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V. MOSES ETAL
MEASUREMENT OF RADIOACTIVITY
ON PAPER CHROMATOGRAMS

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2 Sheets-Sheet 1

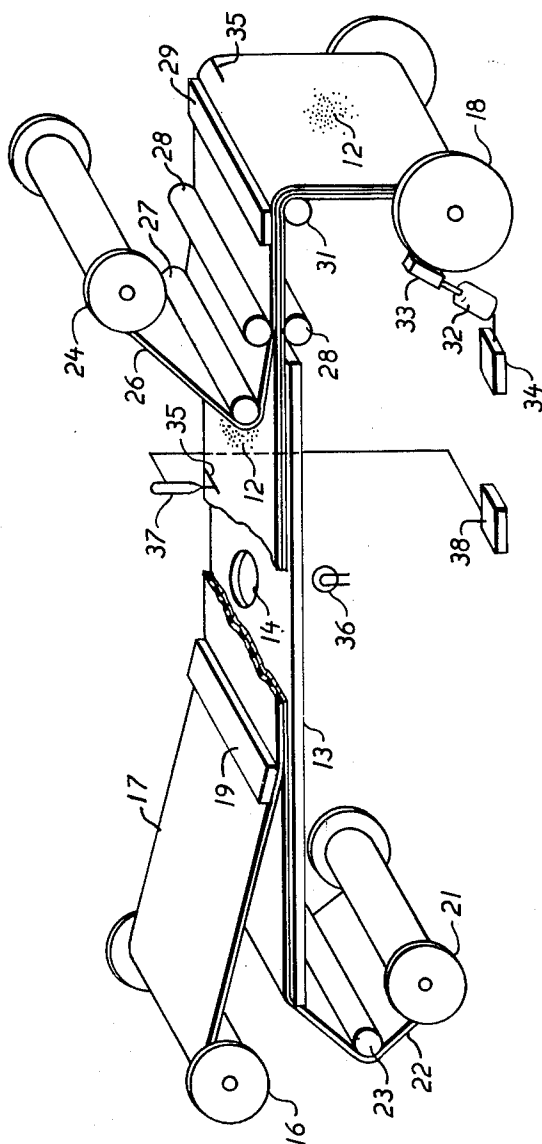


Fig. 1.

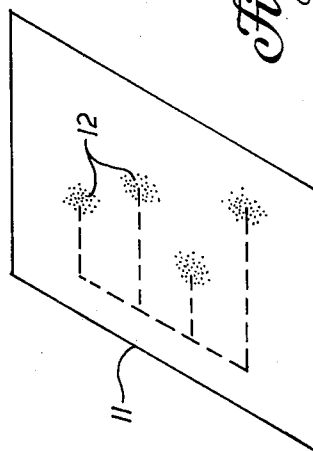


Fig. 2.

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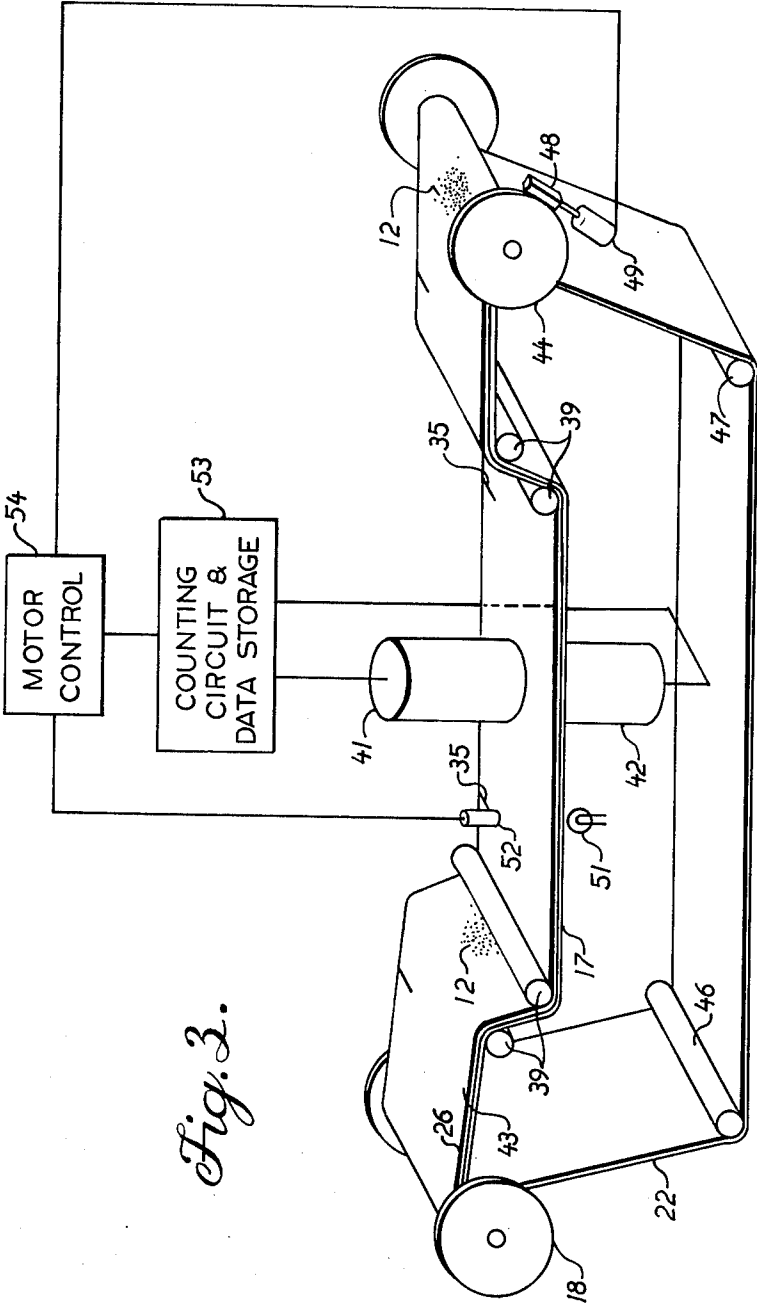


Fig. 3.

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MEASUREMENT OF RADIOACTIVITY ON PAPER CHROMATOGRAMS

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6 Claims. (Cl. 250—83.3)

The present invention relates to techniques for analyzing the chemical constituents of a mixture and more specifically to a method and semi-automatic apparatus for counting the radioactive decay characteristics of radioisotopes adsorbed at separate areas of paper chromatograms.

The art of chromatography is used for separating mixtures of chemical compounds by the phenomenon of varying partition adsorption as the chemicals are carried by solvent flow down an adsorbing medium, which medium is typically a sheet of adsorbent paper or other fibrous material. Generally, the process of paper chromatography is performed by placing a small amount of the mixture to be analyzed near one corner of the chromatography filter paper, running a solvent past this point in one direction, drying the paper, rotating the paper 90 degrees and running another solvent perpendicular to the original direction followed by final drying. Thus, further separation is possible by chromatographing the components in a direction perpendicular to the original direction. The separated components can then be released from the paper by elution, using various solvents, if desired.

Heretofore the recording of the radioactivity of the areas of interest on the paper has mostly been done by manual handling of each chromatogram spot. The manual method of individual handling and counting is very tedious, time consuming, and prone to error. Previous attempts at automatic radioactive counting of paper chromatograms have used a scanner, moving over the paper in one direction. However this results in possible overlap where several compounds are to be detected, and gives poor resolution.

A much more satisfactory procedure is that of converting a two dimensional chromatogram into a one dimensional strip, wherein the radioactivity in each compound can be separately measured by scanning discontinuously along the strip. In the present invention, this is accomplished by three principal steps. A first such step is the radioautographic location of the areas on the paper chromatogram, in which the radioactive compounds of interest are imbedded, and the excision of each such area. The second step comprises the mounting of the excised areas between two strips of Mylar film for which purpose a specialized mechanism is provided. The third step utilizes an automatic counting mechanism in which the strip is driven past a radiation counter for counting and recording of the radioactive decay of each area on the strip, the data being fed to a suitable storage device. The automatic mechanism of the invention eliminates tedium, improves the accuracy of counting, and provides a printed tape record of each radioactive count.

It is accordingly an object of this invention to provide a method and apparatus for facilitating the analysis of radioactively labelled paper chromatograms.

The invention will be better understood by reference to the accompanying drawing of which:

FIGURE 1 is a perspective view of a typical paper chromatogram,

FIGURE 2 is a schematic perspective view of the chromatogram strip loading device, and

FIGURE 3 is a schematic perspective view of the automatic counting mechanism.

Referring now to the drawing and more particularly to FIGURE 1 thereof, a typical finished paper chromatogram 11 is shown with separated radioactive areas 12 distributed on the surface thereof, a measurement of the radioactivity of each such area being needed to complete the chromatographic analysis. The location of each of the areas 12 on paper 11 is determined by conventional radioautographic techniques and the position of each area on the paper is measured and recorded.

As a first step in the method of the present invention, the areas 12 are cut out of the paper 11 for mounting on a backing strip and subsequent passage through an automatic radioactivity counter. Referring now to FIGURE 2, an apparatus is shown for facilitating the mounting of the areas 12 on the backing strip. Such apparatus includes a flat horizontal shelf 13 having a circular opening 14 at the center thereof. A first spool 16, carrying a roll of thin polyester film 17 is mounted above one end of shelf 13 with the spool being rotatable about an axis parallel to the shelf. Film 17 extends along the upper surface of shelf 13 to a take-up spool 18 rotatably mounted below the second end of the shelf 13.

To smooth the film 17 as it unrolls from the spool 16, and to aid in holding the film against shelf 13, a rectangular felt pad 19 is disposed above the film and immediately above the shelf a short distance from the spool 16.

To provide a high strength backing for the thin film 17, a second spool 21 carrying a roll of paper 22 is disposed beneath the first spool 16, in parallel relationship to the first spool. A cylindrical roller 23, parallel to second spool 21, guides the paper 22 as it unwinds therefrom. The paper 22 passes across the shelf 13 to the opposite end and is wound onto the previously described take-up spool 18 together with the film 17. A third spool 24 carrying an additional roll of polyester film 26 is mounted above the shelf 13 and opposite the aforementioned first spool 16. The additional film 26 unwinds from the third spool 24 and passes over a guide roller 27 mounted beneath the spool. Two adjacent parallel cylindrical rollers 28 are mounted at the end of shelf 13 and beneath the third spool 24, the rollers 28 being parallel to spool 24. The two opposed rollers press into close contact the film 17 from the first spool 16, paper 22 from the second spool 21, and the film 26 from the third spool 24, as each passes along the shelf 13. To smooth the combined films emerging from rollers 28 a rectangular felt pad 29 is disposed above the combined films. An additional roller 31 aligns the combined strips prior to being wound onto spool 18, the roller 31 being parallel to the previously mentioned spools and rollers. The combined strip, after passing over roller 31, winds onto spool 18. The motive force for rotating spool 18 is provided by a motor 32 turning a suitable rim drive mechanism 33. Control of motor 32 is provided by a foot switch 34 placed beneath the shelf 13.

In operation, film 17 and paper 22 are threaded through the various rollers as hereinbefore described. The cut-out areas 12 of the chromatogram may then be glued to successive portions of the film 17, the film being moved by operation of foot-switch 34 between each application of a chromatogram area. To facilitate the attachment of the areas 12 to film 17, the operation is carried out over the opening 14 in shelf 13 and a light 36 is disposed beneath the opening to illuminate and identify the work area.

After each application of a chromatogram area 12 to the film 17, a marking device 37 is actuated by a foot pedal 38 to place an opaque mark 35 on film 17 so that the location of each area 12 on film 17 may be identified by automatic photoelectric means during the subsequent counting operation. The foregoing processes are

repeated until all chromatogram areas 12 have been mounted on film 17 and the latter has been wound onto the take-up spool 18.

The next step is transferring the spool 18, containing the wound strip and the chromatogram portions, onto an automatic counting device as shown in FIGURE 3. Spool 18 is mounted at one end of the device along which the film 43 is guided for counting. The double layer of polyester film 43, comprising films 17 and 26, is separated from the paper 22 as it comes off the spool 18, the layer of polyester films 43 passing through a plurality of rollers 39 which guide the film 43 through the gap between a pair of radiation detector tubes 41, 42 which are mounted one above the other below the film 43. The top radiation detector tube 41 thus counts radiation coming from the top of a chromatogram area 12, and the bottom radiation detector tube simultaneously counts radiation from the bottom of the same chromatogram area 12.

Concurrent with the unwinding of the polyester film layers 43, the paper is unwound and passes below the previously mentioned guide rollers 39 and the bottom radiation detector tube 42. The paper 22 is guided to a take-up spool 44 at the opposite end of the device by passing around a first guide roll 46, beneath spool 18 and a second guide roll 47, beneath the take-up spool 44. Guide rolls 46 and 47 are parallel to the previously mentioned guide rolls 39.

After the polyester film 43 has passed through the gap between the top radiation detector tube 41, and the bottom radiation detector tube 42, the film 43 is rewound on the take-up spool 44 together with the paper 22. Take-up spool 44 is rotated by a suitable rim-drive mechanism 48, which is turned by a motor 49.

To provide for fully automatic operation of the counting mechanism, the motor 49 turning the take-up spool 44 is controlled by suitable circuitry 54 so that the film movement is stopped instantly when the opaque mark 35 associated therewith breaks the light beam from a lamp 51 beneath the polyester film 43 to a photocell 52 above the polyester film 43. At this position the chromatogram area is positioned exactly in the gap between the top radiation detector tube 41 and the lower radiation detector tube 42. Radiation from each chromatogram area 12 is counted for a fixed time interval determined by the associated counting circuitry 53. At the end of this interval, circuit 53 actuates motor control 54 so that motor 49 is re-energized, which turns the take-up spool 44 until another chromatogram spot 12 is in place. The cycle is thus continually repeated until each area 12 has been counted.

The counting circuit 53 may include any form of conventional data storage means such as magnetic tape or a card punch unit.

We claim:

1. Apparatus for automatically measuring the radioactivity of a plurality of paper chromatogram segments comprising, in combination, a pair of parallel rotatable spools spaced apart and carrying a thin film strip which has said chromatogram segments mounted thereon at spaced intervals therealong and which is wound on said spools together with a like strip of relatively high strength backing material, a first set of guide rollers disposed between said spools for directing said thin film strip therebetween, a second set of guide rollers spaced apart from the first set thereof for directing said backing strip between said spools along a path spaced apart and parallel to that of said thin film, a pair of adjacent radiation counters disposed one on each side of said thin film strip, drive means operatively coupled to said spools, and control means stopping said spool drive means as each of said chromatogram segments moves between said radiation counters and starting said drive means after said counters have measured the radioactivity of each of said segments for a pre-determined interval.

2. A method for measuring the radioactivity of separate

areas of a paper chromatogram utilizing a radiation counting mechanism of a predetermined end window size comprising:

- (a) determining the position of each of said areas on said chromatogram;
- (b) excising each of said areas from said chromatogram;
- (c) securing each of said areas in spaced linear sequence to a strip of thin radiation-transmitting material;
- (d) marking the position of each area thereon by means of a mark on the strip;
- (e) passing said strips before the end window of said radiation counting mechanism and utilizing said marks to stop relative motion of the said strip and said radiation counting mechanism;
- (f) and counting and recording the radioactivity emitted by each of the said areas during the time said relative motion is stopped.

3. A method for measuring the radioactivity of separate areas of a paper chromatogram utilizing a radiation counting mechanism of a predetermined end window size comprising:

- (a) determining the position of each of said areas on said chromatogram;
- (b) excising each of said areas from said chromatogram;
- (c) securing each of said areas in spaced linear sequence between a pair of strips of thin radiation-transmitting material to form a tape;
- (d) marking the position of each area between said strips by means of an opaque mark on the said tape;
- (e) passing said tape before the end window of said radiation counting mechanism and utilizing said opaque marks to stop relative motion of said tape and said radiation counting mechanism;
- (f) and counting and recording the radioactivity emitted by each of said areas during the time said relative motion is stopped.

4. A method of measuring the radioactivity of separate areas of a paper chromatogram utilizing a radiation counting mechanism of a predetermined end window size comprising:

- (a) determining the position of each of said areas on said chromatogram;
- (b) excising each of said areas from said chromatogram;
- (c) securing each of said areas in spaced linear sequence between a pair of strips of thin radiation-transmitting polyester film to form a tape;
- (d) marking the position of each area between said strips by means of an opaque mark on the said tape;
- (e) passing said tape before the end window of said radiation counting mechanism and utilizing said opaque marks to stop relative motion of the said tape and said radiation counting mechanism;
- (f) and counting and recording the radioactivity emitted by each of the said areas during the time said relative motion is stopped.

5. A method for measuring the radioactivity of separate areas of a paper chromatogram utilizing a radiation counting mechanism of a predetermined end window size comprising:

- (a) determining the position of each of said areas on said chromatogram;
- (b) excising each of said areas from said chromatogram;
- (c) securing each of said areas in spaced linear sequence between a pair of strips of thin radiation-transmitting polyester film to form a tape;
- (d) marking the position of each area between said strips by means of an opaque mark on the said tape;
- (e) passing said tape before the end window of said radiation counting mechanism and permitting the opaque marks to interrupt a light beam to a photo-

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electric cell governing passage of said tape before said end window whereby to terminate relative movement of the said tape and the said radiation counting mechanism;

(f) and counting and recording the radioactivity emitted by each of the said areas during the time said relative motion is stopped. 5

6. A method of measuring the radioactivity of separate areas of the paper chromatogram utilizing a pair of radiation counting mechanisms of given predetermined end window size comprising: 10

(a) determining the position of each of the said areas on said chromatogram;

(b) excising each of said areas from said chromatogram; 15

(c) securing each of the said areas in spaced linear sequence between a pair of strips of thin radiation-transmitting polyester material to form a tape;

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(d) marking the position of each area between the said strips by means of an opaque mark on said tape;

(e) passing the tape so formed between opposed end windows of said pair of radiation counting mechanisms and utilizing said opaque marks on the said tape to interrupt the relative motion of the said tape and the said radiation counting mechanisms;

(f) and counting and recording the radioactivity emitted by each of the said areas during the time said relative motion is stopped.

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