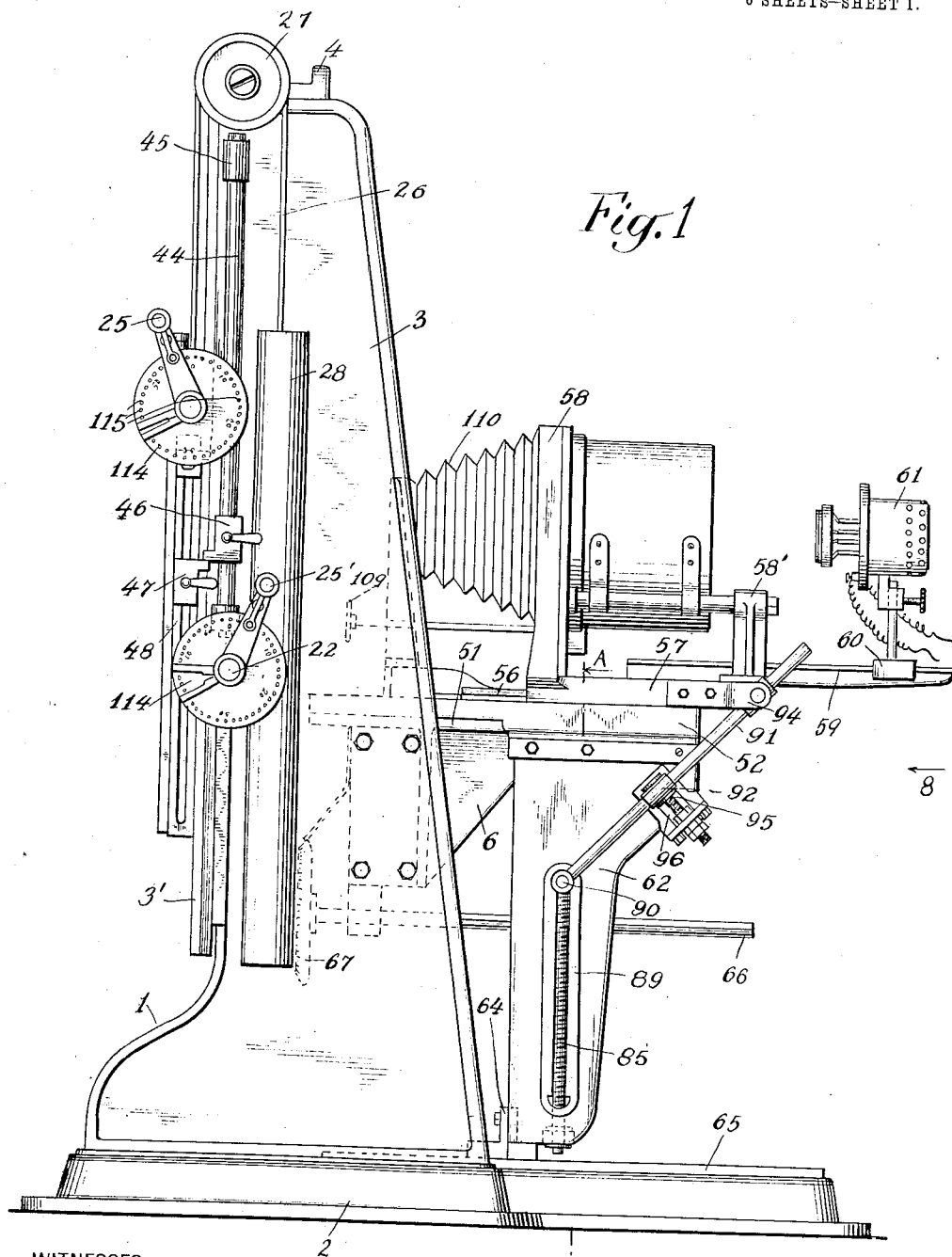


H. M. PILKINGTON.
STEP AND REPEAT MACHINE.
APPLICATION FILED JUNE 14, 1911.

1,131,631.

Patented Mar. 9, 1915.
6 SHEETS—SHEET 1.



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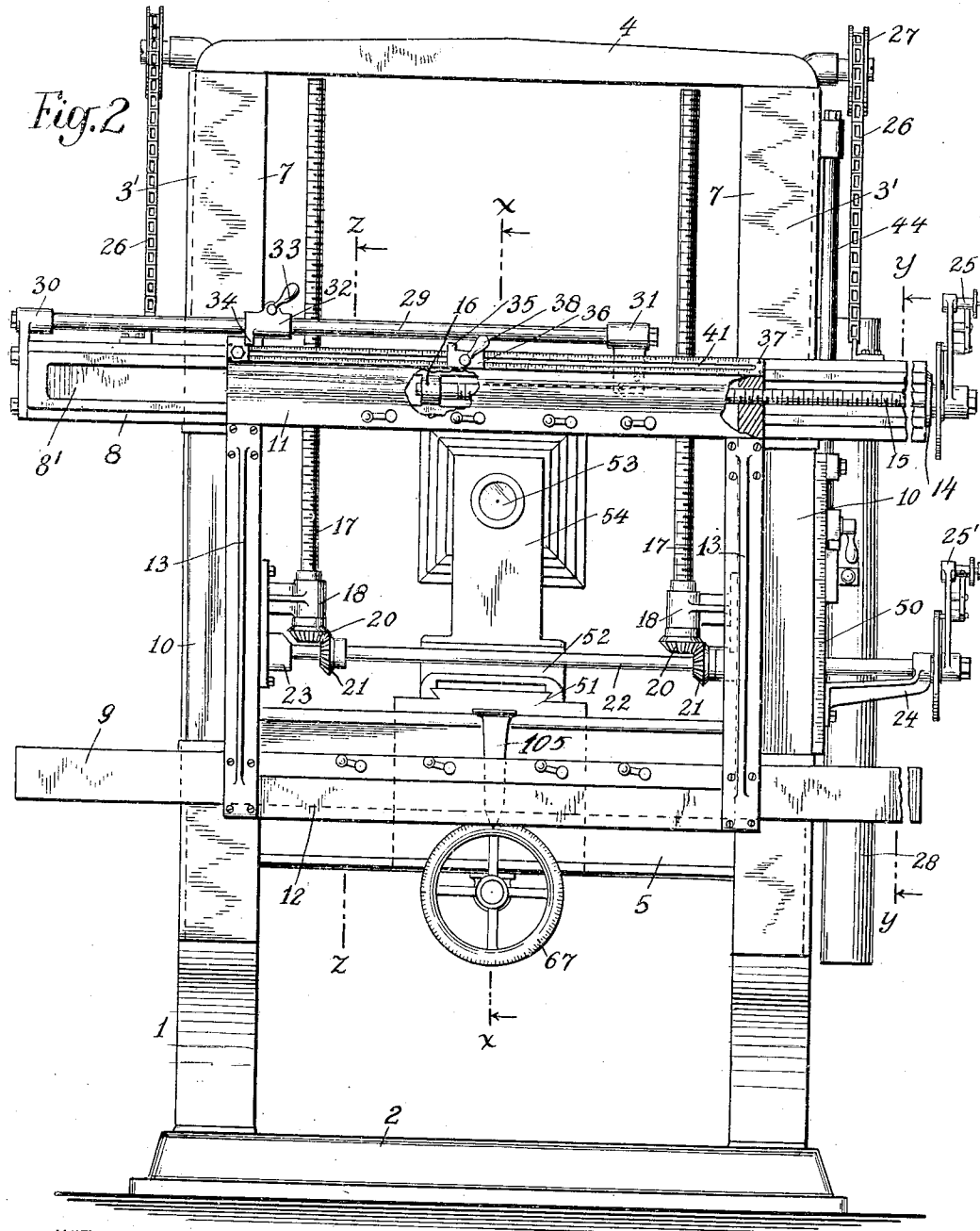
Kempson & Kempson,
his ATTORNEYS

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6 SHEETS—SHEET 2.



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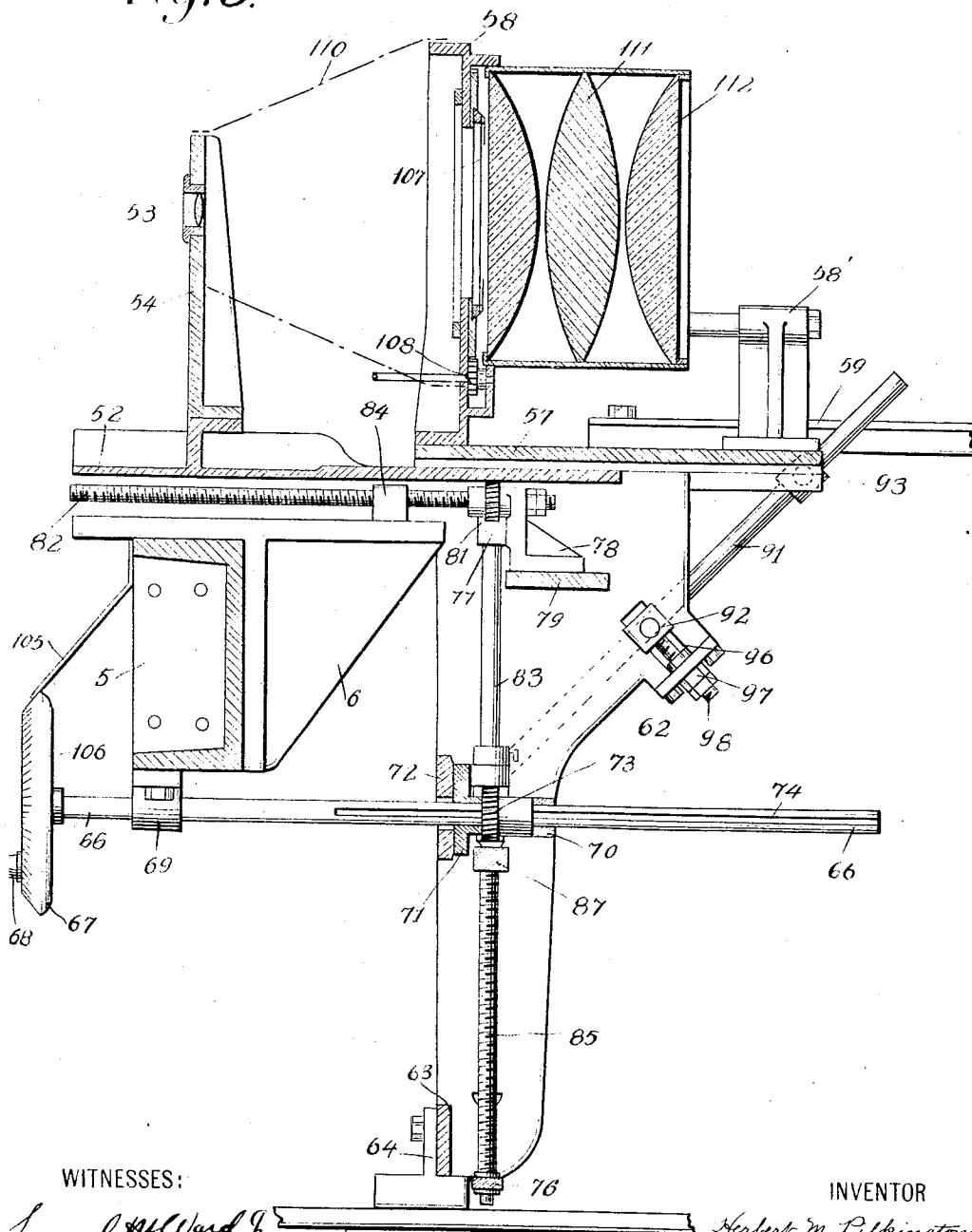
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6 SHEETS SHEET 3

Fig. 3.



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6 SHEETS-SHEET 4.

Fig. 4

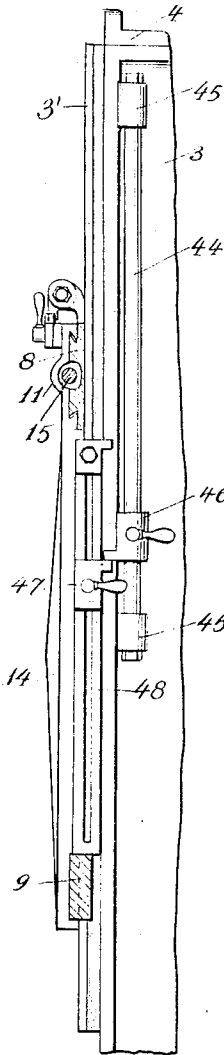


Fig. 5

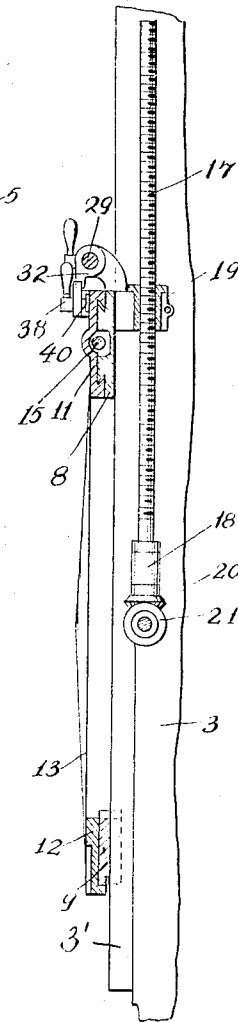


Fig. 7

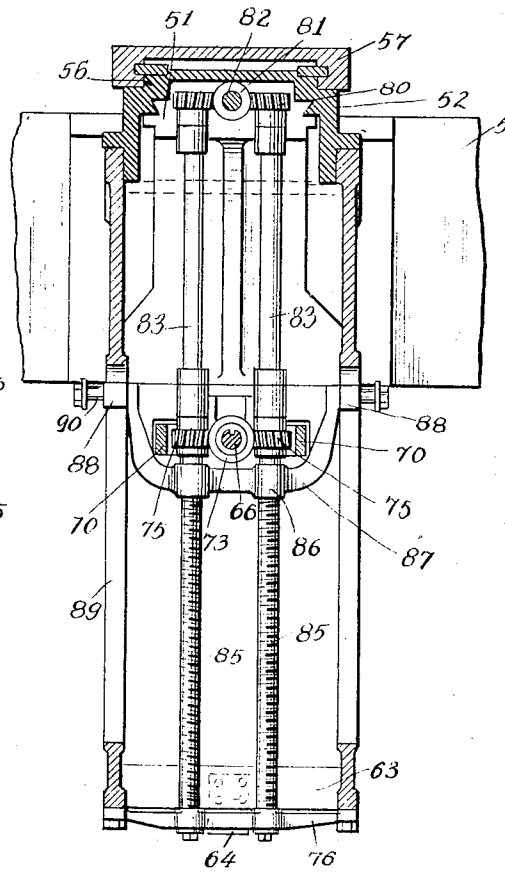
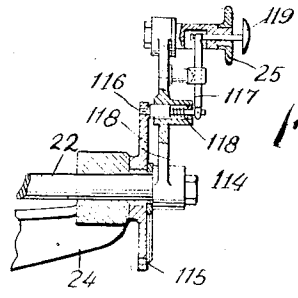


Fig. 6



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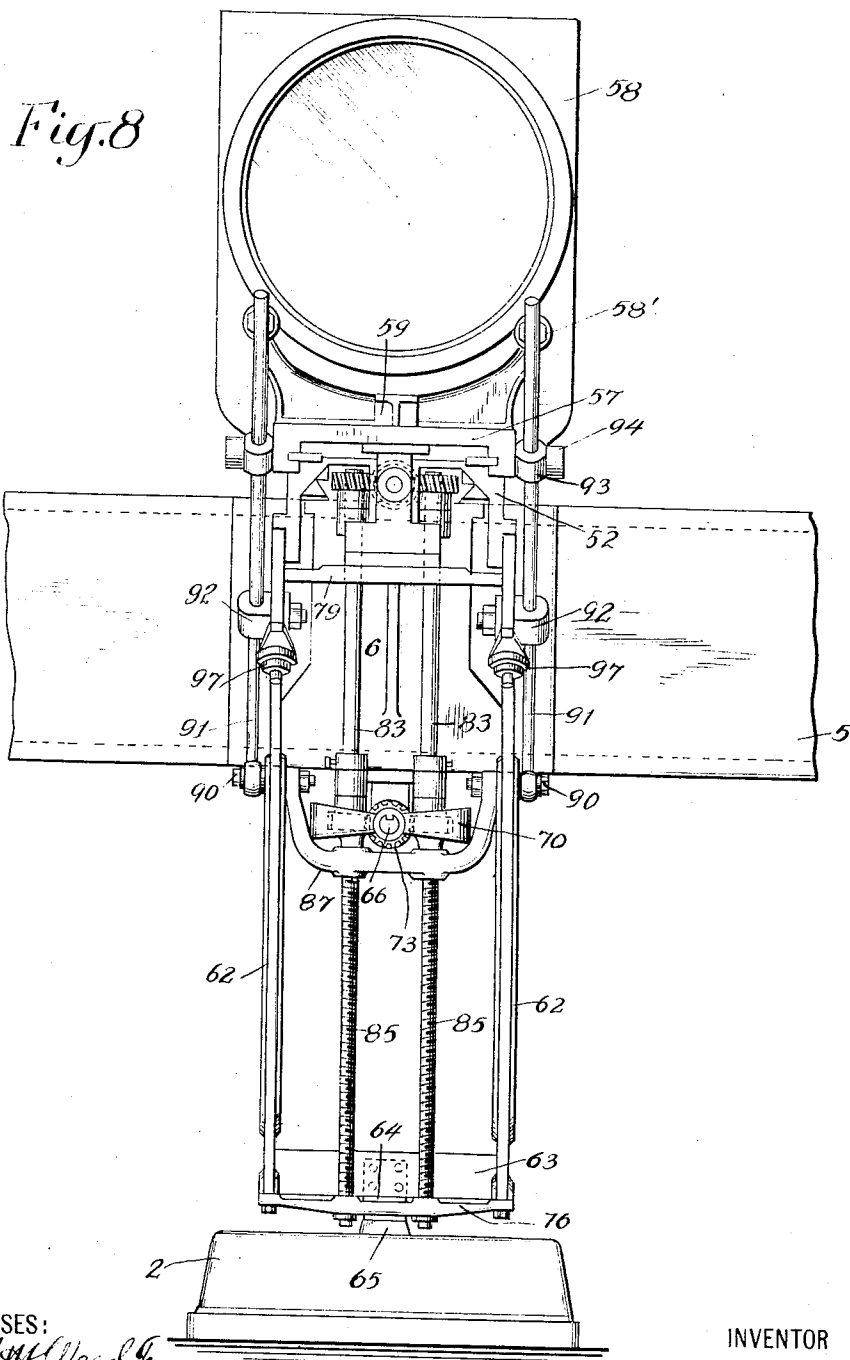
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1,131,631.

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STEP AND REPEAT MACHINE.
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6 SHEETS-SHEET 5.



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STEP AND REPEAT MACHINE.
APPLICATION FILED JUNE 14, 1911

1,131,631.

Patented Mar. 9, 1915.
6 SHEETS—SHEET 6.

Fig. 9.

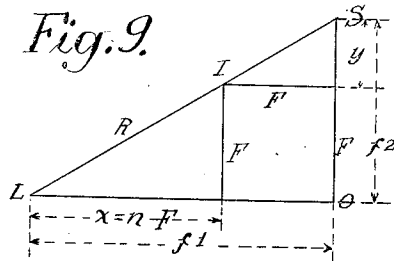


Fig. 10.

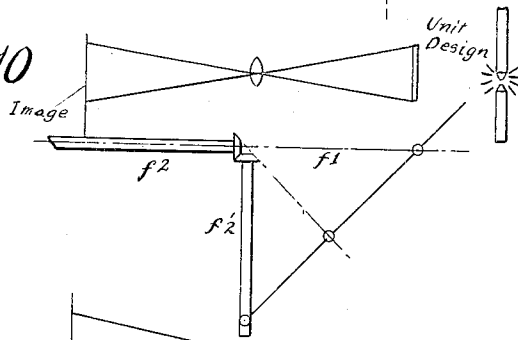
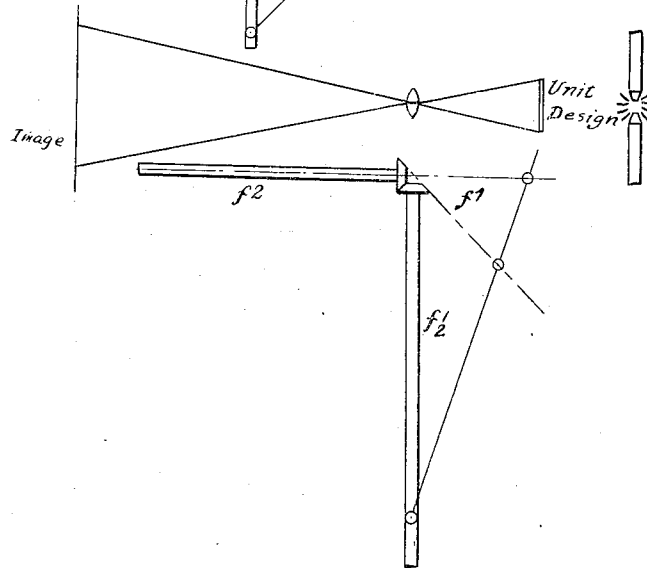


Fig. 11.



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UNITED STATES PATENT OFFICE.

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STEP AND REPEAT MACHINE.

1,131,631.

Specification of Letters Patent.

Patented Mar. 9, 1915.

Application filed June 14, 1911. Serial No. 633,196.

To all whom it may concern:

Be it known that I, HERBERT M. PILKINGTON, a citizen of the United States, and a resident of Arverne, Long Island, county of Queens, and State of New York, have invented a certain new and useful Improvement in Step and Repeat Machines, of which the following is a specification.

My invention relates to step and repeat machines to be used for photographically forming a pattern or design on a sensitized surface from a unit design by successively projecting the image of the unit design through a suitable lens upon successive portions of the sensitized surface so as to produce a design built up of successive images of the unit design of any desired size, or for repeating a design a number of times on different portions of a sensitized surface on which the designs are spaced apart from each other for the purpose of simultaneously making a number of prints from the same plate.

My invention consists in the novel arrangement and construction of step and repeat machines as hereinafter described and claimed.

The object of my invention is to provide a durable and efficient machine of the above type which may be rapidly and accurately operated to build up designs. In this machine the lens and the unit design are simultaneously moved along the line of projection with respect to the sensitized plate so as to vary the size of the image while maintaining the sensitized plate and the unit design always in the conjugate foci of the lens, and the sensitized plate is repeatedly stepped horizontally and vertically transversely to the unit design and the lens without disturbing the previous adjustment of the three elements along the line of projection, the sensitized plate being mounted on a sufficiently stanch and heavy carriage to avoid danger of strain, distortion or lost motion which would affect the delicate adjustment, the carriage being counterbalanced on the main frame so as to be readily moved vertically thereon, and equipped with suitable stops along its lines of movement to limit the distance of its successive movements across the line of projection so that rapid and accurate positioning of the sensitized plate before the lens is obtained.

The successive positioning of an image of

the unit design upon the sensitized plate in building up a design is an exceedingly delicate operation, as in some cases the delicate lines of the intricate configuration of an image must exactly meet and join corresponding lines of similar adjacent images; and even in building up simpler designs, where a plurality of designs for different printing surfaces are to be built up respectively from different parts of a complete unit design as in printing a design requiring more than one color, the registration of the corresponding images on the different plates must be secured in order that the different plates carrying the parts of the complete design in different colors will always register to produce delicate and perfect color effects.

By my new machine successive images of the unit design can be made to register with adjacent ones more readily and accurately and designs more rapidly built up from a unit design than has heretofore been possible.

The sensitized surface upon which the design is formed may be that of a zinc plate or stone which, by subsequent development and etching, may be transformed directly into a printing surface, or the surface may be that of a transparent plate which may be developed, and from which a design may be photographed in a reduced or enlarged size upon a suitable surface which may be etched and then inked and transferred onto a roller which, after being etched, may be used in all kinds of continuous web printing upon textile fabrics, wall paper, etc.

Other features of my invention will be more readily understood by the following description taken in connection with the accompanying drawings, in which—

Figure 1 is a side elevation of a complete machine embodying my invention; Fig. 2 is a front elevation showing the horizontally and vertically adjustable plate carriage and means for operating and adjusting the same; Fig. 3 is a longitudinal section taken on line *x—x* of Fig. 2, showing the means for simultaneously moving the lens and unit design along the line of projection; Fig. 4 is a sectional view taken on line *y—y* of Fig. 2; Fig. 5 is another sectional view taken on line *z—z* of Fig. 2; Fig. 6 is a detail of one of the crank handles for moving the plate carriage; Fig. 7

is a cross sectional view taken on line A—A of Fig. 1, showing the mechanism for moving the slides along the line of projection; Fig. 8 is a rear elevation of the assembled machine looking in the direction of the arrow 8 in Fig. 1; Fig. 9 is a diagrammatic representation of the principle involved in the movement of the lens and object holder along the line of projection so as to maintain the proper focus; and Figs. 10 and 11 illustrate diagrammatically the manner in which the image is reduced or enlarged by the relative adjustment of the sensitized plate holder, lens and object.

Referring to the drawings, Figs. 1 and 2, 1 is a main stationary frame or support mounted on a base 2, the frame consisting of two uprights or side pieces 3 connected at their upper ends by a yoke 4 and also connected intermediate the base and the upper cross piece by means of a channel beam 5 having closed ends bolted to the side frames 3. This channel beam serves to support a bracket 6 on which is mounted the lens sliding frame hereinafter mentioned.

On the front faces of the uprights 3 are bolted smooth vertical guideways 3'—3' on which moves a vertically sliding carriage consisting of upper and lower horizontal bars 8 and 9 which extend across the face of the machine, and project on either side thereof and are connected by end pieces 10. The upper bar 8 has a tongue or guideway 8' formed on its front face along which moves a horizontal sliding carriage consisting of upper and lower cross bars 11 and 12 connected by vertical end pieces 13—13, the sliding engagement being effected by a channel in the upper bar 11 which engages with the tongue or guideway on the bar 8. This horizontally sliding frame is adapted to receive the sensitized plate on which the design or pattern is to be formed. By extending the bars 8 and 9 beyond the uprights 3—3, a much larger plate can be used and moved to extreme position, for a given width of the main frame, thus reducing the weight and cost of the machine. Horizontal movement of this carriage is effected by means of a handle 25 mounted on a threaded shaft 15 which extends in a groove or passage 11' between the adjacent surfaces of the bars 8 and 11. The shaft 15 passes through a threaded nut 121, secured to the rear of the bar 11, and the shaft is journaled at its inner end in a bracket 16 formed in the groove in the front face of bar 8 the shaft at its outer end being journaled in a sleeve or bracket 24 secured to the end of bar 8. The sleeve is provided with a dial plate 114 having suitable markers and a scale hereinafter described, and the shaft is provided with an operating crank handle 25 having a part that moves over the face of the dial, as hereinafter described, to indicate

when the desired angular movements of the shaft have been made. By this means, as the handle 25 is rotated, the horizontally moving carriage is caused to move back and forth along bar 8, depending upon the direction of rotation of handle 25.

Vertical movement of the plate is effected by means of two vertical threaded shafts or screws 17 journaled in brackets 18 secured to the uprights 3, the shafts being provided with threaded nuts 19 (Fig. 5) secured to the rear of the horizontal cross bar 8 of the vertically sliding frame. The lower ends of the vertical shafts 17 are provided with bevel gears 20 meshing with bevel gears 21 on a horizontal shaft 22 journaled in brackets 23, 24' on the main uprights 3, and rotated by means of a crank handle 25', which handle moves over a dial 114' secured to bracket 24' and having suitable indicating mechanism hereinafter described.

In order to overcome the weight of the vertically moving carriage so that it can be readily moved with little effort, thereby decreasing vibration and permitting of more accurate adjustment, the upper cross bar of the vertically sliding frame is connected at each end to a chain 26 passing over rollers 27 journaled at the upper end of the main frame, to the other ends of which chains suitable counterweights 28 are attached, of such weight as to balance the weight of the entire vertically sliding structure. By means of this arrangement the sliding frame can be stepped vertically with much less exertion and strain on the operating mechanism and by much finer gearing and with less jar, thus permitting more ready and accurate positioning of the images projected on the plate.

Each of the dials 114—114' has a graduated scale and suitable markers 120—120' for measuring the desired fractions of a revolution of the different shafts necessary to complete the horizontal and vertical movements of the sensitized plate carriage. The graduation on the dial 114', for example, consists of evenly spaced holes or perforations 115 which are adapted to be engaged by a spring-pressed pin 116 for locking the shaft against rotation, the unlocking of the shaft being effected by pressing upon a knob 119 centered in the handle 25 and operating the pin 116 through a lever 117, the pin being automatically pressed into an adjacent hole by means of spring 118 whenever the operator removes his hand from the knob. By this arrangement, the desired angular movement or fraction of a revolution of the shaft desired may be accurately measured and the shaft may be accurately brought to a stop at the completion of the determined angular movement.

In order to relieve the operator of having to rely entirely upon his head in counting

the number of revolutions necessary to move the plate through each successive step, and to thus expedite the operation of forming the design, I have provided the following feature; A slideway or rod 29 is mounted in brackets 30—31 on the horizontal bar 8, and on this rod is slidingly mounted a stop 32 which may be tightly gripped or loosened on the shaft by means of a handle 33. This stop is provided with a projection 34 to be engaged by a similar projection 35 formed on a stop 36 which is slidingly secured on a graduated strip or bar 37 secured to the upper edge of the upper cross piece 11 of the horizontally moving frame, this stop 36 being also provided with a handle 38 for tightening or loosening it on bar 37. In the particular arrangement shown, the stop 36 is held in engagement with the bar 37 by a projecting head 40 which moves in a slot 41 formed in the graduated bar 37 (Fig. 5). By this arrangement, when it is desired to step the plate holder horizontally along the frame, the stop 36 is set on the bar 37 at a distance from stop 32 equal exactly to the width of the first image which has been projected on the plate and the markers 120 are set apart on the dial at the determined angle corresponding to the fraction of a revolution of the shaft 15 necessary to complete the horizontal step of the plate when (in computing the movement of the plate carriage) a fraction of a revolution is found to be necessary. The handle 25 is then rotated until the stop 36 comes into engagement with the projecting part of the stop 32, when, if it is found, at the end of the movement of the carriage, that the handle has not been moved through the determined fraction of a revolution, as indicated by the registration of the pin 116 with the forward marker, which fraction is necessary to give the exact movement of the carriage, the adjustable stop may be released and the shaft rotated through the remaining fraction; or, if the stop has been set too far in advance, the shaft may be brought back to a position where the pin 116 registers with the hole in alinement with the forward marker. It will thus be seen that the lineally adjustable stops serve as a check on the operator to prevent him from making a mistake of a complete revolution in his computations or in stepping the plate carriage, while the dial, markers and pin provide an accurate means for measuring and indicating the final fraction of a revolution of the shaft. It requires considerable skill on the part of the operator to set the lineally adjustable stops with sufficient precision to accomplish some of the more accurate and finer classes of work which may be done with this type of step and repeat machine; so that it has been found in practice that in doing the finer classes of work it is imper-

tant to have the dial and markers in combination with the linear stops to serve as a check in the setting of the stops; while, on the other hand, the linear stops serve as a check on the operator in computing and in counting the complete revolutions of the shaft. By thus checking the operator in his counting and calculations, he is relieved of considerable responsibility and can thus operate the machine with much greater rapidity than he could otherwise do.

If desired, instead of using the stops as a check on the operator for each individual step movement of the carriage the stops may be used as a means of determining the starting or initial position of the carriage by simply leaving the stops, after they have been brought into engagement with each other, clamped in their respective positions on their slideways, so that in the event that the operator should become confused in counting the necessary number of revolutions in any single step during the movements of the carriage, he may rotate the handle backward until the stops again engage each other, whereupon he will know that the carriage has been brought to its initial position, and then by simply counting the number of revolutions for each step multiplied by the number of exposures which he has made, he will know that the carriage is in position for the next exposure. After this exposure is made, stop 36 is again moved along the graduated bar 37 away from the stop 32 the exact previously measured distance, and the handle 25 is again rotated until the stops engage with each other, and a third projection is made, and so on. A similar arrangement is provided for measuring the successive movements of the plate holder vertically; a vertical slideway or rod 44 being journaled in brackets 45 (Figs. 1 and 2) on which rod a sliding stop 46 is mounted, this stop engaging with a similar stop 47 slidingly mounted in a slotted vertical strip or bar 48 bolted to the end piece 10 of the vertically moving carriage, the slotted strip being graduated on its front edge 50. The operation and adjustment of this mechanism is similar to that just described in connection with the step measuring apparatus for the horizontally moving carriage.

The mechanism for supporting the lens and unit design consists of a slideway or track 51 formed on the upper face of the bracket 6, at the rear of the main frame on which is mounted a sliding frame or carriage 52 carrying a lens 53 mounted in a lens holder 54, and this carriage 52 is provided on its upper surface with a track or guideway 56 on which is slidingly mounted a second frame or slide 57 carrying an object holder 58 in which is placed the unit design to be projected. The rear end of this

slide 57 is also provided with vertical brackets 58 supporting a suitable frame 58 containing condensing lenses 111—112; and on the extreme rear end of this slide there is bolted an extension 59 on which is slid-
 5 ingly mounted a stand or support 60 carrying a suitable lamp 61.

The first sliding side frame or carriage 52 has two depending side pieces 62 connected at
 10 their lower extremities by a cross piece 63 (Figs. 1 and 7) to which is adjustably bolted a shoe 64 moving back and forth on a guideway or track 65 formed on the upper surface of the rear extension of the
 15 main base 2.

In order to move the slides 52, 57 along the line of projection so as to vary the relative positions of the object holder and lens with respect to the plate, for adjusting the
 20 size of the image projected on the plate, I have adopted the following mechanism; A shaft 66 having a hand wheel 67 is supported at its front end in a bracket 69 secured to the channel bar 5, and is journaled
 25 in a yoke 70 mounted on a bracket 71 (Fig. 3) which in turn is secured to a cross piece 72 connecting the depending side pieces 62. The shaft 66 is provided with a spiral gear 73 having a feather engaging a longitudinal
 30 groove 74 formed in the shaft. This gear 73 in turn meshes with spiral gears 75 mounted on vertical shafts 83. The lower ends of the vertical shafts are steadied in a bracket 76, and their upper ends are jour-
 35 naled in bearings 77 extending from a bracket 78 secured to a horizontal web or cross piece 79 connecting the side members 62. Each shaft carries at its upper end a spiral gear 80 which meshes with a spiral
 40 gear 81 keyed on a horizontal screw spindle 82 which is journaled at its rear end in the bracket 78, and held from longitudinal movement thereon by lock nuts so as to insure meshing of the gear 81 with the gears
 45 80. The screw thread of the spindle 82 engages with a nut 84 rigidly secured to the main bracket 6, so that through the medium of the above-described mechanism, the sliding frame 52 is moved back and forth when
 50 the shaft 66 is rotated by handle 68.

The parts of the vertical shafts 83 extending below the bracket 71 (Fig. 3) are provided with screw threads 85 corresponding to the thread on the screw spindle 82. A
 55 yoke 87 (Fig. 7) is provided, having threaded nuts engaging with the threads 85 on the vertical shafts, so that when handle 68 is rotated the yoke is raised or lowered simultaneously with the movement of frame
 60 52 and at the same rate as the frame is moved. The yoke 87 carries at its upper extremities slide blocks 88 (Fig. 7) which are adapted to slide up and down in guide-
 65 ways 89 formed in the side pieces 62; and on the outside of each slide block there is

a pivot pin 90 on which there is pivotally mounted a slide rod 91 (Fig. 8). These sliding rods 91 pass through swiveled guide-
 ways or sleeves 92 swiveled on slide blocks 95, and are connected at their upper ends to
 70 pivoted guides 93 secured in brackets 94 at the rear end of the object supporting slide 57. The slide blocks 95 on which are mounted the fulcrum guides or sleeves 92 are ad-
 75 justed in slots 96 by means of nuts 97 on screws 98. The slide blocks 95 do not slide in the slots during the operation of the machine, but said adjustment is for the purpose of primarily establishing the relation
 80 between the lens carrying slide 52 and the slide 57 carrying unit design, thereby securing the necessary sharpness of the image projected on the sensitized plate. When this adjustment is once made for any particu-
 85 lar lens, the slide blocks 95 then remain fixed in position and the rods 91 slide through the guideways or sleeves 92 which are pivoted on the guide blocks 95 at a fixed point in the slots 96, the fixed position being
 90 obtained by adjusting the nuts 97 on the screws 98. This pivot or fulcrum point for a given lens will be at the intersection of two lines, one parallel to the line of move-
 95 ment of the connection of the sliding lever to the slide 57 which it moves, and at the focal distance of the lens from said line, the other line being parallel to the line of movement of the point of connection of
 100 said lever to the threaded shaft, or, in this case, parallel to the slot 89 along which the other end of the lever slides, and at the focal distance of the lens from said line or slot. This slot 96 along which the fulcrum point is adjusted should extend along a line pass-
 105 ing through the point of intersection of these two lines, for different lenses. Such a line will bisect the angle formed between the slot 89 and the path of movement of the end of the lever connected to the sliding
 110 frame 57, and in the particular machine described, the slot 96 along which the fulcrum point is adjusted will be at an angle of 45 degrees to the vertical slot 89.

When the shaft 66 is rotated to give a downward movement to the yoke 87 the
 115 ends of the yoke draw down with them the sliding rods 91 which, as they move down, change their angle of inclination, and the upper ends being thrown forward, move the slide 57 forward toward the sensitized
 120 plate.

The mechanism is so proportioned that the slides 52 and 57 are simultaneously moved by the rotation of the handle 68, and their respective rates of movement are
 125 such as to decrease or increase the distance of the object holder from the lens so as to vary the size of the image on the sensitized plate while maintaining the relative positions of the lens and object holder with re-
 130

spect to the sensitized plate such as to always maintain the sensitized plate and the object holder in the conjugate foci of the lens. This is shown diagrammatically in Figs. 10 and 11. In Fig. 10, the lens is shown equidistant between the object or unit design and the image, so that the size of the image is equal to that of the unit design. In Fig. 11, the changed positions of the unit design and the lens produce an image three times the linear dimensions of the unit design.

Fig. 9 illustrates the principle involved in the focusing movement; and in this figure, the sides F of the square are equal to the focus of the lens used. Extending two sides OL and OS until they intersect any line R swung through the intersection I of the two opposite sides of the square F , the lengths

$$LO=f',$$

and

$$OS=f'',$$

will be to each other as

$$F(n+1)$$

is to

$$F(1+\frac{1}{n})$$

and are thus equal to the conjugate foci of the lens F for an object distance f' , and the image distance f'' . Let

$$f''-F=Y$$

and

$$f'-F=X$$

and

$$X=nF$$

then

$$X:F=F:Y$$

$$nF:F=F:Y$$

$$Y=\frac{F}{n} \text{ and } f''=F+\frac{F}{n}=F(1+\frac{1}{n})$$

$$X=nF \text{ and } f'=nF+F=F(n+1)$$

Q. E. D.

The diagram of Fig. 9 demonstrates the distances f' and f'' in directions at right angles to each other whereas in actual practice, they are mostly needed in a continued straight line.

Figs. 10 and 11 show how by gearing a rod representing the length f'' , to a vertical rod f' , to which the same movement is imparted in a vertical plane, the length f' is obtained in the horizontal continuation of f'' .

With such a machine as described, when it is desired to enlarge the image on the sensitized plate the shaft 66 is rotated in a

direction to move the lens away from the sensitized plate, and at the same time, through the mechanism described, the rods 91 are drawn down and the object slide 57 is thereby moved upon the lens slide 52 toward the lens but at less speed than the lens is moving away from the sensitized plate holder, so that the distance between the sensitized plate and the lens is increased and the distance between the lens and the object holder decreased, thereby enlarging the image on the sensitized plate while maintaining the focus by the arrangement of the gearing described. Conversely, if it is desired to reduce the image upon the sensitized plate, the shaft 66 is rotated in the opposite direction to move the carriages 52 toward the sensitized plate, the object slide 57 at the same time moving away from the lens.

The hand wheel 67 mounted on shaft 66 has a graduated rim or other portion, adjacent to which is mounted on a suitable part of the frame of the machine, a pointer or index finger 105, beneath which finger the rim is rotated. By this means, when an image of an object is once adjusted on the focusing screen to the desired size for certain work, the reading of the rim 67 is noted, and should the wheel be moved out of position for any reason, or should it be desired at some subsequent time to reproduce the same pattern or design, if the object holder and other apparatus is accurately formed, it will only be necessary to set the graduated wheel at the previous reading and then proceed with the photographing without experimenting to determine the position of the sliding frames for the desired size of image.

In the particular embodiment of the machine shown, the sliding rods 91 are so related to the vertical slot 89 and the lens and sliding frames 52 and 57 are so positioned with respect to the sensitized plate that the transformation of the unit design is approximately unity when the sliding rods 91 are in the position shown, namely, with their lower ends near the upper extremity of the slot 89.

The operation of the machine will be best understood from the following description: A photographic reproduction of the unit design is placed in an annular rotating ring 107 located in the frame 58, and the unit design is adjusted in any suitable position by means of the handle 109 which rotates the ring 107 through pinion 108. When the unit design is in the proper position in its plane, a focusing screen is placed in the sensitized plate holder on the horizontally moving carriage and the sliding carriages on the front of the frame are then operated in the manner described to shift the focusing screen so as to bring the image in a suitable

position thereon, say in the extreme lower left-hand corner. The shaft 66 is then rotated to adjust the image of the unit design upon the focusing screen to the desired size, maintaining at all times a sharp focus of the image on the screen, and the reading of the graduated rim 67 is then noted. When the image is adjusted to the proper size, the image with suitable registration marks is then projected upon it. Stop 32 is then set on the rod 29 and stop 36 is moved along the graduated strip 37 away from the stop 32, a distance equal to the width of the projected image, and the stop 36 is then securely clamped on the graduated scale and the screw 15 rotated to move the carriage horizontally until the stops engage with each other, at which position it will be found that the adjacent lines of the second image when projected on the sensitized plate, will exactly register with corresponding lines of the previously projected image. When this image is projected, the stop 36 is again moved along on the slide 37 and gripped in position, and the horizontal carriage again moved and a third image projected, and so on. When a complete horizontal row of the images is thus formed, the sensitized plate is then moved vertically the height of the projected image, by the rotation of handle 25', the vertical movement being determined by the stops 46 and 47 in the manner described, with relation to the stops 32 and 36 of the horizontally moving carriage, and then a second horizontal row of images is projected as previously described. Or, if desired, a vertical row of images may be completed and then the carriage may be stepped horizontally the width of an image, and so on. In some cases where the design is of a nature which requires such operation, the images may be formed in diagonal lines across the sensitized plate by moving the plate one step horizontally and then a step vertically for the projection of each image.

Where it is desired to print a design having two or more colors, a reproduction of the unit or parts of the unit is made for each color, and a design is formed on a separate plate from each of such units, the completed design on the plates being identical in size and position and consisting respectively, only of that part of the unit design which is to be printed in the particular color desired, so that when the plates are used with their respective colors, the parts of the design on the different plates will exactly register in printing. For instance, if a design is to be printed in two colors, say pink and green, a sensitized plate will be prepared showing consecutive units of the parts of the design to be printed in pink, and another plate will be prepared with the units of the parts of the design to be printed in green. From

these plates, a printing surface for each color would be prepared, and as the respective designs are made from the identical size units projected in identically the same manner to occupy identical positions on the plates, the finished printing surfaces will necessarily register perfectly with each other.

It will be seen that I have provided a machine sufficiently staunch and durable to prevent any distortion or strain on the parts, thus insuring accurate registration at all times, and at the same time, I have so arranged and constructed the parts that the vertical and horizontal adjustment of the sensitized plate may be rapidly accomplished.

While I have described my invention with particularity in connection with the particular machine shown, and in connection with its operation in building up completed designs from unit designs, since this is one of the most exacting requirements of such a machine, yet it will be observed that the machine may be put to other uses, such as suitably spacing upon the same wet or dry plate one or more reproductions of one, or two or more different designs or pictures; and I do not wish to be understood as limiting my invention other than as set forth in the appended claims.

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

1. In a machine of the character described, the combination of a supporting frame, a sliding carriage having means for holding a sensitized plate and mounted on said frame in a plane transverse to the optical axis, means for moving the carriage horizontally in said plane, means for moving the carriage vertically in said plane, relatively adjustable stops for limiting the distance of successive movements of the carriage along its horizontal line of movement or for determining the starting or initial position of the carriage after it has been shifted, and relatively adjustable stops for limiting the distance of successive movements of the carriage along its vertical line of movement or for determining the starting or initial position of the carriage after it has been shifted, one stop of each set being respectively mounted along the lines of movement of the carriage and the other stop of each set being mounted respectively to move with the carriage along its respective lines of movement.

2. In a machine of the character described, the combination of a supporting frame, a sliding carriage having means for holding a sensitized plate and mounted on said frame in a plane transverse to the optical axis, means for moving the carriage on its support in said plane, and two relatively

adjustable stops one mounted on the frame and the other mounted on the carriage in position to engage the first stop to limit the distance of successive movements of the carriage or to determine the starting or initial position of the carriage after it has been shifted, one of the parts on which the stops are mounted being provided with a graduated scale along which the adjustable stop is movable and by which its settings are indicated.

3. In a machine of the character described, the combination of a main supporting frame, a vertically movable supporting carriage consisting of two cross pieces connected by vertical members, one of said cross pieces being provided with a guideway, vertical guideways on the main frame on which said carriage is adapted to move, a horizontally moving carriage mounted on the guideway of the first carriage and having means for holding a sensitized plate, a slideway on one

of the cross pieces of the first carriage, and a stop adjustably mounted thereon, a slideway on the second carriage adjacent said stop, and a second stop slidably mounted on said slideway, each of said stops being provided with means for gripping it in position, a vertical slideway on the main frame having a stop adjustably mounted thereon, a slideway on one of the vertical members of the first carriage adjacent the last stop, and a stop slidably mounted thereon to engage said last stop, and means including vertical and horizontal screws for moving said carriage in their planes.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

HERBERT M. PILKINGTON.

Witnesses:

SAMUEL H. WARD, JR.,
H. B. YOUNKIN.