Dec. 1, 1936. W. R. HARRISON 2,062,415

METHOD AND APPARATUS FOR PRECISION ROLLER SPINNING ARTICLES OF DUCTILE MATERIAL, SUCH AS ROLLED STEEL AND THE LIKE

Filed July 26, 1935 5 Sheets-Sheet 1

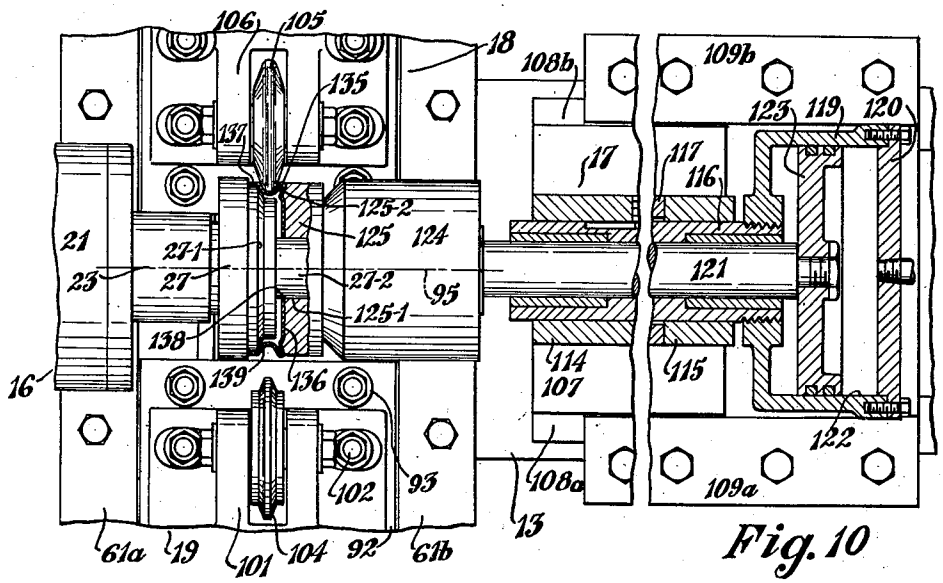


Fig. 10

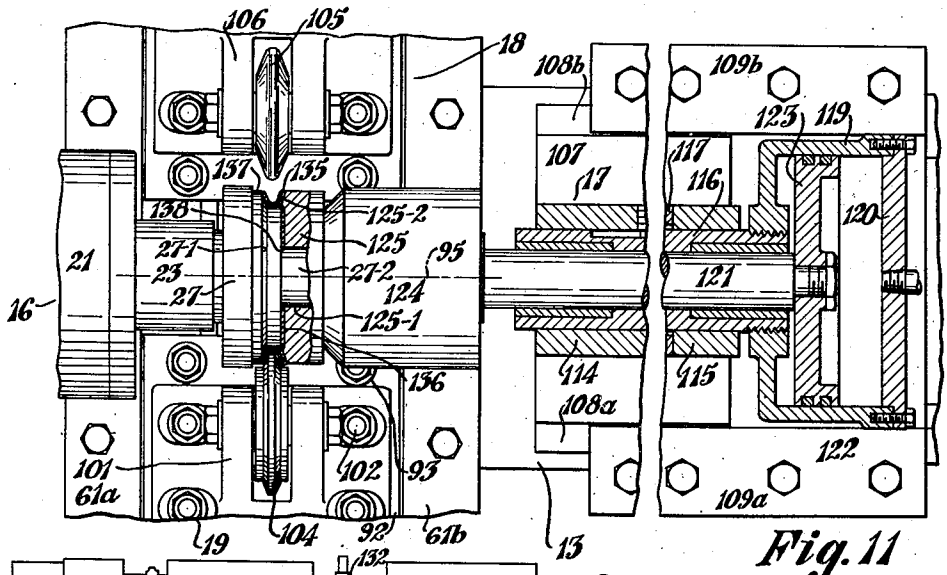


Fig. 11

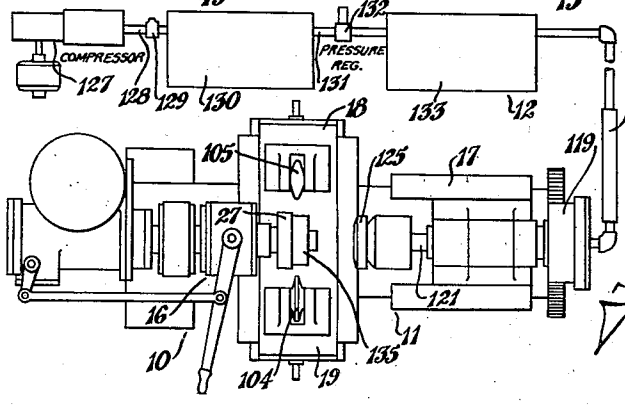


Fig. 1

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Filed July 26, 1935 5 Sheets-Sheet 2

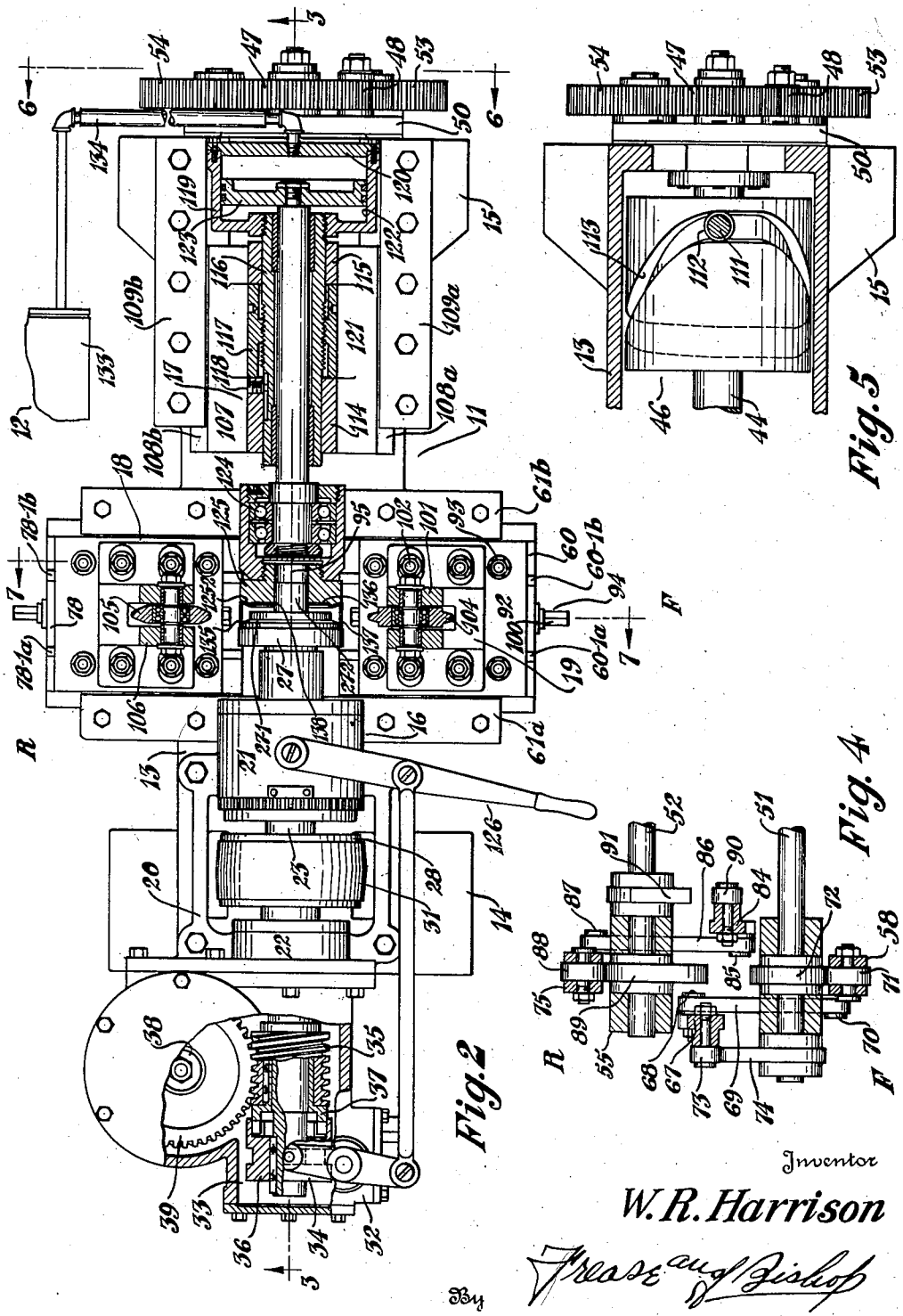


Fig. 2

Fig. 4

Fig. 5

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Filed July 26, 1935 5 Sheets-Sheet 3

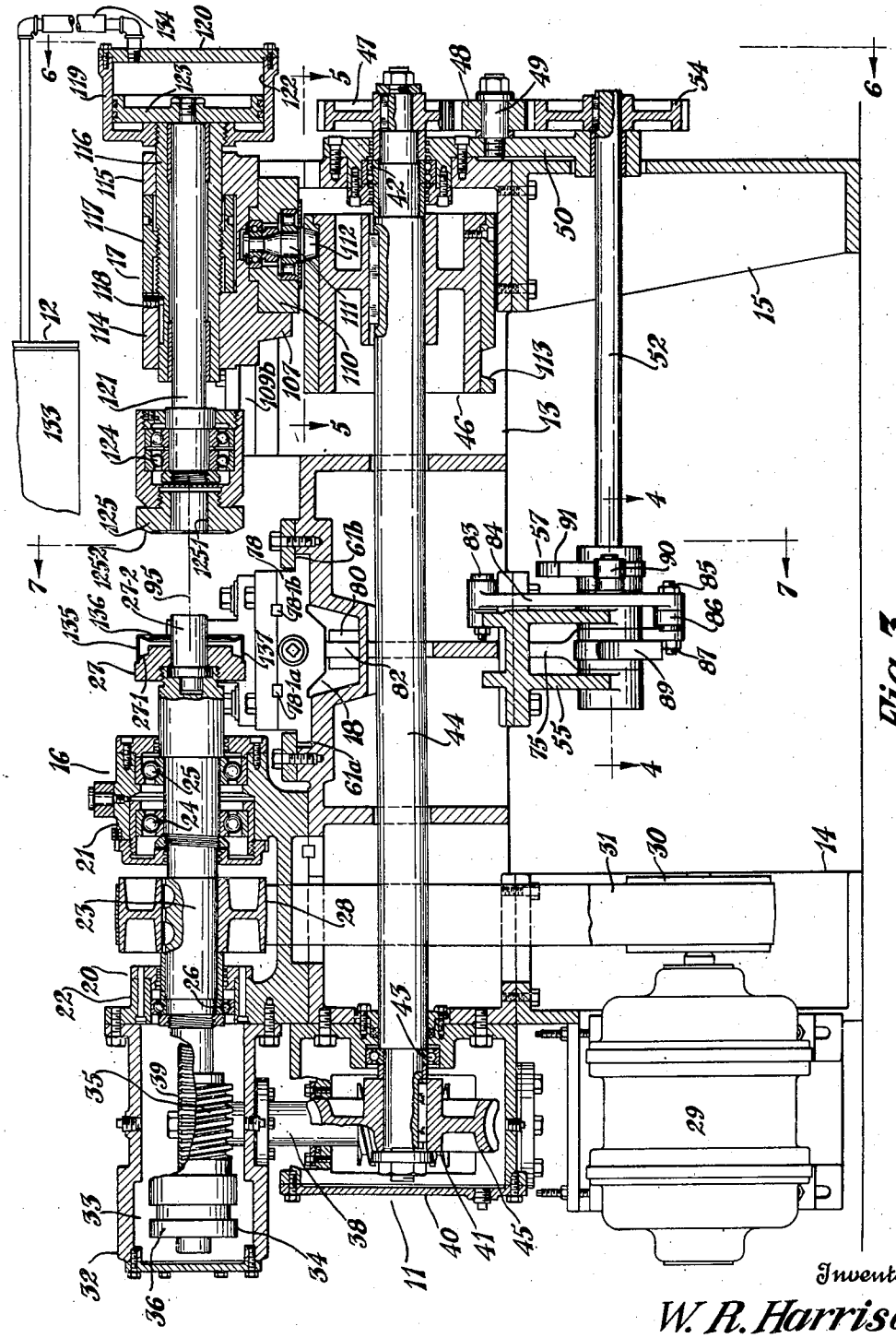


Fig. 3

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METHOD AND APPARATUS FOR PRECISION ROLLER SPINNING ARTICLES OF DUCTILE MATERIAL, SUCH AS ROLLED STEEL AND THE LIKE

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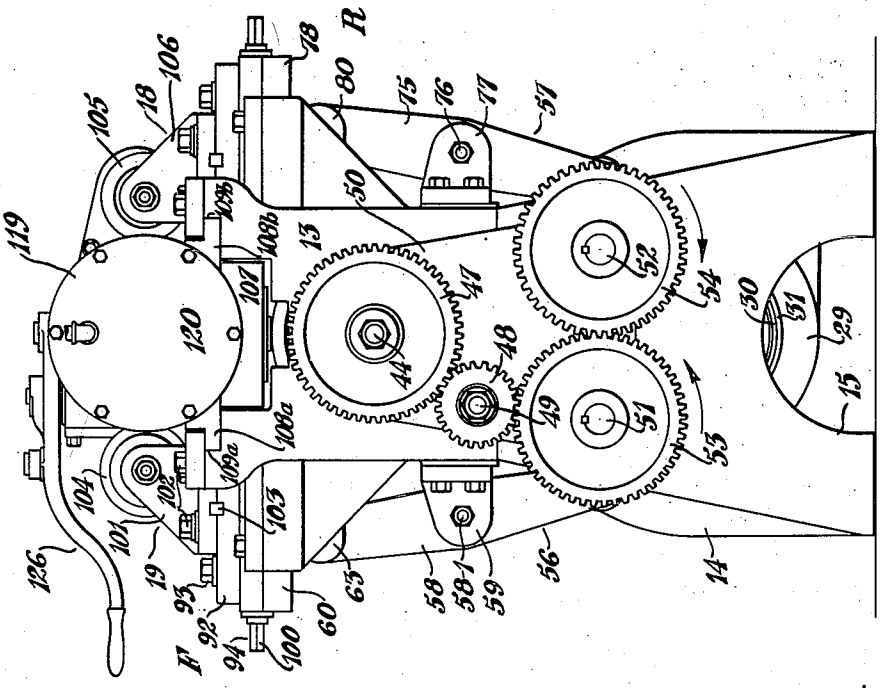


Fig. 6

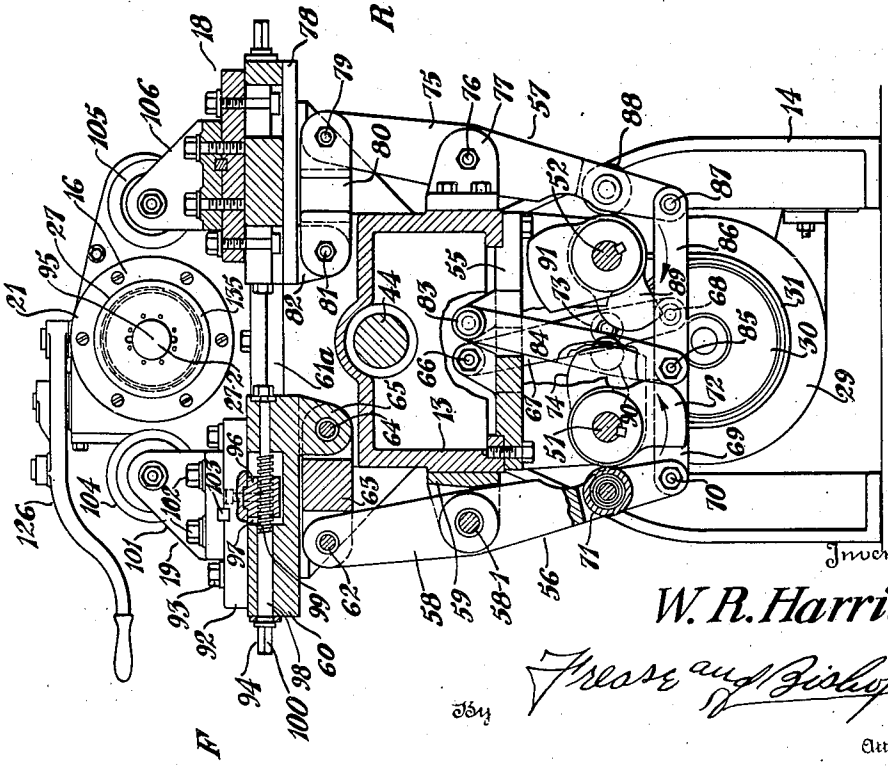


Fig. 7

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METHOD AND APPARATUS FOR PRECISION ROLLER SPINNING ARTICLES OF DUCTILE MATERIAL, SUCH AS ROLLED STEEL AND THE LIKE

Filed July 26, 1935 5 Sheets-Sheet 5

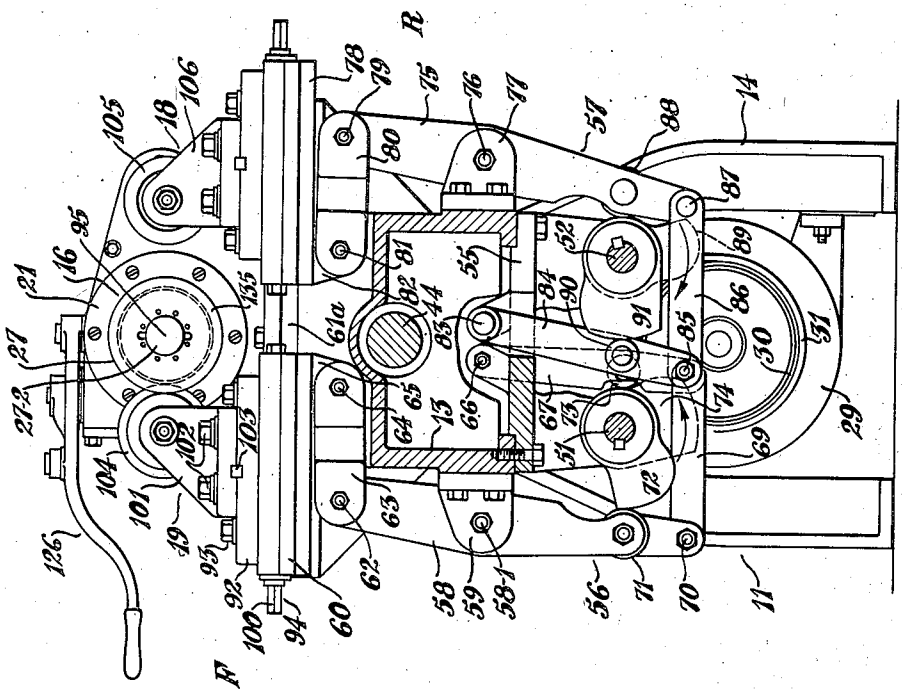


Fig. 9

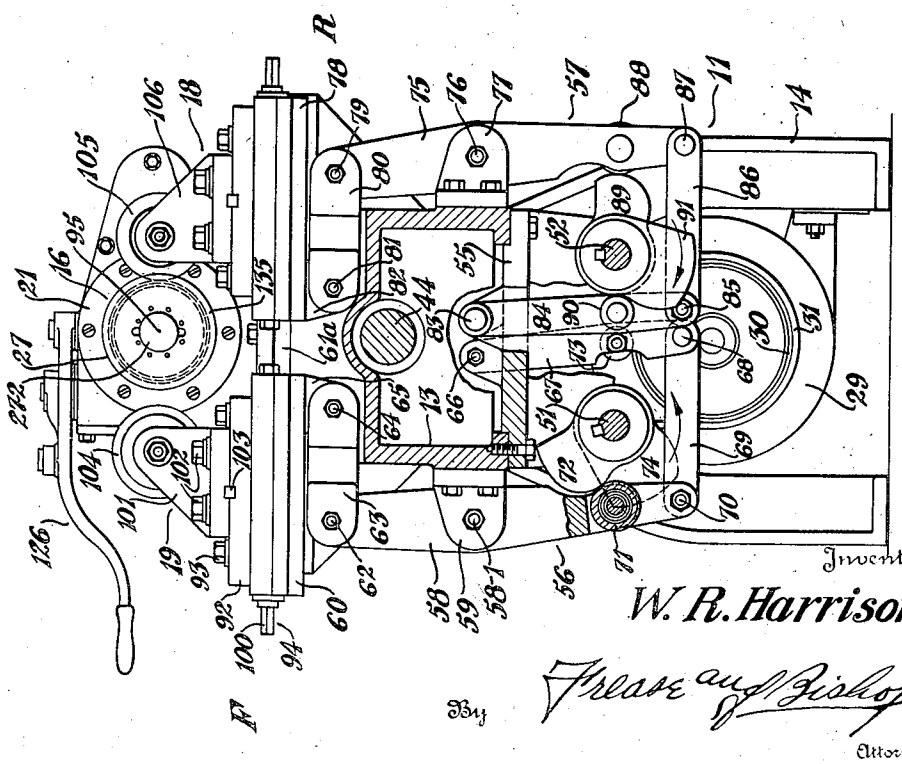


Fig. 8

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UNITED STATES PATENT OFFICE

2,062,415

METHOD AND APPARATUS FOR PRECISION ROLLER SPINNING ARTICLES OF DUCTILE MATERIAL, SUCH AS ROLLED STEEL AND THE LIKE

William R. Harrison, Canton, Ohio, assignor to The Spun Steel Corporation, Canton, Ohio, a corporation of Ohio

Application July 26, 1935, Serial No. 33,210

12 Claims. (Cl. 113—52)

My invention relates to methods and apparatus for precision roller spinning articles such as V-grooved pulleys of ductile material, such as metal, and preferably rolled steel sheets or strips, and which may be subject to blanking and pressing operations to partially form the same prior to the roller spinning.

More particularly the present improvements are adapted for the manufacture of the V-groove pulleys set forth in U. S. Letters Patent No. 1,680,061, of Reynold G. Nelson, issued August 7, 1928, for Spun metal manufacture and product.

In such pulleys, each has a wheel disk and one or more relatively narrow and relatively deep outwardly opening V-grooves formed by flanges integral with the wheel disk.

Such pulleys may be manufactured by the methods and apparatus set forth in said U. S. Patent No. 1,680,061, its division U. S. Patent No. 1,728,002, issued September 10, 1929, or in my prior U. S. Patent No. 1,828,464, issued October 20, 1931.

The method of roller spinning set forth in each of said prior patents generally includes rotating material to be spun, applying radial pressure to the rotating material, and applying an axially directed thrust to the rotating material during the application of the radial pressure.

In the prior R. G. Nelson Patents No. 1,690,061 and No. 1,728,002, the radial pressure is applied by manually actuated non-yielding mechanical means, including a cross feed screw, and the axially directed thrust is applied by means of a piston actuated by the expansion of compressed air introduced into a cylinder for the piston though a manually controlled valve.

In my prior Patent No. 1,828,464 the axially directed thrust is likewise applied by means of an axial thrust piston actuated by the expansion of compressed air introduced into an axial thrust cylinder for the axial thrust piston through a manually controlled valve; and also the radial pressure is applied by means of a cross feed piston actuated by the expansion of compressed air introduced into a cross feed cylinder for the cross feed piston through another manually controlled valve.

In the methods and apparatus of each of said patents, the timing of the relative applications of the radial pressure and the axial thrust is effected by the judgment of the operator who in each case manually operates the valve for the axial thrust piston, and also manually operates either the cross feed screw or the valve for the cross feed piston.

From the standpoint of precision manufacture in the mass production of V-pulleys intended for example as pulleys for the fans of automobile engines, manufacturing tolerances are very rigid, and while the methods and apparatus of my said prior Patent No. 1,828,464 provide for a more uniform run of pulleys than do the methods and apparatus of said R. G. Nelson Patents No. 1,680,061 and No. 1,728,002, yet there is still some variation in a run of pulleys made by the methods and apparatus of my said Patent No. 1,828,464, because of the variations possible in the timing of the relative applications of the radial pressure and the axial thrust.

These variations may be very slight, and may only affect the cold rolled inner surface finish of the V-grooves, but as aforesaid the manufacturing standards set up for automotive V-pulleys make it very important that even slight differences in variations in a run of pulleys be obviated.

From another standpoint when the radial pressure or the axially directed thrust is applied by means of a piston actuated by the expansion of compressed air, successive movements of the piston require utilization of the energy of successive charges of compressed air introduced into the cylinder for the piston, which air charges after expansion are exhausted from the cylinder and passed through an air compressor and recompressed, with a consequent relatively great cost for the required total volume of compressed air for roller spinning runs of pulleys.

The objects of the present improvements include the provision of an improved method and apparatus for carrying out the improved method, and adapted for attaining a relatively high degree of uniformity of finished product in the precision roller spinning of articles of ductile material such as V-groove pulleys of rolled steel.

Further objects of the present improvements include the provision of apparatus for roller spinning in which the benefits of applying preferably the axially directed thrust through the medium of compressed air is attained without necessitating the use of successive expanding charges of compressed air requiring a power cost for the necessary air compressor operation.

Further objects of the improvements include the provision of an improved general and detail arrangement of certain parts of the improved apparatus so as to attain an improved mode of operation for carrying out the improved method hereof.

The foregoing and other objects are attained by the methods, apparatus, parts, combinations,

and sub-combinations, which comprise the present invention, and the nature of which is set forth in the following general statement, and preferred embodiments of which are set forth in the following description, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

The nature of the improved method of the present invention may be stated in general terms as consisting of roller spinning an article of ductile material by rotating the article about an axis, which may be termed the spinning axis, applying upon the rotating article a moving axial thrust or compressive force in the direction of the spinning axis and opposed by a thrust or compressive force, and applying a moving roller spinning pressure upon portions of the article between the compressive forces, the directions of motion of the moving compressive force and of the moving roller spinning pressure being angular to each other, the moving roller spinning pressure being preferably radial with respect to the spinning axis, and the movements of the compressive force and the roller spinning pressure being simultaneous and automatically co-ordinated with respect to each other.

The nature of the improved apparatus of the present invention may be stated in general terms as including opposed rotatable die heads, means for rotating one of the die heads, means for moving one of the die heads towards and away from the other die head, a spinning roller operatively mounted t one side of the axis of rotation of the die heads and between the opposite end planes of the die heads at right angles to the axis of rotation, means for moving the spinning roller towards and away from the axis of rotation of the die heads and rolling position between the die heads, and means for operating the moving means for the die head and the moving means for the spinning roller in co-ordination with respect to each other.

By way of example, a preferred embodiment of the improved apparatus for carrying out the improved method is illustrated in the accompanying drawings forming part hereof, in which

Figure 1 is a diagrammatic plan view of the complete improved apparatus including the improved spinning lathe and the associated compressed air equipment;

Fig. 2, an enlarged fragmentary plan view of the improved apparatus, with portions broken away and illustrated in section;

Fig. 3, a longitudinal vertical sectional view thereof as on line 3—3, Fig. 2;

Fig. 4, a fragmentary plan sectional view thereof as on line 4—4, Fig. 3;

Fig. 5, another fragmentary plan sectional view thereof as on line 5—5, Fig. 3;

Fig. 6, an end elevation thereof looking in the direction of the arrows 6—6, Figs. 2 and 3;

Fig. 7, a transverse sectional view thereof as on line 7—7, Figs. 2 and 3, the rough and finish spinning rollers and associated parts being both in retracted position, and portions being broken away to more clearly illustrate the cam actuated cross feed means for the spinning rollers;

Fig. 8, a view similar to Fig. 7 with the rough spinning roller and associated parts in roller spinning position at the end of the cross feed stroke of the rough spinning roller and the finish spinning roller and associated parts being still in retracted position ready to advance into spinning position;

Fig. 9, a view similar to Figs. 7 and 8 with the finish spinning roller and associated parts being in spinning position at the end of its cross feed stroke, and the rough spinning roller and associated parts being retracted;

Fig. 10, an enlarged fragmentary plan view illustrating the relative positions of the rough spinning roller at the end of its cross feed spinning stroke and the associated parts of the improved spinning lathe, particularly the tail stock parts;

Fig. 11, a view similar to Fig. 10 illustrating the relative positions of the several parts just as the finish spinning roller is about to commence its cross feed spinning operation.

Similar numerals refer to similar parts throughout the drawings.

The improved roller spinning apparatus is indicated generally at 10, and includes an improved automatic roller spinning lathe indicated generally at 11, and associated compressed air equipment indicated generally at 12.

The improved automatic spinning lathe 11 includes a bed 13 supported by a head stock end leg frame 14 and a tail stock end leg frame 15.

Spinning and driving head stock means indicated generally by 16 are secured to the bed above the head stock end leg frame 14 and tail stock means indicated generally by 17 are operatively mounted in a novel manner on the bed above the tail stock end leg frame 15 as is hereinafter set forth in detail.

Between the head stock means 16 and the tail stock means 17 at one side of the bed improved cross feedable rough spinning roller means indicated generally by 18 are operatively mounted in a novel manner as is hereinafter set forth in detail; and opposite the rough spinning roller means 18 on the other side of the bed, cross feedable finish spinning roller means indicated generally by 19 are operatively mounted in a novel manner as is hereinafter set forth in detail.

The head stock means indicated generally by 16 includes a bearing frame 20 secured to the bed 13 and having longitudinally spaced bearing boxes 21 and 22 through which a main drive and spinning shaft 23 extends, and the shaft 23 is journalled in the bearing box 21 as illustrated by opposed ball thrust bearings 24 and 25, and the shaft 23 is journalled in the bearing box 22 as illustrated by a radial ball bearing 26.

The shaft 23 extends through the bearing box 21 towards the tail stock means 17, and is provided on its extremity opposite the tail stock means 17 with a spinning die head 27.

Between the bearing boxes 21 and 22, the shaft 23 has a pulley 28 secured thereon, and the shaft 23 is driven by a motor 29 mounted on the frame 14, the motor having a pulley 30, and a drive belt 31 passes over the pulleys 30 and 28, and is driven by the motor pulley 30 and drives the pulley 28 and shaft 23.

A gear and clutch housing box 32 is secured to the outer end of the bearing box 21 and the shaft 23 extends into the interior compartment 33 of the housing box 32.

Within the compartment 33, the shaft 23 has operatively mounted thereon in a usual manner a clutch 34 and a worm 35, the worm 35 being journalled on the shaft, and the clutch including a member 36 longitudinally slidably keyed to the shaft for connection and disconnection with a member 37 secured for rotation with the worm 35.

The shaft 23 is a horizontal shaft, and at one side thereof the housing box 32 has journalled

therein a vertical shaft 38 upon the upper end of which is secured a worm wheel 39 meshed with the worm 35.

On the lower end of the shaft 38 within another gear housing box 40 there is secured a worm 41.

The bed 13 has journalled therein as by a double thrust ball bearing 42 at the tail stock end and a radial ball bearing 43 at the head stock end, a longitudinal thrust and cross feed drive shaft 44, the head stock end of which has secured thereon a worm wheel 45 meshed with the worm 41 within the housing box 40.

Beneath the tail stock means 17, the shaft 44 has secured thereon a tail stock carriage moving cylindric cam indicated generally by 46, and the shaft 44 extends beyond the tail stock end of the bed 13 and has secured thereon a cross feed drive gear 47 which is meshed with an idler gear 48 journalled as illustrated on a stub shaft 49 mounted as illustrated on a bearing plate 50 at the tail stock end of the bed 13.

The bearing plate 50 journals at one end, cross feed cam shafts 51 and 52, the cross feed cam shaft 51 having secured thereon a gear 53 meshed with the idler gear 48, and the cross feed cam shaft 52 has secured thereon a gear 54 meshed with the gear 53.

Intermediate its ends, the bed 13 has secured thereto a cam shaft and cross feed lever bearing bracket 55 depending from lower portions of the bed 13, and the other ends of the cam shafts 51 and 52 are journalled in the bearing bracket 55.

The cam shaft 51 is operatively connected by cam, link, and lever cross feed means indicated generally by 56 with the finish spinning roller means 19, and the cam shaft 52 is operatively connected by cam, link, and lever cross feed means indicated generally by 57 with the rough spinning roller means 18.

The cam, link, and lever cross feed means 56 include a lever 58 which is pivotally mounted intermediate its ends at 58—1 on a bearing bracket 59 which is secured to the bed 13 at the front or operator side thereof indicated by F.

The finish spinning roller means 19 include a base 60 having spaced parallel gibs 60—1*a* and 60—1*b* extending cross-wise of the bed 13 and slidable in cross-wise extending gibbed ways 61*a* and 61*b* provided in the top of the bed 13.

The upper end of the lever 58 is pivotally connected at 62 with one end of a stub link 63, the other end of which is pivotally connected at 64 with an ear 65 depending from the lower inner end of the base 60.

The other end of the lever 58 extends at the front side of and below the cam shaft 51.

The bracket 55 pivotally mounts at 66 the upper end of a link 67, the lower end of which is pivotally connected at 68 with one end of a cross link 69, which extends below the cam shaft 51, and which at its other end is pivotally connected at 70 with the lower end of the lever 58.

As illustrated, the pivots 58—1 and 66 are horizontally spaced a distance equal to the horizontal distance between the pivots 70 and 68, and the spacing of the pivots 58—1 and 70 is equal to the spacing of the pivots 66 and 68.

The lever 56 has a cam follower roller 71 journalled thereon opposite the cam shaft 51, and the cam shaft 51 has secured thereon a cross feed pressure cam 72 which operates against the roller 71.

The link 67 has a cam follower roller 73 journalled thereon and the cam shaft 51 opposite the roller 73 has a cross feed return cam 74 secured thereon which operates against the follower roller 73.

The cam, link, and lever cross feed means 57 are similar to the cross feed means 56, but include certain reversely or oppositely arranged members, and the cross feed means 57 operate in a reverse cycle to that of the cross feed means 56.

In order to clearly describe the operation of the improved automatic spinning lathe 11, it is desirable to further describe the cam, link, and lever cross feed means 57 in detail, as follows:

The cam link and lever cross feed means 57 include a lever 75 which is pivotally mounted intermediate its ends at 76 on a bearing bracket 77 which is secured to the bed 13 at the rear side thereof indicated by R.

The rough spinning roller means 18 include a base 78 having spaced parallel gibs 78—1*a* and 78—1*b* extending cross-wise of the bed 13 and slidable in the cross-wise extending gibbed ways 61*a* and 61*b* at the rear side of the bed.

The upper end of the lever 75 is pivotally connected at 79 with one end of a stub link 80, the other end of which is pivotally connected at 81 with an ear 82 depending from the lower inner end of the base 78.

The other end of the lever 75 extends at the rear side of and below the cam shaft 52.

The bracket 55 pivotally mounts at 83 the upper end of a link 84, the lower end of which is pivotally connected at 85 with one end of a cross link 86, which extends below the cam shaft 52, and which at its other end is pivotally connected at 87 with the lower end of the lever 75.

As illustrated, the pivots 83 and 76 are horizontally spaced a distance equal to the horizontal distance between the pivots 85 and 87, and the spacing of the pivots 76 and 87 is equal to the spacing of the pivots 83 and 85.

The lever 75 has a cam follower roller 88 journalled thereon opposite the cam shaft 52, and the cam shaft 52 has secured thereon a cross feed pressure cam 89 which operates against the roller 88.

The link 84 has a cam follower roller 90 journalled thereon and the cam shaft 52 opposite the roller 90 has a cross feed return cam 91 secured thereon which operates against the follower roller 90.

The finish spinning roller means 19 include, in addition to the base 60, an intermediate adjusting and mounting plate 92 which is adjustably secured upon the top of the base 60 by bolt and slot means 93, and which is provided with adjusting means indicated generally by 94 for adjusting the position of the plate 92 on the base 60 cross-wise towards or away from the axis of rotation 95 of the spinning head 27 and shaft 23.

The adjusting means 94 as illustrated include a sleeve nut 96 depending from the bottom of the plate 92 and extending into a pocket 97 formed in the upper face of the base 60.

A shouldered bolt 98 extends through suitable concentric bores provided in the base 60 on opposite sides of the pocket 97 and extending at right angles to the vertical plane including the axis of rotation 95, and the bolt 98 has threads 99 formed thereon which screw through the sleeve nut 96.

At its outer extremity the bolt 98 as illustrated has a squared head 100 whereby the bolt 98 may be turned by a wrench applied to the squared head 100, thus moving the plate 92 towards or away from the spinning axis 95.

A bearing bracket 101 is secured upon the top of the plate 92 preferably by cap screw means 102 and key means 103 extending parallel with the axis 95 and fitting in oppositely opening longitudinal grooves formed in the top of the plate 92 and at the bottom of the bracket 101.

The bracket 101 has journalled therein a finish spinning roller 104.

The rough spinning roller means 18 are generally similar to the finish spinning roller means 19, but include reversely arranged parts since the rough spinning roller means operate at the opposite side of the spinning axis of rotation 95.

The rough spinning roller means 18 has a rough spinning roller 105 journalled in its bearing bracket 106.

The tail stock means indicated generally by 17 includes a carriage 107 having opposite gibs 108*a* and 108*b* extending longitudinally parallel with the spinning axis 95 and longitudinally slidable in longitudinally extending gibbed way means 109*a* and 109*b* provided in the upper surface of the tail stock end of the bed 13.

The carriage 107 has secured to its lower portion a cam follower bearing block 110 which journals preferably by anti-friction bearing means as illustrated, a cam follower 111 which is rotatable about a vertical axis located in the vertical plane passing through the spinning axis 95, and the cam follower 111 has a preferably conical head 112 which extends into a sloping walled cam groove 113 formed in the cylindric cam 46, as shown in Figs. 3 and 5.

The tail stock carriage 107 furthermore includes at opposite ends thereof longitudinally spaced bearing portions 114 and 115 having concentric and equal diameter bores formed therein and being coaxial with the spinning axis 95.

An externally cylindric tail stock piston rod guide and cylinder mounting sleeve 116 slidably extends through the bores of the bearing portions 114 and 115 of the carriage 107 and is provided with means for longitudinally adjusting its position with respect to the carriage 107, which as illustrated include an internally threaded sleeve 117 which bears at opposite ends on end faces of the bearing portions 114 and 115 and which screws upon threads formed upon central portions of the sleeve 116.

Slot and pin means 118 operatively interposed between the bearing portion 114 and the sleeve 116 prevent rotation of the sleeve 116, and accordingly rotation of the internally threaded adjusting sleeve 117 serves to move the externally threaded guide and mounting sleeve 116 towards or away from the spinning die head 27.

As illustrated, the guide and mounting sleeve 116 extends beyond opposite ends of the carriage 107 and the tail stock end of the sleeve 116 has secured thereon a cylinder 119 having an outer removable cylinder head 120.

A longitudinal thrust piston rod 121 slidably extends through the sleeve 116 into the bore 122 of the cylinder 119, and the bore 122 of the cylinder 119 has slidably mounted therein a piston 123 which is secured therein to the end of the piston rod 121.

The other end of the thrust piston rod 121 is provided as illustrated with ball bearing means 124 which rotatably mount a tail stock spinning die head 125.

In the normal operation of the improved automatic spinning lathe 11, the clutch 34 is in connected position as shown in Fig. 2.

Link and lever means indicated generally by 126 are operatively associated with the clutch 34 for disengaging the clutch member 36 from the clutch member 37 and thus from driving connection with the worm 35, so that when desired, the parts driven by the worm 35 may remain stationary even though the spinning shaft 23 is rotating. The cross feed drive means for the spinning rollers and the tail stock moving means are at such time easily adjusted, and initial adjustments of the same and other parts of the machine are easily made.

The compressed air equipment for the apparatus includes an air compressor 127 delivering a supply of compressed air through pipe 128 and check valve 129 to a main storage tank 130 from which air passes through pipe 131 and a pressure regulator 132 into a secondary storage tank 133 where the pressure is maintained for example at 90 pounds per square inch.

Pipe and flexible tube means 134 provide a communication from the tank 133 with the interior of the cylinder 119 where the piston 123 is thus subject to the pressure of the confined mass of compressed air contained in the cylinder 119, the pipe and tube means 134 and the tank 133.

The head stock spinning die head 27 includes a frusto-conical face 27—1 for forming one side flange of a V-groove pulley, and also includes a pilot 27—2 which is adapted to fit into and be received by a pilot socket 125—1 provided in the tail stock spinning die head 125.

The tail stock spinning die head 125 has a frusto-conical face 125—2 for forming the other side flange of a V-groove pulley.

The rough spinning roller 105 has a wedge shaped outer annular periphery with a relatively blunt curved apex for initially forming a groove between the frusto-conical faces 27—1 and 125—2 of the opposed die heads 27 and 125.

The finish spinning roller 104 has a formed outer annular periphery corresponding to the inner cross section of the finished pulley.

In the operation of the improved roller spinning apparatus 10 to carry out the improved method hereof, a partially formed annular tubular pulley 135 including a wheel disk 136 and a tubular annular flange 137 extending laterally from the disk is formed from a sheet or strip of preferably rolled steel, preferably by draw pressing operations.

The partially formed pulley 135 has a central aperture 138 therein which fits over the pilot pin 27—2 as best shown in Fig. 3.

With the parts of the automatic spinning lathe in the relative positions shown in Figs. 1 and 3, the partially formed pulley 135 is inserted upon the spinning die head 27 after which the tail stock carriage 107 moves by operation of the cam 46 towards the head stock, and the tail stock spinning die head 125 abuts against the wheel disk 136 as shown in Fig. 2, with a displacement of the piston 123 from the adjacent end of the sleeve 116 against the confined mass of compressed air in the cylinder 119.

The cam, link, and lever cross feed means 57 for the rough spinning roller means 18 then commence to operate to advance the rough spinning roller 105 from the retracted position as shown in Fig. 7 to the spinning position between the die heads shown in Figs. 8 and 10 wherein the rough spinning roller 105 is rolling the partially formed groove 139 in the tubular flange 137 of the partially formed pulley 135.

The cam, link, and lever cross feed means 57

then operate to retract the rough spinning roller 105 from between the die heads 27 and 125.

The cam, link, and lever cross feed means 56 now operate to advance the finish spinning roller 104 into the partially formed groove 139 to finish spin the desired V-pulley, and the piston 123 advances towards the adjacent end of the sleeve 116, the tail stock spinning die head clamping the wheel disk 136 against the adjacent end of the head stock spinning die head 27 as shown in Fig. 11.

The cam, link, and lever cross feed means 56 then retract the finish spinning roller 104 to the initial position as shown in Fig. 7, and the tail stock carriage 107 is retracted to its initial position as shown in Figs. 1 and 3.

In such position, the finished V-pulley may be removed from the spinning die head 27 and another partially formed pulley 135 placed thereon by the operator, and each pulley 135 is automatically subject to the above described operation of the machine for carrying out the improved method hereof.

I claim:

1. The method of roller spinning an article of ductile material which includes rotating the article about an axis, applying upon the rotating article a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another compressive force, and applying a moving roller spinning pressure upon portions of the article between the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

2. The method of roller spinning an article of ductile material which includes rotating the article about an axis, applying upon the rotating article through a compressible medium a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another compressive force, and applying a moving roller spinning pressure upon portions of the article between the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure

3. The method of roller spinning an article of ductile material which includes rotating the article about an axis, applying upon the rotating article a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another stationary compressive force, and applying a moving roller spinning pressure upon portions of the article between the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

4. The method of roller spinning an article of ductile material which includes rotating the article about an axis, applying upon the rotating article through a compressible medium a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another stationary compressive force, and applying a moving roller spinning pressure upon portions of the article between the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

5. The method of roller spinning a tubular article of ductile material which includes rotating the tubular article about an axis, applying upon one end of the tubular article a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another compressive force applied against the other end of the tubular article, and applying a moving roller spinning pressure upon outer portions of the tubular article between the ends thereof and the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

6. The method of roller spinning a tubular article of ductile material which includes rotating the tubular article about an axis, applying upon one end of the tubular article through a compressible medium a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another compressive force applied against the other end of the tubular article, and applying a moving roller spinning pressure upon outer portions of the tubular article between the ends thereof and the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

7. The method of roller spinning a tubular article of ductile material which includes rotating the tubular article about an axis, applying upon one end of the tubular article a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another stationary compressive force applied against the other end of the tubular article, and applying a moving roller spinning pressure upon outer portions of the tubular article between the ends thereof and the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automatically coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

8. The method of roller spinning a tubular article of ductile material which includes rotating the tubular article about an axis, applying upon one end of the tubular article through a compressible medium a moving compressive force in the direction of the axis of rotation, opposing said compressive force by another stationary compressive force applied against the other end of the tubular article, and applying a moving roller spinning pressure upon outer portions of the tubular article between the ends thereof and the compressive forces, maintaining an angular relation between the directions of motion of the moving compressive force and the moving roller spinning pressure, and automati-

cally coordinating with respect to each other the movements of the compressive force and the roller spinning pressure.

9. Apparatus for roller spinning and the like, including opposed rotatable die heads, means for rotating one of the die heads, means for moving one of the die heads towards and away from the other die head, a spinning roller operatively mounted at one side of the axis of rotation of the die heads and between the opposite end planes of the die heads at right angles to the axis of rotation, means for moving the spinning roller towards and away from the axis of rotation of the die heads and rolling position between the die heads, and means for operating the moving means for the die head and the moving means for the spinning roller in co-ordination with respect to the movements of each other.

10. Apparatus for roller spinning and the like, including opposed rotatable die heads, means for rotating one of the die heads, means slidably mounting one of the die heads including a member movable with the die head towards and away from the other die head, a confined mass of compressible medium interposed between the movable member and the die head slidably mounted thereby, a spinning roller located at one side of the axis of rotation of the die heads and between the opposite end planes of the die heads at right angles to the axis of rotation, a member journal mounting the spinning roller and movably operative to move the spinning roller towards and away from the axis of rotation of the die heads and rolling position between the die heads, and means for operating the movable die head mounting member and the movable spinning roller mounting member so as to co-ordinate the movements of the die head and the spinning roller with respect to each other.

11. Apparatus for roller spinning and the like, including opposed coaxial rotatable die heads, means for rotating one of the die heads, means for moving one of the die heads towards and away from the other die head, a spinning roller operatively mounted at one side of the axis of rotation of the die heads and between the opposite end planes of the die heads at right angles to the axis of rotation, means for moving the spinning roller towards and away from the axis of rotation of the die heads and rolling position between the die heads, and means for operating the moving means for the die head and the moving means for the spinning roller in co-ordination with respect to the movements of each other.

12. Apparatus for roller spinning and the like, including opposed coaxial rotatable die heads, means for rotating one of the die heads, means slidably mounting one of the die heads including a member movable with the die head towards and away from the other die head, a confined mass of compressible medium interposed between the movable member and the die head slidably mounted thereby, a spinning roller located at one side of the axis of rotation of the die heads and between the opposite end planes of the die heads at right angles to the axis of rotation, a member journal mounting the spinning roller and movably operative to move the spinning roller towards and away from the axis of rotation of the die heads and rolling position between the die heads, and means for operating the movable die head mounting member and the movable spinning roller mounting member so as to co-ordinate the movements of the die head and the spinning roller with respect to each other.

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