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A MULTIPLE CONE SPLITTER FOR RAPID SAMPLING IN THE LABORATORY*

By

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A MULTIPLE CONE SPLITTER FOR RAPID SAMPLING IN THE LABORATORY

By Richard Kellagher

ABSTRACT

The multiple cone sample splitter, constructed of three powder funnels and three brass cones mounted alternately in a vertical column over a tray containing small sector-shaped sample retainers, obtains representative sample fractions of 5 to 50 percent in one operation. The use of this type of sample splitter reduces the time consumed in more conventional methods of sample splitting by about 75 to 80 percent.

INTRODUCTION

In connection with studies of monazite sands, large numbers of samples have been submitted for grain-count analysis. These samples were received as panned concentrates ranging in weight from 10 g to 500 g and consisting of unsized mixtures of heavy minerals.

The amount of sample desired for microscopic analysis was 300 to 500 grains. In view of the large number of samples a disproportionate amount of time was spent merely in sampling the material.

Although conventional methods of sample splitting (Otto, 1933; Taggart, 1947; Milner, 1940; Krumbein and Pettijohn, 1938) using the Jones splitter, the Microsplit, and hand-quartering gave the desired accuracy, the time consumed in these operations was prohibitive. Studies of sample splitting were made by the writer and a multiple cone splitter has been designed and constructed to obtain representative fractions of 5 percent to 50 percent.

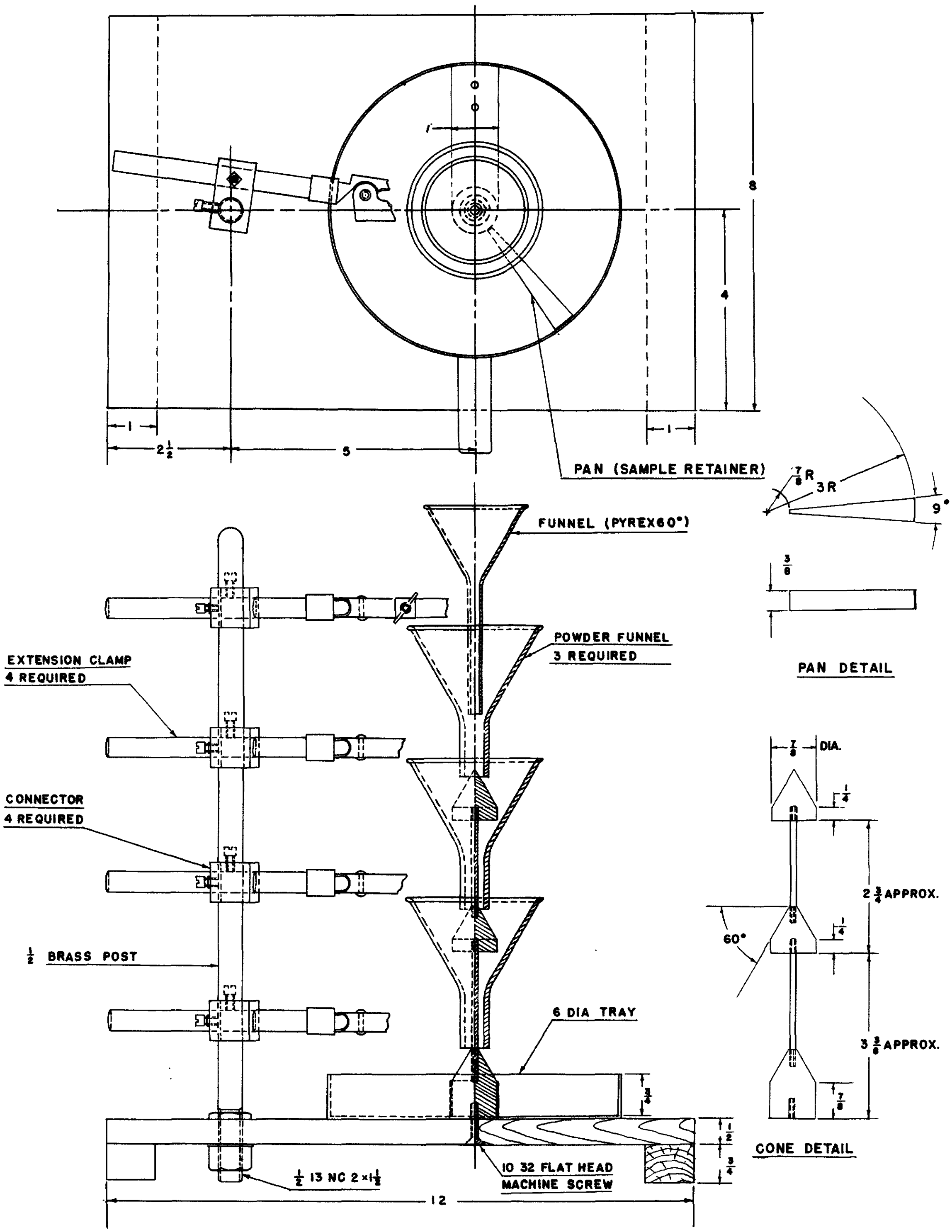
Thanks are due to Jerome Stone, Richard Marquiss, and Charles Spengler, and to others of the Geological Survey, who made grain counts and otherwise assisted in checking the accuracy of the splitter. The splitter was built in the instrument shop by Camillo Massoni. The work was done on behalf of the Division of Raw Materials of the Atomic Energy Commission.

DESCRIPTION OF THE MULTIPLE CONE SAMPLE SPLITTER

The multiple cone sample splitter consists essentially of three short stem, wide bore funnels used for powders and three brass cones mounted alternately in a vertical column with one of the cones at the base and a funnel at the top; this assembly is mounted on a wooden base, approximately 8 by 12 in.

The three cones are stationary, spaced approximately 2 to 3 in. apart, and are supported by a steel rod bolted to the base in a vertical position (fig. 1). The powder funnels are held in adjustable clamps mounted on a brass post that is also bolted to the base in a vertical position. When assembled, the narrow openings of the funnels are centered over the cones by means of the adjustable clamps. A variable space or gap can be set to accomodate the sample by raising or lowering the funnels. Below the basal cone and surrounding it is a circular stainless steel tray 6 in. in diameter with a wall height of 3/4 in. The tray consists of a removable section and a section fixed to the wooden base with screws, limiting the tray to one position. The split tray permits rapid removal of the sample and facilitates cleaning.

Figure 1. MULTIPLE CONE SAMPLE SPLITTER



At the top of the sample splitter is a small funnel to direct the stream of mineral grains to the apex of the uppermost cone.

Small sector-shaped pans are used as sample retainers. They have walls 3/8 in. high and are made to include an arc of 9 degrees or approximately 2 1/2 percent of the area of the circular tray. One or more of these pans may be used depending on the amount of the initial sample and the amount of the sample needed for analysis. When a sample is to be split the retainers are placed in the tray like spokes in a wheel and should be equally spaced to assure representative sampling.

OPERATION

The sample splitter should be in a level position with all funnels centered over their respective cones before a sample splitting operation is begun. A trial run may be made to check the distribution of the sample in the tray. If the distribution is uneven, an adjustment of the funnel should be made. With care the sample splitter will remain in operating condition indefinitely.

The sample to be split is poured into the small funnel at the top of the column and flows to the apex of the first cone where it is thrown to the walls of the next funnel and then flows to the next cone. This is repeated at the next funnel and basal cone. The sample retainers in the circular tray capture a representative portion. The amount of sample retained can be varied by the addition or removal of sample retainers. Adjustment of the gap between each funnel and cone can be made to accommodate different size fractions. The gap between the basal cone and funnel controls the spread of the sample in the tray.

Owing to its simple design and ease of operation this sample splitter performs the task in a fraction of the time used in other methods and maintains the required accuracy.

The apparatus is easily cleaned by removing and emptying the tray and sample retainers and sweeping the tray, funnels, and cones with a soft brush.

ACCURACY

The area of each pan is approximately 2.5 percent of the entire collection area hence 2.5 percent of the sample. In actual use, however, the amount retained by each of 3 pans placed 120° apart is approximately 5 percent of the sample. This is due to the apparent increase in pan area caused by the height of the pan sides which enables each pan to capture grains in trajectories that would normally fall outside the base boundaries of the pan.

Experiments using 5 pans adjacent to each other show that the center pan will capture close to the theoretical amount (2.5 percent), whereas the outer pans capture 25 to 30 percent more (table 1).

A series of tests had been made to determine the accuracy of the splitting operation. These tests were concerned with the distribution of the sample in the tray after pouring and, more important, with the reproducibility of amount and kind of initial sample mixed in the sample retainer.

Sample distribution was studied by pouring a measured amount into the splitter and measuring and comparing the amounts captured by the sample retainers placed at various positions in the tray. The results of this experiment (table 2) show that with the sample

Table 1.--Results of tests of multiple cone splitter using five adjacent pans. Sample: quartz, 5 g; magnetite, 5 g. Results on pans 1, 3, and 5.

Sampling sequence	Pan no.	Magnetite retained (g)	Quartz retained (g)	Average (g)
Magnetite first and then quartz	1	0.167	0.151	0.159
	3	0.143	0.119	0.131
	5	0.176	0.145	0.160
Quartz first and then magnetite	1	0.157	0.150	0.154
	3	0.129	0.119	0.124
	5	0.157	0.145	0.151
Mixed (magnetite and quartz)	1	0.154	0.152	0.153
	3	0.120	0.121	0.120
	5	0.154	0.156	0.155

Table 2.--Results of tests of multiple cone splitter with the pans placed 120° apart and rotated 120° for each run. The sample consisted of equal volumes of quartz and magnetite.

Run no.	1 Retained (g)	2 Retained (g)	3 Retained (g)	4 Retained (g)	5 Retained (g)	6 Retained (g)	Average (g)
Pan no.							
1	0.965	0.961	0.893	0.897	0.876	0.895	0.881
2	0.850	0.868	0.881	0.884	0.907	0.930	0.887
3	1.065	1.008	1.100	1.132	1.080	1.053	1.07

adjustments described this sample splitter will give even distribution in the tray.

Two tests were made with mixtures of 50 percent magnetite and 50 percent quartz by weight to determine the distribution of the sample, the capacity of the sample retainers, and the effect of segregation in the initial sample on the resulting split. The results of these tests are shown in tables 1 and 3.

Finally a number of trials were made of the actual operating performance of the splitter. Five samples of known composition varying in weight from 2 g to 7 g were prepared from measured weights of ilmenite, quartz, monazite, zircon, and garnet. Two splits from each sample were obtained and grain counts were made on each by two mineralogists A and B and in some cases by a third (C). The results of these trials are shown in table 4.

SUMMARY

The sample splitter has served its purpose in that it has reduced the amount of time needed for sampling and that the results obtained have been within the required limit of accuracy.

The material used was uniform in size and this may have contributed to these satisfactory results. The factors governing the operation of a cone type sample splitter are grain size, grain shape, and specific gravity. The tests made thus far have been limited to well-sized material and do not give the operational limits of the splitter.

Further experiments are planned to take into consideration these factors and to determine the operational limits of the splitter.

Table 3.--Results of tests of multiple cone splitter using 10 g quartz and 10 g magnetite with 3 pans 120° apart.

Sampling sequence	Pan no.	Magnetite retained (g)	Quartz retained (g)	Average (g)
Magnetite first and then quartz	1	0.295	0.280	0.288
	2	0.322	0.303	0.312
	3	0.341	0.325	0.333
Quartz first and then magnetite	1	0.285	0.315	0.300
	2	0.274	0.284	0.279
	3	0.345	0.349	0.347
Mixed (magnetite and quartz)	1	0.302	0.294	0.298
	2	0.284	0.286	0.285
	3	0.333	0.342	0.338

Table 4.--Results of grain counts of five samples prepared with the multiple cone splitter

Sample no. and weight (g)	1 7.003							2 1.912							3 3.709							4 2.388							5 6.322						
	Split 1			Split 2			Actual	Split 1			Split 2			Actual	Split 1			Split 2			Actual	Split 1			Split 2			Actual	Split 1			Split 2			Actual
Mineral	A	B	C	A	B	C		A	B	C	A	B	C		A	B	C	A	B	C		A	B	C	A	B	C		A	B	C	A	B	C	
Ilmenite	43	44	42	36	37	40	44	40	40	41	40	42	40	37	28	29	30	31	30		32	64	73	74	64	73		64	28	33	38	30	32	39	34
Quartz	54	53	55	61	60	57	54	54	55	55	51	50	53	52	58	53	54	59	56		52	27	23	22	28	24		32	58	50	55	62	56	58	59
Monazite								1	1	1	4	3	2	4	6	8	8	8	7		8	9	4	4	8	2		4	13	17	7	13	10	3	7
Zircon								3	2	2	1	2	2	4	5	7	4	1	2		4														
Garnet	3	2	3	3	3	3	2	2	1	1	4	3	2	3	3	3	4	1	1		4														

REFERENCES

Krumbein, W. C., and Pettijohn, F. J., 1938, Manual of sedimentary petrography, New York, Appleton-Century-Crofts, Inc.

Milner, H. B., 1940, Sedimentary petrography, 3d ed., London, Thomas Murby and Co.

Otto, G. H., 1933, Comparative tests of several methods of sampling heavy mineral concentrates: Jour. Sedimentary Petrology, vol. 3, pp. 30-39.

Taggart, A. F., 1947, Handbook of mineral dressing, New York, John Wiley and Sons.