll-carrying head may be adjusted with great nicety. Side walls are formed as box beams, as clearly appears in Fig. 2, while end walls are formed as channel beams, as clearly appears in Fig. 1^A.

The main body of roll-carrying head H is hollow and open at the top, springs 82 bearing against the flanged tops of its side walls. The bottom of the head, however, is provided with a flooring 88. On this flooring as a foundation within the hollow of the head is mounted a prime mover 89 with a substantially horizontal driving shaft 90 for supplying power for the traversing movement of the rolls R^1 and R^2. On this under side of this flooring 88 are formed the undercut guideways 77 for the roll-carrying frames 22 of the working rolls. These guideways 77 are formed symmetrically with respect to the longitudinal plane of symmetry, and the shaft 90 of the driving motor lies in this plane of symmetry, as shown in Fig. 2.

There are two of the roll-carrying frames 22, one lying on each side of the transverse axis of symmetry of the machine, as appears in Figs. 1^A and 1^B. Each of them comprises a main body 22 mounted in the guideways 77 to slide laterally in traversing movement. They are provided with depending roll axis supports or bearings 91 and 92. These bearings jointly support a large journal shaft 93 having a fixed relation both to the roll frame 22 and the rolls themselves. The rolls are journaled on shaft 93 between the bearings 91 and 92. Between the bearings the shaft is surrounded by an adapter sleeve 94 upon which the inner raceways of the anti-friction bearings 95 and 96 bear. The interior of the rolls R^1, R^2 is hollowed out and the inner surface itself constitutes the outer raceways of these anti-friction bearings. One of them is provided within the hollow of the rolls at each end whereby they have a well distributed support upon shafts 93. The raceways of the rolls are undercut and separated by a central web 97 whereby the rollers of the anti-friction bearings are retained against lateral displacement. The inner raceways are confined against a lateral displacement by lateral engagement with the adjacent end faces of bearings 91 and 92, and the provision of suitable spacers between them.

The bearing 92 is extremely short, being formed by a plate secured by machine screws 98 to the end face of the frame 22. Its bearing surface is constituted by an aperture 99 concentric with shaft 93 and fitting over a bearing collar 100 screw threaded on to the extreme inner end of the shaft 93. This collar is in turn provided with an exterior flange 101 serving as a spacer between the inner face of the bearing 92 and the inner raceway of the inner anti-friction bearing 96. The inner raceways of the bearings, and the sleeve 94 are retained in place by direct engagement with these collars 100. Lubricant is supplied to the bearings by forcing it into a channel 102′ having a mouth in the ends of shaft 93.

The bearing 91 relative to bearing 92 is of extended length, being formed in the relatively thick depending central body of the frame 22. Shaft 93 is keyed in bearing 91 by spline 102 against rotation with the working roll. Just outside the bearing 91 it is provided with a shoulder 103 preventing axial movement in the bearing 91 during the transverse movements of the roll. Outside of this shoulder the body of the shaft is extended laterally substantially to the outer borders of the machine at large. Its outer end is of reduced cross section and formed as a screw 104, constituting a part of the traversing mechanism presently to be described. The end 105 of its portion of large cross section is provided with a combined aligning, supporting and packing bearing 106 in the concentric sleeve extension 107 from the traversing mechanism T. Except for the inner bearing 92 which affords a very substantial support indeed, and may in fact afford any degree of support desired, the shaft 93 is arranged in bearings 91 and 106 as a cantilever, carrying the working roll at its inner end.

The traversing mechanism T comprises in the main a gearing connection between the drive shaft 90 of prime mover 89 and the axis shafts 93 of the working rolls R^1 and R^2. Drive shaft 90 of the prime mover 89 is provided with lateral extensions 108 at each end substantially parallel to the mounting shaft 93 of the rolls and also to the guideways 77. The ends of the roll-carrying head H are extended longitudinally beyond the columns C where they are faced in substantially vertically-extending planes. The guideways 77 of the roll-supporting frames 22 are extended throughout the extended length of the roll-carrying heads H. A unit supporting frame 109 for the traversing mechanism is bolted detachably to each end of the head H. In it, at its upper end, are provided bearings 110 for the extended end 108 of shaft 90. Its lower end depends from the extended ends of the head H and is provided with the underhanging sleeved extension 107 previously described as constituting the guideway for the laterally extended end of the roll shaft 93. This sleeved extension is braced from the body of the casing 109 by a series of exterior buttressing webs 111. Intermediate the extended shafts 108 and 93, the casing carries in the same plane with them a fixed idler shaft 112 mounting on journals 113 a central idler 114. Through pinion 115, keyed on drive shaft 108, this idler 114 transmits power to gear 116 operating upon the screw 104 of shaft 93. Gear 116 is provided with an elongated hub 117 interiorly screw threaded upon the screw 104, the length being made sufficient to wear effectively under the heavy power required to be transmitted through the screw for the traversing operations. Interiorly, the hub sleeve 117 is journaled in a sleeve bearing 118 centered in the sleeve 107. On each side of the body web of gear 116, close to bearing sleeve 118 and hub 117, is provided an anti-friction axial thrust bearing 119, the inner and outer raceways of which bear, respectively, against the web of the gear and interior shoulders 120, 121 of the walls of the casing 109 of the mechanism at large. The outside shoulder 121 is constituted by the end of a detachable flanged collar 122 co-axial with screw 104, and of an exterior diameter slightly greater than the diameter of the exterior anti-friction thrust bearing 119. Thereby, when the collar 122 is removed, the bearing may be removed. Moreover, shoulder 121 projects interiorly a sufficient extent to admit the disengagement of gear 116 from idler 114 through axial movement outwardly toward the outside of the casing 109, admitting independent rotations and operations of the then separated parts of the mechanism.

The casing 109 is itself made in inner and outer halves secured together by bolts 123, upon removing which the halves may be separated and any or all of the gears contained therein removed. The casing 109, when its halves are assembled, however, and in place upon the machine, is oil sealed, whereby upon the placement of a certain amount of lubricant in its interior, all of the enclosed parts are continually lubricated from its reservoir supply. The inner end of sleeve 107 is lubricant sealed by the bearing 106, as has been said, throughout the traversing stroke of shaft 93. The collar 122 opposite is provided centrally with a tubular capped casing 124 which receives the projected outer end of the screw 104 upon its outward traverse, effectually sealing this side of the casing, yet permitting entire freedom of movement of the screw. Lubricant is borne up from the bottom of the casing by the gear 116 to the gears in series with it. Bearings themselves are lubricated mainly by this upwardly borne lubricant. Lubricant passageways 125 past the sleeve and thrust bearings 118, 119 insure proper passage and drainage of lubricant around the hub 117 of gear 116 and screw 104.

Throughout the machine the mechanisms are constructed as independently detachable and replaceable units. The traversing mechanism just described can be bodily removed from the machine merely by removing the securing bolts 126 and removing screw 104 from the gear 116. Since the guideways 77 extend throughout the length of the roll head H, the roll supporting frames 22, with the shafts 93, and rolls R^1 and R^2, can be independently removed merely by sliding through the ends of the ways. Moreover, the relative arrangement of the traversing mechanism, the roll head and the blank supporting construction is such that whenever the rolls are traversed outwardly to the full extent, access to the rolls and their carrying frames can be easily had by reaching over the top of the blank support B and working between them. This gives ease of access for lubrication and for the operation of removing and replacing the rolls which can be effected merely by removing the detachable bearing 92 in any case. Rolls need be removed from time to time for renewal or regrinding, and this feature of accessibility is important. The driving motor 89 can be most easily removed and replaced by uncoupling shaft 90 from its extensions 108 and hoisting the motor out of the open top of the head by crane. The roll head H itself needs rarely to be removed, but in any case when necessary it is removed merely by releasing nuts 80 at the tops of the columns and removing the bridges 79, which may be bodily hoisted off of the columns by an overhead hoist. In fact, where desired, the entire assemblage of mechanism connected with the roll head H may be lifted with it sufficiently to give the additional access desired, or to be entirely removed from the machine. The columns themselves are located beyond the sides of the blank positioning mechanism B, as clearly shown in Fig. 2, with the result that this entire mechanism supported on sub base 10 may, merely by removing the securing means 11 and by removing the upper arms 35 of the approach and separation mechanism which carry the interlocked dogs, be bodily removed and replaced lengthwise of the machine. By releasing coupling 14, as appears in Fig. 1A, it can also be bodily removed transversely of the machine. Whenever its interior parts are to be worked upon, or when, to gain accessibility to them, it is required that the blank support B be lifted from its bearings, this is of an advantage. It is of even greater advantage in case of needed ovehauling of the machine; since for mere change of platen it is possible to traverse the rolls R^1 and R^2 laterally apart sufficiently to enable the platen to be removed. Change in the design of a blank to be operated upon necessitates at times change of the form of the platen, in which some taper is usually provided. This can easily be removed merely by withdrawing the anchoring bolts 44.

The operation of the various mechanisms of the machine is co-ordinated through both electrical and mechanical means to secure operation upon blanks placed upon the blank holder B according to continuously and automatically repeated cycles. The traversing motor 89 in the roll head H is a motor of the automatically reversing type, the reverse of which is under the control of the traversing movement of the traversing working rollers R^1 and R^2. This is to say that at the extreme movement of inward traverse, the close of this movement operates appropriate circuit controllers to reverse the motor 89 and effect its rotation in the direction to cause outward traverse of the rolls R^1 and R^2. At or near the close of the movement of outward traverse, circuit controlling means are operated to again reverse the motor, this time to cause its rotation in the original direction, to again initiate the movement of retraverse toward the center of the machine. The range of this movement is adjusted so that the rolls R^1 and R^2 approach each other very closely near the center of the machine on the retraverse movement, as closely as the relatively thin bearings 92 permit, or so closely without this minimum limit as the work desired on the central area of the blank requires. The outward range of the movement has a limit sufficient to enable the working rolls to work over the full diameter of the blank holder B. Electrical circuits and the controlling devices are not shown herein since they constitute a separate invention.

Receiving its power through the traversing movements brought about as described, the approach and separation mechanism functions on its inward stroke, brought about by the engagement of dog 19 with dog, 21, to raise the blank support B with the blank which shall have been placed upon it into working engagement with the rolls R^1 and R^2, and to lock the toggles G in the extreme raised position by moving the center bearing 32 of the toggles slightly past the vertical center line. This condition is reached precisely at the time rolls R^1, R^2 reach their extreme inward position of retraverse, and the motor 89 is reversed. The ensuing outward traversing movement constitutes the working stroke, so to speak, of the rolls. In this stroke they are borne hard down upon the blank under the great pressure built up by the toggles G in their final locking movement in which they have forced the blank into contact with the rolls against the heavy pressure of the springs 82 which bear roll-carrying head H and rolls R^1 and R^2 to the work. Co-ordination between the opening of the traverse movement and the locking of toggles G may be accurately secured by adjusting the dog 19 of the arm 35. As the traversing movement progresses, the blank is spun and rolled by the co-action of the working rolls R^1 and R^2 of the blank holder B, the rolls R^1 and R^2 being rotated through their engagement with the blank. The blank holder is preferably coaxially tapered to a degree sufficient to regulate the desired taper of the disc, although in the course of the natural operation of the machine, even in the absence of taper in the blank holder B (which forms no part of the present invention), the rolls work upon the blank to taper it from the center outwardly. Immediately upon the establishment of a traversing engagement, the blank in the zone exterior to the working rolls R^1 and R^2 begins to dish up, and this dishing continues until the traversing movement is concluded, disappearing entirely only when the rolls reach the edge of the blank. At the close of the working engagement, dog 21 engages dog 20 and unlocks toggles G, whereupon the blank support drops away from the working rolls R^1, R^2. At or near this time the motor 89 is reversed to retraverse the rolls. During the early stage of retraverse, the worked blank is removed from the blank holder B and a fresh blank is substituted. This is accomplished by a special feeding mechanism coacting with the blank holder in its approach and separation movements.

The feeding mechanism comprises front and back trackways 126′ and 127, respectively, the tracks of which ways are detachably carried by clamping means 128 with the columns C (see Figs. 3 to 6). The rails extend substantially parallel and are arranged symmetrically with respect to the transverse plane of symmetry of the machine. Through the detachable clamping means 128 the rails may be adjusted vertically and also horizontally to assure parallelism. In general, they lie in a horizontal plane perpendicular to the vertical axis of the machine. Trackways contain interior grooves 129 within which are mounted on the front of the machine the feeding-in mechanism 130, and on the back of the machine the removing mechanism 131. The feeding-in mechanism 130 comprises a tubular framework 132 of substantially rectangular form, and of less width than the distance between the rails of the track 126′. The corner fixtures 133 of this frame which interconnect the perimetral tubular branches are provided with laterally-extending studs 134 extending into the grooves 129, and there provided with anti-friction rollers 135 by means of which the frame 132 may be rolled along the track 126′, confined within its grooves 129. Centrally of the transverse tubular member of frame 132 is secured a bracket 136 which projects forwardly and upwardly, and at its upper end is provided with a plane face 137. To this face is bolted a horizontally extended expansive blank support 138 in the form of a wide but elongated plate. This plate has its inner end forked symmetrically with respect to the transverse plane of symmetry of the machine in which the longitudinal center line of the plate and the bracket 136 both lie. Overlying this plate and secured also to bracket 136 is a resilient arm 139 paralleling the length of the plate slightly above the body. At its outer end this arm is provided with a centering pin 140 having a knob 141 by means of which it may be grasped and the arm 139 bodily lifted with the pin. Upon release, the spring of the arm 139 carries pin 140 toward plate 138. Pin 140 is substantially in axial alignment with the crotch of the fork 138′. Together with the crotch of the fork, the pin 140 constitutes a blank centering means establishing a blank feeding position for a blank rested upon the expansive surface of the plate 138.

The groove 129 in the bracket track 126′ is extended along several paths. Its uppermost portion is substantially horizontal and lies slightly below the top of the blank support B so that when the frame 132 is supported within it, the frame is substantially horizontal. Bracket 136 and plate 138 project a blank held by the plate upwardly at an angle to the horizontal. At its inner extremity this groove drops at right angles to a lower level, as indicated at 142, and there joins a return branch of the groove 129. The relative angularity of the plate 138 and frame 132 is such that when this drop occurs, plate 138 is dropped not only to a horizontal position, as indicated in Figs. 3 and 5, but also to the horizontal plane of the top face of the blank support B. The lower branch of the groove 129 at some distance from the inner end of the trackway is inclined upwardly and again joins the main branch through a switch 143, which is closed against entrance from the upper groove, and may be entered only from the lower groove 129. At its outer extremity groove 129 turns downwardly and inwardly along an arc-shaped path contained in segment 144 carried from the lower edge of each rail. This segment has a radius equal to the distance between the spaced supporting studs 134 of frame 132.

When the feeding-in mechanism 130 is drawn by frame 132 outwardly, the inner roller 135 passes through the switch 143, and the frame is supported wholly from the upper branch of the groove 129 in a substantially horizontal position. The blank-supporting plate 138 is outside of the machine. A blank may now be placed upon plate 138 and slid under supporting pin 140 either by inserting its edge between the point of the pin and the crotch of the plate, or by grasping knob 141 and lifting pin 140 slightly. In either case, the knob 141 being released, the pin enters an aperture punched in the center of the blank and centers it upon the holder, thus defining a feeding-in position. Thereupon the approach and separation mechanism A having operated to separate blank support B from the working rolls R^1 and R^2, the frame 132 is grasped and projected forwardly along the confined rectilinear pathway afforded by tracks 126, and the blank is projected in the space between the top of the lowered blank holder B and the working rolls R^1 and R^2, which are undergoing retraverse. At the moment the innermost rollers 135 reach the drop 142 in the groove 129, the centering pin 140 has reached a position of coincidence with the center of the blank support immediately over the blank top of the centering pin 46, the upper end of which, as will be seen, is tapered. The inner end of frame 132 automatically drops through the branch 142 of the trackway groove, and the blank holder 138 and the blank drop with it. At the same moment, the centering pin 140 is engaged on its under end by the upper end of the centering pin 46, releasing the blank from its slot and centered engagement with the feeding-in mechanism 130, and allowing it to fall over the conical upper end of the centering pin 46 into centered engagement with the blank holder B. Thereupon the frame 132 is withdrawn rearwardly, the outer rollers 135 riding in the upper branch of groove 129, and the inner rollers riding in the lower groove 129, the plate 138 being withdrawn in a horizontal plane from beneath the fed blank until its inner forked end 138′ clears the edge of the blank. Immediately afterward, the inner rollers 135 engage the switch 143 and pass into upper branch of groove 129, whereupon the normal horizontal position of frame 132 is restored and with it the normal position of the parts carried thereby. A second blank may then be inserted on the feeding position defined by the axis of the centering pin 140.

The blank-removing mechanism 131 is in its major aspects similar to the blank feeding-in mechanism 130. Similar parts are similarly numbered. The blank support plate 138, however, instead of being provided with a resilient arm 139, carrying the centering pin 140, is provided with a yieldingly mounted rigid arm 145 which on its end carries a somewhat elongated downwardly projecting tubular pin 146. This arm is mounted on a horizontal pivot 147 overlying the supporting plate 138, and is yieldingly urged toward the plate 138 by a spiral spring 148 engaging beneath its extended outer end. Both its pivotal mounting and its extended outer end are in the form of a bracket 149, the main body of the arm being tubular. This bracket carries a detent 150 on its under side. The detent, when the arm is raised, is engaged by a trigger or latch 151 having a beveled upper end 152 spring-pressed to engaging position by spiral spring 153 carried by bracket 136, and is pivoted at 154 on the bracket 136. The cradle 28 of the blank positioning mechanism P carries an adjustable dog 155 engaging the extended lower end of the trigger 151 to effect its release. The centering pin 146, as will be seen clearly in Figure 6, is tubular in form and is angularly adjustable.

The longer portion of groove 129, in the case of this removing mechanism 13, is the lower portion. The short branch instead of being the inner and lower portion, is the upper and outer portion, the drop 142 being located intermediate the ends of the longer lower branch. The location of switch 143, too, is changed, connecting the lower and upper branches of the grooves 129 at the outer end instead of the middle of the longer groove.

The angular relations of the parts are such that when frame 131 is withdrawn from the machine, the blank holder 138 extends angularly upward, and the parts occupy substantially the relation shown in Fig. 3. Here the trigger 151 has been released and the centering pin 146 is holding the blank upon the blank support 136. By grasping the rearwardly-extending operating handle 156, the arm 145 and centering pin 146 may be raised to the position shown in Fig. 6 until trigger 151 again engages the detent 150 and holds arm 145 in raised position. The removed blank may then be taken from the blank holder and the removing device 131 is ready to be operated to remove a succeeding blank. The blank initially fed to the machine having been rolled, and before the approach and separation mechanism has separated the blank holder B and the blank from rolls R^1 and R^2, the frame 132 is drawn backward a short distance until the outer rollers 135 pass through switch 143 into the upper short branch of groove 129. This changes the plane of the blank holder 138 to the plane of the upper face of the blank holder B. The frame 132 then being moved forward with the outer rollers in the upper groove and the lower rollers in the lower groove, inserts the inner end of blank holder 138 beneath the dished edge of the blank being worked on the rotating blank holder B and projects it slightly therebeneath just sufficient to enter it, ready to be shoved home. The moment the rolling operation is complete, it is shoved home until the crotch of the fork embraces pin 146. At this moment, the tubular centering pin 146 overlies the upper end of the tapered blank holder centering pin 46, and at the same moment the lower end of the trigger 151 is engaged by the detent 155 on the cradle 28 in its lowered position, the trigger is pulled and arm 145 is projected toward the blank holder 138 by spiral spring 148. This projects tubular pin 146 over the upper end of the centering pin 46. The relations of the lengths of the upper and lower branches of the grooves 129, and of the drop, are such that at this moment the outer rollers 135 are in position to enter the drop 142. The operator then depresses the rear end of frame 132 raising the worked blank from the blank holder center pin 46 and transferring it to the removal position established by the centering pin 146 to the blank holder 138 of the removing mechanism 131. As this transfer takes place, the separating movement of the blank support B ensues, assisting the transfer. The operator then withdraws frame 131 horizontally outward along the lower branch of groove 129, the parts being in the relative positions shown in Fig. 3. Immediately afterward, the fresh blank mounted upon the feeding-in mechanism 130 is fed in by that mechanism.

Clearly I have obtained the objects of my invention. Not only is my machine simple, sturdy and practicable throughout, but these and other objects and advantages are attained with a great enhancement of the efficiency of the machine as a whole. The work done is very heavy, but the consumption of power is very economical. The embodiment of the approach and separation mechanism in connection with the platen B rather than the traversing rolls R^1, R^2, or perhaps more properly speaking, the association of the approach and separation mechanism with one of the working elements of the machine and the traversing mechanism with the other of the working elements of the machine, not only reduces the mass to be moved in the approach and separation movements, and through the reduction in inertia enables one to speed up the operation of the machine, but also eliminates that very heavy complexity which usually results through too great a concentration of mechanisms in or about a single structure.

Further, I have invented and been able to practice in this improved machine an entirely new and highly advantageous method of rolling, the outstanding advantage of which is that which enables the rolling operations to be performed without the shock of impact of the working elements of the machine. Other advantages are economy in operation and rolling, and a more accurate contour determination. This method consists in relatively completing the approach movement of the blank and the traversing rolls before the retraversing movement of the rolls toward the center of the blank is complete, whereby there results a gradual building up of the working pressure of the rolls with the blank, free from harmful impacts incident to sudden building up, as in earlier types of machines. The rolls do some work during the finishing of the retraversing movement, thereby working their way more readily to the depth desired and commence their traversing movement radially outward of the work at full depth, but burdened with less work, whereby the contour in the inner regions of the blank is more accurately attained. This method I practice in this machine through the establishment of the extended interlocking connection between dogs 21 and 19 during the retraverse movement of the rolls R^1 and R^2, gradually bringing the toggles to locked position. The platen B actually reaches a maximum upward movement of approach as the toggles pass over the center, and as they move inwardly over the center into the locked position, separate ever so slightly from the rolls R^1, R^2. This gradual movement builds up the pressure to its maximum by easy stages after the first contact with the traversing rolls is established, the rolls work toward their depth gradually, and the proper depth is actually reached very soon after if not immediately upon the starting of the rolls on their outward movement of traverse. Through this method I achieve a new cycle of operation, the traversing of the rolls radially outward in working engagement with the blank, until they leave the edge of the blank, the ensuing substantially instantaneous separation movement brought about by the said unlocking of the toggles as dogs 21 engage dogs 20, the substantially instantaneous retraverse movement of the rolls brought about through operation of the limit switch of the control system (not shown) or any equivalent device, and the recommencement of the cycle as dogs 21 engage in extended contact with dogs 19 before the retraverse movement is complete, thereby gradually approaching the blank and the working rolls, and gradually building up the working pressure.

It will be observed that dogs 19, 20 and 21 are duplicated for each toggle in the face of the fact that the toggles are geared together. This, when the dogs are properly set (as they always should be), insures a symmetry of distribution of the application of power of the approach and separation mechanism through the traversing mechanism. Notwithstanding, should there be any misadjustment, this misadjustment is taken care of temporarily at least through the heavy gear between the individual toggles, and the machine will continue to do its work in an acceptable if not a perfect manner. So, gross misadjustment is prevented from injuring the machine, and so minor misadjustment is equalized through the very mechanism itself. In rolling to an accuracy of fractions of thousandths of an inch, as can be accomplished in this machine, such symmetry of forced application and compensation for misadjustment is of substantial advantage.

In the substantially instantaneous separation movement of my new cycle, the approach and separation mechanism is cushioned by the engagement of the cradle 28 with cushioning springs 157 socketed in the sub base, as shown in Figure 2. The toggles are locked in approached relation by the engagement of pads 159 on arms 34 with the faces of cradle 28 (see Fig. 1^B.)

The rolling operation may be of course carried out with the tension of springs 82 and the resultant relative rigidity of position of the rolls R^1, R^2 set at any determined value. The pressure may be relatively low whereby the working rolls R^1, R^2 give to a greater or lesser extent through a substantial part or the whole of the working contact with the blank. Even though the platen is straight, I have found that I can roll tapered disks by a rectilinear traverse of such yieldingly held rolls on lines parallel incrementally at least to the plane face of the platen. This method is the subject of a separate application. The method practiced in this machine consists in pre-setting the springs 82 to derive a working pressure for the rolls R^1, R^2 in excess of that required to work any normal blank stock to the depth desired, but insufficient to hold the rolls to the work should the working pressure be built up by any abnormal conditions to a value in excess of the normal working pressure. In this case, I dish or taper the face of the rotatable blank support B to assist the rolls in producing the taper desired. It is only necessary to assist them, since the unavoidable minimum of elasticity in the columns C, and other parts in the train supporting the working rolls R^1, R^2, and the blank support B in their relative positions, together with the natural take-up of lost motion and reduction in thickness of films, etc., produces some resiliency. Therefore, the actual dishing or tapering of the blank supporting platen B is at an angle of convergence to the rectilinear path of traverse of the rolls R^1, R^2 substantially less than the angle of convergence of the tapered section of the disk desired.

The power for the rolling operation is largely supplied through the main driving motor 12 which drives the constantly rotating blank support B, and through frictional engagement with its supporting (and working) face, also drives the blank placed upon it and the traversing rolls R^1, R^2. But the power required for the outward traversing movement of the rolls R^1 R^2 is also substantial. This power is in the major portion that required for the spinning operation, whereas the power required for rotating the blank support B, the blank, and the rolls R^1 R^2 is largely the power required for rolling. Rolls R^1 R^2 are, therefore, subject to a very high axial thrust. This axial thrust is taken up by thrust bearings 158, the radially-extending rollers of which are interposed between the central web 97 of the rolls and the adjacent raceways of the radial bearings 95, 96. The removable collar 122 is really a safety device or guard against the mis-application of this high traversing thrust in case through accident or design the working rolls R^1 R^2 on their retraversing movement are allowed to abut each other through the carrying frames 22. In such case the building up on retraverse of the extremely high axial thrust breaks the bolts which secure the collar 122 in place and screw 104 thrusts gear 116 outwardly, sliding it out of mesh with the idler 114 and automatically cutting off the power of traversing motor 89.

The number of modifications of which my invention may be found susceptible without departing from its generic spirit may be somewhat reduced by reason of its inherent simplicity, but it is without doubt subject to appreciable modification in most if not all phases without departing from its generic spirit and without sacrificing the objects which I have attained. I intend that the annexed claims shall cover all such modifications and others to which the generic spirit embodied may entitle me as inventor.

What I claim is:

1. A machine of the character described comprising a head carrying a radially traversing blank working roll and a rotating blank support, said head and support having a relative movement of approach and separation to present the work to and remove it from the action of said roll, means for traversing said roll, and means operative as a result of said traverse to effect said approach and separation movements.

2. A machine according to claim 1 in which the power for the approach and separation movements is derived from the traversing movements of the roll.

3. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection with the radial traverse mechanism of the roll.

4. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection of variable ratio so as to effect a fast separation and a slow approach movement.

5. A machine according to claim 1 in which the approach and separation movement of the rotating blank support is effected through self-locking toggles locked in the extreme of approach movement and unlocked upon the initiation of the separation movement.

6. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection with the radial traverse mechanism of the roll through interengaging dogs respectively associated with the rotatable blank support and the traversing mechanism.

7. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection with the radial traverse mechanism of the roll, said direct mechanical connection associated with the rotatable blank support and the traversing mechanism and comprising two dogs associated with one of the mechanisms and one coacting dog with the other, which one dog is momentarily in engagement with one of the two upon the initiation of the separation movement, and extensively in engagement with the other during the approach movement.

8. A machine according to claim 1 in which the approach and separation mechanism comprises a toggle arranged on the opposite side

of said blank support from said roll carrying head, and having a branch extended past said blank support into position for engagement with the roll traversing mechanism.

9. A machine according to claim 1 in which the approach and separation mechanism comprises a toggle arranged on the opposite side of the blank support from said roll carrying head, said toggle having its lower branch extended upwardly past the blank support into position for engagement with the roll traversing mechanism.

10. A machine according to claim 1 in which the approach and separation mechanism comprises a toggle arranged on the opposite side of the blank support from the roll carrying head and having a branch extended past said blank support, the extended portion of said branch being provided with a lateral extension substantially parallel to the plane of traverse of the working roll, and dogs carried by said extension for engagement with a coacting dog on the traversing mechanism.

11. A machine according to claim 1 in which the rotating blank support is raised and lowered to effect the approach and separation movements in combination with a blank feeding mechanism operating in a plane defining a lowermost extreme of the separation movement of said rotating blank support.

12. A machine according to claim 1 in which the rotating blank support is raised and lowered to effect the approach and separation movements in combination with a blank removing mechanism operating in a plane defining the uppermost extreme of the approach movement of said blank support.

13. In a machine of the character described, a base, a rotating blank support having axial driving means journaled in said base, and an approach and separation mechanism to move said blank support longitudinally of its axis, which mechanism flanks the axis of rotation and is arranged adjacent the periphery of the blank support and on opposite sides thereof.

14. A machine according to claim 1 in which the approach and separation mechanism acts upon the blank support through a carrying cradle for the blank support supported against rotative movement but free to move axially.

15. A machine according to claim 1 in which the approach and separation mechanism comprises means for axially moving the blank support attaining rigidity in the extreme of the approach movement and maintaining the blank support locked in the extreme of the approach movement in the outward working traverse of the roll independently of the traversing mechanism, said means being non-rigid in the separation movement.

16. A machine according to claim 1 in which the approach and separation movement is effected through a system of toggles arranged between the base and the blank support.

17. A machine according to claim 1 in which the approach and separation mechanism is comprised of a transverse shaft in the end of the base removed from said blank support, and a toggle on each end of the shaft intervened between the same and said blank support.

18. A machine according to claim 1 in which the approach and separation mechanism is comprised of two transverse shafts extending through the base of the machine, said shafts being geared together and having toggles extending between the base and the blank support associated with the ends of said shafts.

19. A machine according to claim 13 in which the approach and separation mechanism underlies the perimeter of the rotating blank support, and operating means therefor having lateral and upward extensions past the work support.

20. A machine of the character described comprising a base, a cradle having a movement longitudinally of the base but supported against rotative movement, and a rotating blank support carried by the cradle and rotated from the base, together with means for longitudinally separating and approaching the cradle from the base.

21. A machine according to claim 20 in which the rotatable blank support is journaled both in said cradle frame and in said base.

22. A machine according to claim 20 in which said rotating blank holder is provided with thrust bearings in said cradle and radial bearings in said base.

23. A machine according to claim 22 in which radial bearings for said blank support are also provided in the cradle.

24. A machine according to claim 20 in which the rotating blank support is driven by a spline connection with a relatively fixed rotating shaft journaled in said base.

25. A machine according to claim 20 in which the cradle frame has a cylindrical guide bearing in said base and additionally a non-cylindrical bearing.

26. A machine of the character described comprising a main base, a sub base mounted thereon, a blank holder carried by said sub base at its extremity removed from said main base, columns anchored in said main base at the foot of the sub base and independently thereof and extending past the sub base to points thereabove, a working roll head carried by said columns, and a working roll borne by said head and engaging the blank on the holder carried by the sub base.

27. A machine according to claim 26 in which the columns flank the sub base and are

spaced therefrom, and an approach and separation mechanism adapted to effect relative approach and separation between said working roll and blank support is intervened between the sub base and columns.

28. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection with the radial traverse mechanism of the roll, said connection being arranged in a plane parallel to the rotating axis of the blank support.

29. A machine according to claim 1 in which the approach and separation movements are effected by toggles and the roll is carried by a supporting frame interlocked with said toggles in a plane parallel to the axis of the blank support.

30. A machine according to claim 1 in which the approach and separation movements are effected by a direct mechanical connection with the radial traverse mechanism of the roll, said connection being arranged in a plane parallel to the rotating axis and intersecting the perimeter of the rotating blank support.

31. A machine of the character described comprising a blank support, a roll carrying head relatively adjustable thereto, a blank working roll carried by the head, columns constituting the mounting for said roll carrying head and projecting thereabove, bridges interconnecting the tops of said columns, and yielding means between the bridges and said roll carrying head.

32. A machine according to claim 31 having an adjustable stop device against which such yielding means normally acts, whereby to set the degree of approach and separation of the blank support and the working roll.

33. A machine of the character described comprising a main base, a sub base mounted thereon, a blank holder carried by said sub base at its extremity removed from said main base, a working roll head, a working roll borne by said head and engaging the blank on the holder carried by the sub base, columns anchored in the main base at the foot of the sub base and extending past said sub base to the top of the machine, said columns carrying the roll head adjacent their upper ends whereby they are in tension in the rolling operation throughout substantially their entire lengths.

34. A machine of the character described, comprising a hollow roll-carrying head, a blank working traversing roll traversable over one face of said head, and a driving motor for said roll mounted within the hollow of the head.

35. A machine according to claim 34 in which the head is substantially horizontally arranged with a floor on its bottom, having guides supporting the traversing roll beneath the floor, and the driving motor set upon the floor within the hollow.

36. A machine according to claim 34 in which the axes of the motor and the traversing roll are substantially co-extending and there is provided gearing between them.

37. A machine of the character described comprising a roll carrying head, a pair of blank working rolls traversable over one face of said head, a driving motor mounted on the other face of said head, said rolls having independent outwardly extended axes geared commonly to the axis of the driving motor.

38. A machine of the character described comprising a blank support, and a pair of traversing rolls having opposed axes, and independently traversable supporting frames for said traversing rolls affording them axial support from opposite sides, the support of which on the adjacent sides is constituted by a relatively thin plate.

39. A machine of the character described comprising a blank traversing roll, a supporting frame for the same, and a relatively fixed roll supporting axis carried by the frame and having a lateral extension through the intermediary of which said roll is traversed.

40. A machine of the character described comprising a blank traversing roll, a U-shaped supporting frame for said roll, affording it axial support and having a relatively extended bearing for said axis on its outward side and a relatively contracted bearing for said support on its inward side.

41. A machine of the character described comprising a blank traversing roll, a rigid member by means of which said roll is traversed, intermeshed gears driving said member endwise, a casing enclosing said gears and of a width greater than the base of said gears, and a thrust collar on said casing, yielding whenever the bearing pressure exceeds a determinate maximum to permit the gears to pull axially out of mesh without removal from said casing.

42. A machine of the character described comprising a blank traversing roll, a rigid member by means of which the roll is traversed, and a thrust pressure limiting device associated with said member to limit the pressure built up through the traversing movements.

43. A machine of the character described, a traversing roll, a thrust screw by means of which said roll is traversed, and an elongated casing for said screw, and traversing mechanism engaging said screw within the casing to drive the same.

44. A machine according to claim 43 in which the traversing mechanism includes an elongated worm gear complemental to said screw and journaled in said casing.

45. A machine according to claim 43 in

which said casing is closed at its outward end and open at its inward end, and a combined guiding and packing member is provided on the screw to work within the open end.

46. A machine of the character described comprising a blank traversing roll having an axial movement of traverse and an extended supporting axis, and an oil-encased traversing mechanism engaging said axial extension and housing and lubricating the same.

47. A machine of the character described comprising a work traversing roll having an axial movement of traverse, an oil-encased traversing mechanism deriving a rectilinear traversing movement, and connections between said mechanism and said traversing roll.

48. A machine of the character described comprising a roll carrying head, a working roll adapted to be traversed with respect to said head, and a traversing mechanism including a unitary supporting frame structure by means of which it is mounted upon said head and through which the traversing mechanism may be removed as a unit from the head.

49. A machine according to claim 48 in which the head carries a prime mover releasably coupled to said traversing mechanism, and the traversing roll is detachably coupled thereto.

50. A machine according to claim 48 in which the roll head overhangs the ends of the machine and the traversing mechanism unit is secured to said overhanging ends and depends therefrom to effect driving connections with the working roll.

51. A machine of the character described comprising a work traversing roll, and a shaft through which said roll is journaled having an axial movement by means of which said roll is traversed together with traversing mechanism directly engaging said shaft to effect said movement.

52. A machine of the character described comprising a main base, a sub base adjustably anchored thereto, a blank support carried by the sub base, columns flanking said sub base and spaced therefrom whereby said sub base may be removed between two columns, together with a blank working roll supported from said columns.

53. A machine according to claim 52 in which there is provided traversing mechanism adapted to traverse the working roll over a blank, and an approach and separation mechanism between the working roll and the blank support having a removable interlock with the traversing mechanism whereby either the working rolls or the sub base may be freely removed as a unit.

54. A machine of the character described comprising a blank support, a working roll adapted to be traversed over the same, a traversing mechanism for the roll, an approach and separation mechanism between the roll and the support and having a removable interlock connection therewith whereby either the blank support or the working roll may be freely removed as a unit independently of the other.

In testimony whereof I hereunto affix my signature.

EMIL A. NELSON.