United States Patent Office 3,282,208
Patented Nov. 1, 1966

3,282,208

PLANOGRAPHIC PRINTING PLATE AND PROCESS

Milton M. Ruderman, 230 Grist Mill Lane, Great Neck, Long Island, N.Y.

No Drawing. Filed Sept. 25, 1963, Ser. No. 311,325
9 Claims. (Cl. 101—149.2)

This application is a continuation-in-part of abandoned application Serial No. 820,093, filed June 15, 1959.

This invention relates to planographic printing and is particularly concerned with a novel method for the planographic printing of full continuous tones on a printing press.

Offset lithography or planographic printing is carried out by use of a printing plate with a completely flat surface. The printing plate is chemically treated to bring about a counteractive printing surface, i.e., so that the printing area will accept oily ink and repel water, and so that the non-printing area will accept water and repel the oily ink. In performing the printing process the plate is moistened with water and inked, following which the plate is pressed against a rubber blanket which transfers the inked image to the paper being printed.

The continuous tones obtainable in planographic printing by use of the present invention at least substantially equals that resulting from the use of the photogelatin or collotype process. Such latter process involves printing from plates without a mechanical screen or dots, such plates having a microscopic grain formation, and produces what is known in the trade as continuous-tone result, an approach to a literal photographic tonal effect.

Substantially all present day printing involving differences in tone from one part of the printed area to another is done by a halftone process. In accordance with this process separated solid areas like the elements of a stencil are what are printed. These solid areas are small dots of solid material which dots vary in size in direct relationship to the tones being matched. The dots are so small, however, that the presence of them is not distinguishable to the naked eye but their size variations create the optical illusion of variations in tonal values.

As is well known, the halftone process involves exposing the original copy to be duplicated through a camera lens and a cross-ruled glass or film screen. This screen, in some manner, breaks down the different tones into dots of varying size as just indicated. The photo sensitive element or printing plate which eventually receives the screened image is then used to run off proofs for comparison with the original copy before the actual press run. This trial and error system proceeds until simulation satisfactory to the shop and customer is achieved. Of course, when the copy to be duplicated is in color this must be broken down into three or four colors, each of the three or four colors being processed in the manner just described.

To date this halftone system has been about the sole one used, and it is almost universally used, in photo mechanical printing where large numbers of copies are desired. Nevertheless, it leaves considerable to be desired for a great deal of sharpness and detail are lost in utilizing halftone screens. All tones are degraded, and final proofs can never compare to the original copy.

Up until the last few years the printing plates used in planographic halftone printing have been metal plates coated with light sensitive coatings made from dichromated colloids. The coatings involved were albumen, gum, glue, gelatin, and the like, which, when mixed with

a dichromate, dried, and then exposed to light, changed to a water insoluble coating which becomes the image part of the plate. These colloids were very heavy in viscosity, being from 8 to 10 degrees Baumé, and were of appreciable thickness when coated on a metal plate.

The very heaviness of the colloid plate coating is what set the minimum size of dots or fine lines which are reproducible. Planographic printing does not permit a dot to be brought up from a wide base to a fine point as in letterpress or in gravure printing. Lithographic plates are only of one level. Therefore, any dot or line could not be smaller than the base bond to the plate. Any attempt to make a smaller dot or line would wear off in press operation. The fineness of the screen used was thus controlled by limitations imposed by the light sensitive coating thickness on the plate. Following this line of thinking, many print shops today refuse screened material made with a screen having more than 150 lines to the inch.

To date photogelatin or collotype printing is the only process which has been used in lithographic printing without involving screening. The use of this process has been very limited and it has serious shortcomings. The photogelatin is very soft, resulting in indeterminate short press runs. Furthermore, the work done by this process does not have the quality desired, nor does it consistently produce a uniform quality of printed sheets.

In recent years the dichromated colloid coatings on plates have been largely replaced by light sensitive diazo coatings. These coatings carry an image which is very hard and is firmly bonded to the metal of the plate, thus permitting long press runs. The performance of such diazo coated plates is equal to the standard colloid coated metal plates prepared and used in the industry while maintaining constant uniformity of duplication and full tonal range fidelity.

Though the characteristics of the plates were improved by the introduction of the diazo coatings, the industry has continued with the use of screens following all the steps that were utilized in planographic halftone printing previously using coatings which were dichromated colloids. The only simplification was that whereas dichromated colloids would not normally accept grease and hence greasy printing inks, and would have to be made water or grease receptive by the use of proper etches in the processing, diazo coatings may be used for offset printing without any treatment other than exposure to light under a master pattern followed by development.

Contrary to all existing beliefs I have discovered that by using planographic plates carrying diazo coatings, full continuous tones involving the range of all values from pure white to solid black can be imaged directly on to the diazo coating so that the image on the coating, besides being a continuous one, has all the variations of tone found in the original copy, and that when such planographic plates are inserted in a press they produce copy which has all the true values of the original. Exposure through a screen and the use of separate solid dot-like elements are eliminated. No longer is it necessary to represent variations in tonal values by means of optical illusion.

Not only can continuous tones of such quality be achieved in accordance with my discovery, but the original expectation that an image on a planographic printing plate which is not made up of dots would not last long in actual production has not materialized. To the contrary, whereas the prior procedures employing diazo plates in accordance with the halftone system

would give expectation of 20 to 30 thousand impressions from a plate, tests involving press runs in accordance with my invention show that a number of impressions considerably greater than this are obtainable by plates exposed to continuous tone in accordance with the invention.

The findings of the invention that printing ink will adhere to the surface of a flat plate for transfer in direct quantitative relationship with respect to the strength of the continuous tone positive that was used to expose the plate was unbelievable to experts in the industry until they were shown the results of the method of the invention. Though I have spent close to 30 years working with planographic printing and have made a study of all the aspects of it and have kept up-to-date on all the improvements that have been made, I am not sure that I know the correct theory which makes my invention and discovery work.

It is accordingly the principal object of my invention to provide a method for making continuous tone positive plates for use in planographic printing.

Another object of the invention is to provide a novel method of planographic printing which eliminates the intermediate screening heretofore employed and thought necessary to convey tone values in offset lithographic printing.

Still another object is to provide a novel method of planographic printing which permits the printing of large numbers of copies of continuous tone subjects on a printing press.

Another object is to provide a novel method of planographic printing which permits the printing of a large number of copies which are accurate reproductions of the original, are of uniform quality throughout, and present greater detail than ever heretofore achieved.

A further object is the provision of a method of planographic printing which enables the planographic printing of continuous and continually varying tone images while employing materials readily available on the market and to those skilled in the art.

A still further object of the invention is to provide a novel planographic printing plate which is readily made without the necessity for the use of expensive equipment or treatment by specialists in the course of its production.

Yet another object of the invention is the provision of a method of planographic printing which produces greatly improved printed reproductions of original copy material without the necessity for the use of expensive equipment or manipulation by specialists during the printing process.

Still further and more detailed objectives of the invention will in part be obvious and in part be pointed out as the description of the invention proceeds.

The method of printing full continuous tone copies in accordance with the invention may be employed in forming a positive reproduction of a positive master pattern, or a negative reproduction of a negative master pattern, in other words, it will produce a printed product which is a reproduction of the original. For simplification, both of such types of master pattern and printed copy made therefrom are referred to hereinafter as "positives." The method employs a planographic plate which is coated with a "diazo" compound. The planographic plate after having been suitably exposed is developed so that the diazo compound remains on the base and forms the substance of the image. Thus the areas which are totally black in the original mask the corresponding areas on the printing plate when the plate is exposed to light through the master pattern. Such areas of the plate remain fully coated with diazo compound after the development, and accept greasy ink in the printing operation to reproduce the black area as such on the printed copy. Totally white areas on the master pattern produce corresponding areas on the printing plate from which the light decomposition products of the diazo compound are removed, so that such areas do not accept the greasy ink. Areas of the printing plate corresponding to areas of the master pattern which have tonal values lying between total black and total white will have the light decomposition products removed therefrom during the development of the printing plate in proportion to the degree of light intensity to which each area of the plate was exposed. Such areas of the printing appear to accept greasy ink in proportion to the surface density of the light decomposition products of the diazo compound remaining thereon after development of the plate, so that the printed reproduction of each such area will contain ink in proportion to the tonal value of the original or master pattern. Such variation in tonal value appears to occur from molecule to molecule, or at least between small groups of surface molecules of the light decomposition products of the diazo compound at the surface of the printing plate. To the naked eye and under a low powered magnifying glass such variation appears continuous, as in a photographic image of the same subject.

With respect to the plates, they are normally of metal and commonly of zinc or aluminum formed for securement around a roll of a planographic press. The thickness of the plate is not important, but, as examples, aluminum plates for small presses run about .007" in thickness while for the larger presses a thickness will run up to .012". The light sensitive coatings on the metal plates can be applied in various manners such as by roller action, by dipping, or they can be wiped on by hand. The coatings are very thin and need to be no more than the sort of film that would be applied by hand wiping.

In explaining how my discovery is applied in the carrying out of the novel method of the invention, it must first be recognized that in the planographic printing industry each shop has its own ideas on such things as materials to use, exposure times, and other factors that can be varied for the obtaining of optimum results. Thus, certain of the details of my illustration could be subject to variation depending upon the practice of the particular shop. Nevertheless, the basic principles would be the same.

In the first place, densitometer tests must be made of the diazo coating selected by the particular shop under its normal shop conditions. This test is to determine the density or sensitivity range of the coating. This is needed since almost every printing order has readable matter incorporated into it along with reverses, tints, etc. The normal exposure for line work is used.

In proceeding in accordance with a preferred embodiment of the method of the invention, the material to which the coating on the printing plate is to be exposed for transfer by either contact or projection, is assembled into stripped flats on a clear plastic or glass support. With such material, which will be assumed to include both readable matter and continuous tone material, in place, the processing of the printing plate can be proceeded with.

The first step is to expose a continuous tone step tablet on the plate so that it shows thereon, using the normal exposure time for the particular shop. These step tablets are formed with sections stepped up in ascending grey, from white to dense black, with the steps being numbered in sequence up the scale from light to dark. In halftone printing the step tablets used are exposed on an edge portion of the same plate that receives the exposure from the flat but in a position on the plate which will not show in the actual printing. According to the invention, however, the continuous tone step tablet used is exposed right on to the face portion of one plate since a duplicate plate is to be used for the exposure of the flat thereon.

Next the place on which the step tablet has been exposed is developed, put on a press, and a few press sheets run off. The step scale is then analyzed from the stand-

point of the results obtained on the press sheets. No such analysis can be made when working with continuous tones until the press sheets are run off, for the diazo coating on the printing plate may print tones resulting from exposure to the scale which are not visible to the human eye from an examination of the plate itself. Once the press sheets are run off, the step scale as reproduced on them is analyzed to give the range of the particular printing plate.

As an example, with an exposure time of 4 minutes, the sheet may show the scale to start printing in the 4th number and to print up to the 8th number. If for the particular scale the 8th number reads 1.48 density, and the 4th number reads .32, then the density range of the coating on the plate being treated will be the difference between these, or 1.16. Most scales have a total range of 3.00.

Knowing then what the range of the plate is for an exposure time of 4 minutes, decrease of the exposure time on a positive plate will cause the 1.16 range to commence towards or at the bottom of the scale. Reversely, the range can be moved up towards or to the top of the scale by increasing the exposure. The camera man must make all of his continuous tone films fall within the determined range of sensitivity of the coating on the plate. If the sensitivity range of the printing plate, determined as in the foregoing, is suitable as it stands, then the prepared flats including continuous tone positives can be exposed on the duplicate plate as was used for exposing the step tablet.

If the sensitivity range of the particular plate being used is not considered to be wide enough, then, as a feature of this invention not heretofore employed, the sensitivity range must be extended once the plate has been exposed, by varying the development treatment in order to arrive at the desired optimum for the particular diazo coating used. Examples of such variation of development treatment are given below.

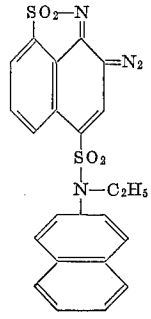
A marked difference exists between the exposure of halftone material on a plate and continuous tone material and it is my belief that it is this difference which has prevented other workers in the art from making the discovery that I have made. The difference resides in the fact that on visual inspection of a plate exposed to continuous tone material, one cannot tell what the tonal range of the eventual printing to appear on the press sheet will be. The apparent image visible on the coating is less than the full image that the plate will print. In fact, one skilled in the art, on examining such a plate before making prints, and not knowing that it carried the image of a continuous tone subject, would throw the plate away as being apparently worthless. The contrary is true where the image is the result of exposure to halftone material for there visual inspection of the plate will inform a pressman what result he will obtain on the printed sheet.

The method in accordance with the invention may be practiced with positive working planographic plates, that is, those having any light-sensitive diazo compound which itself is oleophilic and capable of accepting greasy ink, and whose light decomposition products do not accept greasy ink but accept water, i.e., have hydrophilic properties. The diazo compound used as the coating on the plate must also be such that after its exposure and development its light decomposition products will not remain on the base member of the plate in amounts varying with the degree of its exposure to light, thus to form the substance of the image with all of its continuous tonal variations.

The following are non-limiting examples of planographic printing plates made in accordance with the invention, and of methods of printing, employing such plates, in accordance with the invention. The parts indicated in the examples are by weight if not otherwise stated.

Example I

The light sensitive coating on the printing plate has as its active component an imino-quinone diazide of the naphthalene series having the formula



The coating was formed by dissolving the diazide in glycolmonomethyl ether to form a two-percent solution of the diazide. Such solution was brushed onto the mechanically roughened surface of an aluminum foil, the coating then being thoroughly dried.

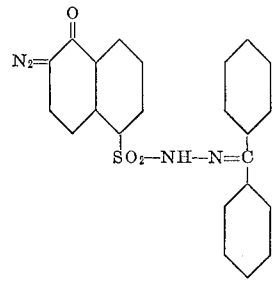
The thus coated foil was then exposed to light under a continuous tone master or pattern. The plate was then developed by wiping the exposed coating thereon with a one-percent solution of trisodium phosphate. In order to eliminate all tendency of the areas from which the light decomposition products of the diazo compound have been removed to accept greasy printing ink over a long press run, the plate was subsequently wiped briefly with a one-percent solution of phosphoric acid.

The plate was now mounted on the cylinder of a conventional offset press, the plate cylinder of the press being dampened by water and inked with a greasy offset printing ink. The printed copies thus produced were faithful reproductions of the original or master pattern, and contained the same continuous tonal gradation as the original.

The contrast obtained with the above concentration of trisodium phosphate used as the developer is an intermediate one. The greatest contrast in copies printed by the plate is obtained when the pH of the developer is highest, i.e., 13 or 14, less contrast being progressively obtained as the pH is reduced as by diluting the developer with water, toward a value of about 8.

Example II

A mechanically roughened aluminum foil was coated with a one-percent solution of a diazo compound having the formula:

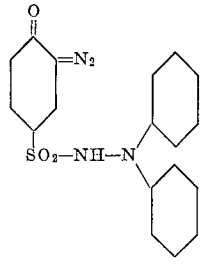


in glycol monomethyl ether. The dried foil, after exposure under a continuous tone positive pattern, and development with a five-percent solution of disodium phosphate, exhibited a positive image of the pattern. The plate was thereafter treated with an acid medium such as monoammonium phosphate, to prevent the adherence of ink thereto at unwanted areas.

The plate was mounted on a conventional offset press, was moistened with water and inked with a greasy ink, and continuous tone reproductions of the original continuous tone positive pattern were printed by the plate.

Example III

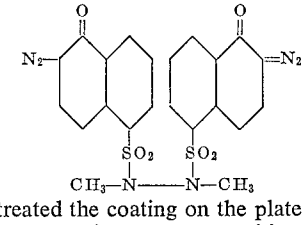
An aluminum foil was coated with a dioxane solution containing 0.5-one percent of a diazo compound having the formula:



After the coating was dried the sensitized foil was exposed to light under a continuous tone pattern. The plate was developed with a solution of disodium phosphate, thereby developing a positive image on the plate. The disodium phosphate was preferably employed in a five-percent to ten-percent solution, the degree of contrast in the developed plate diminishing with decrease of concentration of the solution. After the plate was developed it was treated with mono-ammonium phosphate solution, in order to decrease the tendency of the printing ink to adhere to the portions of the plate from which the diazo compound had been removed. After the above treatment, the printing plate was mounted in a conventional offset printing press, the plate was moistened and supplied with a greasy ink, and a number of positive printed copies were thereby produced.

Example IV

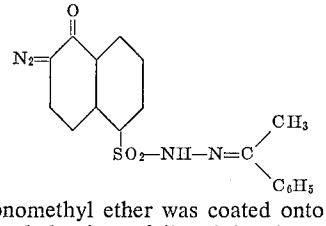
An aluminum foil was coated with a dioxane solution containing 0.5—one percent of a diazo compound having the formula:



After being treated the coating on the plate was subjected to light under a continuous tone positive pattern. The development of the plate, and subsequent treatment with an acid carrying medium and its use on an offset printing press were the same as those set forth in Example III above.

Example V

A one-percent solution of a diazo compound having the following formula:

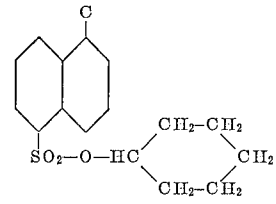


in glycol monomethyl ether was coated onto a mechanically roughened aluminum foil and the plate, after a short predrying was dried for 5 minutes at a temperature of 90° C. to remove the solvent.

The sensitized plate was exposed to light under a positive transparent continuous tone pattern and the exposed layer was then developed by means of a five-percent water solution of disodium phosphate. The thus exposed and developed plate was wiped with one-percent phosphoric acid solution and was then mounted on an offset printing press wherein moistened with a greasy ink it produced a number of continuous tone printed positive reproductions of the original.

Example VI

A 1.5 percent solution of the naphthoquinone-(1,2)-diazide-(2)-5-sulfo-acid-cyclohexyl-ester having the formula:

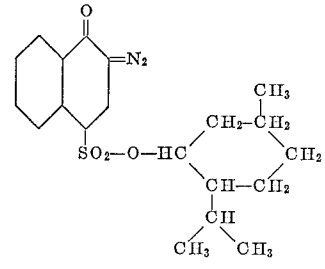


in glycol monomethyl ether was applied as a thin layer to a mechanically roughened aluminum foil, and such coating layer was thoroughly dried. The dried layer was then exposed to light under a positive continuous tone master pattern and then developed with a five-percent solution of sodium hydroxide. The resulting developed coating was then treated with a one-percent solution of phosphoric acid and rinsed. After drying the plate was then ready for use on an offset printing press supplied with a greasy ink, thereby to print positive reproductions of the original which had the same continuous tonal gradation as had the original.

The above light sensitive layer on the plate may, if desired, contain up to thirty-percent rosin. Instead of being mechanically roughened the aluminum foil may be superficially oxidized before being coated with the light sensitive material.

Example VII

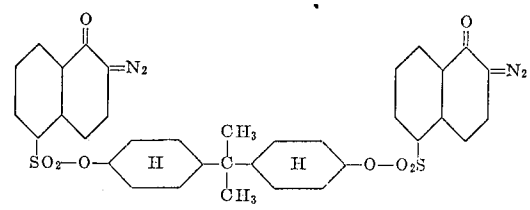
0.9 part by weight of the diazide set forth above in Example VI were mixed with 0.6 part by weight of naphthoquinone - (1,2) - diazide-(2)-4-sulfo-acid-menthyl ester having the formula:



Such mixture was dissolved in 100 parts by weight of glycolmonomethyl ether. This solution was applied to a mechanically roughened aluminum foil by means of a plate whirler. The coating layer was thoroughly dried and was then exposed to light behind a positive continuous tone master pattern, and finally rubbed in thinly with greasy ink. The image on the exposed coating on the plate was developed with a ten-percent solution of disodium phosphate. The thus developed plate, after being rinsed and dried was employed to produce positive continuous tone reproductions of the master pattern by being mounted on an offset printing press and being supplied with a greasy printing ink.

Example VIII

1.5 parts by weight of the bis-naphthoquinone-(1,2)-diazide-(2)-5-sulfonic acid ester of B,B-bis-(p-hydroxy-cyclohexyl)-propane having the formula:



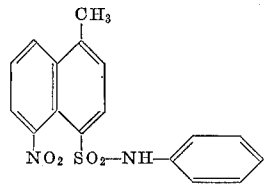
were dissolved in 100 parts by weight of monomethyl-

glycol ether. The solution was coated onto a mechanically roughened aluminum foil and upon thorough drying, the formed thin layer was exposed to light under a positive continuous tone master pattern.

The exposed layer was treated with a three-percent solution of trisodium phosphate, thereby removing to varying degrees the areas of the coating which had been struck by light. The developed coating was then treated with a solution of mono-ammonium phosphate and after being rinsed and dried was used to make positive continuous tone prints in the usual manner upon an offset printing press.

Example IX

A one-percent solution of 1-methyl-5-nitronaphthalene-4-sulfanilide having the formula:

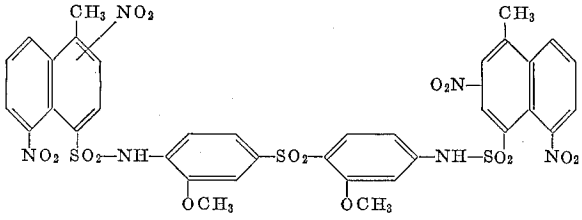


in a mixture consisting of equal parts by volume of glycol monomethyl ether and dimethyl-formamide was whirlcoated onto a mechanically roughened aluminum foil with the aid of a plate whirler. The coated foil was briefly dried with the aid of hot air and the drying was then continued for about 5 minutes at 90° C.

Subsequently the sensitized foil was exposed under a transparent continuous tone film master to a suitable source of light. The exposed coating was developed by swabbing with a five-percent solution of trisodium phosphate, following which it was briefly wiped over with a one-percent phosphoric acid solution. Thereafter the plate thus produced was employed as a printing plate on an offset printing press, printing positive reproductions of the master pattern after it had been moistened and coated with a greasy ink in a conventional manner.

Example X

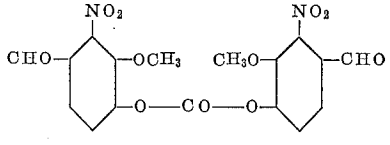
A one-percent solution of p,p'-bis-(methyl-5-, X-dinitro - naphthalene - 4 - sulfonamide)-2,2'-dimethoxy-diphenylsulfide having the formula:



in glycol monomethyl ether was coated upon aluminum foil. After being treated the coating was exposed to light behind a positive continuous tone master pattern. The thus exposed plate was developed by being subjected to a five–ten-percent solution of trisodium phosphate following which it was treated with a one-percent solution of phosphoric acid. The resulting printing plate when employed upon a conventional offset printing press, moistened with water, and supplied with a greasy ink, produced printed copies which were excellent reproductions of the continuous tone positive master pattern.

Example XI

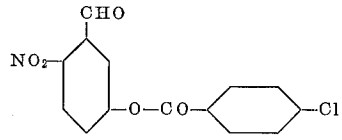
A solution in which 1 part by weight of bis-(2-methoxy-3-nitro-4-formyl-phenyl)-carbonate having the formula:



and 0.2 part by weight of a phenol-formaldehyde lacquer were dissolved in 100 parts by volume of dioxane, and were whirlcoated onto a mechanically roughened aluminum foil. The foil was then dried, first with warm air, and then for 5 minutes at a temperature of 90° C. The foil was then exposed under a positive continuous tone transparent pattern and developed by swabbing first with a 10-percent and then with a 15-percent solution of disodium phosphate. After wiping with a one-percent solution of phosphoric acid the plate was rinsed and dried. It was then mounted on an offset printing press, moistened and inked with a greasy ink in a conventional manner, and employed to make a number of copies of printed continuous tone reproductions of the original master pattern.

Example XII

A one-percent solution of the 3-formyl-4-nitrophenyl-(1)-chloro benzoic acid ester having the formula:

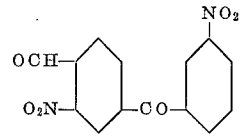


in glycol monomethyl ether was whirlcoated onto an anodically oxidized aluminum foil and the foil was then well dried. By exposing the light-sensitive layer to light under a transparent continuous tone positive pattern, an image was produced which is developed with a three–five-percent solution of trisodium phosphate and submitted to an after treatment by wiping over with a one-percent solution of phosphoric acid.

The thus treated foil was rinsed and dried, after which it was mounted on an offset printing press and employed to make printed copies by moistening it and inking it with a greasy ink.

Example XIII

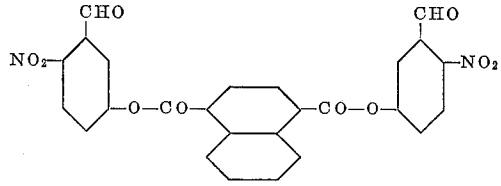
An aluminum foil was light-sensitized by coating with a solution, in which one-percent of 3,3'-dinitro-4-formyl-benzophenone having the formula:



was dissolved in a solvent mixture consisting of 25 parts by volume of dimethyl formamide and 75 parts by volume of glycol monomethyl ether. After drying, the foil was exposed to the light of an arc lamp under a transparent continuous tone master pattern. Exposure time 8–10 minutes. In order to develop the positive image produced on the light-sensitive layer, the exposed foil was swabbed with a two-three percent solution of trisodium phosphate. After being subsequently wiped over with a one-percent phosphoric acid solution, the foil may be moistened, inked wth a greasy ink, and used as a printing plate.

Example XIV

One part by weight of the compound having the formula:



and 0.2 part by weight of shellac are dissolved in 50 parts by volume of dimethyl formamide by heating them in a water-bath, and then 50 parts by volume of glycol monomethyl ether were added to the solution. On a plate-whirler a mechanically roughened aluminum foil

was coated with the thus obtained solution and after a short period of drying with hot air, drying was continued for 5 minutes at a temperature of 90° C., in order to obtain the complete removal of the solvents. Then the sensitized foil was exposed to the light of an arc-lamp, under a continuous tone master pattern. The plate was developed with a one-percent solution of trisodium phosphate. Afterwards the plate was then swabbed with a very dilute phosphoric acid (about one percent), rinsed and dried. It was then used as a printing plate on an offset press, being moistened and inked with a greasy ink, to produce continuous tone printed reproductions of the original master pattern.

The above 14 examples of diazo compositions useful in practicing the method of the invention are not exclusive; many others may also be used. To be useful in the carrying out of the invention the diazo coating must be of adequate light sensitivity to make its use feasible, must react selectively to exposure to light, and must be developable whereby to produce image areas which retain greasy ink. The above exemplary diazo coatings are all of different compositions. No two provide quite the same characteristics and depending upon the particular purpose some are better than others and of different density ranges. Any of those normally available at present can be used in the method of the invention with varying degrees of satisfaction. The coatings, whether already present on the plate or applied by the user are very thin being measurable in microns, as is known to those skilled in the art. With respect to developers for the coatings on the plates the normal practice is to use the standard developers recommended by the manufacturer of the particular plate.

Standard greasy inks used in offset printing are satisfactory for the carrying out of the invention. Such inks are available from the following manufacturers, as well as others: Superior Ink Company of New York, N.Y.; Siebold Ink Company of New York, N.Y., and the International Ink Company (Division of Inter-Chemical Corporation) of New York, N.Y.

From my study and development work since making the discovery on which this invention is based, however, it appears to me that excellence of product can be enhanced by the utilization and development of inks of finer grain than those generally now available. The presently available inks have their grain size related to the smaller size dots that occur in printed copies made with the halftone system. If my theory of why my continuous tone method works is correct, the particle or molecule size of the ink can be made much smaller, and can be related to the molecular condition of the image part of the diazo plate. This latter then would be the limiting factor insofar as the ink used is concerned.

My discovery of the fact that continuous tone prints, that is, prints with graduated continuous tonal variation, can be made in very large numbers using thin coated diazo coatings on plates bids fair to revolutionize the art of planographic printing. No longer is screening necessary, nor it is necessary to rely on the optical illusion achieved by variations in the size of individual dots to simulate the appearance of a subject. Instead the subject can be much more closely depicted by the continuous tone imaging method of the invention. Material improvement in the product is achieved. Not only does it just look better to the normal observer, but it is much better in such factors as definition in tonal value when carefully examined. The continuous graduated tone printed product is closely comparable in appearance to the results obtainable by purely photographic reproduction of an original having such continuous graduated tonal values. It solves many problems and eliminates many drawbacks that existed in the printing art.

One example is the reproducing of large elements, such as maps, from small filmed negatives, which maps even when examined through a magnifying glass provide definition enabling small objects to be detected which were completely obscured by the halftone system. Nevertheless, such maps as well as all the other material heretofore printed in halftone can now be printed in at least the same numbers from a single plate as has heretofore been done with halftone plates. The continuous tone plates of the invention are thus equally suitable for use in printing employing modern, high speed planographic presses.

In the foregoing I have set forth by way of example and incorporation by reference everything that is necessary to enable those skilled in the art to adopt and practice the invention. It is to be understood, however, that my disclosure is for illustrative and not limiting purposes since those skilled in the art on considering such disclosure may well comprehend variations and modifications falling within the spirit and scope of the invention.

Speaking more generally since certain changes in the materials set forth and in the carrying out of the above method and different embodiments of the invention may be made without departing from the scope of the invention, it is intended that all matter contained in the foregoing disclosure shall be interpreted as illustrative and not in a limiting sense.

Having described my invention what I claim as new and desire to secure by Letters Patent is:

1. A positive working planographic printing plate having a water-insoluble diazo coating thereon which has been exposed to light directly under a continuous tone master pattern without the use of a halftone screen and subsequently developed, said diazo coating having an image thereon which is inked with a greasy printing ink in continuously varying amounts in the various areas thereof in amounts proportional to the tones of the corresponding areas of the master pattern.

2. A positive working planographic printing plate having a water-insoluble diazo coating thereon which has been exposed to light directly under a graduated continuous tone master pattern without the use of a halftone screen and subsequently developed, said diazo coating having an image thereon which is devoid of stencil-like separations, and which is inked with a greasy printing ink in continuously varying amounts in the different areas thereof so that when the ink on the image on the printing plate is transferred to a copy sheet to be printed the thus transferred printed image has continuously graduated tonal values which vary in direct relationship to the tonal values of the master pattern.

3. Those steps in the method of mechanically providing continuous tone copies of a continuous tone subject which comprise exposing a flat positive working planographic printing plate having a hard thin water-insoluble diazo coating thereon directly to the continuous tone subject without the use of a halftone screen to form an image in a portion of said coating in graduated manner in relationship to the tonal values of said subject, and after said exposure developing said coating, applying greasy ink to the flat surface of the thus exposed and developed diazo coating to cause said area to retain ink in amounts varying in relation to the variations in said tonal values and mechanically transferring said ink from said image area to a copy sheet.

4. Those steps in the method of providing continuous tone copies of a continuous tone subject which comprise moistening and applying greasy ink to the flat surface of a hard thin exposed and developed water-insoluble diazo coating on a positive working planographic printing plate, said coating having a continuous tone photographically formed scale area of varying stepped tonal value thereon to cause said scale area to retain ink in amounts varying in relation to the variations in said tonal values, transferring said ink to a copy sheet, directly exposing a counterpart of said diazo coated positive working plano-

graphic printing plate to a continuous tone subject without the use of a halftone screen while varying the exposure in accordance with the preferable range indicated by the reproduction of said scale on said copy sheet, developing the coating on said counterpart plate to provide a continuous tone printing surface, applying ink to the image portion of the developed coating on said counterpart plate, and mechanically transferring the ink retained by said coating to a copy sheet to form a continuous tone inked copy of the continuous tone subject.

5. The method of mechanically printing continuous tone copies of a continuous tone subject which comprises directly exposing a flat positive working planographic printing plate having a thin water-insoluble diazo coating on the surface thereof to the subject without the use of a halftone screen under sufficient illumination to form a continuous tone image on the plate, developing such coating, applying ink to the image portion of such developed coating, and mechanically transferring the ink retained by said coating to a copy sheet to form a continuous tone inked copy of the continuous tone subject.

6. In planographic printing, the method of mechanically reproducing copies of a subject in continuous tone which comprises directly optically exposing without the use of a halftone screen the water-insoluble diazo coating on a positive working planographic printing plate to the continuous tone subject to be copied under sufficient illumination to form an image area in said coating in graduated continuous tone throughout said area, developing the coating so exposed, inserting said plate in a planographic press, and employing said plate in said planographic press for the mechanical printing of continuous tone copies of the subject.

7. The method of mechanically producing continuous tone copies of a continuous tone subject which comprises directly optically exposing without the use of a halftone screen the water-insoluble diazo coating on a positive working planographic printing plate to the continuous tone subject to be copied under sufficient illumination to form a continuous tone image area in said coating in graduated continuous tone throughout said area, developing said coating and employing said plate to mechanically print a multitude of said copies by employing said developed coating as the continuous tone ink transfer member in a mechanical planographic printing process.

8. The method of mechanically forming continuous tone printed copies of a subject which comprises exposing a flat positive working plate having a hard thin water-insoluble diazo coating thereon directly to the continuous tone subject without the use of a halftone screen to form an image in a portion of said coating in graduated manner in relationship to the tonal values of said subject, and after said exposure developing said coating, contacting the flat face of said developed coating with ink from a supply to cause ink to adhere in varying amounts to said image portion of the plate in direct relationship to the relative tonal values of the same, and mechanically transferring such ink from said coating to sheets for the making of continuous tone copies of the subject.

9. Those steps in the method of providing continuous tone copies of a continuous tone subject which comprise directly exposing without the use of a halftone screen a water-insoluble diazo coating on a positive working printing plate to a continuous tone subject, adjusting the developer to be used by varying the pH thereof to vary the sensitivity range of the coating on said plate, developing said exposed coating with said adjusted developer, applying ink to said developed coating, and mechanically transferring said ink from said developed coating to a surface to be printed upon.

References Cited by the Examiner

UNITED STATES PATENTS

2,692,827	10/1954	Brinnick	96—33
2,754,209	7/1956	Schmidt et al.	96—33
2,854,338	9/1958	Herrick et al.	96—75

FOREIGN PATENTS

296,008	10/1929	Great Britain.

OTHER REFERENCES

Hartsuch, Chemistry of Lithography, 1954, Second Printing, Lithographic Technical Foundation, New York, New York, pp. 124–127.

Jaffe, Halftone Photography, 2nd ed., 1960, Lithographic Tech. Foundation, New York, pp. 1 and 2.

Photo Technique, vol. 1 Dec. 1939, pp. 14 and 44.

The Focal Encyclopedia of Photography, vol. 2, The Focal Press for the Caxton Publishing Co. Ltd., New York, pp. 1273 and 1274.

Smethurst, Science and Applications of Photography, Proceedings of The International Conference held on the occassion of the Centenary of The Royal Photographic Society of Great Britain, London 19–25 September 1953, The Royal Photographic Society of Great Britain London (Publisher) pp. 526–528.

NORMAN G. TORCHIN, *Primary Examiner.*

A. D. RICCI, *Assistant Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,282,208 November 1, 1966

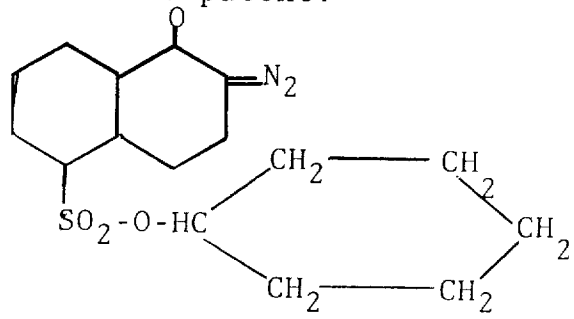
Milton M. Ruderman

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, lines 39 to 44, for the upper left-hand portion of the formula reading

N_2- read N_2=

column 8, lines 5 to 14, the formula should appear as shown below instead of as in the patent:



column 9, line 14, for "nitronaphthalene-" read -- nitro-naphthalene- --; column 10, lines 17 and 18, for "nitrophenyl-(1)-chloro benzoic acid ester" read -- nitro-phenyl-(1)-p-chloro benzoic acid ester --.

Signed and sealed this 29th day of October 1968.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents