March 12, 1963 T. J. ETZRODT, JR., ETAL 3,081,403

METHOD AND APPARATUS FOR SCANNING AND ANALYZING MATERIAL

Filed Jan. 11, 1960 2 Sheets-Sheet 1

FIG. 1.

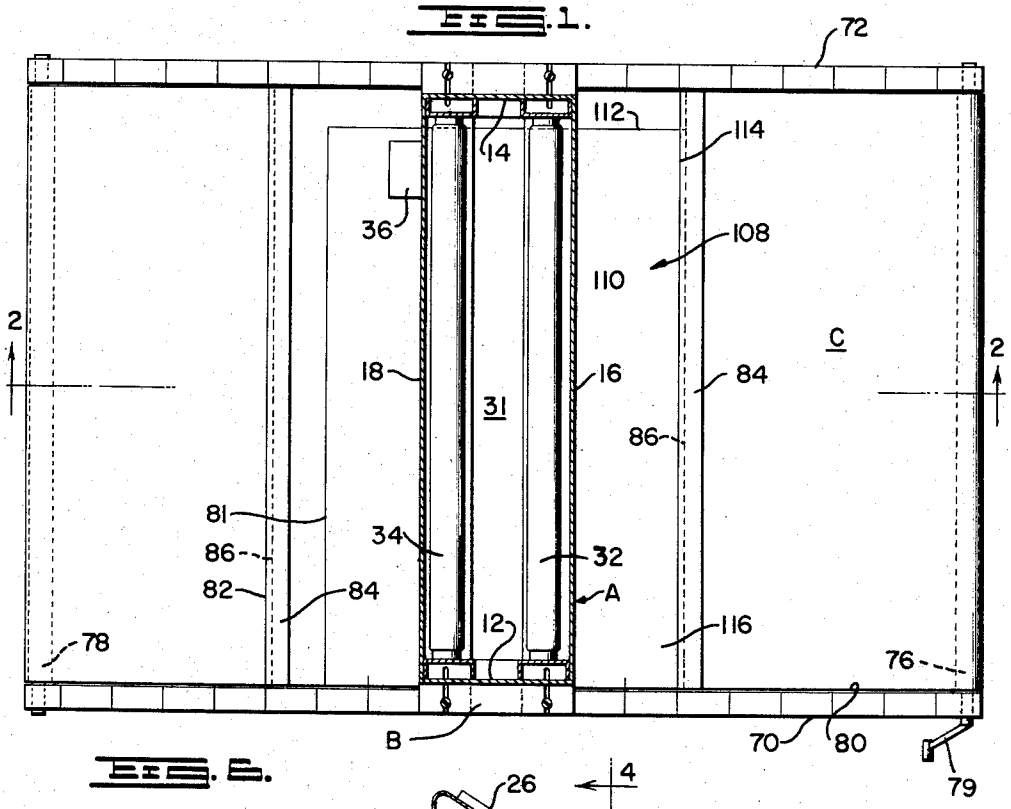


FIG. 2.

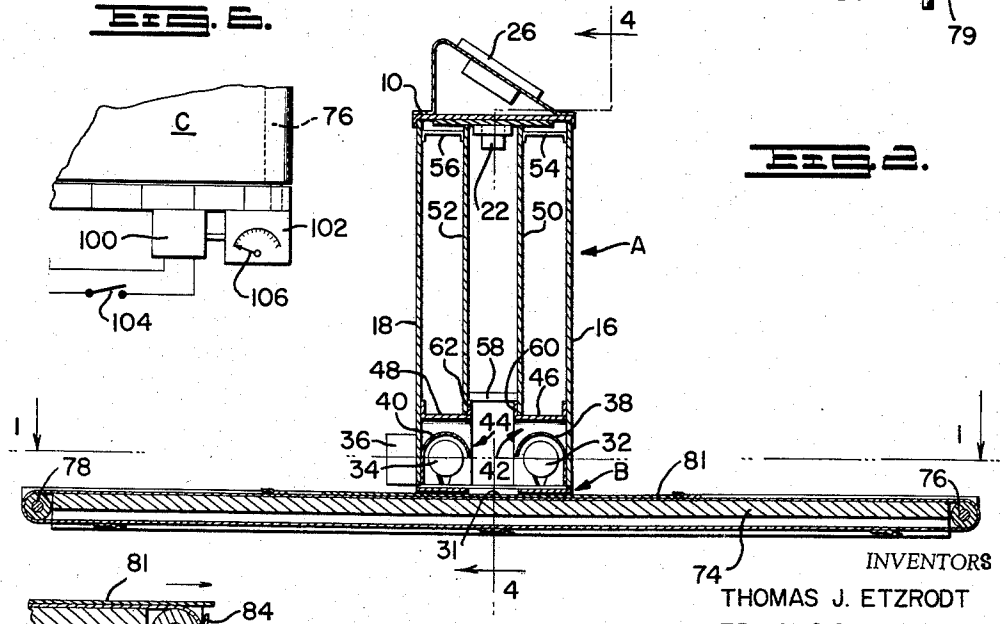
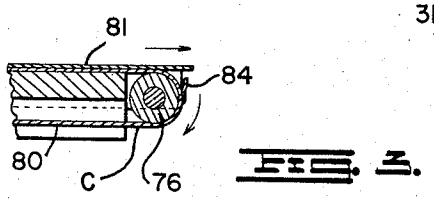


FIG. 3.



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FIG. 4.

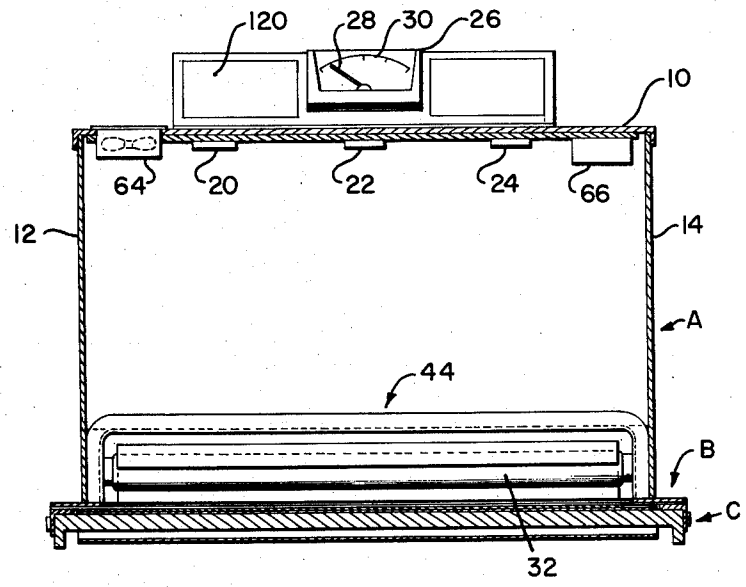
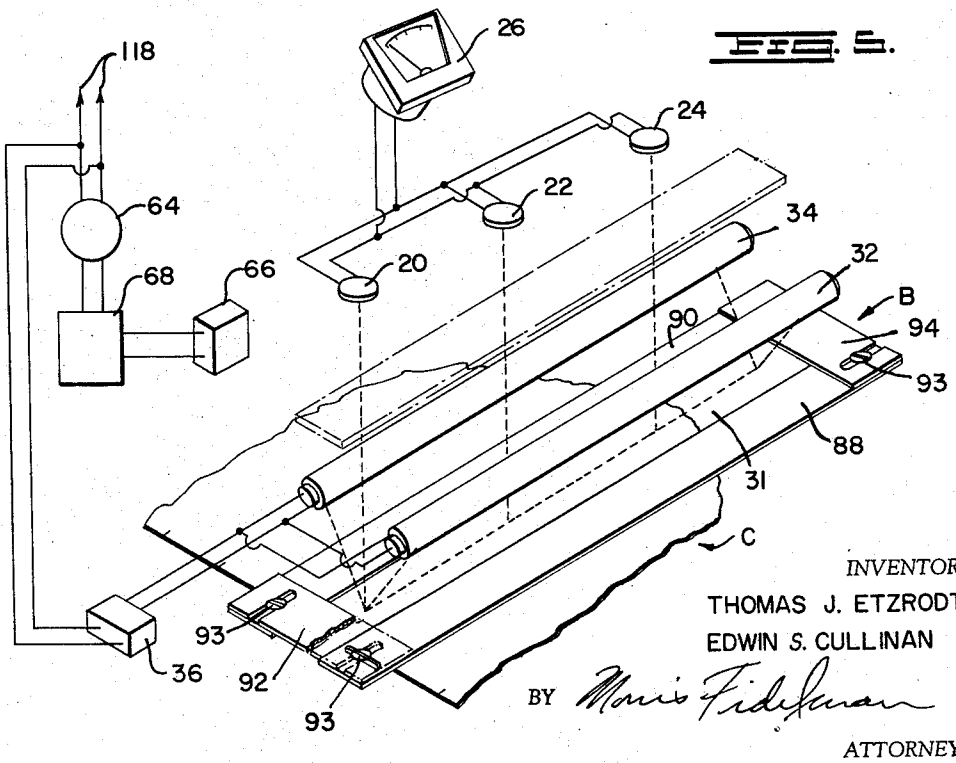


FIG. 5.



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METHOD AND APPARATUS FOR SCANNING AND ANALYZING MATERIAL

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4 Claims. (Cl. 250—239)

The present invention relates to an improved photoelectric scanning apparatus and more particularly to an apparatus for and method of analyzing and comparing characteristics of color pigments.

Modern techniques of research, development and production have advanced to the state where quality control of materials and products is difficult to maintain. Visual inspection has become obsolete and automatic controls for machines and processes are now a necessity.

Our invention utilizes the principles of the photoelectric cell in an improved method and apparatus for determining quality characteristics of materials by analyzing and comparing light rays reflected or transmitted by such material.

The inspection and analysis of gaseous, liquid or solid materials is within the scope of our invention, and many types of scanning operations may be performed. However, for the purposes of illustrating and describing our invention the preferred embodiment is set forth in conjunction with quality control in the printing of newspapers, magazines, books and similar related web or sheet surfaces.

Typical ink delivery regulating devices utilized in newspaper printing plants are illustrated in Patents 2,497,648 to Worthington, issued February 14, 1950, and 2,821,919, to Dressel, issued February 4, 1958. In these patents the quantity of ink delivered and consequently the amount transferred to the paper web is effected by a plurality of "keys" each controlling ink fed to columnar areas of the paper. These columnar "keys" controls for ink feed mechanisms are regulated by experienced personnel and visual inspection and judgment have been relied upon for meeting quality standards. Variations of individual eye-sight together with poor viewing conditions and increased production speeds have resulted in products of poor quality. Excessive ink on high speed rollers caused ink "misting" within the plant producing an unhealthful atmosphere and inadequate lighting resulting in difficult working conditions.

With the above problems and difficulties of prior printing practices in mind, an object of our invention is to provide an enclosed photoelectric scanning device for analyzing the pigment density of a colored material, as a basis of determining the quality of such material.

Another object of this invention is to provide an apparatus for photo-electric determination of the amount of ink pigment present upon discrete areas of a printed sheet, such as, the columnar portions of a newspaper.

Another object of our invention is to provide an apparatus for obtaining interpretative data relative to the density of ink pigment upon a surface and the amount of ink needed to duplicate such density in a printing operation thereby eliminating human judgment in the printing of high quality products.

Another object of this invention as applied to newspaper printing is to provide cleaner pressrooms, equipment, and environmental conditions and to enhance the quality of the printed product.

A still further object of this invention is to provide an improved photo-electric scanning apparatus including a conveyor to present discrete areas of columnar portions for analysis.

A still further object of this invention is to provide a

photoelectric scanning apparatus of improved construction and sensitivity for analyzing characteristics of pigments.

Additional objects and a fuller understanding of the invention may be obtained by referring to the following description and claims taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a plan view, partly in section, illustrating the material guiding and feeding conveyor of our invention;

FIG. 2 is a cross sectional view along the line 2—2 of FIG. 1 showing the association of the scanning and material conveyor devices of our invention;

FIG. 3 is an enlarged cross sectional view of a material aligning and positioning feature of the conveyor device;

FIG. 4 is a sectional view of the apparatus along the line 4—4 of FIG. 2;

FIG. 5 is a schematic view of several principal elements of this invention; and

FIG. 6 illustrates a modified conveyor driving mechanism.

With reference to the drawing the present apparatus generally includes a scanning unit A located over an aperture masking member B extending laterally of and adjacent to the surface of a conveyor table C.

Throughout this description and particularly in the accompanying claims the term "density" has been used to mean the quantity of color pigment per unit of area.

The scanning unit housing A is of boxlike construction forming a substantially light-proof enclosure having a top wall 10, end walls 12 and 14, and extended parallel side walls 16 and 18. The top wall 10 may be removably secured to the other walls of the housing A and provides support for a photo electric sensing system including a plurality of photoelectric cells 20, 22 and 24 of which there may be any number spaced apart along the length of the wall. Cells 20, 22 and 24 are mounted on the underside of the top wall 10 and directed to scan the apertured area defined by mask B, presently described. These cells are preferably connected in parallel to generate an integrated electric current proportional to the intensity of incident light reaching the cells.

The amount of integrated current output from the several photoelectric cells 20, 22 and 24 is fed to a conventional meter 26 having a visual indicating needle 28 sweeping a scale 30. Scale divisions, not shown in detail, preferably span from 0 to 200 with fractional markings for interpretative purposes presently described.

Illumination of test material within the apertured area 31 is provided by a pair of tubular fluorescent lamps 32 and 34 mounted within the lower portion of the housing 10 and arranged to extend longitudinally of and adjacent to opposite sides of the aperture. The power circuit for these lamps, indicated in FIG. 5 preferably includes a voltage regulator 36 to insure a steady and efficient source of light. Each lamp 32 and 34 is respectively provided with suitable reflectors 38 and 40, adjustably mounted to concentrate light upon the apertured area 31. The specific details for mounting the lamps 32 and 34 with their reflectors 38 and 40 are not shown as such features are well known and for the present purpose it will be observed that inverted U-shaped channel members 42 and 44 provide fixtures for the lamps and include horizontal web portions 46 and 48.

Light reflected from test material within the aperture 31 passes upwardly within the housing through a passageway defined by partitioning walls 50 and 52 to fall upon the cells 20, 22 and 24. These walls are mounted upon web portions 46 and 48 and are spaced from the side walls 16 and 18 by brackets 54 and 56.

In certain applications of this invention, it has been found desirable to filter the light incident upon the cells

to more closely match the sensitivity of the normal eye. Such a filter may constitute a glass-like plate **58** supported upon ledges **60** and **62** of the webs **46** and **48** of the lamp fixtures **42** and **44**. Yellow-green filters are well known in this connection and various other light modifying filters may be utilized for selecting colors of desired frequencies or for varying the sensitivity of the photoelectric cells.

Experience has indicated that high temperatures alter the sensitivity of the photoelectric cells and therefore to maintain such cells at approximately room temperature an electrically operated fan **64** may be provided and in turn controlled by a thermostatic switch **66** through the relay **68**.

As shown in the drawings the scanning unit housing A rests upon the mask member B and extends laterally across and adjacent the top surface of a conveyor table C. While holddown devices may be utilized, the housing A may simply rest upon the mask B. The open lower portion of the housing A and position of the lamps **32** and **34** permits ready access to these units for purposes of maintenance and repair and replacement.

The conveyor table C consists essentially of a pair of longitudinally extending side rails **70** and **72** and a rectangular plane surfaced body **74** preferably arranged within a horizontal plane. Rails **70** and **72** are provided with terminal extensions and include bearing units for rollers **76** and **78** for supporting and movably positioning an endless conveyor web **80**. Movement of the web **80** may be effected manually by means of a crank device **79** connected to the roller **76**. However, power means as illustrated in FIG. 6 and presently described, in more detail, is preferred.

Material **81** to be presented at the aperture **31** is advanced by the conveyor web **80** beneath the mask member B. To properly align and position such material **81**, such as printers' and advertisers' proofs or columnar portions of newsprint, the web **80** is provided with spaced flaps **82** extending laterally thereof to form lap-type headstops. Flaps **82**, preferably, are strip-like sheet material being secured over the leading half **84** of their surface to the web and including a wing-like area **86** adapted to overlie an associated sheet of test material. In FIG. 3 flap **82** is indicated as passing over the roller **76** where the roller curvature flexes the web and the wing-like portion **86** assumes a generally tangential position releasing the test material sheet **81**.

The mask member B has been designed primarily for use in connection with scanning columnar portions of newspaper webs and to this end consists of four adjustably mounted metallic strips **88** and **90** constituting end portions while **92** and **94** comprise relatively long side portions. The end extremities of this mask B are secured to the rails **70** and **72** by screw and slot fastenings **93**, and in a like manner the side portions **92** and **94** complete the apertured area **31**. This area it will be noted extends laterally across and above the material conveyor web **80** and may be adjustably varied to define discrete portions of such material. An alternate arrangement for varying the aperture **31** may include adjustably mounting the strips **88** and **90** or end portions **92** and **94** upon the housing A. Thus, in effect, the mask B may form a bottom wall of the housing. In newspaper printing the columnar areas vary slightly from one newspaper to another and in other scanning operations areas of varying shape and size may be accommodated.

It is particularly desirable in columnar newspaper work to provide a scale associated with the web sheet material as portions are advanced and scanned. Such scale indicated by numeral **98** may be permanently inscribed upon the side rails **70** and **72** of the conveyor table C, or simply applied upon tapes or strips attached to such rails. In this latter case, tapes may be provided calibrated to the varying aperture dimensions.

A modified conveyor drive unit is generally illustrated in FIG. 6 and includes a well known drive device including an electric motor **100** which through an adjustable fractional turn clutch **102** imparts desired advancement to the conveyor web **80**. In this connection a selection switch **104** when depressed energizes the motor for clutch actuation and partial advance of the conveyor. An adjustment **106** of the clutch permits the same to be set to desired columnar widths and in operation automatically presents successive areas for scanning. To more clearly define columnar areas, numeral **108** designates such an area in FIG. 1 as bound by the lines **110**, **112**, **114** and **116**.

The scale for newspaper printing may be calibrated with respect to the integrated current output of the cells **20**, **22**, etc. so that zero reading represents the quantity of light received by such cells from a densely pigmented surface such as a solid heavy black colored newspaper columnar area. The 200 reading on the scale **30** represents the light received by the cells **20**, **22** etc. from a fresh clean columnar area of newspaper web. Intermediate readings, therefor, represent proportional densities of pigments on tested areas and such density determinations may be converted into the setting of "key" controls or other controlling devices feeding ink to the selected columnar sections of a newspaper web. The galley and advertisers proofs in newspaper or other printing preferably are subjected to analysis for adjusting the ink feed controls.

In operation, with electric power supplied from the lines **118** the lamps **34** and **32** will be energized and operating electric power from lines **120** will activate the conveyor drive motor **100**. A galley proof or similar test web or such is placed upon the conveyor C and the leading edge of such sheet **81** aligned transversely of the conveyor under the wing-like tab **86** of flap **82**. Assuming the columnar areas of the galley proof or sheet **81** are of the dimensions indicated in the drawing and the mask B, and the conveyor clutch **102** are preperly adjusted to successive depression of switch **104** will intermittently advance the conveyor C and sheet **81** to place adjacent columnar areas **108** within the aperture **31**.

The light reflected from the various test areas will fall upon the cells **20**, **22**, etc. and generate an integrated current output as indicated by deflection of needle **28** upon scale **30**. As set forth hereinbefore the value of the current indicated by the meter **26** will be proportional to the pigment density and such value may be interpreted in terms of ink pigment necessary to duplicate the column of printed material. For convenience interpretative or conversion factors **120** may be arranged near the meter **26** as shown in FIG. 4.

In certain applications of the apparatus of our invention the nature of the determination or analysis may require color frequency discrimination or selection, and therefore, sensitivity of the cells **20**, **22**, etc. may if necessary, be modified by proper use of light filters or modifiers such as **58** shown, in operative position in FIG. 2.

In applications concerning comparative analysis of materials such as liquids, textiles, plastics, food, paint, plant and other colored material it is within the concept of the invention to utilize only one or a plurality of units of our apparatus. Plural scanning units may be interconnected to a single indicating or meter panel or the current output of such scanning units may be integrated for operating the ink supply control keys of the ink mechanism such as illustrated by Patents Nos. 2,497,648 and 2,821,919 discussed previously as well as other related apparatus such as defective material handling systems and the like.

Although the above description relates primarily to the use of our invention in conjunction with printing, and particularly as used in printing newspapers, numerous other applications involving color density determination, and color quality comparisons and interpretations may be handled. Certain modifications of the apparatus may be required for such uses and it is intended that the apparatus

and modifications thereof will be unrestricted within the scope of the appended claims.

We claim:

1. Apparatus for determining the pigment density of an article comprising a light proof housing having a top wall, vertical end walls, spaced upright interior horizontally elongated walls extending between said end walls and to said top wall and providing the side boundaries of a horizontally elongated light transfer passageway having an elongated article positioning opening at the lower part thereof, elongated illuminating sources mounted in the lower part of said housing exteriorly of each of said interior walls parallel to and offset outwardly from said interior walls and delivering light to said opening, a plurality of photoelectric cells mounted at horizontally spaced locations on said top wall for and delivering an electrical current proportional to the light incident on an article at said opening and delivered thereto through said passageway, and means connected to said cells and responsive to current delivered thereby.

2. Apparatus as defined in claim 1 in which said light sources are fluorescent lamps disposed above said opening on each side thereof.

3. Apparatus as defined in claim 1 in which said light sources are fluorescent lamps disposed on each side of said passageway and a filter member is provided horizontally disposed in said passageway between said light sources and said photoelectric cells.

4. Apparatus as defined in claim 1 in which horizontally adjustable plates are provided for determining the size of the article positioning opening.

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