

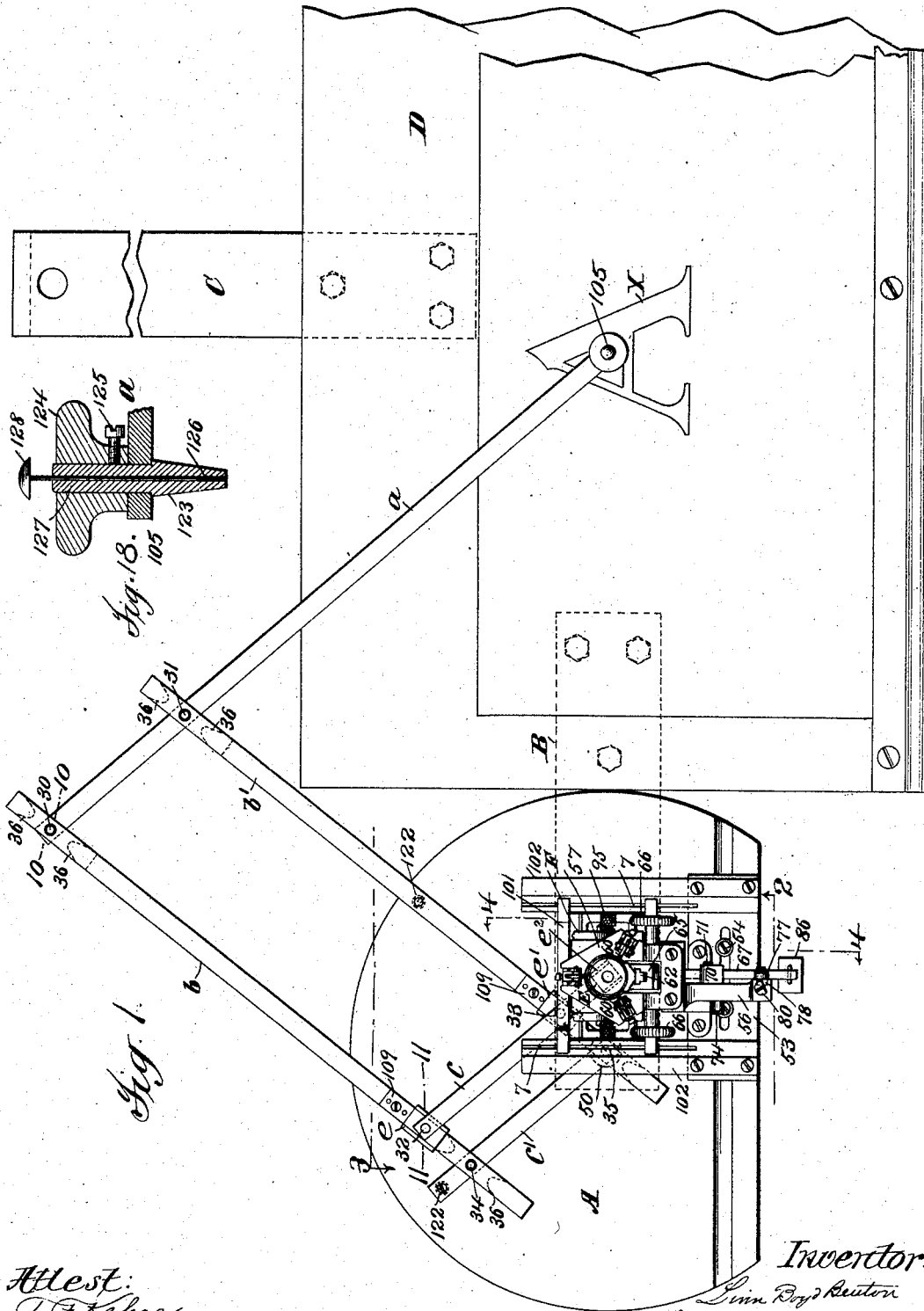
No. 790,172.

PATENTED MAY 16, 1905.

L. B. BENTON.
TRACING APPARATUS.

APPLICATION FILED JULY 21, 1899.

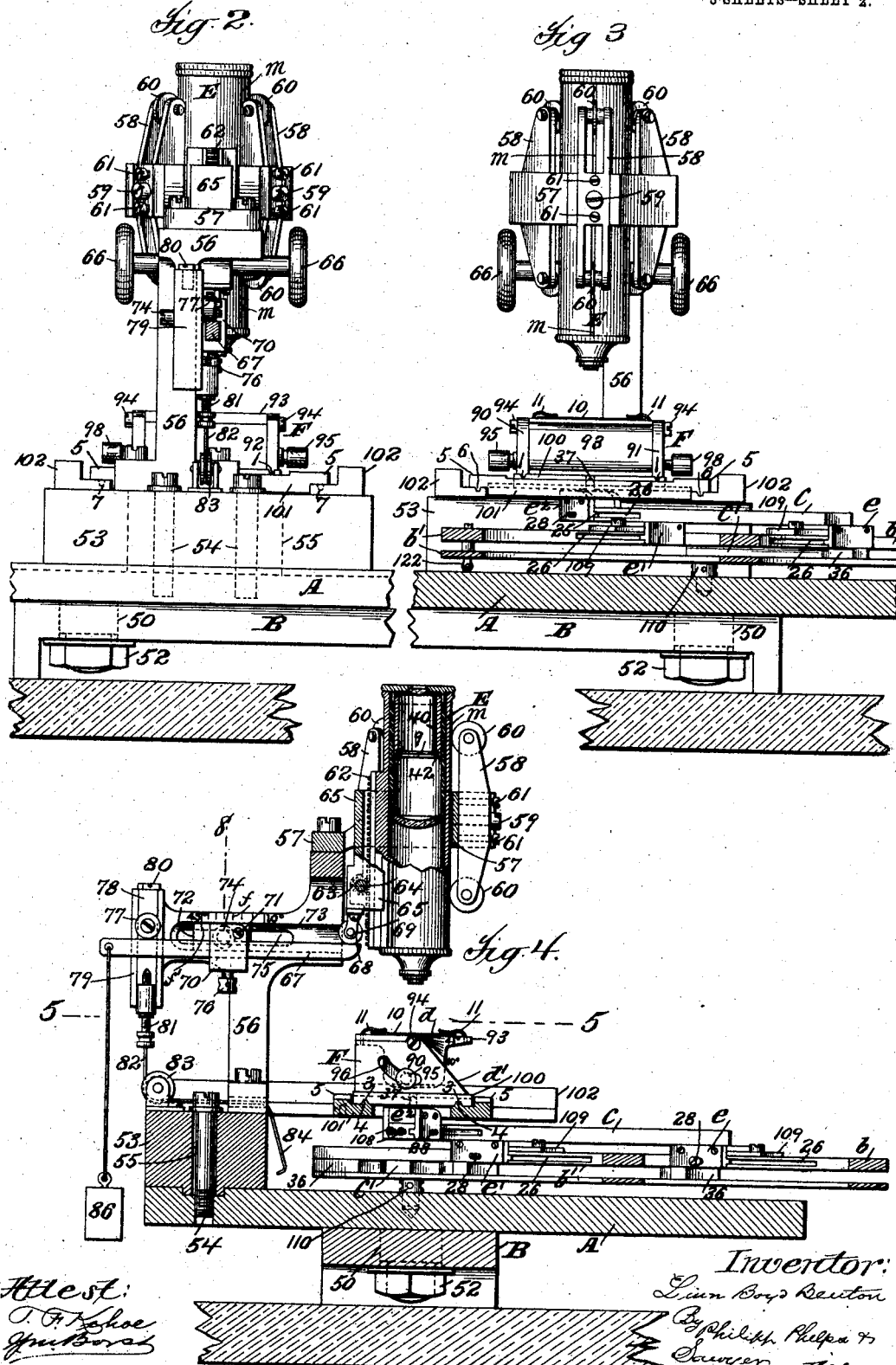
3 SHEETS—SHEET 1.



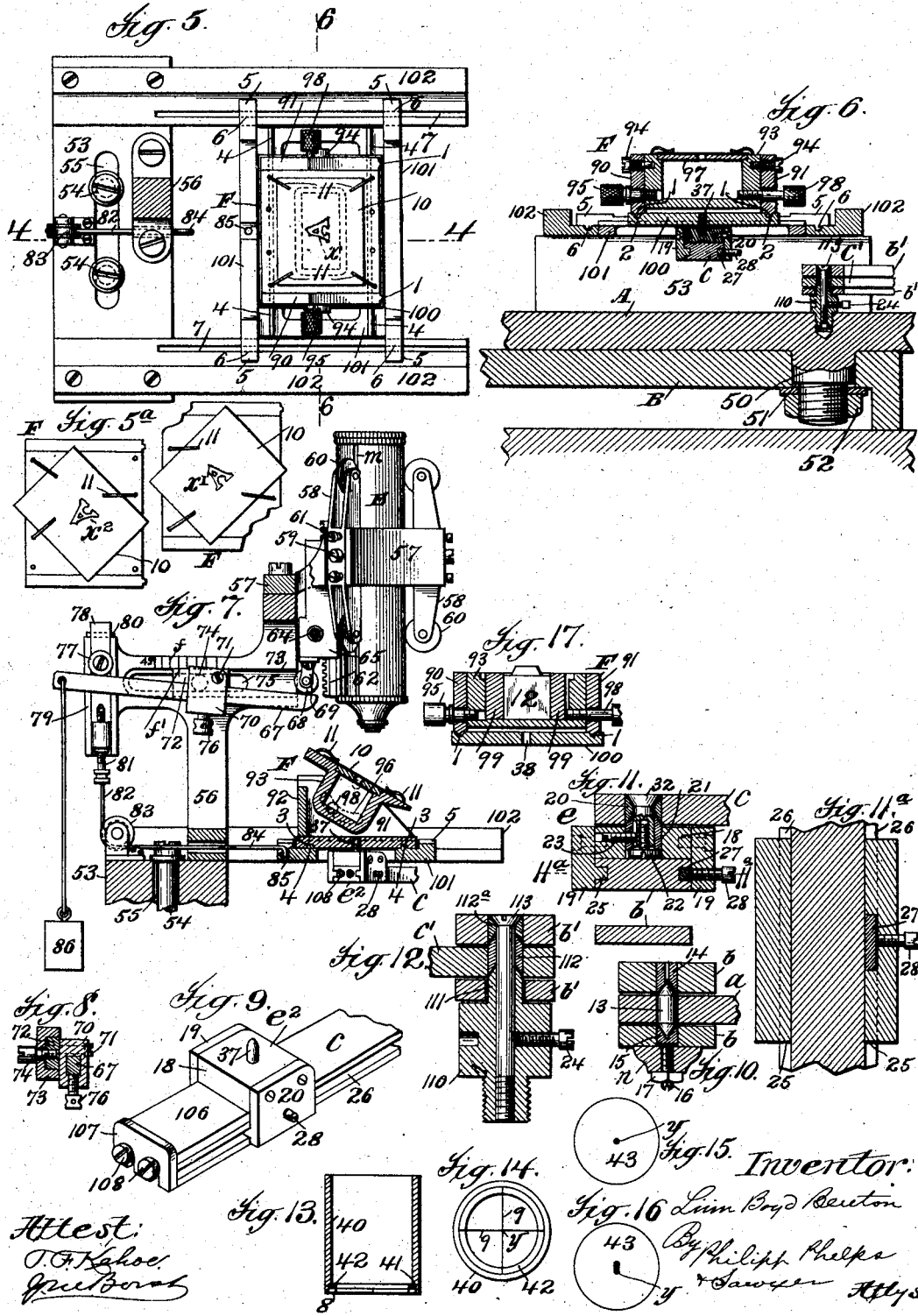
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UNITED STATES PATENT OFFICE.

LINN BOYD BENTON, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TYPE FOUNDERS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

TRACING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 790,172, dated May 16, 1905.

Application filed July 21, 1899. Serial No. 724,584.

To all whom it may concern:

Be it known that I, LINN BOYD BENTON, a citizen of the United States, residing at New York city, county of Richmond, and State of New York, have invented certain new and useful Improvements in Tracing Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The general class of apparatus to which the present invention relates includes various forms of apparatus—such as drawing apparatus, engraving-machines, and the like—in which a pattern of some form is traced either by moving the tracer over the pattern or the pattern over the tracer and the universal tracing movement of the tracer or pattern transmitted through suitable connections, such as a pantograph, to a marking or cutting tool of some form acting on a blank or to the blank itself, so as to reproduce the pattern upon the blank by the movement of the tool or blank, the pattern being either increased or diminished in size in reproduction or otherwise changed by varying the tracing movement in transmission. I aim especially, however, at the production of a simple and efficient apparatus of this general class by which enlarged type or type-bar patterns may be reproduced from a small design, such as a print of a type or type-bar or from the type or type-bar itself, or from a similar small drawing or engraving, my particular object being to provide an apparatus for producing such enlarged patterns suitable for use in a machine for cutting type punches or dies.

Certain features of the invention may be embodied in an apparatus capable only of reproducing a pattern with all lines of the reproduction parallel with those of the pattern and increased in dimension in the same proportion, but the invention includes also certain novel features by which an improved tracing apparatus is provided capable by simple and convenient adjustments of varying the direction of the lines of the reproduction relatively to the pattern so as to reproduce a

pattern with the lines inclined in either direction relatively to the pattern, and one of the components of the tracing movement may be varied independently of the other, so as to vary one dimension of the reproduction independently of the other.

For a full understanding of the invention a detailed description of an apparatus embodying all the features of the same as applied in their preferred form in connection with the production of enlarged type-patterns will now be given in connection with the accompanying drawings, forming a part of this specification, and the features forming the invention will then be specifically pointed out in the claims.

Figure 1 is a plan view of the complete tracing apparatus. Fig. 2 is a rear view of the microscope and pattern-supporting table on a larger scale, the view being taken on the line 2 of Fig. 1. Fig. 3 is a front elevation of the same on the line 3 of Fig. 1. Fig. 4 is a cross-section on the line 4 of Figs. 1 and 5, showing the microscope in partial section. Fig. 5 is a horizontal section showing the pattern-table in plan, the view being taken on the line 5 of Fig. 4; and Fig. 5^a shows the pattern turned for oblique distorted reproductions. Fig. 6 is a cross-section of the same on the line 6 of Fig. 5. Fig. 7 is a view similar to Fig. 4, the pattern-table being shown inclined or in position for reducing the vertical dimensions of a letter. Fig. 8 is a sectional detail on the line 8 of Fig. 4, showing the construction of the fulcrum for the lever by which the microscope is adjusted by the pattern-table. Fig. 9 is a perspective detail showing the means for adjusting the point by which the pantograph engages the pattern-table. Figs. 10 and 11 are sectional details of the pivots of the pantograph-arms, the sections being taken on respectively the lines 10 and 11 of Fig. 1. Fig. 11^a is a horizontal section on the line 11^a of Fig. 11. Fig. 12 is a vertical section of the fixed pivot of the pantograph on a larger scale than Fig. 6. Fig. 13 is a detail section of the sleeve which car-

ries the microscope-tracer with a crossed wire-tracer. Fig. 14 is a bottom plan view of the same. Fig. 15 shows a modified form of tracer. Fig. 16 shows an oblong tracer. Fig. 17 is a detail showing the pattern-holder in section with a type for reproduction. Fig. 18 is a detail section of a reproducing-marker.

Referring now to the drawings, A is a table supported and adapted to be rotated in a horizontal plane on one or the other of two brackets B C, secured to a table D, upon which is held a sheet of paper or other material on which the pattern is to be reproduced. The table A is secured to the bracket B, as shown in Fig. 1, by a depending screw-threaded stud 50, formed on its lower face, which enters an opening 51 in the end of the bracket B and is secured thereto by a nut 52. It will be understood that the tables A and D are in turn supported by a table or in any other convenient manner.

The tracing-microscope E is mounted on the table A in the following manner: A block 53 is adjustably secured to the table A by bolts 54, which pass through slot 55, formed in the block 53, and enter screw-threaded openings in the table A. On the block 53 is supported a bracket 56, having two arms at its upper end, one of which has secured to it a second bracket 57, which surrounds the microscope E. The bracket 57 carries three vertical arms 58, which are secured to the bracket 57 by screws 59. The upper and lower ends of the arms 58 carry narrow rolls 60, which bear against the microscope-cylinder, this allowing the microscope to slide up and down easily.

These rolls 60 run in grooves *m* in the microscope, which fit the rolls closely, so as to keep the microscope from turning. The rolls 60 are adjusted to and from the microscope by adjusting-screws 61, so that just the desired pressure at opposite ends of the arms may be secured. The microscope may be moved up and down to get the proper focus, as usual, by means of a rack 62, secured to the microscope and engaging a pinion 63, carried by a shaft 64, mounted in a block 65, in which the microscope is frictionally held, the shaft being provided with the usual thumb-pieces 66.

When the pattern is in the horizontal position shown in Fig. 4, the block 65 will be held stationary at the proper point by means of a lever 67, the inner end of which engages a roll 68, mounted in bracket 69, secured to the block 65. The lever 67 is carried by a block 70, fulcrumed by screw 71 to an adjustable block 72, which is moved as required in a guideway 73 in the other arm of bracket 56 and secured in position on the bracket 56 by a locking-screw 74, which passes through a slot 75, formed in the bracket 56, and the block 70 is made fast to the lever 67 by a set-screw 76. (See Fig. 8.) The outer end of the lever 67 bears against the under side of a roll 77, carried by a slide 78, which at certain times is

adapted to be moved vertically in a guideway 79, formed in the outer end of the bracket 56. The slide 78 is held against upward movement by a screw-head 80, which turns in the top of the guideway 79 and may be adjusted to overlap the upper end of the slide 78, and thus hold the microscope in position, except as it is adjusted by the thumb-pieces 66. The head 80 has a cut-away portion which when it has been brought to register with the slide 78 allows said slide to move vertically. The outer end of the lever 67 carries a counterbalance-weight 86, and the lower end of the slide 78 carries a headed screw 81, to which is attached one end of a cord or wire 82, running over a pulley 83, the other end of the cord 82 being formed with a hook 84 for connection to the pattern-carrier when the lever is to be actuated thereby. The block 65 may thus be held stationary or may be moved up and down by the pattern-carrier, and its movement relatively to the pattern-carrier may be adjusted by adjusting the fulcrum of the lever 67, for purposes presently to be described.

The pattern-carrier F is box-like in form and consists of two sides 90 91 and a back 92, the front portion being open to allow a table 93, on which the pattern lies, to be swung vertically between the sides 90 91, so as to place the pattern at different inclines to the horizontal. The swinging table 93 is pivoted to the sides 90 91 by screw-pivots 94 and has on one side a locking-screw 95, which runs in a curved slot 96, formed in the side 90 of the carrier F, so that the table may be locked in different inclined positions by the screw 95. The swinging table 93 is preferably hollow, as shown, so as to hold a type when desired, but for a pattern drawing or print has a cover 97, upon which is placed the card or paper bearing the pattern to be reproduced. This card or paper is held firmly in its proper position on the table by spring-clips 11. The side of the table adjacent the other side 91 of the carrier F is provided with a set-screw 98, so that a type or type-bar 12 may be placed in the hollow portion of the table 93 by removing the cover 97, as shown in Fig. 17. If the type or type-bar is small, blocks 99 will be placed against its sides and the locking-screw 98 turned in until the type or type-bar is locked in position. The screw 98 passes through a curved slot in wall 91, this slot and slot 96 being formed on arcs struck from the pivots 94 as centers, so that the screws 95 98 move in these slots as the swinging table 93 is adjusted.

The pattern-carrier F, with table 93, is mounted for movement under the microscope by the pantograph in the following manner: Each of the lower edges of the plates 90 91 of the carrier F is provided with ribs 1, which enter grooves 2, formed in the upper surface of a plate 100, these ribs and grooves being at right angles to the base-line of the pattern, so

that the proper position of the base-line of the pattern relatively to the microscope may be adjusted in setting the machine by moving the pattern-carrier under the microscope
 5 along these grooves, and the ribs and grooves assure the parallel position of the pattern-carrier relatively to the table 100 when it is removed and replaced. The pattern-carrier is held in adjusted position by its own weight;
 10 but holding means may be used, if desired. The plate 100 is rectangular in form and on its lower surface is provided with another pair of grooves 3, the grooves 3 running on ribs 4, formed on a plate 101. The plate 101 is also
 15 rectangular and has at each of its four corners, as shown in Fig. 5, lugs 5, which have formed on their lower faces ribs 6, running in grooves 7, formed in each of two stationary supporting bars or rails 102 102, which are secured to the block 53. The ribs 4 and grooves 7 extend at right angles to each other, and the plates 100 and 101 form a carriage which supports the pattern-carrier F. It will be seen from the drawings that the carrier thus supported may be moved horizontally under the
 25 microscope in any direction.

Referring now to the pantograph connections for moving the pattern-carrier and reproducing the tracing of the pattern, the
 30 reproducing tool or follower is formed by a pencil or other tool 105, which is carried by one end of pantograph-arm *a*. Two arms *b* *b'* are pivoted to the other end of the arm *a* at the pivots 30 31, the arms *b* *b'* being pivoted at their inner ends to two arms *c* *c'* at the points 32 33 34 35. Each of the arms *b* *b'* is composed of two strips of metal secured together at their ends by blocks 36. The pivot 35 is the point at which the pantograph
 40 is pivoted to the table A and is directly above and in line with the stud 50 of the table, so that the table may be rotated concentrically with the movement of the pantograph-arm *b'*. The inner end of the arm *c* carries an adjustable block, which will be described in detail hereinafter and which is provided with a pin 37, which enters an opening 38 in the bottom of plate 100 of the carrier F, as shown in
 45 Figs. 6 and 7, so that the movement of the pantograph will, through the pin 37 of the arm *c*, move the plates 100 101 and the carrier F under the microscope, so that the pattern may be traced by the tracer in the microscope and the tracing movement reproduced by the follower 105.
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Any suitable form of reproducing-tool may be used, and for marking upon paper or cutting metal or other suitable materials I have shown in detail in Fig. 20 a construction of
 60 reproducing-tool which is preferably used and which forms a specific feature of the invention. In this construction a post 123 passes through the arm *a* of the pantograph and is shouldered so as to bear against the
 65 under side of the arm *a*, the portion below

the arm *a* being of just the required length to rest upon the blank on the table D and support the pantograph-arm *a* during the tracing operation. Above the arm *a* this post 123 carries a finger-piece 124, which is set down
 70 against the upper side of the arm *a* and held in position by a set-screw 125. The post 123 is provided with a central perforation running vertically through the post, and this perforation receives at its lower end the lead or other
 75 marking device 126, upon which rests a pin 127, extending above the post 123 and provided with a top finger-piece 128. In the use of the apparatus the reproducing-tool will be held and guided with one finger on the finger-
 80 piece 128 and the other fingers grasping the finger-piece 124, the post 123 thus being held down upon the blank under light pressure, so as to secure an easy movement, while at the same time holding the arm *a* exactly horizontal, and the desired pressure upon the lead or
 85 other marking device 126 is secured by the pressure on the finger-piece 128, the pin 127 moving down through the post 123 as the part 126 wears away. By this support of the
 90 pantograph-arm *a* by the post 123 all vertical strain upon the pantograph in use is avoided and the proper smooth movement of the pantograph-pivots secured, the pantograph being supported at the pivots by rollers 122 or similar means, as usual in pantograph constructions.
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The detail construction of the pantograph and its pivots may be varied widely, but the construction shown embodies certain specific
 100 features of my invention and is preferably used. This construction will now be described.

The construction of the pivots 30, 31, and 34 of the arms *b* *b'* are alike, as shown in Fig. 10, and are formed with the arm *a*, passing
 105 between the two bars of arms *b* or *b'*, with the double-pointed pivot-pin 13 passing through and preferably fixed in the arm *a* by being driven in tight and having its opposite ends seated in conical bearings formed in the
 110 lower end of a short pin 14, fast to the upper bar of the arm *b* and in a pin 15, carried by the lower bar of the arm *b*. The pin 15 fits tightly in the lower bar of the arm *b*, but is adjustable therein to proper position for the
 115 desired movement of the pivot and to take up wear by the following means: On the under side of the lower bar of the arm *b* is a piece *n*, having a screw-threaded opening through which passes screw 16, bearing against the
 120 under side of pin 15 and provided with lock-nut 17. By setting screw 16 in or out the bearing may be tightened or loosened and the parts then locked in position by nut 17. By the use of the separate piece *n*, which
 125 may be soldered or otherwise secured to the arm *b*, I am enabled to secure conveniently the accurate alinement of the openings through the three bars forming the arms *a* *b* at the pivot by avoiding tapping threads therein
 130

and boring all the three bars at the same time, holding them rigidly together and in position by any suitable means.

The arm *c* is pivoted to the arms *b b'* at 32 33 by means permitting the adjustment of the arm *c* longitudinally of the arms *b b'*, and as the pivots at 32 33 are alike description of one will suffice for both. Referring to Figs. 11 and 11^a, the arm *c* is mounted on an adjustable head *e*, which consists of a bearing-block 18 and depending side plates 19 thereon. The block 18 rests on the upper bar of the arm *b*, the arm *c* being supported on the upper face of the block 18. In the arm *c* is fitted tightly a bearing-sleeve 20, having upper and lower inclined faces, the lower inclined face bearing against the upper inclined face of a similar sleeve 21 in the block 18. The pivot-pin 32, having an inclined surface on the under side of its head seated in the bearing-sleeve 20, passes through both the sleeves 20 21 and is entered at its lower end by a tightening-screw 22, which bears against the lower end of sleeve 21, the joint being tightened by drawing down pin 32 by screw 22 and loosened by rotating screw 22 in the opposite direction, as shown in Fig. 11. A set-screw 23, passing through block 18 and entering a keyway in the side of the pivot-pin 32, locks the pin 32 in adjusted position and holds it from turning. The adjustable head *e'* of the pivot 33 is exactly the same in form and construction as the head *e*, just described. This construction provides a very simple and efficient adjustable pivot-mounting by which great accuracy of movement may be secured. The use of the bearing-sleeves 20 21 separate from the arm *c* and block 18 permits these two parts to be bored together, so as to assure accurate alinement. As the arms are not subject to wear, but only the sleeves 20 21, the bearing may be renewed by putting in new sleeves when those in use become worn too much for correction by adjustment.

The arms *c c'* must always be parallel to obtain a uniform movement of the carrier F, and to obtain such parallelism the pivots 32 34 and 33 35 should always be at equal distances from each other on the arms *b b'*. This relation is obtained and the size of the reproduction varied by the adjustment of heads *e e'*, which are made adjustable on the upper bars of the arms *b b'*, as follows: The plates 19 19 of the head *e* or *e'* have inwardly-extending ribs 25, which enter grooves 26, formed in the edges of the upper bar of the arm *b* or *b'*, the rib 25 of one of the plates 19 being cut away and a short block 27 inserted, which is pressed against the inner face of the groove 26 of the arm *b* by a set-screw 28. If it is desired to adjust the pantograph to reproduce a letter or other pattern on a larger scale than that shown in the drawings, in which the pantograph is shown as set for its smallest reproduction, except in Fig. 9, the

set-screws 28 of the heads *e e'* are loosened, and the heads *e e'*, which carry the pivots 32 33, are moved along arms *b b'* toward the fulcrum 35 of the pantograph to the desired position and then locked by tightening up screws 28.

The block *e''* on the inner end of the arm *c* is made adjustable on the arm *c* in the same manner as the heads *e e'* and is moved on the arm *c* toward the pivot 33 the same distance that the heads *e e'* of the pivots 32 33 are moved toward the pivots 34 35, so that the pin 37 is kept at the same distance on bar *c* from pivot 33 as the distance of pivot 33 on bar *b'* from pivot 35. Adjusting-blocks 106 are preferably used to assure accuracy of adjustment, these blocks being of different lengths for different-sized reproductions and are inserted between the heads *e e'* and fixed abutments 109, and the heads *e e'* set up against them in adjusting. In the main views these adjusting-blocks 106 are not shown, as the pantograph is set for its smallest reproduction and the heads *e e'* set directly against abutments 109; but in Fig. 9 a block 106 is shown in connection with block *e''* on arm *c*, the outer end of the block bearing against a block 107, which is slotted to pass over two screws 108, secured to the end of the arm *c*. When the block *e''* has been adjusted to position, the set-screw 28 is turned to tighten the block 27 and secure the block *e''* to the pantograph-arm *c*, and the blocks 106 107 then removed. In the same manner adjusting-blocks 106 are used in connection with the adjustment of heads *e e'*.

The pivot 35, by which the pantograph is pivoted to the table A, is constructed as follows, as shown in Fig. 6 and in detail in Fig. 12: Screwed into the table A is a post 110, having its upper part 111 reduced in diameter and upon which is fitted, so as to turn smoothly, the inner end of the lower bar of arm *b'*. The upper end of the post 110 is formed with a conical bearing-surface fitting into a conical bearing in a short sleeve 112, fitted tightly into the arm *c'*, and the upper end of the sleeve 112 has a conical bearing-surface fitting into a conical bearing on the under side of a sleeve 112^a, fitted tightly into the top bar of arm *b'* and having a conical bearing-surface at its upper end entered by the inclined under surface of the head of a screw 113, which passes down through the sleeves 112 and screws into the post 110. The bearing may thus be adjusted by screw 113 as desired and the parts then locked by set-screw 24, passing through post 110 and bearing against screw 113. This provides a very efficient fixed pantograph-pivot, capable of working very accurately and with the pivot-plane close to the pivot-plane of block *e''*, thus avoiding tendency to vertical torsion in operation and securing a smooth and accurate movement. It will be understood that the pivot-plane of the arm *b'* is in the sleeve 112^a, the

lower bar of this arm acting here only as a brace. The arms *b' c'* may be bored together, securing accurate alinement and the sleeves renewed when desirable.

5 For the proper reproduction of a letter or other pattern by tracing the outline of the letter as placed on the table 93 and carried by it under the microscope it is necessary to have
10 a very fine tracing-point in the microscope and at the proper point in the line of the exact center of the field of view and different tracers may be used under different conditions. I preferably use a tube 40, carrying
15 a tracer adapted to be placed within the microscope, the tube being cut away at its lower end so as to form a shoulder 41. A ring 42 is fitted into this cut-away portion and rests against the shoulder 41. This ring 42 carries the tracer in proper position relatively to the
20 eyepiece and objective in a compound microscope, such as shown, so as to act as a collimator in tracing the pattern. In the form shown in Figs. 13, 14 this tracer is made by crossed threads, as usual in collimating, as
25 follows: The ring 42 is slit or cut at points ninety degrees apart, as shown at 8, and into these slits or cuts are slipped two fine silken strands 9, crossing each other at right angles, as shown in Fig. 14, the intersection *y* of said
30 strands being the point by which the eye will follow the outline of the character or letter carried by the table 93 of the carrier F and this intersection thus forming the tracer. In place of the ring 42 a glass disk 43 may be
35 placed in the end of the tube 40 with a small dot at its center, as shown in Fig. 15, the position of said dot *y* corresponding to the intersection *y* of the threads 9 and the dot forming the tracer. In Fig. 16 is shown an ob-
40 long dot forming a compensating tracer for use in non-proportional reproductions, as explained hereinafter.

The operation of the apparatus will now be described. The operation in proportional
45 ortholinear reproduction will be understood without extended description. In such reproduction the pattern on table 93 is then horizontal, as shown in Figs. 1 to 6. The microscope is adjusted to proper focus by the
50 thumb-pieces 66, and the slide 78 is detached from the pattern-carrier F and held against upward movement by the screw 80, so that the block 65, with the microscope, is held stationary by the lever 67. Either of the tracers
55 shown in Figs. 14 and 15 or any other suitable point or circular tracer may be used in the microscope, and the operator, with his hand on the follower 105 and his eye applied to the microscope, moves the pattern-carrier
60 F through the pantograph, so as to trace the lines of the letter on the table 93, the letter "A," as shown, and this letter is reproduced enlarged by the follower 105 on the blank on table D, all the components of the tracing
65 movement of the pattern-carrier F being re-

produced in exactly the same proportional enlargement. The apparatus is illustrated as set for its smallest enlargement of the pattern; but this may be widely varied by adjusting
70 the blocks 32 33 toward the pivots 34 35 and correspondingly adjusting the block *e'* toward the pivot 33, as previously described, and of course any greater enlargement than that of the apparatus as illustrated may readily be
75 secured by constructing the pantograph accordingly.

In non-proportional ortholinear reproduction for producing letter reproductions from the same pattern with the height of the letter changed, the width remaining the same, or
80 with the width of the letter changed, the height remaining the same, a non-proportional enlargement of the pattern is required, which is secured by modifying one component of the tracing movement independently of the
85 other, and this result is obtained by rocking the pattern-table 93 on its pivots 94, so as to incline the pattern to the horizontal, as shown in Fig. 7. It is obvious that if the pattern-table be inclined to the horizontal, as shown
90 in Fig. 7, and the pattern-letter be laid upon the table thus inclined the movement of the pattern-carrier F to the right or left in Fig. 7—that is, vertically of the pattern-letter when
95 placed as in Fig. 5—will be less than its to-and-fro movement—that is, horizontally or widthwise of the letter—and the latter movement will not be affected by the inclining of the pattern. It is clear also that the movement of the pattern-carrier vertically of the
100 letter will be decreased more or less, according as the table 93 is more or less inclined to the horizontal. By rocking the pattern-table 93, so as to incline the pattern more or less
105 to the horizontal, therefore, the component of the tracing movement that determines the enlargement of the letter vertically is more or less decreased relatively to the other component of the tracing movement which determines the enlargement of the letter horizon-
110 tally or sidewise, and thus different varieties of type-patterns may be produced from the same letter-pattern, all having the same proportional enlargement sidewise, but varying in enlargement vertically. If it be desired to vary the enlargement of the letter horizontally or sidewise, retaining the same enlargement vertically, it is obvious that this result may
115 be secured by turning the pattern-letter on the pattern-table at right angles to the position in which it is shown in Fig. 5; but in that case the reproduced letter upon the table D will stand sidewise to the base-line of the table. To secure the correct position of the reproduced letter, the table A in that case is
120 removed from the bracket B and mounted upon the bracket C, which may readily be done with the construction shown, employing the stud 50 and nut 52. With the table A thus transferred ninety degrees about the table D
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to the bracket C the pattern-letter may be turned ninety degrees from the position shown in Fig. 5, so as to vary this enlargement side-wise, while the reproduced letter upon the blank on table D still stands vertical to the base-line of the table, as in Fig. 1. In this non-proportional reproduction the adjustment of the apparatus is as follows: The pattern-table 93 is inclined at the desired angle to the horizontal, according to the variation from proportional enlargement desired, by loosening the set-screw 95 and swinging the table on the pivots 94, the accurate positioning of the table being secured by the scale d on the side plate of the table, which is read against the inclined straight edge d' of the side 90. This scale is shown as running from "10°" to "45°," which are about the limits within which inclination of the table is desired in practice. The table 93, having been inclined at the proper angle, is locked in position by the screw 95. As the distance from the microscope of the part of the pattern being traced varies as the higher and lower portions of the inclined pattern are brought into tracing position, it is necessary that some means should be provided for preserving the focus during this variation of the distance of the pattern from the microscope. This result may obviously be attained by raising and lowering either the microscope or the pattern; but it is preferable to move the microscope, and in the apparatus shown the desired result is secured by raising and lowering the microscope according to the elevation of the part of the pattern being traced. This is the office of the lever 67, as actuated by the slide 78, connected to the pattern-carrier F by the cord 82 and hook 84, as shown in Fig. 7, and adjusting means are provided by which the amount that the microscope is raised or lowered for the same extent of horizontal movement of the pattern-carrier may be varied according to the degree of inclination of the pattern-table 93. For this purpose the bracket 56 is provided with a scale f , shown as running from "10°" to "45°" and corresponding to the scale d of the table 93, and the block 72 is moved along this scale until the point f' registers with a point on the scale f corresponding to the degree on the scale d at which the table 93 is inclined. It will be seen that this shifts the fulcrum of the lever 67, so that a horizontal movement of the pattern-carrier F, transmitted through the cord 82 and the slide 78, produces a greater movement of the end of the lever 67, which engages the roller 68 on block 65, carrying the microscope, according as the point f' is moved further up on the scale f , and thus the microscope is raised and lowered more or less by the movement of the pattern-carrier F, according as the degree of inclination of the pattern-table 93 is increased or diminished. The fulcrum-block 72 is adjusted by first loosening the lock-screw 74 and the set-screw

76 and then moving the block 72 along the guideway 73, the swinging block 70 also moving along the lever 67 until the proper position is attained, when the screws 74 and 76 are tightened to hold the parts in place. The pattern-table 93 having been adjusted to the proper angle of inclination, the block 72 having been adjusted accordingly, the cord 82 connected to the pattern-carrier by inserting the hook 84 in the opening 85 in plate 101, and the screw 80 having been adjusted so as to release the slide 78 and permit its vertical movement, the apparatus is in adjustment for operation in non-proportional enlargement. The microscope will then be raised as the pattern-carrier F moves to the right in Fig. 7 by the slide 78 drawing down the rear end of the lever 67, and thus moving the other end of the lever 67 and the microscope-carrying block 65 upward, and the loosening of the cord 82 as the pattern-carrier F moves to the left in Fig. 7, permitting the microscope and block 65 to move down, thus raising the outer end of the lever 67 and the slide 78 as far as permitted by the cord 82, which depends upon the movement of the pattern-carrier, so that a smooth steady up-and-down movement of the microscope is secured. The operation of the apparatus in this non-proportional ortholinear enlargement is exactly the same as in proportional ortholinear enlargement, except that the component of the tracing movement by which the vertical dimension of the reproduced letter are determined is varied relatively to the component by which the side-wise dimension of the reproduced letter are determined, with the result of obtaining a reproduced letter having the same sidewise dimension as with the pattern-table 93 horizontal, but with the vertical dimension of the letter reduced more or less, according to the degree of inclination of the pattern-table. In this operation the movement of the pattern-carrier F is of course horizontal, and the same as with the pattern-table horizontal, except as to the extent of its movement in one direction, and the action of the microscope is varied only by its up-and-down movement as controlled by the pattern-carrier through the lever 67 to preserve the proper focus.

In non-proportional enlargements from the same pattern, as above described, the tracers shown in Figs. 14 and 15 or any other suitable tracing-point or circular tracer may be used as in the case of proportional enlargements; but a tracing-point or a circular tracer produces in such non-proportional reproductions a change of the style of the type, which is not usually desired, by reducing the weight of each of the lines of the letter which run transverse to the component of the tracing movement, which is varied, as well as the height or width of the letter as a whole, so that the widthwise lines of a letter which is formed with the vertical component of the

tracing movement reduced are proportionally narrower than the vertical lines, and the vertical lines of a letter formed with the horizontal or widthwise component of the tracing movement reduced are proportionally narrower than the widthwise lines. While this effect may be disregarded or otherwise corrected and a tracing-point or circular tracer used, it may interfere with the desired similarity in appearance of different varieties of type of the same style, especially in the larger type, and therefore in such non-proportional reproductions I preferably use a tracer of such form as to compensate for the difference between the ratios of enlargement of the vertical and widthwise components of the movement of the tracer. The tracer I employ for this purpose is oblong and preferably formed with straight sides and round ends, as shown in Fig. 16, where the tracer is shown as formed by a spot y on the glass disk 43, although it will be understood that the tracer may be formed in any other suitable manner. The two diameters or horizontal dimensions of the tracer should be such that the axis of the tracer as the latter follows the horizontal or widthwise lines of a pattern-letter which is to be reproduced with its vertical dimension reduced relatively to its horizontal dimension shall increase the width of the horizontal line-space in the pattern, so as to compensate for the ratio of reduction of the vertical dimension of the letter as a whole, and thus secure the same proportional enlargement of the width or weight of the horizontal lines of the pattern as of the vertical lines, and that in tracing the vertical lines of a pattern-letter the horizontal or widthwise dimension of which is to be reduced relatively to the vertical dimension the width of the vertical line-space in the pattern shall be increased, so as to compensate for the ratio of reduction of the horizontal dimension of the letter as a whole, and thus secure the same proportional enlargement of the width or weight of the vertical lines as of the horizontal lines. It will be understood that in either case the dimension of the tracer that determines the distance of its axis from the line of the letter in tracing the lines to which the compensation is not to be applied—that is, the vertical lines when the letter is reduced vertically and the horizontal lines when the letter is reduced horizontally—will be the same as that of a circular tracer for the proportional enlargement determining that dimension of the letter depending upon the component of the tracing movement which is not varied, and the other dimension of the tracer, which determines the distance of the axis from the line of the letter in tracing the other lines, will be increased or diminished relatively to such proportional dimension to secure the result desired. The increase or decrease of one dimension of the oblong tracer relatively to the

other will depend not only upon the inclination of the pattern, but also upon the weight of the lines to which compensation is to be applied—that is, the width of the line-space in the pattern—the increase or decrease of the tracer dimension being such that it will compensate for the decrease in weight of the lines below that which would result from using a tracer of the same dimensions in both directions. Whether the tracer dimension shall be increased or decreased will depend upon the form of pattern—that is, whether the tracer follows the inside of the lines of the pattern, as in following a matrix-pattern, or the outside of the lines of the pattern, as in following a type-pattern—it being obvious that the width of the line-space movement of the tracer-axis in following a matrix-pattern is increased by reducing the distance of the axis from the matrix-wall, while in tracing a type-pattern increasing this distance of the axis from the type-line increases the width of the line-space movement of the tracer, and decreasing this distance decreases the width of this movement. In tracing a matrix-pattern, therefore, the compensating dimension of the tracer will be decreased relatively to its normal dimension to such an extent that the difference between the two dimensions bears to the width of the vertical line-space of the pattern the ratio of the reduction for which compensation is to be made, thus widening the path of movement of the axis of the tracer in following the lines to be compensated. In tracing type-patterns the proportion will be the same; but the compensating dimension of the tracer will be increased instead of decreased to compensate for the reduction. For purpose of illustration the tracer y in Fig. 16 is shown as formed for tracing a type-pattern with the normal dimension of the tracer the same as that of the tracer y in Fig. 15 and the other dimension increased for compensation. In this calculation it is obvious that the width of the line-space to be used is not the actual width of the vertical lines, but the width of the path of movement of the axis of a proportional tracer in following these lines, as this path of movement determines the movement of the follower and is, in fact, the pattern line-space. This line-space equals the actual line width minus the diameter of the proportional tracer in the case of a matrix-pattern and the actual line width plus the diameter of the proportional tracer in the case of a type-pattern.

The above statement of the theory of my compensating tracer is made for full disclosure of the invention, and with this statement the calculation of the dimensions of a tracer for exact compensation for any non-proportional reproduction may readily be made. It will be understood, however, that such exact compensation is not required, and it will be found in practice that an oblong

tracer of about medium compensation may be used for the different non-proportional reductions required and secure compensation sufficiently accurate for all practical purposes.

5 It will be understood also that where the lines to be compensated vary in weight only an approximate compensation can be secured by such a compensating tracer; but by calculating the tracer by the average width of the
10 lines to be compensated a sufficiently accurate compensation can be secured even in such cases.

A tracer formed with one of its tracing dimensions greater than the other may be used
15 not only as a compensating tracer to preserve the relative weights of vertical and horizontal lines in non-proportional reproductions, as above described, but also for varying the weight of vertical and horizontal lines in either
20 proportional or non-proportional reproductions. This is frequently desirable in making type-patterns, the width or weight of the horizontal or vertical lines of type being varied largely relatively to each other, especially
25 in display-type, and with the machine of the present invention type-patterns may readily be made with any desired variation in weight of the vertical and horizontal lines relatively to each other by the use of oblong tracers
30 proportioned to secure the result desired. From the above description of the use of the oblong tracer in compensating the calculation and use of the oblong tracers in varying the relative weights of lines from their relative
35 weights in the pattern being traced will be clear, it being understood that the pattern line-space of those lines the weight of which is to be increased will be widened by decreasing the dimension of the tracer determining the
40 weight of these lines in tracing a matrix-pattern and by increasing this dimension of the tracer in tracing a type-pattern and just the reverse in decreasing the weight of any lines of the pattern relatively to the others. In
45 either increasing or decreasing the weight of lines in tracing either matrix or type patterns it will be understood that the two dimensions of the tracers will be proportioned according to the increase or decrease in line weight desired.
50

The apparatus shown is capable of use not only in ortholinear reproduction, either proportional or non-proportional, but also for
55 any reproduced pattern may be similarly distorted and inclined either to the right or left relatively to an ortholinear pattern and at different degrees of inclination. This result is secured by inclining the pattern-table 93, as above described in the case of non-proportional reproductions, and turning the letter or
60 other pattern on the table from its position shown in Fig. 5, so that its base-line extends at an angle to the plane of tracing movement,
65 the letter being turned to the right if an

italicized letter is to be produced and to the left if a back-slope letter is to be produced. The degree of italicizing or back slope of the reproduction will depend upon the amount the pattern-letter is turned and the inclination
70 of the table 93, and by varying one or both of these widely-different results may be secured. For illustration, I have found in practice that with the table inclined at an angle of forty-five degrees to the plane of tracing
75 movement, the horizontal in the machine shown, and the letter turned at different angles from ten to forty degrees a reproduced letter is italicized or back-sloped at angles varying from about seven to about twenty
80 degrees. With the letter turned at an angle of forty-five degrees and the table 93 inclined at different angles from thirty to forty-five degrees the reproduced letter is italicized or back-sloped at angles varying from about
85 eight to about twenty degrees. Of course the distortion increases with the inclination of the table. I have shown in Fig. 5^a at a' and a'' the pattern-letter positioned relatively to its position shown in Fig. 5 for such italicized
90 and back-sloped reproductions, the letter being turned at about forty-five degrees. With the table inclined at about thirty degrees, as shown in Fig. 7, the letter at a' will be reproduced italicized at an angle of about eight
95 degrees, and the letter at a'' will be reproduced back-sloped at the same angle. This feature of the apparatus is a very valuable one not only in producing italicized or back-sloped letter designs, but also in that it enables corresponding right and left designs of any character to be readily produced. It is obvious that with the pattern turned on table
100 93 as just described for distorted and inclined reproduction the reproduced letter will stand at an angle to the base-line of the blank on table D. To correct this, the blank on table D may be turned to stand at such an angle relatively to the base-line of the table D that the base of the reproduced letter is brought
105 into parallelism with the base-line of the blank. A letter inclined to the left or right, but with its base-line parallel with the base-line of the blank on the table D, will be thus produced. I prefer, however, to rotate the table A, with
115 the microscope and pattern-carrier, concentrically with the pivot 35 of the pantograph, so as to secure this same result of positioning the reproduced inclined letter relatively to the blank on table D and maintain the base of this blank parallel with the base-line of the table D, as shown in Fig. 1. This is the object of mounting the table A upon the stud
120 50 in bracket B, so that by loosening nut 52 the table may be turned with the stud in bracket B to just the position required by the reproduced inclined letter upon the blank on table D. As the stud 50 is in line with the pivot 35 of the pantograph, this movement
125 does not vary the action of the pantograph,
130

but simply positions the reproduced letter to correct the change of position therein resulting from the turning of the letter-pattern on pattern-table 93. The angle through which the table A is to be turned can be readily determined by operating the apparatus, so that it is unnecessary to calculate it.

While the invention has been illustrated and described in connection with an apparatus for producing enlarged type-patterns, it will be understood that the features forming the invention may be applied also in other classes of apparatus and that the apparatus shown may be used either with or without such modifications as are within the skill of those acquainted with the art in doing various kinds of work.

While a microscope is preferably used in apparatus embodying the present invention and the invention includes certain combinations including a microscope, the invention, broadly considered, includes also apparatus employing any other suitable form of eyepiece or sight-piece for tracing and that the use of any eyepiece is not essential to the embodiment of some of the features forming parts of the invention.

In the apparatus shown the pattern is moved relatively to the tracer for the tracing movement and the marker forms the follower and is moved in accordance with the tracing movement, and this is much the more convenient and preferable construction, and it is especially desirable to move the pattern-carrier in connection with the tracing of the pattern through a microscope or other eyepiece. It will be understood, however, that many features of the invention are applicable also to machines in which the marker is stationary and the blank-holder forms the follower and that it is possible also in some classes of work to produce the tracing movement by moving the tracer, with the microscope or other eyepiece, over a stationary pattern instead of moving the pattern. It will be understood also that many modifications may be made in the apparatus shown without departing from the invention and that the invention is not to be limited to the exact form or arrangement of parts illustrated and that many of the features forming the invention may be used in apparatus not employing other features forming part of the invention claimed herein.

What is claimed is—

1. The combination of an eyepiece, a tracer between the eyepiece and the pattern, a pattern-carrier for non-proportional reproduction adapted to hold the pattern inclined to the plane of tracing movement to vary one component of the tracing movement independently of the other, and movable for tracing the pattern, a follower, and connections for transmitting the tracing movement to the follower, substantially as described.

2. The combination of an eyepiece, a tracer

between the eyepiece and pattern, a pattern-carrier movable for tracing the pattern and having a pattern-holder provided with means for adjusting the pattern-holder at different inclinations to the plane of tracing movement of the pattern-carrier to vary one component of the tracing movement independently of the other, a follower, and connections for transmitting the tracing movement of the pattern-carrier to the follower, substantially as described.

3. The combination with an eyepiece, a tracer between the eyepiece and pattern, a follower, and connections for transmitting the tracing movement to the follower, of means for automatically adjusting the distance of the eyepiece from the pattern in accordance with the tracing movement, substantially as described.

4. The combination with a microscope and tracer for tracing a pattern by the eye, a pattern-holder adapted to hold a pattern inclined to the plane of tracing movement, a follower, and connections for transmitting the tracing movement to the follower, of means for automatically adjusting the distance of the microscope from the pattern in accordance with the movement of the pattern to compensate for the inclination of the pattern and preserve the focus, substantially as described.

5. The combination with a microscope and tracer for tracing a pattern by the eye, a follower, and connections for transmitting the tracing movement to the follower, of means actuated by the tracing movement for adjusting the distance of the microscope from the pattern to compensate for the inclination of a pattern inclined to the plane of tracing movement and preserve the focus, substantially as described.

6. The combination with a microscope and tracer for tracing a pattern by the eye, a follower, and connections for transmitting the tracing movement to the follower, of means actuated by the tracing movement for adjusting the distance of the microscope from the pattern to compensate for the inclination of a pattern inclined to the plane of tracing movement and preserve the focus and adjustable to vary the extent of movement of the microscope in accordance with the degree of inclination of the pattern, substantially as described.

7. The combination with a microscope and tracer for tracing a pattern by the eye, a pattern-carrier movable for tracing the pattern, and connections for transmitting the tracing movement from the pattern-carrier to the follower, of a lever actuated by the tracing movement of the carrier for moving the microscope toward and from the pattern in accordance with the tracing movement to compensate for the inclination of a pattern inclined to the plane of tracing movement and preserve the focus, and means for adjusting the fulcrum of said lever to vary the extent of movement

of the microscope in accordance with the degree of inclination of the pattern, substantially as described.

8. The combination with a microscope and 5 tracer for tracing a pattern by the eye, a pattern-holder adjustable to position the pattern at different inclinations to the plane of tracing movement, a follower, and connections for transmitting the tracing movement to the fol- 10 lower, of means actuated by the tracing movement for moving the microscope toward and from the pattern to compensate for the inclination of the pattern and preserve the focus and adjustable in accordance with the adjust- 15 ment of the pattern-holder to vary the extent of movement of the microscope, substantially as described.

9. In a tracing apparatus having a tracer and follower and connections for transmitting 20 the tracing movement to reproduce a pattern, the combination of means for varying the extent of the tracing movement in one direction to vary one component of the tracing movement independently of the other for non-pro- 25 portional reproduction, and a tracer having its tracing portion formed in two dimensions, the difference between the two dimensions of the tracer being such as to compensate for said variation of one component of the tracing 30 movement, substantially as described.

10. A tracing apparatus having its pattern inclined to the plane of the tracing movement for varying one component of the tracing 35 movement independently of the other, and a tracer having its tracing portion formed in two dimensions, the difference in the two dimensions of the tracer being such as to compensate for said variation of one component of the tracing movement, substantially as de- 40 scribed.

11. The combination with a tracer and follower, of a pattern-carrier movable for tracing the pattern in a plane inclined to the plane 45 of the pattern, and connections for transmitting the tracing movement of the pattern-carrier to the follower, substantially as described.

12. A tracing apparatus having its pattern inclined to the plane of the tracing movement and set with its base-line at an angle to the 50 plane of tracing movement to produce italicized or back-slope reproductions of letter or other designs, substantially as described.

13. The combination with an eyepiece, a 55 tracer between the eyepiece and pattern, a follower, and a pantograph for transmitting the tracing movement to the follower, of a pattern-carrier movable for tracing the pattern and a pattern inclined to the plane of the tracing 60 movement and set with its base-line at an angle to the plane of tracing movement to produce italicized or back-slope reproductions of letter or other designs, substantially as described.

14. The combination with an eyepiece, a

tracer between the eyepiece and pattern, a fol- 65 lower, and a pantograph for transmitting the tracing movement to the follower, of a pattern inclined to the plane of the tracing movement and set with its base-line at an angle to the plane of tracing movement to produce itali- 70 cized or back-slope reproductions of letter or other designs, and a table on which the pattern, tracer, and eyepiece are mounted adjustable in the plane of tracing movement and about the fixed pivot of the pantograph as a 75 center, substantially as described.

15. The combination with a tracer, a pattern-holder, and follower, and a pantograph for transmitting the tracing movement to the 80 follower, of a table on which the pattern is mounted adjustable in the plane of tracing movement and about the fixed pivot of the pantograph as a center, substantially as described.

16. The combination with an eyepiece, a 85 tracer between the eyepiece and pattern, a pattern-holder, a follower, and a pantograph for transmitting the tracing movement to the follower, of a table on which the pattern, 90 tracer, and eyepiece are mounted, adjustable in the plane of tracing movement and about the fixed pivot of the pantograph as a center, substantially as described.

17. The combination of an eyepiece and a 95 pattern-holder, one of said members being movable relatively to the other for tracing the pattern, a tracer between the eyepiece and pattern having its tracing portion formed in two 100 unequal dimensions to vary one component of the tracing movement, a follower, and connections for transmitting the tracing movement to the follower, substantially as described.

18. The combination with a microscope, 105 tracer and a pattern-holder, one of said members being movable relatively to the other for tracing the pattern, said tracer having its tracing portion formed in two unequal dimensions to vary one component of the tracing movement, a follower, and connections for trans- 110 mitting the tracing movement to the follower, substantially as described.

19. The combination with microscope E and support-block 65 in which the microscope is adjustable for focusing, of lever 67 support- 115 ing said block, connections for actuating said lever by the tracing movement for automatically raising and lowering the microscope, and means for detaching said lever from the member by which it is moved in the tracing movement and locking said lever in position to hold 120 the microscope stationary, substantially as described.

20. The combination with microscope E and support-block 65 in which the microscope is 125 adjustable for focusing, of lever 67 supporting said block, connections for actuating said lever by the tracing movement for automatically raising and lowering the microscope and

means for adjusting the fulcrum of said lever in accordance with the inclination of the pattern, substantially as described.

21. The combination with the bar *a* carrying pivot-pin 13, of the bars *b* on opposite sides of the bar *a* carrying pins 14, 15 forming seats for the pivot-pin 13, and screw 16 pressing against pin 15, substantially as described.

22. The combination with the bar *a* carrying pivot-pin 13, of the bars *b* on opposite sides of the bar *a* carrying pins 14, 15 forming seats for the pivot-pin 13, piece *n* formed separately from bar *b* and secured thereto, and screw 16 passing through piece *n* and pressing against pin 15, substantially as described.

23. The combination with the bar *c* and block 18, of bearing-sleeves 20, 21, in said bar and block, pivot-pin 32, and screw 22 entering the pivot-pin for drawing the parts together, substantially as described.

24. The combination with the bar *c* and block 18, of bearing-sleeves 20, 21, in said bar and block, pivot-pin 32, screw 22 entering the pivot-pin for drawing the parts together, and set-screw 23 passing through block 18 and bearing against the pivot-pin, substantially as described.

25. The combination with grooved bar *b* and block 18 having flanges 19, 19 and ribs 25, of loose locking-block 27, and set-screw 28, substantially as described.

26. The combination with grooved bar *b* and block 18 having flanges 19, 19 and ribs

25, of loose locking-block 27, set-screw 28, and bar *c* having an adjustable pivot-mounting on block 18 above bar *b*, substantially as described.

27. The combination with bars *b' c'*, of pivot-post 110 having an inclined seat at the end, bearing-sleeves 112, 112^a in bars *b', c'*, and screw 113 entering post 110 for holding the parts together and having an inclined surface seated in bearing-sleeve 112^a, substantially as described.

28. The combination with pantograph-arm *a*, of post 123 carried by said arm and adapted to rest upon the blank, finger-piece 124 above the arm, and a marker, substantially as described.

29. The combination with pantograph-arm *a*, of perforated post 123, and finger-piece 124, said post being perforated to receive a marker with its upper end in position for pressure by the finger of the operator's hand holding the finger-piece, substantially as described.

30. A microscope for tracing-machines having a tracer the tracing portion of which is formed in two unequal tracing dimensions to vary one component of the tracing movement, substantially as and for the purpose described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LINN BOYD BENTON.

Witnesses:

MORRIS F. BURTON,
T. F. KEHOE.