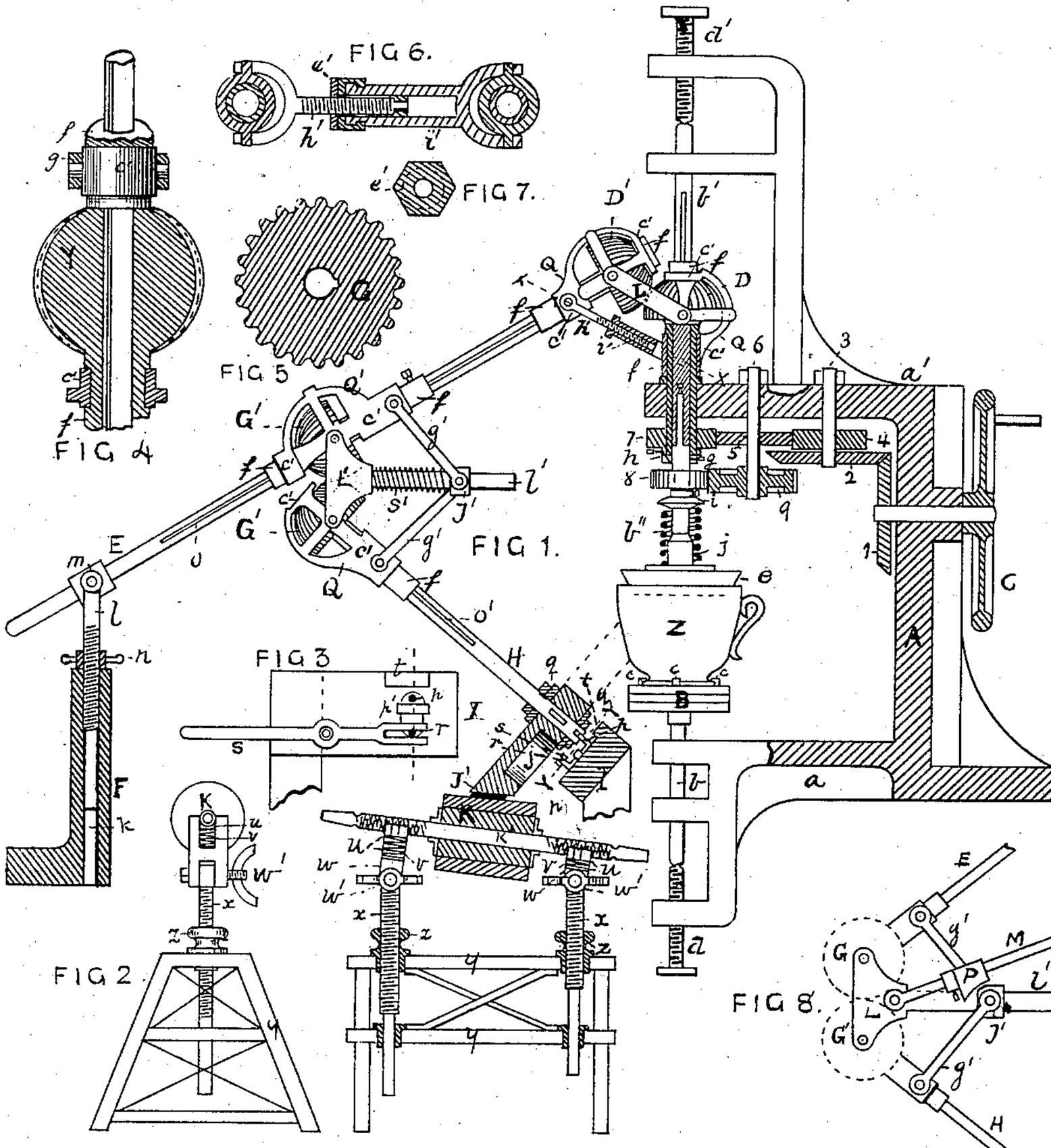
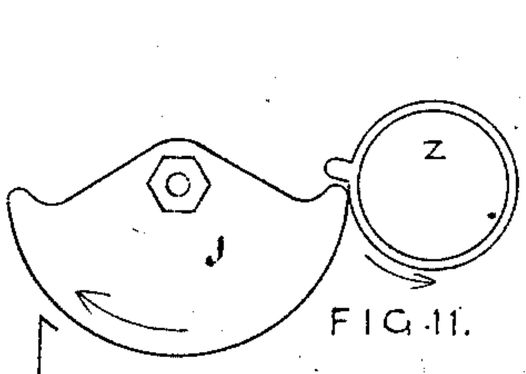
(No Model.) 5 Sheets—Sheet 1.

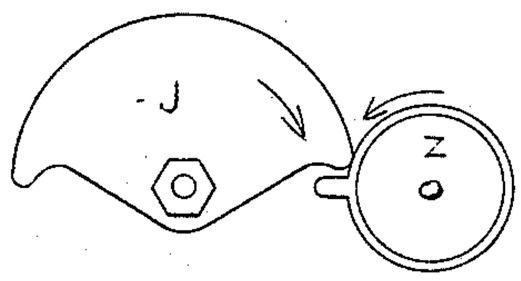
H. SCHULZE-BERGE.

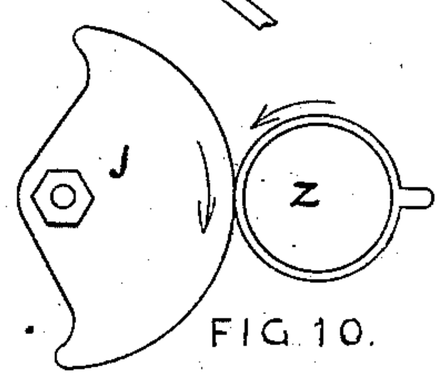
MACHINE FOR PRINTING ON GLASSWARE.

No. 316,836. Patented Apr. 28, 1885.









Witnesses—

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(No Model.) 5 Sheets—Sheet 2.

H. SCHULZE-BERGE.

MACHINE FOR PRINTING ON GLASSWARE.

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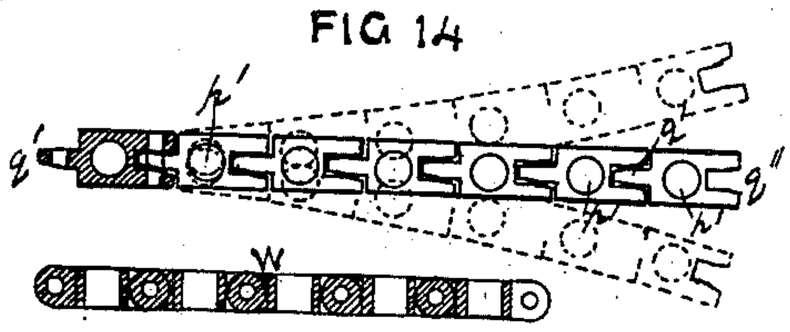

FIG 14

FIG 15.

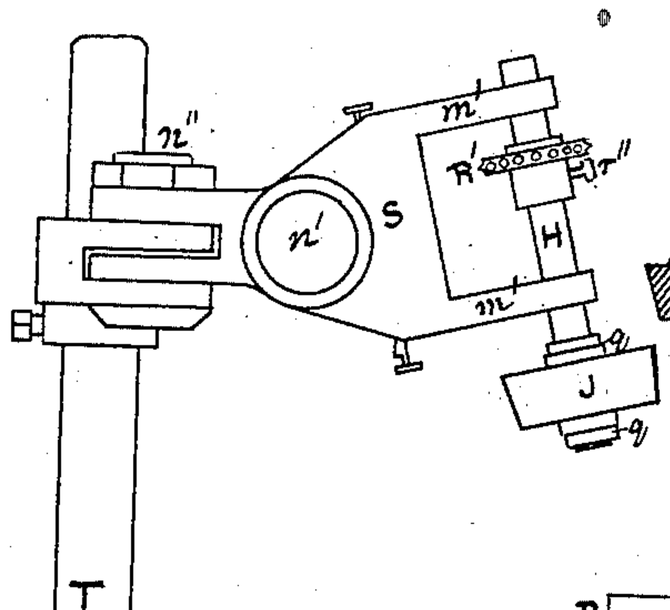

FIG 12

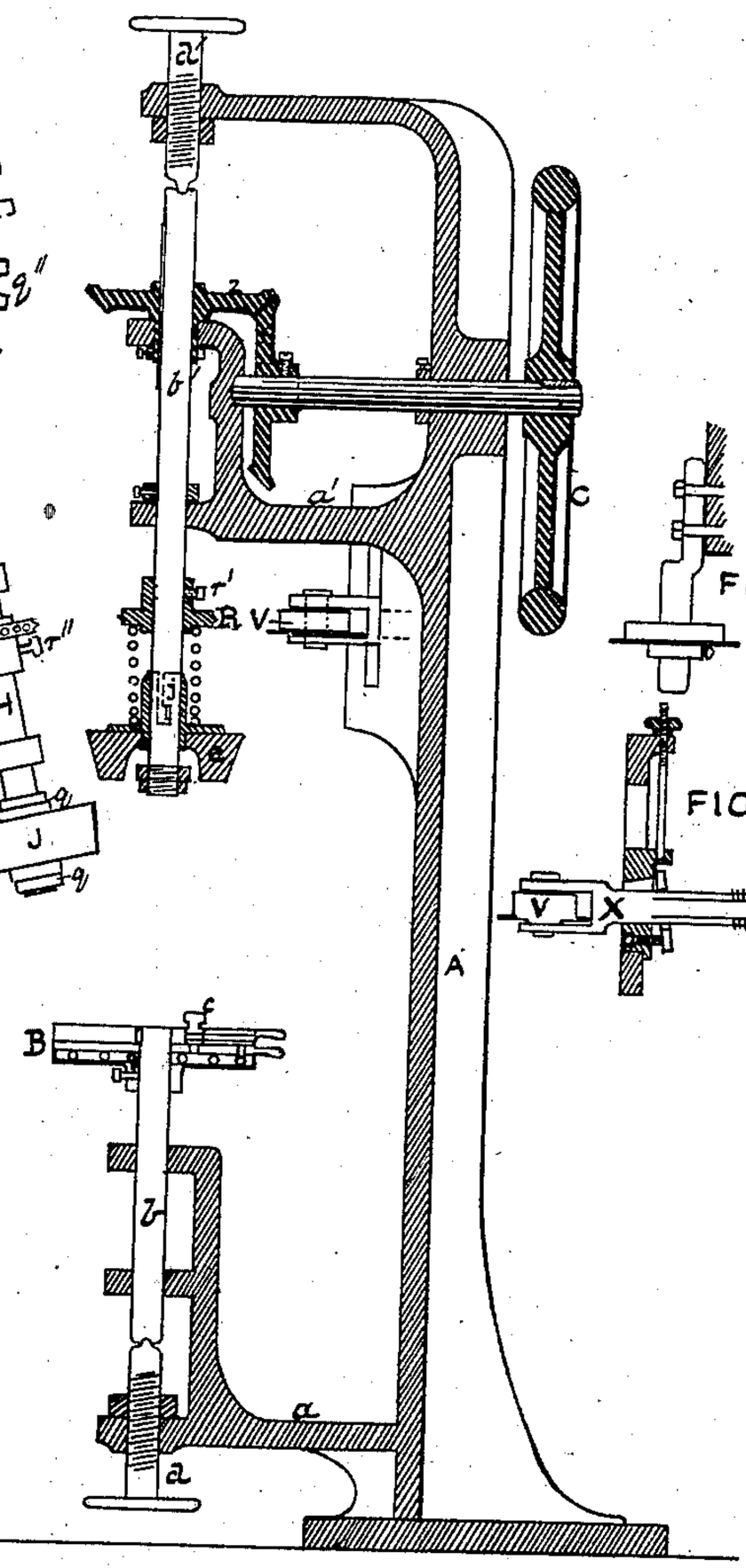

FIG 16.

FIG 17.

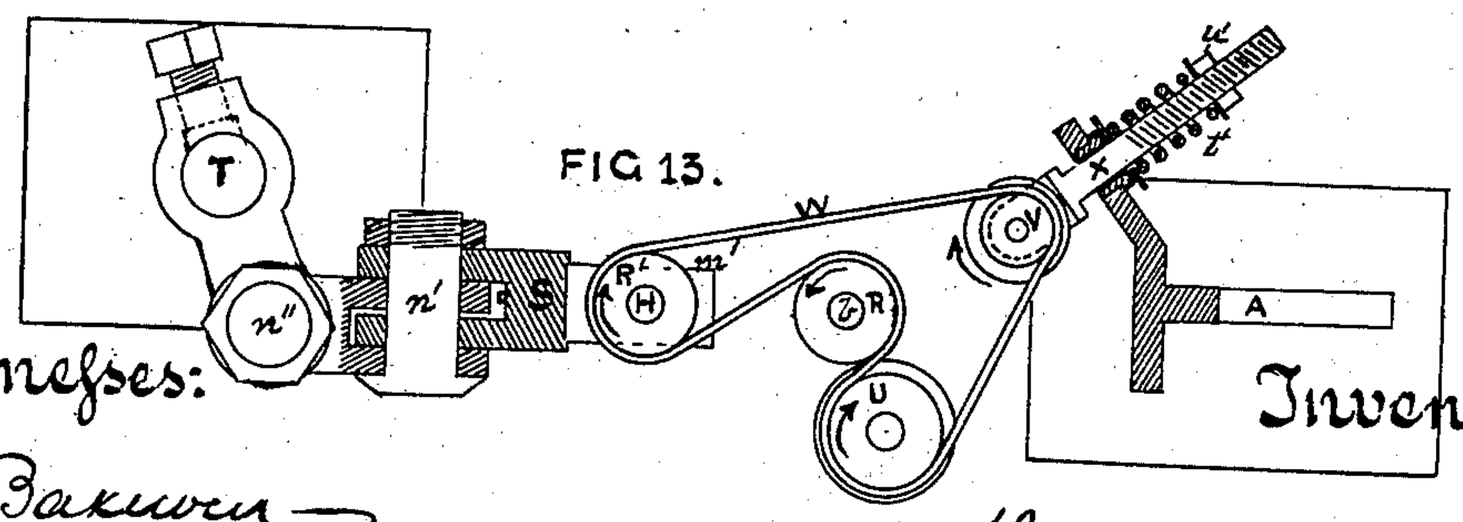

FIG 13.

Witnesses:

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(No Model.) 5 Sheets—Sheet 3.

H. SCHULZE-BERGE.

MACHINE FOR PRINTING ON GLASSWARE.

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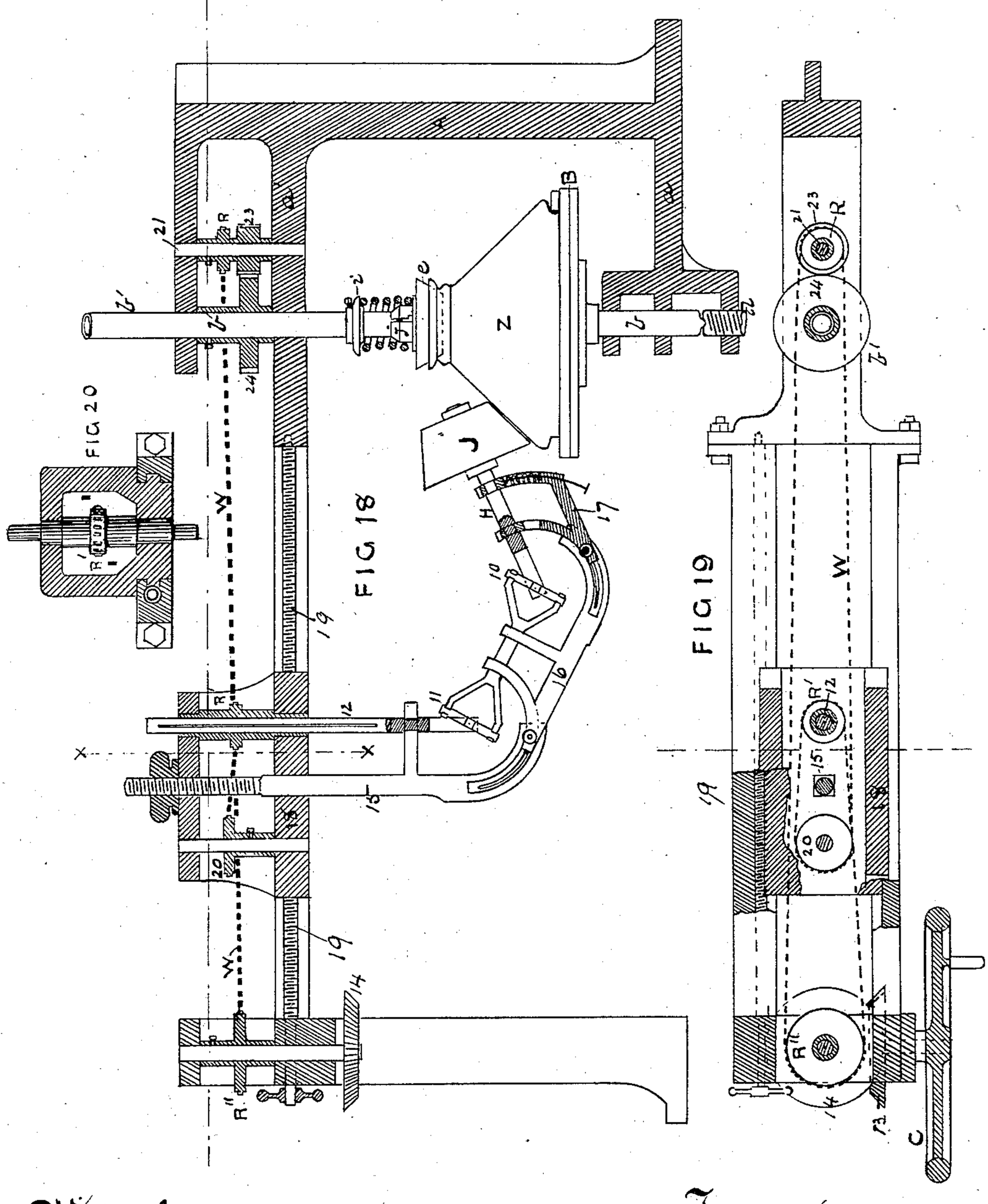

Witnesses:

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Jno. K. Smith

Inventor:

Hermann Schulze-Berge

(No Model.) 5 Sheets—Sheet 4.

H. SCHULZE-BERGE.

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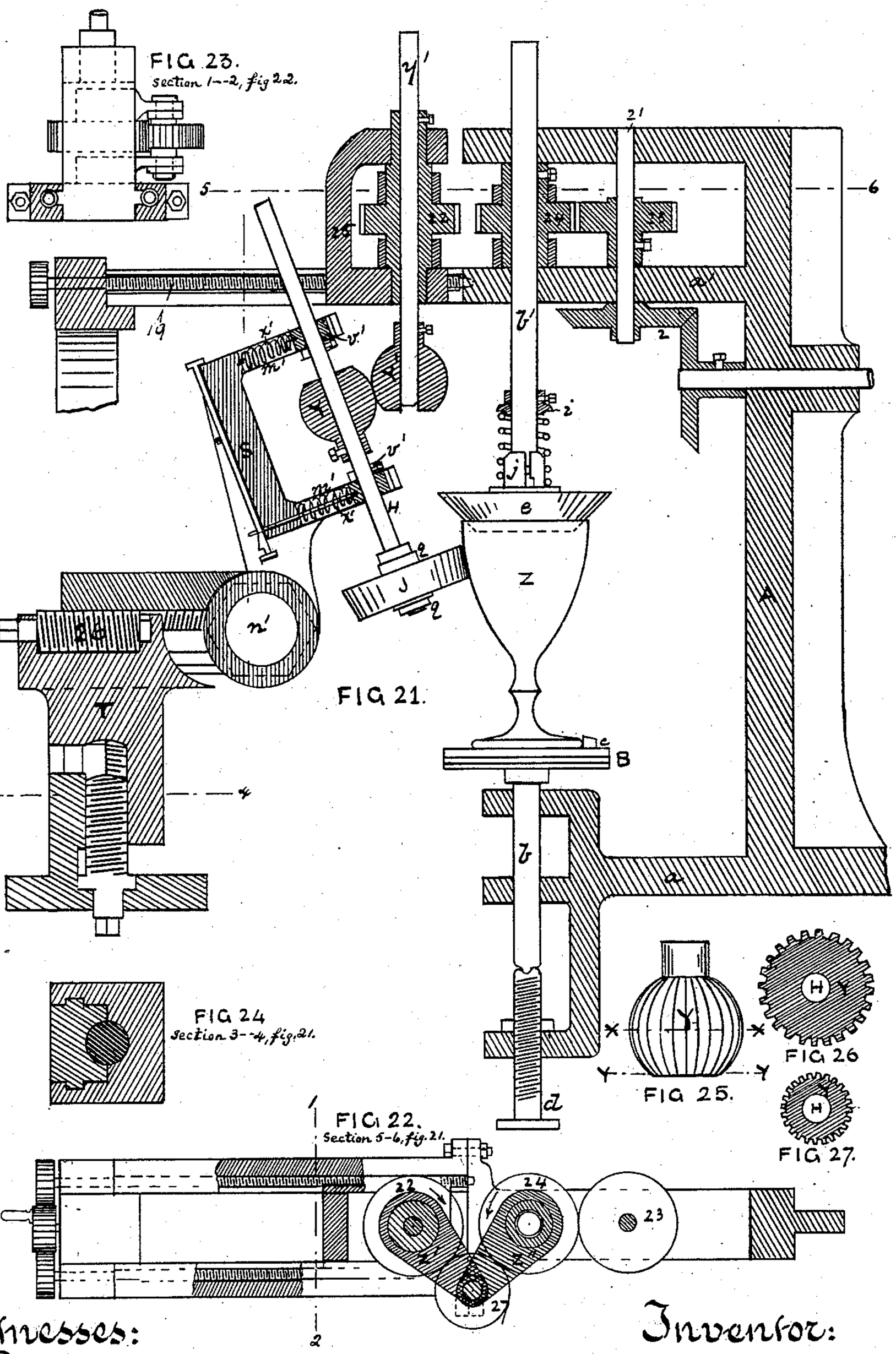

Witnesses:
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Jno. K. Smith

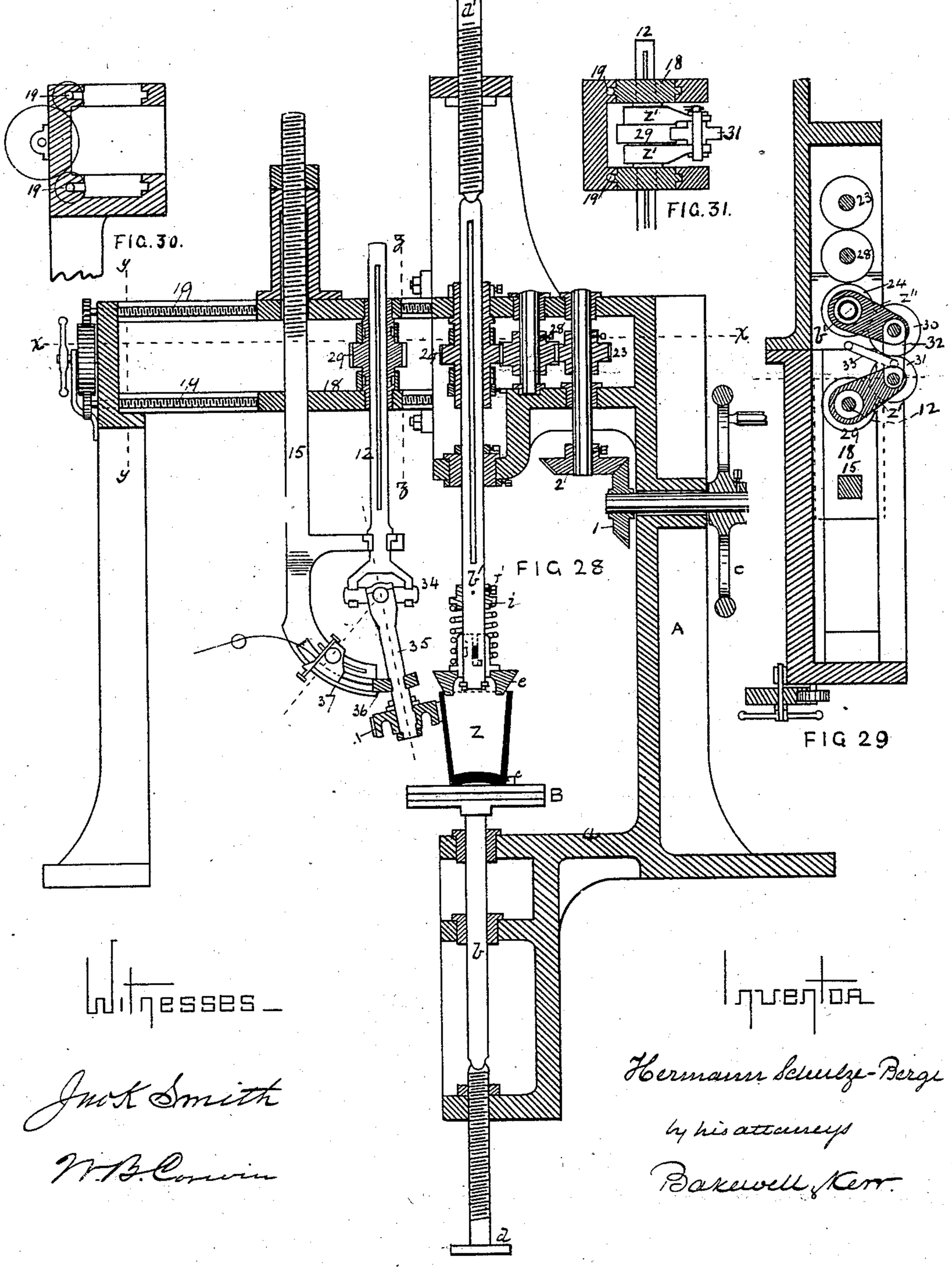
Inventor:
Herman Schulze-Berge

(No Model.) 5 Sheets—Sheet 5.

H. SCHULZE-BERGE.

MACHINE FOR PRINTING ON GLASSWARE.

No. 316,836. Patented Apr. 28, 1885



Witnesses—

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UNITED STATES PATENT OFFICE.

HERMANN SCHULZE-BERGE, OF ROCHESTER, ASSIGNOR TO HIMSELF AND JESSE H. LIPPINCOTT, OF PITTSBURG, PENNSYLVANIA.

MACHINE FOR PRINTING ON GLASSWARE.

SPECIFICATION forming part of Letters Patent No. 316,836, dated April 28, 1885.

Application filed January 11, 1884. (No model.)

To all whom it may concern:

Be it known that I, HERMANN SCHULZE-BERGE, of Rochester, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Machines for Printing on Glassware; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figure 1 is an elevation of my improved machine, partly in section. Fig. 2 is an end elevation of the printing-roller and its frame. Fig. 3 is a plan view of the step and adjusting devices of the shaft of the printing-roller on the dotted line *y y* of Fig. 1. Fig. 4 is a longitudinal section of a spherical gear-wheel, which may be substituted for the semi-spherical gear-wheels shown in Fig. 1. Figs. 5, 6, 7, and 8 are details of the hemispherical gearing, Fig. 6 being a section on the dotted line *x x* of Fig. 1. Figs. 9, 10, and 11 are figures illustrating the use of sector printing-rollers. Fig. 12 represents a modified construction of machine with my improvement, and Figs. 13 to 17 are details of construction. Figs. 18, 19, and 20 represent another modification of my improvement. Figs. 21 to 27 represent still another modification thereof. Fig. 28 represents another modification of my machine, and Fig. 29 is a section through the dotted line *x x* of Fig. 28. Figs. 30 and 31 are sections on the lines *y y* and *z z*, respectively, of Fig. 28.

In the several figures like letters of reference denote similar parts of the machine.

My invention relates to machines for printing on the surface of articles of glass and china ware, and has special reference to the overcoming of certain difficulties in the use of machinery for this purpose in place of hand operations—such as painting on the glass with a brush, or applying the pattern or design by means of a stamp or with a stencil and brush.

Owing to the great variety in shape and size of the articles which require such decoration, printing-machines of ordinary construction are inapplicable to such work, and even if they could be so applied they would require a separate machine for various classes of articles, so that one of the objects of my invention is to provide a machine which is capable of printing on the surface of articles of regular or irregular shape, whether cylindrical, cylindroidal, tapering, or bulging, and with or without handles or other projecting parts which would interfere with the continuous rotation of a printing-roller on the surface of the article; but the most serious difficulty is that, even in articles which are simple in shape, the variation in diameter between different specimens of the same article prevents the possibility of printing a continuous design which should match at the point of commencing and closing the printing by the mere rolling contact of a printing-roller with the surface to be printed on. These difficulties I have overcome by the machine which I am about to describe.

The purpose for which my machine is particularly designed to be used is the impressing, by means of a printing-roller, on hollow articles of glassware and china-ware, for the purpose of decoration, designs or patterns which are to be either etched on the glass or, being deposited thereon with suitable fusible coloring-matter, are to be burned onto the surface.

I have in other patents, recently granted to me, described particularly my method of etching the surface of glassware by depositing thereon pulverized fluorides or alkalies, which, on the exposure of the glass to a suitable degree of heat, unite with the silica of the glass and etch its surface; or, if colored designs are to be employed, the desired pattern is printed on the glass with fusible metallic colors, and the design is then burned in the usual way. In any of these cases the fluoride, alkali, or coloring-matter is either mixed with a suitable vehicle and the mixture used as an ink for printing on the surface of the glass or china to be decorated, or the design is printed with varnish or other suitable liquid substance, and the powdered fluoride, alkali, or coloring-matter are dusted over the surface, adhering only to that part of the surface to which the varnish or other vehicle is applied. My machine is designed to print the required pattern or design on the surface of the glass or china by means of a printing-roller on which the design is formed in relief, the article to be printed

on being placed on a revolving lathe, while the printing-roller revolves in contact with the surface of the article to receive the impression. Where, as is most common, the design is a continuous one, formed by the frequent repetition of one or more patterns, it is all important that the design should be perfect at the point where the printing commences and where it also terminates, so that the point of commencing and closing should not be perceptible on the finished article, and that the pattern should be continuous and complete all around the article of glass or china ware. This could be easily accomplished if the articles to be printed on were all of exactly the same circumference by making the circumference of the printing-roller to correspond precisely therewith; but as this is not the case even in pressed-glass articles made in the same mold, I accomplish the desired effect by giving to the printing-roller and article to be printed on the same positive speed of rotation, even though their surface speed is different. The revolution of the printing-roller in exactly the same time as that of the article printed on will of course produce the desired result; but if the diameters are different the surface of the one having the larger diameter must slip on the surface of the other to make up for the difference of surface speed, and if this slip motion is distributed uniformly, so as to be no greater at one point of the revolution than at any other, the effect will be, if the difference of diameter is not too great, that the pattern will be printed without blurring. This may be effected by attaching a pulley to the shaft of the lathe and another to the shaft of the printing-roller and employing a crossed belt, which arrangement is within the scope of my present invention; but as a belt is apt to become loose and slip, this device does not answer perfectly where the pattern is a delicate one and nice work is required. I prefer, therefore, to employ positive gearing between the spindle of the lathe and the shaft of the printing-roller.

By the use of the machine which I am about to describe I have printed with a single printing-roller of eight and one-tenth inches circumference a continuous delicate pattern on a glass article of eight and eight-tenths inches circumference, and with the same roller I have printed the same pattern on an article of six and six-tenths inches circumference, repeating the design the same number of times on each, and closing the pattern so exactly that it is impossible to tell where the printing commenced. In one case the roller was of greater diameter than the article, so that the roller slipped on the article, and in the other case the roller was of smaller diameter and the slip was in the article.

The mechanical devices which may be employed for producing the required synchronism of revolution of the lathe and printing-roller are various, such as a belt and pulleys, ordinary gear-wheels, or chain and sprocket wheels, &c.; but my invention does not consist, merely, in connecting the shaft of the lathe and printing-roller, as it is also desirable that the shaft of the printing-roller should be made adjustable, so as to incline more or less to the spindle of the lathe, so that the machine may print on articles of various diameters, either of cylindrical or tapering shape and of various degrees of taper. To accomplish this, it is necessary so to construct the machine that the distance between the shafts of the lathe and of the printing-roller may be changed, as well as their relative angle of inclination, and this without interfering with the operative contact of the gearing devices.

In Fig. 1 of the accompanying drawings, A is the standard or frame of the lathe, which supports and rotates the article of glass, china-ware, or other material on which a pattern or device is to be printed, such as a cup, goblet, vase, lamp-shade, &c. It has two brackets, *a a'*, the lower one, *a*, of which carries the spindle *b* of the chuck B, on which the cup Z or other article is secured. The chuck B has gripping-jaws, (three or more,) two of which, *c*, are shown in the drawings. These jaws slide in grooves in the upper plate of the chuck, and are pressed toward the center of the chuck by means of a spring or springs, as described in another application which I have made for Letters Patent. The bearing-surfaces of the jaws *c* should be faced with india-rubber, so as to give them a better hold on the article Z, and give sufficient pressure to secure it from slipping on the chuck without injuring the article.

A further description of the chuck is unnecessary here, as any device which will firmly hold and accurately center the article Z on the chuck may be used.

The chuck-spindle *b* is stepped onto a screw, *d*, in the lower bracket, *a*, so that the chuck may be raised or lowered. The upper bracket, *a'*, furnishes the bearings of the upper spindle, *b'*, of the lathe, which is centered on top by a screw, *d'*, so that the spindle *b'* may be raised or lowered for the purpose of adjustment. A tapering plug, *e*, is connected with the lower end of the upper spindle of the lathe, and is of such shape and size as to fit into the mouth of the article Z, placed on the chuck. The plug *e* may be made of wood or other suitable material, and is removably fixed to the spindle, so that it may be changed so as to suit the article placed on the chuck.

The upper spindle may be made of one piece; but I prefer to make it in two pieces, so that, if desired, the chuck B may be made to revolve at a different speed from the printing-roller. For this purpose the lower part, *b''*, of the upper spindle of the lathe is made to fit into a cylindrical socket in the lower extremity of the spindle *b'*, as shown in Fig. 1.

Revolving motion is given to the upper spindles, *b' b''*, by means of a wheel, C, which may

be turned by hand or otherwise. A bevel-wheel, 1, on the shaft of the wheel C, gears into the bevel-wheel 2, which has its bearing on a hanging shaft, 3, attached to the frame A. On the same shaft, 3, above the bevel-wheel 2, is a cog-wheel, 4, which gears into an idler-wheel, 5, which has its bearing on another suspended shaft, 6, attached to the frame A. The idler 5 gears into a cog-wheel, 7, keyed to the spindle b', so that the turning of the wheel C causes the spindle b' to revolve. The lower end of the spindle b' is hollow, having a cylindrical bore which receives the upper end of the spindle b'', which forms a continuation of the spindle b'. A set-screw, g, serves to fasten the spindle b'' to the spindle b', so that if the set-screw g is loosened the spindles b' and b'' may revolve independently of each other, while, if the screw g is tightened, the revolution of the spindle b', effected as before described, carries with it the spindle b''. It may be desired, however, that the spindle b'' shall revolve faster than the spindle b', and to effect this a cog-wheel, 8, is keyed to the spindle b'', and a cog-wheel, 9, of larger diameter, gearing into cog-wheel 8, is placed on the lower end of the hanging shaft 6. If, then, the the set-screw g is loosened, and the wheel 9 placed on the shaft 6, the spindle b' will be revolved by the gear-wheels 1, 2, 4, 5, and 7, while the spindle b is revolved at a more rapid speed by the wheels 1, 2, 4, 5, 9, and 8. If the cog-wheel 9 is made twice or three times the diameter of the cog-wheel 8, the spindle b'' will revolve twice or three times as fast as the spindle b'. The spindles b' and b'' may be caused to revolve at the same speed without removing the cog-wheel 9 by tightening the set-screw g and loosening a set-screw, h, which fastens the cog-wheel 7 to the shaft b', in which case the cog-wheel 7 will become loose on the spindle b', and both spindles will be revolved at the same speed by the cog-wheels 1, 2, 4, 5, 9, and 8.

On the lower part, b'', of the upper spindle is an adjustable collar, i, between which and the plug e is placed a spiral spring, which serves to keep the plug pressed into the mouth of the article Z, the plug e being attached to a sleeve, j, into which the lower end of spindle b'' enters by a slot in the sleeve and a pin on the spindle. The circumference of the plug e should be covered with india-rubber or similar substance, so as to give it a firm hold on the article Z, because the rotation of the chuck B is communicated from the spindle b' by means of the connection effected by the article Z placed between the chuck B and the plug e.

At the upper end of the sleeve f, on the spindle b', is keyed one of a pair of hemispherical gear-wheels, D D', the other wheel, D', being fastened to the upper end of an inclined shaft, E, which is supported at its lower end by a standard, F, attached to the bed-plate of the machinery or to some firm support. The standard F has a vertical bore, k, to receive a rod, l, to the upper end of which is pivoted a sleeve, m, through which the shaft E passes. The rod l has a screw-thread cut on it, on which is screwed a hand-wheel, n, with a female screw cut in the center of its hub, which bears on the top of the standard F, so that by turning the hand-wheel n the rod l may be raised or lowered in the standard F. The bore of the standard F is smooth, so that the rod l may be raised or lowered without turning on its axis.

On the shaft E, between the gear-wheel D' and the standard F, is placed a hemispherical gear-wheel, G, which meshes into a corresponding hemispherical gear-wheel, G'. The gear-wheel G is loose on the shaft E, so as to slide on it; but it is caused to turn with its shaft by means of a spline or feather, o, on the shaft E. The construction and arrangement of the hemispherical gear-wheels D D' and G G' will be hereinafter described; but no claim is made on them here, as they form the subject-matter of another application for Letters Patent, filed simultaneously herewith. The gear-wheel G', which meshes into the wheel G, is placed at one end of the printing-roller shaft H, the upper end of which is supported as hereinafter described, and its lower end is supported by an adjustable step, p, attached to a support, I, which should be firm and yet capable of being moved to any position required by the shape and size of the article Z. The wheel G', which is adjustable on the shaft H on a feather or spline, o', is fastened in position by a set-screw.

To the lower end of the shaft H is secured the printing-roller J, which is removable and may be adjusted on the shaft H by means of nuts q, screwed on the shaft above and below the roller. The printing-roller J is in the shape of a truncated cone. It is made of wood or other suitable material, and to its circumference is attached, by means of glue or otherwise, the type or pattern f', Fig. 1, to be printed on the glass, which is made of india-rubber or other equivalent material in a mold, the design being in relief. The support I, to which the step p of the printing-roller shaft is attached, is placed in such proximity to the chuck B of the lathe that the surface of the printing-roller will come in contact with the surface of the cup or other article placed on the chuck B.

It is obvious that if the diameter of the article Z were greater, or that of the printing-roller smaller, the proper contact of the roller and article could be easily effected, either by raising or lowering the roller J on its shaft H and the chuck B by means of the adjusting-screws d d', or by changing the position of the gear-wheel G on its shaft E and moving the step p correspondingly.

In order to prevent the contact of the printing-roller J with the article Z when the latter is being placed on the chuck, when the ma-

chine is in use, I have provided for a slight motion of the printing-roller J away from the article by means of the adjustable step *p*, before mentioned. This arrangement is shown more clearly in Fig. 3. The step *p* is a pin projecting from the block I on which block is another pin, *r*, which is engaged by the bifurcated end of the lever *s*, so that by moving the handle of the lever *s* the step *p* may be moved a short distance in either direction. A stop, *t*, arrests the motion of the step *p* toward the chuck B, so as to prevent the article Z being struck by the printing-wheel by a too violent movement of the lever *s*.

Immediately below the printing-roller J is placed the inking-roller K, on which the ink or substance with which the printing is to be done is placed, so as to apply it to the surface of the design on the printing-roller J. The inking-roller is a cylinder covered with a suitable coating of gelatine or printing-roller composition, and is attached to a shaft, *k'*. Right and left hand screw-threads are cut on the shaft *k'*, which works in automatically-reversing bearings, so as to give the inking-roller a motion back and forth in the line of its axis in the way commonly practiced in connection with the ink-distributing rollers in printing-machines, and which, therefore, need not be particularly described. The inking-roller turns on its axis by frictional contact with the printing-roller J, which has a positive rotary motion with its shaft H.

Under the journal-bearings *u u* of the shaft of the inking-roller are spiral springs *v v*, which serve to give an uniform bearing of the printing-roller on the inking-roller, so as to keep their surfaces parallel to each other. Each of the journal-boxes *w w* of the inking-roller shaft is hinged to the top of a cylindrical rod, *x x*, which rods are supported in a frame, *y*, by means of nuts *z z*, which rest on the top of the frame *y*. The rods *x x* have screw-threads, which take into the threads of the nuts *z z*, so that by turning the nuts the rods *x x* may be raised or lowered and the proper inclination given to the inking-roller shaft to adapt it to the inclined surface of the inking-roller K. A screw bolt and nut, *w'*, forms the hinge by which each of the journal-boxes *w w* is hinged to the rods *x x*, so that by tightening the nut the inking-roller shaft is set firmly in its proper position.

I have described the printing-roller as being a truncated cone; but in place of this I sometimes use a segment of a truncated cone, such as is shown in Figs. 1, 9, 10, and 11. This is desirable where the article to be printed on has a handle or handles which project from the surface of the article so far as to prevent the use of a printing-roller having a continuous unbroken surface. In such case if it is desired to print the pattern all around a cup or other article, if it has one handle, as in the illustration given in the drawings, one end of the roller is placed close to one side of the handle, as shown in Fig. 9. Then if the cup and roller revolve in the direction of the arrows, their relative position when the cup has performed a half-revolution will be that shown in Fig. 10, and when the revolution of the cup is complete they will assume the position shown in Fig. 11, the handle of the cup having passed the extremity of the inking-roller. In this case the diameter of the roller should be about twice that of the cup Z, and the lathe must be so geared, as before described, by loosening the set-screw *g* and adding the cog-wheel 9, as that the chuck B shall make one complete revolution on its axis while the printing-roller J makes only one-half of a revolution. If the article Z has no handle or other obstruction, and it is desired to use a printing-roller of the same diameter as the cup or other article Z, then the cog-wheel 9 is removed, and the lower part, *b''*, of the upper spindle is fastened by the set-screw *g*, and then the chuck B will revolve in the same time as the spindle *b'*; or, instead of removing the cog-wheel 9, the set-screw *g* may be tightened and the set-screw 7 loosened, as in either case the spindles *b'* and *b''* will revolve together and with the same speed as the spindle of the printing-roll.

The importance of having the spindle of the lathe and the spindle of the printing-roller move at the same rate of speed, irrespective of the relative surface-speed of the printing-roller and of the article to be printed on, has been already referred to; but it is evident that the same effect is obtained if the speed of the article to be printed on be twice, thrice, or any given number of times that of the printing-roller, in which case a partial revolution of the printing-roller will print the entire circumference of the article, and in which case, also, as before stated, a roller may be used which is a sector of a cylinder the arc of which bears the same proportion to a complete circle that the speed of the printing-roller spindle bears to that of the lathe-spindle; but in this case the diameter of the printing-roller should be correspondingly increased, so that the surface-speed of the printing-roller and of the article to be printed on may be nearly the same.

The hemispherical gearing by which the spindle *b'* of the lathe is connected with the shaft E, and the shaft E is connected with the printing-roller shaft H, consists in each case of a pair of wheels of hemispheroidal shape on the outer surface of the teeth, the imaginary surface at the pitch-line of the teeth being a true hemisphere. Fig. 5 shows a section of one of these gear-wheels on the equatorial plane. The teeth gradually diminish in depth and width toward the pole, so that at whatever angle the axes of these wheels are placed toward each other the teeth will mesh into each other. Each of these gear-wheels is provided with a cage, Q, with a sleeve, *c'*, at both ends, if the shaft extends above and below the wheel, (as in the case with the wheels D and G,) the

sleeves being prevented from turning on their respective shafts H, E, and *b'* by a spline or feather. These cages Q encircle the gear-wheel on one side only, so as to cover little more than one-half of the gear-wheel, leaving the other half exposed, so as to mesh into its mate. The two cages of each pair of wheels are connected by two links, L, one on each side, the links being pivoted at each end to one of the cages Q, the pivotal point being on diametrically-opposite sides of the equatorial diameter of the gear-wheels, and the length of each link between the pivotal points being equal to the exact equatorial diameter between the pitch-lines of each wheel. In order to keep these wheels in the proper relative position to each other, a further connection is made between the two cages of each pair of wheels. The wheels D D', which connect the spindle *b'* and the end of the shaft E, have an extensible connecting-bar consisting of two pieces, *h'* and *i'*, *i'* being a cylindrical socket and *h'* a screw-rod, which enters the socket *i'*. Each of these is bifurcated at the outer end, the bifurcation spanning the sleeve of one of the cages Q, to which it is pivoted. The bore of the socket *i'* is smooth, and an annular cap, *e'*, which turns freely on the end of the socket *i'*, serves as a nut, screwing on the rod *h'*, so that by turning the cap *e'* the distance between the pivotal points of the pieces *h'* and *i'* may be increased or diminished. This construction is shown in detail in Fig. 6. The cages Q' of the other pair of gear-wheels, G G', have also a double connection, consisting of the link L', before mentioned, and two rods *g' g'*, each of which is pivoted to one of the sleeves *c' c'* of the cages Q' Q', and both of which are also pivoted to a sleeve, *j'*, on the arm *l'* of the link L of the gear-wheels G G'. The arm *l'* extends from the link L at right angles to it, and a spiral spring, *s'*, around the arm *l'*, pressing down on the sleeve *j'*, not only serves to preserve the proper relative position of the gear-wheels G and G', but permit of a spring motion to the shaft H of the printing-roller, keeping it pressed up against the article Z to be printed on, and allowing it to yield to any irregularity of curvature of the article. In place of the spiral spring *s'* on the arm of the link, a lever-arm, M, may be used, pivoted at one end to the link L, while near the other end is a sliding weight, N, and between the weight and pivotal point on the lever M is a sliding collar, P, fastened by a set-screw in such position as to bear against the sleeve *j'* and press it outward from the gear-wheels. The use of the weight is an advantage, as by adjusting its position on the lever M the pressure of the printing-roller J on the article to be printed on may be regulated at pleasure. This modified construction is shown in Fig. 8. From this description, and a reference to Fig. 1 of the drawings, it will be seen that the position of the printing-roller J relatively to the article Z is susceptible of a great variety of changes.

I desire not to limit myself to the exact devices shown in the machine just described, because when the principle of operation which I have referred to is suggested, and is illustrated in an operative machine, various modifications of mere mechanical devices and arrangements of parts may be used which would be within the scope of my invention. I will, therefore, by way of illustration, describe some of the modifications of which my improved machine is susceptible without departing from the principles of construction and operation of my invention.

On Sheet 2 of the drawings is represented the application of a flexible metallic chain and sprocket wheel to the spindles of the lathe and printing-roller in order to secure exact uniformity of rotation.

Fig. 12 represents a machine the main parts of which are similar to the corresponding parts of the machine already described, and are similarly lettered. The spindle *b'* is operated by the wheel C and the beveled cog-wheels 1 and 2. The arrangement of the chuck B and its spindle *b*, and of the tapering plug *e* on the upper spindle, *b'*, are as before described. The printing-roller J is fastened by the nuts *q q* on the lower extremity of the printing-roller shaft H, which has its bearings in the arms *m' m'* of the frame S, which is pivoted by two hinge-joints, *n' n''*, (the hinges of which have their axes at right angles to each other, so as to admit of lateral and vertical adjustment,) to the standard T. On the upper spindle, *b'*, of the lathe is a sprocket-wheel, R, and a corresponding sprocket-wheel, R', of equal diameter and same number of teeth, is secured to the shaft H of the printing-roller. These sprocket-wheels are adjustable on their shafts by means of the set-screws *r' r''*. The teeth of the sprocket-wheels should be tapering, so as to enter readily into the holes *p'* in the chain. The sprocket-chain, of which Fig. 14 is a side view and Fig. 15 a top view, is made of links all of exactly the same size and shape, having a tapering tongue, *q'*, at one end, and a notch, *q''*, at the other end, the notches being slightly enlarged at their extremities, and each link being pivoted to the adjoining one by a hinge-pin. The object of enlarging the notches and tapering the tongues is to permit of a sufficient degree of side flexure of the chain, as shown in Fig. 14, to accommodate it to as great an inclination of the axes of the sprocket-wheels as possible. In order to prevent the necessity of crossing the chain as it passes from one sprocket-wheel to the other, so as to cause the spindles to revolve (as if directly geared together) in opposite directions, and to secure sufficient rigidity of the chain to avoid any uncertainty or inequality in the motion of the spindles, I introduce two pulleys, U and V, the operation and function of which are shown in Fig. 13. The link-chain passes around the pulleys U and V and the sprocket-wheel R', so as to in-

close them, and around the sprocket-wheel R, so as not to inclose it. The pulley V is pivoted to an arm, X, (see Figs. 13 and 17,) inserted into an opening in the frame of the machine, and a spiral spring, t', bearing against a nut, u', serves to keep the sprocket-chain tight, and also permits the printing-roller being drawn away from the article to be printed on when the printing is finished.

Sheet 3 of the drawings shows a modification of my machine in which a link-chain and sprocket-wheels are also used, showing how the motion may be applied when the article to be printed on tapers upward instead of downward, as in the previous illustrations. In this sheet, Fig. 18 is a side view, and Fig. 19 a plan view, of the machine, the several parts of the machine which correspond substantially with parts of the machine first described being marked with the same letters. In Fig. 18 the article Z to be printed on is a lamp-shade the surface of which inclines at an angle of about forty-five degrees. The shaft H of the printing-roller J is connected by means of two universal joints, 10 11, of ordinary construction, with a vertical shaft, 12, to which rotary motion is communicated by the sprocket-wheel R′ by means of a link-chain, W, from the sprocket-wheel R″, which is caused to revolve by the wheel C, and a pair of beveled cog-wheels, 13 and 14, (one of which is seen in Fig. 18 and the other in Fig. 19.) The vertical shaft 12, which operates the printing-roller, has its bearings in a sliding carriage, 18, which is adjustable in ways on the top of the frame of the machine, so as to change the distance of the shaft 12 and lathe-spindle b', as may be desired, and to adjust the printing-roller J to a great variety of articles of different size and shape. A vertical arm, 15, with two sliding and pivoted joints, 16 and 17, serves as a frame to carry the printing-roller shaft H and the double universal joint 10 and 11. The vertical arm 15 is supported by and adjustable vertically in the sliding carriage 18. The sliding carriage is moved in the frame of the machine by means of a screw, 19. In the sliding carriage 18 there is also an idler sprocket-wheel, 20. Another sprocket-wheel, R, on a shaft, 21, near and parallel to the spindle b' of the lathe, also receives motion from the chain W; and a cog-wheel, 23, on the shaft 21 of the sprocket-wheel R, gears into a cog-wheel, 24, on the spindle b'. By reference to Fig. 19 it will be seen that the sprocket-chain W passes from the sprocket-wheel R″ to and around the sprocket-wheel R; but it also passes around the sprocket-wheel R′ on the shaft 12, with which the printing-roller is connected, and the idler sprocket-wheel 20, both of which are carried by the sliding carriage 18, so that the gearing connection of spindle b' and shaft 12 is maintained, notwithstanding that the relative distance of the shaft 12 and spindle b' may be changed by shifting the position of the sliding carriage.

Another modification of devices for preserving the geared connection, and consequently the same degree of speed of the spindles of the lathe and printing-roller, is illustrated in the machine shown in Sheet 4, Figs. 21 to 27. In this machine, which is very similar to that shown in Sheet 2 of the drawings, the printing-roller J is supported on a standard, T, and is carried by a frame, S, substantially such as shown in Fig. 12, Sheet 2, the frame being capable of motion for the purpose of adjustment in the arc of a circle both horizontally and vertically. The frame S has two arms between which, on the printing-roller shaft H, is keyed a spherical gear-wheel, Y. The shaft H is supported by bearings v' v' on the arms m' m'. These bearings slide in grooves in the arms, and a spiral spring, x', in each of the grooves, pressing against the sliding bearings, forces the shaft H of the printing-roller J forward, and not only keeps the roller up to its work, but permits it to yield in case of any inequality of contour of the surface which is receiving the impression of the roller. Parallel to the spindle b' of the lathe is a vertical shaft, y', to which power is applied to operate the machine. This shaft is attached by key or set-screw to the cog-wheel 22, which has its journals in the sliding carriage 25 in the frame of the machine, and is adjustable by means of a screw-rod, like the sliding bearings in the machine already described and shown in Fig. 18. At the lower end of the vertical shaft y' is a gear-wheel, Y′, which gears into the wheel Y on the shaft H of the printing-roller J. In order that the gear-wheels Y and Y′ may gear together when the angle of inclination of the spindle b' to the shaft H is changed, the gear-wheels are of the shape of truncated spheres, as shown in Fig. 25. Figs. 26 and 27 are cross-sections of the truncated spherical gear-wheel on the dotted lines x x and y y of Fig. 25, respectively, and Fig. 4 on Sheet 1 shows the manner in which they are attached to their shafts. Like the hemispherical wheels of Fig. 1, they will mesh into each other equally well whether their axes be parallel with or inclined to each other. As the frame S of the printing-roller is raised or lowered by turning on a pivot having its center at n', the gear-wheel Y would be moved out of gear with the gear-wheel Y′ if the printing-wheel were raised; but this change of position is accommodated by moving the frame S forward by means of the screw 26, or by moving the sliding carriage 25 of the gear-wheel Y′ until the gear-wheels again engage each other. In order to preserve the gearing connection of the cog-wheel 22 on the shaft y', and the cog-wheel 24 on the spindle b of the lathe, a third cog-wheel, 27, is placed between the cog-wheels 22 and 24, which third cog-wheel is supported by two sets of plates, Z′ Z″, placed on the collars of the cog-wheels 22 and 24, the extremities of these plates forming the journals for the third cog-wheel, 27. By this means the axes of the cog-wheels 22 and 24 can be moved

apart until the axis of the third cog-wheel, 27, is in line with them without destroying the gearing connection. By this means (the cog-wheels 22 and 24 being of exactly the same diameter and number of teeth) the lathe will perform each revolution in exactly the same time as the printing-roller, while the position of the printing-roller and its distance from the center of revolution of the lathe can be altered at will without interfering with the motion of the spindles.

On Sheet 5 of the drawings is represented a form of my machine in which a universal joint of the common description is used. The spindle *b'* of the lathe is connected by the cog-wheels 1, 2, 23, 28, and 24 with the prime-wheel C, substantially as before described in regard to the machine shown in Sheet 4. The vertical arm 15 and shaft 12 of the printing-wheel are connected with the sliding carriage 18, which is moved in either direction toward or from the spindle of the lathe by means of the screws 19 19. The shaft 12 of the printing-wheel has a cog-wheel, 29, keyed to its shaft. In order to enable the shaft 12 of the printing-wheel to be moved away from the spindle *b'* of the lathe without throwing the cog-wheel 24 on the lathe-spindle out of gearing-connection with the cog-wheel 29, which rotates the printing-wheel J, a device is employed (shown in Fig. 29) resembling that shown in Fig. 22 of Sheet 4, in which the cog-wheels 22 and 24 are connected by two sets of plates, *Z' Z''*, and a third or idler wheel, 27. In that case the printing-roller shaft H is geared to the shaft of the cog-wheel 22 by the cog-wheels Y Y', and therefore the printing-roller J and the lathe-spindle *b'* revolve in opposite directions, as if geared together; but in the construction shown in Fig. 28, Sheet 5, the shaft *y'* and its cog-wheel being dispensed with, it is necessary to interpose two idler-wheels, 30 and 31, between the cog-wheels 24 and 29 on the spindles *b'* of the lathe and 12 of the printing-roller. In this case, therefore, the plates *Z' Z''*, (see Fig. 29,) instead of being pivoted together at their outer ends, are each pivoted to one of the two idlers 30 and 31, and their axles are connected by a pair of links, 32, one on each side of the idlers 30 and 31. By this construction the shafts of the printing-wheel and lathe may be separated until the axes of wheels 29, 30, 31, and 24 are in a right line, without their being thrown out of gear. In order to preserve the proper position of the plates *Z' Z''*, a link, 33, is pivoted to the frame of the lathe-machine, and to the link 32, which is parallel to the axis of the wheel 24 and idler 30, and keeps the wheels in their proper relative position. At the lower end of the shaft 12 is the universal joint 34, to which is attached a short shaft, 35, to the lower end of which the printing-roller is immediately attached, so that as the shaft 12 revolves on its axis the short shaft 35 will revolve in like manner when the shaft 35 is set at an angle to the shaft 12. This adjustment of the shaft 35 out of a right line with the vertical shaft 12 is in order to give the printing-roller J the proper inclination to suit the taper of the article Z set on the lathe-chuck B. This adjustment is effected by means of the lower bearing, 36, of the short shaft 35 being made to slide in the grooves 39 in a curved arm, 37, at the lower end of the vertical arm 15, and held in position by the weighted rod 38, which in this instance is substituted for the springs *x'* in Fig. 21.

I am aware that in printing-machines for printing with type on paper the type-roller and impression-cylinder are sometimes so geared together that they revolve exactly in the same period of time; but in this case the circumference of the type-cylinder is exactly the same as that of the impression-cylinder; but the difference between such device and mine is that there is no impression-cylinder used by me, and that the article to be printed on may be of different length of circumference from the printing-cylinder, and in practice such is almost always the case, so that there is a constant and regular slip motion between the surface of the printing-cylinder and that of the article to be printed on, which never occurs in type-printing machines; and the important feature of my invention is that by means of a slip motion of the surface of the type-roller on the surface of the article to be printed on, or vice versa, there may be a difference in the length of circumference of the printing-roller and article to receive the impression, either being larger than the other, and yet by forcing them to revolve in the same time each completes its revolution, or one, two, or more complete revolutions, in exactly the same time as the other completes a single revolution, with the result of producing an exact registration of the pattern or design at the point where the printing commences and terminates.

Having thus described my improvement, what I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination of a tapering printing-roller with a lathe for holding and revolving the article to be printed on, the shafts of the lathe and printing-roller being connected, substantially as described, in such manner that one of them shall revolve as many times for each single revolution of the other as the number of times that the diameter of the smaller (whether it be the printing-roller or the article) is most nearly contained in the diameter of the larger, substantially as and for the purpose described.

2. The combination of a revolving printing-roller provided with an elastic printing-surface with a lathe for holding and revolving the article to be printed on, each having a positive revolving motion communicated by gearing, substantially as described, operating both of them, so that one of them shall complete a single revolution in exactly the same time as that in which the other makes one,

two, or more complete revolutions, irrespective of the relative surface speed of the printing-roller and object to be printed on, substantially as described.

3. In machines for printing on articles of tapering or irregular cylindroidal shape, a lathe for holding and revolving the article to be printed on, in combination with a tapering revolving printing-roller, the shafts of both being connected, so as to revolve at a given relative speed, substantially as described.

4. A tapering sector printing-roller, in combination with a lathe for holding and revolving the article to be printed on, having a positive motion on its axis, substantially as and for the purposes described.

5. In machines for printing on articles of tapering or cylindroidal or other irregular curved shape, a lathe for holding and revolving the article to be printed on, in combination with a tapering printing-roller and an inking-roller the shaft of which is set in bearings which are adjustable to a greater or less degree of horizontal inclination, substantially as and for the purpose described.

6. In machines for printing on articles of tapering, cylindroidal, or other irregular curved shape, a tapering printing-roller, in combination with a weighted lever for obtaining an adjustable yielding pressure of the printing-roller against the article to be printed on, constructed and arranged substantially as described.

7. In machines for printing on articles of tapering or cylindroidal shape, a lathe for holding and revolving the article to be printed on, in combination with a tapering revoluble printing-roller having a shaft which is adjustable, substantially as described, to conform the angle of inclination of the printing-surface to that of the surface to be printed on, the shafts of the printing-roller and lathe being connected, so as to revolve at a given relative speed, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 15th day of December, A. D. 1883.

HERMANN SCHULZE-BERGE.

Witnesses:
W. BAKEWELL,
W. B. CORWIN.