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APPARATUS FOR DEEP-ETCHING, PREFERABLY OF PRINTING PLATES

Original Filed Sept. 11, 1953

2 Sheets-Sheet 1

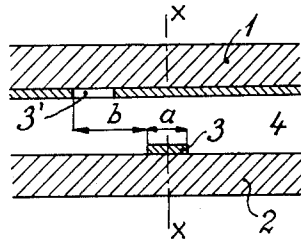


Fig. 1.

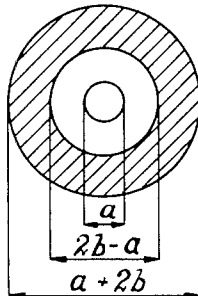


Fig. 2.

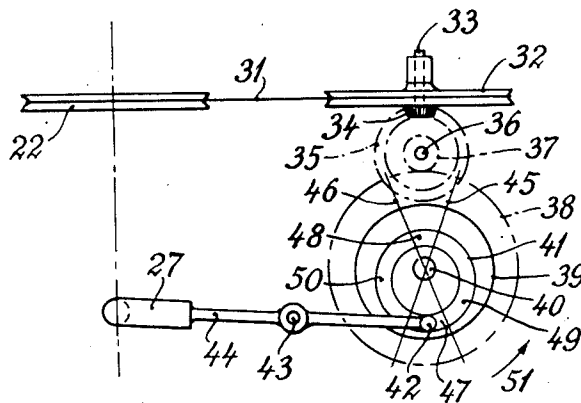


Fig. 3.

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Fig. 4.

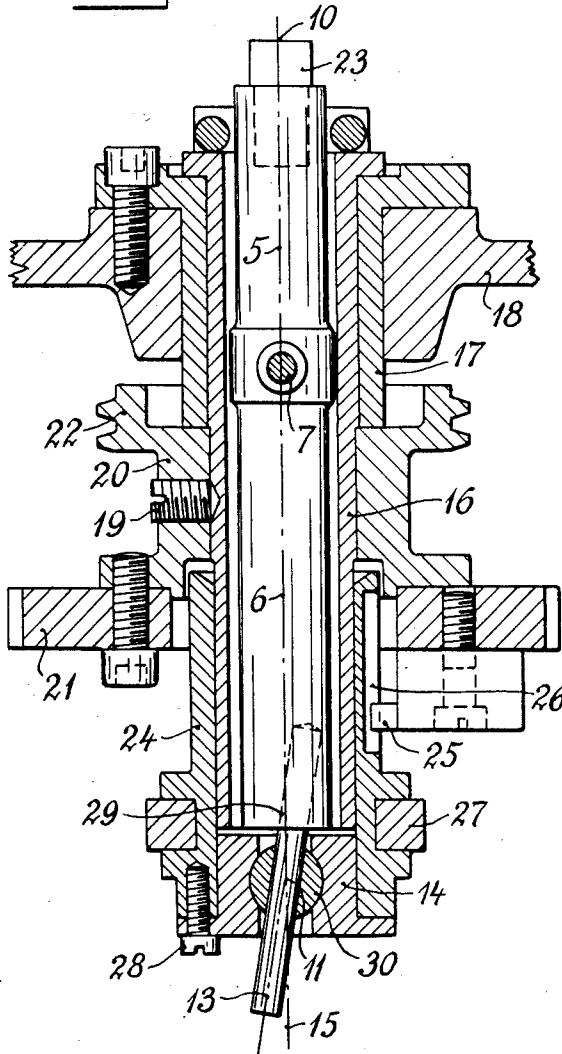
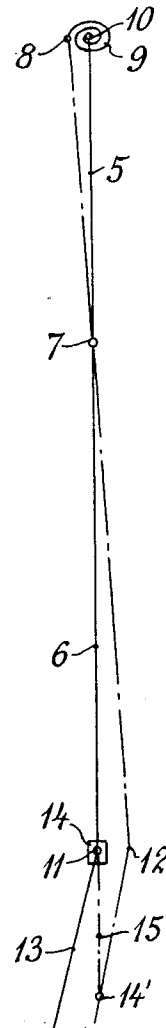


Fig. 3.



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## APPARATUS FOR DEEP-ETCHING, PREFERABLY OF PRINTING PLATES

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Original application September 11, 1953, Serial No. 379,586. Divided and this application August 31, 1954, Serial No. 453,293

7 Claims. (Cl. 95—73)

This application is a division of our application number 379,586, filed September 11, 1953.

This invention relates to apparatus for deep-etching printing plates. U. S. Patent No. 2,692,828 relates to a method of making a printing plate, comprising the steps of forming a first image from a first coating of light-sensitive, etchant-resistant material on the face of a printing plate by placing a negative in contact with said coating, subjecting the plate to the action of light and developing the plate, applying a second light-sensitive, etchant-resistant coating to said plate of a material different than that of said first coating, placing the negative in contact with said second coating and in registry with the first image, imparting a parallel motion between the plate and the negative along a closed curve while subjecting the plate to the action of light and developing the plate so as to form a second image which overlies said first image and which has its marginal boundaries of all lines, marks and dots enlarged to the same degree throughout its area so that such enlarged boundaries of the second image extend beyond the margins of the first image, etching the plate until the enlarged boundaries of said second image fall off by being undercut up to close proximity with the edges of the first image, removing the second image with a solvent which does not remove the first image, and then effecting a final etch.

However, when in the original or the negative to be reproduced elements are present which have a lesser extent than the width of the enlarged boundaries, the problem arises to have exposed to light the portions of each element which on the plate are located between the first image and the interior limitation of the light which the corresponding element lets through to the second coating, during a parallel motion with a constant amplitude.

In order to illustrate the condition reference is made to Fig. 1 of the annexed drawing which is drawn to a highly enlarged scale for a single element and for better understanding, with the negative 1 lying at a distance above the plate 2 on which has been printed already the element 3 of the first image 1. This element corresponds to the transparent portion 3' of the coating 4 of the negative 1. As will be seen portion 3' has been displaced the length  $b$  (the width of the protecting boundaries), to the left of element 3, and  $b$  is larger than the width  $a$  of element 3. Assuming now that the negative (which in practice will be in contact with the second coating on the plate 2 above the first image of which 3 is an element) executes a parallel-motion, for instance, along a circle with the center line  $x-x$  and with diameter  $a+2b$  during the exposure of the light-sensitive second coating (not shown in Figure 1) above the first image, then it is obvious that the second coating will be exposed only along a circular ring with an exterior diameter  $a+2b$  and an interior diameter  $a+2b-2a=2b-a$ , whereas the portion of the second coating which lies inside the circle having the last-mentioned diameter will not be exposed.

This is shown in Fig. 2, wherein the exposed portion of the second coating is hatched and wherein each ele-

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ment 3 or 3' respectively is, for sake of simplicity, considered to be a circle with diameter  $a$ .

According to the first method, Patent No. 2,692,828, it is presumed that  $b$  is less than  $a$  and that the exposure of the second coating to light takes place in such a manner that initially the negative is printed on the second coating in registry with the first image, whereupon the exposure of the second coating takes place during the parallel-motion with an amplitude  $b$ .

This problem, wherein  $b$  is larger than  $a$ , has consequently not been solved by the method of the mentioned patent. However, as long as  $b$  is less than  $a$  one obtains by use of said patented method protective edges all having the same width so that the number of required etchings is reduced, and a qualitatively better result is obtained. Furthermore, the work is cleaner. However, the second coating must still be initially exposed to light with the negative in registry with the plate, before the exposure during the parallel-motion is started.

The present invention consists in an apparatus for carrying out the method which is the subject matter of co-pending application No. 379,586 which, broadly speaking, is a method for making a printing plate by placing a photographic negative of the image to be reproduced in contact with a light-sensitive etchant-resistant coating on a plate and imparting a parallel motion between the plate and the negative along a closed curve while subjecting the plate to the action of light. By means of the said apparatus it is possible to obtain a complete exposure of the second coating, no matter how large  $b$  is as compared to  $a$ , and consequently independently of whether  $b$  is less or greater than  $a$ . At the same time the above-mentioned first exposure can be executed with the negative in registry with the plate as a part of the exposure operation.

According to said method which the apparatus of this invention is capable of carrying into effect the amplitude of the parallel-motion is continuously and controllably varied so that those portions of the plate are exposed which are located between each separate element on the first image and the inner edge of the light passed through by the corresponding element on the negative to the second coating during a parallel-motion having constant maximum amplitude.

Reference is made to the accompanying drawings, in which:

Figure 1 is a highly enlarged diagrammatic cross sectional view illustrating corresponding portions of both a negative and a printing plate, with the negative shown spaced from the printing plate for clarity of illustration;

Figure 2 is a diagram illustrating certain difficulties encountered in this art;

Figure 3 is a diagram illustrating the apparatus for varying the parallel motion amplitude;

Figure 4 is a cross sectional view illustrating apparatus in accordance with the invention; and

Figure 5 is a diagrammatic plan view illustrating further elements in addition to the apparatus shown in Figure 4.

Thus, with reference to Fig. 1, when the amplitude of the parallel motion is not at a constant maximum distance  $b$ , but is varied from this value down to zero and back again, the whole area of the second coating, viz: the circle with diameter  $a+2b$ , will be exposed to light.

This can be accomplished in several ways. A suitable manner is to gradually alter the amplitude one or more times during the contact printing on the second coating from zero to the adjusted maximum and back, so that all elements of the second coating which correspond to the elements of the first image, with the addition of the edge width  $b$ , are exposed, because the plate or the negative during the contact printing is forced to follow a spiral-

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shaped parallel-motion from zero to maximum amplitude, thus resulting in the exposure to the exterior line of the desired edge width *b*, and then back to zero. During this procedure the amplitude may be held at maximum for a short time, as well as held at zero for short duration. The amplitude may also be altered from zero stepwise to maximum and in corresponding manner back to zero.

It is obvious that the plate may be moved in relation to the stationary negative, or vice versa. In the illustrated example it is presumed that the plate 2 is moved parallelly (Figure 1) to a stationary negative.

In Figure 3, an arm 5, 6 is pivoted about a fixed point 7. The arm portion 5 is pivotally connected at 8 with the plate which is capable of movement parallel to the negative by means not shown. In order to have the arm 5, 6 oscillate about pivot 7, so that the point 8 will follow a tight spiral 9 from point 8 inwards to point 10 (zero) and a similar spiral back to 8, a corresponding spiral motion is imparted to the point 11 of the arm portion 6. During spiral movement the arm is rotatable about its axis simultaneously with the amplitude variation by moving the lower end of arm portion 6 from zero at point 11 to a maximum at point 12. Rigidly connected to the arm portion 6 is an extension 13 which forms an angle with arm portion 6 of somewhat less than 180° and on which a sleeve 14 is displaceable from point 11 upwards and downwards. Sleeve 14 is moved in a path which is a longitudinal extension of arm portion 6 in its zero position and which is indicated by the line 15 from point 11 downwards to point 14'. As long as the sleeve 14 is in the position (at point 11) shown in Figure 3 and the arm 5, 6 is rotated, the amplitude at point 10 will be zero. But if the sleeve 14 is displaced downwards to 14', point 11 will have been shifted out to point 12 and point 10 shifted to point 8. During rotation of the arm about the axis 15, the point 12 as well as the point 8 will travel in a circle about point 11 and point 10 respectively. During such rotation, displacement of sleeve 14 downwards to point 14' will of necessity force point 10 to follow the spiral path 9.

This principle is illustrated in the structure shown in Figure 4 wherein the numerals 5, 6, 7, 10, 11, 13, 14, 15 correspond to and indicate the same parts referred to in Figure 3.

In Figure 4, the arm 5, 6 is pivotable about a transverse pin 7 attached in a surrounding sleeve 16 rotatable about the longitudinal axis which passes through points 10—11. This sleeve is rotatable in a bushing 17 in frame 18 but cannot be displaced longitudinally. Externally on sleeve 16 another sleeve 20 is attached by set screw 19, to which is attached a driving gear 21 and a cord pulley 22. The point 10 is in the centre of the top face of a pin 23 in the upper arm portion 5.

Lowermost on sleeve 16 is third sleeve 24 which by means of a pin 25 attached to gear 21 is slidable in a longitudinal groove 26 exteriorly on sleeve 24. The sleeve 24 is movable up and down by means of a fork 27. A bottom piece 14 is attached to sleeve 24 by a screw 28 and a guide member 30 is pivoted in such bottom piece. Member 30 has a diametrical bore through which the arm extension 13 is passed, extension 13 being rigidly received in an inclined bore 29 in the lower end of arm portion 6, so that the sleeve 24 with bottom piece 14 and guide member 30 may be displaced relatively to extension 13.

In the position shown in Figure 4 the motion amplitude at 10 is zero. But if the bottom piece 14 is moved downwards along sleeve 16 and consequently shifting point 11 downwardly along on line 15 (axis of arm portion 6), the arm 5, 6 will assume an inclined position in sleeve 16, and then when the members 21, 20, 22, 19, 16, 7 and arm 5, 6 with 23, 28, 14, 13 and 30 are rotated, the point 10 will move in a spiral path 9 from zero (at point 10) to a point proportional the displacement of piece 14.

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Therefore, it is the fork 27 which controls at any one instant the amplitude of the parallel-motion, whereby the amplitude (and consequently the edge width *b*) may be adjusted from maximum to zero.

The movement of fork 27 may be controlled by a lever and a cam which latter is rotated by means of the cord pulley 22, so that the cam rotates once for a certain number of revolutions of pulley 22. It should be clear that it is thus possible to automatically obtain any desired spiral motion of point 10 and any parallel-motion of the plate 2 relative the negative 1.

Figure 5 diagrammatically shows an example of the operative connection between cord pulley 22 and fork 27. The pulley 22 through belt 31 actuates another pulley 32 on shaft 33. The pulley 32 through bevel wheels 34, 35 transmits a driving force to the pin 36 of a pinion 37 which is in mesh with a larger gear 38 on shaft 40 of cam 39. The groove 41 of the cam engages a pin or roller 42 carried by one end of a lever 44 which is pivoted about a fixed pin 43 and the other end of which terminates in the fork 27. The cam groove 41 has two dwell portions, viz: between the diameters 45 and 46, a portion 47 with a large radius and a portion 48 with a small radius. The transitions 49 and 50 between the dwell portions have an increasing and a decreasing radius respectively. In the position shown, the fork 27 and the sleeve or bottom piece 14 are in their uppermost position and point 10 is in its zero position. If the cam 39 were to rotate in the direction of arrow 51, no parallel motion of the plate 2 will occur until the pin 42 passes the dwell portion 47.

But when pin 42 enters the groove portion 50, it will move continuously upwards, so that sleeve 14 will be displaced downwards as seen in Figure 4. The point 10, will therefore move along the spiral path 9 out to point 8, namely until the pin 42 enters the next dwell of cam 39. During the dwell, point 8 will move in a circular path. Then when the pin 42 enters groove portion 49, the fork 27 will gradually move upwards, and consequently the amplitude of the parallel motion will be reduced uniformly down to zero during a spiral motion inwards from point 8 to point 10. The rotational ratio *n* between sleeve 16 and shaft 40 is approximately 15 to 1, in other words, the spiral motion of point 10 outwards and inwards and the circular motion of point 8 at the outer edge of the spiral path and the stand-still motion of point 10 at the inner edge of the spiral path requires about 15 revolutions of arm 5, 6 for one revolution of shaft 40.

If the fulcrum pin 43 of the lever 44 is arranged to be adjustable along the lever, then the amplitude of the parallel motion (and thus the width *b*) may be varied or adjusted. Adjustment of the pin 43 inwards to the centre line of bottom piece 14 will result in zero amplitude.

Of course, amplitude variations may also be obtained by altering the shape of the cam groove 41.

The term "contact printing" used herein is to be understood as meaning that negative and plate during exposure to light are maintained in contact with each other. By "contact" it is understood that the plate can be moved relative to the negative without any friction of practical importance arising between them, but both are so close to each other that the light gets no opportunity to protrude laterally.

We claim:

1. Apparatus for making a printing plate by placing a member in the form of a photographic negative of the image to be reproduced in contact with another member in the form of a plate having a light sensitive etchant resistant coating thereon and imparting a parallel motion between the members along a closed curve while exposing a light sensitive member to light, comprising a lever pivoted within a sleeve and having one end pivotally connected to one of the members, the other end of such lever being provided with an angled extension receivable within a bottom piece which is slidable in a fixed path

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toward and away from the sleeve in such a manner that the said second-mentioned end of the lever during movement of the bottom piece away from the lever will be moved off center relative to the sleeve.

2. Apparatus according to claim 1, in which the sleeve, within which the lever is pivoted, is rotatable about its longitudinal axis, the bottom piece being slidable along said sleeve and being restrained from rotating therewith.

3. Apparatus according to claim 2, in which a gear is attached to the sleeve and serves to impart rotation thereto.

4. Apparatus according to claim 3, in which a mechanism is provided to move the displaceable bottom piece toward and away from the sleeve in a predetermined ratio with the revolutions of the sleeve.

5. Apparatus according to claim 4, in which said mechanism comprises a rotatable cam operable by the gear

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carried by the sleeve, such cam being in engagement with one end of another pivoted lever, the other end of which is in operative engagement with the bottom piece.

6. Apparatus according to claim 5, in which said other pivoted lever has an adjustable fulcrum permitting variation in the amplitude of the parallel motion between the members.

7. Apparatus according to claim 6, in which the fulcrum is adjustable towards the centreline of the bottom piece to obtain zero amplitude.

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