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DROP VOLUME MEASURING APPARATUS

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The present invention relates to an apparatus for collecting predetermined volumes of liquids which issue in drop form from a source thereof.

The present invention is especially useful in an automatic fraction collection apparatus of the type shown in Patent No. 2,710,715 to George Gorham, dated June 14, 1955, and assigned to the assignee hereof. Said patent provides for obtaining predetermined quantities of liquid issuing in drop form from a chromatography column, or the like, and as shown therein, a predetermined quantity of the liquid is collected in each of a plurality of receptacles or containers. Said quantities may be determined, as provided in said patent, by counting the number of drops which issue from the chromatography column or by permitting each receptacle to receive drops for a predetermined period of time. Due to the fact that the drops issuing from the chromatography column may vary in volume, it is possible that there may be some differences in the volumes of the liquid collected in each of the receptacles whether the drop counting or the time counting arrangement is used. Under certain circumstances, it may be highly desirable, or even critical, that an extremely exact amount of liquid be collected in each of the receptacles. Consequently, it is an object of the present invention to provide a highly novel apparatus for collecting with great accuracy the same amount of a drop-falling liquid in each of a plurality of receptacles.

It is another object of the present invention to provide apparatus for measuring the volume of liquid collected in each of the receptacles of a fraction collector or the like, so as to provide an equal volume of liquid in each of the receptacles.

Another object is the provision of a highly novel and highly accurate device for collecting drops by volume rather than by counting the drops or on a time relationship.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description considered in connection with the accompanying illustrative drawings.

In the drawings, which illustrate the best mode presently contemplated of carrying out the invention:

Fig. 1 is a combined block diagram and schematic representation of an apparatus pursuant to the present invention;

Fig. 1A is a more or less schematic view of part of the apparatus of Fig. 1; and

Fig. 2 is a series of wave forms utilized in the explanation of said apparatus.

As here shown, the drop-volume measuring apparatus **10** is utilized in connection with chromatography column **11** of conventional construction, provided with an outlet **12** through which liquid, in the form of drops, issues after passing through adsorbent substance **14** provided in the column. Provision is made for a light source **16** from which light passes through an aperture **18** provided in a suitable light shield **20**, the light being formed into a beam **22** by said aperture. The beam of light **22** is focused by the lens **24** onto a photo-sensitive device or photo tube **26**. The beam **22** passes below the outlet **12** of the column **14**, passing across the fall or drop path of the drops of liquid issuing from the outlet **12**. Consequently, it will be apparent that a drop passing through the drop position D1 will intercept the light beam **22** passing to the photo-electric device **26**.

The interception of the beam **22** by a drop at position D1 will cause a pulse **28** (Fig. 2) to be generated in the output of the photo-tube **26** which pulse is fed to the amplifier **30**. Three conventional and well known delay-circuit stages **32**, **34** and **36** which, for example and not by way of limitation, may be suitable multivibrators, are connected in parallel across the output of the amplifier **30**, each of which stages is simultaneously triggered by an amplified pulse **28** at the output of the amplifier **30**. The delay circuits **32**, **34** and **36** are similar in construction but each provides a different delay period. Delay circuit **32** provides a minimum delay period which is equal to the time T2 minus T1, as shown in Fig. 2, the delay circuit 34 providing an intermediate delay which is equal to time T4 minus T1, and the delay circuit **36** providing a maximum delay which is equal to time T6 minus T1. The delayed pulse **38**, at the output of delay circuit **32**, is utilized to trigger a driven sweep circuit **40**. The driven sweep circuit **40** is of conventional construction and, as is well known to those skilled in the art, provides a voltage which is linear with respect to time. The output of circuit **40** is fed, as a horizontal sweep voltage, to the cathode ray camera tube **42**. For each pulse **38** used to trigger the driven sweep circuit **40**, there is provided one horizontal sweep in the camera tube **42**.

In addition to the previously noted light source **16**, there is provided an additional light source **44** whose rays pass through a diffusing glass **46** and through the aperture **48** in a light shield **50** to form the beam **52**. The beam **52** passes through a collimating lens **54** and through a focusing lens **56** onto the face of a conventional camera tube **42**. The beam of light **52** is positioned below the light beam **22** and also traverses the drop or fall path of the drops of liquid issuing from the outlet **12** so that each drop, as it passes through the position D2, intercepts the light beam **52**. It will be apparent that whenever a drop falling from column **11** intercepts the light beam **52**, the drop is imaged on the face of the camera tube **42**. A conventional high voltage and low voltage power supply for the camera tube **42** is indicated by the reference numeral **58**. The delay introduced by the delay circuit **32** is timed in relation to the time required for the drop to pass from the position D1 to the position D2 thereof, so that the delayed pulse **38** triggers the sweep circuit **40** shortly after a drop in position D2 is imaged on the face of the camera tube **42**.

The signal voltage developed by the imaging of the drop on the camera tube **42** is applied to a conventional time comparison circuit **60** which, as is well known to those skilled in the art, provides an output voltage proportional to the time duration of the output signal from the camera tube. More specifically, it will be understood that a substantially spherical drop at position D2 provides a two-dimensional image on the face of the camera tube **42**, which produces a square wave pulse **62** at the output of the camera tube **42**. Said pulse **62** has a time duration, for example of T3 minus T2, which is proportional to the width of the drop passing through position D2. The square or rectangular pulse **62** is fed to the time comparison circuit which, as previously indicated, is a conventional circuit and provides a voltage or signal output pulse **64** whose amplitude is proportional to the width or time duration of pulse **62**.