Jan. 19, 1937. K. ZWICK 2,067,962

ENGRAVING AND COPYING MACHINE

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Fig. 2

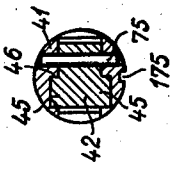
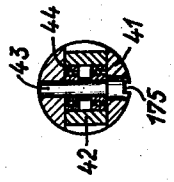


Fig. 3



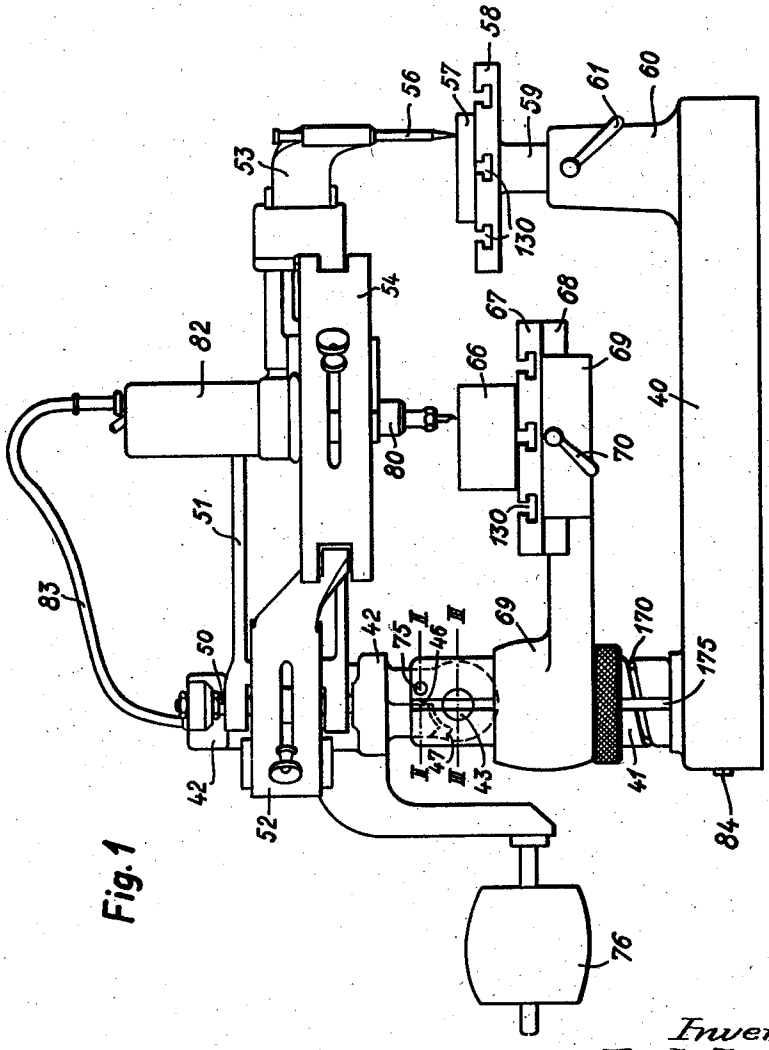


Fig. 1

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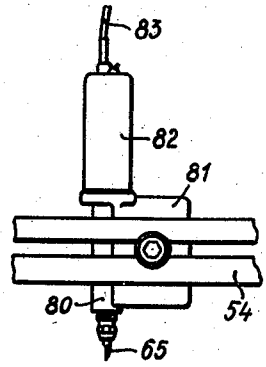

Fig. 4

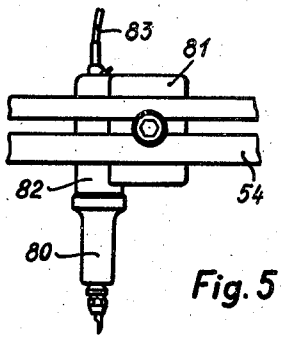

Fig. 5

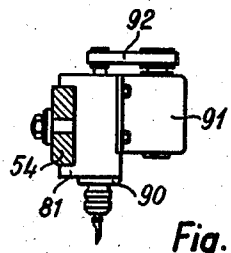

Fig. 7

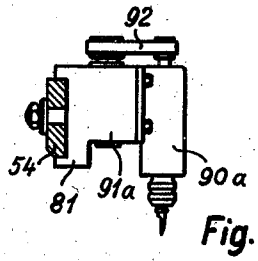

Fig. 9

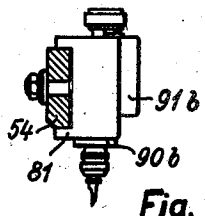

Fig. 11

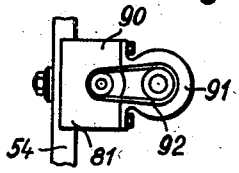

Fig. 8

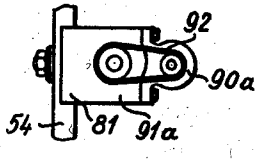

Fig. 10

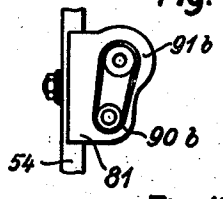

Fig. 12

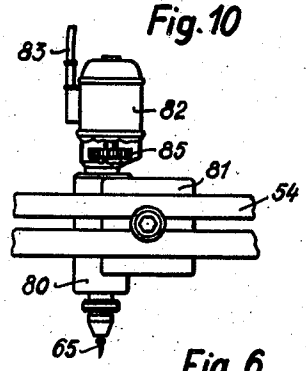

Fig. 6

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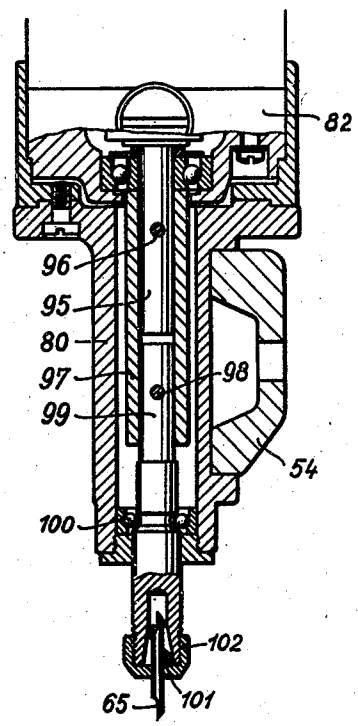

Fig. 13

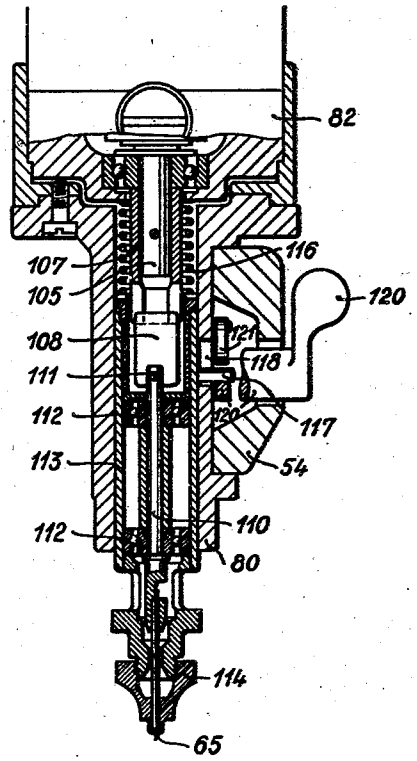

Fig. 14

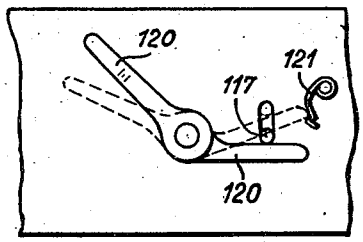

Fig. 15

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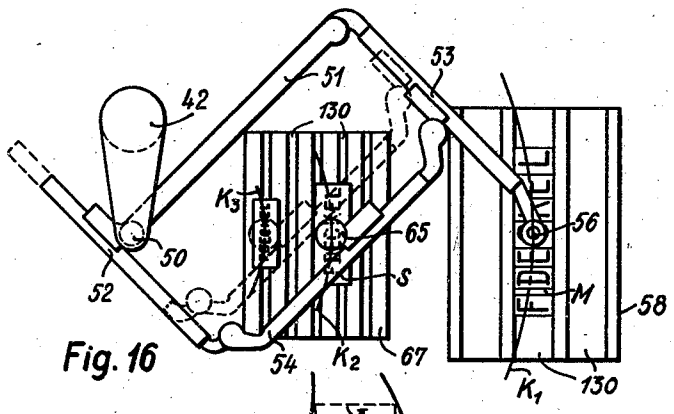

Fig. 16

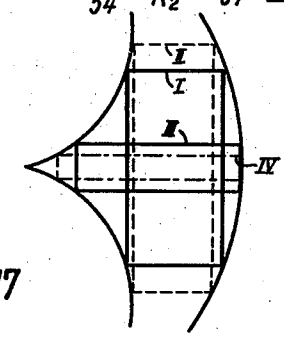

Fig. 17

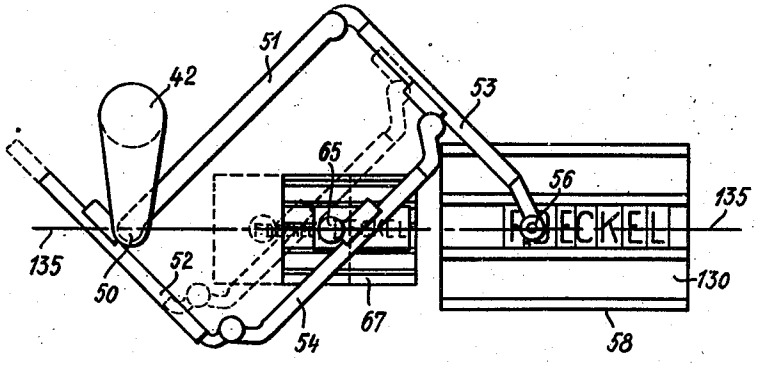

Fig. 18

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Fig. 19

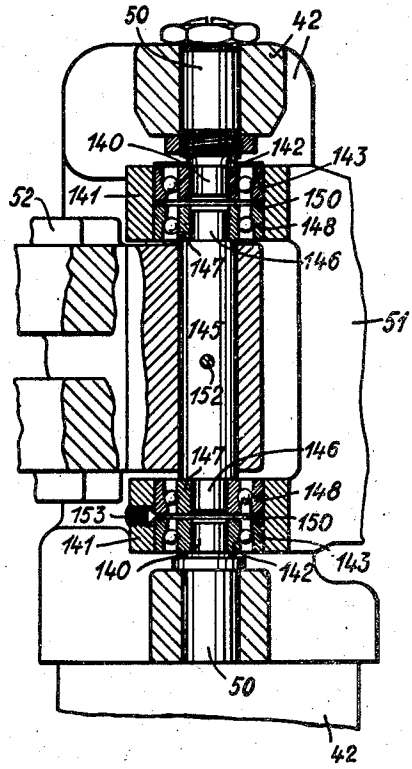
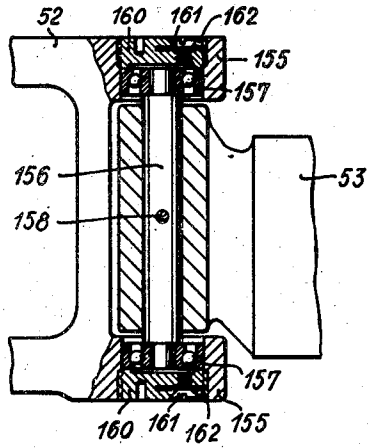


Fig. 20



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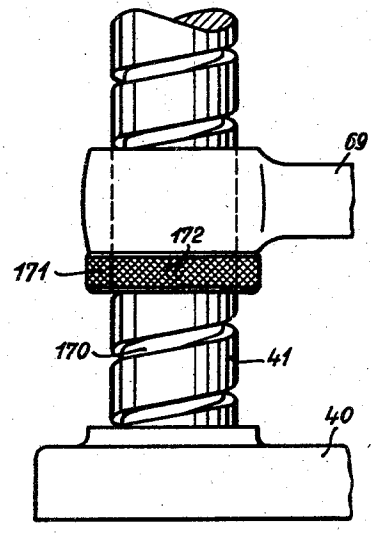

Fig. 21

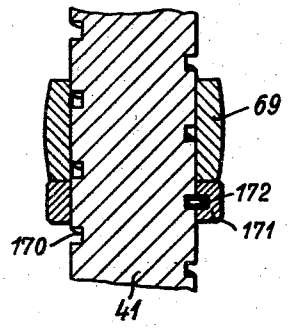

Fig. 22

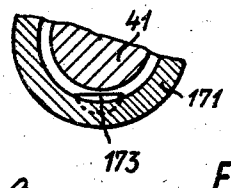

Fig. 23

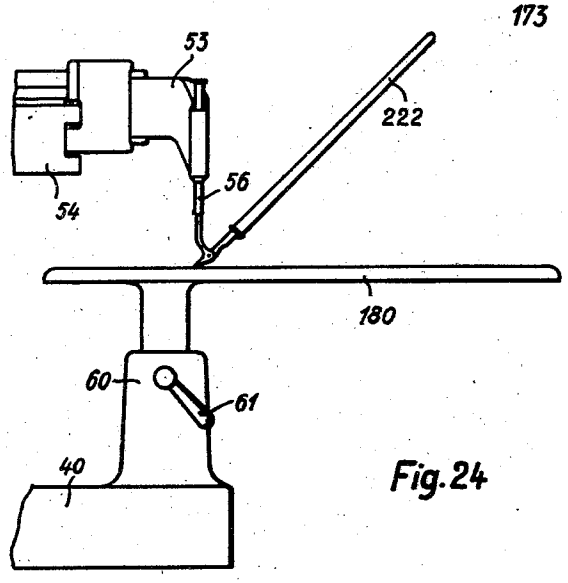

Fig. 24

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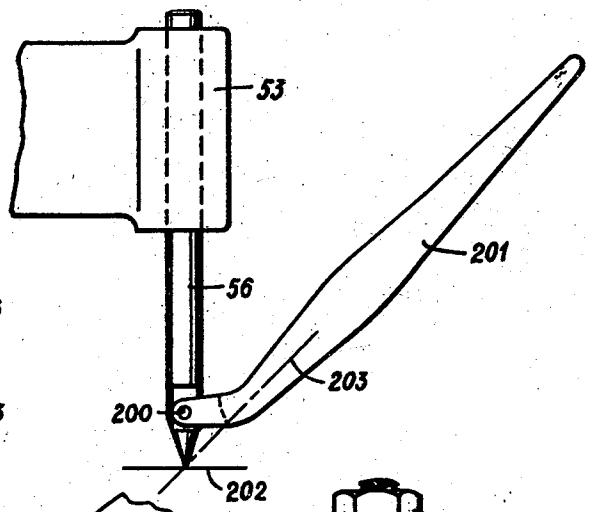
Fig. 25



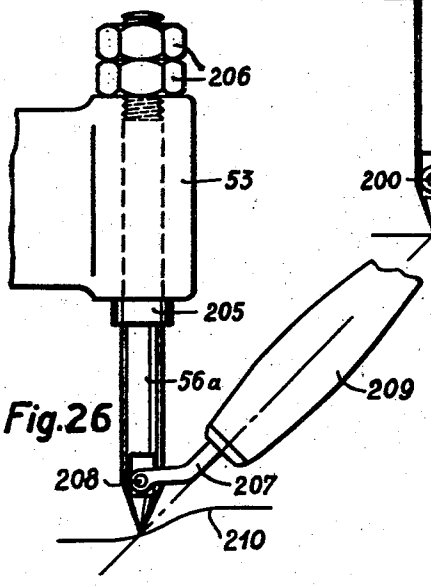


Fig. 26

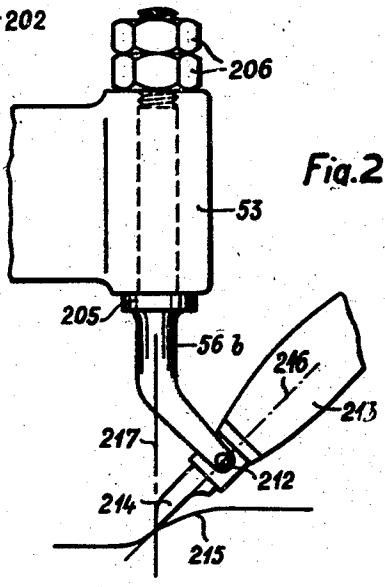


Fig. 27

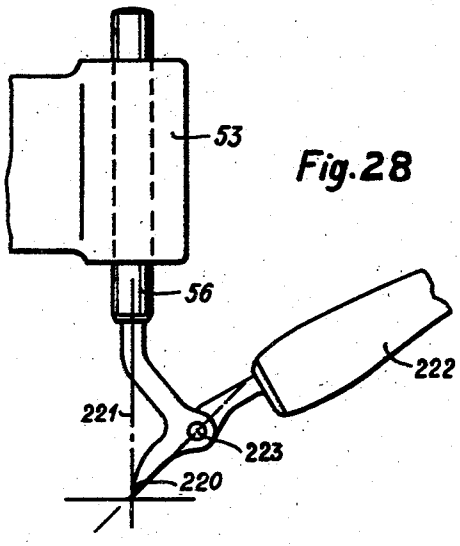


Fig. 28

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UNITED STATES PATENT OFFICE

2,067,962

ENGRAVING AND COPYING MACHINE

Kürt Zwick, Munich, Germany, assignor to Friedrich Deckel, Munich-Prinz Ludwigshohe, Germany

Application May 15, 1933, Serial No. 671,277
In Germany May 17, 1932

14 Claims. (Cl. 90—13.1)

This application relates to engraving and copying machines, and particularly to such machines of the class in which pantograph mechanism is employed.

An object of the invention is the provision of generally improved and more satisfactory machines of this character.

Another object is the provision of improved means for driving the cutting element or engraving tool of such machines, and particularly of improved means for mounting a driving motor directly upon the pantograph mechanism in close association with the cutting tool, so that the motor and tool may be moved together as a single unit when it is necessary to shift the tool to a new position of adjustment.

Another object is the provision of an improved construction for the joints of the pantograph mechanism, whereby such joints may be constructed more satisfactorily and economically and may employ standard bearings of a type readily obtainable on the market, in place of the special bearings hitherto employed in such machines.

Still another object is the provision of an improved arrangement of the supports or tables for holding the work and the pattern or model to be copied, and especially of an arrangement enabling the work to be moved to a new position with a minimum of effort when the setting or ratio of the machine is changed.

A further object is the provision of improved means for raising or lowering a work or pattern holding table or support, and for holding it at any desired elevation.

A still further object is the provision of an improved table or support for the model or pattern to be copied.

Yet another object is the provision of improved guiding or manipulating means for the movable stylus or tracer of an engraving or copying machine.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Fig. 1 is a diagrammatic side elevation of an engraving and copying machine constructed in accordance with one embodiment of the present invention;

Fig. 2 is a horizontal section taken substantially on the line II—II of Fig. 1;

Fig. 3 is a similar horizontal section substantially on the line III—III of Fig. 1;

Fig. 4 is a fragmentary elevation showing one form of driving means for the engraving tool;

Fig. 5 is a similar view of a modified form of driving means;

Fig. 6 is a similar view of still another form of driving means;

Fig. 7 is an elevation, with parts in vertical section, of still another form of driving means for the engraving tool;

Fig. 8 is a plan of the arrangement shown in Fig. 7;

Fig. 9 is a view similar to Fig. 7 showing still another form of driving means;

Fig. 10 is a plan of the arrangement shown in Fig. 9;

Fig. 11 is a view similar to Figs. 7 and 9 showing still another form of driving means;

Fig. 12 is a plan of the arrangement shown in Fig. 11;

Fig. 13 is a vertical section taken centrally through the engraving tool spindle and associated parts, illustrating one form of construction of these parts;

Fig. 14 is a similar view illustrating another possible construction of these parts;

Fig. 15 is a side elevation of part of the mechanism shown in Fig. 14;

Fig. 16 is a diagrammatic plan of part of the machine shown in Fig. 1 with various parts omitted for the sake of clearness;

Fig. 17 is a diagram illustrating the limits of motion of the pantograph mechanism shown in Fig. 16;

Fig. 18 is a view similar to Fig. 16 illustrating a preferred improved arrangement of the holding means for the work and for the model or pattern;

Fig. 19 is a vertical section illustrating an improved form of bearing between certain of the pantograph arms and their supporting standard;

Fig. 20 is a similar view illustrating an improved form of bearing at another joint between two of the pantograph arms;

Fig. 21 is a fragmentary side elevation of part of the mechanism shown in Fig. 1, illustrating means for raising and lowering the work table in somewhat greater detail than shown in Fig. 1;

Fig. 22 is a vertical section taken substantially centrally through the parts illustrated in Fig. 21;

Fig. 23 is a horizontal section through part of the mechanism illustrated in Fig. 22, showing a slightly modified form of construction;

Fig. 24 is a fragmentary elevation illustrating a different form of pattern table which may be substituted for that shown in Fig. 1, and also

illustrating an improved form of guiding means for the tracing point or stylus;

Fig. 25 is a side elevation of one form of improved guiding or manipulating means for the tracing point or stylus of the machine;

Fig. 26 is a similar view of another form of guiding means;

Fig. 27 is a similar view of still another form, and

Fig. 28 is a similar view of yet another embodiment of guiding means in accordance with the present invention.

The same reference numerals throughout the several views indicate the same parts.

Referring now especially to Figs. 1 and 16 of the drawings, there is shown diagrammatically an engraving and copying machine comprising a base 40 having a column 41 rising therefrom, to the upper end of which column a carrier 42 is pivotally connected by a pivot pin 43. Ball bearings 44 (Fig. 3) may surround the pivot 43 so that the carrier 42 may move readily, and the motion of the carrier about its pivot may be limited by engagement of lugs 45 on the carrier (Fig. 2) with abutments 46 and 47 formed on the column 41.

The carrier 42 is provided with a laterally curved or bowed portion from which pivots 50 extend upwardly and downwardly and serve as fulcrums for the pantograph arms 51 and 52 to which, in turn, the other pantograph arms 53 and 54 are pivotally connected.

A tracing point or stylus 56 is mounted at any convenient point on the pantograph mechanism, such as at the outer end of the arm 53, for cooperation with a pattern or model 57 held on any suitable pattern table or support 58 which may have a downwardly extending shank 59 adjustable upwardly and downwardly in a hollow column 60 and held in any desired adjusted position by a clamping screw operated by the handle 61.

Also mounted on the pantograph mechanism is a suitable cutting tool 65, preferably rotated by power means, and arranged to operate upon the work indicated diagrammatically at 66, mounted for example on a suitable work support 67 which has a horizontal guideway 68 slidable in a general direction toward and away from the column 41 in corresponding guideways of an arm 69 mounted for vertical adjusting movement upwardly and downwardly on the column 41, as described in greater detail hereafter. A clamping screw operated by the handle 70 serves to hold the work support 67 in any position to which it is adjusted along its guideways.

As well understood by those skilled in the art, the position of the various pantograph arms with respect to each other and the position of the cutting tool 65 on the arm 54 on which it is mounted, may be varied or adjusted from time to time in order to change the ratio of reduction of the machine.

When work in relief is being produced, the tracing stylus 56, and with it the entire pantograph mechanism and cutting tool, may move upwardly and downwardly by oscillating the carrier 42 about its pivot 43. When plane or flat work is being done, however, the pantograph linkage may be held in a substantially horizontal plane by any suitable locking means, such as by inserting a pin 75 (Figs. 1 and 2) through alined holes in the column 41 and the carrier 42. The weight of the pantograph mechanism and associated parts, which are substantially all on one side of the carrier 42, may be counterbalanced by any suitable means such as the counterweight 76.

Heretofore the cutting tool has frequently been driven by means of a motor (usually stationary) on the pedestal or base of the machine, connected by long belts with the cutting tool. This form of construction is unsatisfactory in several ways, partly because the necessary supporting parts, braces, etc., limit to some extent the free movement of the pantograph system and are apt to obstruct the work. Various other positions for the driving motor have also been proposed, but in each of them, so far as known to applicant, there are serious disadvantages such as the necessity of using braces, or the obstruction of the work, or the hampering of the movement of the pantograph linkage, or the necessity of separately adjusting the motor each time that the tool is moved to change the reduction ratio.

According to the present invention, all of these defects and disadvantages are eliminated by placing the driving motor directly on the pantograph mechanism closely adjacent the cutting tool to be driven by the motor. The motor and the tool are mounted together for bodily movement as a single unit when the tool is adjusted along the pantograph arm. Thus it is not necessary to make separate adjustment and setting of the motor and of the tool, when the machine is shifted to a different reduction ratio. Also, according to the present invention, elastic transmission means is used between the motor and the tool so that vibration of the motor does not reach the cutting tool, and an ordinary commercial motor may thus be used in place of an expensive special motor.

This feature of the invention may be carried out in a number of possible ways. Preferably, and as shown especially in Figs. 1 and 4, the tool 65 is mounted for rotation in suitable bearings within a bearing member 80 fixed to a slide 81 mounted for adjustment longitudinally along the pantograph arm 54. An electric motor is mounted in axial alinement with the tool 65 and closely adjacent thereto, the motor being within a motor housing 82 secured to and just above the bearing member 80. The motor may be supplied with electric current in any suitable manner such as through the cord 83 which may extend down alongside or through the column 41 to the electric plug 84 in the base 40.

The arrangement shown in Fig. 5 differs slightly from that shown in Figs. 1 and 4, merely in that the motor housing 82 and the bearing member 80 are dropped downwardly somewhat with respect to the slide 81, the slide being connected to the motor housing rather than to the bearing member.

In Fig. 6 there is shown a construction quite similar to that illustrated in Figs. 1 and 4, but in place of using a simple motor there is a built-in raising and lowering device indicated diagrammatically at 85 for shifting the tool longitudinally to raise or lower it when desired.

Figs. 7 and 8 illustrate still a further modification in which the slide 81 is formed on the tool block or bearing member 90, while the motor housing 91 is a separate piece bolted or otherwise secured to one side of the member 90 as shown. In this case, the tool may be connected to the motor as by means of a belt 92, preferably embodying elastic material such as rubber, so as to lessen the possibility of motor vibration reaching

the tool. The motor may be readily removed without disturbing the tool block 90.

Figs. 9 and 10 illustrate a further modification which differs from that of Figs. 7 and 8 in that here the motor housing 91a is formed on the slide member 81, while the tool block or member 90a is a separate piece bolted or otherwise suitably secured to the motor housing. As before, the motor and the tool may be connected by a belt 92 of elastic material.

In Figs. 11 and 12, it is seen that the parts are all made in a single integral piece embodying the slide portion 81, the tool block or bearing portion 90b, and the motor housing portion 91b.

Fig. 13 of the drawings shows a detail of one possible form of construction, illustrating the pantograph arm 54, the motor 82 above the pantograph arm, and the tool housing or bearing member 80 below the motor housing. As here shown, the motor shaft 95 may be connected by a pin 96 to a sleeve 97 surrounding the shaft and extending downwardly below the lower end of the shaft. The sleeve, in turn, is connected by a pin 98 to the spindle shaft 99 which has a ball bearing 100 for supporting it near the lower end of the member 80. The engraving tool 65 itself may be secured to the spindle 99 in any suitable manner, such as by being held in the conical collet 101 clamped in place by a clamping nut 102.

Another form of construction, especially suitable when it is desired to employ a depth limiter with the engraving tool, is illustrated in Figs. 14 and 15. As in Fig. 13, the motor 82 is shown above the pantograph arm 54, with the tool block or bearing member 80 extending downwardly from the motor housing. The motor shaft 105 is connected by a pin 106 to a tube 107 which extends down below the bottom of the shaft 105 and is provided with vertical slots at diametrically opposite points. A flat piece 108 extends into these slots and may slide vertically up and down the slots but is forced to rotate with the tube 107 and motor shaft 105. The tool spindle 110 is secured to the piece 108 in any suitable manner, such as by the pin 111, and this tool spindle is supported by means such as the ball bearings 112 from a tube or sleeve 113 slidable vertically in the housing or member 80. The depth limiter 114 is secured to the lower end of the sleeve 113. Due to the inherent elasticity of the thin plate 108, this plate constitutes an elastic connection between the motor and the tool spindle.

A spring 116 above the sleeve 113 presses downwardly on the upper end of the sleeve and tends to shift it to its lowermost position, in which a pin 117 on the sleeve comes into contact with the lower end of a slot 118 through which the pin projects. The sleeve, and with it the entire tool and depth limiter, may be raised by the action of a lever 120, one end of which underlies the projecting end of the pin 117, as indicated in Fig. 15. Manipulation of a conveniently accessible part of the lever 120 thus raises the pin 117, raising the tool and depth limiter. The parts may be held in this raised position, if desired, notwithstanding the action of the spring 116, by engaging the end of the lever 120 with a retaining spring 121, as shown in dotted lines in Fig. 15.

Another important feature of the present invention is the provision of improved means for holding the work and the sample or pattern to be copied. Heretofore, it has been customary to place the major axis of the work table and the model table in a direction transverse to a plane passing through these tables and through the main fulcrum of the pantograph system. Such an arrangement is shown in Figs. 1 and 16, where it is seen that the major axis of the model or pattern table 58 extends approximately perpendicular to a vertical plane passing through the center of this table and the fulcrum 50, and the same is true of the major axis of the work table 67. As usual, the tables are provided with means for clamping the model and the work to the respective tables, which means may be in the form of T-shaped slots 130 extending in the direction of the major axis of each table.

This arrangement has some advantages, in that when the pantograph swings as a whole about its fulcrum 50, the stylus 56 and cutting tool 65 swing through arcs which are substantially along the major axes of the tables and of the work or model held thereon. Such an arc of the tracing stylus is indicated at K1, and of the cutting tool at K2, and a similar arc of the cutting tool when adjusted to a different ratio of reduction is indicated at K3.

This arrangement has important disadvantages, however, in that when the pantograph mechanism is adjusted for a different ratio of reproduction, it is necessary to move the work in a direction transverse to its axis and the major axis of the work table; that is to move it from substantially the position of the arc K2, to substantially the position of the arc K3, for example. This may be especially disadvantageous when working upon round objects such as pens, fountain pen barrels, et cetera, because it often takes considerable time to fit such articles into proper position on the table after once they have been unfastened from it. The arrangement has the further disadvantage that, when reproducing lettering as indicated in Fig. 16, the lettering ordinarily extends in the direction of the major axes of the tables and is not conveniently readable by the operator when he stands in his usual position.

One of the important features of the present invention, therefore, is a new arrangement of the work and model tables whereby the above mentioned disadvantages are overcome and improved results are attained. According to this new arrangement, illustrated in Fig. 18, the major axes of both the model table 58 and the work table 67 are arranged in alinement with each other, substantially in a vertical plane passing through these tables and through the pantograph fulcrum 50. Such a vertical plane is indicated diagrammatically by the broken line 135.

With this arrangement, the pantograph tracing point 56 and cutting tool 65 move along the major axes of the tables and of the work and model supported thereon, when they move substantially toward and away from the fulcrum 50. This arrangement has the definite advantage that when the reproduction ratio is changed by adjustment of the pantograph mechanism, it is not necessary to move the work transversely, but it may be moved longitudinally to the proper position for the new ratio, which longitudinal movement is much easier and less difficult than a transverse movement. It has the further advantage that when the operator stands in the usual position, he is able to read the lettering on the model and on the work in a substantially upright and easily seen position, as indicated in Fig. 18.

The range of movement of the tool when near

the fulcrum is somewhat limited, but any disadvantage arising from this is more than compensated for by the advantages above mentioned. The diagram shown in Fig. 17 illustrates by arcs the possible ranges of movement of the tool under given conditions. The rectangles I and II show possible rectangular areas over which the tool could work effectively when the major axis is arranged in the usual direction indicated in Fig. 16, while rectangles III and IV show possible areas over which the tool can work effectively in the new arrangement shown in Fig. 18.

As an aid in simplifying the shifting from one ratio to another, the work table 67, in either arrangement but especially when arranged as in Fig. 18, is preferably movable toward and away from the fulcrum 50. Such movement has been described above in connection with Fig. 1, in which it is seen that the table 67 has guideways 68 movable along corresponding guideways in the supporting arms 69 in a direction toward and away from the pantograph fulcrum. Also in the new arrangement shown in Fig. 18, the clamping means such as the slots 130 extend in the direction of the major axes, toward and away from the fulcrum. Consequently the work or the pattern can be loosened and slid along the clamping slots to a new position, without entirely unclamping the work on the pattern.

The present invention also provides improved bearings for the pantograph mechanism. Heretofore it has been usual to provide the joints of the pantograph mechanism with special bearings, which has increased the expense to a considerable extent. According to the present improvement, the pantograph mechanism is so designed and constructed that ordinary commercial bearings readily obtainable on the market, of the type frequently known as magnet bearings, may be employed.

As shown in Fig. 19, the carrier 42 is provided with pivots 50 which project downwardly and upwardly from the upper and lower parts of the carrier, and these pivots have reduced ends 140, as plainly shown in the drawings. The pantograph arm 51 has a pair of eye portions 141 vertically spaced from each other and surrounding the pivot portions 140. Instead of making a ball race directly on the pivot portions 140, or otherwise requiring a special bearing, these portions 140 may be simply of plane cylindrical shape so that each may be received in and embraced by the inner ball race member 142 of an ordinary commercial ball bearing of a type readily available and commonly known as a magnet bearing. The outer ball race member 143 of the bearing fits snugly in the eye portion 141 of the pantograph arm 51.

The other pantograph arm 52 which rotates about the same fulcrum may be provided with a vertical pin 145 having reduced ends 146 in alinement with the pivot ends 140 and projecting into the openings in the eye portions 141 of the arm 51, as plainly shown in the drawings. Similar ordinary ball bearings may be employed between the pin portions 146 and the eyes 141, these bearings having inner ball races 147 embracing the pin ends, and outer ball races 148 fitting within the openings in the eyes 141.

Washers 150 may be employed between the two outer ball races 143 and 148 in each of the eyes 141, so that the inner ball races 147 and 142 will not contact with each other or cause any friction during oscillation of the pantograph arms. The arm 52 may be secured against movement longitudinally on its pivot pin 145 by any suitable means such as the pin 152, while the pantograph arm 51 may be secured against vertical movement by a set screw 153 passing through the wall of the lower eye portion 141 and contacting with the washer 150 or other appropriate part to hold the bearing assembly within this lower eye against axial movement.

The other joints of the pantograph system may be similarly provided with standard ordinary bearings as shown in Fig. 20. Here there is indicated, for example, the joint between the pantograph arm 52 and the arm 53. The arm 52 may be provided with eye portions 155 similar to the eye portions 141, and the arm 53 has a pin 156 which, like the pin 145 above described, has reduced ends projecting upwardly and downwardly into the eye portions of the other arm. Around these reduced ends are ordinary magnet bearings 157 as plainly shown in the drawing. A pin 158 may pass through the pin 156 to hold it against axial movement.

Endwise or axial play of the bearings within the eye portions 155 can be prevented by plugs 160 screwed into the bearing openings in the eyes, as shown. To secure these plugs against accidental turning in the openings in which they are screwed, each may be provided with a clamping screw 161 passing through a flap 162 separated from the rest of the plug by a slit as shown, so that when the screw 161 is tightened, one side edge of the plug will tend to be compressed and will clamp the threads on this edge of the plug securely against the threads with which they are engaged on the eye portion 155.

Another feature of the invention is the provision of improved means for raising or lowering and holding the work table or model table or both. This improved means is here illustrated as applied particularly to the work table. Referring now to Figs. 1, 21, and 22, it is seen that the column 41 on which the work table supporting arm 69 is mounted, is provided with a screw thread 170, which thread is preferably of substantially square cross section as indicated in the drawings. A ring 171 surrounds the column 41 and is rotatable thereon just beneath the arm 69, and this ring has suitable means for engaging the screw thread, such as the pin 172 projecting into the thread as shown in Fig. 22. It is seen that the ring 171 thus acts as a nut, and as it is rotated with relation to the column 41, it travels up or down the screw thread and raises or lowers the arm 69, and acts as a support to hold the arm 69 at any desired elevation.

As a further improvement, instead of providing the ring 171 with a pin 172 for engaging the screw thread, the ring may have one or more flat pieces 173 (Fig. 23) for engaging the thread, which flat pieces may be so set in the ring as to obtain a substantial area of bearing on the square screw thread.

To prevent the arm 69 from swinging around the column 41 as an axis, the column may be provided with a groove or keyway 175 (Figs. 1, 2, and 3) and the arm 69 may be provided with a lug or key fitting loosely in the keyway, so that vertical movement of the arm is not prevented but so that swinging of the arm around the column is restrained.

Still another feature of the present invention comprises certain improvement in the model or pattern table or support. Instead of a model table of the type shown at 58 in Fig. 1, it is pre-

ferred in many instances to substitute a table as shown at 180 in Fig. 24, which table is extended for a considerable distance in one or more directions beyond the actual pattern itself, to provide a support of substantial area for the arm or hand of the operator. This is especially desirable where the machine is to be employed in copying a flat pattern having lettering, writing, or any design which requires careful tracing.

Improved means for moving or guiding the tracing stylus of the pantograph is also an important feature of this present invention. Various forms of such improved means are shown in Figs. 25 to 28, inclusive. Referring first to Fig. 25, it is seen that the stylus 56 has pivoted thereto at 200 a handle or guiding member 201 in substantially the shape of a penholder, which may be conveniently grasped by the fingers of the operator in a natural and easy way so that the point of the tracing stylus 56 may be readily guided and moved over any desired lines on the surface of the pattern or model 202. Normally the guiding member 201 is held at substantially the angle illustrated in Fig. 25, in which it is noted that the axis of the holder, indicated by the broken line 203, passes substantially through the point of the stylus. The holder 201 may be oscillated about its pivot 200, however, to place it at a greater or less angle to the stylus, as the convenience of the operator may require.

The stylus illustrated in Fig. 25 may be both movable longitudinally and rotatable about its own axis with respect to the pantograph arm 53 on which it is mounted. This is suitable for flat work, but when relief work is to be done, the stylus should be incapable of longitudinal movement with respect to the pantograph arm, so that as the stylus moves in a vertical direction over the relief of the pattern the pantograph system will be moved in a corresponding vertical movement. Such a stylus, suitable for relief work, is illustrated in Fig. 26. Here, the stylus 56*a* is freely rotatable about its own axis in the pantograph arm 53, but is restrained against vertical movement by means of a collar 205 on the stylus below the arm 53, and a pair of lock nuts 206 on the upper end of the stylus above the arm 53.

A modified form of guiding arrangement is illustrated in Fig. 26, in which a member 207 is pivoted to the stylus at the substantially horizontal axis 208. The member 207 has a shank having an arcuate cross section similar to that of an ordinary pen, and which may be inserted in the usual pen slot of any ordinary conventional penholder 209. The penholder may then be used for guiding the stylus over the pattern or model, just as in the case of the guiding member 201 previously described. The pattern or model may be either flat, or may be in relief, as indicated at 210 in Fig. 26.

In Fig. 27 there is shown still another modification in which the stylus member 56*b* itself does not touch the pattern, but has a forked lower end pivoted at 212 to the guiding member 213 shaped like a penholder and having an end 214 for contact with the pattern 215. The end 214 of the contacting member constitutes the real tracing point in this arrangement. When the guiding member 213 is held at the proper angle, its axis 216 intersects the axis 217 of the stylus member 56*b* right at the tracing point of the member 214. The tracing point being at an angle to the surface of the pattern makes it easier for the operator to observe the exact location of the point on the pattern.

Still a further improvement is illustrated in Fig. 28. Here, the stylus member 56 is materially bowed or offset near its lower end, as plainly shown in the drawings, although the actual tracing point 220 is brought back to be directly on the main axis 221 of the member 56. The guiding member 222, in the shape of a penholder or the like, is pivotally connected to the stylus 56 at the pivot 223 which is in the bowed part of the stylus, materially offset from the axis 221. With this arrangement the guiding member 222 may be freely moved up and down about its horizontal axis 223 without in any way affecting the position of the tracing point 220, thus being somewhat more accurate than the arrangement shown in Fig. 27, and yet the angular arrangement of the end of the stylus adjacent the tracing point 220 permits close observation of the tracing point with relation to the model or pattern to be guided, so that extremely fine and accurate work may be accomplished.

I claim:

1. An engraving and copying machine comprising a pantograph system including a plurality of pantograph arms pivotally connected to each other, a rotary cutting tool having bearing means mounted on one of said arms and bodily adjustable longitudinally of said arm; and a driving motor closely adjacent said tool for rotating said tool, said motor having bearings other than said bearing means of said tool and being supported from said pantograph arm and connected to said tool for bodily movement therewith when the tool is adjusted longitudinally of said arm.

2. An engraving and copying machine comprising a pantograph system including a plurality of pantograph arms pivotally connected to each other, a rotary cutting tool and a driving motor therefor both mounted on one of said arms in substantially co-axial relation to each other, with the motor above the tool, said motor and tool being bodily adjustable together along said arm, and elastic coupling means operatively connecting said motor to said tool.

3. An engraving and copying machine comprising a pantograph system including a plurality of pantograph arms pivotally connected to each other, a bearing member, a cutting tool rotatably mounted within said bearing member, an electric motor including a housing member, said bearing member and housing member being connected to each other to move with each other bodily as a unit, one of said members being mounted on one of said pantograph arms for adjustment along said arm, and means operatively connecting said motor to said tool to rotate the tool from the motor.

4. An engraving and copying machine comprising a pantograph system including a plurality of pantograph arms pivotally connected to each other, a rotary cutting tool spindle mounted on one of said arms and bodily adjustable along said arm, a driving motor operatively connected to said tool spindle and mounted closely adjacent said tool spindle for bodily movement with the tool spindle when the tool spindle is adjusted along said arm, a sleeve surrounding said spindle, bearing means supporting said spindle from said sleeve, and means for moving said sleeve longitudinally thereby to move said spindle in a longitudinal direction independently of said motor.

5. An engraving and copying machine of the pantograph type comprising a fulcrum having a

pivot member, a pantograph arm having a portion surrounding and spaced from said pivot member, a ball bearing removably mounted between said pivot member and said surrounding portion of said pantograph arm, said ball bearing including an inner ball race encircling said pivot member and an outer ball race fitting within said surrounding portion of said pantograph arm, another ball bearing removably mounted in said pantograph arm in axial alinement with the first mentioned ball bearing, a second pantograph arm, and a pivot member secured to said second pantograph arm and held in said second ball bearing.

6. An engraving and copying machine of the pantograph type comprising two pantograph arms to be pivotally connected to each other, a pin mounted on one of said arms and projecting therefrom, a portion on the other of said arms encircling the projecting portion of said pin, and a ball bearing of substantially standard commercial construction operatively interposed between said pin and said encircling portion of said other pantograph arm, said ball bearing including an inner ball race separate from but embracing said pin and an outer ball race fitting within the encircling portion of said other pantograph arm.

7. An engraving and copying machine comprising a base, a fulcrum mounted on said base, a pantograph system mounted for oscillation about said fulcrum, an upwardly extending column on said base, an arm movable upwardly and downwardly along said column, an article support mounted on said arm, a screw thread on said column, and means encircling said column for engaging said screw thread and for supporting said arm, so that said arm may be adjusted to different positions to permit said support to be held at different elevations.

8. An engraving and copying machine comprising a base, an upwardly extending column on said base, an arm movable upwardly and downwardly along said column, an article support mounted on said arm, a substantially square screw thread on said column, and a ring encircling said column beneath said arm, said ring having means engaging said screw thread so that said ring may be rotated on said column to raise it or lower it along the column and to hold said arm and said support at different positions of adjustment.

9. An engraving and copying machine of the type including a pantograph system, a cutting tool mounted on said pantograph system, and a tracing stylus also mounted on said pantograph system, characterized by a handle substantially in the shape of a penholder connected to said tracing stylus for conveniently moving the stylus to shift said pantograph system and said cutting tool.

10. An engraving and copying machine of the type including a pantograph system, a cutting tool mounted on said pantograph system, and a tracing stylus also mounted on said pantograph system, characterized by a handle substantially in the shape of a penholder pivotally connected to said stylus for oscillation about a substantially horizontal axis, said penholder serving as a means for conveniently manipulating said stylus to shift said pantograph system and said cutting tool.

11. An engraving and copying machine comprising a pantograph system, a cutting tool mounted on said pantograph system, a tracing stylus also mounted on said pantograph system, and a handle substantially in the shape of a penholder secured to said tracing stylus for conveniently moving the stylus to shift said pantograph system and said cutting tool, the axis of said penholder passing substantially through the tracing point of said stylus.

12. An engraving and copying machine, comprising a base, an upwardly extending column on said base, a pantograph system mounted pivotally on a carrier, and link or bearing means carried by said carrier and encircling a pivot in the upper end of said column, said link or bearing means and said pivot being arranged within said column.

13. An engraving and copying machine comprising a base, an upwardly extending column on said base, an arm movable upwardly and downwardly along said column, an article support mounted on said arm, a screw thread on said column, means encircling said column for engaging said screw thread and for supporting said arm, said means being rotatable on said column to cause it to travel along said thread so that said arm and said article support may be adjusted to different elevations, a substantially horizontal pivot mounted on said column adjacent its upper end, a carrier mounted on said pivot and capable of pivotal movement with respect to said column, pantograph linkage means mounted on said carrier, and a tool mounted on said linkage means for cooperation with an article held on said article support.

14. An engraving or copying machine, comprising a base, an upwardly extending column element on said base, a carrier element, a substantially horizontal pivot connecting said two elements to each other so that said carrier element may oscillate relatively to said column element about a substantially horizontal axis, a pantograph system pivotally mounted on said carrier element, a cutting tool mounted on said pantograph system, and cooperating interengaging parts on said column element and said carrier element, including a lug on one of said elements and abutment means in the path of said lug on the other of said elements, for limiting the extent of oscillation of said carrier element with respect to said column element in one direction and to hold said carrier element in predetermined position against the tendency of the weight of said pantograph system to turn said carrier element on its horizontal axis.

KURT ZWICK.

Certificate of Correction

Patent No. 2,067,962. January 19, 1937.

It is hereby certified that the name of the patentee in the above numbered patent was erroneously written and printed as "Kürt Zwick" whereas said name should have been written and printed as *Kurt Zwick*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of March, A. D. 1937.

[SEAL]

HENRY VAN ARSDALE,
Acting Commissioner of Patents.