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H. C. PURDY

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PHOTOGRAPHIC LIGHT-SENSITIVE ELEMENT

Original Filed March 7, 1947

FIG. 1

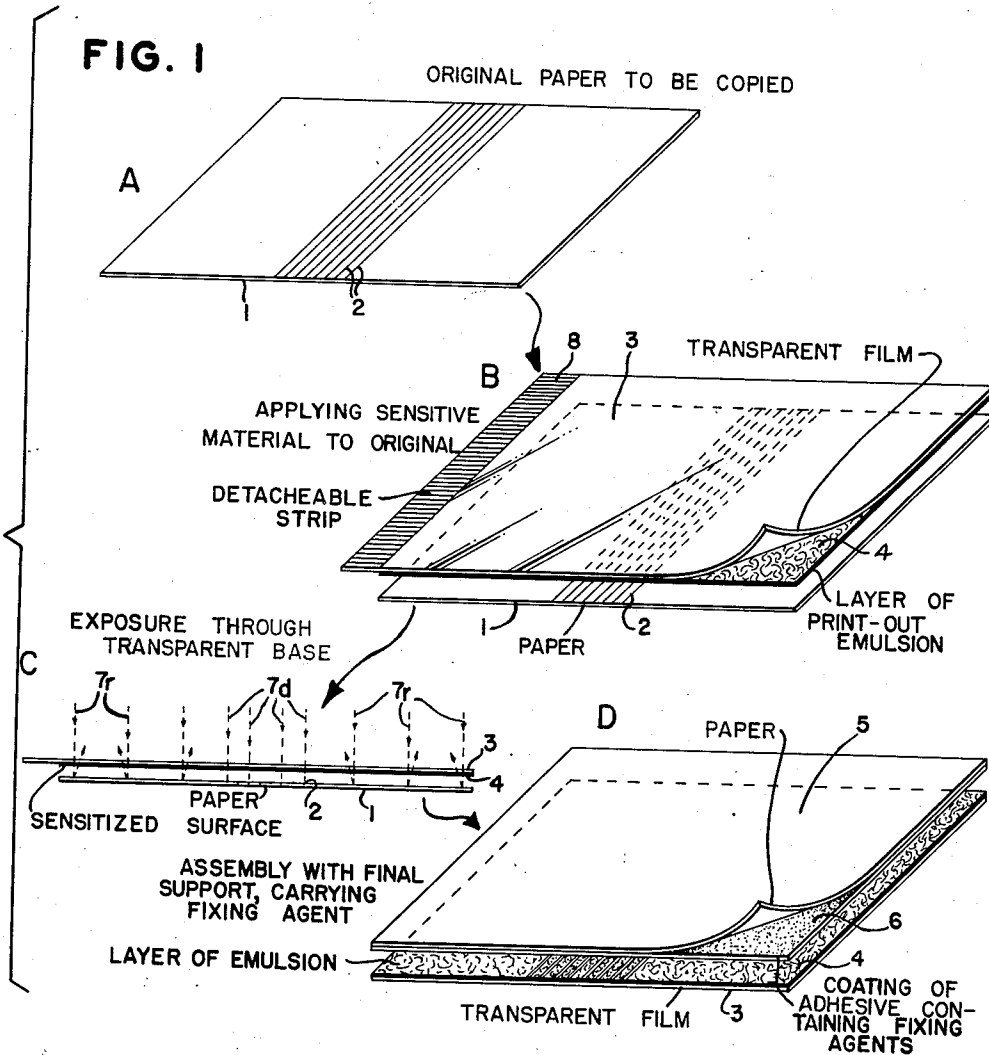
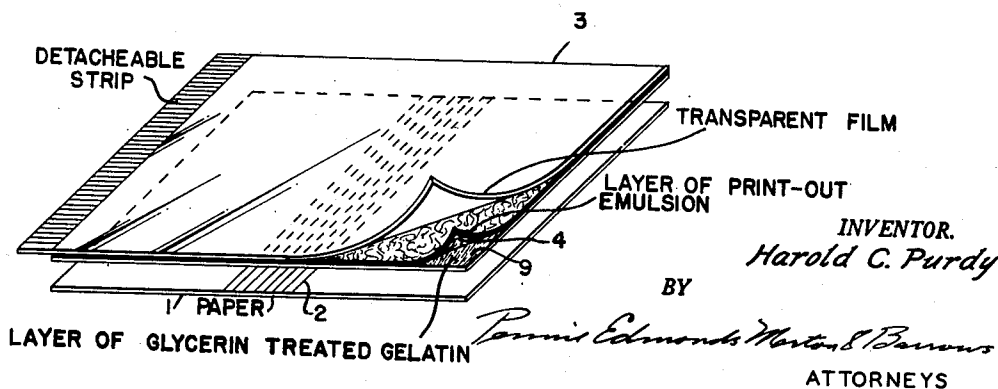


FIG. 2



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PHOTOGRAPHIC LIGHT-SENSITIVE ELEMENT

Harold C. Purdy, Friendship, N. Y.

Original application March 7, 1947, Serial No.
733,067. Divided and this application Novem-
ber 9, 1948, Serial No. 59,096

1 Claim. (Cl. 95—8)

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This invention relates to the art of making photographic duplicates of originals such as printed matter or the like. The invention includes improvements in photographic duplicating processes, improvements in materials suitable for such use, and also improvements in the duplicate or copy as a finished product.

This application is a division of my application Serial No. 733,067, filed March 7, 1947.

A particular object of the invention is to provide improvements in the art of making photographic duplicates whereby specialized knowledge and skill on the part of the maker of the duplicates is not required. My invention makes it unnecessary to use special printing fixtures, developing and fixing equipment, or other fixtures or equipment not commonly found in business offices.

At present there are innumerable devices and processes in use for making duplicates or copies of printed matter, manuscripts, charts, and drawings, that range from simple, inexpensive printing frames with aqueous or vaporous developing equipment, up to the well known photostat machines which have elaborate and semi-automatic exposure and developing equipment, but which are far beyond the means or requirements of the usual business office. The procedure in making such duplicates is, in general, the same for all cases: i. e., an image, usually latent, is impressed upon a light-sensitive emulsion by the action of light passing through the original or reflected from its surface; the sensitized emulsion and its supporting base are removed from exposure to light after an interval of time which depends upon the characteristics of the emulsion, the quality and intensity of the light, the ingredients of the developing and fixing solutions or vapors, and the atmospheric conditions obtaining during the successive steps of the process; and upon removal from the action of light, the image is developed and fixed, or merely fixed as the case may be, by one of two general methods. One is to subject the exposed emulsion to the chemical action of a vapor, oftentimes that of mercury or ammonia, which action develops the latent image and fixes it more or less permanently in the emulsion. The equipment for controlling the vapor and handling the sensitized sheets, without inconveniencing the personnel of the usual business office, requires elaborate and special equipment which is not applicable to any other office requirement. The other general method is to immerse the exposed print in a solution of chemical agents suitable for developing the latent image, washing off the excess developing solution and by-products, and re-immersing in other chemical solutions suitable for fixing the image in the emulsion. This is followed by another washing and the subsequent drying of the print. Here, as in the vapor proc-

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ess, special equipment is required that is not applicable to any other office use.

In the use of either the vapor or solution process, there is, in addition to the necessary specialized equipment, a certain amount of knowledge and skill required of the maker of the duplicate, which likewise is not applicable to any other requirement of the usual business office. This special knowledge and skill is applied in manipulating and regulating the mechanical features of the equipment, adjusting the time of exposure, and determining the time of development which varies with the degree of exposure to light, ingredients of the developing and fixing agents, and changes in concentration of the chemical agents as the process continues. This same knowledge and skill, when developed to a greater degree, becomes the art of the photographer. In fact, the processes, principles, and practices used in making duplicates are those used in photography, and are so widely known and published that a more detailed description of them is superfluous here.

In general, it may be stated that my invention comprises an improved photographic print or duplicate of any original such as printed matter or the like, this print comprising an exposed layer of light-sensitive printing-out emulsion permanently bonded to a layer of sheet material by an adhesive, the emulsion having been fixed by reaction of the emulsion with the chemical fixing agents incorporated in the adhesive. My invention also contemplates the use of chemical toning agents incorporated in the adhesive to produce the desired toning effect.

Another feature of my invention involves the use of a color gauge carried by the sheet of transparent material which is coated with or contains a light-sensitive printing out emulsion, this color gauge being preferably detachably secured to a marginal portion of the sheet or film of transparent material. This color gauge has the color and tone of the emulsion after the emulsion has been adequately exposed to light and accordingly the use of this gauge makes it possible to produce uniform prints or duplicates by exposing the film to light until the color and tone of the emulsion matches the color and tone of the color gauge.

My invention also contemplates the production as an article of manufacture, of an unexposed print comprising a film of transparent material carrying a light-sensitive printing out emulsion, the emulsion being covered by a layer of material having an exposed tacky surface whereby the unexposed print may be temporarily bonded to the surface of the original until the emulsion has been exposed to light to the desired extent; i. e., the emulsion carried by the film of transparent material may be coated or covered with a layer of gelatin having its exposed surface treated with glycerin to make it tacky.

In general, it may be stated that my improved process comprises placing on a surface of the original a transparent film carrying a light-sensitive printing-out emulsion, exposing the film to light until it acquires an image of the original of the desired intensity, removing the film from the original and bonding it to a layer of sheet material carrying an adhesive having incorporated therein chemical fixing agents for fixing the emulsion. As indicated above, the process may also include the use of a color gauge carried by the emulsion coated film so that any desired number of duplicate prints of uniform exposure can be readily made by exposing each film to light until the image acquires a color and tone matching that of the color gauge.

For convenience and clarity, certain terms used throughout this specification may be defined as follows:

"Original" is the printed page, manuscript, drawing, or the like, which is to be duplicated or copied.

"Print" (noun) when completed, becomes the duplicate of the original. It may be negative or positive, as these terms are used in the photographic art. It comprises a light-sensitive element in, or on a suitable supporting base.

"Print" (verb) to expose to the action of light.

"Unexposed print" has not been exposed to light.

"Exposed print" has been exposed to light, but in the case of a latent image is undeveloped.

"Developed print" has been exposed to light and the latent image developed to a state of visibility. This term does not apply to printing-out processes.

"Fixing" or "fixation" is the permanent cessation of the printing and developing processes in a developing-out emulsion, or the permanent cessation of printing in printing-out emulsions.

"Developing-out" process or material: the action of light produces a latent image that becomes visible only by chemical development.

"Printing-out" process or material: the action of light produces a visible image. It requires no development.

"Toning" is a chemical reaction producing desired changes in colors and tones.

One objective of this invention being the diminution or elimination of the requirement of skill in the photographic art, I find that this is best accomplished by using printing-out emulsions instead of developing-out emulsions. It is common knowledge that the intensity of artificial light in business offices is continually fluctuating and changing because of the inherent characteristics of present day power supply lines. Since the quantity of light required to produce an image in any sensitized emulsion is represented by a factor—commonly called the time-intensity factor—which is the resultant of the time of exposure multiplied by the intensity of the light, and since the variations in the intensity are indeterminate by any means available in the usual business office, the period of time required to produce a latent image is unknown, and it can be determined only by specialized knowledge and a skillful use of a trial and error method.

A still greater degree of skill and knowledge is required to develop the latent image to a satisfactory degree of contrast between high-lights and shadows, which development partially compensates for the inaccurate determination of the time-intensity factor. Thus, one objective of this invention would be defeated by the use of such

a developing-out process, and therefore I prefer to employ a printing-out process.

The production of an image in a printing-out process is a function of the time-intensity factor to a far greater extent than in a developing-out process. In the latter, development accentuates the image begun by the action of light, whereas in a printing-out process, the light alone produces the full visible image. A notable characteristic of all printing-out emulsions referred to in this specification, is that the image progressively becomes darker as the time-intensity factor is increased, and the degree of contrast between the high-lights and shadows of the finished print is proportional to the quantity of light having reacted upon the emulsion.

According to one embodiment of my invention, this degree of contrast may be continuously observed by the maker of the print without regard to the elapsed time, without the use of instruments or other equipment, and without the use of a trial and error method. The depth of tone of the exposed print, or the color as the case may be with certain emulsions, is a measure of the quantity of light that has reacted upon the emulsion; and this tone or color can be predetermined for all values of the time-intensity factor. That is, a light of low intensity will require a longer period of exposure than a light of greater intensity, but in all cases, equal time-intensity factors—or equal quantities of light—will produce corresponding tones and colors in all prints having the same light-sensitive emulsion. Thus the skill and knowledge required to make a duplicate with a printing-out emulsion is limited to an ability to compare colors and tones.

Typical embodiments of my invention are illustrated in the accompanying drawings in which:

Fig. 1 in illustrations A, B, C and D illustrates the various stages of a process for making a duplicate of an original according to my invention, illustration A representing an original such as a white or light-colored sheet of paper with a black or dark-colored printed character thereon, illustration B representing an unexposed print comprising a transparent film placed over the original with light-sensitive emulsion in contact with the original, illustration C representing the original and print exposed to a source of light, and illustration D representing an exposed print removed from exposure to light and placed in contact with a second sheet, one side of which is coated with adhesive; and

Fig. 2 represents an unexposed print comprising a transparent film carrying a light-sensitive emulsion and a layer of material having a tacky surface in contact with an original.

To exemplify one embodiment of my invention, the following procedure is used for making duplicates of opaque or translucent originals: Illustration A of Fig. 1, as stated above, represents an opaque original 1 which is a white or light colored sheet having a black or dark colored character 2 printed thereon. Upon this original 1 is placed a transparent or translucent film 3 having a light-sensitive emulsion 4 on one side thereof, with said emulsion in contact with the surface of the original; the film becoming the duplicate or print. The print, which may adhere to the original by means described hereinafter, is exposed to the action of a suitable light whereupon the light-sensitive element in the emulsion changes color in proportion to the quantity of light acting upon it, and an image of printed character 2 is produced in emulsion 4.

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To facilitate the determination of the proper tone and color to which the duplicate is to be printed, and to further diminish the degree of skill required of the maker of the duplicate, a strip of suitable material 8, illustration B of Fig. 2, is attached to or made a part of sheet 3; the color and tone of material 8 being that of the deepest tone to which the image is to be printed. The color and tone of the indicator strip 8 may be different for different emulsions, but in all cases it can be correctly predetermined for the emulsion to which it is attached or made a part of.

When the color or tone or both, as the case may be, corresponds to the color and tone of indicator strip 8 which is attached to or made a part of sheet 3, a sufficient quantity of light has acted upon the sensitized emulsion and the desired contrast will have been produced between the image and the background. The print is then removed from exposure to light and from contact with the original, and is laid upon a flat surface, such as a desk top, with emulsion 4 facing upwards. A second sheet 5, which has been provided as a component part of the finished duplicate, and which bears one side an adhesive 6 holding in suspension suitable chemical agents for fixing the image in emulsion 4, is now moistened by any means at hand and is made to adhere permanently to exposed emulsion 4 on print 3 by holding the surfaces in intimate contact by pressure, or by squeegeeing, until the adhesive has set. Moistening adhesive 6 not only effects a permanent bond between sheets 3 and 5, it also wets the chemical agents suspended in the adhesive and makes possible a chemical reaction between the light sensitive emulsion and the fixing agents, which reaction brings to an end further action upon the emulsion by the light.

The duplicate when thus completed, comprises a transparent film supporting an emulsion which bears an image of the original, held in permanent bond with a strong and durable second sheet by an adhesive impregnated with fixing agents, in such a manner that the emulsion and fixing agents are enclosed between the inner surfaces of film and second sheet.

Although a translucent film or emulsion may be satisfactory for the purpose of exposing the print, it is nevertheless necessary to have a transparent film on the duplicate. Emulsion 4 has been in contact with original 1, and if the duplicate is to be an obverse of the original, the image must be viewed through the film. Further, the emulsion being on the reverse side of the film, permanent contact between emulsion and fixing agents becomes immediately possible; whereas, any other relative location of the emulsion would require the use of special equipment for fixing the image before it could be bonded to the second sheet.

The method of printing used in this embodiment of the invention is well known in the photographic arts, and is variously termed "reflectography," "reflex printing," "irradiation printing," and "contact printing," although the latter term is applied to all printing wherein contact is made between the print and original—usually a negative in photography—whether the light is transmitted through the original or reflected from the surface thereof. The principle underlying these methods of printing is illustrated in illustration C of Fig. 3. Film 3 has been placed in juxtaposition on the original 1 with the emulsion 4 in contact with the face of the original, as de-

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scribed above, and exposed to light. Assuming rays of light 7d and 7r to be approximately parallel, rays 7r pass through transparent film 3 and are reflected back from the white surface of original 1, and again react upon the light sensitive emulsion. Thus rays 7r have a greater effect upon the emulsion than rays 7d which pass through the emulsion and are absorbed by the dark surface of printed character 2. The duplicate is therefore the reverse of the original as to high-lights and shadows, when the usual type of printing-out emulsion is used, although this need not necessarily be the case in all instances.

I have eliminated the need for special equipment for fixing the image in the emulsion by suspending the fixing agents in adhesive 6 which is coated on one side of sheet 5. It has been the customary practice in the photographic arts to fix prints with an excess of chemical agents and then wash away the residue as a final step in the procedure. The only apparent reasons for this procedure are: It fits in with, and becomes a similar part of the successive steps taken to develop the latent image in developing-out processes, and toning in printing-out processes, wherein each print may require a different treatment because of the reasons already described; and it provides an excess of chemicals to compensate for changes in concentration of the solutions as successive prints are made. According to my invention, however, where a definite quantity of light is known to have acted upon the emulsion, it has been found that the relative amounts of light and dark areas on the print can be approximated closely enough to permit calculation of the amounts of fixing agents actually required to fix the image. There is, in other words, a molecular balance between the substances comprising the light-sensitive elements and those comprising the fixing agents suspended in the adhesive of the second sheet. The exact amounts of chemical agents being thus provided as component parts of the finished duplicate, no skill is required to properly proportion them during the making of the duplicate, no judgment is required in the degree of treatment, and no equipment is necessary that is not commonly found in business offices.

There is a time element in the fixing of prints in the usual processes wherein an excess of chemical agents are used, which time element also obtains in my method of fixing prints. However, I find that the action due to light ceases, within the limits permissible in highly contrasting prints, upon the application of the fixing agents suspended in the adhesive. The chemical reaction is not instantaneous, but rather extends over an appreciable length of time, although not as long as may be required when a print is fixed and developed in excess of chemical agents. Since the amount of fixing agent has been calculated to molecularly balance the light-sensitive elements, and the chemical action eventually ceases; and since action due to light receives its greatest retardation at the time of application of the fixing agents, very little change in the appearance of the print, due to action of light, takes place after it has been placed in contact with the second sheet. Any slight change that does occur after application of the second sheet accentuates the depth of tone, which is a desirable result.

To better explain the effects of the retardation of the action of light and the gradual cessation of the fixing process, it should be noted that one characteristic of all printing-out processes,

especially those using silver chloride as the light-sensitive element, is the slowness of the reaction to light in comparison to the speed obtained in developing-out processes which utilize silver bromide as the active element. This characteristic slowness of printing out emulsions allows an appreciable amount of time in which the exposed prints may remain in subdued light without perceptible change in the appearance of the image. For example, an emulsion adapted to be printed in sunlight—as are emulsions used commercially by photographers for making “proofs”—may be sufficiently printed in one to two minutes when exposed to direct sunlight, but will remain perceptibly unchanged for many hours in a sunlit but shaded room. This characteristic quality of printing-out emulsions, together with that of the almost complete suspension of the action of light upon application of the fixing agents, makes printing-out emulsions especially adaptable to the objectives of this invention by eliminating the necessity for dark rooms and dark cabinets.

In general it may be stated that the embodiment of this invention described above in detail comprises a light-sensitive, printing-out emulsion supported by a transparent film, to which is attached an indicator having the exact color and tone of the emulsion when said emulsion is sufficiently exposed to light; the film being then placed over the original with the emulsion in contact with the original, and the whole exposed to a suitable source of light until printed to the color and tone of the indicating element, regardless of the length of time required because of the quality and intensity of the light; the exposed print being then removed from exposure to light, from contact with the original, and from the indicating element which is of no further use; the print being then placed upon a flat surface with the emulsion side uppermost, a second sheet is permanently bonded to the film by an adhesive which holds in suspension suitable chemical agents for fixing the image in the emulsion; the finished duplicate comprising an exposed film in complete and permanent contact with a strong and durable second sheet, and enclosing between them the exposed emulsion in molecular balance with the fixing agents.

Although the above embodiment of this invention has proved satisfactory in all respects, I have also found that many variations may be made in materials and procedure without departing from the spirit thereof. As examples of such variations, I find that instead of applying a light-sensitive emulsion to a supporting base, the light-sensitive element may be incorporated in the base itself. This can be done with the usual gelatin emulsions by first forming a comparatively hard and tough film of gelatin by the use of alum, alum compounds, and solutions of formaldehyde, as is commonly done in the photographic art; then coating this film with the sensitized emulsion and adding a final layer of the hard, tough gelatin to form a protective surface. The light-sensitive element is then within the body of the film instead of being on it. In other instances, well known in the art, light-sensitive elements may be incorporated in the material comprising the base, and for the purposes of this invention, the sensitive element may be in, or on, the supporting base. Another modification of the means to support the sensitive emulsion is to provide a firm base to support said sensitive emulsion, which may be stripped

from the emulsion either before or after exposure. In this case, the base merely supports the sensitive film prior to use, and prevents injury to the film when packaging and handling, and does not become a part of the finished duplicate.

Another variation in the general procedure is in the application of the fixing agents. The colors of printing-out emulsions are changed during reaction with the fixing agents. In the event the resulting colors are unattractive, or otherwise unsuitable, they can be altered by the use of chemical agents known as toners. It is commonly known that toners and fixing agents may be combined in the same solution and applied simultaneously. The method used in an embodiment of this invention wherein toner is to be used, has been to mix the toner and fixing agents in the proper, predetermined proportions and suspend them in the adhesive of the second sheet which, when moistened, brings them into solution. In the commercial use of the products of this invention, it is often desirable to provide toners which will produce a choice of colors without the necessity of changing the other constituents of the finished duplicate. In such cases, I find it feasible to provide the required toner in solution as one of the component parts of the finished duplicate, and using it instead of water to moisten the adhesive. The end results are the same, and a variety of tones and colors may be obtained with a minimum of constituent parts.

Still another variation in the use of the products of this invention concerns the use of the second sheet. Heretofore, this has been described as a firm and durable component. Instead, this may be a delicate, transparent film which is coated with adhesive and fixing agents; in which case, the film supporting the sensitized emulsion may be correspondingly firmer and more durable. This procedure is especially desirable when the duplicate must be transparent.

There are many chemical compositions of light-sensitive materials and many methods of applying them according to this invention. The following procedures are described in detail as being typical and illustrative of the fundamentals and principles underlying this invention.

One example of the procedure embodying this invention may be performed entirely with materials obtainable from tradesmen dealing in photographic materials in the usual course of business. Printing-out paper, known to photographers as “proof” paper, is usually produced by coating an emulsion of silver chloride in gelatin on a supporting base of opaque paper. It is to be understood that although silver chloride is the light sensitive element in a gelatin vehicle, other ingredients may be added to procure certain desirable results such as speed of exposure, color, and to balance molecularly the toning and fixing agents, all of which are well known and used in the art. When such a commercial emulsion is coated on a transparent film, it possesses all the characteristics necessary to sheet 3, described herein. After exposure, this emulsion can be toned and fixed with commercial preparations known in trade channels as toners and fixing salts. The predominant constituent of the fixing salts is sodium thiosulphate and this may be used alone to effect a satisfactory fixation of the image, without the use of the other ingredients common to the commercial preparations.

When prints are fixed with sodium thiosulphate, the color of the emulsion changes to a disagreeable yellow hue. Hence, prior to fix-

ing, and after exposure, it has been the practice to treat the emulsion with a solution of gold chloride; the gold replacing the silver in the emulsion and producing a pleasing dark purple tone, almost black.

If the toner and fixing agents are combined in one solution, as mentioned before, toning and fixing will take place simultaneously with an excess of both agents. According to this invention, the toning and fixing agents are suspended in the adhesive 5 of sheet 5 in proper amounts to molecularly balance the light-sensitive elements of emulsion 4. Although such exact amounts are preferred, actually a slight excess of either toner or fixing salts will have no injurious effect upon the materials comprising the finished duplicate, nor on the final color or density of the print.

A similar example may be performed without the use of commercial preparations, but with the basic chemical elements and compounds. A light-sensitive emulsion is prepared by dissolving ammonium chloride, sodium chloride, and ammonium citrate in water in the proportions, by weight, 6:3:10, respectively, to form a normal solution. This solution is then mixed with gelatin which has been dissolved in water in the proportion, by weight 3:44, respectively. To this gelatin-chloride mixture, a solution of silver nitrate is then added in sufficient amount to molecularly balance the chlorides in the reaction wherein silver chloride is formed as a precipitate; the silver chloride being the light-sensitive element. A slight excess of silver nitrate is often considered beneficial to printing-out emulsions, as are other ingredients which are indicated by the skill and knowledge of the emulsion maker in bringing about certain desirable results. The emulsion having been coated on one side of the transparent film, or other supporting base, and exposed to light as heretofore described, toning and fixing complete the process. Gold chloride produces a satisfactory color in silver emulsions, although platinum and tungsten and other metals may be used instead. Sodium thiosulphate being the fixing agent, it is combined with the gold chloride and certain ancillary ingredients in the following proportions, by weight: gold chloride 1, citric acid 20, ammonium thiocyanate 40, alum 20, lead nitrate 22, lead acetate 22, and sodium thiosulphate 20. The procedure used in compounding these ingredients is well known in the art. However, it must be understood that my procedure is to suspend all or part of the ingredients in the adhesive on the second sheet, or otherwise incorporate these ingredients in the adhesive, as by moistening the adhesive with water containing such ingredients.

I find that suitable adhesives have already been provided and are available in the customary trade channels. Illustrations of the general nature of such adhesives may be had from the following descriptions: (1) An adhesive known commercially as envelope gum is made by dissolving gum arabic, sugar, and starch in warm water in the proportion, by weight, 1:4:1, respectively. Dextrine may be substituted for gum arabic, and glucose for sugar, with boric acid added as stiffener, with equally good results. (2) Rice water boiled to a suitably thick jelly is inert to the chemical agents used herein, and is otherwise a suitable adhesive for this process. (3) Gum arabic, gum tragacanth, and glycerin mixed in the proportions, by weight, 4:1:4, respectively, 75

is quite satisfactory where opaque adhesives are permissible. (4) One application of the products of this invention requires that the second sheet be a metal plate. In this case, the adhesive may be made of gum arabic, gum tragacanth, and glycerin, as above, with the addition of thymol in the proportions, by weight, 4:1:4:14, respectively.

While the above adhesives illustrate that the most common materials can be used in this method of making duplicates, actually, the best adhesive material is the gelatin of the emulsions. In this procedure, the light-sensitive emulsion is prepared and applied as described herein. The toning and fixing agents are dissolved in gelatin and applied to the second sheet, after which the gelatin coat is treated with glycerin to produce a tacky surface. When the second sheet is to be applied to the print, the gelatin is moistened and the print pressed on to the second sheet, the gelatin of the print and the gelatin of the second sheet becoming one homogeneous substance.

When printing duplicates of printed pages of books and loose sheets, it is necessary that the print be in close and complete contact with the surface of the original. If at any point close contact is not made, a dispersion of light at that area will render the image indistinct. One method of holding the film in close contact while printing, which can be used successfully with gelatin emulsions, is to form a soft layer of gelatin that has been treated with glycerin, over the sensitized emulsion. This soft layer of gelatin, shown at 9 in Fig. 2, will remain tacky over a long period of time and will adhere to the surface of paper and most other materials, and may be withdrawn from contact without leaving a perceptible trace of gelatin on the original. In packing for commercial purposes, the tacky side of the film is placed against a protective sheet which is discarded when a print is to be made.

While I have described in considerable detail certain typical illustrative embodiments of my invention shown in the accompanying drawings, it is to be understood that my invention is not limited to these particular embodiments but include such modifications thereof as fall within the scope of the appended claim.

I claim:

As an article of manufacture, an unexposed print comprising a film of transparent material carrying a light-sensitive silver-salt printing-out emulsion, and a layer of gelatin covering said emulsion on the side thereof remote from the film, said layer having an exposed tacky glycerin-treated surface.

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