July 12, 1932. I. GURWICK 1,867,405

INTAGLIO PRINTING

Filed May 9, 1929 4 Sheets-Sheet 1

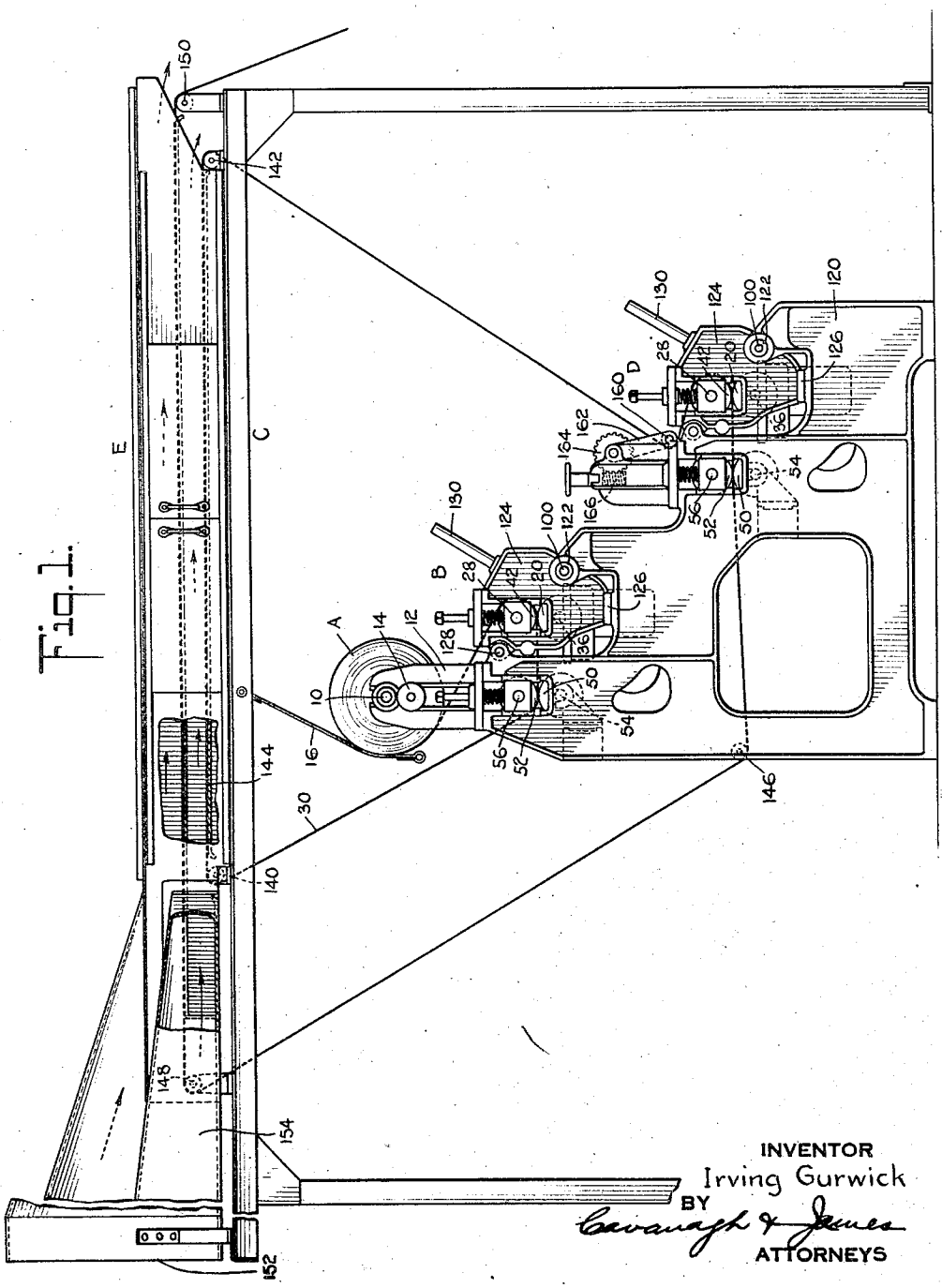


Fig. 1.

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Fig. 2.

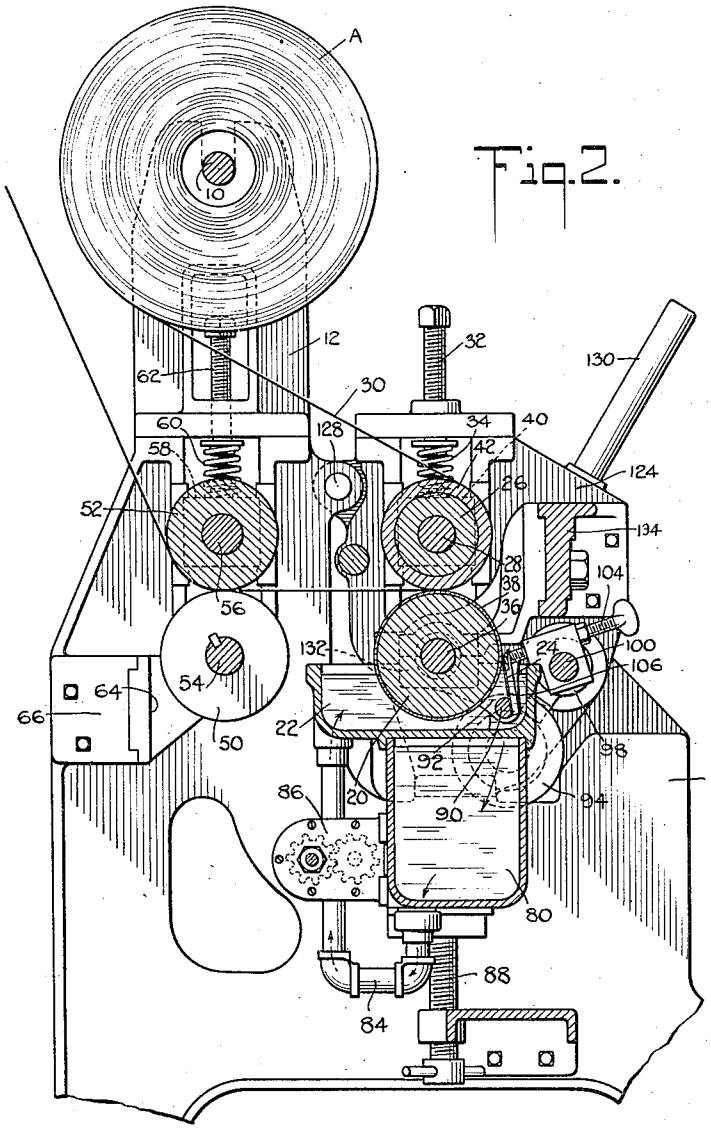
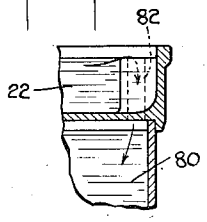


Fig. 2a



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Fig. 3.

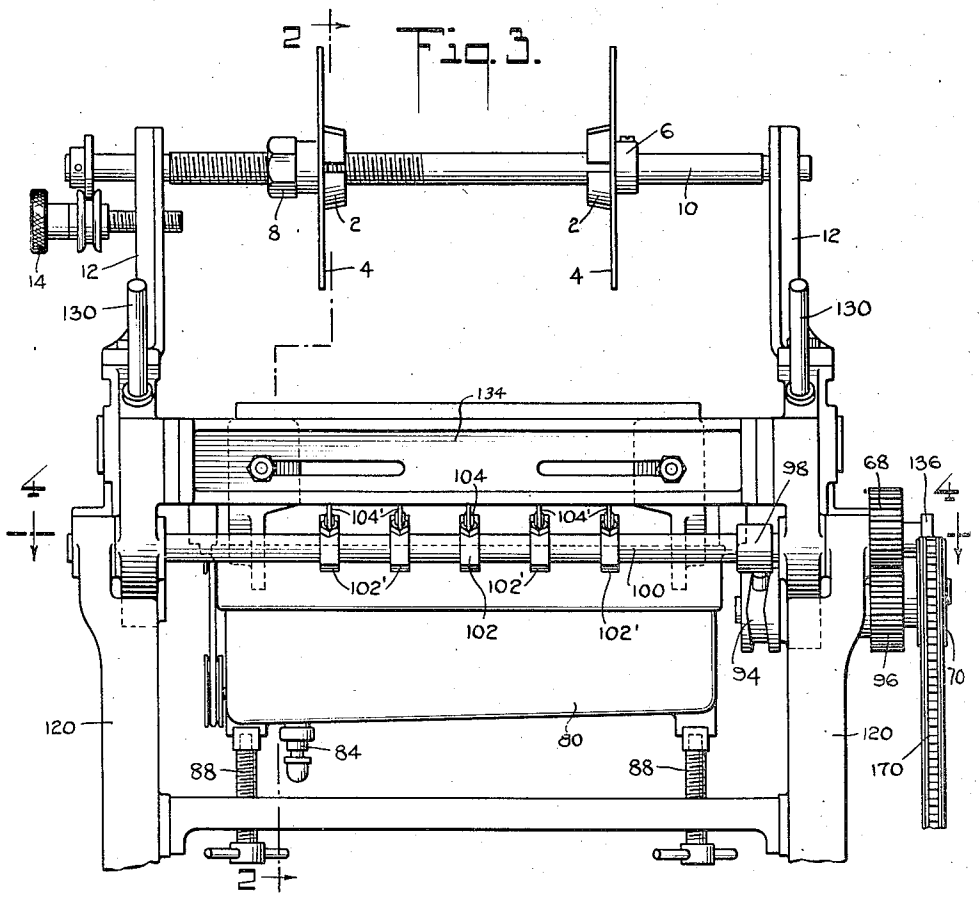
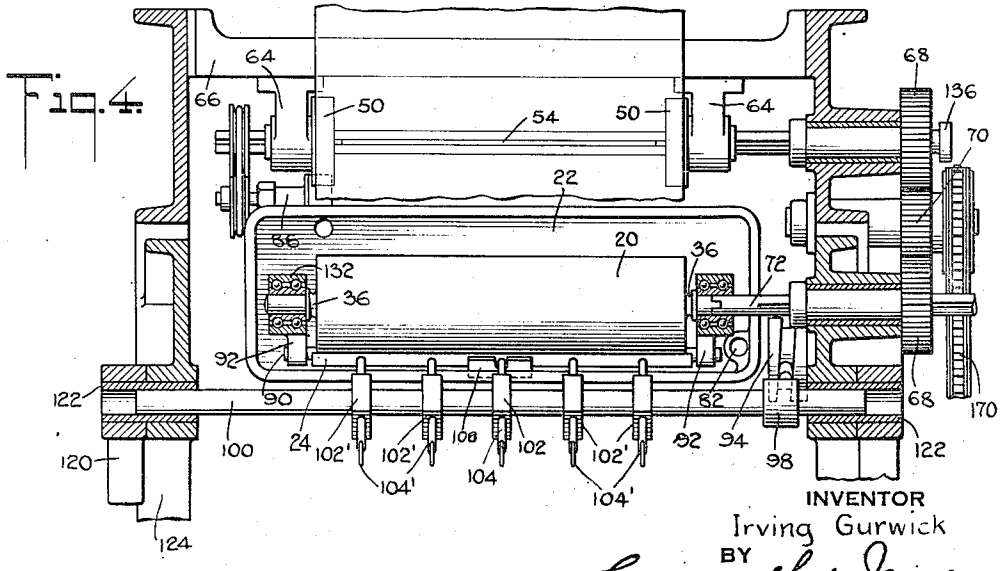


Fig. 4.



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Fig. 5.

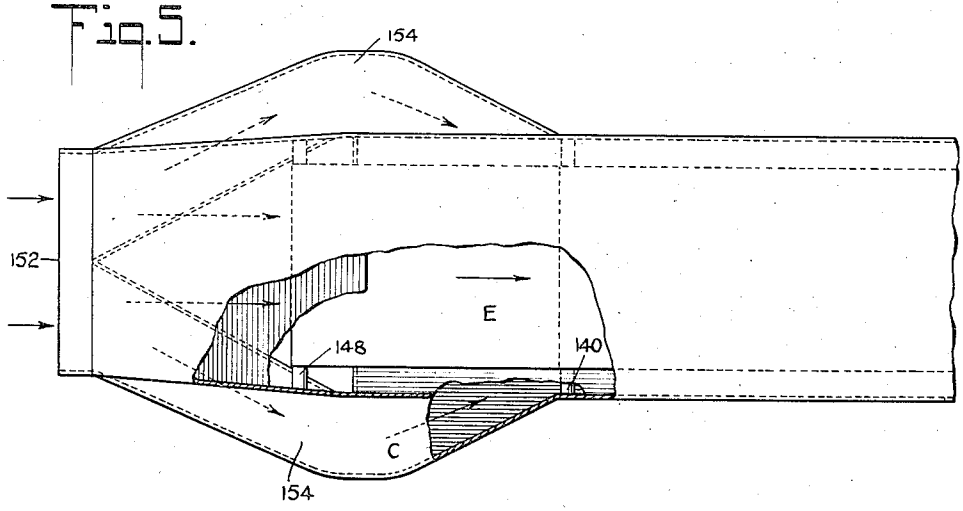
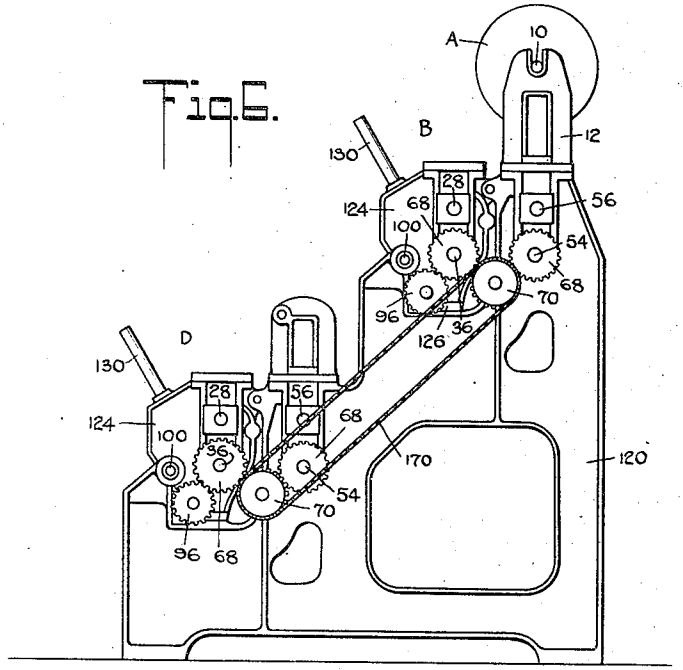


Fig. 6.



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UNITED STATES PATENT OFFICE

IRVING GURWICK, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO TRANSPARENT PACKAGING & PRINTING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

INTAGLIO PRINTING

Application filed May 9, 1929. Serial No. 361,584.

This invention relates to printing, and more particularly to a method and means for intaglio printing of colors on transparent cellulose paper and like material.

In intaglio printing it is customary to etch the printing roller to only a slight depth to make possible fine tone effects. The printing pressure must be kept high in order to make the feed of the paper web positive. When attempting to apply the intaglio printing process to transparent cellulose paper such as the product known commercially as cellophane, or other like relatively non-absorbent and transparent stock, several difficulties arise, for fine tone effects are not desired, and, owing to the transparency of the paper, a deep or solid color is necessary. In order to obtain this depth of color the etching on the printing roll may be made many times the depth used in ordinary printing. If the printing pressure is then kept at the usual amount, suitable for positively feeding the web, the pressure will cause a "squeeze back" of the freshly deposited color. The cellulose paper being grease-proof and therefore non-absorbent to the ink or color, and the color lying entirely on the surface, the feeding pressure spreads the color and so ruins the clarity of the printed outline, for the color streaks at the edges in an uneven and ragged manner.

It is not feasible to employ the usual type of intaglio printing machine, and to merely lessen the printing pressure, for the reason that the pressure then becomes insufficient for positive feed of the web through the machine. Furthermore, the quality of the results obtained when printing on transparent cellulose paper is markedly dependent on the pressure used, so that this pressure should preferably be adjusted during the printing operation, but adjustment of the printing pressure may vary the rate of feed of the web and thus spoil the printed impression. This defect is even more serious when attempting multi-color printing, for the different color impressions must be kept in exact registry. A primary object of my invention, therefore, is to overcome the foregoing difficulties, and to do this I separate the functions of printing and feeding, so that the printing pressure may be made relatively light, and may be adjusted during operation for best results, while the feeding pressure may be made sufficiently great to insure positive feed.

Another difficulty met with when printing on transparent cellulose paper and like stock, is that because of variations in the thickness of the stock, variations in atmospheric temperature and humidity conditions, and the relative inflexibility of the stock, occasionally a wave is developed in the web as it is being fed thru the machine. Under high pressure this wave will be ironed into a crease, and, transparent cellulose paper being brittle, such a crease so weakens the product that it may be ruined. To obviate the likelihood of producing ironed creases is a further object of my invention, which I fulfill by an advantageous arrangement of the feeding means which will be described later, together with the fact that the greatly lessened printing pressure which I employ is not itself sufficient to iron a wave into a closely pressed crease.

Even in ordinary intaglio printing it is necessary to use inks or colors which are free-flowing, and fairly rapidly drying. When printing on transparent cellulose paper, which is practically non-absorbent, the color lies entirely on the surface, and it is difficult to obtain sufficiently rapid drying of the printed web to permit of continuous subsequent operations, such as the printing of another color, or the cutting off of the sheet into the finished product, and consequently even more high volatile solvents and colors are used, but this aggravates a problem found in intaglio work, namely, the great difficulty experienced because of the tendency of the color to thicken in the color bath or fountain in which the printing roller rotates. To attempt to retain the consistency of the color it has heretofore been attempted to employ a stirrer or agitating means to constantly mix the color in the bath, but this attempted solution of the problem suffers from the disadvantage that the more a volatile color is agitated the faster it is evaporated, so that the

entire body of color, on the average, is thickened more rapidly.

To overcome this difficulty, and to retain the desired consistency of the color over a relatively long period of time, is another object of the present invention, which I fulfill by rotating the printing roller in one body of the color, and continuously circulating color therethrough from another body of color, the first body preferably being small, and the second body preferably being large and unexposed to the air in order to prevent evaporation.

The excess color picked up by the printing roller during its rotation in the color bath is scraped or wiped from the printing roller by a doctor blade before the printing surface reaches the paper. Obviously, the color must be wiped off the entire etched copper cylinder perfectly, except for the color which is to be left in the etched grooves. It is, therefore, necessary to turn the copper cylinder to absolute trueness and to grind the edge of the doctor blade perfectly straight. However, it is also necessary to highly polish the cylinder to remove tool marks, for these show up in the final printed product. In polishing it is very difficult, if not impossible, to obtain an absolutely true cylinder, and consequently the color may pass the doctor blade at some portion of the printing roller. It is not desirable to attempt to overcome this by merely tightening the pressure of the doctor blade against the entire printing roller, and accordingly, a further object and feature of my invention resides in the provision of a relatively flexible doctor blade and a considerable number of adjusting screws which are distributed along the blade and which are independently adjustable so that additional pressure may be placed on the blade in the region where color is passing through.

If, for some reason, the printing machine is stopped, a line of color dries on the printing cylinder at the doctor blade. When the machine is again started the printed product is spoiled by reason of the streak produced by this line drying. It is still another object of this invention to avoid line drying during a dwell period of the machine, which I do, broadly, by preventing air from getting between the doctor blade and the printing roller, and instead filling this region with color not only when the machine is in operation, but even during the dwell period. This is most simply accomplished by mounting the doctor blade at a distance above the color level in the bath such that when the machine is stopped the color rises to the edge of the blade, presumably by capillarity. The provision of suitable means for adjusting the color level is another object of my invention.

The difficulties experienced in attempting to obtain rapid drying of the printing have already been mentioned, and a still further object of my invention is to insure sufficiently rapid drying of even a solid color printed on transparent cellulose paper to permit of multi-color printing, or of subsequent cutting or finishing operations on the printed web in a reasonably short space of time, so that the operation may be kept continuous and rapid.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the method and the intaglio machine elements and their relation one to the other as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawings in which:

Fig. 1 is an elevation of the multi-color intaglio printing machine embodying my invention;

Fig. 2 is an enlarged section through one of the printing units;

Fig. 2ª is a detail showing the overflow conduit of the color bath;

Fig. 3 is a front elevation of the printing unit shown in Fig. 2;

Fig. 4 is a horizontal section taken in the plane of the line 4—4 of Fig. 3;

Fig. 5 is a partially sectioned plan view of the dryer; and

Fig. 6 is an elevation looking at the side opposite that shown in Fig. 1.

Referring to Figs. 1 and 6 there is a paper roll A, the stock from which is fed through a first printing unit B, then through a dryer C, after which the dried stock is fed through a second printing unit D, and then back to a dryer E, from which it is finally fed to other machines for subsequent operations.

Referring more particularly to Figs. 1, 2, and 3, the paper roll A is supported on plugs 2 and between flanges 4, the spacing of which may be adjusted to fit the particular width of roll then being used by means of a collar and set screw 6, and a nut 8. The paper roll shaft 10 is movable axially in the pedestals 12 by an adjusting knob and regulating collar 14 to help exactly center the roll in the machine. The brake 16 helps keep the paper taut as it is being unrolled.

The printing units B and D, shown in Figs. 1 and 6, are identical except that a different color is used with each, and a description of the unit B will therefore serve as a description of either. With especial reference to Figs. 1, 2, 3, and 4, there is a printing roller 20 which rotates in a color bath 22, and is wiped by a doctor blade 24, and is pressed against the web 30 by a squeezer roller 26, the pressure of which against the printing roller may be adjusted by adjusting screws 32 bearing on compression springs 34.

The printing roller 20 is carried by a shaft 36 and comprises a copper cylinder 38 in

which the design to be printed is etched in the customary manner, except that a depth of about 15 thousandths instead of only 2 thousandths is used. The squeezer roller 26 is carried by a shaft 28 journalled in the spring pressed bearings 40. The outer surface of the squeezer roller is encased in rubber, as is indicated at 42.

The problem of printing on transparent cellulose paper and like paper is made especially difficult because, on the one hand, owing to the transparency of the paper, it is desired to deposit a deep solid color, and on the other hand, because of the non-absorbent property of the paper, this deep color is subjected to squeeze back. For this reason, I very greatly lighten the printing pressure and, in fact, if necessary I constantly adjust it by means of the adjusting screws 32 during the operation of the machine in order to obtain best printing results.

The resulting pressure is too light and too variable to be suitable for obtaining positive feed of the web 30 through the machine. Positive feed is, of course, essential in order to obtain the correct impression from the printing roller, and also in order to synchronize the operation of successive printing units or other machines designed for subsequent operations upon the printed product. Now, according to my invention, the feed is accomplished by auxiliary feeding means instead of by means of the printing roller 20 and squeezer roller 26, as has been customary heretofore. The additional feeding means may grip the web at a pressure best suited for feeding and regardless of the magnitude of the printing pressure.

The feeding means is here exemplified by a pair of feed rollers 50 cooperating with a rubber encased presser roller 52. The feed rollers 50 are carried by a shaft 54, and are relatively narrow in width and properly located to engage only the margins of the web 30. The presser roller 52 is of constant diameter in order to accommodate the feed rollers regardless of the width of web then being printed, and is carried on a shaft 56 journalled in vertically reciprocable bearings 58, which are forced downwardly by compression springs 60, the tension of which is adjusted by adjusting screws 62. This pressure may be made extremely great, and easily sufficient for positive feed of the web 30. The feed rollers engage only the margins of the web, beyond the width of the printing roller, and therefore grip the web at a portion other than that being printed, so that the printed product is not affected by the pressure used between the feed and presser rolls.

It has already been mentioned that for one or more of a number of reasons the transparent cellulose paper is apt to develop waves, and that these waves, if ironed into creases, spoil the product. One great advantage of the lightened printing pressure employed in my machine is the fact that this pressure is insufficient to iron the waves into creases, that is, the waves may successfully go through the printing operation. At the same time the feed rollers ordinarily are not likely to introduce creases because they engage the web only at the margins. However, upon the approach of a rather bad wave it is desirable to attempt to remove it, or to let it pass without trouble, and to this end one or another of the feed rollers 50 may be released from engagement with the web. A cam movement may be provided whereby either wheel may readily be lowered, but in the present machine I have merely arranged that the brackets 64, which carry the feed rollers 50 and determine their axial location, may be released from and slid along the supporting rail 66, in order to leave only one of the rollers in contact with the web, this adjustment being the same as that used when the width of web is changed. The shaft 54, of course, is splined to impart rotation to the feed wheels while permitting axial movement thereof.

It is essential that the rate of feed of the web exactly equal the peripheral velocity of the printing roller. This condition is most simply met by making the feed wheels 50 and the printing roller 20 exactly equal in diameter and rotating them at equal speeds. To this end the printing roller shaft 36 and the feed wheel shaft 54 each carry similar gears 68, which commonly mesh with a drive gear 70. The printing roller shaft 36 is driven by an extension 72 which is splined to the gear 68 in order to accommodate different widths of printing roller for use with different widths of paper stock. In each case the width of the printing roller or of the impression thereon is small enough to leave unprinted margins for engagement by the feed wheels.

It was previously pointed out that intaglio printing in general, and particularly printing of the type herein described, necessitates highly volatile rapidly drying colors or inks. It is essential to keep the consistency of the ink fairly constant during operation, but this is difficult, owing to its rapid evaporation. To merely provide a large ink bath and a stirrer therefor is not desirable, because stirring augments to the rate of evaporation of the color. In accordance with my invention, the ink fountain or bath 22 is made as small as is conveniently possible, and the main bulk of color is carried in a closed reservoir or tank 80. The bath 22 is provided with an overflow conduit 82 which leads directly into the tank 80, as is most clearly shown in Fig. 2a. From the bottom of the tank 80 a pipe 84 leads to a circulating pump, here exemplified by the gear pump 86 by

which the color is elevated into the bath 22. In this manner I continuously circulate color through a bath 22 from another body of color 80. The bath being a relatively small body of color, and the main body of color in the tank 80 not being exposed to the air and therefore not being subject to evaporation, the total evaporation is reduced to a minimum. Meanwhile the continuous circulation of the color causes the consistency to remain that of the average, which changes but slowly, and may be corrected occasionally by the addition of a fresh supply of color.

The doctor blade 24 must contact with the printing roller 20 at a point above the level of the color in the bath. When the machine is stopped for some reason, a line of color is apt to dry on the cylinder at the doctor blade, and then when the machine is again placed in operation this line shows up as a streak across the printed product. To obviate this defect I cause the color to completely fill the gap between the printing roller and the doctor blade when the machine is stopped, just as though it were in operation, and so prevent air access behind the blade. I find that in practice this may be accomplished in an exceedingly simple manner by arranging the doctor blade so that its point of contact with the printing roller is only slightly above the color level, for in such case the color rises to the edge of the doctor blade, presumably as a result of capillary attraction. In this manner fresh liquid is kept in contact with the printing roller right up to the edge of the doctor blade, and no air is admitted between the blade and roller, where it might cause line drying.

The foregoing solution presupposes the ability to adjust the relative elevation of the color level and the doctor blade, and this adjustment I prefer to obtain by varying the color level. As was already mentioned in connection with Fig. 2a, the color depth within the bath is determined at a fixed amount by the overflow conduit 82, and I therefore vary the elevation of the entire color bath rather than the level of the liquid therein. The construction already described whereby the auxiliary tank 80 is mounted directly beneath the bath 22 and rigidly connected thereto by the pipe 84 and pump 86 makes this a simple matter, for the entire assembly of the bath, the tank, and the circulating system may be raised or lowered as an integral unit, the adjustment being made by jack screws 88.

It may here be mentioned that the entire unit consisting of the bath 22, the tank 80, and the pump 86, may readily be removed from the machine and another used in its stead when the color is to be changed. This is a great improvement over the process formerly employed, which necessitated draining the color supply, cleaning the system thoroughly, and then adding the new color.

The lower edge of the doctor blade 24 is mounted on a supporting rod 90, the ends of which are reciprocably fitted in bearings 92 which are fixedly related to the main bearings of the printing roller. The upper edge of the doctor blade is ground to fit the particular size of printing roller then being used, and, in the case of the smaller size of rollers, is preferably set at the printing roller center line. The level of the color bath may then be kept constant over a considerable range of size of printing roller, the roller merely setting more deeply into the bath as its size is increased. For a large change in size of printing roller the entire color bath and circulating system may be lowered, and in such a case a doctor blade of different width is used in order to make it possible to keep the difference in elevation of the edge of the doctor blade and the level of the color bath about at the value desired for the prevention of line drying.

In order to prevent the doctor blade from wearing rings or ridges on the surface of the printing roller which might show up in the printed product, it is desirable to vibrate the blade longitudinally of the roller during operation. For this purpose, I provide a cam 94 which is geared to the printing roller shaft by a gear 96. A cam follower 98 engages the cam 94, and is rigidly affixed to a screw block holding shaft 100. This shaft carries a screw block 102 in which an adjusting screw 104 is threaded. The end of the screw presses against the doctor blade 24 near its edge, and also passes through the slot of a yoke 106 which is fixed at its lower edge to the doctor blade 24 and the rod 90. When the machine is in operation the shaft 100 is vibrated by the cam 94 and cam follower 98, and this vibration is imparted to the doctor blade and to the supporting rod 90 thereof.

The copper cylinder of the printing roller must be highly polished in order to remove the tool marks left when the cylinder is being turned true. It is almost impossible to complete this polishing operation without sacrificing the trueness of the printing roller to some extent, and this is apt to later show up in operation by color passing the doctor blade at one or another portion of the printing roller. This is especially true with the thin and highly volatile colors used with cellulose paper. Even if it were feasible it would not be desirable to attempt to correct this difficulty by applying a greater pressure to the entire doctor blade.

In accordance with a further feature of my invention the doctor blade 24 is made of some relatively flexible material, such as German silver, and is kept in contact with the printing roller by a considerable number of adjusting screws, which, in the case here illustrated, are similar to the screw 104, being numbered 104', and are mounted in screw

blocks 102′, similar to the screw block 102. These screws, being independently adjustable, make it possible to apply additional pressure to the doctor blade at that portion thereof past which color is leaking. With the arrangement as shown, the entire doctor blade equipment, including the rod 92, the doctor blade 24, the screw block holding shaft 100, and the various screw blocks and adjusting screws, all vibrate as a unit under the influence of the cam 94. The vibratory travel is relatively slight, and the degree of irregularity in the printing cylinder counteracted by the adjusting screws 104 and 104′ is also extremely slight, so that one does not interfere with the other. In fact, the adjustment of the screws 104′ is preferably made while the machine is in operation, and therefore is never so extreme as to prevent the desired vibration of the doctor blade.

Provision is made for changing the printing roller, and to this end to the main frame 120 of the entire machine there is pivoted about the bushings 122 of the vibratory shaft 100 a printing roller frame 124. The frame 124 is provided with rest plates 126 and anchor lugs 128 so that it may be rigidly held in position during operation. It is also provided with handles 130 which may be swung downwardly after releasing the lugs 128 in order to oscilate the printing roller frame 124 about the pivot 122, and so swing the printing roller out of the color bath. When the frame has been inverted the bearing caps 132 may be removed and the printing roller lifted bodily out of place, and another inserted in its stead.

An important feature of the present machine is its ability to accommodate different sizes of printing roller. Thus, if the length of the printing roller is changed the spacing between the bearings may be adjusted to accommodate the change by sliding them along the sloted rail 134, and locking them in correct position. If the diameter of the printing roller is changed it is then necessary to also change the diameter of the feed wheels 50. This may be readily accomplished by pulling the splined shaft 54 out of the machine with the aid of the pull-out handle 136, and releasing the feed wheels 50 from the brackets 64. Upon changing the diameter of the printing and feed rollers the tension of the pressure springs may be correspondingly altered. It should be observed that turning the printing roller frame 124 about the shaft 100 does not alter the doctor blade vibrating mechanism, the printing roller gear 68 and the cam shaft gear 96 remaining in mesh, while the printing roller gear 68 and the drive gear 70 disengage, as is best shown in Fig. 6.

For multi-color work the first print must be made bone dry before the second print is applied. Even with single color work the print must be made bone dry before subsequent cutting and finishing operations may proceed. Owing to the almost completely non-absorbing properties of transparent cellulose paper, and because of the depth of the solid color printed thereon to avoid transparency, it is exceedingly difficult, but equally desirable, to obtain the necessary dryness. For this purpose I have devised a dryer which operates on the principle of forcing a large quantity of air past the printed surface at a very high velocity.

Thus, referring to Figs. 1 and 5, there is provided a pair of dryers C and E, the dryer C being used between the first and second printing units B and C, while the dryer E is used for the finished printed web. Each dryer consists essentially of a rectangular wind tunnel sufficiently wide to take the web, but relatively small in cross sectional area. The web of paper stock 30 passes over idlers 140 and 142 of the dryer C, and between the idlers is supported on a plate 144, which may also constitute the bottom of the dryer tunnel. Similarly, the web 30 on leaving the printing unit D is guided by idlers 146, 148, and 150 to and through the dryer tunnel E. A large quantity of air, say 2500 cubic feet per minute, is forced by a suitable fan through a large conduit 152, which converges at the dryer down into the tunnels. The air coming through the upper portion of the conduit 152 is fed directly into the dryer E. The air coming through the lower portion of the conduit 152 is divided and led through side bypass conduits 154 and then into the lower tunnel C, which begins at a point between the idler rollers 140 and 148. This precaution is taken in order not to have the air supply for the lower tunnel forced against the portion of the web 30 approaching the idler roller 148.

The small cross sectional area of the dryers C and E imparts an extremely high velocity to the air moving therethrough, which rapidly carries away the volatile solvents of the printing colors. The high velocity also serves to reduce the air pressure within the tunnels, and this aids the evaporation and drying of the colors. In extreme cases heated air may be utilized, but I find that with the arrangement here set forth excellent results may be obtained without resorting to this expedient.

In multi-color printing it is essential that the successive prints be properly superimposed or brought into registry. To adjust the registry compensating means are provided which, referring to Fig. 1, comprise a compensating roller 160 carried on an arm 162 which is oscillated by a gear 164 meshing with a manually adjustable worm 166. In order to keep the prints in registry it is essential for the printing units B and D to run in absolute synchronism, and for this

purpose they should be geared together by a positive drive, here exemplified by the chain and sprocket drive 170 indicated in Fig. 6. The drive for the entire machine may be taken through any desired one of the shafts, and this drive should also preferably be a positive one in order that the machine may be put into synchronism with other machines intended for subsequent operations on the printed web.

From the foregoing detailed description it will be understood that in operation paper is fed from a roll A through a first printing machine B, then to a high velocity air dryer C, after which it is led to a second printing machine D, which is equipped with compensating means to bring the two prints into registry, and finally through another high velocity air dryer E, after which the printed paper may be led to additional machinery for cutting and/or folding, and the like. The printing machines are especially adapted for depositing a deep solid color on non-absorbent material, the printing pressure being relatively light and accurately adjustable to prevent squeeze-back. The feed is accomplished by separate feed wheels having a suitable high pressure for positive drive, and these feed wheels may be released in the event of the occurrence of a bad wave in the web. Despite the depth of color rapid drying is accomplished by the use of a high velocity air stream in a tunnel of small cross sectional area, and by the use of very volatile inks or colors, which, however, are not subject to undue evaporation in the color baths owing to my novel system employing a small bath and a large closed tank with a circulating pump therebetween. Longitudinal color streaks are prevented by the multipoint adjustable and flexible doctor blade, and transverse line drying is prevented by the advantageous location of the blade edge relative to the color level. These various features are accompanied by manifold additional advantages which will be readily apparent to men skilled in this art from the foregoing detailed specification.

A preferred method of interrelating the several bodies of color used, and the multicolor product resulting therefrom are disclosed and claimed in my copending continuation in part application Ser. No. 541,974, filed Jan. 4, 1931.

It will be apparent that while I have shown and described my invention in the preferred form, many changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, defined in the following claims.

I claim:

1. In intaglio printing, the method of printing on transparent non-absorbent stock which includes etching the printing roller to several times the normal depth, and commensurately lessening the printing pressure in order to prevent squeeze back of the resulting solid color.

2. In intaglio printing, the method of preventing squeeze back when printing solid color on non-absorbent paper which includes printing with a relatively light printing pressure, insufficient to properly feed the paper, and feeding the paper independently of the printing means but in synchronism therewith by pulling the paper through the printing means in a positive manner.

3. In intaglio printing, the method which includes printing at a pressure best suited for printing and not best suited for feeding the web to be printed, and simultaneously feeding the web thru the printing means by gripping it on a portion other than that being printed at a point closely following the printing means.

4. In intaglio printing the method which includes printing at a pressure best suited for printing and not best suited for feeding the web to be printed, and simultaneously feeding the web synchronously thru the printing means by gripping it, at a pressure best suited for feeding and not best suited for printing, on a portion of the web other than that being printed at a point following the printing means.

5. In intaglio printing, the method which includes feeding the stock thru the printing means independently thereof by pulling the stock therethrough positively, and adjusting the printing pressure during the printing operation for optimum printing results.

6. In intaglio printing of solid color on non-absorbent stock, the method which includes printing at a relatively light pressure in order to prevent squeeze back, feeding the stock through the printing means independently thereof, and adjusting the printing pressure during the printing operation for optimum results.

7. In intaglio printing, the method of avoiding ironed creases which includes subjecting the web to only a relatively light printing pressure across its width, and applying a relatively heavy feeding pressure at a point following the printing cylinder on only the margin of the web.

8. In intaglio printing on transparent cellulose paper and like brittle paper stock, the method of avoiding ironed creases which includes subjecting the stock to only a relatively light printing pressure across its width, and upon the occurrence of a wave in the stock, applying a relatively heavy feeding pressure at only one of the margins of the stock in order to let the wave go by without ironing it into a crease.

9. In the operation of an intaglio printing machine having a bath of color, a printing roller rotating therein, and a doctor blade, the method of preventing the drying of a line

of color on the printing roller at the doctor blade during a dwell period of the machine which includes mounting the doctor blade at a distance above the color level such that when the machine is stopped the color rises to the edge of the doctor blade.

10. In the operation of a printing machine used for printing on transparent cellulose paper and other like non-absorbent stock, the method which includes etching the printing roller to several times the normal depth, commensurately lessening the printing pressure in order to prevent squeeze back of the resulting solid color, and rapidly drying the printing by forcing a large quantity of air past the surface of a printed portion of the stock and confining said air stream closely to the stock in a stream of small cross-sectional area so that the air moves past the printed surface of the stock at a very high velocity.

11. An intaglio printing machine used for printing solid color on relatively non-absorbent paper comprising a printing roller etched to a depth a number of times that ordinarily used for paper, a squeezer roller, and means to force the printing and squeezer rollers together with a very light printing pressure.

12. The combination with an intaglio printing machine used for printing solid color on non-absorbent paper, of means other than the printing means to positively feed the paper through the printing means independently of the printing means.

13. An intaglio printing machine comprising a printing roller, a squeezer roller therefor, means to force the squeezer roller against the printing roller at a relatively light pressure best suited for printing but not suited for feeding the web, and additional feeding means arranged to positively grip the web with a relatively heavy pressure on narrow marginal portions thereof other than and lying outside of that being printed at a point following the printing and squeezer rollers.

14. An intaglio printing machine comprising a printing roller, a squeezer roller therefor, means to force the squeezer roller against the printing roller at a relatively light pressure best suited for printing but not suited for feeding the web, and a feed wheel and presser means therefor arranged to engage with a relatively heavy pressure only the margin of the web at a point closely following the printing roller, said margin lying outside of the portion of the web being printed.

15. An intaglio printing machine comprising a printing roller, a squeezer roller therefor, means to force the squeezer roller against the printing roller at a relatively light pressure best suited for printing but not suited for feeding the web, a pair of feed wheels and presser means therefor arranged to grip the web with a relatively heavy pressure on the opposite margins thereof at a point following the printing roller and to draw it through the printing and squeezer rollers, and means for forcing the presser means against the feed wheels with a pressure sufficient to insure positive feeding of the web, said margins engaged by said feed wheels lying outside of the portion of the web being printed.

16. An intaglio printing machine for printing on transparent cellulose paper and like brittle paper stock comprising a printing roller, a squeezer roller therefor, means to force the squeezer roller relatively lightly against the printing roller in order to avoid creasing a wave in the stock, a pair of feed wheels and presser means therefor arranged to engage only the margins of the stock, and means permitting the release of the grip of one or another of the feed wheels in order to permit the passage of a wave therein without ironing it into a crease.

17. In an intaglio printing machine, a printing roller, a bath of color therefor, a doctor blade therefor, and means for so relatively positioning the edge of the doctor blade and the level of the color that during a dwell period of the machine the color rises to the edge of the doctor blade and thereby prevents line drying of color on the roller.

18. An intaglio printing machine comprising a printing roller, a bath of color therefor, a doctor blade therefor, and means for varying the level of the color bath relative to the edge of the doctor blade, including an overflow conduit for establishing the color level within the bath, and a screw adjusting means for varying the elevation of the bath.

19. An intaglio printing machine comprising a printing roller, a flexible doctor blade therefor, a plurality of adjusting screws distributed along the length of the blade and independently adjustable in order to flex the doctor blade into more perfect contact with the printing roller, and means to slightly reciprocate the doctor blade and adjusting screws longitudinally of the printing roller.

20. An intaglio printing machine comprising a printing roller, a doctor blade therefor, means for so supporting the doctor blade as to permit reciprocation thereof both transversely and longitudinally of the printing roller, a screw block holding means extending parallel to the doctor blade, a plurality of adjusting screws spaced along and threaded in the screw blocks for pressing the doctor blade against the printing roller, a cam, a cam follower cooperating therewith and arranged to slightly reciprocate the screw block holding means, the adjusting screws, and the doctor blade longitudinally of the printing roller, and means to rotate the printing roller and the cam.

21. An intaglio printing machine comprising a printing roller, a squeezer roller therefor, means to force the squeezer roller against the printing roller at the optimum printing pressure, additional feed and presser rollers closely following the printing roller, means to force them together with sufficient pressure to insure positive feed through the printing and squeezer rollers, and means for rotating the printing and the feed rollers at exactly equal peripheral velocities.

22. An intaglio printing machine for printing on transparent cellulose paper and the like comprising a deeply etched printing roller, a squeezer roller therefor, means to force the squeezer roller lightly against the printing roller at the optimum printing pressure, feed wheels and a presser roller therefor arranged to engage only the margins of the stock at a point following the printing roller, means to force the presser roller against the feed wheels with sufficient pressure to insure positive feed through the printing and squeezer rollers, and means for rotating the printing roller and the feed wheels at exactly equal peripheral velocities.

23. An intaglio printing machine arranged to accommodate printing rollers of different widths comprising bearings for the printing roller shaft, brackets for holding the bearings, means permitting axial adjustment of the brackets, a driving gear for said printing roller, a fixed bearing for said driving gear, and a splined shaft interconnecting the gear and printing roller, in order to accommodate changes in width of the printing roller.

24. An intaglio printing machine arranged to accommodate different widths of web comprising bearings for the printing roller shaft, brackets for holding the bearings, means permitting axial adjustment of the brackets, a pair of feed wheels for engaging the margins of the paper stock, means permitting axial adjustment of the feed wheels, and driving means for the printing roller and feed wheels suitably arranged to accommodate the desired axial adjustments of the printing roller bearings and the feeder wheels.

25. An intaglio printing machine arranged to accommodate different size printing rollers comprising means to support the printing roller, a squeezer roller, means to adjust the position and the pressure of the squeezer roller against the printing roller, a doctor blade, means to adjust the position and pressure of the doctor blade against the printing roller, a color bath, and means to adjust the elevation of the color bath in order to accommodate the size of printing roller being used and in order to determine the color level relative to the position of the doctor blade.

26. An intaglio printing machine arranged to accommodate different size printing rollers comprising means to support the printing roller, a squeezer roller, means to adjust the position and the pressure of the squeezer roller against the printing roller, a doctor blade, a color bath, a closed auxiliary color tank located subjacent the bath, an overflow pipe leading from the upper level of the bath into the tank, a pump connected between the bottom of the tank and the bath for circulating color through the tank and bath, and means to adjust the elevation of the bath, the tank, and the circulating system as a whole in order to accommodate the size of printing roller being used and in order to determine the color level relative to the position of the doctor blade.

27. An intaglio printing machine for printing solid color on transparent cellulose paper and the like, comprising a printing roller, a squeezer roller therefor, means for forcing the squeezer roller relatively lightly against the printing roller in order to prevent squeeze-back, feed means arranged to positively grip the web at a portion not being printed, and means to rapidly dry the resulting printed web including a tunnel, means to feed the printed stock through the tunnel, and means to force a large quantity of air through the tunnel at high velocity.

28. A multicolor intaglio printing machine comprising a first printing means, a second printing means, a forced draft air tunnel for drying the printed web between the first and second printing means, and means to drive the first and second printing means at exactly equal peripheral velocities, said air tunnel including a supply conduit of large cross-sectional area, and a drying conduit of small cross-sectional area, so as to move the air past the printed web at high velocity.

29. A multicolor intaglio printing machine comprising a first printing means, a second printing means, a forced draft air tunnel for drying the printed web between the first and second printing means, compensating means between the first and second printing means in order to bring them into registry, and means to drive the first and second printing means at exactly equal peripheral velocities, said air tunnels including a supply conduit of large cross-sectional area, and a drying conduit of small cross-sectional area, so as to move the air past the printed web at high velocity.

30. A multicolor intaglio printing machine comprising a first printing means, a second printing means, a forced draft air tunnel for drying the printed web between the first and second printing means, compensating means between the first and second printing means in order to bring them into registry, means to drive the first and second printing means at exactly equal peripheral velocities, and a forced draft air tunnel for drying the web after it leaves the second printing means, said air tunnels including a supply conduit of large cross-sectional area, and a drying conduit of

small cross-sectional area, so as to move the air past the printed web at high velocity.

31. An intaglio printing machine used for printing solid color on relatively non-absorbent paper comprising a printing roller etched to a depth a number of times that ordinarily used for paper, a squeezer roller, means to force the printing and squeezer rollers together with a very light printing pressure, and means other than the printing means to positively feed the paper through the printing means independently of the printing means but in synchronism therewith.

Signed at New York, in the county of New York and State of New York, this 20th day of April, A. D., 1929.

IRVING GURWICK.