APPARATUS FOR DETERMINING THE EVAPORATION END POINT OF VOLATILE LIQUIDS

James M. Phelan
James A. Wilson

Inventors

By: Attorney
APPARATUS FOR DETERMINING THE EVAPORATION END POINT OF VOLATILE LIQUIDS

James M. Phelan, Cranford, and James A. Wilson, Stanhope, N.J., assignors to Eso Research and Engineering Company, a corporation of Delaware

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The present invention relates to a photo-evaporimeter apparatus adapted for the determination of the evaporation rates of volatile liquids. More particularly the invention relates to an apparatus for the photo-electric determination of evaporation rates. Specifically, the invention contemplates a means whereby a non-transparent, light-transmissive, wettable material is made more translucent by wetting with the volatile liquid to be tested, and the intensity of light transmitted by the material is sensed and measured during evaporation of the liquid from the material. The evaporation end point of the liquid is determined at that point at which no further change occurs in intensity of the light transmitted. Under certain conditions, the determination may be based on a measurement with reference to the light transmission characteristic of the material before wetting. This basis is only feasible when the volatile liquid employed is substantially colorless and does not effect a permanent change in the light transmissive character of the wettable material. The invention particularly contemplates employment of a wettable material which is an absorbent material.

It is an object of the invention to provide a means whereby the evaporation end point of a liquid may be determined easily and in a relatively short period of time, as compared with conventional procedures, and without complicated or delicate equipment and techniques. Another object contemplated is to provide a convenient and simple apparatus and operating procedure for evaporation end point determination wherein not only the overall rate of evaporation is indicated, but also the rate of evaporation for any time interval less than required for total evaporation or end point determination. It is a further object of the invention to permit such determinations to be made from extremely small sample portions of the volatile liquid. It is also an object of the invention to provide a system and procedure for determination of evaporation end points and/or evaporation rates, adapted for employment in conjunction with suitable systems for process and product control in the refining or blending of fluid materials such as in the refining of hydrocarbon materials, or in the blending of refined products, wherein the evaporation characteristics of such materials are critical factors.

The invention and its objects may be more fully understood from the following description, when it is read in conjunction with the accompanying drawings wherein:

Fig. 1 is an exploded view, in perspective, of a simple form of the apparatus contemplated;
Fig. 2 is a schematic showing in vertical section, of another form of the apparatus according to the present invention;
Fig. 3 is a diagrammatic showing representative of an apparatus according to the invention, as it may be applied to a substantially continuous determination of the evaporative characteristics of a process flow stream, and for the purpose of controlling such characteristics in any desired fashion; and

Fig. 4 is a diagrammatic showing of a portion of the apparatus as illustrated by Figure 2 wherein an alternate arrangement for passing a strip of absorbent material through the device is illustrated.

In Fig. 1, the numeral 1 designates a casing or housing for a light source such as a fluorescent tube indicated in the drawing by the numeral 2. The housing 1 is provided with a cover 3 in which there is provided a port such as is designated by the numeral 4. The port 4 is shown to be located in the cover between two strip elements 5 and 6 respectively, extending laterally over the cover in substantially right angular relation to the longitudinal axis thereof and between them forming a recess 7, wherein the cover is the bottom wall. If desired, of course, the recess may be a part of the cover being formed integrally therein. This recess is adapted to receive a strip of a non-transparent, light-transmissive, wettable material designated in the drawing by the numeral 8. Preferably, the strip of material is an absorbent material and has a longitudinal dimension greater than the width of the cover 3 or casing 1 and is provided with a defined circular area 9 imprinted or otherwise impressed upon the surface of the strip. The circular area 9 is of substantially the same dimension as the port 4 and is spaced from one end of the strip 8 by a distance substantially equal to the distance of the port 4 from either edge of the cover. Also as shown or indicated, the strip 8 has a lateral dimension substantially equal to the width of the recess portion 7 and the circular area 9 is located on the strip in spaced relation to the sides thereof. When the strip is inserted in the recess, the circular area 9 will substantially correspond to, and be disposable in substantial registration with the port 4. The depth of the recess as provided by the thickness of the elements 5 and 6 is gauged so as to be slightly greater than the thickness of the strip of absorbent material 8.

The elements 5 and 6, or the surface of the cover 3, when the recessed portion is formed integrally, provides a support for a light-meter 10, such as a Standard Weston Light Meter (Model No. 715) as manufactured and offered for sale by the Weston Electric Instrument Corporation of Newark, N.J. The instrument as employed in the present invention was provided with a graduated scale covering a 5° range with 1° divisions. For the present purpose, the back of the meter was removed and replaced with a shield having a port therein corresponding to the port 4 in its dimension, and the light shield port could be made to coincide with the light port 4. Preferably, the port 4 is also covered with some translucent material, such as thin white paper, frosted glass, or cloth, in order to slightly diffuse the emitted light. The intensity of the light source may be fixed, but preferably some suitable and conventional means for controlling light intensity is included in the circuit connected thereto.

In the operation of the device as illustrated by Fig. 1, a strip of absorbent material such as that indicated by the numeral 8, is wetted with a liquid for which the evaporation point is to be determined. Wetting is accomplished by applying a drop (0.02 to 0.05 cu. centimeter) of the liquid to the center of the circular area 9 on the strip. The strip is then immediately inserted in the recess 7 so as to bring the end of the strip nearest the circular area into registration with the opposite edge of the cover 3 and the recess 7. In this way, the circular area is brought into coincidence with the port 4 and the corresponding port provided in the back of the light meter. The light meter scale readings are then recorded at intervals over such period of time as required to reach a point of no change in the recorded intensity of light transmitted through the absorbent material. The time taken to reach this point is the evaporation time for the liquid. Preferably, the determination is made under controlled
temperature conditions. This may be accomplished by enclosing the instrument with a shield spaced from the instrument from about one to about two inches, and wherein the shield is provided with suitable openings to permit a substantially uniform flow of air upwardly within the shield. For the purposes intended, the heat derived from the light source, in conjunction with thermal circulation of air over the surface of the strip, is usually sufficient to induce evaporation of the sample applied to the absorbent strip. In the region of the sample employing a 6" double type fluorescent lamp, the temperature has been found to average between 105° and 120° F. Where especially accurate results are required, the determination should be made in a series of separate determinations for each liquid. In each determination, the ambient atmosphere of the instrument, the air conditioned and substantially maintained at a constant temperature of 72° F. and a relative humidity of 40%. Each liquid was further subjected to an evaporation end point determination by means of a Modified Jolly Balance, employing conventional techniques for the operation thereof, to provide a basis of comparison for the results obtained by the presently disclosed apparatus and method.

The nature of the liquids employed in these determinations and the results obtained are indicated from the following tables:

**Table I**

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Boiling Range, °F.</th>
<th>Evaporation Time for Individual Runs in Seconds</th>
<th>Average Time in Seconds</th>
<th>Percent Deviation</th>
<th>Relative Time (Toluol=1)</th>
<th>Evap. Time In Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>102-108</td>
<td>Run #1  45</td>
<td>Run #2  45</td>
<td>115</td>
<td>±1</td>
<td>0.30</td>
</tr>
<tr>
<td>B</td>
<td>229-238</td>
<td>Run #1  115</td>
<td>Run #2  115</td>
<td>235</td>
<td>±2</td>
<td>0.40</td>
</tr>
<tr>
<td>C</td>
<td>489-498</td>
<td>Run #1  235</td>
<td>Run #2  235</td>
<td>459</td>
<td>±2</td>
<td>0.50</td>
</tr>
<tr>
<td>D</td>
<td>278-282</td>
<td>Run #1  267</td>
<td>Run #2  267</td>
<td>524</td>
<td>±2</td>
<td>0.60</td>
</tr>
<tr>
<td>E</td>
<td>317-330</td>
<td>Run #1  372</td>
<td>Run #2  372</td>
<td>744</td>
<td>±2</td>
<td>0.70</td>
</tr>
<tr>
<td>F</td>
<td>316-355</td>
<td>Run #1  990</td>
<td>Run #2  990</td>
<td>1,980</td>
<td>±2</td>
<td>0.90</td>
</tr>
</tbody>
</table>

In Table I, the several hydrocarbon liquids are designated alphabetically, and identified by their typical boiling ranges. The liquid designated B is toluol, and as a relatively pure material is used as a reference in the results tabulated, and particularly for comparison of evaporation times determined according to the present invention with those determined conventionally by use of a Modified Jolly Balance. The total evaporation time for each liquid on each run made therewith is also shown. The average of these runs in each instance is shown in comparison with the time for evaporation of the sample required for operation of the Modified Jolly Balance. The shorter times of determination as shown over that for the conventional smaller volume (0.002 to 0.05 cubic centimeter as compared with about 2.0 cubic centimeters) may be employed according to the present invention.

In view of the fact that the differences in the evaporation times of the respective systems is so wide, provision is made in Table I for a proportional comparison. The evaporation time for toluol by either system is taken as a base figure equal to 1. The time for evaporation of each of the liquids in either system is then shown in its proportion to the evaporation time for toluol. When thus related, the substantial uniformity of results by either system is evident.

**Table II**

<table>
<thead>
<tr>
<th>Percent Change in Light Meter Scale Reading</th>
<th>Time In Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

In Table II, derived from data obtained from the evaporation determinations made for each of the liquids designated in Table I, and shows the percent change in light
meter scale deflection indicated from a curve of average value plotted from such data. In this table, the total evaporation time shown for each liquid is as also shown in Table 1. In addition, the equivalent total time in minutes is included for each liquid.

The apparatus as illustrated by Fig. 2 is basically similar to that as shown by Fig. 2. In Fig. 2, the numerals 11 and 12 respectively designate an instrument body and a capping piece therefor. These elements may be of any desired shape, but in the form contemplated by the drawing they are circular. The body 11 is provided with a generally rectangular recessed slotted portion 13, which extends diametrically across the body, opening upwardly through the upper end of the body and radially thereof at each end of the slotted portion.

The body 11 and piece 12 each defines a concentric tubular passageway, 14 and 15 respectively, opening through their upper and lower ends. These passageways are of substantially equal diameter, and as shown, when the body and capping piece are assembled, are disposed in substantially coaxial relation. The upper end of the passageway 14, defines a port which opens through the bottom of the recess portion 13. As in the device as illustrated by Fig. 1, the passageways and thereby the port is intended to have a diameter less than the width of the recessed portion 13. With the capping piece 12 applied as shown, it cooperates with the body 11 and recessed portion 13 to form a passageway, rectangular in cross section, which intersects the axis of the passageways 14 and 15 at right angles thereto.

The numeral 16 designates a slide adapted for insertion in the recess portion 13, with the lower surface of the slide in slidable surface contact with the bottom wall of the recess portion, and supported thereby. The upper surface of the slide is preferably recessed to receive a strip of a non-transparent light-transmissive material of the character previously described, and designated in Fig. 2 by the numeral 17. A stop member 18 is disposed laterally of the slide 16 at its forward end, providing an abutment for the forward end of the strip 17. The slide 16 is further provided with an orifice or port 19 opening through the recessed portion thereof intermediate the ends, and a lateral slot member 20 dependent from the lower surface at a distance from the center of port 19 substantially equal to that from the axis of passageway 14 to the outer wall of the body 11. By means of stop 23, the port 19 is automatically brought into coaxial registration with the passageways 14 and 15 when the slide is fully inserted in the recess 13. In similar fashion, the stop 18 provides for proper registration with port 19 of an indicated spot for application of a liquid sample on the strip 17, such as the circular area 9 on the strip 8 shown and described with reference to Fig. 1. In this instance, such a circular area would have a center spaced from the forward end of the strip 17 by a dimension equal to the distance from the stop to the center of the port 19. Further, as shown in Fig. 2, the port 19 is preferably provided with a light diffusion means such as a frosted glass insert indicated by the numeral 21 in the drawing.

The overall thickness of the slide 16 with strip 17 applied thereto is gauged to the depth of the recess 13, so as to be substantially less than such depth and to provide a free space above the strip 17 which opens inwardly from each end of the recess into communication with the passageway 15. The passageway 15 in turn communicates with a conduit passageway 22 extending radially therefrom through the cap piece. A nipple 23 threaded into the outer end of the passageway provides for connection to either a suction pump or a pressure pump, not shown, for circulation of air over the upper surface of the strip 17.

In the apparatus as illustrated by Fig. 2, the required light source is indicated by the numeral 24. Preferably this source constitutes a projection lamp and condensing lens system with means for cooling the lamp and the light source generally in order to minimize the heating effect thereof. The beam of light from such source may be focused so as to pass directly into the lower end of the passageway 14, or preferably, as shown, it may be focused on an adjustable reflecting means such as a mirror indicated by the numeral 25, and the reflected beam directed into the passageway 14 by suitable adjustment of the reflecting means. In any event, in order to maintain a substantially constant temperature in the vicinity of the strip 17 and to overcome any possible heating effect of the light source, the body 11 is provided with means for circulating an inert exchange medium in indirect heat exchange relation thereto, such as the conduit coil 26 shown, including inlets 27 and outlet 28 thereof.

In Fig. 2, further, the numeral 29 designates a light sensitive element supported over the upper end of the capping piece 12 so as to expose a light sensitive surface over the upper end of the passageway 15. This light sensitive element may be of any conventional type including a light meter as represented and described with reference to Fig. 1. In Fig. 2, the light sensitive means shown is representative of a photo-electric cell unit also manufactured and offered for sale by the Weston Electric Instrument Company of Newark, N.J., and designated as their model 856, Type 1. Electric leads 30 and 31 connect the unit 29 to a microammeter 32, adapted to register and indicate the strength of signals produced in the photo cell unit 29 by light transmitted from the light source 24 through the light transmissive strip 17.

Operation of the device as shown in Fig. 2 is quite comparable with that of the device as shown in Fig. 1. A drop of a liquid sample is applied to the strip 17 in place on the slide 16. The slide and strip are inserted in the recess 13 and positioned substantially as shown. The ammeter needle deflection is read at this point and at periodic intervals during evaporation. That point at which the needle deflection remains constant is then taken as the evaporation end point. The results obtained during the operation and from interval to interval are compared with similar data obtained by the same operation with a sample of known evaporation characteristics.

In the apparatus shown by Fig. 3, the method substantially as set forth with reference to Fig. 2 is applied to a system for controlling a product side stream from a distillation column. In the drawing, the numeral 101 designates a distillation column provided with a condensing coil 102, including an inlet conduit 103 and an outlet conduit 104. A flow control means such as a solenoid flow control valve 105 is shown as disposed in the inlet conduit 103. Obviously other equivalent operating and actuating means may be substituted for those shown for the purpose of illustration. A product side stream is drawn from the distillation column as by means of the conduit 106. The numeral 107 designates a housing or cabinet which provides an evaporation chamber internally thereof. The chamber is provided within inlet 108 for an introduction of a stream of air of substantially constant temperature and humidity, and at a substantially constant flow rate. The numeral 109 designates an outlet for such air from the evaporation chamber.
analyze and translate electrical signals transmitted thereto from the photo-electric cells by way of the circuits designated in the drawing by the numerals 1105, 111B, 112B, 113B and which the tape is wound after passage through the cabinet 107 along a path which passes between the respective series of light sources and photo-electric cells by way of the entrance and exit slots 120 and 121. Suitable idler or tension rolls as indicated by the numerals 122, 123, 124 and 125 may be provided. In an alternate arrangement, the strip 117 may be in the form of a continuous belt substantially as described with reference to Fig. 4.

Means for wetting the tape with the volatile liquid to be tested includes a sample draw-off conduit 126, connected at its downstream end to the product side stream conduit 106, pump 127, flow meter 128 and heater conduit 126. The conduit 126 terminates within the cabinet 107 in a discharge outlet or nozzle 130 disposed directly above the absorbent strip 117, and immediately before the series of light sources and photo-electric cells. A collection trough or funnel 131 is provided immediately below the strip of absorbent material substantially in alignment with the outlet 130 and in communication with a liquid discharge conduit 132 extending outwardly through the cabinet wall as shown. Rollers 133 and 134, are disposed above and below the strip 117 in the area of the collection trough 131, and intermediate the outlet 130 and the series of light sources and photo-electric cells. Means not shown are provided to apply pressure on the strip 117 through the rollers 133 and 134.

In operation of the apparatus according to Fig. 3, the strip of absorbent material 117 is passed through the cabinet 107 as indicated by the directional arrows. A measured and controlled quantity of liquid is withdrawn from the product side stream 106 by way of the conduit 126 as means of the pump 127 and conduit 128. This sample stream is passed through heat exchange coils 129, direct heat exchange relation with the air passed through the cabinet 107 by way of the conduits 108 and 109, to be discharged from the outlet 130 against the strip of absorbent material. In order to insure adequate and uniform wetting of the tape by the sample liquid, the amount of liquid discharged against the strip 117 from the outlet 130 is controlled so as to provide an amount in excess of that required. This excess is then removed from the strip by the pressure of the rolls 133 and 134 to be collected and discharged from the cabinet by way of the trough 131 and the discharge outlet conduit 132.

As the strip of absorbent material moves through the cabinet 107, the circulation of air through the cabinet, by way of conduits 108 and 109, evaporates the liquid sample. The rate of movement of the strip of absorbent material is adjusted to such speed as will insure substantially complete evaporation of the sample prior to the time it passes the last of the light sources and photo-electric cells in the series. The rate of evaporation of the liquid from the absorbent material strip is analyzed by the photo-electric cells by sensing the amount of light transmitted by the tape. The amount of light which the tape will transmit at any point in its path between the sensing means, is related directly to the quantity of liquid which remains unevaporated. Therefore, the rate at which the liquid evaporates can be measured by noting the rate of decrease in light transmission of the absorbent strip as its moves from the wetting point toward the exit 121 from the cabinet 107. The point at which there is no further decrease in transmitted light corresponds to the point at which the sample is completely evaporated, and the time required for the strip to reach this point is the total evaporation time. Intermediate points can be located corresponding to any specific degree of sample evaporation.

Light intensity data transmitted from the photo-electric cells are analyzed electrically in the control mechanism 115 providing the evaporation characteristic of the liquid applied to the absorbent strip. One or more detection points can be established as control points and the signals from the corresponding photo-electric cells employed to control the distillation column operating characteristics, as for example by regulating flow of a heat exchange fluid through the condenser coil 162. The signals derived from the several photo-electric cells may furthermore be employed in such fashion as to provide control for a number of process operating variables and product characteristics simultaneously. Likewise, several evaporimeter devices of the character shown in Figure 3 may be combined in an integrated system in such a way as to control several product streams at the same time and with relation one to another.

In Fig. 4, the strip of absorbent material, corresponding to that designated by the numeral 117 in Figure 3, is indicated by the numeral 217. In this modification of the apparatus, the absorbent strip is a continuous strip which instead of being wound on drums such as the drums 118 and 119 of Fig. 3, passes over the idler drums 218 and a motor driven drum 219 in such fashion that the strip is continuously passed into and out of a housing or cabinet 207. In the drawing, the numerals 222, 223, 224 and 225 designate idler rollers similar to the rollers 122, 123, 124 and 125 of Fig. 3. Also the parts designated in Fig. 4 by the numerals 240, 241 to 244 inclusive, 216A to 214A inclusive, 216B to 214B inclusive, 220, 221, and 230 to 234 inclusive are the counterparts of elements as shown in Fig. 3 which bear similar numbers in a 100 series.

In the modified form of the apparatus as shown in Fig. 4, provision is made for cleaning and drying the strip of absorbent material, substantially in the manner shown, wherein the strip 217, passing over the drum 219, is lead into a wash tank 240 containing a body of solvent material, passed therethrough over a series of rollers as indicated by the numeral 241, and then between a pair of pressure rolls 245 and 246 to remove excess solvent prior to passing the absorbent strip through a drying chamber wherein the strip is subjected to a stream of heated air passed through the chamber 124 as by means of inlet and outlet conduits 243 and 244 respectively.

As previously indicated, an apparatus of the character illustrated by either Fig. 3 or Fig. 4 may also be employed to control liquid blending operations. For example, by arranging the series location or spacing of the individual light sources and light sensitive means so as to correspond to time intervals between these cooperating elements required to produce a predetermined series of percent change characteristics such as indicated by Table II, and when using a sample of known or desired evaporation characteristics, the signals derived from any or all of the light sensitive means may be utilized so as to provide for automatic control of pumps or valves in a series of flow lines connected in a blending system and in any well known and accepted fashion.

What is claimed is:
1. An apparatus for measuring the evaporation rate of a volatile liquid, comprising means for emission of a linear series of individual light beams of substantially equal and constant intensity, a corresponding series of light sensitive elements wherein each element is interposed in one of said beams and spaced from said emission means along the path of said beam, means for passing an elongated strip of a translucent wettable material between said
series of light sensitive and light emission means in a path intercepting said beams, means for at least partially wetting said strip of wettable material with a controlled portion of said volatile material in advance of the first light beam and light sensitive element in said series, means for substantially completely drying said wetted strip in advance of the last beam and light sensitive means in said series, and means for electrically exhibiting the difference in intensity of light transmitted by said strip to the first light sensitive means in said series, and that transmitted to any selected light sensitive means subsequent thereto in said series.

2. In an apparatus for producing volatile liquids, wherein in the evaporation rate of the liquid produced is a critical characteristic thereof, and wherein said apparatus includes control means operable to determine said critical characteristic, including means to actuate said control means, the improvement which comprises means for emitting light of substantially constant intensity and for directing said light along a predetermined path, light sensitive means disposed in said light path, in opposed relation to said light emission means and spaced therefrom longitudinally of said light path, said light sensitive means being adapted to produce electrical signals having an E.M.F. proportional to the intensity of the light in said path, means for interposing an elongated strip of a translucent, wettable material in said light path intermediate said light emission and light sensitive means, means for applying a controlled portion of the volatile liquid from said producing apparatus to said strip of wettable material disposed in advance of said light emission and light sensitive means thereby initially wetting said strip, means for drying said strip while it is interposed in said light path, means to receive and exhibit electrical signals produced by said light sensitive means responsive to light transmitted through said initially wetted strip during and after drying thereof, said means including means to energize said control actuating means in response to any predetermined E.M.F. characteristic of signals received from said light sensitive means.

3. An apparatus according to claim 1 wherein said means for at least partially wetting said strip of wettable material comprises a liquid receiver trough disposed in substantially parallel co-extensive relation to one surface of said strip, a conduit having a discharge outlet directed toward one or other surfaces of said strip and arranged adjacent said trough, and a pair of liquid extraction rolls adapted to pass said strip between them while applying pressure thereto, said rolls disposed substantially within an area corresponding to that of said trough and spaced from said discharge outlet in the direction of travel of said strip.

4. An apparatus according to claim 1 wherein said elongated strip of wettable material comprises a substantially continuous belt of said material.

5. An apparatus for measuring the evaporation rate of a volatile liquid, comprising a housing defining an elongated evaporation chamber; means for passing an elongated strip of a translucent, wettable material through an elongated travel-path including said chamber; means within said chamber for directing individual light beams of substantially equal intensity against one surface of said strip, said means being disposed as a linearly spaced series along said travel-path; a corresponding series of light-sensitive elements disposed in said chamber along said strip travel-path opposite the other surface of said strip, with each element in said series in opposed, paired relation to a corresponding light beam directing means in said series of such means; means disposed within said chamber, in advance of the first of said paired light beam directing means and light-sensitive elements, for at least partially wetting said strip with a controlled portion of said volatile material; means for passing air of controlled temperature and humidity through said chamber, whereby to evaporate said volatile material from said strip in advance of the last of said paired light beam directing means and light sensitive elements; and means for electrically exhibiting the difference in intensity of light transmitted by said strip to the first light-sensitive element in said series of elements and that transmitted to any selected light-sensitive element subsequent to the first in said series.

6. An apparatus according to claim 5 wherein said means for at least partially wetting said strip of wettable material comprises a liquid receiver trough disposed within said chamber substantially in parallel, co-extensive relation to one surface of said strip, a conduit extended into said chamber having a discharge outlet directed toward the other surface of said strip and toward said trough, said conduit including a heat exchange section upstream from said outlet and in heat exchange relation to said air passed through said chamber, and a pair of liquid extraction rolls adapted to pass said strip between them while applying pressure thereto, said rolls disposed substantially within an area corresponding to and coextensive with that of said trough and spaced from said discharge outlet in the direction of travel of said strip.

7. An apparatus for measuring the evaporation rate of a volatile liquid, comprising a housing defining an elongated evaporation chamber; means for passing a continuous strip of a translucent, wettable material through through an extended travel-path including said chamber; means within said chamber for directing individual light beams of substantially equal intensity against one surface of said strip, said means being disposed as a linearly spaced series along said travel-path; a corresponding series of light-sensitive elements disposed in said chamber along said strip travel-path opposite the other surface of said strip, with each element in said series in opposed, paired relation to a corresponding light beam directing means in said series of such means; means disposed within said chamber in advance of the first of said paired light beam directing means and light-sensitive elements, for at least partially wetting said strip with a controlled portion of said volatile material; means for passing air of controlled temperature and humidity through said chamber, whereby to evaporate said volatile material from said strip in advance of the last of said paired light beam directing means and light-sensitive elements; and means for electrically exhibiting the difference in intensity of light transmitted by said strip to the first light-sensitive element in said series of elements, and that transmitted to any selected light-sensitive element subsequent to the first in said series.

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