

Feb. 27, 1951

C. Q. GLASSEY

2,543,013

PRINTING PLATE AND METHOD OF PRINTING

Filed April 30, 1947

5 Sheets-Sheet 1

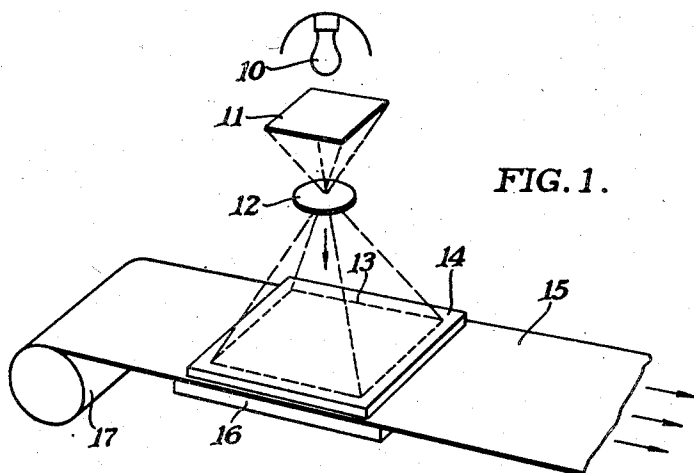


FIG. 1.

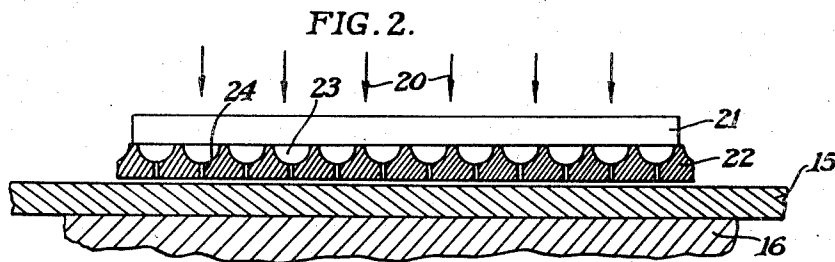


FIG. 2.

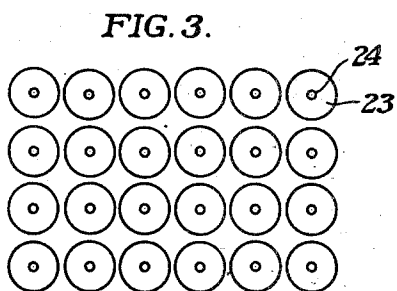


FIG. 3.

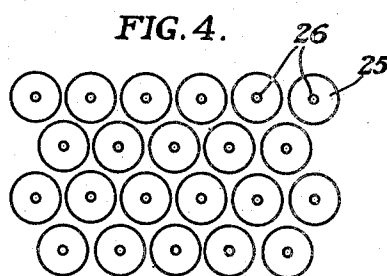


FIG. 4.

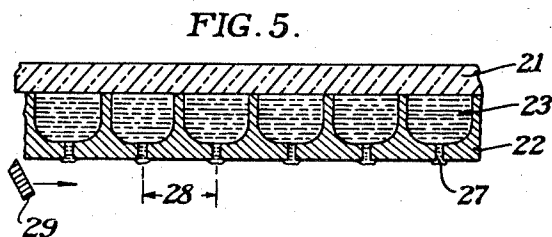


FIG. 5.

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FIG. 6.

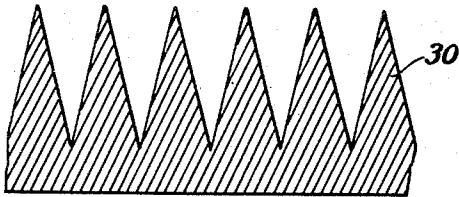


FIG. 9.

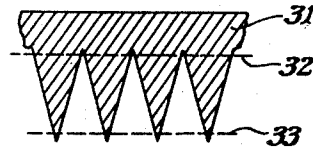


FIG. 7.

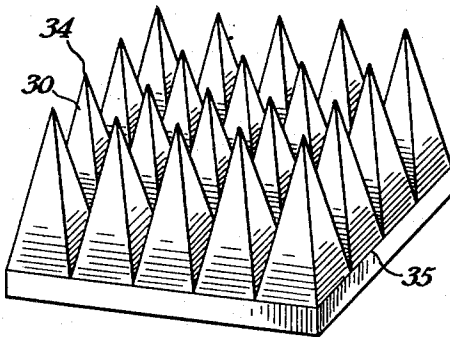


FIG. 10.

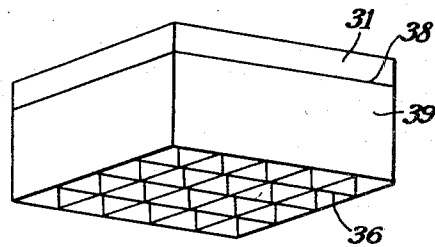


FIG. 8.

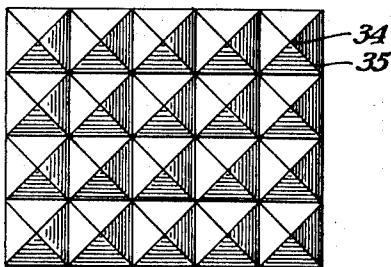


FIG. 11.

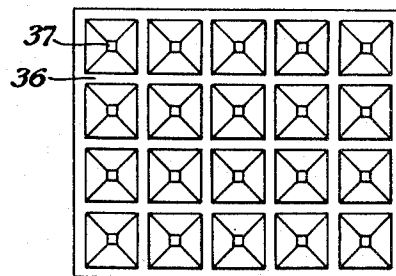
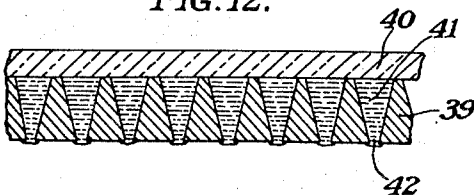


FIG. 12.



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FIG. 13.

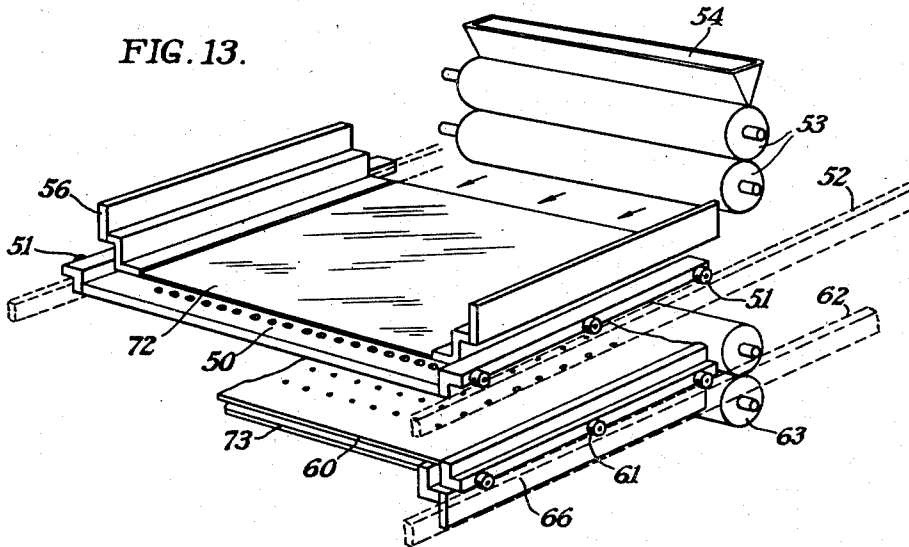
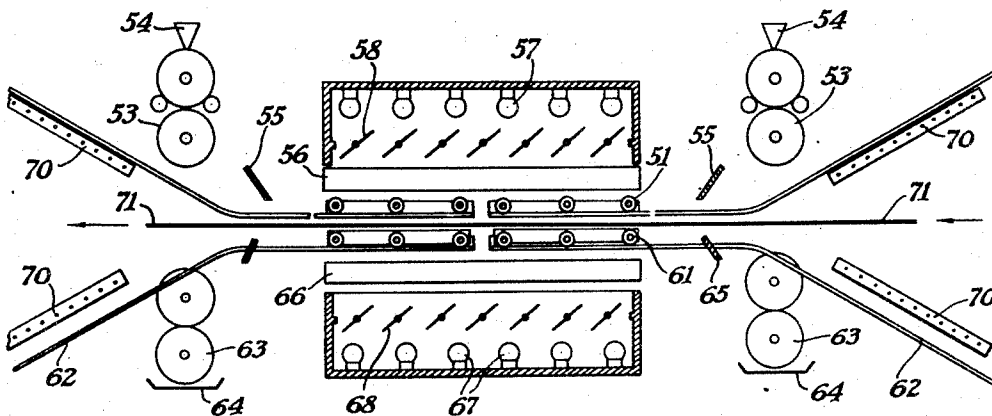


FIG. 14.



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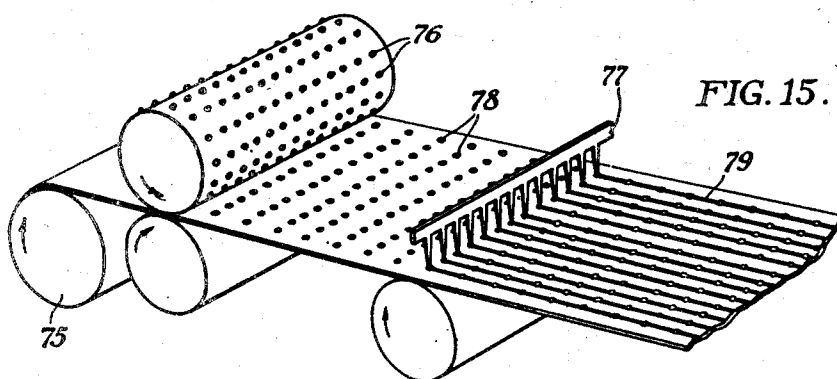


FIG. 15.

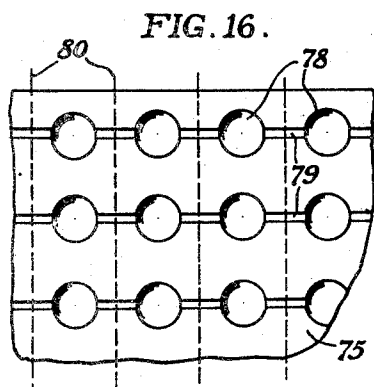


FIG. 16.

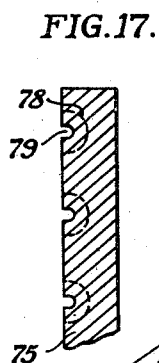


FIG. 17.

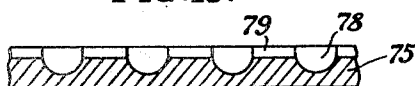


FIG. 18.

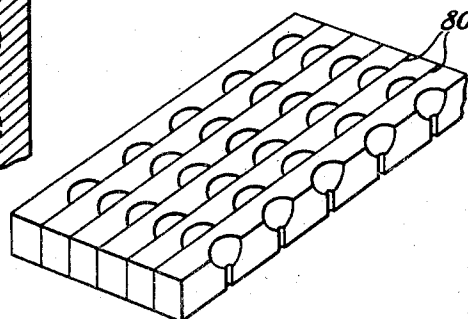


FIG. 19.

FIG. 20.

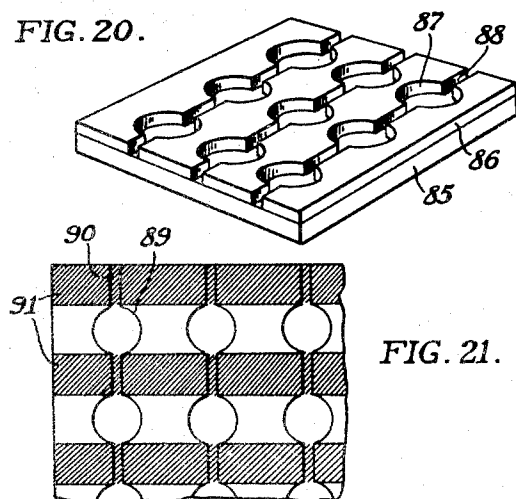


FIG. 21.

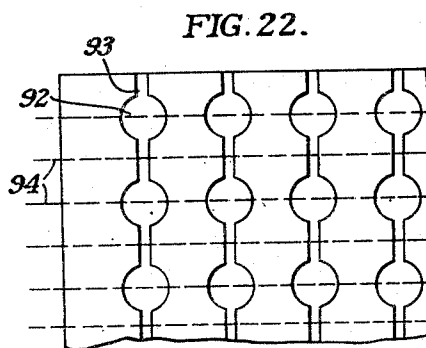


FIG. 22.

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PRINTING PLATE AND METHOD OF PRINTING

Filed April 30, 1947

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FIG. 23.

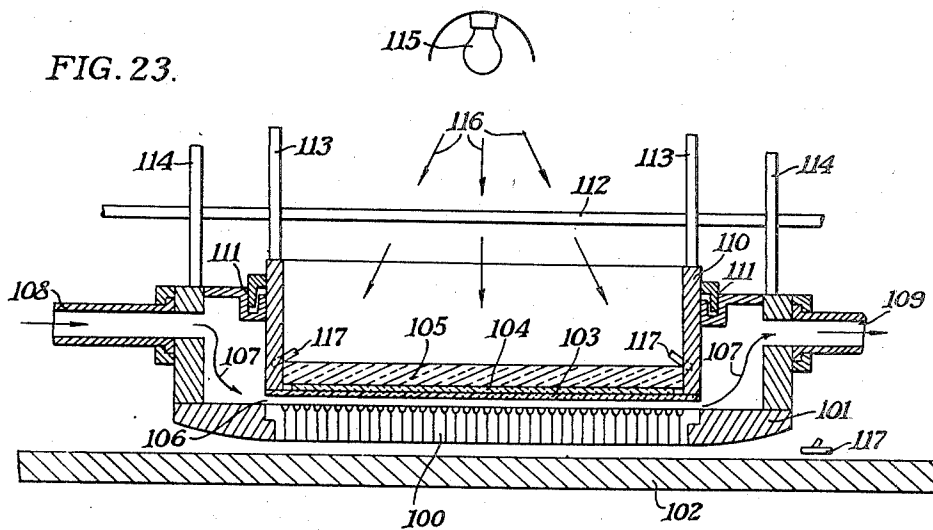


FIG. 24.

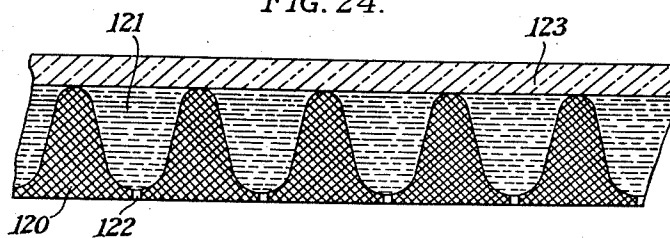
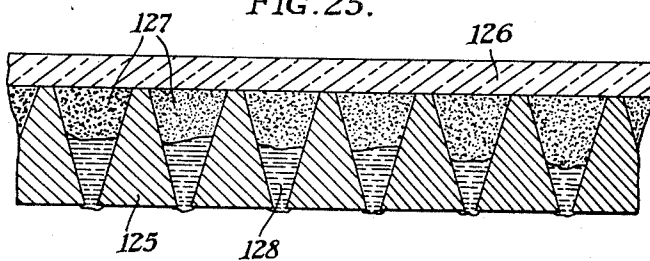


FIG. 25.



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UNITED STATES PATENT OFFICE

2,543,013

PRINTING PLATE AND METHOD OF
PRINTING

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corporation of New Jersey

Application April 30, 1947, Serial No. 745,019

9 Claims. (Cl. 101—426)

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This invention relates to printing plates.

Cross reference is made to copending applications Serial Number 731,173 of Alexander Murray and Serial Number 731,372, now U. S. Patent 2,487,865, of Glassey filed February 27, 1947, having to do with the deposition of ink a line at a time by a row of ink cells.

Cross reference is also made to a series of applications, Serial Numbers 749,445, 749,446, and 749,447 filed May 21, 1947 by Alexander Murray which disclose details of species of the present invention.

The object of the present invention and of all species thereof is to provide a method of printing whereby ink is deposited on paper or the like directly in accordance with a radiant energy image, for example, a light image formed by projection from or contact with a photographic negative. That is, a photographic negative may be placed in contact with the rear surface of a printing plate according to the invention and ink is deposited from the other surface when the rear surface is illuminated through the negative. Similarly the image may be impressed on the rear surface of the plate by optical projection instead of by contact.

Other objects of the invention all stem from this main object and include the simplicity of the printing press, the ease of operation thereof, and the relatively high speed obtainable with low cost equipment.

According to the invention the printing plate consists of a sheet of solid material either plastic or metal or other suitable material preferably heat absorbing, with a single layer of cells uniformly distributed over the plate and with a narrow opening from each cell through the front or printing surface of the plate. The diameter of each opening is of capillary order which means that printing fluid in the cells will be affected by the well known surface tension effects which occur in capillaries. The total area of the openings is less than 5 per cent of the total printing area and for the sake of definiteness, it is pointed out that there are at least 1,000 cells per square inch which corresponds to a 33 line halftone screen. The invention is intended for higher quality work corresponding to halftone screens up to 300 line. In certain embodiments of the invention the cells are closed except for the capillary opening and are filled through this opening. In all embodiments the cells are closed except for the capillary opening during the printing step. However, certain forms of printing plates described in detail below are made of two separable layers, the front one of which contains the cells and each cell has a relatively large opening through the rear of the front layer. That is, the front layer contains perforations of fine diameter at the front surface but relatively coarse diameter in the rear surface. The other layer serves to cover and close the relatively large rear

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openings of the cells. With this form of plate, the cells are filled with ink from the rear. After filling the cells with ink the rear openings may be immediately closed and any excess ink which is forced through the capillary openings by this closing operation, is then wiped off with a doctor blade. On the other hand, it is more satisfactory to wipe the rear surface of the cellular layer after the cells have been filled before clamping the closing layer thereon. The capillary action at the front openings serves to hold the ink level in the cells during the rear surface wiping operation so that the front surface does not have to be wiped which, of course, is a great convenience during printing.

Thus the method of printing according to the invention comprises filling a cellular plate with ink, by one of the above described methods, then placing the front surface of the plate either in contact or very close to the surface of the material to be printed upon, which may be either paper or some other material such as a thin transparent pellicle as described below in one special embodiment of the invention. The rear surface of the plate is then illuminated with a radiant energy image negative to that to be printed. The whole surface of the plate may be illuminated at one time or, in order to permit the use of less intense light sources, the print may be made one part at a time. This may involve scanning the rear surface of the plate with a line or spot of light, but since the printing plate corresponds to the whole area of the print, this is not to be confused with scanning by the ink depositing means. The distinction is between scanning of paper by an inking pen or nozzle and scanning of the inking member itself which in this case is a cellulose plate.

As with any photographic process, the time and intensity of exposure is controlled in accordance with the density required in the printed image. That is, the illuminating step is continued for a period of time sufficient to heat the contents of the cells and to expel printing ink from the cells to the amount desired in the final print. The heating of the cells is differential in accordance with the image intensity.

Because of its generic nature, the present invention also contemplates several different methods of preparing the above described printing plates and some of these methods are described in detail below. They include casting of a plate from a matrix in which embodiments, many of the tricks developed in the preparation of phonograph records, may be applied with advantage, and other systems in which the cells are prepared in strips and then assembled to form the printing plate. This novel device is particularly referred to by Murray as a Glassey block, but the term "plate" is adopted in the present specification to correspond to its common meaning in the printing arts. It is shown herein

how a Glassey block may be used as a printing plate.

The advantages of the invention and the method of operation thereof will be fully understood from the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a perspective sketch illustrating the method of printing according to the invention.

Fig. 2 is a greatly magnified cross section of part of Fig. 1.

Figs. 3 and 4 are top views of two different arrangements of the cells in the printing plate of Fig. 2.

Fig. 5 is a greatly enlarged section of a preferred form of printing plate.

Figs. 6, 7 and 8 are a vertical section, a perspective view, and a plan view of a mold on which to form one type of printing plate.

Figs. 9, 10 and 11 are the corresponding views of a printing plate formed on the mold shown in Figs. 6, 7 and 8.

Fig. 12 is a greatly enlarged section of a printing plate thus made.

Figs. 13 and 14 are respectively a perspective view and a vertical section of the essential features of a four-color printing press according to one embodiment of the invention.

Figs. 15 to 19 illustrate another method of making a cellular plate for the invention.

Figs. 20 to 22 illustrate a slightly different way of doing the same thing.

Fig. 23 illustrates a printing press according to the invention employing the printing fluid itself as the temperature control medium.

Figs. 24 and 25 are greatly enlarged cross sections of preferred forms of printing plates for use with the present invention.

In Fig. 1 light from a lamp 10 illuminates a photographic negative 11 and the image thereof is projected by means of a lens 12 and focused as indicated by broken lines 13 on the upper surface of a printing plate 14. The front surface of the printing plate is in contact with a roll of paper 15 which is clamped between the printing plate 14 and a supporting member 16 which is preferably slightly resilient to assure perfect contact between the paper and the printing plate at all points. After a print has been made in this manner, the details of which are to be described below, the printing plate 14 is raised and the paper 15 is moved to unroll from the supply roll 17, the next area to be printed.

The details of the plate are shown in Figs. 2 to 5. The plate consists of a transparent layer 21 and a cellular layer 22 having cells 23 distributed, as shown in Fig. 3, at the corners of a rectilinear lattice. From each cell 23 there extends a capillary opening 24 to and through the printing surfaces of the plate. The cells 23 are filled with ink and, as shown in Fig. 5, this ink extends to the printing surface and is held level therewith as indicated at 27 by surface tension. Excess ink may be removed from the printing surface by moving a doctor blade 29 thereacross when necessary. The distance 28 between adjacent capillaries is $\frac{1}{300}$ of an inch when 300 line quality is desired in the print. The area of the capillaries 24 is less than 10 per cent of the total printing area of the plate since it must not be greater than the area of the finest dot to be printed. The arrows 20 in Fig. 2 indicate the radiant image falling on the upper surface of the printing plate, which image heats the cells 23 differentially and forces ink from the capillar-

ies 24. It is possible to make more than one print without refilling the cells, but for the most uniform results it is preferable to refill the cells between each print and to bring the plate and the ink to a uniform initial temperature.

Fig. 4 illustrates a slightly different arrangement of the cells 25 with the capillaries 26 at the corners of a diagonal lattice.

A mold, a greatly enlarged section of which is shown in Figs. 6, 7 and 8, is made by cutting grooves in two directions in a metal plate. The bottoms of the grooves form lines 35 which constitute the edges of the base of each pyramid 39, the apex of which is indicated at 34. This mold is used for preparing any number of printing plates from a plastic or other suitable material. The plastic 31 is coated on the pyramidal surface and allowed to harden before it is stripped from the surface. After stripping, the plastic is then polished or shaved down until the deepest points in the pyramidal pits corresponding to the apices of the mold pyramids 34, just break through making small orifices 37 whose diameter is of capillary order. The whole cell may be considered to be of capillary order, of course, but the concomitant surface tension effects are important only at the small front orifices. Broken lines 32 and 33 indicate the levels down to which the surfaces of the plastic plate are polished. This gives a plate 39 whose upper surface 38 includes the tiny perforations 37 and whose lower surface 36 is a flat grid with relatively large rectangular openings therein. In Fig. 11, one is looking at the perforated plate from the large aperture side.

In Fig. 12 the cells in the plate 39 are filled with ink 41 which extends just to the small opening forming a surface 42. The relatively large opening to each cell is closed by a glass plate 40 which is placed on the upper surface of the cellular plate. Preferably there should be good contact between the closure plate 40 and the cellular plate 39, but slight leakage between cells is critical only with respect to the finest details in the picture being printed. That is, the quality of the final print depends on the accuracy of the seal between the plates 39 and 40. The expansion of the ink in the cells does not tend to force the plates apart because of the relatively easier path of expansion afforded by the capillary openings.

Figs. 13 and 14 illustrate a four-color printing press employing a cellular plate of the rear inking type. The plates 50 and 60 are carried by supporting members 51 and 61 with wheels which ride on tracks 52 and 62. The printing surface of the plates 50 and 60 face each other and during the actual printing step, the sheet 71 to be printed is clamped between these two printing surfaces by means of clamps 56 and 66 which also carry the negatives 72 and 73 to be printed and the plates which seal the rear opening of the cells. The sheet 71 to be printed is a thin transparent pellicle which is to be later laminated to a white support such as paper. In Figs. 13 and 14 the plates are shown just before the printing operation. The cycle starting at this point will now be described. The clamping bars 56 and 66 carry color separation negatives 72 and 73 which come down firmly on the upper surface of the printing plates 50 and 60 and then under the clamping pressure force the plates toward each other to clamp the pellicles 71. This step lifts the printing plate 60 and its wheel 61 off the tracks 62. The upper plates are carried on tracks 52 which are in sections so that a section of the track also moves down as the clamping step is performed.

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The spring members for returning the tracks to their operative position are omitted from the drawings for the sake of clarity.

After the four plates clamp the pellicle 71, the Venetian blind type of shutters 58 and 68 open, allowing light from the lamp houses 57 and 67 to illuminate the negatives 72 and 73. The radiant energy images thus impinging on the backs of the printing plates 50 and 60 force ink as above described from the printing surface to deposit on the pellicle 71. After sufficient exposure, the shutters 58 and 68 close, the plates 50 and 60 then unclamp the pellicle 71 and return to the positions shown in the drawings. The pellicle 71 is then moved forward one step and at the same time the printing plates move on the tracks 52 and 62 off to one side of the printing position. As they move to one side the rear or large aperture side of each plate is inked by ink rollers 53 and 63 which carry ink from the supply reservoirs 54 and 64 respectively. To insure constant and uniform temperature at the start of each printing operation, the printing plates pass adjacent to temperature control member 70 as they are being inked. As the plates then move back toward the printing position, doctor blades 55 and 65 wipe the excess ink, if any, from the rear surface of the plates. The wiping action does not tend to force ink beyond the end of the capillaries because of the surface tension at this point. The plates are thus moved back to the position shown in the drawings ready to start the next cycle. It is preferable to ink the back of the plates only while they are moving in one direction, but the details of the mechanism for moving the inking rollers to permit one way inking only have been omitted from the drawings for clarity since this is not an essential feature of the invention. Depending on the speed of operation desired any suitable moving mechanisms may be used but are omitted from the drawings for clarity. Even hand operation is satisfactory since uniformity is assured by the above described arrangement of parts.

Another method of making cellular printing plates is shown in Figs. 15 to 19. A plastic sheet from a roll 75 moves between two rollers the upper one of which is provided with knobs 76 which emboss pits 78 on the sheet which then moves under a comb-like tool 77 which cuts shallow trenches 79 between the pits in each row. The depth of the trenches 79 is of capillary order. The depth of the pits 78 is greater than that of the trenches and of course less than the thickness of the sheet 75. This sheet is then sliced along lines 80, by means not shown, to form strips having approximately half a pit and half a connecting trench at each point. The strips are then re-assembled edge-on as shown in Fig. 19 with the half pits up and the trenches down to form capillaries. The re-assembly could have the pits and trenches face to face so that each of the final pits would be the size of a full pit 78 and the capillaries would be twice the diameter compared to those shown in Fig. 19 but this is not as useful since the whole point of the method of manufacture is to get small pits and small capillaries accurately made. The arrangement shown in Fig. 19 gives pits and capillaries half the size of those obtained by the face-to-face method. If larger pits and capillaries are desired, it would be better to start with larger bosses 76 and deeper grooves 79.

A similar method of making a plate from metal or other etchable material is shown in Figs. 20

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to 22 in which the upper surface of a metal foil 85 or other etchable foil is provided with a photo resist 86 having holes 87 and connecting channels 88 therein through which etching fluid may be applied to the metal plate 85. Any of the standard photographic methods of providing the holes 87 and 88 may be used.

After the etching has proceeded long enough to make trenches 90 into the depth desired, strips of dragon's blood 91 are applied transversely covering the trench areas but leaving the pit areas exposed for further etching. This etching proceeds until pits 89 of suitable depths are formed. The resist is then removed, leaving a plate with pits 92 and connecting trenches 93 to be sliced along broken lines 94 in exactly the same way as the embossed sheet shown in Fig. 16. The similarity of Figs. 22 and 16 will be readily apparent, the main difference being that the foil is an etched sheet in one case and embossed sheet in the other.

In Fig. 23 a slightly different form of printing press is shown in which the cellular block 100 is carried in a frame 101 and is clamped during the printing operation to paper 102 but is shown in the drawing during a stage in which the plate is separated from the paper. A thin glass plate 103, a photographic negative 104 to be printed, and a thick glass plate 105 are held away from the back of the printing plate 100 during the inking operation but lowered during the later printing step. The printing ink flows as indicated by arrows 107, in through a supply tube 108, across the back of the printing plate 100 through a relatively narrow space 106 and out through a tube 109, to be circulated, preferably through a constant temperature bath back to the supply tube 108. Thus the printing ink itself serves as the coolant bring the printing plate 100 back to its initial temperature at the start of each cycle as the plate is being inked. In this general connection it should be noted that the transference of printing ink from the cells to the paper carries some of the heat with it and thus the cooling operation is not as difficult as it might otherwise be.

The upper plate 103 is carried by a box-like member 110 which is sealed by a low pressure seal 111 with respect to the ink chamber 106. After the plate has been inked the front surface thereof may be wiped with the doctor blade 117 if necessary, but if the plates are not clamped too suddenly this is not necessary since the capillary action of the ink holds the level even with the printing surface until the back of the plate has been clamped and the ink forced from the chamber 106. This level holding action is preferably aided by lowering the pressure in the ink circulating system, particularly during the clamping operation. Rotation of a control shaft 112 carrying cams 113 and 114 first moves the member 110 down to clamp the block 100 and then moves the whole printing plate and support 101 down to clamp the paper 102. Then the light from the lamp 115 as indicated by arrows 116 is allowed to illuminate the printing block 100 through the negative 104 to print on the paper 102 as above described.

A preferable form of printing plate is shown in Fig. 24 in which the cellular plate is made of a black heat absorbing material 120 and the cells 121 extend almost all the way therethrough with only a very short capillary tube 122 at the printing surface of the plate. The upper surface of the cells is closed by a transparent layer 123 as

in the other plates described. This particular plate has the advantage of allowing much higher speed of operation both because of the rapid heat absorption at each cell and because the short capillaries reduce the ink ejection time of the plate, but this in turn tends to reduce the uniformity of the inking operation. The printing operation is so rapid that the heat transfer from one cell to the next is negligible. Preferably the ink itself is highly heat absorbing, which is of course true of most inks because of the pigment therein.

The rate of printing depends, of course, upon the rate of expansion of the printing fluid in any of the embodiments above described and some improvement in this respect is obtained from the embodiment shown in Fig. 25. The plate shown in this figure, which corresponds closely to that shown in Fig. 12, is made up of a heat absorbing material 125 with pyramidal cells therein and a cover plate 126. The upper portion of each cell is filled with wax 127 because this material has a much higher rate of expansion than alcoholic inks for example. Between 43° and 57° C., white paraffin wax has an extraordinary coefficient of expansion given as above .0015 for linear expansion which corresponds to a cubical coefficient of about .005 which is about 5 times that of alcoholic inks. Furthermore, the wax should preferably contain some heat absorbing material such as carbon black or finely divided metal powder such as copper, silver, iron and the like. The black wax is heated somewhat to plasticize it and then rolled into the ink-charged cells with a uniform pressure or pressed in by all-over pressure just sufficient to leave the lower tenth of the cell volume charged with ink 128. The upper surface of the cellular plate is then laminated permanently to the cover glass 126 since all subsequent inking of the plate must be from the front. It will be noted that the operation of inking from the front in this case is not too difficult since immediately after printing, the plate will be at a high temperature and a cool ink flowed on to the plate will be drawn into each cell by the contracting wax. Thus in this embodiment, the inking not only aids the cooling, but there is a mutual cooperation since the cooling aids the inking.

Incidentally, it should be noted that the expansion of the plate material 125 is preferably kept to a minimum by the use of Invar-like materials but the detrimental effect caused by the expansion of the plate itself is not directly proportional to this expansion because the cell's size does not change too greatly thereby. It will be understood that the invention is not limited to the structure and processes above described but is of the scope of the appended claims.

I claim:

1. The method of printing which comprises preparing a cellular printing plate having a single layer of cells uniformly distributed over the plate and with a narrow opening from each cell through the printing surface of the plate, the total area of the openings being less than 10 per cent of the total printing area of the plate and with each cell being at least partly filled with printing fluid, the fluid being substantially level in each opening with said printing surface, placing the printing surface substantially in contact with the surface of the material to be printed upon, illuminating the other surface of the plate with a visible and infrared image negative to that to be printed and continuing the illuminating for a period of time

sufficient to heat the contents of the cells differentially in accordance with the image intensity at each point and to expel printing fluid from the cells to the amount desired in the final print.

2. The method according to claim 1 in which the rear layer of the printing plate is separable from the cell layer to expose a relatively large rear aperture from each cell, which method comprises the specific steps of filling the cells completely with printing fluid through the relatively large rear apertures and closing said relatively large rear apertures by said rear layer as part of the step of preparing the cellular printing plate.

3. The method of printing according to claim 1 in which the illuminating extends at one time over the whole of the area to be printed.

4. The method of printing which comprises applying ink to the rear surface of a substantially uniform cellular layer plate, each cell having a narrow opening through the front surface of the plate and a relatively large opening to the rear, the ink filling the cells, covering said rear surface with a layer transparent to radiant energy to close off the relatively large rear openings, placing said front surface substantially in contact with a sheet of paper, illuminating the rear surface with a visible and infrared image negative to that to be printed and continuing the illuminating for a period of time sufficient to heat the ink in the cells differentially in accordance with the image intensity at each point and to expel ink from the cells to the amount desired in the final print.

5. The method of printing according to claim 4 including the additional step of wiping the front surface to remove any excess ink after the rear surface is covered.

6. The method of printing according to claim 4 which includes the additional step of wiping the rear surface before covering and closing it.

7. The method of printing according to claim 4 in which the illuminating extends at one time over the whole of the area to be printed.

8. A printing plate comprising a sheet of solid material with cells uniformly distributed over the plate, with a narrow opening from each cell through one surface namely the printing surface of the plate, the diameter of each opening being of capillary order, the total area of the openings being less than 10 per cent of the total printing area, being at least 1000 cells per square inch, with a relatively large opening from each cell through the other surface of the sheet and a removable transparent solid layer over and closing said relatively large openings.

9. A printing plate according to claim 8 in which each cell is just filled with printing ink and the plate is at uniform temperature.

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The following references are of record in the file of this patent:

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2,373,087	Alger	Apr. 10, 1945
2,427,836	Chollar	Sept. 23, 1947

Certificate of Correction

Patent No. 2,543,013

February 27, 1951

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 72, for "prined" read *printed*; column 7, line 18, strike out "in", first occurrence; column 8, line 52, after the word and comma "area," insert *there*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of May, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.