Aug. 13, 1968 R. C. JOHNSTON 3,397,315

METHOD AND APPARATUS FOR EVALUATING THE PRINTING SPEED OF DIAZOTYPE MATERIALS

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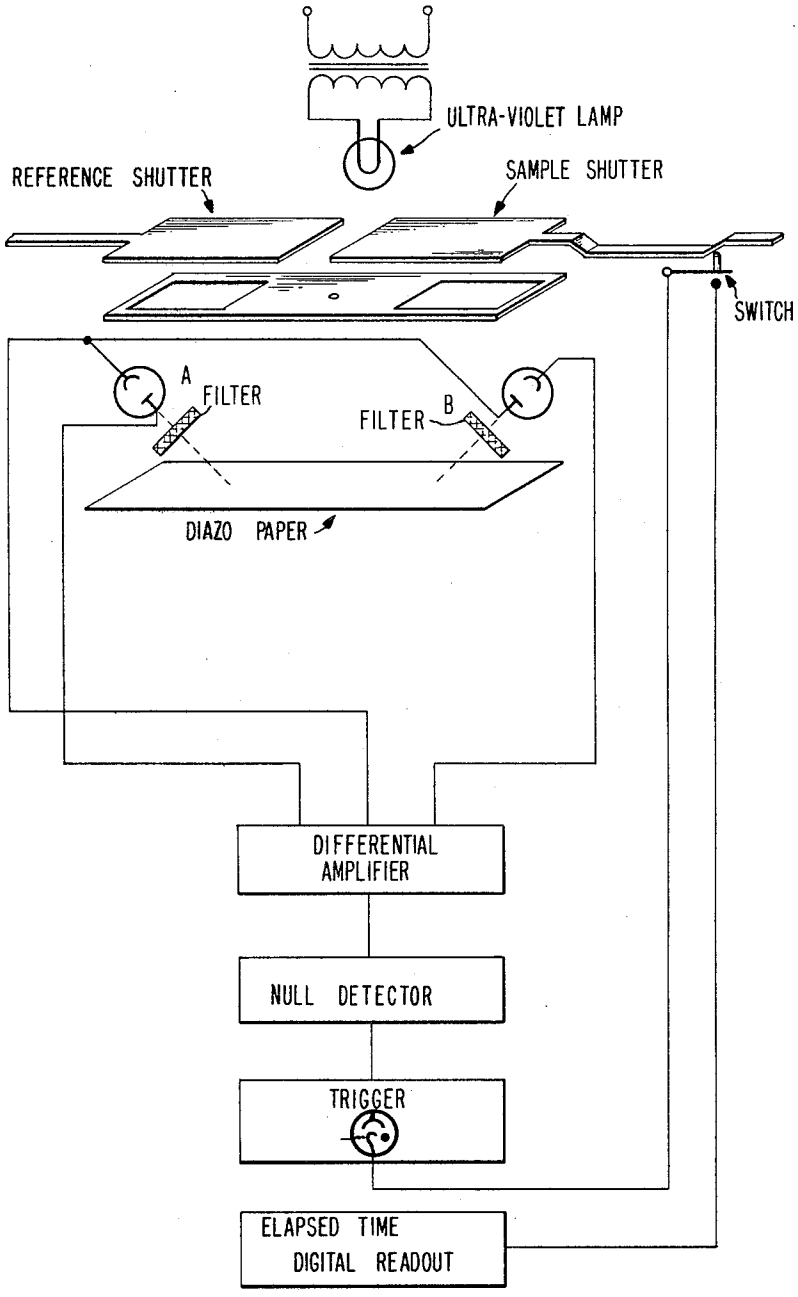


FIG. 1

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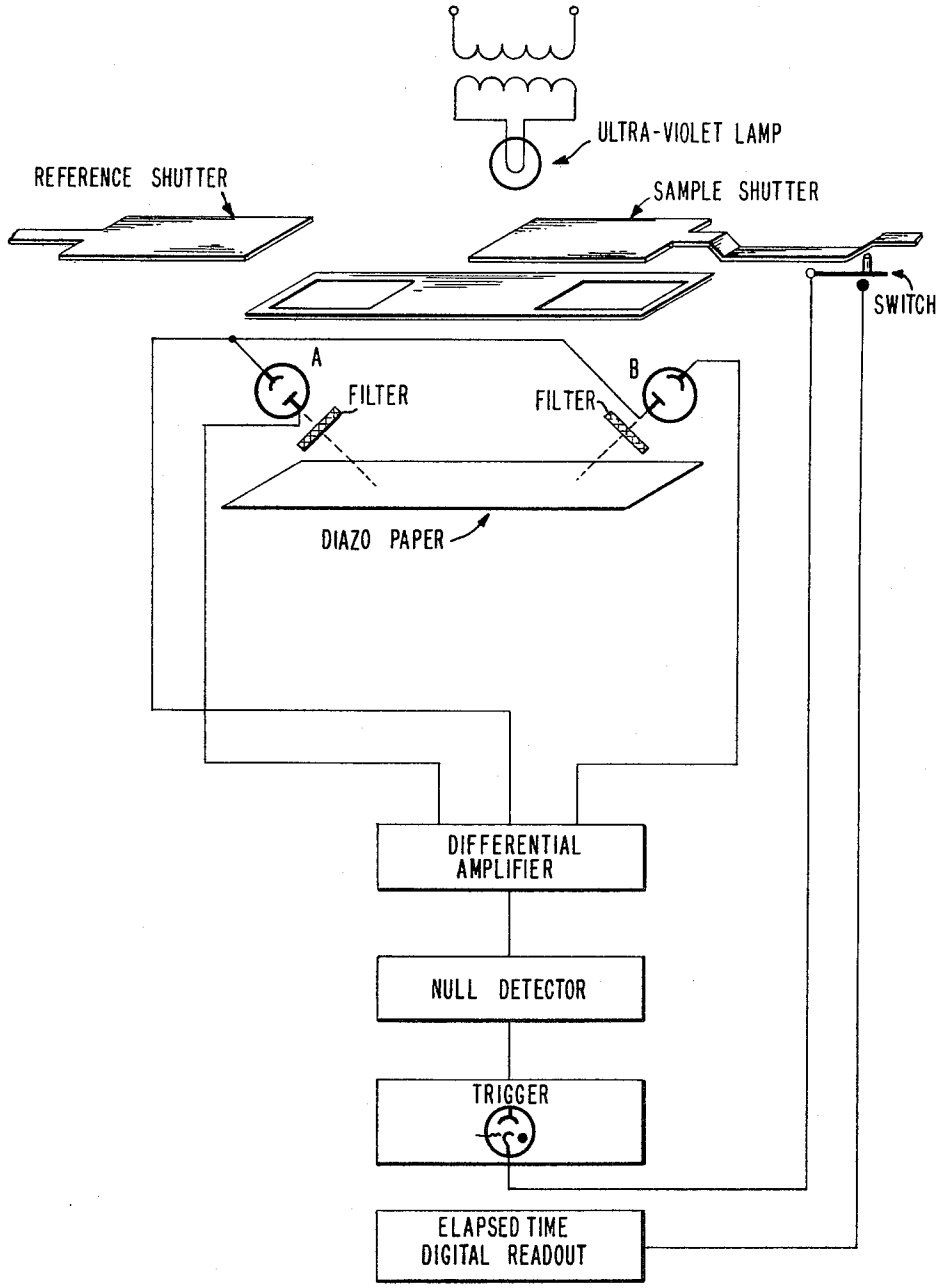


FIG. 2

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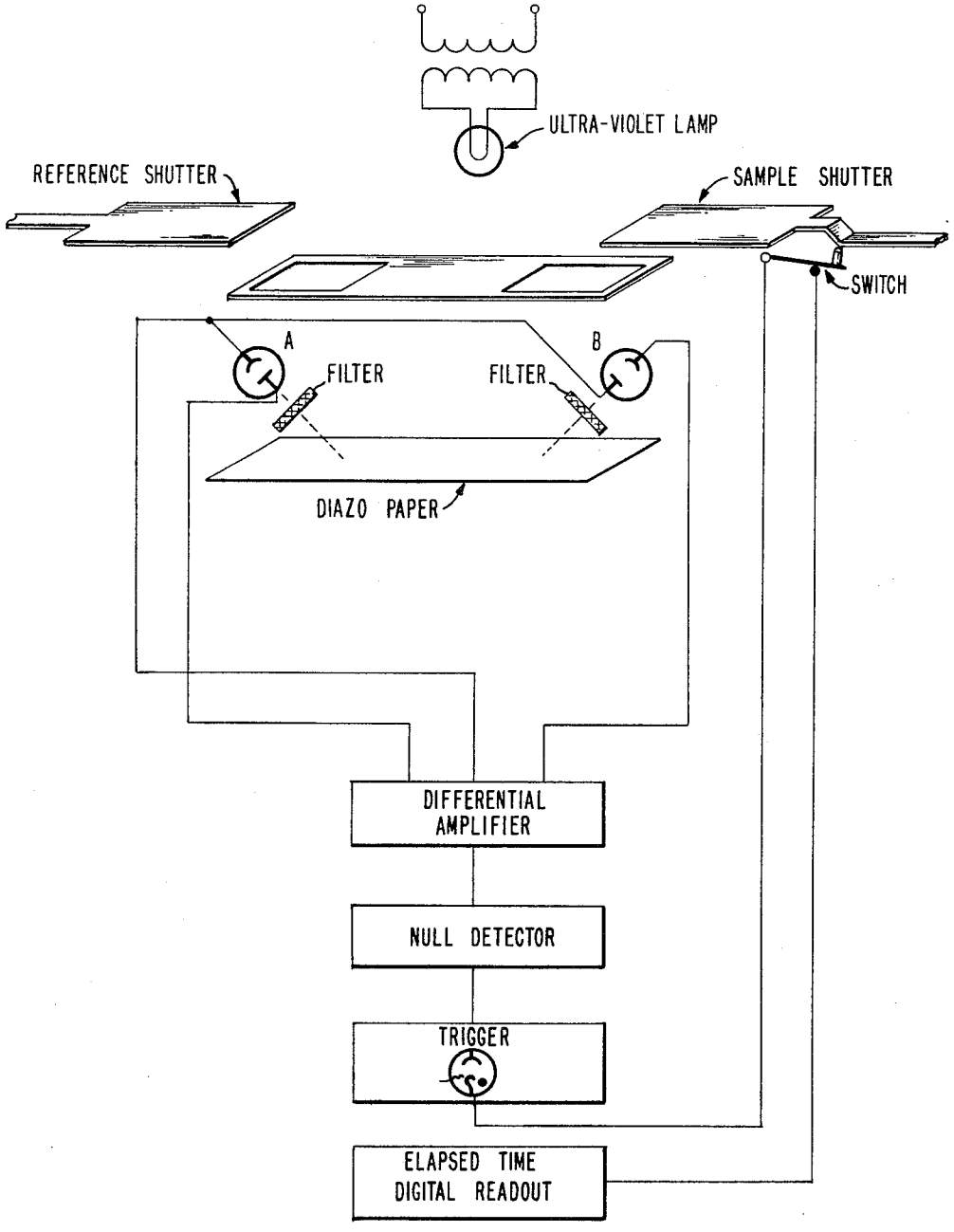
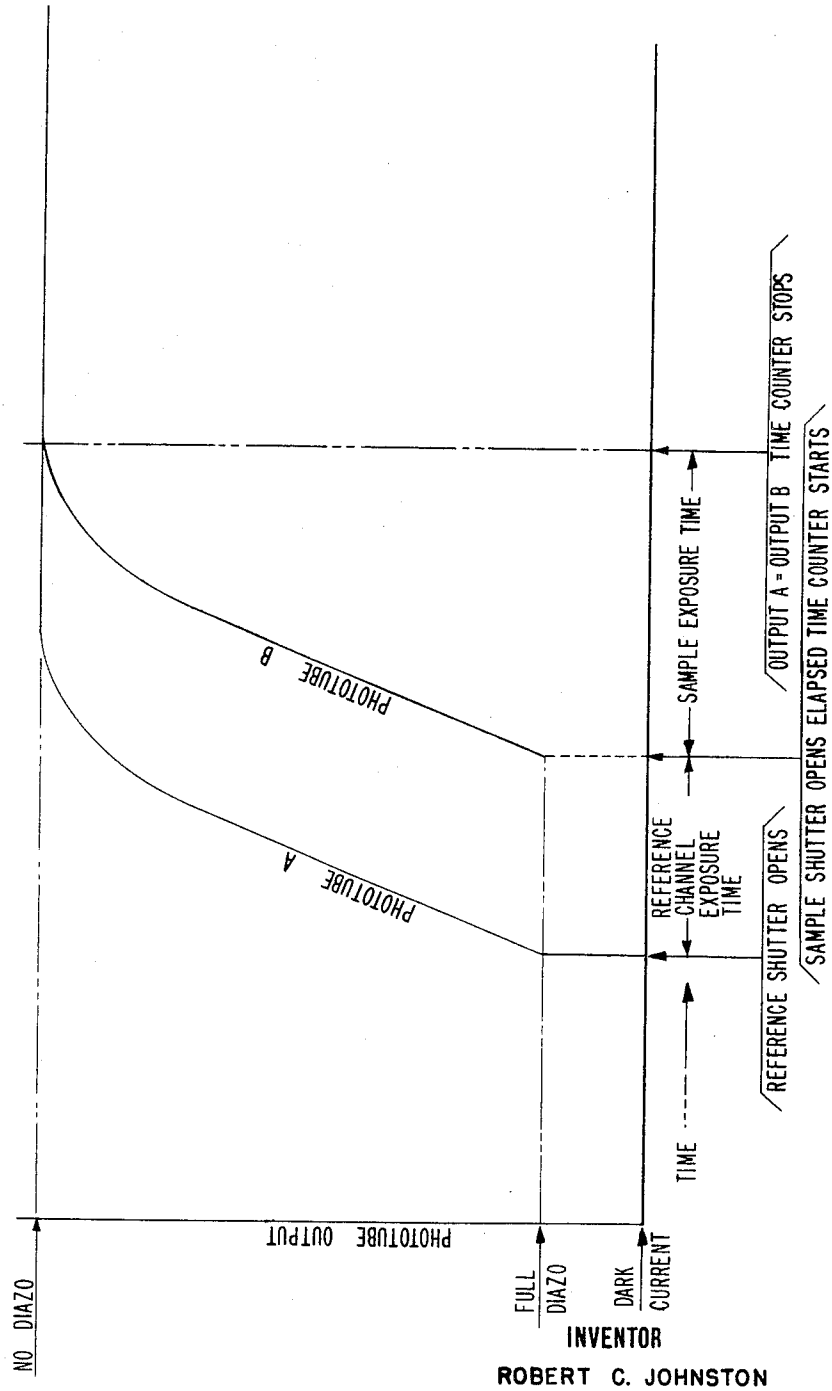


FIG. 3

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FIG. 4



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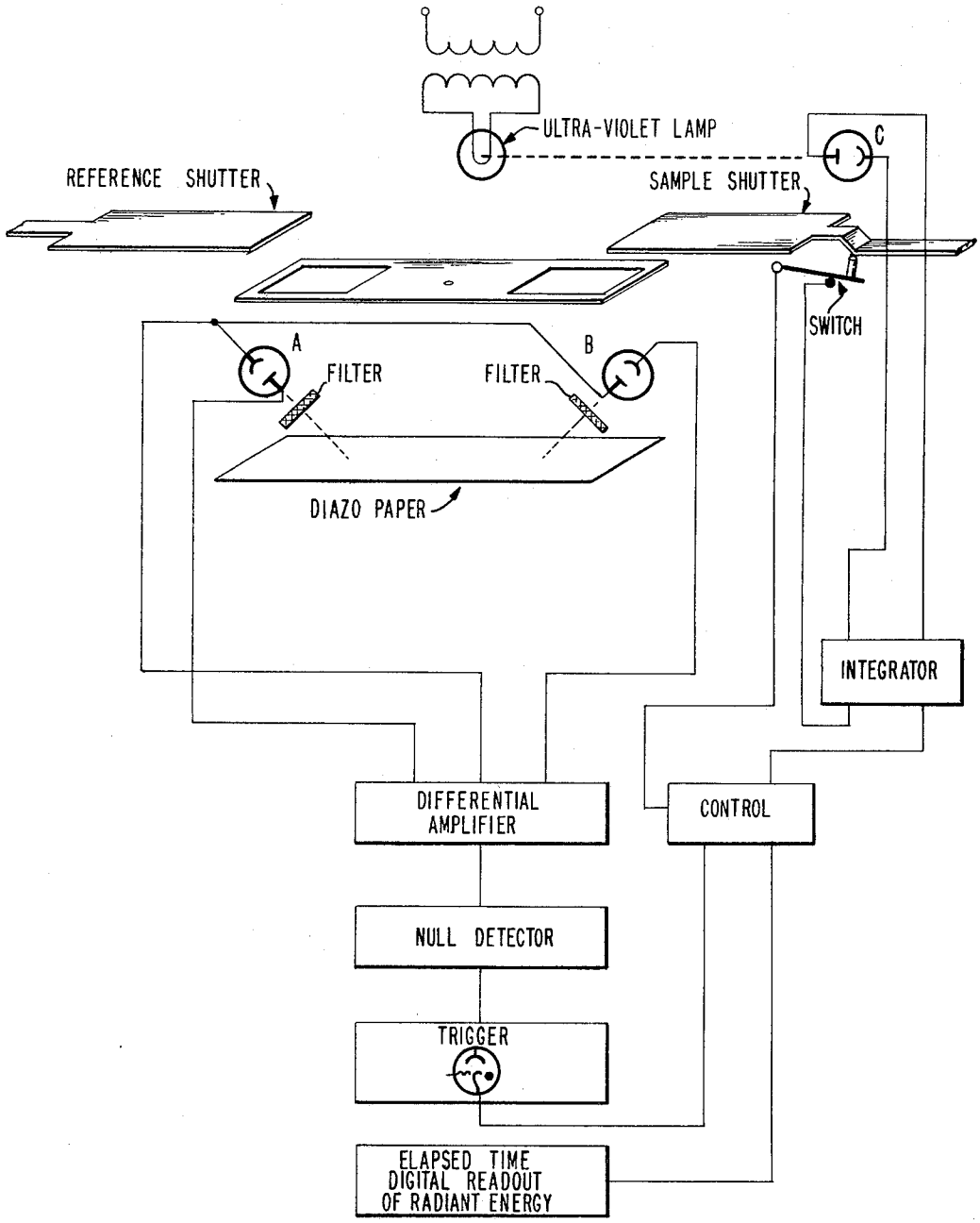


FIG. 5

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METHOD AND APPARATUS FOR EVALUATING THE PRINTING SPEED OF DIAZOTYPE MATERIALS

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7 Claims. (Cl. 250—83.3)

This invention relates to the art of photocopying and, particularly, to the evaluation of such copy materials wherein the light-sensitive coating is a diazonium compound. Materials of this type have had wide acceptance in the duplicating field. Due to the fact that the copy obtained from a translucent original results in a positive image, such material, in contra-distinction to "blueprints," is generally referred to as a whiteprint material.

The light-sensitive properties of diazotype materials are due to the fact that the diazonium salts used in the coating undergo photolytic decomposition when subjected to ultraviolet radiation. Thus the exposure needed to produce an acceptable print is determined by the radiation energy required to decompose all (or nearly all) of the diazonium salt present in the areas corresponding to the background areas of the orginal. Whereas the diazonium salts in the "line" areas of a print which has received an imagewise exposure will not be completely decomposed and will be available upon development for coupling reaction with suitable dye components which ultimately yields the azo dye image responsible for the finished print. In trade parlance, the decomposition of the diazonium coating is generally referred to as "burning out the diazo."

The printing speed of diazotype materials is a function of the quantity of diazonium salt present per unit area.

In the coating of diazo sensitized paper and other base materials it is of critical importance that the printing speed of these materials be determined and controlled within rather close limits.

Coaters of these materials allows a variation of only ±10% from the nominal printing speed and in order to achieve this tolerance it is generally necessary to determine printing speed with an accuracy of ±5% or better. Once known, the printing speed may be controlled by adjusting the concentration of the diazonium salt in the coating solution or by adjusting the amount of solution applied per unit area of the material, e.g., by adjusting the air pressure of the doctoring air knife.

A typical coating solution of the two-component type might be an aqueous solution of the following:

	Percent
Citric acid	5.0
Zinc chloride	4.0
Thiourea	5.0
Glycol	6.0
2,3-dihydroxy-6-naphthalene sulfonic acid, sodium salt	2.5
p-diazo-N,N-dimethyl aniline chloride, zinc chloride double salt	1.0
Saponin	0.05

To correct for a printing speed found to be 10% too slow, for example, the diabo concentration may be decreased to 0.9%.

A typical coating solution of the one-component type might be an aqueous solution of the following:

	Percent
Citric acid	1.0
1,3,6-naphthalene trisulfonic acid, sodium salt	1.0
Glycol	5.0
p-Diazo - N - ethyl - N - benzyl aniline chloride, zinc chloride double salt	1.2
Saponin	0.02

If, for example, the printing speed of a coating made with this solution were found to be 5% too fast, the concentration of the diazo salt might be increased to 1.26%.

Heretofore, the printing speed has generally been determined by exposing and developing a print in a commercial whiteprinter or other exposing device and visually comparing this print with another made simultaneously on paper of known and closely comparable printing speed. By this cumbersome means, requiring human judgment, a person with long developed skill could estimate printing speeds to within ±5%.

Another method sometimes used is to expose a sample of the unknown material to a light source of calibrated intensity for a known time. The end point may be estimated visually or determined by plotting densities obtained against energy flux at the exposure plane. Visual determination of the end point is, of course, subject to errors in judgment, while the method of reading and plotting densities is tedious and unsuited to production control.

It is accordingly a primary object of this invention to provide a method and apparatus for automatically determining the printing speed of diazo sensitized materials without depending on the judgment of the operator for evaluation.

It is a further object of the invention to indicate the printing speed directly in digital units.

It is a particular feature of the invention that the method is simple and the apparatus requires no special skill for its operation.

It is a particular advantage of the invention that the evaluation of the printing speed requires no development of the material and overcomes the problems inherent in any visual estimate and is rapid enough to be used as a production control of the coating facility.

Other objects and advantages will be apparent from the following description of the invention, pointed out in particularity in the appended claims, and taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic representation of an apparatus for practicing the invention, shown in a standby state with the shutters closed;

FIG. 2 is a similar view showing the first step in the method of operation with one shutter element open;

FIG. 3 is a view similar to FIG. 2 depicting the succeeding step of operation with both shutter elements open;

FIG. 4 is an explanatory curve illustrating the operational sequence of the sensing elements; and

FIG. 5 is a schematic representation of a modified apparatus, incorporating an integrator for the source of radiant energy and an indicator of the integrated flux.

The subject apparatus and method of operation takes advantage of the fact that the diazonium salts, with which all diazo sensitized materials are coated, absorb strongly in the near ultraviolet regions of the spectrum. The ultraviolet light reflected or transmitted by the material is thus a good measure of the amount of diazonium salt on the sheet at any time during exposure. Accordingly, printing speed is measured by the time, or the energy, required to decompose all or nearly all of the diazo salt present over a unit area.

By comparing the ultraviolet light reflected from or transmitted by a sample area with that for a similar area in which the diazo has already been photolyzed, one is able to determine the time required to photolyze all or nearly all the diazonium salt during exposure to a light source of substantially constant intensity.

Referring to the figures, the ultraviolet lamp represents the source of radiation for the exposure of the sample material such as a diazo coated sheet of paper. A shutter having dual exposure openings and closure leaves is

placed between the source and the paper for effecting sequential exposure thereof. The first shutter element is designated as the reference shutter and the other as the sample shutter. The diazo paper is so placed that when the shutters are opened, two distinct portions or areas defined by the shutter configuration are exposed to radiation. A pair of phototubes, A and B, are so placed that each is receiving radiation reflected from a particular area of the paper and is thus energized by the radiant energy falling on the cathode element thereof. A filter associated with each phototube absorbs unwanted radiations in the infrared and visible spectrum and allows only spectral energy in the ultraviolet region to reach the photocathodes. The phototubes are connected to a differential amplifier, which may be of any conventional type, in which, under balanced condition of the phototubes, the output will be zero. This condition is detected by a null detector which in turn energizes a triggering element effecting closure or opening of a current path as the case may be.

The particular circuits utilized are not disclosed in detail inasmuch as the invention is not concerned with these, per se, but only in the conventional operational sequences thereof. An indicator in the form of a counter having a digital display indicates—in the arrangement shown in FIGS. 1, 2, and 3—the time required for completing one phase of the operation, as will be explained later.

The first step in the method is shown in FIG. 2 by the opening of the reference shutter which allows exposure of the diazo paper in the portion sensed by the phototube A. A preset time after this opening, the sample shutter is opened (FIG. 3) allowing exposure of the diazo paper in the area sensed by the phototube B. Simultaneously with the opening of the sample shutter, the switch is actuated, starting the operation of the elapsed time counter. It is to be noted that the reference shutter remains open so that in the second phase of operation, both shutters are open and both areas of the paper are exposed to radiation. When the conductivity of phototube B equals that of A, a condition of balance is reached, at which time the null detector actuates the trigger element which stops the operation of the elapsed time counter. The time required from the opening of the sample shutter to the stopping of the timer is taken as the indication of the printing speed of the diazo coating of the sample material.

The above operation will be further elucidated by referring to the curve shown in FIG. 4. The abscissa represents "time" and the ordinate, "phototube output." At the point on the time scale when the reference shutter opens, the current in phototube A is that of the dark current which will rise proportionately with the decomposition of the diazo to saturation when there is no more diazo on the exposed areas. After a preset time delay, the sample shutter is opened and phototube B will begin to conduct. The current therein will rise similarly as in phototube A until it reaches the same level. At this point, the output of phototube B is the same as that of A and this condition of balance triggers the mechanism so as to stop the elapsed time counter. Consequently, the time taken for the second exposure is, in essence, the indication of the printing speed of the diazo coated material. In other words, it is the indication of the time required to burn out the diazonium salt in the sample area to the degree it was burned out in the reference area. In actual practice, it is preferable not to carry the sample exposure to the point of complete decomposition of the diazo but to choose the end point at some place where a small amount of diazonium salt still remains. This may be accomplished in various ways such as by decreasing the energy sensed by the reference phototube with an appropriate neutral density filter or by any other optical or electrical means which will lower the response thereof. This can be visualized by observing the two curves. If the response of phototube A is lowered, its corresponding curve will similarly be lowered so that the intersection of the two will be displaced at another point.

In practical tests of the method above described, eminently satisfactory results have been obtained in examining various types of diazo coated materials. A tabulation of these tests is given hereinbelow:

"AZON" Paper	Average of 10 readings (seconds)	Standard Deviation	Relative Standard Deviation, Percent
Rapid Blue (2121)	69.1	±0.73	±1.05
Standard Blue (2021)	93.2	±0.50	±0.53
Ultra Rapid Blue (2521)	32.7	±0.40	±1.23
Standard Black (1921)	119.7	±1.07	±0.90
Rapid Moist (6121)	85.7	±0.60	±0.69
Standard Moist (6021)	126.7	±1.12	±0.88
Fast Sepia (4516)	100.5	±0.98	±0.98
Standard Sepia (4116)	210.5	±2.38	±1.13

While the indication of elapsed time proved quite satisfactory to evaluate the printing speed of diazo type materials, the modification of the apparatus shown in FIG. 5 introduces further advantages. It will be readily understood that in making exposures from a source of radiant energy for test purposes, it is essential that such a source be stable and constant, otherwise the ultimate results would not be accurate. It is well known that ultraviolet lamps are greatly influenced by voltage fluctuations and changes in ambient temperature. Consequently, it is necessary to supply a constant voltage and also maintain the ambient temperature substantially constant. Manifestly, since the results are predicated on the energy required to decompose the diazonium salts in a test area in unit time, the measure of this energy may also serve as an indication of the printing speed.

Accordingly, in FIG. 5 the apparatus is modified by introducing a phototube C which senses the radiation of the source and is connected to an integrator of the received energy. The switch actuated by the sample shutter starts the integrator which also starts the operation of a digital read-out counter. When the current in phototubes A and B are balanced and the null point is reached, the trigger operates to pulse a control unit which shuts off the operation of the digital counter. The indication of this counter, while in operation, follows the output of the integrator and thus gives a digital read-out of the radiant energy utilized during exposure time of the sample area. The modification above described does not alter the sequential operation of the method but monitors the radiant energy output and indicates this for the particular time required for the sample exposure. This is particularly advantageous in that it eliminates the need of cumbersome components for maintaining constant light intensity. Moreover, it is independent of changes in the ultraviolet light intensity within acceptable tolerances, resulting in a more accurate evaluation of the end results.

What is claimed is:

1. The method of determining the printing speed of diazo coated materials, such as paper, which comprises exposing a first portion of said material to radiation predominantly in the ultraviolet spectrum from a fixed source for a preset time, thereafter exposing a second portion of said material to said source while continuing exposure of said first portion, initiating the start of an elapsed time counter upon exposure of said second portion, photoelectrically sensing each of said portions and automatically stopping said counter when the photoelectric sensing of said second portion matches that of said first portion, the elapsed time indication of said counter representing a measure of the printing speed of said material.

2. The method of determining the printing speed of diazo coated materials in accordance with claim **1** wherein said photoelectric sensing represents the intensity of ultraviolet radiation reflected from said portions.

3. The method of measuring the photolytic reaction time of diazo coated materials to radiation which comprises initiating first a burn-out of the diazo composition in a sample area of the material under test by exposure to ultraviolet light while shielding a second corresponding area from said light, thereby establishing a reference area, initiating thereafter the burn-out of said second area while maintaining exposure of said reference area, photoelectrically comparing said areas and indicating the time duration required for said second area to reach the degree of burn-out of said reference area, said time duration representing the measure of the photolytic reaction time of said material.

4. The method of measuring the photolytic reaction time of diazo coated materials in accordance with claim 3 wherein the photoelectric comparison of said area corresponds to the difference in the absorption of radiation of the coatings of said areas.

5. In an apparatus for measuring the printing speed of diazo coated materials, a source of ultraviolet radiation, shutter means for sequentially exposing selected portions of said material of substantially identical area to said radiation, photoelectric sensing means adjacent each of said portions and adapted to respond to radiation reflected therefrom, an elapsed time counter, switching means for starting operation of said counter upon movement of said shutter means for initiating exposure of said second portion, electronic means for stopping the operation of said counter upon condition of balance due to substantially equal response of said sensing means, the time duration indicated by said counter representing the printing speed of said material.

6. The method of determining the printing speed of diazo coated materials, such as paper, which comprise exposing a first portion of said material to radiation predominantly in the ultraviolet spectrum from a fixed source for a preset time, thereafter exposing a second portion of said material to said source while continuing the exposure of said first portion, initiating the integration of the exposing spectral energy upon exposure of said second portion, photoelectrically sensing each of said portions and automatically stopping said integration when said photoelectric sensing of said second portion matches the sensing of said first portion, and indicating the integrated value in terms representing a measure of the printing speed of said material.

7. In an apparatus for measuring the printing speed of diazo coated materials, a source of ultraviolet radiation, shutter means for sequentially exposing selected portions of said material of substantially identical area to said radiation, photoelectric sensing means adjacent each of said portions and adapted to respond to radiation reflected therefrom, an integrator for the radiated spectral energy, switching means for starting operation of said integrator upon movement of said shutter means for initiating exposure of said second portion, electronic means for stopping the operation of said integrator upon condition of balance due to substantially equal response of said sensing means, and means for indicating the integrated energy value in terms representing the printing speed of said material.

No references cited.

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