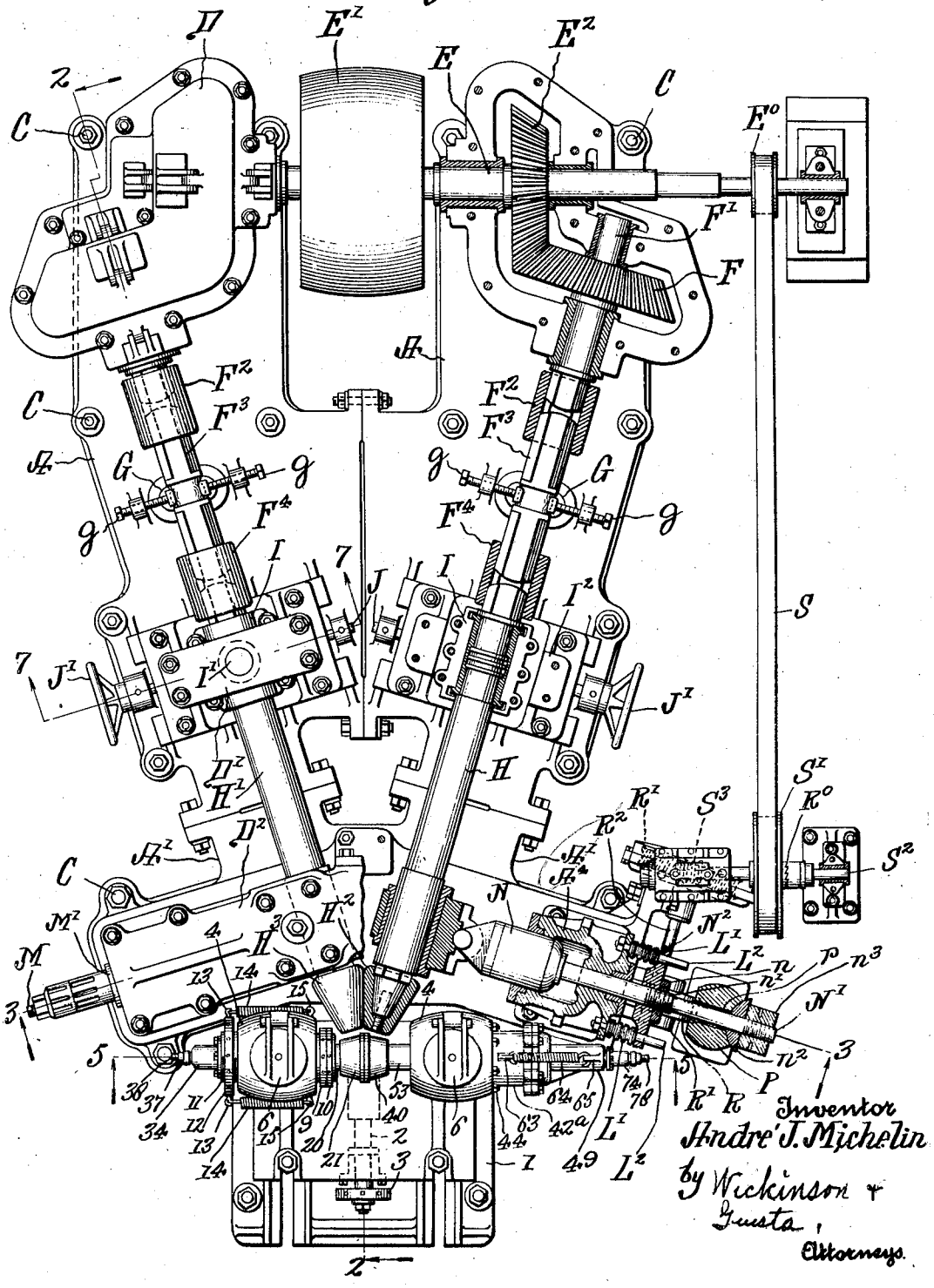
Nov. 2, 1926. 1,605,755

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MANUFACTURE OF WHEEL DISKS

Filed Feb. 21, 1922 5 Sheets-Sheet 1

Fig. 1.



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MANUFACTURE OF WHEEL DISKS

Filed Feb. 21, 1922 5 Sheets-Sheet 2

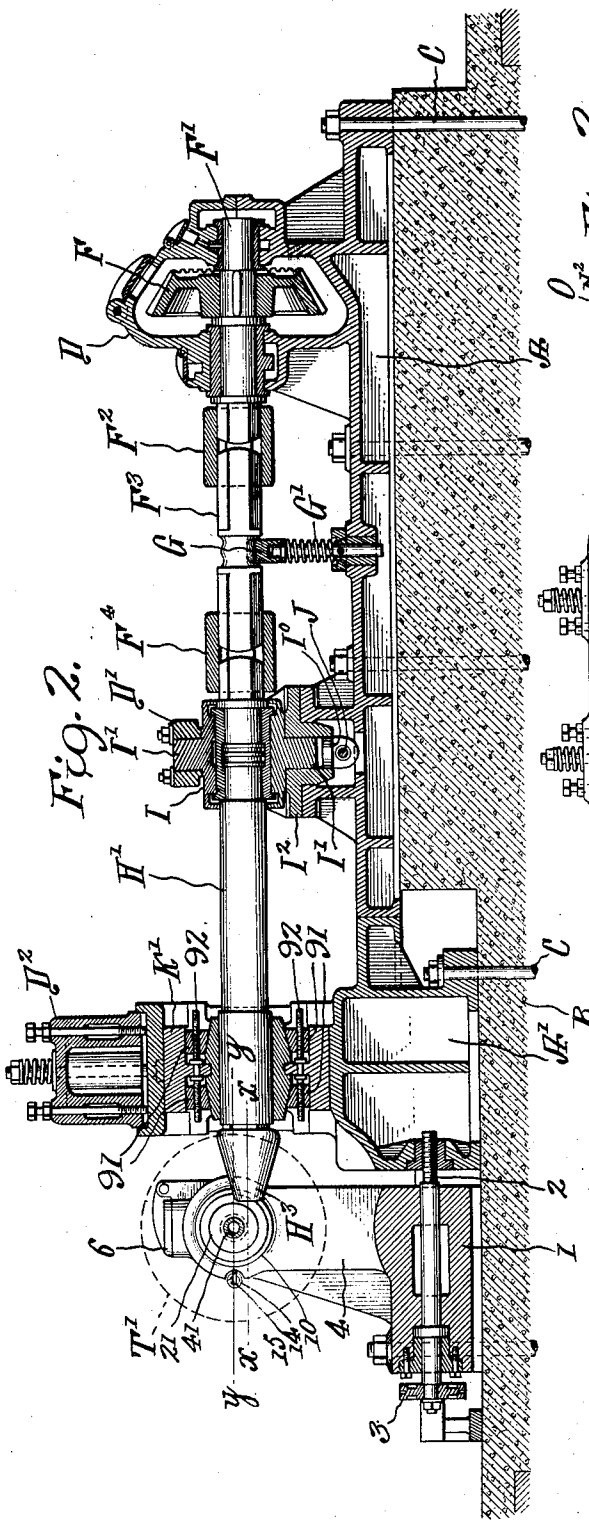


Fig. 2.

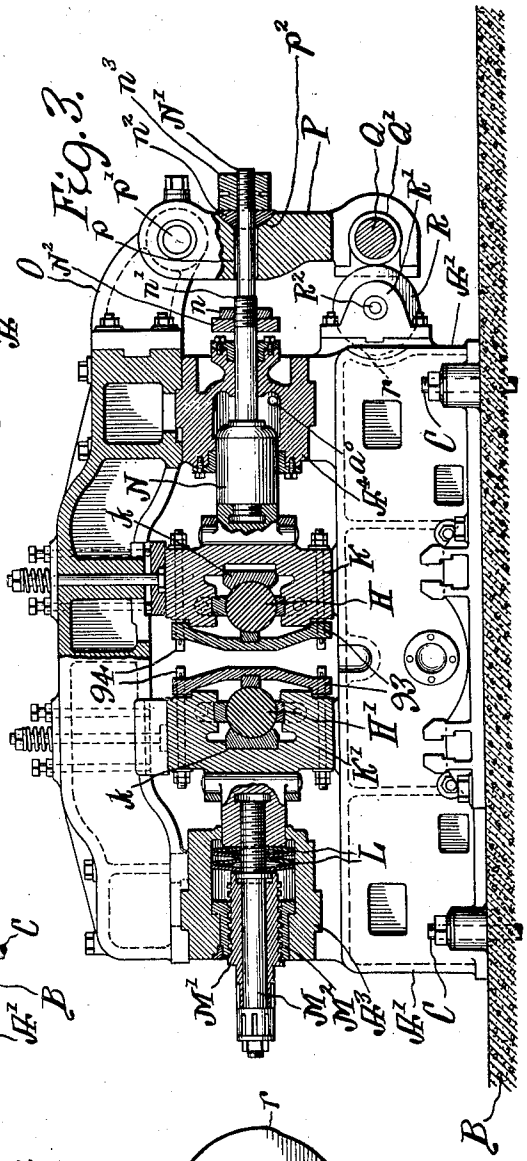


Fig. 3.

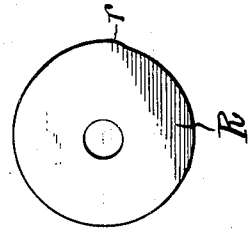


Fig. 4.

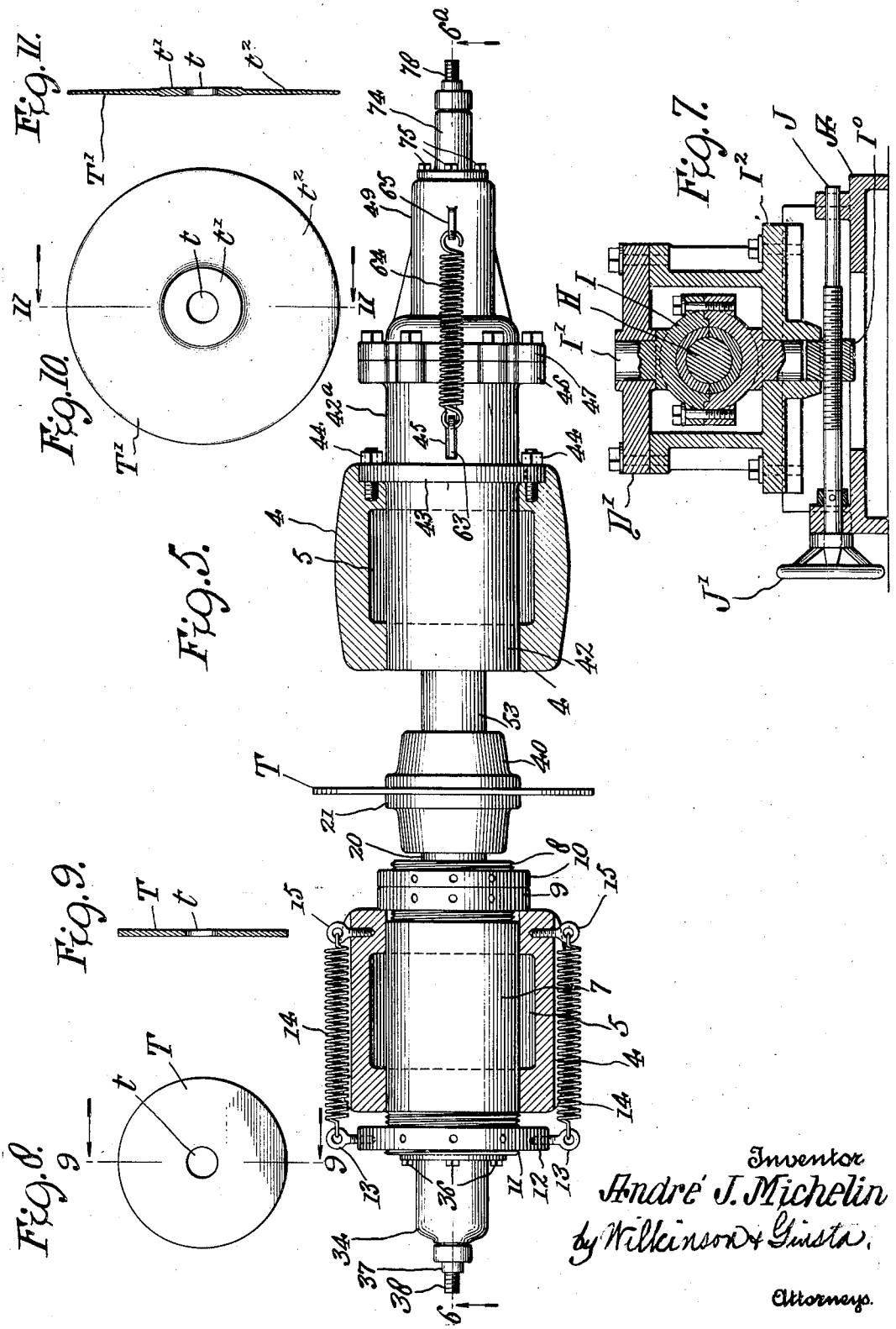
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MANUFACTURE OF WHEEL DISKS

Filed Feb. 21, 1922 5 Sheets-Sheet 3




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MANUFACTURE OF WHEEL DISKS

Filed Feb. 21, 1922 5 Sheets-Sheet 4

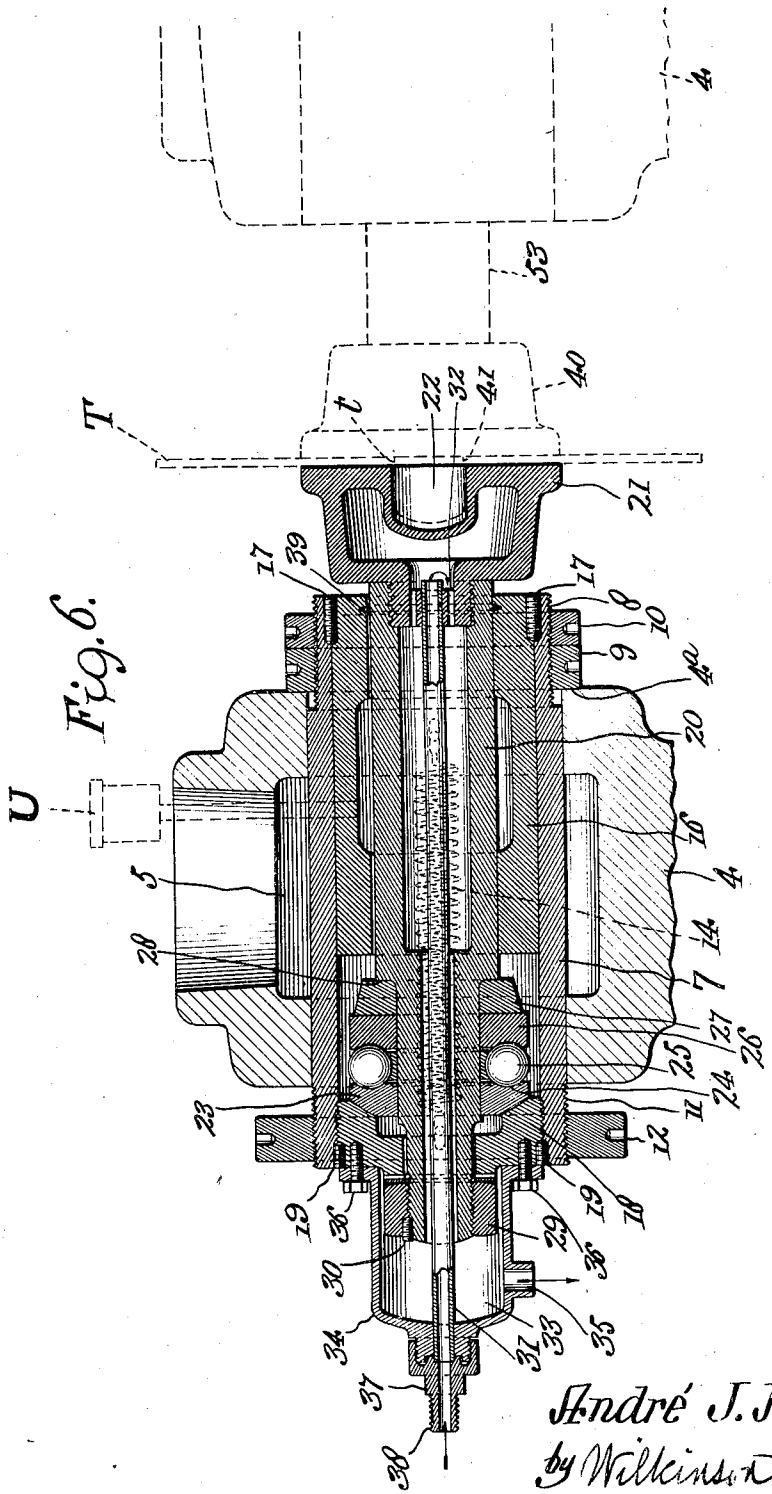



Fig. 6.

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MANUFACTURE OF WHEEL DISKS

Filed Feb. 21, 1922 5 Sheets-Sheet 5

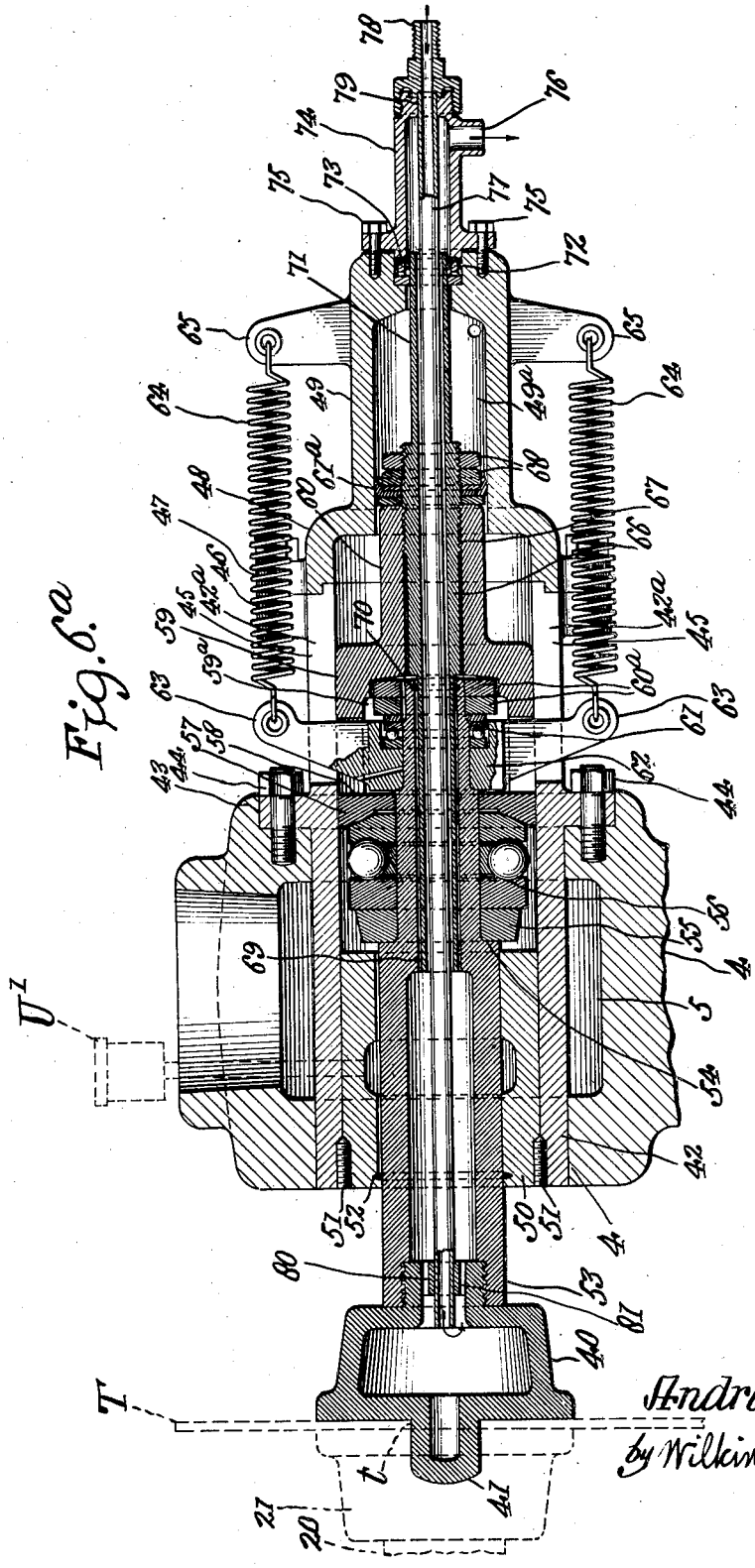


Fig. 6a.

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# UNITED STATES PATENT OFFICE.

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## MANUFACTURE OF WHEEL DISKS.

Application filed February 21, 1922. Serial No. 538,258.

My present invention relates to improvements in the manufacture of web plates for vehicle wheels, in which an annular disk is used, to which disk the metal rim adapted to carry the tire is attached, and the disk and the rim carrying said tire are adapted to be detachably connected to the hub of the wheel.

My present invention is especially directed to the improved manner of rolling out the disk to the proper tapered form before it is dished or flanged.

The present invention relates therefore only to that step of rolling the disk to the desired thickness in its various parts, and does not relate at all to the subsequent operations of shaping the disk or machining the same before the rim is attached.

According to my present invention I provide a blank in the form of an annular disk of malleable metal, preferably forged steel, which may be rolled either hot or cold, but preferably hot, into an annular plate, preferably having a thickened central portion and tapering in thickness from the center towards the periphery. The central portion, which is provided when the web plate is completed, forms a reinforced bearing for the fastening bolts, by means of which the web plate is attached to the hub of the wheel.

My invention will be more fully understood after reference to the accompanying drawings, in which like parts are indicated by similar reference symbols throughout the several views, and in which:—

Figure 1 is a plan view, partly in section, of the apparatus in which the plate is rolled from the disk.

The disk is not shown in this figure.

Figure 2 shows a vertical section along the broken line 2—2 of Fig. 1, and looking in the direction of the arrows.

Figure 3 shows a vertical section along the broken line 3—3 of Fig. 1, and looking in the direction of the arrows.

Figure 4 is a detail showing the cam used for regulating the distance between the rolls.

Figure 5 is a plan view, partly in section, of the apparatus for holding the disk in place while it is being rolled.

Figure 6 shows a section, on a larger scale, of the left-hand portion of Fig. 5, said section being taken along the line 6—6ª of Figure 5.

Figure 6ª shows a section of the right-hand portion of Fig. 5 on a similar scale to Fig. 6, taken along the line 6—6ª of Figure 5;

Figure 7 shows a section along the line 7—7 of Figure 1, and looking in the direction of the arrows;

Figure 8 shows a side elevation; and Figure 9 a cross section through Fig. 8 along the line 9—9 of the disk blank;

Figure 10 shows a cross section of the finished disk after the rolling process has been completed; and

Figure 11 shows a section along the line 11—11 of Figure 10.

A and A′ represent the bed plates or castings on which the operative parts are mounted, which bed plates are preferably mounted on a suitable concrete construction B, and attached thereto by foundation bolts C, the whole forming a very rigid structure. The bed plates are provided with suitable bearings for the rotating parts, and where needed covers are provided, such as D, D′ and $D^2$ shown in Figs. 1 and 2. These covers are omitted from the right hand portion of Fig. 1 so that the parts beneath may be properly shown.

E represents the driving shaft which may be driven in any convenient way, as by means of the pulley E′. This pulley is merely typical of any suitable means of applying the necessary power to the apparatus. The shaft E is provided with two bevel gear wheels $E^2$ fast thereon, one of which is shown exposed in Fig. 1 and the other being beneath the cover D. These bevel gears $E^2$ mesh with corresponding bevel gears F on the stub shafts F′, which are connected by the couplings $F^2$ to the intermediate or connecting shafts $F^3$, the weight of which intermediate shafts is supported on the yokes G, supported by the springs G′. The sockets carrying the yokes are held in place by means of adjusting screws *g* shown in Fig. 1.

The forward end of this intermediate shaft $F^3$ is connected by the coupling $F^4$ to the rear end of the corresponding roller shaft. There are two of these roller shafts H and H′, carrying the tapered rolls $H^2$ and $H^3$. By this arrangement the interme-

diate or connecting shaft permits a flexible connection between the rear or stub shaft F′ and the roller shaft proper, which will permit the slight lateral movement of the roller shaft without disturbing the driving mechanism, as will be hereinafter described. The tapered rolls $H^2$ and $H^3$ are in the form of frustums of cones, having the angle of the opposite cones so arranged as to provide the requisite taper to the disk or blank incident to the operation of the rolling.

The roller shafts H and H′ are journaled at their rear end in thrust bearings I, which are trunnioned as at I′ in the frame $I^2$, and in the cap D′, see Fig. 7; which frame may be slightly shifted horizontally by means of the screw J, driven by the hand wheel J′, which screw engages a nut or sleeve $1^0$, as shown in Fig. 7. This adjusting arrangement is provided for both shafts as shown in Fig. 1. The roller shafts are journaled near their front ends in grease bearings K and K′, provided with adjustable bearing blocks allowing for the expansion of the journals during the rolling operation and adjusting of the center lines of the two rolls in the same horizontal plane (essential condition for obtaining good results in rolling).

The bearing blocks are adjusted by means of wedges 91 operated with screws 92 and with removable caps 93 adjusted by screws 94. see Figs. 2 and 3.

One of the lubricated bearings, such as K′, is connected by means of journals, forming a swivel joint, to an arrangement having a certain elasticity produced by Belleville washers L. The swivel joint allows the bearing to be subject to a normal reaction of the shaft whatever its movements about rear thrust bearing while revolving.

The Belleville washers yield to an abnormal force caused by the advance of the movable roll and thus prevent the breaking of any mechanical parts. They are mounted on the stem M which passes through the screw-threaded sleeve M′, and engages in the outer sleeve $M^2$ held in the housing $A^3$. The compression of the spring washers L aforesaid is adjusted by means of the screw arrangement just shown, and the purpose of this is to afford a resilient bearing which will permit the corresponding roller $H^3$ to yield slightly under the pressure incident to the rolling operation.

The opposite bearing K is pressed upon by the hydraulic ram N, which is shown in the forward position in Figs. 1 and 3. This hydraulic ram moves in the heavy cylinder $A^4$, which may be supplied with liquid, under pressure, from any convenient source, through the opening $a^0$, as shown in Fig. 3. The pressure exerted by this ram tends to force the roll $H^2$ towards the roll $H^3$. These bearings rest directly upon the base of mill and are guided above by a cross beam which connects parts $A^3$ and $A^4$. This cross beam is provided with two guiding plates held up by means of springs and adjusted by means of screws to obtain a smooth fit without appreciable play to allow moving of bearings sideways either when rolls are adjusted or during the rolling operation.

The piston N is normally pressed outwards, that is towards the disk to be rolled by the hydraulic pressure referred to, but when this pressure is released it is drawn backwards by the Belleville washers or cup springs L′, see Fig. 1, which are mounted on the stems $L^2$ passing through the yoke $N^2$ fast to the piston rod N′. The position of this yoke and the consequent pressure on the spring washers L′ may be adjusted by means of the nuts $n$ engaging the screw threads $n'$ on the piston rod N′. Thus when the hydraulic pressure is turned on there is a tendency of the piston to move outwards against the action of the spring washers L′, and these washers not only serve to withdraw the piston when the pressure is released, but also tend to ease the shock when the hydraulic pressure is turned on.

In order to secure uniformity of action, and to cause the machine to complete, in a given cycle with as little waste of energy as possible, the operation of rolling each separate disk, I provide a positive lock arrangement which will control the outward movement of the hydraulic piston N which will now be described.

The piston rod N′ passes freely through the opening $p$ in the heavy lever P, which is pivoted as at $p'$ in the bearing block O. This lever P is provided with a socket $p^2$ to engage the concave washer $n^2$ mounted on the piston rod N′, which washer is adjusted in the desired position by means of the nut $n^3$ as shown in Fig. 3.

It will be seen that the hydraulic pressure on the piston N will tend to press the lower end of the lever P to the left, as shown in Fig. 1. The lower end of this lever carries a roller shaft Q, having the roller Q′, which engages the cam R journaled in suitable bearings R′, see Figs. 3 and 4, and also Fig. 1. This cam R has very slight eccentricity, the maximum radius being at the point $r$. This cam is shown in the position for the maximum inward movement of the piston in Fig. 3, and as turned through 180° in Fig. 4.

The cam R is so rotated from the main driving shaft that it will perform a single revolution incident to the entire operation of rolling each single disk, as will be hereinafter more fully described.

In order to accomplish the rotation of this cam in the proper relation relative to the rotation of the other parts of the mechanism, I provide means for driving said cam from the main driving shaft E, comprising the pulley $E^0$, the belt S and the parts driven

thereby. Instead of a belt I may use a sprocket chain, or suitable gearing. This belt S drives the pulley S′, mounted on the shaft $S^2$, which carries the worm $S^3$, see Fig. 1, which worm drives the worm wheel R′, mounted on the shaft $R^2$ carrying the cam R. Thus it will be seen that the rotation of the driving shaft E will cause the rotation of the cam R, but at a very much reduced speed.

In order to throw the cam driving means into and out of engagement when desired, I provide a suitable clutch mechanism $R^0$, as indicated diagrammatically in Fig. 1. Any suitable clutch mechanism may be used for this purpose or the clutch mechanism may be omitted entirely if desired.

Thus it will be seen that I have described means for rotating the rolls and yet allowing a certain space between the same, means for positively regulating the movement of one roll towards the other, maintaining their rotating movement through application of an intermediate shaft with couplings, means for applying pressure to the rolls, and means for adjusting the position between the rolls. It now remains to describe the means for feeding the disk to the rolls.

The arrangement for accomplishing the feeding operation is shown in Figs. 1, 2 and 5 to $6^a$, which will now be described.

The feeding apparatus is shown at the left of Figs. 1 and 2, and details thereof are shown in Figs. 5, 6 and $6^a$. The blank is ordinarily in the form of a flat annular disk, as shown at T in elevation and in section in Figs. 8 and 9, which disk is provided with a central perforation *t*. The disk is shown in the finished form at T′ in Figs. 10 and 11, in which there is a reinforced flat annular central portion *t′* and a tapered web $t^2$. The perforation *t* remains the same after the disk has passed through the rolling process hereinbefore described.

The feeding device comprises a stand 1, which has longitudinal adjustment towards or away from the rolls, which adjustment is effected by means of the screw 2 turned by the hand wheel 3, see Fig. 2. This adjustment is used for rolling disks of various diameters. For instance to be able to roll disks of larger or smaller diameters it would be necessary to set the stand farther away from or nearer to rolls. At each end of this stand is an upright or standard 4, see Figs. 1, 2, 6 and $6^a$. Each standard is provided with a chamber 5 to receive cooling water which is normally closed by a hinged cap 6, which cap is shown in Figs. 1 and 2, but is omitted from the other figures for the sake of clearness in the drawings.

Mounted in the head of the left-hand standard as shown in Figs. 5 and 6, is a cylindrical casing 7, externally screw threaded as at 8 to receive the screw collars 9 and 10, and screw threaded at the other end as at 11 to receive the screw collar 12. The collar 12 is provided with eye bolts 13 to which the springs 14 are attached, which springs are connected to eye bolts 15, fast to the standard 4, and these springs tend to press the casing to the right, towards the disk T, as shown in Fig. 5.

Mounted inside of the casing 7 is a sleeve or bushing 16 which is secured to the casing 7 by means of the set screws 17, and thus this sleeve 16 slides with the casing 7. At the opposite end of the casing from the screws 17 the said casing is provided with an annular head 18, held in place by the set screws 19. This head is centrally perforated as shown in Fig. 6. The sleeve 16 and the head 18 form guides for the hollow spindle 20, to the forward end of which is screwed the gripping member 21. This member is provided with a socket 22 to receive the centering tongue of the opposite gripping member, as will be hereinafter described.

The backward thrust of the spindle 20 is taken up by a suitable thrust ball bearing comprising the fixed annular disk 23, provided with a ball race 24 to receive the balls 25, in front of which balls is a bearing ring 26 and a washer 27 which engages the shoulder 28 of the spindle 20. The rear end of the spindle is provided with a lock nut 29, held in place by the set screw 30. Extending through the hollow spindle 20 is a pipe 31 to supply the cooling medium, such as water, which enters the hollow head of the gripping member 21 and flows outwards through passages 32 therein, and back through the hollow spindle 20 into the chamber 33 contained in the cap 34, from whence it escapes through the outlet 35 and is carried to waste. This cap 34 is secured to the head 18 by the screws 36, and the rear end of said cap is provided with a smaller screw cap 37 with a nozzle 38 for the hose or other source of water supply.

It will be seen that the springs 14 will tend to move the casing 7 and the parts carried thereby to the position for engaging the disk, but that these will yield and permit the gripping member 21 to be pressed backwards when the disk is held between said gripping members, as shown in Figs. 5 and 6.

The sideway movement obtained by springs 14 pulling on ring 12 facilitates placing of disk T upon centering lug 41 in that it moves gripping member 21 to right which allows disk to clear roll $H^3$ when put in position.

The backward movement of the casing 7 will be limited by the adjusting collars 9 engaging against the shoulder $4^a$ of the standard 4, whereas the forward sliding movement of the spindle 20 will be limited by stop collar 12 shown to the left in Fig. 6.

Suitable packing may be provided where

desired, such as the packing 39, shown to the right of Fig. 6.

I have described the left-hand gripping member and parts connected thereto, as shown in Figs. 5 and 6; the opposite gripping member with the parts connected thereto are shown to the right of Fig. 5 and in detail in Fig. 6ª. In this arrangement the gripping member 40 is provided with a centering lug 41, which projects through the perforation *t* in the disk T and engages in the socket 22 of the opposite gripping member.

The gripping member 40 is pressed into engagement with the disk by means of a hydraulic ram and is automatically withdrawn when the pressure on said ram is released by springs, as will now be described.

Referring especially to the right of Fig. 5 and Fig. 6ª, 42 represents a cylindrical casing extending across the head 4 of the standard which is provided with the annular flange 43 secured to the standard head by means of the bolts 44. This cylindrical casing extends to the rear as shown at 42ª and is slotted as at 45. At the rear end it is provided with an annular flange 46 which is secured to the flange 47 of the enlarged end 48 of the hydraulic cylinder 49.

Mounted in the cylindrical casing 42 is a bearing sleeve 50 which is held in place therein by the set screws 51 and is provided with a suitable packing 52. Projecting through this bearing sleeve 50 is the tubular spindle 53 carrying the gripping member 40. This tubular spindle is shouldered as at 54 to engage the ring 55 of the thrust ball bearing, which is provided with a ball race 56 generally similar to that already described in connection with Fig. 6. Exterior to this ball race is a spherical guiding ring 57 which does not turn in the apparatus, but which is pressed towards the antifriction bearing by the face 58 of the enlarged portion 59 of the hydraulic piston 60. This hydraulic piston is provided with suitable packing 61ª in the chamber 49ª of the hydraulic cylinder 49.

The hydraulic piston 60 is longitudinally perforated as shown, and is chambered, as at 59ª, to receive the rings 60ª fast on the rear end of the spindle 53, in front of which rings is the antifriction bearing 61, to engage the yoke 62, which has arms 63, connected by the springs 64, to the arms 65 projecting from the hydraulic cylinder 49. The purpose of this arrangement is to cause the springs 64, which are normally under tension, to automatically withdraw the gripping member 40 from engagement with the disk and with the cooperating gripping member 21.

To facilitate cooling the parts, I provide a hollow sleeve 66, screwed into the piston 60 as at 67, and carrying lock nuts 68 exterior to the piston packing 61ª. This hollow sleeve is reduced at its forward end, as at 69, and a packing 70 is provided between it and the tubular spindle 53 to prevent mixing of the oil used in lubrication and the water used in cooling.

The reduced portion 69 of the sleeve 66 is clear of the inner bore of the spindle 53 so as to not impede in any way the rotation of said spindle. The rear end of this sleeve 66 is also reduced in diameter, as at 71, and projects into the stuffing box 72 formed at the rear end of the hydraulic cylinder. The packing in this stuffing box is pressed upon by the annular flange 73 of the hollow cap 74, which is secured to the outer end of the hydraulic cylinder by means of the bolts 75. This cap is hollow as shown, and is provided with an outlet 76.

Passing through this cap and through the sleeve 66, and through the hollow stem 53, is the tube 77 for supplying cooling water; the water being supplied through the nipple 78 from a hose or other source of supply. This pipe is supported at one end in the bearing 79 in the cap 74, and at its other end in the bearing 80 in the gripping member 40. The cooling liquid flows through the nipple 78, and through the pipe 77 and into the hollow chamber in the gripping member 40, whence it returns through the passages 81, exterior to said pipe, back to the hollow cap 74 and out through the outlet 76.

The lubricant is supplied to the thrust bearing shown in Figs. 6 and 6ª from the grease cups U and U′, shown in dotted lines in said figures.

In order to secure the highest efficiency in the operation of the machine, it is important that the axis of the disk being rolled shall not lie in the plane of the axes of the two rolls. Preferably such axis should be lying in a plane above and parallel to the plane passing through the axes of the two rolls, such difference in elevation being shown by the lines *x*—*x* and *y*—*y* of Figure 2.

The advantages of this arrangement will be more fully brought out after explaining the operation of the apparatus, which will now be described.

The rollers $H^2$ and $H^3$, being of the desired profile for the finished disk, are spaced apart to receive the same by releasing the hydraulic pressure on the ram N, which will cause the springs $N^2$ to withdraw the ram and with it the roller $H^2$ far enough to permit the admission of the edge of the blank. About the same time the blank is inserted between the gripping members 21 and 40, the perforation in the blank is slipped over the tongue 41, while the gripping member 40 is in the retracted position under the action of the springs 64. The gripping member 40 is then pressed towards the gripping member 21 by supplying hydraulic pressure to the cylinder 49, and the gripping

members are in the assembled position for holding the disk blank, as shown in Figure 5. The center of the disk remains stationary during the rolling operation, that is it does not move towards or away from said rolls, while said disk rotates about its axis.

The hydraulic pressure is then admitted to the ram N, pressing the roller $H^2$ towards the roller $H^3$ and the disk will be held between the rollers under the yielding pressure permitted by the springs L, see Fig. 3.

The rolls driven by shaft E will roll the piece to be wrought by causing an elongation of the metal towards the periphery of the disk and a progressive decrease in thickness of the blank in order to obtain the desired section as the roll $H^2$ moves closer and closer towards roll $H^3$. The elongation of the metal is more easily effected by placing the axis $y$—$y$ of the blank to be rolled above axis $x$—$x$ of the rolls as shown in Fig. 2. This also reduces the rolling time. It is especially desirable that the work should be rapidly done so that it may be completed before the temperature of the disk falls too low, and at the same time it is obviously desirable to have the work accomplished with as little waste of energy as practicable.

It will be noted that with the construction shown there will be obtained a polishing effect and a rational drawing out of the metal allowing to obtain disks being perfectly flat.

In order to regulate the time in which the disk is being operated upon in the apparatus, and at the same time to control the actual work done on the disk, I provide the cam shown in Figs. 1, 3 and 4, with the means for driving the same shown more especially in Fig. 1. This cam is rotated slowly under the action of the worm $S^3$, driven by the belt S, which worm drives the worm wheel R', and with it the shaft $R^2$, and cam R rigidly held on said shaft. This cam engages the roller Q' on the shaft Q, and serves as a positive stop to the forward movement of the piston N, see Fig. 3.

The point $r$ of maximum throw of the cam is so adjusted that the piston N will be held backwards at the beginning of the operation of rolling the disk, and as this cam rotates, the piston N will be allowed by the cam to move the roller $H^2$ more and more towards the roller $H^3$ so that at the end of one complete revolution of the cam the operation of rolling a single disk will be completed.

When the rolling operation of a single disk has been completed, the hydraulic pressure on the piston N is released and said piston is drawn back by the springs $N^2$ far enough to permit the removal of the rolled disk as soon as the gripping members are separated. These gripping members are separated by the springs 64 when the hydraulic pressure on the piston 60 is released. The rolled disk may then be removed and a new blank may be inserted as before, and the cycle of operations may be continued indefinitely.

The blanks are inserted in the machine while hot, and in order to keep the gripping members cool while in use, and also to provide for a certain amount of shrinkage at the center of the disk being rolled, I provide a cooling arrangement, such as is shown in Figs. 6 and $6^a$ in which water is inserted from opposite ends of the apparatus through the pipes 38 and 78, and, flowing inward through the axes of the gripping members, enters the hollow heads of said members and returns through passages exterior to the pipes 31 and 81, respectively, and finally escapes through the waste orifices 35 and 76, respectively.

The heavy thrust incident to the pressing together of the gripping members by the hydraulic piston 60 is taken up by the thrust ball bearings shown in Figs. 6 and $6^a$, and these bearings are caused to run in oil or suitable lubricant supplied to the chambers 5, which chambers are normally closed by the caps 6 as shown in Fig. 11.

The shells of rollers $H^2$ and $H^3$ are made of hard metal. They are tapered so that the intersection of their center lines will fall beyond center of blank to be rolled and allow, owing to the possibility of changing position of front and rear bearings, rolling of different profiles with the same rolls. These roller shells can easily be removed when worn.

It will be seen that the flexible shaft arrangement with intermediate shaft and coupling, shown in Figs. 1 and 2 will permit the two rollers to be moved together or separated without interfering with the proper operation of the driving mechanism, and that the position of the two rollers will be adjusted opposite to each other when desired. Moreover, it will be noted that spring buffers or bearings are provided which will eliminate the sudden shocks incident to the use of hydraulic mechanism of the character described, and will serve to prevent the breaking down and untimely wearing out of the apparatus from such shocks.

The time of rolling may be varied if desired by changing the shape or contour of the cam, making the cam shorter if desired.

The stand carrying the gripping members may be adjusted toward or away from the rolls by means of the adjusting screw 2 and the hand wheel 3, but once set for any class of work it would ordinarily remain in the fixed position, but if desired it may be moved backwards or forwards whenever necessary, to set it for the different size disks to be rolled.

It will be obvious that various modifications might be made in the herein described

apparatus, and in the construction, combination and arrangement of parts which could be used without departing from the spirit of my invention; and I do not mean to limit the invention to such details except as particularly pointed out in the claims.

Having thus described my invention what I claim and desire to secure by Letters Patent of the United States is:—

1. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of tapered rollers mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a stand mounted adjacent to said rollers, and a revoluble work holder carried by said stand and having its axis in a different horizontal plane from the plane including the axis of said rollers.

2. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a stand mounted adjacent to said rollers, and a revoluble work holder, comprising longitudinally movable gripping members, carried by said stand and having its axis in a different horizontal plane from the plane including the axes of said rollers.

3. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, means for positively limiting said movement, a stand mounted adjacent to said rollers, and a revoluble work holder carried by said stand.

4. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers toward the other when desired, a cam arrangement for positively limiting said movement, a stand mounted adjacent to said rollers, and a revoluble work holder carried by said stand.

5. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, a hydraulic ram for forcing one of said rollers towards the other when desired, and a revoluble work holder.

6. In a mill for rolling disks, the combination with a pair of flexible shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, cup springs for separating said rollers, a hydraulic ram for forcing one of said rollers towards the other when desired, and a revoluble work holder.

7. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a cam arrangement for positively limiting said movement, and a revoluble work holder.

8. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for moving one of said rollers towards the other when desired, a stand mounted adjacent to said rollers, a revoluble work holder, comprising longitudinally movable gripping members, carried by said stand, said work holder and means for conveying cooling fluid to said gripping members.

9. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a cam arrangement for positively limiting said movement, a stand mounted adjacent to said rollers, a revoluble work holder carried by said stand, and means for conveying cooling fluid to said work holder.

10. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, a hydraulic ram for forcing one of said rollers towards the other when desired, a stand mounted adjacent to said rollers, a revoluble work holder carried by said stand, and means for conveying cooling fluid to said work holder.

11. In a mill for rolling disks, the combination with a pair of flexible shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mount-

ed on the ends of said shafts, cup springs for separating said rollers, a hydraulic ram for forcing one of said rollers towards the other when desired, a stand mounted adjacent to said rollers, a revoluble work holder carried by said stand and including longitudinally movable gripping members, and means for conveying cooling fluid to said gripping members.

12. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, means for positively limiting said movement, a stand mounted adjacent to said rollers, a revoluble work holder carried by said stand, and means for conveying cooling fluid to said work holder.

13. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of tapered rollers mounted on the ends of said shafts, means for forcing one of said rollers towards the other, a revoluble work holder having its axis in a different horizontal plane from the plane including the axes of said rollers, and means for supplying cooling fluid to said work holder.

14. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of tapered rollers mounted on the ends of said shafts, means for forcing one of said rollers towards the other, a revoluble work holder having its axis in a horizontal plane above the plane including the axes of said rollers, and means for supplying cooling fluid to said work holder.

15. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a revoluble work holder, comprising longitudinally movable hollow gripping members, said work holder, and means for supplying cooling fluid to said hollow gripping members.

16. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of rollers in the form of truncated cones mounted on the ends of said shafts, means for separating said rollers, means for moving one of said rollers towards the other when desired, a revoluble work holder, comprising longitudinally movable hollow gripping members, and means for supplying cooling fluid to said hollow gripping members.

17. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of tapered rollers mounted on the ends of said shafts, a hydraulic ram for forcing one of said rollers towards the other, a cam arrangement for positively limiting said movement, and a revoluble work holder.

18. In a mill for rolling disks, the combination with a pair of shafts set at an angle, and means for simultaneously driving said shafts in reverse directions, of tapered rollers mounted on the ends of said shafts, a hydraulic ram for forcing one of said rollers towards the other, a cam arrangement for positively limiting said movement, and a revoluble work holder.

ANDRÉ JULES MICHELIN.