Dec. 2, 1958 R. HELL 2,863,000

DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 1

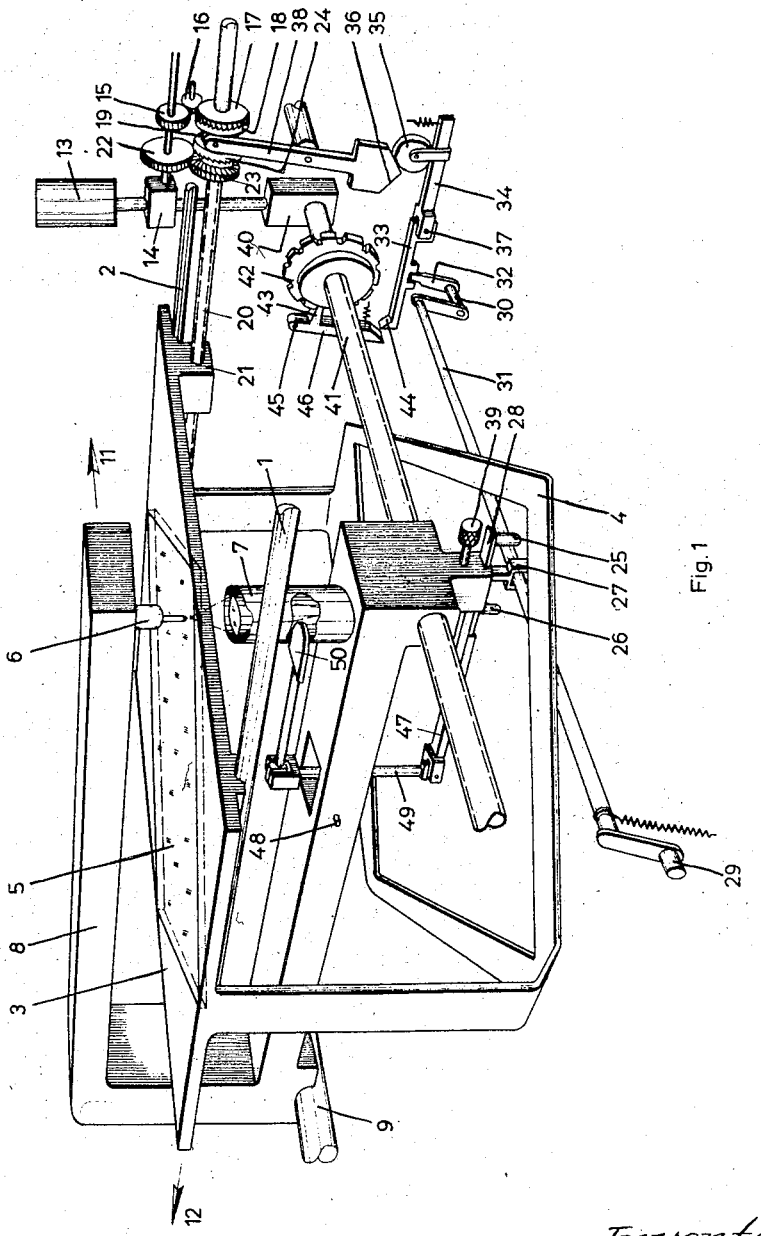

Fig. 1

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DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 2

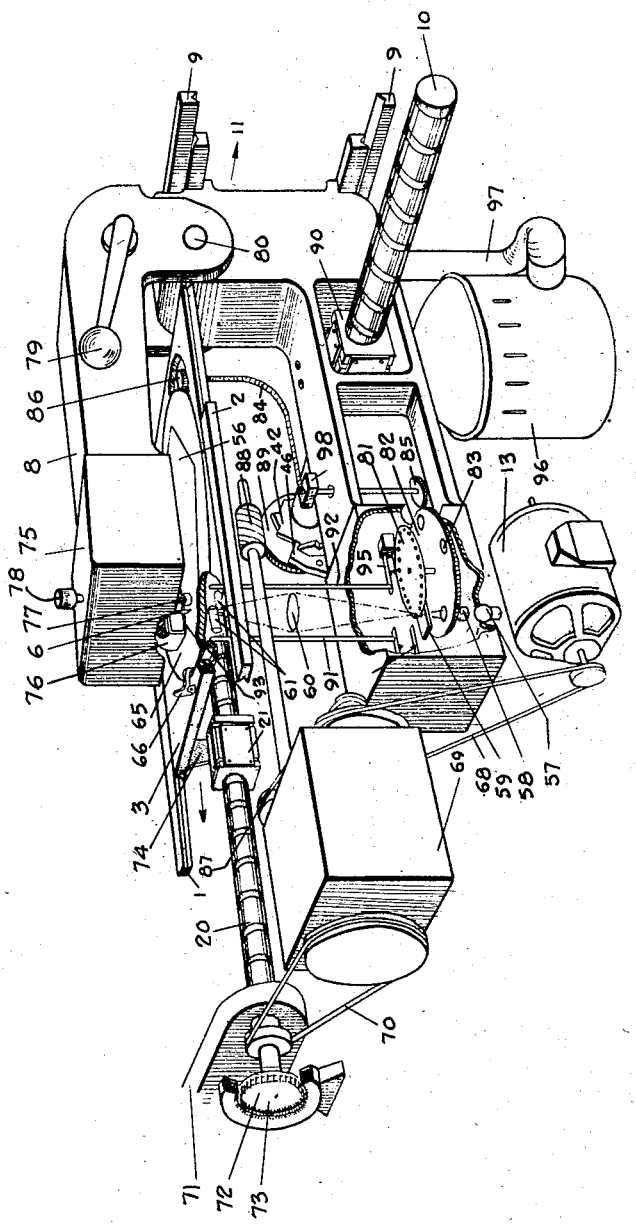

Fig. 2

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DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 3

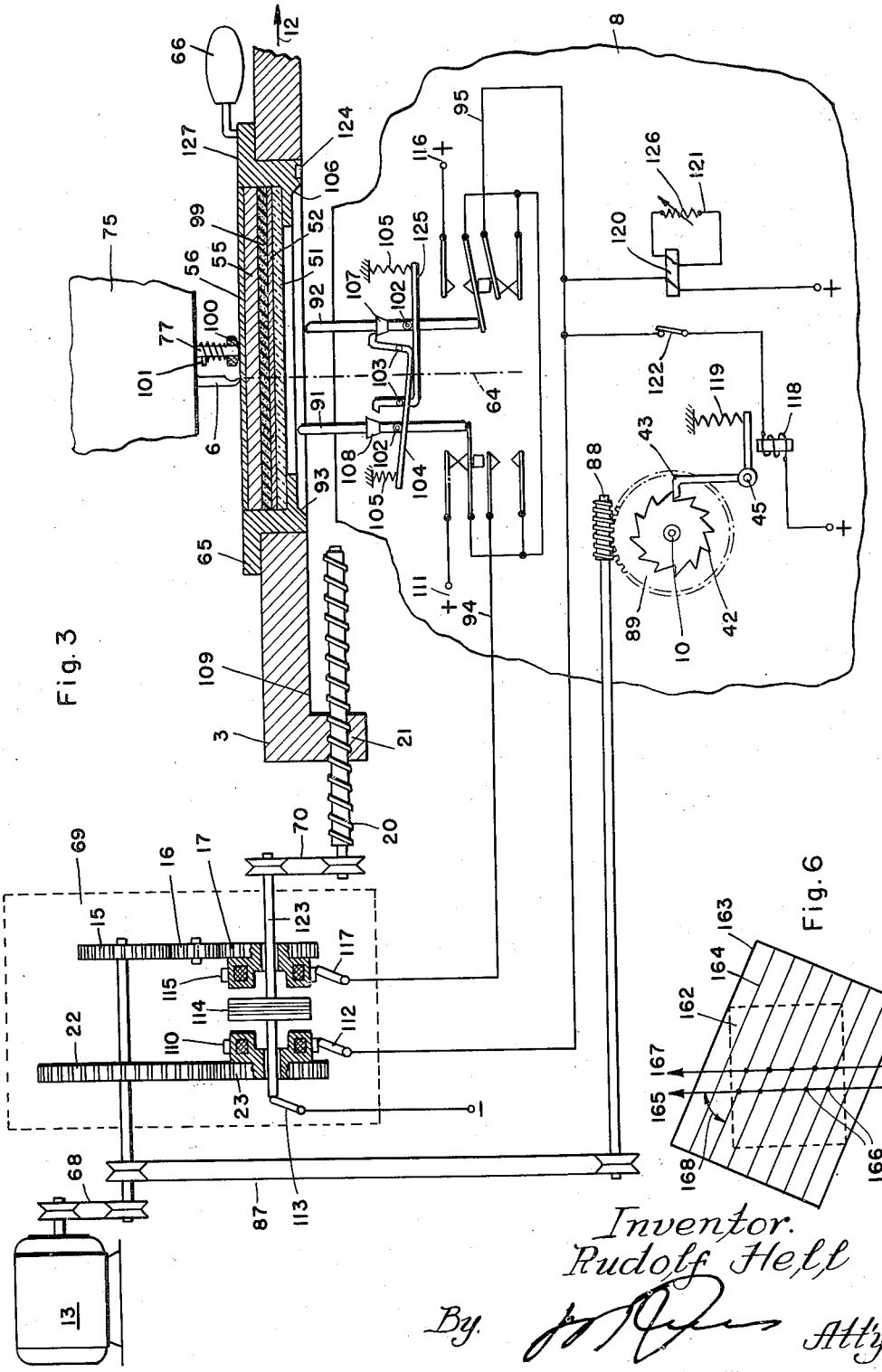

Fig. 3

Fig. 6

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DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 4

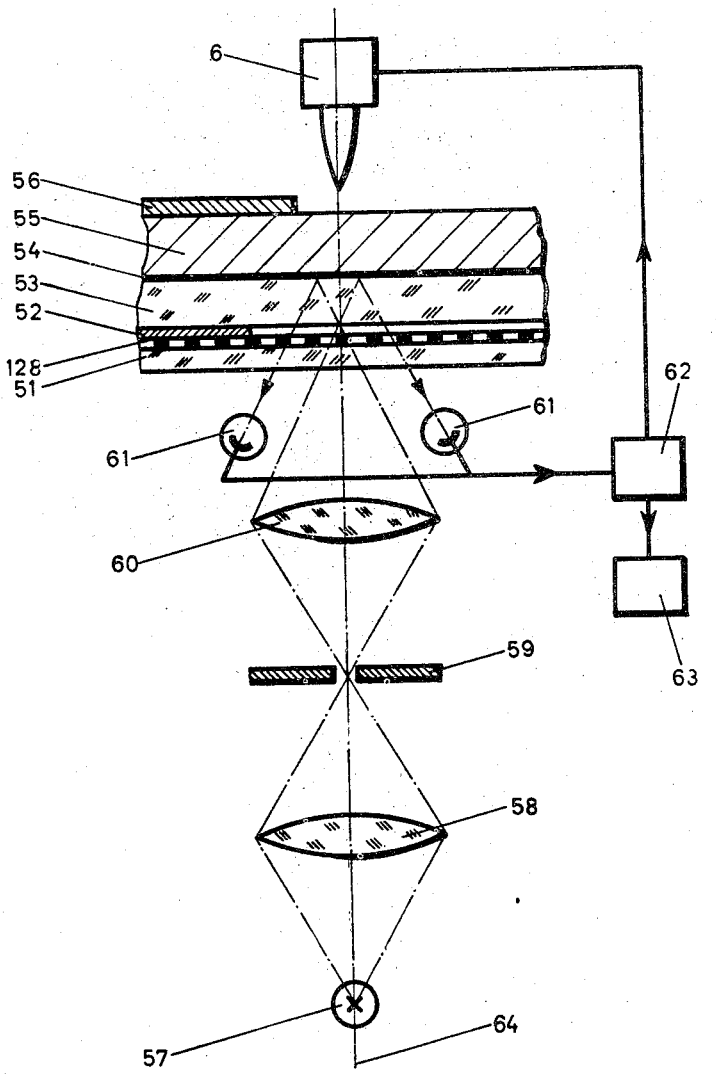

Fig. 4

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DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 5

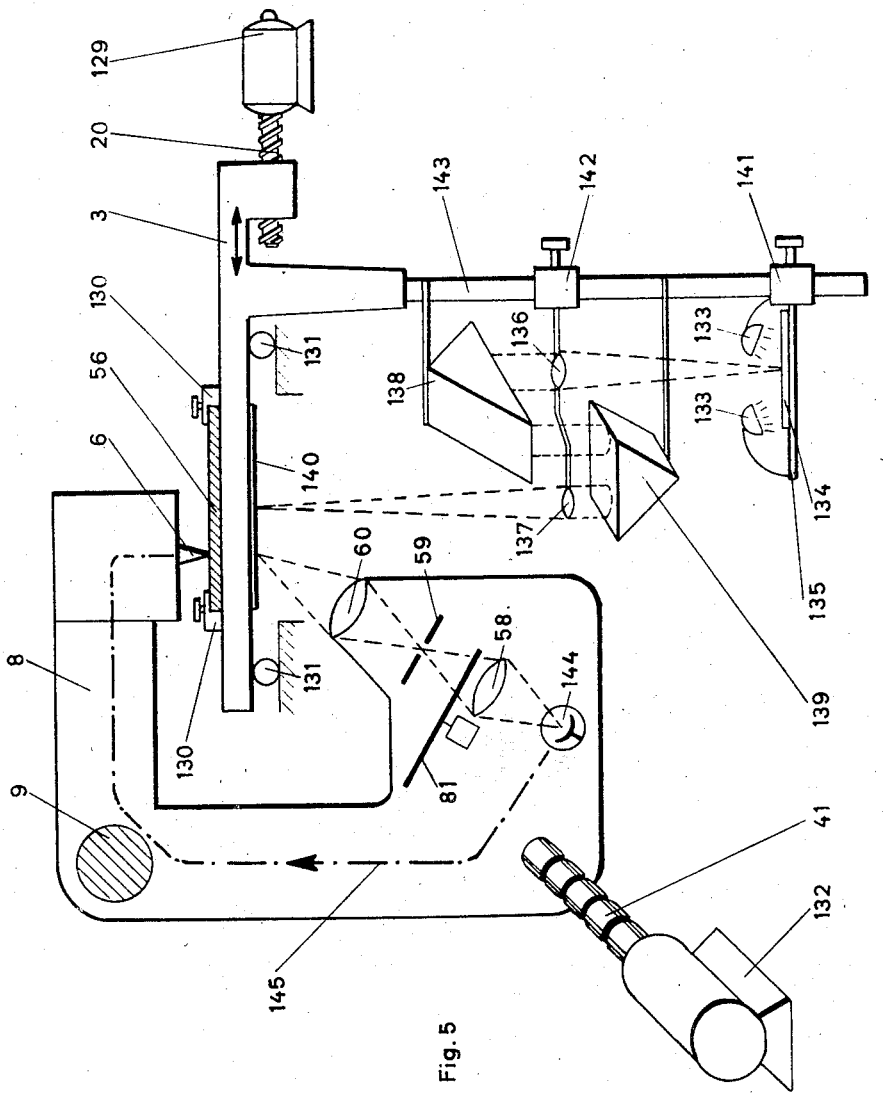

Fig. 5

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DEVICE FOR MAKING PRINTING BLOCKS

Filed May 5, 1953 6 Sheets-Sheet 6

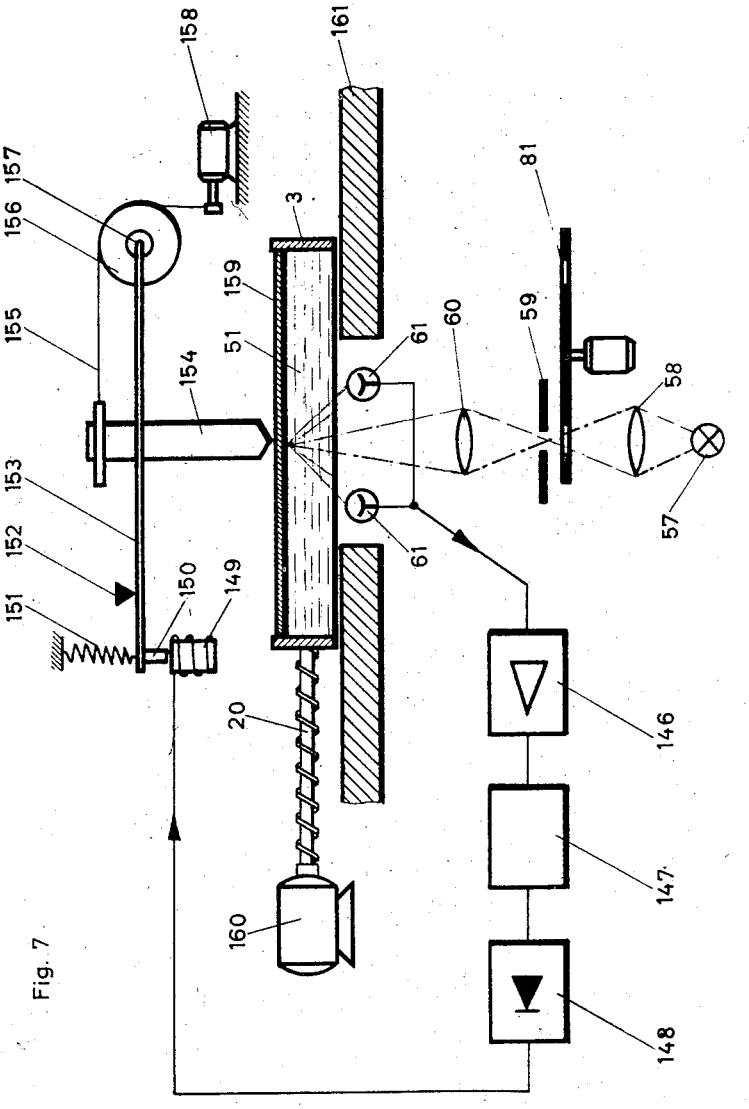

Fig. 7

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United States Patent Office 2,863,000 Patented Dec. 2, 1958

2,863,000

DEVICE FOR MAKING PRINTING BLOCKS

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Application May 5, 1953, Serial No. 353,212

Claims priority, applications Germany May 9, 1952, Sweden, July 14, 1952, and Netherlands September 9, 1952

11 Claims. (Cl. 178—6.6)

This invention is concerned with the production of printing blocks or plates.

In processes employing methods of picture telegraphy for the production of printing plates, an original picture copy is scanned line for line with the use of a photosensitive cell. In the same manner, an engraving tool whose action is controlled by the photoelectric currents, is moved line for line over the printing plate blank to be treated, the movements of the scanning member and of the engraving member always being in correspondence with each other. As engraving members may be used pressing, drilling, milling, cutting or burning tools.

In some of the known processes, the picture copy and the printing plate blank are positioned side by side on a common drum or on two drums mounted on a common shaft. During rotation of the drum or drums, the scanning member is advanced along a generatrix of the drum surface so that the picture copy is scanned along a helix and the printing plate is produced in the same manner. The common shaft insures synchronism between the scanning of a line on the picture copy and on the plate respectively. The feed motion is obtained through an endless belt or a feed screw. In the latter case, a divided feed screw is required having portions with right-handed and left-handed threads for the scanning and graving members, respectively, so that the two members may perform oppositely directed feed movements. In this manner, the printing plate will bear the mirror image of the picture copy, so that prints made from the plate will in turn have their sides correct. A high degree of precision is required of the two feed screw portions.

In other known processes, the picture copy and the printing plate blank are arranged side by side on a common flat carriage which performs both line movements and line-to-line shifts while the scanning and graving members are stationary. In this case, adjacent lines are scanned consecutively in the same direction without shift motion. Between successive line scannings, the carriage is returned with simultaneous line shift movement. This arrangement has the disadvantage that the printing plate is not produced as a mirror image of the original.

In other known arrangements the picture copy and the printing plate blank are positioned on two separate carriages whose movements are coupled mechanically. Line movement takes place in the same direction for both carriages, while the line shifts are oppositely directed so that the image on the plate will be produced as a mirror image of the picture copy. Advantageously the line and shift movements are divided up between the interconnected carriages and the scanning members. In any case, however, it is again necessary to employ a divided feed screw in order to obtain the image on the printing plate as a mirror image of the copy, with the screw sections threaded oppositely and requiring high precision since even slight differences in line spacing will be observed by the eye as a disturbing line pattern particularly in the case of screen-processed printing plates.

The present invention relates to the production of screen-processed or of screenless printing plates, the type of tool employed being immaterial to the inventive concept. The invention avoids the disadvantage of two oppositely directed feed motions with its resultant requirements of the feed screw or similar feed mechanisms and the need for precision, and nevertheless produces the printing plate image as a mirror image of the picture copy. According to the invention, the picture copy is located on one side and the printing plate blank on the other side of one carriage or table. The scanning and graving members are fixedly positioned opposite each other on opposite sides of the table. When the table performs the line and shift motions (with the shift taking place in known manner only during return of the carriage) the printing plate image will automatically be produced as the mirror image of the picture copy. This arrangement is distinguished by its simple construction and avoids all drawbacks which, in the arrangements heretofore known, arise from the transmission of the feed motions from the scanning member to the graving member. Of particular advantage is an arrangement wherein the line movement is carried out by the table while the shift movement is performed by the scanning and graving members which are mounted opposite to each other on a common arm.

In printing pictures with half-tones, it is desirable for the printing plate to present a screen pattern with the full-line direction extending at an angle of 45° to the edge of the picture. It is known to produce screens of this type by scanning the picture copy at an angle of 45° to the picture edge and producing the plate in the same manner. In this operation, a (for example square) picture copy is mounted diagonally on a carriage or drum. Since in drum arrangements the line movement always remains of constant length, the area being scanned has a side length corresponding to the diagonal of the copy and is thus of a size twice the area of the copy itself. Half of the printing plate thus produced, and half the time of operation, are accordingly not utilized.

This disadvantage of the so-called diagonal carriage is obviated according to the present invention by the provision of a reversing mechanism which terminates and reverses the line movements of the carriage or table whenever the scanning member reaches the edge of the picture copy. In contrast to known reversing mechanisms, which are adjustable solely to the over-all dimensions of the copy and which always determine the line movement at a constant value, a device positively controlled by the picture edge precludes the scanning of the areas located beyond the picture edges, which are useless for reproduction.

In one embodiment of the invention, the table, which performs the line motion, carries a frame having the shape and position of the picture copy, which latter is mounted at an angle of 45°. In addition, the arm, which performs the shift motions, carries two abutments respectively corresponding to the beginning and the end of a line and whose spacing from each other is adjustable to conform to the size of the picture copy. These two abutments extend into the frame and, upon engagement by the latter, operate a rocking lever to reverse the direction of line motion through the medium of a linkage and a clutch. Thus, if picture copy (for example square) is scanned in diagonal direction, the frame carried by the table will strike the abutment associated with the end of the line, and the abutment will rock a lever to its other position in which it reverses the scanning movement through a clutch. At the end of the ensuing return movement, the opposite side of the entrained frame will abut against the second abutment associated with this side, which abutment will rock the same lever back to its initial position and restore the initial direction of the scanning motion. Since during the shifts, the abutments travel along diagonals of the frame while the latter reciprocates at right angles thereto in the direction of the

lines, the frame will strike against the abutments sooner and sooner as the abutments get nearer a corner of the frame. In this manner, the line movement becomes shorter and shorter and at all times corresponds to the length of a diagonal line of the picture copy. The same principles apply to rectangular picture copies and frames.

According to a further object and feature of the invention, the table has a specular surface on which the picture copy is mounted. When the edge of the copy passes beyond the scanning member which illuminates it, the specular surface of the table will reflect the incident light into the photoelectric cell with an intensity that exceeds the light diffusely reflected by the original. In this manner, upon passage beyond the edge of the picture, a strong impulse is created in the cell which may, for example, actuate a reversing relay that is not energized by the weaker impulses from the picture. The relay causes the line movements to be reversed each time this happens, so that the table will perform a reciprocatory motion only between the edges of the picture.

In one arrangement of this nature, in which, for example, the scanning member projects a light spot onto the copy whose light is diffusely reflected into the photoelectric cell, the light rays, after passing beyond the edge of the picture copy, would be reflected in the direction of incidence by the specularly reflective table surface and would thus fail to reach the photoelectric cell.

Therefore, according to invention, the axis of the scanning member is arranged obliquely to a line normal to the table surface so that the light reflected by the specular table surface will just enter the photoelectric cell. If the axis of the scanning member extends normal to the table surface, the latter is provided with fluting such that the incident light rays are deflected or diffracted into the photoelectric cell with an intensity which exceeds that of the diffuse light reflected by the copy. In another embodiment, the table surface is formed by a heavy mirror plate glass pane supporting the picture copy on one side, an image of the light source for the scanning member being projected onto the copy. After passage beyond the copy edge, the light beam will penetrate the plate glass pane and will be reflected only by the reflective coating at the back thereof. Since due to the thickness of the pane the image of the light source will no longer be sharp at the back surface of the pane, the rays will no longer be reflected in the direction of incidence but will only be projected into the photoelectric cell.

According to a further feature of the invention the table has an exchangeable insert or frame mounted therein which receives the picture copy—face down in the direction of scanning—and the printing plate blank superposed thereover, and which at the same time carries the reversing means extending below the table. Advantageously the parts defining a recess for receiving the picture copy are designed so as to serve as the reversing means. In this case, two small, easily movable and fixedly spaced abutment pins cooperate with the frame; these pins control, without any mechanical connecting linkage but through the medium respective sets of contacts, an electromagnetic clutch for the table reversing mechanism. The elimination of linkage for a mechanical clutch permits the reversing means to be arranged directly on the carriage frame without obstructing the scanning mechanism. Moreover, actuation by contacts requires only small forces. Consequently, after actuation of an abutment pin, the table will coast to a stop smoothly and will then reverse its direction. The electromagnetic clutch controls the direction of travel of the table much more rapidly than does a mechanical clutch so that only little time is lost in the reversing operation. At the same time this clutch actuates a magnet which momentarily releases a detent wheel for the shifting feed of the scanning arm. Preferably the abutment pins are interlocked and participate in the shift motion of the scanning arm.

The reversing means on the insert frame corresponds to the picture copy not only as to position and shape but also as to size. To permit printing plates to be produced economically from picture copies of small size, the insert frame is replaced by another one having a smaller recess for the copy and forming correspondingly smaller reversing means. In practice, three or four such insert frames are adequate; for example, in the case of plates for newspaper printing, they may correspond to pictures extending in width over one, two, three and four columns, respectively.

The provision of a special insert frame for the table according to the invention has the special advantage that the frame can be angularly displaced relative to the table. In printing plates for color printing it is necessary to produce the individual screen-processed plates, each corresponding to a component color, with a screen that is angularly offset by a certain amount relative to the screens of the other plates. This angle may be set by simply rotating the insert frame. Advantageously, such rotation of the frame is coupled with rotation of a turret carrying color filters within the path of the rays of the scanning device, so that each color filter has a predetermined screen angle associated therewith.

When employing synthetic foils as the printing plate material, it is advantageous to press the foil firmly against its support during the graving operation by clamping means attached to the graving mechanism, for example, in the form of a "foot." In this case, the insert frame must be larger than the foil positioned in its recess, at least by an amount sufficient so that, after passage beyond the edge of the foil, the foot will still have sufficient bearing support during the coasting phase of the table motion up to the reversing point. To this end, the top face of the insert frame is formed with a flat bearing surface flush with the inserted foil. In this manner, the foil need not be larger than the picture copy, resulting in saving of material.

The insert frame according to the invention is provided on its underside with a check mark in the form of a small white or black-and-white area adapted to be moved into the path of the rays of the scanning device and serving for the electrical adjustment of the apparatus.

To produce the screen pattern required for reproducing half-tones in printing plates known apparatus provide for a periodic or intermittent phenomenon which is superimposed over the graving operation. This causes the continuous-line treatment of the printing plate to be resolved into dotted treatment, with the frequency determining the screen size and hence being termed screen frequency. In order that the individual screen dots of adjacent lines will be next to each other or offset by a constant amount relative to the next preceding line, the screen frequency is synchronized with the scanning motion of the tool.

In the present invention this synchronism is maintained by scanning, simultaneously with the copy mounted on the carriage, a screen template moving in synchronism therewith. In contrast to the known procedure, however, this template is placed directly on the picture copy, and both are scanned jointly and simultaneously by one and the same scanning device. If the scanning of the copy is effected by means of a small light spot traveling thereover in successive lines, the lines of the screen template will periodically cover the copy and will at these points prevent reflection of the light from the copy into the photoelectric cell. This produces an intermittent or chopped photoelectric current which is amplified and directly controls the graving tool.

The advantages of this operation reside not only in the fact that there can be no play between the drive for the screen frequency producer and the other motion producing mechanisms since the screen frequency is produced

in situ on the picture copy, but also in the extreme simplicity of construction of such an arrangement. The precision accomplished by the mounting of picture copy and printing plate blank on opposite sides of a positively moved table, is fully preserved when using such a screen template.

According to this aspect of the invention, the screen template is applied to the picture copy by placing a plate having the screen line system therein, directly upon the copy. For a given speed of scanning, the spacing of the screen lines corresponds to the screen frequency. For example, the screen plate may consist of a scratched glass pane, a lattice with blackened lines, or a flexible foil provided with grooves. By using different screen plates with varying line spacing, the screen desired for the printing plate may be selected at will. If the lines of the superposed screen are perpendicular to the direction of scanning, the screen dots of successive lines in the printing plate will be next to each other, which is desirable for example when employing a wedge-shaped cutting graver. If the screen dots of consecutive lines of the printing plate are to be offset from those of the next preceding line, as is preferred, for example, when employing a spoon- or scoop-shaped graver, the line screen will be placed on the picture copy at an angle to the direction of scanning. The obliqueness will then be exactly such that the lines of scanning will intersect the screen lines at points that are located intermediate the points of intersection of the preceding line.

Instead of placing the screen plate directly upon the picture copy, it may be positioned at a suitable distance therefrom. In this manner, the copy image to be scanned will be resolved into dots, as is well known from the photographic cross-screen process in autotype or halftone etching.

The line screen placed on the picture copy consists of lines and gaps of finite widths. The scanning light spot travels over this line screen; or alternatively the entire screen template and original are illuminated, and an optical system is employed to single out an image element which will project light into the photoelectric cell. The shape and size of the scanning light spot or of the singled-out picture image element relative to the widths of the lines and gaps of the screen plate will determine the variations of the photoelectric current as a function of time, that is, the graph form of the impulses controlling the graving tool. With varying brightness of the picture copy and thus with varying amplitudes of the impulses, the steepness of the gradients of the impulse graphs will vary correspondingly. If the impulses control the graving tool directly, these impulse gradients will at different times conform differently well to the graving operation. For this reason, advantageously, the picture contents, that is, the amplitude of the impulses, and the screen frequency of the intermittent and modulated photoelectric current are separately fed to an oscillator that produces modulated impulses of constant steepness for the control of the tool.

In practice, especially in newspaper printing, the picture copy is in most cases of a different size than is required for the printing block. It is, therefore, customary to reduce or enlarge the copy to the required size by the indirect method of photographic reproduction and to use this reduced or enlarged picture as the copy to be scanned. Since any additional photographic reproduction or intermediate picture-taking involves not only additional labor and time loss, but also considerable loss of tone values, it is desirable to be able to dispense with this intermediate photographic process in the electro-mechanical production of printing plates.

Therefore, in a modification of the invention, the uniformly illuminated copy is projected, by means of an objective and in a manner known per se, onto an image plane situated on one side of the table, and only this projected image is scanned photoelectrically. In this optical image projection, the scale of reproduction is determined by varying the distance of the objective and the distance of the picture copy from the image plane, in such a manner that the size of the copy or of a section thereof is enlarged or reduced to the size desired for the printing plate. The projected image may either be formed in the image plane without the use of a projection screen or may be intercepted on a diffusely reflecting picture screen. When using such a screen, the projected image is scanned with the use of a real or virtual diaphragm which is positively moved relative to the screen. The light diffusely reflected by each element of the image impinges into the photoelectric cell which travels along. By the scanning of the projected image or image section, the relative scanning movement, taking place in the line-wise and line-shift directions, will be transmitted on the same scale to the graving member. The printing plate thus produced will accordingly bear the desired picture section on the desired enlarged or reduced scale.

As long as the table supporting the printing plate blank is disposed stationary, the table as well as the projected image must be scanned, by the graving and scanning members respectively, in two directions at right angles to each other. But if these two motions are carried out by the table itself or if they are divided up between the table and the scanning and graving members, then, according to invention, the projecting apparatus is moved in common with the table. The projected image is thereby likewise moved along with the table. Thus it is possible to cause the image to be projected onto the underside of the table and to engrave the printing plate blank on the upper side of the table. In that case, according to the invention, the projecting apparatus is rigidly mounted on the table. In order to obtain a side-true (that is, not mirror-reflected) projected image, there is inserted into the path of rays of the projecting apparatus an image-reversing device which may, for example, consist of two crossed, totally reflecting prisms or of two objectives between which a real intermediate image of the picture copy is located. In this manner, the printing plate blank on the upper side of the table will receive a mirror image of the picture copy. The invention presents the advantage that variations of the scale of reproduction are effected in the optical portion of the system while the transmission of the projected image onto the printing plate blank takes place without the intervention of mechanical gearing and thus also without picture defects.

If the table has a diffusely reflecting projection screen thereon on which the projected image is scanned, a line screen template may be also applied in this case so as to produce a resolved image on the projection screen. For example, the lines of the screen template may be printed in black on the projection screen.

As is well known, screen-processed printing plates are generally specially prepared for the form. In the known "relief etching" process, a screenless relief plate is chemigraphically produced from the picture copy, with the bright picture portions more deeply etched than the darker ones. This relief plate is placed under the printing plate during matrix production or printing, so that the small screen elements representing the lights can recede and are relieved of the load. In the known "back etching" process a screenless relief is produced chemigraphically on the reverse side of the printing plate so that the thickness of the latter is less at the bright picture portions than at the dark ones. This causes the small screen elements to be relieved of load during the matrix preparation or during printing. Thus, in either case the remaining conical screen dots of the autotype, serving to reproduce the bright parts, are caused by this preparing operation to be positioned beneath the remaining, larger screen surfaces constituting the printing plane.

The invention relates to the production not only of printing blocks but also of relief plates such as they are required for readying for the form. In this case again

the picture copy is scanned on one side of the table while the relief plate is being engraved on the other side thereof. By producing the printing plate and the relief plate in one and the same recess of the table insert, exact correspondence of printing plate and relief plate is insured. To shorten the time required for making the relief plate, the picture copy can be scanned with a larger light spot and a higher rate of feed, and simultaneously the relief plate can be graved with a broad planing or milling tool.

According to the invention it is also possible to engrave the reverse side of the screen-processed printing plate itself—comparably to the back etching process—to make it ready for the form. In such case, image engraved on the printing plate blank is photoelectrically scanned. To this end, the finished screen-processed printing plate is disposed in the recess of the table or table insert frame with the engraved side facing the scanning member. Since according to the invention the scanning and graving members are exactly opposite each other, complete coincidence between printing plate and back relief is insured at all times. In the process according to the invention, the stroke of the graving tool, which may be constructed as a cutting or planing graver or as a rotary drilling or milling tool, is controlled in accordance with the size of the screen elements of the printing block; in scanning light portions, that is, small screen elements, the stroke is so large and the back graving so deep that these elements are sufficiently relieved during printing. The graving is done with sufficiently wide tools in continuous areas free of screen pattern.

It will be understood that instead of the back relief, a separate relief plate can be engraved in the same manner, in which case the engraved side of the printing plate is again scanned while the relief plate is positioned on the other side of the printing plate or of the table.

In accordance with this invention, in making the screen-processed printing plate ready for the form, the surface thereof is advantageously provided with mirror polish or colored. The individual screen elements will then present a different reflecting power from that of the surrounding depressions. Thus, if a light ray of constant intensity strikes one or more screen elements, the intensity of the reflected light will depend on the size of the area elements. This light is projected into the photoelectric cell of the scanning device and produces the current controlling the graving tool. When using black color, the size of the area elements and the stroke of the graving tool will be proportional to each other; if the surface of the printing plate is white, the control current must be so reversed that a large stroke corresponds to small area elements. In order to maintain the control current free of the intermittency of the screen during scanning, the mean value of the sizes of a plurality of screen elements can be obtained either by incorporating retarding elements in the circuit of the control current or by having a larger scanning light spot simultaneously illuminate a plurality of elements. However, since a pulsating current is easier to amplify than a direct current, the scanning light beam may be modulated by a rotating perforated disk, or the photoelectric current may be modulated by a special oscillator, at a high but arbitrary frequency, and may then be demodulated again after amplification.

The accompanying drawings illustrate several embodiments of the invention.

Figs. 1 and 2 illustrate in perspective views machines for producing printing blocks;

Fig. 3 shows the drive and the contact reversing means for the graving table;

Fig. 4 illustrates an optical reversing mechanism for the table;

Fig. 5 diagrammatically illustrates a machine with adjustable or variable scale of reproduction;

Fig. 6 explains the operation of a line screen template placed on the original; and

Fig. 7 shows an arrangement by which the reverse side of a screen-processed printing plate can be made ready for the form.

In a housing (not shown in Fig. 1) are arranged two guide rods **1** and **2** on which a scanning table **3** is movably mounted. Secured to the table is a frame **4** having the position and shape of the cutout **5** formed in the table. In the cutout **5**, a glass pane is arranged upon which the picture copy is placed face down. Over the copy is placed a plate (not shown in Fig. 1 for the sake of clarity) upon which the printing plate blank is clamped. The latter is acted upon on its upper surface by the graving tool **6** while the copy is scanned from below by means of the scanning member **7**. The graving and scanning members are opposite each other and are mounted on a carriage **8** straddling the table **3** and guided on a guide rod **9** and a feed screw **41**. The carriage performs feed movements in the direction of the arrow **11** while the table **3** performs the reciprocatory line movements perpendicular thereto as indicated by the arrow **12**. In scanning the picture copy, the printing plate blank thus receives a mirror image thereof. The drive for the table **3** and the scanning carriage **8** is derived from a motor **13** which, through a gearing **14** and gears **15**, **16** and **17**, is connected to gear **18** of clutch **19**. The gear **18** is fixedly connected to the feed screw **20** which is threaded and moves the table **3** in the direction of arrow **12** by means of a nut **21**. If the clutch **19** is engaged in the opposite direction, the drive is transmitted from gearing **14** through gears **22** and **23** to gear **24** which is likewise fixedly connected with feed screw **20**. The latter will then rotate in the opposite direction so that the table **3** is returned in the direction opposite to that indicated by arrow **12**. Due to the different transmission ratios of gears **22**, **23** as against **15**, **16**, **17**, the return movement of the table **3** takes place faster than its forward movement. Reversal from forward to return movement and vice versa is effected by means of the frame **4** in conjunction with two abutments **25**, **26**, associated with the beginning and end of the line movement. The abutments **25** and **26** are rigidly connected to each other and to a fork **27** and extend into the frame **4**. These parts are mounted in a rail **28** connected to the carriage **8** and present a lost motion that corresponds to the distance between the two terminal positions of a bar **31** tilting about the pivots **29** and **30**. As the frame **4**, in its forward motion in the direction of arrow **12**, strikes against abutment **25**, the latter and the fork **27** are moved in the same direction and the bar **31** likewise rocks over in this same direction. Through an arm **32** and linkage **33**, **34**, the roll **35** is likewise moved in the same direction. The roll **35** resiliently rides on a cam **36**, the link **34** receding during this motion of the roll by virtue of its pivotal connection at **37**; and the roll **35**, after passing over the tip of the cam **36**, will abruptly rock the clutch lever **38** to the other side. In this manner, the direction of rotation of the screw **20** is reversed so that the table **3** and frame **4** will now move in the opposite direction. As in this return movement the frame **4** strikes against abutment **26**, the latter and the fork **27** are urged in the direction of the return movement, the bar **31** and lever arm **32** rock back into the starting position shown in Fig. 1, and the roll **35** also rocks the clutch lever **38** back to its initial position. The original direction of rotation is thus restored, and the table begins to move forward again in the direction of arrow **12**. If the picture copy just fills the cutout **5**, the frame engagements will correspond exactly to the scanning of the edges of the picture. If the copy is smaller than the cutout **5** or the frame **4**, the abutments **25**, **26** are moved apart by means of the adjusting screw **39** and a gear connection not illustrated in detail in Fig. 1, until the frame will again abut at those moments when the scanning member **7** reaches the edges of the copy.

During this reciprocatory motion of the table 3, in the direction of the lines, the motor 13 drives through gearing 14 a further gearing 40 which is connected to the feed screw 41 through a slip clutch (not shown) accommodated in the housing of gearing 40. The screw 41 meshes with the scanning arm 8 so that the latter may be given a feed motion in the direction of arrow 11. Rigidly mounted on the feed screw 41 is a detent wheel 42 engaged by a pawl 43. As long as the wheel 42 is held in position, the motor will act upon the slip clutch without bringing about any feed motion. This condition is illustrated in Fig. 1; at this stage the forward movement of table 3 in the direction of arrow 12 takes place without any feed of the carriage 8. Upon reversal of table 3 from forward to return movement, a dog 44 on link 33 urges the lever 46, pivoted at 45, in the direction of arrow 12, causing the pawl 43 to be withdrawn from engagement with the detent wheel 42 so that the screw 41 with the detent wheel 42 is driven by the slip clutch. The carriage 8 will now perform the feed or line shift motion perpendicular to the direction of the lines while the table 3 meanwhile performs its return movement. The detent wheel 42 rotates until the pawl 43 engages the next notch of the wheel 42 whereby the feed motion ceases. During reversal from table return to forward movement, which takes place through linkage 33, 34 and roll 35, the pawl 43 is not actuated by the dog 44; for in the movement of link 33 and dog 44 in the direction toward roll 35, the lever 46 cannot yield in this direction, but the dog 44 yields downwardly and the pivot 37 moves up so that this reversing operation does not initiate any feed motion. In this manner, the table 3 performs a reciprocatory motion whose forward component is slow and takes place while the feed motion is blocked, while the return motion is fast and is simultaneous with a feed motion of constant magnitude.

As the detent wheel 42 is rotated tooth by tooth whereby the lines are consecutively scanned, the arm 8 with the abutments 25, 26 will move closer to the corner of the frame 4. This causes the reversals of the line movement to take place even sooner as the distances within the rectangular frame 4 become shorter and shorter. The picture, which is mounted at an angle of 45° to the picture edge, will thus be scanned line for line always within the edges of the original. After the spacing of the abutments 25, 26 has been adjusted for the size of the original, smaller pictures can be scanned and reproduced as desired without making the area outside the picture field effective.

The rail 28 carries an extension 47 which controls the shutter or diaphragm 50 through a lever 49 rotatable about pivot bearing 48. If upon initiation of the return movement of table 3 the abutment 25 is urged in the direction of arrow 12, the extension 47 will move in the same direction and will interpose the shutter 50 into the path of the rays of scanning member 7. In this manner, the scanning member is maintained dark during the entire return movement of the table. Consequently the graving member 6 remains inoperative during line return. Upon initiation of forward movement of the table 3, the frame 4 urges the abutment 26 in the direction opposite the arrow 12 so that the shutter 50 is withdrawn by lever 49 and the optical path is cleared for the forward movement of the table.

In Fig. 2, the table 3 is guided on rails 1 by means of a plurality of anti-friction bodies for movement in the direction of arrow 12. Mounted in a recess of table 3 is an exchangeable insert 65 which is adapted to be rotated about its vertical axis by means of a handle 68. The insert 65 has the printing plate blank 56 inserted therein whose surface is flush with the top side of the insert 65.

The motor 13 drives through a belt drive 68 the gearing arranged in gear box 69, the latter also containing an electromagnetic reversing clutch shown in greater detail in Fig. 3. Thence the belt drive 70 transmits the drive to the feed screw 20. 71 designates a bearing for screw 20; 72 is the rotor of a phonic wheel whose stator 73 is stationary. The phonic wheel serves to produce the screen frequency. The feed screw 20 is engaged by the nut 21 rigidly connected with table 3 through an angle member 74, which nut imparts scanning motion to the table 3.

The arms of carriage 8 straddle the table 3 and support thereabove the graving system 75 with the cutting graver 6, a nozzle 76 for drawing off chips, and the presser foot 77. By means of a knurled screw 78 the presser foot 77 can be raised or lowered within the graving system 75 so as to adjust the graving tool 6 at the proper distance from the surface of the printing plate blank 56. Preferably, an adjusting instrument is employed for this purpose, which instrument senses, and permits retention of, the requisite distance of the graver tip from the surface of the printing plate blank as determined by a sample graving. Any newly inserted replacement tool can be immediately calibrated to correct zero position by means of the graver gauge thus obtained. For example, the graver gauge may consist of a base plate upon which the presser foot 77 is placed. Slightly spaced above the base plate is an adjustable contact spring which, upon contacting the graver tip, closes a circuit including a signal light. The knurled screw 78 is turned until the signal light indicates engagement of the contact by the graver tip 6 and thus proper adjustment of the graver.

The carriage arm 8, equipped with detent means, is rotatable about bearing 80 by means of lever 79, whereby it may be raised with respect to the table 3. Below the table 3, the carriage 8 contains the scanning mechanism consisting of the illuminating lamp 57, condenser lens 58, apertured shutter 59, objective 60 and two photoelectric cells 61. The path of the rays further includes a rotating perforated disk 81 for producing intermittent light, and a disk 82 containing a variety of color filters 83. Rotation of this color filter turret 82 is coupled with rotation of the insert 65 through a flexible shaft 84, two gears 85, 86 and gearing 98.

The carriage 8 is guided on rails 9 by means of suitable anti-friction members and is movable in the direction of arrow 11 transversely of the direction of movement 12 of table 3. The drive for the feed motion is likewise derived from motor 13 via the belt transmission 68, through a further belt transmission 87 and a worm and gear drive 88, 89. The worm gear 89 always rotates in the same direction and transmits its motion through a slip clutch (not shown) to the detent wheel 42 as long as the pawl 46 releases the wheel 42. The detent wheel 42 is rigidly connected with the feed screw 10 which is engaged by a nut 90 mounted on the carriage 8. When the pawl 46 locks the detent wheel 42, rotation of the screw 10 and the feed motion are thereby interrupted.

On opposite sides of the scanning device are provided two abutment pins 91, 92 which engage into the reversing frame 93 provided on the insert 65. The reversing frame corresponds in size to the insert 65 employed. The sloping surfaces of this reversing frame 93 when engaging the abutment pins 91, 92 push the latter downwardly whereby these pins actuate either one of two sets of contacts 94, 95 arranged therebelow and serving to control the electromagnetic clutch provided in the gear box 69. The abutment pins 91, 92 are moved along in the direction of feed 11 by the arm 8.

The blower 96 is connected with the suction nozzle 76 of the graver system through a tube connection 97.

Fig. 3 shows a further embodiment of the exchangeable insert in section. The insert 65 is rotatable in the table 3 by means of the handle 66. A cutout of the insert 65 contains, lowermost, a glass pane 51, thereover the picture copy 52 face down, and thereover a layer 99 of sponge rubber. Over the latter are a cover plate 55 and the printing plate blank 56. The graver system 75 bears with its foot 77 against the upper surface of the

printing plate blank **56** and urges the latter firmly against the plate **55**. In addition, the printing plate blank **56** is held at four points of the cutout in the insert **65** by clamps (not shown). The presser foot **77** is surrounded by a felt ring **100** which is urged against the surface of the blank **56** by a spring **101** and keeps the cut chips off the engaging surface of foot **77**. Opposite the cutting tool **6** is arranged the scanning mechanism, of which only the optical axis is indicated at **64** in Fig. 3.

The pins **91, 92** each carry a dog **102** which dogs engage levers **104** and **125** respectively, rockable about pivots **103**. These levers are pulled upwardly by springs **105** thereby urging the pins **91, 92** upwardly. Assuming that the pin **92** is depressed and latched by lever **104** and cam **107**; upon movement of table **3** in the direction of arrow **12**, the sloping face **93** of the insert **65**, serving as the reversing frame, will strike against pin **91** and depress the latter. The latching lever **104** will thereby release cam **107**, and pin **92** will be projected upwardly; lever **125** will then engage over cam **108** of pin **91** and keep it latched in that position. The converse operation will not take place until the frame surface **106** depresses pin **92** and thus releases pin **91**. As the table **3** moves in the direction of arrow **12** and depresses pins **91, 92** in succession, the two levers **104, 125** release cams **107** and **108**. But as the tips of the abutment pins **91, 92** in this case engage the underside **109** of table **3**, both pins will remain depressed. That pin which is released first by the table **3** will then spring up again and latch the other pin so that one abutment pin will always remain depressed and one pin will project upwardly.

The abutment pins **91, 92** each operate a set of contacts **94, 95** comprising an upper contact, closed in the inoperative position, and a normally open lower contact. For example, pin **92** has opened the upper contact of contact set **95** and closed the lower contact. This causes the clutch magnet **110** in gear box **69** to be energized, being supplied with current through terminal **111**, upper contact of **94**, lower contact of **95**, brush and contact ring **112**, and grounded brush **113**. Consequently, the clutch magnet **110**, driven by gears **22, 23** and loosely mounted on shaft **123**, will drive clutch plate **114** and, through belt drive **70** and feed screw **20**, will impart rapid motion to the table **3** in the direction of arrow **12**. When the scanning device has reached the edge of the picture, the reversing face **93** of the frame strikes against pin **91** and actuates contact set **94**. At the same time, abutment pin **92** is released by its latch and contact set **95** is reversed. This causes clutch magnet **115** to be supplied with current through terminal **116**, upper contact of **95**, lower contact of **94**, brush and contact ring **117** and brush **113**. The clutch magnet **115**, driven through gears **15, 16** and **17**, and rotating loosely on shaft **123** in the opposite direction to that of clutch magnet **110**, drives clutch plate **114** and imparts to table **3** a slow motion opposite to the direction of arrow **12**. Thus, due to the reversal controlled by the frame, the table performs a reciprocatory motion. If both pins are depressed, the upper contacts of both sets **94, 95** will be open so that no current flows to either clutch magnet **110, 115**. The table **3** must then be cranked back manually.

When pin **92** initiates table return, current is supplied not only to clutch magnet **110** but also to magnet **118**, connected in parallel. This causes the pawl **46** to be withdrawn from detent wheel **42** in opposition to spring **119**. The detent wheel **42** is then driven by the continuously rotating gear **89** through a slip clutch not shown, whereby the feed screw **10** for line shift is rotated and initiates the feed or line shift motion of arm **8**. Simultaneously with magnet **118**, relay **120** is also energized, which relay responds with a time lag due to the shunt **121** and opens its contact **122** only after the detent wheel **42** has rotated through an angle corresponding to one tooth. Consequently, magnet **118** is deenergized and causes latching of detent wheel **42**. This terminates the feed motion of carriage **8**. The time lag of relay **120** can be adjusted by means of resistor **126** so as to open contact **122** only after the detent wheel **42** has rotated through an angle corresponding to a plurality of teeth. This increases the feed motion of carriage **8**, as required in the production of relief plates that are produced with broad graving tools and coarse scanning.

Although reversal is initiated by frame surfaces **93** and **106** respectively when the optical axis **64** reaches the edge of the picture, reversal of the table movement requires a finite period of time. During this time, foot **77** leaves the surface of the printing plate blank **56**, which should be no larger than the picture copy for economic reasons. In order, nevertheless, to afford a support for foot **77**, the upper side of insert frame **65** is designed as a supporting surface **127** which is flush with the surface of the printing plate blank.

The underside of insert **65** bears a check mark **124** consisting of a black-and-white area and moving into the path of the scanning rays. It serves for the calibration of the amplifiers of the machine. Instead, only a white mark may be provided and the "black scanning" replaced by electrical disconnection of the photoelectric cells.

Fig. 4 illustrates a different reversing arrangement. In this embodiment, reversal of line movement upon arrival at the picture edge is initiated optically. The cutout or recess **5** of the scanning table, as in Fig. 1, receives a glass pane **51** on which the picture copy rests, face down. In this embodiment, there is placed over the copy a mirror glass plate **53** with its reflecting layer **54** at the top. This mirror plate is covered with a base plate **55** on which the printing plate blank **56** is secured. The light source **57** is projected by a lens **58** onto an apertured diaphragm **59**, and a further lens **60** projects it into the plane of the picture copy **52** in the form of a sharply defined point of light. As long as the copy is situated in the path of the rays of this illuminating arrangement, the light will be diffusely reflected by the front side of the copy and will reach the two photoelectric cells **61**. The photoelectric currents control the graving tool **6** in known manner through an amplifier **62** proportionally to the brightness of the original, and the graving tool acts on the printing plate blank **56**. When this scanning device has just passed beyond the edge of the copy **52**, as shown in Fig. 4, the light will no longer be diffusely reflected in the plane of the copy **52** but will penetrate the mirror glass plate **53**. The rays are then reflected at the specular rear surface of plate **53** and reach the cells **61** with an intensity which is many times greater than that of the light which is only diffusely reflected on the original. The currents thus induced in the photoelectric cells are stronger than the currents resulting from scanning the copy and are electrically separated from the latter. For example, they may be adapted to energize a relay in the amplifier **62** which relay does not respond to the weaker currents. This relay actuates the reversing mechanism **63** which causes reversal of the direction of scanning of the table. In this manner, the line motion is reversed whenever the copy edge is traversed, regardless of the size of the copy and its position relative to the table. Simultaneously with the line motion controlled in this manner, during each return movement of the table the scanning member is advanced by a constant amount, such movement being controlled, for example, in the manner described with the use of a linkage and a detent wheel. In the arrangement according to Fig. 4, however, the line shift motion may instead be released by signals acting upon the reversing device **63** by having a reducing mechanism single out only every second signal, associated with the initiation of the return movement. The reversing mechanism prevents areas located outside the picture edges from being included in the scanning operation.

In a further embodiment of invention, the mirror glass plate **53** is omitted and the base plate **55** rests directly

on the picture copy 52. The side of the base plate 55 facing the picture copy presents a reflective, fluted surface which, during scanning, again reflects higher light intensities into the photoelectric cells than the merely diffusely reflective original. This causes the reversing signals to be released upon traversal of the picture edge.

In a further embodiment of the invention, the optical axis 64 of the scanning device is inclined to the base plate 55 so that after traversing the picture edge the light rays are reflected by the smooth, specular underside of base plate 55 into the photoelectric cells 61. This intensity is again greater than that of the light diffusely reflected by the picture copy 52 and leads to energization of the reversing relay in amplifier 62.

The described arrangements are thus suitable for scanning both in the direction of the edge of the picture copy and at angles thereto; and the picture copy may be smaller than the cutout 5 of table 3 and will nevertheless be scanned only within its picture field.

In Fig. 5, the two light sources 133 illuminate the picture copy 134 arranged on a small table 135. The objective 136 renders the rays parallel while the objective 137 collects them on a screen 140. Thus, an enlarged or reduced image of the copy 134 is projected onto the screen 140. The scale of reproduction is selected by varying the distances of the copy 134 and the objectives 136, 137 from screen 140 by means of sliding brackets 141, 142 displaceably mounted on a rod 143. Interposed in the path of the rays are two crossed, totally reflecting prisms 138, 139 so that the image projected onto screen 140 will agree in the position of its sides with the copy 134. The screen 140 is positioned on the underside of table 3, which may, for example, be supported on rollers 131. The table 3 also carries the rod 143 with the projection device. Through motor 129 and feed screw 20, the table 3 is given the reciprocatory scanning movement within the plane of this figure. On the top side of table 3, the printing plate blank 56 is secured by means of two clamps 130.

The scanning and graving carriage 8 moves in the line-shift direction at right angles to the above scanning motion. The carriage 8 is guided by bar 9 and is moved perpendicularly to the plane of the drawing by means of motor 132 and feed screw 41. The image projected onto screen 140 is scanned by a scanning mechanism comprising an objective 60, a shutter or diaphragm 59, a collimator lens 58, a photoelectric cell 144 and a rotary apertured disk 81. The scanning device passes only a small elementary area of the projected image, receives the brightness thereof and converts it into a photoelectric control current. The latter actuates the graving tool 6 in a known manner through the connecting line indicated at 145, and the tool 6 produces the engraving on the printing plate blank 56 on the upper side of table 3. The carriage movement causes the image projected onto screen 140 to travel past the scanning device line for line.

The means for reversing the direction of movement have been omitted from Fig. 5 for the sake of clarity.

In Fig. 6, 162 designates the picture copy arranged on the underside of table 3, over which copy a line-screen plate 163 has been placed. In the case of a coarse screen pattern this may consist, for example, of blackened lines 164, while for a fine screen it may comprise a closely ruled glass plate. The screen plate 163 and the copy 162 are well illuminated in all directions and are scanned by the scanning mechanism line for line in the direction indicated at 165. The resultant photoelectric currents are amplified in conventional manner and fed to the graving tool which acts on the printing plate blank 56 on the other side of the table 3 in synchronism with the scanning device.

Due to the series of lines 164 and intermediate gaps, the light reflected from the copy 162 into the optical scanning mechanism is alternately permitted to pass and interrupted. In this manner, the photoelectric current will fluctuate similarly periodically so that the graving tool controlled thereby will produce a dotted pattern on the plate blank. The distances of the screen dots on the plate blank correspond to the spacing of the lines 164 of the screen plate 163. The points of intersection 166 of lines 164 with the scanning device 165 on the original 162 correspond to the centers of the screen dots produced on the plate blank.

The spacing between two adjacent scanning lines 165 and 167 is made equal to the distance between two consecutive screen dots 166 within the line 165 by correspondingly selecting the magnitude of the line shift. The lines 164 of screen plate 163 subtend the angle 168 with the scanning device 165. This angle is selected in Fig. 6 in such a manner that the points of intersection of lines 164 with the next-following scanning line 167 are offset by one-half the dot spacing from the points of intersection 166 of the preceding line 165. The size of angle 168 is arc tan 2, or approximately 63.5°. By mere rotation of lines 164 relative to the original 162 or relative to the scanning device 165, any desired other degrees of screen offset can be obtained.

Fig. 7 illustrates a modification of the invention by means of which the reverse side of a screen-processed printing plate can be made ready for the form, but which in principle corresponds to the machines shown in Figs. 1 to 5. The screen-processed printing plate 159 is inserted in the cutout or recess of table 3 or of the carriage insert frame, which is provided with a glass pane 51. The colored, screen-processed side of the printing plate 159 faces down and toward the optical scanning mechanism 60. Above the table 3 is arranged a highly simplified graving member. The table 3 is moved line for line past the scanning member in the conventional manner by means of the motor 160 and feed screw 20. The line-shift or feed movement, perpendicular thereto, of the scanning and graving members has not been shown in Fig. 7 for the sake of clarity.

In the scanning mechanism, the incandescent lamp 57 illuminates the apertured diaphragm 59 through lens 58, and an image of the diaphragm is projected onto the engraved side of printing plate 159 through a further lens system 60. The perforated disk 81 periodically interrupts the passage of the rays. Two photoelectric cells 61 intercept the light reflected at the printing plate surface and translate the light impulses into current impulses. The photoelectric currents are amplified in amplifier 146. In a further stage 147 they are reversed in such a manner that a small control current will correspond to great brightness of the reflected light. The photoelectric current is demodulated in rectifier 148 and fed to a magnet 149. Rockable about pivot 157 is a lever 153 which may, for example, carry a rotary milling cutter 154. The latter is driven through a belt 155 and a deflecting pulley 156 by a motor 158. The milling cutter 154 is in exact alignment with the scanning light spot of the optical device 57 to 60. The forward end of lever 153 carries a soft iron core 150 adapted to be attracted by magnet 149 in opposition to the force of spring 151. Upward movement of lever 153 is limited by stop 152. It will be understood that different electromagnetic or electrodynamic systems 149—150 may be used.

The aperture of diaphragm 59 is so dimensioned that the light spot defined thereby will cover several screen-pattern elements on the face of printing block 159. In this manner, a mean value of the magnitude of several screen elements is formed, whose mean area defines the intensity of reflected light. The smaller the area of the screen elements, the lower will be the photoelectric current and the greater will be the controlling current on the output side of reversing stage 147. Consequently, when scanning small screen elements, the lever 153 will be strongly attracted by magnet 149 so that the milling cutter 154 will dig out a heavy layer from the reverse side of printing plate 159, while when scanning large

screen elements, the reverse side of the plate will remain unmachined. With intermediate values, the magnitude of the stroke will vary correspondingly.

Due to the relief-like engraving of the reverse side of the screen-processed printing plate, the small screen dots will recede during matrix-formation or printing and are thus relieved of load. Thus, the tips of these screen dots remain undamaged.

By a modification of the embodiment shown in Fig. 7 it is possible to provide a particularly simple apparatus for preparing printing plates for the form. The scanning member is arranged above, and the graving member below, the table **161**, the two members again facing each other. With the frame **3** and the glass pane **51** omitted, the printing plate is placed on the table plate **161** with its screen-processed face up. The plate is manually moved to and fro below the scanning light spot. Since the printing block and the light spot are visible to the operator, the portions of the block bearing light subjects can be selected. While the printing plate is being lightly pressed against the table **161**, the reverse side is engraved under photoelectric control. Treatment of the remaining portions of the printing plate may be dispensed with. In this manner, not only is the mechanical drive eliminated but also the treating time is considerably shortened.

Changes may be made within the scope and spirit of the appended claims which define what is believed to be new and desired to have protected by Letters Patent.

I claim:

1. An engraving machine for making printing plates, comprising a single unitary reciprocable engraving table, means for mounting on one side of said table a copy carrying an image which is to be reproduced, means for mounting on the opposite side of said table a flat plate blank a side of which is to be engraved in accordance with the contents of the image on said copy, a single carriage having two arms straddling said table along opposite sides thereof, a photoelectric scanning system carried by one of said arms and facing the image on said copy, an engraving system including an engraving tool carried by the other arm and facing the surface of the side of said plate blank which is to be engraved, means for reciprocating said table in positive operating and return strokes relative to said photoelectric scanning and engraving systems, means for stepwise moving said carriage and therewith the image on said scanning and engraving systems after each operating stroke of said table in a direction perpendicular to the reciprocating motion of said table, and means governed by said photoelectric scanning system for operatively controlling said engraving system during each operating stroke of said table so as to cause said engraving tool to engrave on said plate blank along successive lines the contents of said copy.

2. A machine and cooperation of parts according to claim 1, wherein the operatively active portions of said scanning system and said engraving system are disposed exactly opposite each other and facing said table on opposite sides thereof.

3. A machine and cooperation of parts according to claim 1, comprising a reversing mechanism for reversing the motion of said table at a point of each operating stroke thereof which corresponds exactly to an edge of said copy.

4. A machine and cooperation of parts according to claim 3, comprising a frame carried by said table, and abutment means carried by said frame for controlling the operation of said reversing mechanism.

5. A machine and cooperation of parts according to claim 3, comprising an abutment for each of two edges of said copy for respectively controlling the reciprocation of said table, one of said abutments controlling said reversing mechanism, and means for adjustably spacing said abutments.

6. A machine and cooperation of parts according to claim 5, comprising a shutter governed by the abutment which controls said reversing mechanism for blocking the path of the rays of said photoelectric scanning system during the return stroke of said table.

7. A machine and cooperation of parts according to claim 3, comprising a frame for respectively supporting said copy and said plate blank, and means for angularly adjustably mounting said frame on said table.

8. A machine and cooperation of parts according to claim 7, comprising a color filter turret disposed in the path of the rays of said photoelectric scanning system, and means for operatively coupling said frame with said turret.

9. A machine and cooperation of parts according to claim 3, comprising a frame carried by said table, abutment means carried by said frame, a circuit including contacts controlled by said abutment means, and electromagnetic clutch means controlled by said contacts for governing the reciprocating motion of said table.

10. A machine and cooperation of parts according to claim 3, wherein said copy is a screened plate having on one side an image engraved thereon and, facing said photoelectric scanning system, and a relief plate blank mounted on said table and facing said engraving system to be engraved in accordance with the screen pattern elements appearing upon said engraved side of said plate.

11. An engraving machine for making printing plates ready for printing operations, comprising a single unitary reciprocable engraving table, frame means on said table for initially receiving on one side thereof a copy carrying an image which is to be reproduced, with said image facing away from said table, and for initially receiving on the opposite side thereof a flat plate blank one side of which is to be engraved in accordance with the contents of the image on said copy, a single carriage having two arms straddling said table along opposite sides thereof, a photoelectric scanning system carried by one of said arms and facing the image on said copy, an engraving system including an engraving tool carried by the other arm and facing the surface of the side of said plate blank which is to be engraved, means for reciprocating said table in positive operating and return strokes relative to said photoelectric scanning and engraving systems, means for stepwise moving said carriage and therewith said scanning and engraving systems after each operating stroke of said table in a direction perpendicular to the reciprocating motion of said table, and means for governing said photoelectric scanning system for operatively controlling said engraving system during each operating stroke of said table so as to cause said engraving tool to engrave on said plate blank along successive lines the contents of the image on said copy, thus completing the engraving of the printing side of said plate blank, whereupon such engraved plate blank is removed and reinserted into said frame means with the engraved side facing said photoelectric scanning system and the reverse side facing said engraving system for the purpose of relief engraving said reverse side, by repeating said scanning and engraving operations, in accordance with the pattern elements appearing on the engraved side thereof, thereby readying said plate for printing.

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