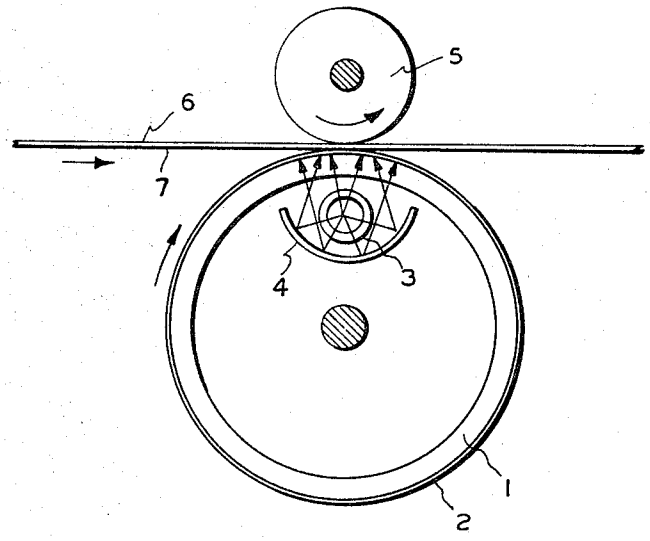
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THERMAL DEVELOPING APPARATUS

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THERMAL DEVELOPING APPARATUS

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ABSTRACT OF THE DISCLOSURE

An infra-red source is located inside a glass cylinder adjacent a restricted portion of the cylinder to concentrate heat at sheet material passing in contact with the cylinder. An external metallic coating prevents passage of certain radiation through the cylinder while conducting heat.

The present invention relates to a thermal developing apparatus and method and, more particularly, to a thermal apparatus and method suitable for developing diazo type photographic materials. The invention, however, is not limited to the photographic art and is capable of utilization in other fields where carefully controlled heating of sheet material under certain specified conditions is desirable or necessary.

In the prior art, processes for utilizing diazo materials for photography are many and varied. The process has been widely applied to systems for copying documents for use in offices as well as in larger industrial plants. This copying process has been applied in various forms and the use of various forms of radiation for development purposes also has been suggested.

In general aspects the diazo photographic method is based on the use of certain diazo compounds which have the property of decomposing when exposed to the action of certain types of actinic radiation. Upon decomposition materials are produced which are essentially colorless and which remain so regardless of subsequent or further exposure to light or other forms of radiation. On the other hand, certain of these compositions, when not exposed to actinic radiation appropriate for their decomposition, have the property of combining with other initially colorless materials known as couplers to produce, upon coupling, intense colored or black dyes. These dyes, when developed by coupling, are essentially unaffected by further exposure to light or other actinic radiation and hence are capable of forming permanent visible images.

Hence, by incorporating a diazo layer on or in a support such as sheet of paper, film base, or the like, a means is provided by which an original image may be photographed on the sheet. The composition incorporated into or placed upon the sheet is preferably one which is initially soluble in water. Preferably, an aqueous solution of the diazo material is weakly acidified, as by means of certain organic or other weak acids, for example, citric acid, tartaric acid, boric acid and the like. Auxiliary chemical compounds also may be dissolved in the solution, along with the acidic diazo and coupling components. Together, these ingredients will yield a light sensitive coating solution. After application of such solution to the support base, a paper sheet for example, the moisture may be removed to leave the active chemicals in situ.

When a sheet treated as above is exposed to the action of appropriate actinic radiation, for example ultra-violet light, through a layer of material which is transparent to such radiation, opaque image portions of said layer will prevent the inactivation by the radiation of the diazo compound underlying them. As a result, the diazo compound in exposed areas is destroyed but where protected by the opaque image portions of the original it is not affected. Thereafter, by placing the exposed sheet in an alkaline environment, e.g., on exposure to ammonia vapor, or by causing an evolution within such sheet, or within a

coating thereon of an alkaline reagent such as ammonia vapor, or by treating the surface with an aqueous solution of such a reagent, or treating with any composition including a liquid or gaseous alkaline agent, coupling takes place. The coupling compound, under the alkaline conditions, combined with the remaining and still active portions of the diazo compound in the unexposed areas. The result is that such unexposed areas are converted to permanent dyes. Hence, there is formed an exact and positive reproduction on the sheet of the image carried by the original through or upon which the radiation was exposed.

The development of a photographic sheet, exposed in the manner just described, normally requires a certain amount of heat. In a preferred form of the present invention, where a material capable of generating the required alkaline agent is also incorporated into the sheet or its coating, heat may be applied to release or generate the alkaline agent, for example, ammonia gas. When this occurs, the development will take place. Under such conditions there is no necessity of subjecting the sheet to immersion in liquids or even to flowing a further quantity of gaseous ammonia over its surface. On the other hand, even where gaseous ammonia or the equivalent is used, it is desirable and often necessary to apply heat of a certain controlled intensity.

In the process just described, and in other processes which depend upon temperature effects or controlled heating for the desired development, it is obviously essential to have an apparatus capable of applying the right amount of heat at the right temperature and for a suitable period of time. It is obviously desirable that such apparatus be simple, be relatively inexpensive, and be small and compact, particularly when it is to be used in office systems and the like.

Hence, it is an object of the present invention to make available a simple, effective heating device for developing copy materials in the manner described in general terms above. An ancillary object is to provide an improved method by which copy sheets and other photographic materials may be promptly developed by thermal means, with a minimum of expense and effort.

A further object is to devise a simple and effective apparatus for handling sheet material at a rapid rate and applying the optimum heat thereto during passage through the apparatus. A related object is to devise an improved method of controlling the application of heat to separate sheets or to web material, where it is essential that the quality and duration of the heat be controlled with a high degree of accuracy.

A still further object involves the development of prints on sheet material carrying self-developing coatings in a manner which minimizes the handling difficulties normally associated with the operation in the prior art. Additional objects involve an improved method of developing permanently visible images in or on an exposed sheet of the diazo type by directly applying controlled heat for an optimum period to bring out an image. This is accomplished without danger of over- or under-development due to inherent instability, typical in the prior art, of the heating system and the diazo type materials passed therethrough.

Further objects are to apply the required heat universely and uniformly over the entire surface of sheet or web material passing therethrough to accomplish efficient development without the necessity of immersion in liquid or gaseous developing agents.

Another object is the provision of a novel element for irradiation by the infra-red heat source to result in a highly efficient means for applying the thermal energy required to cause development of the sensitized diazo coating on copy paper.

A further object is the provision of a means for irradiating sensitized diazo copy paper with infra-red radiations of a quality which avoids false or undesirable exposure to radiations below 4500 Angstrom units.

Other objects and advantages will be apparent from the following detailed description taken in conjunction with the attached drawing wherein:

The single figure is a schematic representation of a preferred apparatus for the heat development of photographic materials such as those of the diazo type.

The present invention finds application in diazo type apparatus for making duplicate copies of originals by means of a diazo copy paper having a diazo coating which is reactive to ultra-violet radiation to form a latent thermal diazo image which is developed by heat into a visible image. Such apparatus includes a first radiation source having a spectral quality predominantly in the ultra-violet range which irradiates a first source, a second radiation source having a spectral quality in the infra-red range which irradiates a second surface and means for passing said copy paper in contact with the original over the first surface to subject the copy paper to ultra-violet radiation to thereby form a latent thermal diazo image on the copy paper and means for subsequently passing said copy paper over the second surface to subject the latent thermal diazo image on said copy paper to heat thereby developing said latent thermal diazo image into a visible image.

The present invention is specifically concerned with the second radiation source and the second surface. Referring to the figure, there is shown a cylinder **1** which serves as a rotating base for a metallic coating **2**. The cylinder **1** is formed of a material which is transparent to infra-red radiation and preferably is formed of glass which may be of the heat resistant type, e.g., Pyrex glass. The ends of the cylinder **1** are closed and the cylinder is rotatably mounted in the usual known manner. The metallic coating **2** is made of a material which is highly absorptive of infra-red radiations and also is a good thermal conductor.

The dichroic coatings used in connection with this invention are prepared by depositing metal vapors in high vacuum on a suitable support, preferably glass. Metals which can be deposited in this fashion include gold, silver, copper, aluminum, magnesium and a variety of other metals including those of the rare earth series.

A single coating may suffice in many instances; although, depending upon the type of coating desired, there may be applied from three to nineteen separate coatings. The metallic coating will usually be about 0.003 to 0.005 inch thick. Additional information regarding such coatings may be found in the commercial literature such as "Coatings" published by the Liberty Mirror Division of Libbey-Owens-Ford Glass Company of Brackenridge, Pa., "Interference Filters" by Bausch & Lomb of Rochester, N.Y., and "FS Multi-Layer Interference Films" by Fish-Schurman Corporation of New Rochelle, N.Y.

The thickness of the metallic coating **2** is important and must be sufficiently great to provide the desired durability and to prevent passage of radiations below about 4500 Angstrom units through said coating. In other words, the coating2shouldeitherre flectorabsorbsubstan
the coating **2** should either reflect or absorb substantially all radiations below 4500 Angstrom units. The thickness of the metallic coating **2** must be sufficiently great to also provide fast, e.g. substantially instantaneous, heat transfer of the thermal energy required to convert the latent diazo image to a visible image.

An infra-red heat source **3** is mounted within the cylinder **1**. An infra-red reflector **4** is mounted adjacent the heat source **3** so as to reflect the infra-red radiations emanating from said source onto the inner wall of cylinder **1**. A pressure roller **5** is rotatably mounted parallel to and in contact with the cylinder **1** adjacent the heat source **3**. The pressure roller **5** is preferably of a spongy material so as to yieldably contact the surface of cylinder **1**. Diazo copy paper **6** is shown in position between pressure roller **5** and cylinder **1**. In practice, the paper **6** would be passing from left to right between said roller and said cylinder. A latent thermal diazo image has been formed on the under side **7** of paper **6** by previous exposure of said paper and an original being copied to ultraviolet radiation. As the under side **7** is exposed to the heat of metallic coating **2**, the latent thermal diazo image thereon is developed into a visible image.

In operation, the copy paper **6** is selectively preexposed along with the original by ultra-violet radiation employing the usual means which are not here illustrated. This pre-exposure forms the latent thermal diazo image on the under side **7** of said copy paper. Thereafter, the copy paper **6** is fed into the nip of roller **5** and cylinder **1** with the latent image coming into contact with the metallic coating **2**. The infra-red heat source **3** which is mounted in close proximity to the metallic coating **2** opposite roller **5** and which is backed up by infra-red reflector **4** heats said coating which then transmits the thermal energy provided by said source to the latent thermal diazo image to develop it into a visible image. The metallic coating **2** not only provides for rapid or substantially instantaneous heat transfer of thermal energy from said source to said latent thermal diazo image, but also prevents transmission of any radiation below 4500 Angstrom units to said latent image, thereby avoiding spurious, wanton, undesired exposure of the sensitized coating of the copy paper **6**. This results in clear and undistorted visible images in the final developed copy.

If desired, the infra-red heat source **3** can be triggered for each individual print or sheet of copy paper, thereby eliminating heat build-up within the apparatus when it is running but not actually developing latent thermal diazo images.

It will be obvious that various additional modifications may be made in the apparatus and it is intended to cover such modifications by the claims which follow, as far as the prior art properly permits.

What is claimed is:

1. An apparatus for exposing diazo and other sheet materials to controlled heat which comprises a rotatable glass cylinder having an external heat-conductive metallic coating thereon just sufficient to prevent transmission to the outside from the inside of the cylinder of radiation below about 4500 Angstrom units, said cylinder having therein a source of infra-red radiation mounted in closer proximity to a first portion of said cylinder in the path of said sheet material than to other portions of the cylinder.

2. The apparatus as claimed in claim **1** wherein said metallic coating is 0.003 to 0.005 inch thick.

3. The apparatus as claimed in claim **1** wherein an infra-red reflector is mounted within said cylinder adjacent said radiation source to reflect radiation toward said first portion.

4. The apparatus claimed in claim **2** wherein said metallic coating is silver.

5. The apparatus as claimed in claim **1** wherein a pressure roller is rotatably mounted parallel to said cylinder and adjacent said first portion, the surface of said roller intimately contacting the metallic coating of said first portion for pressing said copy material into intimate contact with said coating.

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