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The Separation of Small Amounts of Inorganic Cations by Chromatographic Methods. II. An Automatic Scanner for Radio Paper Chromatograms

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The construction of a sensitive and well resolving scanner of chromatograms is described, permitting the determination of R_F-values for as little as $5 \cdot 10^{-7}$ mC Co^{60}.

The investigation of radio labelled compounds by means of paper chromatography has found application during the last ten years. Two different scanning methods have been used, either autoradiography or registering of the counts by passing a Geiger-Müller counter. The former has the disadvantage of being slow and difficult to interpret quantitatively, and resolves spots, near one another, rather badly. The second method is not as simple as the first but is fast, quantitative and gives good resolution. Different automatic scanning GM-apparatus have been described [1–4]. In a scheme of separating spallation products of copper [6], investigated at this laboratory, an apparatus was constructed, which is similar to a later published scanning [5] device in essential parts.

SCANNING INSTRUMENT

The construction and connections are illustrated in Fig. 1. The paper strips *A* are continuously passing a small slit *B* below a thin mica window of a bell-shaped GM-counter *C* (20th Century El. EW 3 H), shielded by a lead castle *D*, the lower parts of which are shown in Fig. 2. The moving paper strip is guided by a small concavity *E* with the same width, 3.5 cm, as the strips. The slit is 3.5 × 0.2 cm and its height 0.25 cm. In the cylindrical concavity *F* the GM-counter directly rests above the slit (distance window-paper strip hence 0.25 cm) or if desired with some Al- or Pb- sheets between to adsorb the β-rays.

The movement of the strips is synchronized to the movement of a writing recorder (Easterline Angus Graphic Ammeter) by a fine thread *G*, attached to the paper by a clamp *H*, resting on a Lucite stand *K*, and with its other end wound around the shaft of the drum that moves the chart of the recorder. The

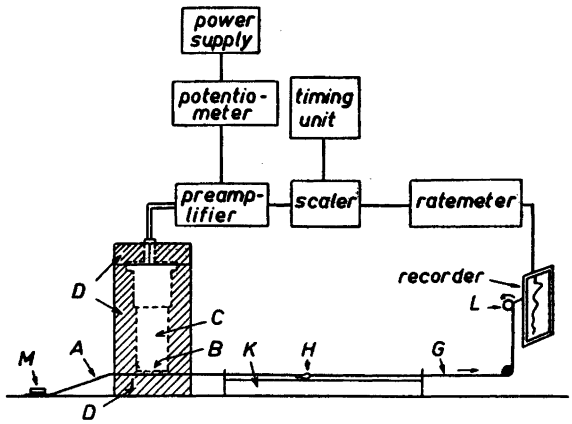

Fig. 1. Diagram of scanner and connections.

rate of the paper movement, compared to that of the chart, is regulated and shifted by small spools L of different radius and also by altering the gear connection shaft-chart in the recorder. The thread and strip are tightened by a small lead plate M.

All counting equipment is of conventional Harwell type. High voltage is supplied to the GM-counter via a potentiometer + power supply, type 200, fed into the scaler (type 1009 A) and registered both by a scale of 100 circuit + mechanical register, controlled by a timing unit (type 1003), and also by a ratemeter (type 1138 A) + recorder. The recorder is calibrated so as to write directly on the lined chart the number of counts per second, and the integrating capacities regulated to give a smooth and sensitive curve.

INVESTIGATIONS

a) *Tests of sensivity, reproducibility etc.* In order to determine the sensivity and smallest registered and well resolved amount of radioactive material, exact volumes of Co^{60} + inactive Co were applied to the strips, eluted by means hof te method, described earlier [7], counted and recorded. As the number of mC per ml of the Co-solution had been determined against a Co-standard, the

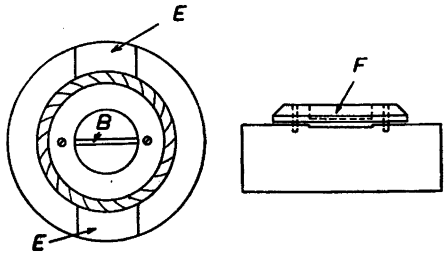

Fig. 2. Lead castle, lower part.

Table 1. Registered counts, less background, from strips, to which different λ-amounts of Co^{60} had been applied.

Number of λ	Registered impulses	
		with extra Pb-plate
1	185 ± 38 232 ± 34	67 ± 22 71 ± 26
2	450 ± 35 495 ± 36	123 ± 21 155 ± 26
3	683 ± 46	175 ± 30
4	972 ± 49	263 ± 35
5	1 180 ± 50 1 190 ± 45	321 ± 33 345 ± 29
10	2 185 ± 60 2 351 ± 54	657 ± 39 662 ± 31
20	4 607 ± 74	1 342 ± 43
25	5 968 ± 82	1 715 ± 47

smallest amount of Co^{60} to give well defined peaks with the same R_F as those, obtained by spraying the strips with rubeanic acid, could be calculated and was found to be $\sim 5 \cdot 10^{-7}$ mC (mean of 20 experiments), *e.g.* 22.5 disintegrations per second. Deducting background, only 35 impulses were then registered by the scaling circuit, but nevertheless the R_F could be determined to within ± 10 %.

11.8 % of the total disintegrations were counted by the counting assembly, *i.e.* the effective angle is ~ 40°.

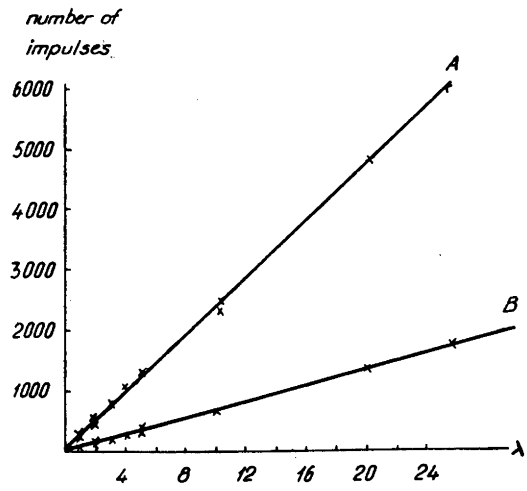

Fig. 3. Registered number of impulses of different amounts of Co^{60} (data from Table 1); A without and B with Pb-absorbator.

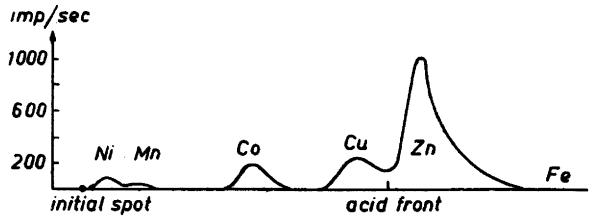

Fig. 4. Separation of Cu-spallation products with methyl-iso-propylketone + 15 % 8 N HCl.

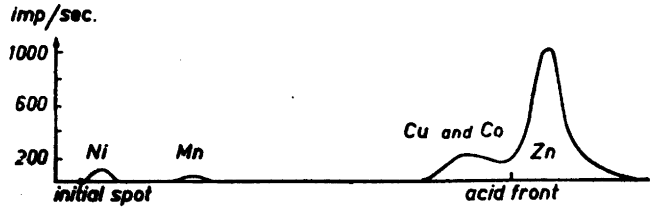

Fig. 5. Separation of Cu-spallation products with methyl-iso-propylketone + 15 % 10 N HCl.

Smooth curves could never be obtained, when very weak radioactive solutions were counted, as the integrating capacity had to be small to resolve the peaks. The width of peaks, registered from strong γ-emitting isotopes, such as Co^{60}, was larger than that of the real spots on account of γ-penetration through the thin Pb-plate near the slit, but these effects could partly be eliminated by an additional Pb-plate, placed between the mica-window and the paper, with exactly the same dimensions of the slit. The effective angle was then diminished to $\sim 12°$, the γ-boundary effects were almost screened but the sensivity also diminished.

To test the properties of the equipment, the above experiments were performed, applying Co^{60} in different areas and activities to the strips. Results are shown in Table 1 and Fig. 3, which indicate the good reproducibility and quantitative measuring properties of the apparatus, independant of the final areas of the spots.

b) *Separation efficiency.* The apparatus was used to trace the spallation products of copper [6]. The separations, obtained, and the well defined peaks are illustrated in Figs. 4—5. The Fe-activity is very weak and unregistered in the ratemeter range employed.

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