

[54] **SUSPENSION SAMPLING**

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73/421.5 R

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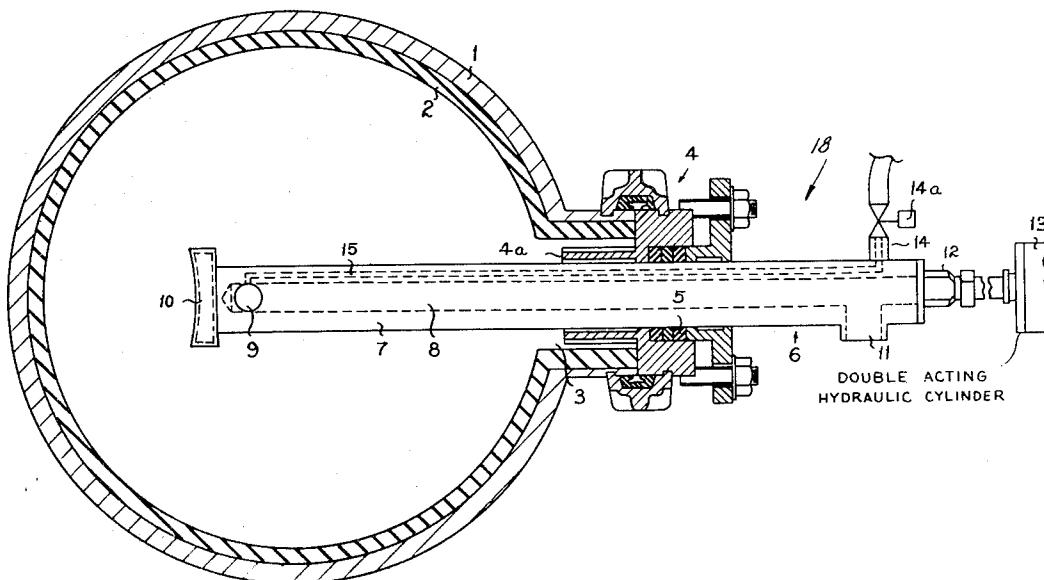
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[57] **ABSTRACT**

A suspension sampling device designed for taking, at regularly timed intervals, samples of ore pulp slurries having abrasive characteristics, as they are passed through a pipeline; the device being provided with means for inserting a sampling tube into the pipe for removal of a representative portion of the flowing pulp stream, and when necessary, means for removing from the sampling tube all portions of the sample taken which may adhere to, or tend to remain within, the sampling tube after its withdrawal from the pipeline.

3 Claims, 4 Drawing Figures



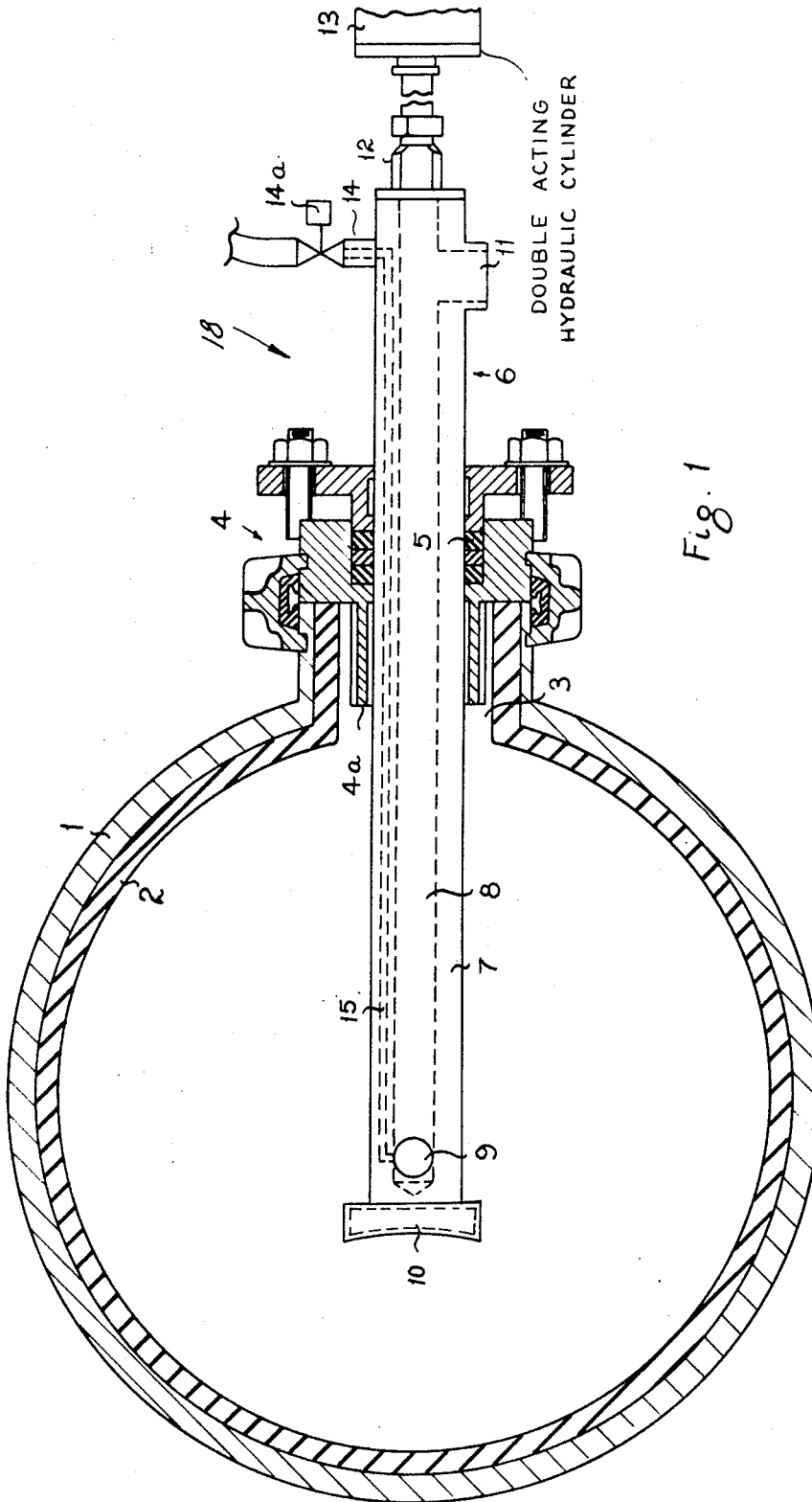


Fig. 1

Fig. 3

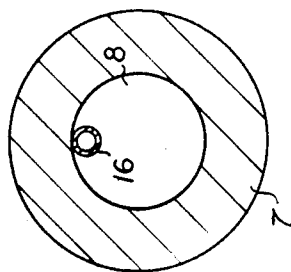
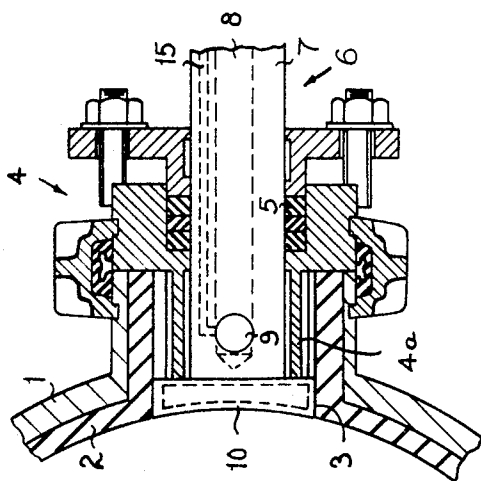
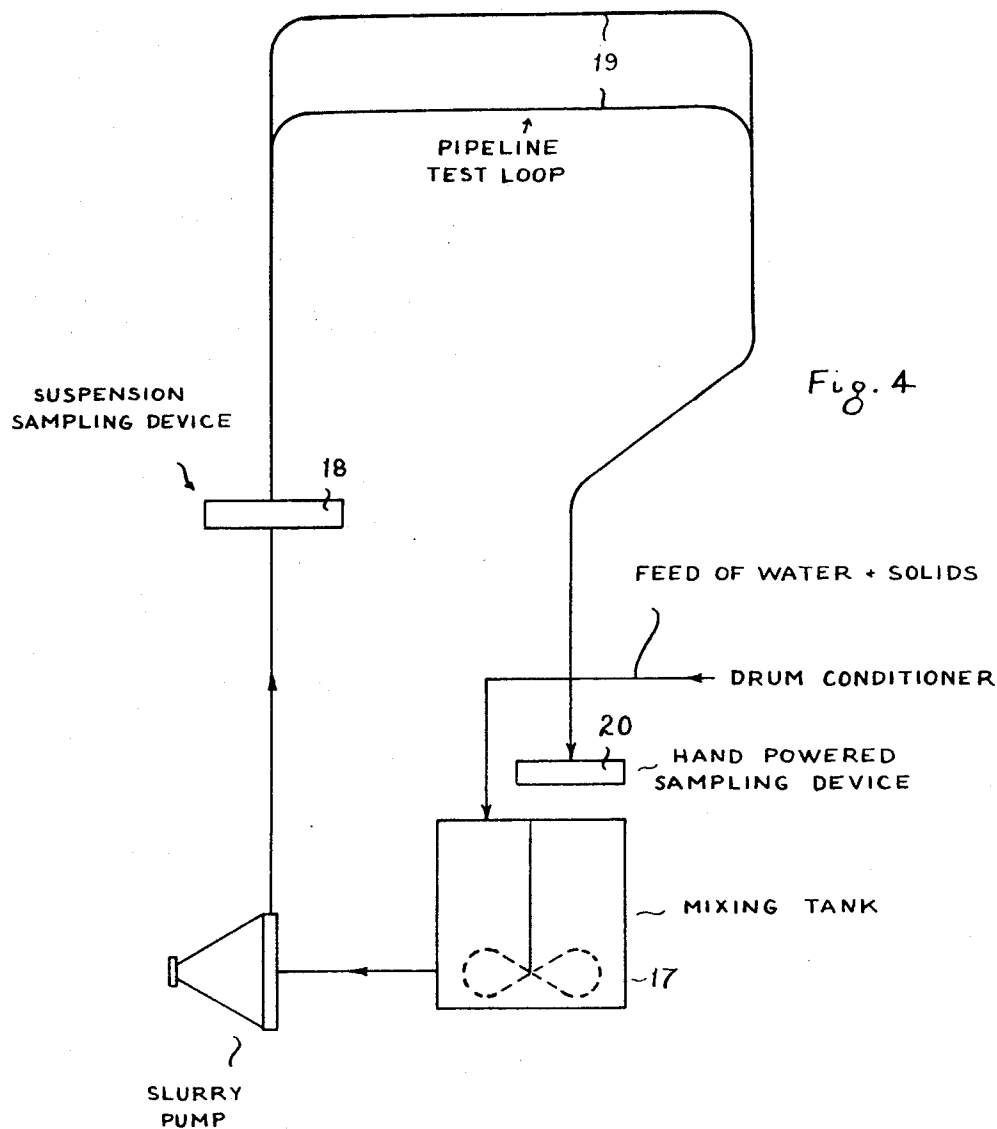


Fig. 2





SUSPENSION SAMPLING

The present invention relates to a suspension sampling device used for taking, at regularly timed intervals or at any desired intervals samples of ore pulp slurries having abrasive characteristics, as they are flowing through a pipeline. The device also is designed to obtain said samples at any desired point along the path of the pipeline which may be horizontal, vertical, or at any desired slope. The sampling device is mounted perpendicular to the pipeline at the point of sampling and in a position so as to permit discharge of the sample taken by means of gravity flow from the sampling tube.

The present invention may be used for sampling all kinds of flowable materials such as solids suspended in liquids at all flowable consistencies. It is particularly useful in sampling all types of ore pulp slurries which are generally known to have abrasive characteristics, such as iron ore pulp slurries, and similar materials, which have been ground in grinding mills with water as the carrier, and which are transported by means of pipelines from one point to another in orthodox beneficiation processing plants. Under these conditions it is often desirable or necessary to sample the flow of the pulpstream to determine the chemical and/or physical characteristics of the ore pulp in order to know the values of said characteristics so that necessary alterations may be made at any preceeding point in the processing flowsheet to avoid undesirable characteristics in the ore pulp at any point further along in the processing flowsheet. This practice of sampling of ore pulps in any ore beneficiation plant is well known to those who practice the art of mineral dressing of ores.

In the past, various devices have been used to take or to cut such samples. For example, hand sample cutters, or, mechanically operated sample cutters, have been used. Such devices are well known in the field of mineral processing. Typical of those in use throughout the field of mineral processing are those illustrated in Taggart's "Handbook of Mineral Dressing," published by John Wiley & Sons, Inc., ninth printing, 1966 in Chapter 19, pages 32 (FIG. 7) and 46-47 (FIGS. 37 and 39). One factor common to the design of all such sample cutters is that they must be used at the point of discharge of the pulpstream, that is, at a point where the transporting pipeline discharges into a sump, or similar open container or at a sample jump in a launder. The design of such sample cutters necessitates the cutting path of the sample cutter be in a more or less horizontal plane. Very often this is a distinct disadvantage since the point of sampling may be too far downstream to permit adjustments in the flowsheet variables that are required to maintain proper chemical and/or physical characteristics of the flowing pulp. Also, the point of sampling may be at such a remote point in distance that much time and expense is involved in obtaining the requisite sample. Large volumes of pulp are difficult, if not impossible, to sample at the point of discharge from a launder or pipeline.

Use of the aforementioned hand sample cutters has been largely replaced, during recent years, by use of the mechanical sample cutters. This factor has eliminated the high expense of labor used in hand sampling. Equally important, the use of mechanical sample cutters has eliminated the element of human error, inherent in most hand sample cutting procedures. Nevertheless, hand sample cutting is often used for special pur-

poses such as in research and development programs, or, to obtain especially desired, but infrequently obtained, samples. In such cases, hand sample cutters are preferably used over mechanical sample cutters merely to decrease the relatively high cost of installing the mechanically operated units. The process of hand sample cutting, although inherently involving a high element of human error, can be a quite accurate method of sampling; usually, however, the process must be performed by a qualified, technically trained engineer or a well trained, highly skilled technician. Therefore, hand sample cutting, if properly and accurately performed, still requires a high cost of labor.

According to the present invention, the suspension sampling device may be used at any desired point along the path of travel of the pipeline and in any diameter of pipe. Provision has been made for means to flush from the sampling tube, said means in the preferred concept being water or the carrying vehicle, any material of the obtained sample that may remain in the sampling tube such as by adherence to the walls of said tube, or, if the tube is in a relatively horizontal position, that portion of the sample that may have a tendency to settle on the bottom inside wall of the tube. The flushing means also prevent the gradual buildup of solids on the inside walls of the sampling tube. The latter effect is often present on samplers of known types, as aforementioned, when used to sample streams of ore flotation pulps having relatively high alkalinity values wherein the use of hydrated lime for the purpose of pH control causes precipitation from certain waters of carbonate salts of alkaline earth metals. This phenomena is known to those who practice the art as lime scaling of pipelines. The scale can often entrap mineral values during deposition and cause inaccuracies of sampling.

The invention will now be described with particular reference to the accompanying drawings in which similar elements are indicated by the same reference numerals:

FIG. 1 is a cross-sectional view of the suspension sampling device when the sampling tube is in an extended position while taking a sample from a pipeline,

FIG. 2 is a cross-section of a portion of the device shown in FIG. 1 but with the sampling tube withdrawn from the pipe,

FIG. 3 shows a cross-section of the sampling tube showing a modification of the means for flushing the tube clean after withdrawal of the tube from the pipe,

FIG. 4 shows a schematic arrangement of a test circuit in which the suspension sampling device of the present invention was compared to a hand powered sampling device.

In FIG. 1 the pipeline 1, conveys the main flow of slurry. The pipe 1 may be provided with a lining 2 to prevent erosion and wear from the abrasive slurry carried therein. The pipe 1 is also provided at the desired point with an opening 3, in which the suspension sampling device 18 is affixed by conventional means indicated at 4. Such means include conventional packing gland 5 to form a seal with the sampling tube 6 to permit its insertion into the pipe 1 and withdrawal or retraction therefrom without leakage. The means 4 are provided with an annular flange 4a extending axially of the sampling tube to act as a stop as will be described more fully hereinafter.

The sampling tube indicated generally at 6 comprises a longitudinal, cylindrical tube 7 having a central axial

bore 8 which extends from the outer end of the tube to a point short of the inner end. At the inner end of the bore 8 there is provided a transverse port 9 for permitting the slurry to enter the axial bore 8 when the sampling tube 6 is extended into the pipe 1. At the end of the tube 7 there is provided a cap-like member 10 of resilient, abrasion resistant material, such as rubber, which has a concave outer surface as seen in FIG. 1, whereby when the tube 7 is in its retracted position as seen in FIG. 2, will form a substantially flush surface with the inside of the pipe 1 to eliminate eddies and turbulence in the slurry passing therethrough. Also as will be seen in FIG. 2 the cap-like member 10 presses against the end of the flange 4a to assist in effecting a seal therewith, thus serving to seal off the transverse inlet port 9, when the tube is retracted. The cap-like member 10 is also designed to fit uniformly into the opening 3 to also assist in sealing off the sampler tube 7 from the pipeline 1.

At the outer end of the tube 7 there is provided an outlet port 11 from which the collected sample is withdrawn from the sampling device. The outermost end of the bore 8 is plugged by a capping as shown at 12. A double acting hydraulic or pneumatic cylinder 13, of any conventional type, is connected to the outer end of the sample tube 7 as shown in part in FIG. 1 and when actuated will move the tube into the pipe and subsequently will withdraw it, so that the sample taken in at port 9 may be collected upon leaving the outlet port 11.

The cylinder 13 can be actuated by any suitable means including, for example, any conventional type of timing mechanism, whereby any desired type or interval of periodic or timed sampling can be provided.

As mentioned above means for flushing out the bore 8 are provided. These means include a liquid inlet 14 and a supplemental duct or channel 15 provided in the wall of the tube 7 to supply the flushing liquid, such as water, to the inner end of the tube to enter the bore 8 adjacent the inlet port 9. Means of a conventional type, as shown schematically at 14a are provided for regulating the quantity of and the timing of the flow of the flushing liquid so that the liquid will flush out the bore 8 after the sampler tube 7 has been withdrawn from the pipe 1 as shown in FIG. 2.

It will be understood that the double acting hydraulic cylinder 13 selected for actuating the sampler tube may be one which will introduce the tube just half way into the pipe 1 or may be one which will introduce the tube to extend completely across the pipe 1, or any intermediate distance as shown in FIG. 1.

In place of the channel 15, if desired, a supplemental tube 16 for conducting the flushing liquid to the inner end of the bore 8 may be provided as shown in FIG. 3.

In typical ore beneficiation plants, pulpstreams are sampled to provide measures for process control purposes. Such plants generally operate on a continuous around-the-clock bases. Tremendous tonnages and volumes of pulp are processed on a daily basis, throughout each year to provide the nation's requirements of metals. Each beneficiation plant develops its own flowsheet which is unique according to the characteristics of the ore and its mineral values. To provide the measures required for processing controls throughout the flowsheet being used for any particular or individual ore being treated, samples are taken to determine such factors as: chemical analyses, screen analyses, distribution of metal values by size (screen analyses by assay

of fractions), specific gravity of pulp slurries (pulp densities, percentage of solids, or liquid to solids ratios), alkalinities, acidities, turbidities, flow tonnage determinations, material balances, metallurgical controls, and for a variety of other purposes.

In the beneficiation of ores and minerals during recent years, the practice known as "on-stream analysis" has come into being. In this practice, ordinary mechanical samplers are usually used to individually sample several flowing streams of ore/mineral pulps. Each of these samples, as taken, may individually flow by gravity, or be pumped to a common x-ray fluorescence spectrograph for chemical analysis (assay) of from one to as many as several elements. Such assay results, with other normal metallurgical information such as weigh scale tonnages, may be fed to a computer. The computer is capable of producing accurate metallurgical balances and these balances, obtained periodically, may be used to correct improper operating conditions. In essence, this practice provides means for accurate, efficient metallurgical control of a mineral processing flowsheet. Surprisingly, the major costs for such installations are not due as much to the relatively high cost for spectrographic equipment as they are to the sampling systems that are used. The cost of a sampling system can easily amount to four times that of the spectrographic system.

The high cost of sampling systems is largely due to the fact that individual mechanical type sampling units must be installed at the discharge end of ore/pulp pipelines, that is, at points where the pipeline discharges into pump sumps or the like.

A considerable economic advantage may be obtained in the use of the suspension sampling device of this invention over various mechanical sampler designs for two essential reasons. One is that the sampler of this invention can be installed at any point in the path of the transporting pipeline. A second reason is that the sampler of this invention can be installed for about one-half of the cost of the various mechanical sampler designs known to those who practice the art.

The suspension sampling device of the present invention was tested for accuracy, repeatability and representivity of sampling as compared to an ideally installed hand powered sampling device. The tests were conducted under the strictest of practical engineering controls. The work was performed at the Pickands Mather & Co. Research Laboratories, Hibbing, Minnesota. The flow circuit used was a pipeline test loop as depicted in FIG. 4. In this flowsheet, finely ground mineral concentrates and water were introduced from a drum conditioner into a mixing tank 17. The latter discharged by means of a slurry pump into a 6 inch diameter pipeline loop, element 19. Suspension sampling device 18 was installed in the pipeline at the point illustrated. About one minute was required for the pulp to be pumped the length of the pipeline where it was discharged back into the mixing tank 17. At the point where the pulp discharged from the pipeline loop 19 into the mixing tank 17, a hand powered sampling device 20 was installed for test comparison purposes. It should be noted that all operating factors were under highly technical controlled, nearly automatic, conditions.

Three separate and individual tests were performed in the following manner:

Test 1:

Comparative data were obtained to weigh results obtained with the suspension sampling device of the present invention cutting one-half the distance of the pipeline diameter against results obtained with the hand powered sampler cutting the full diameter of the pipe discharge.

Test 2:

A similar comparative test weighed the results with both samplers cutting one-half of the pipeline diameter.

Test 3:

A similar comparative test weighed the results with both samplers cutting the full diameter of the pipeline.

Statistical analyses of the comparative test results obtained from the three tests showed the following results. It is to be noted in Tables 4 and 5 of each of Tests 1, 2 and 3 that "SS" designates the sample obtained by the suspension sampling device of the present invention and that "HS" designates the sample obtained by the hand powered sampling device.

TEST 1 - TABLE 1

Evaluation of Suspension Sampling Device

Statistical Comparison of Suspension Sampler (Sampling 1/2 Pipe) to Hand Sampler (Sampling Total Pipe)

% Fe Assay of Screen Fractions

Mesh	Hand Sampler $\bar{X}$	S	Suspension Sampler $\bar{X}$	S	Comparison σ	t	Student's t	Significant Difference ?
+100	41.87	1.38	43.06	1.18	1.44	1.31	3.18	No
+150	57.95	0.69	57.74	0.69	0.77	0.43	3.18	No
+200	62.98	1.33	62.56	0.30	1.07	0.62	3.18	No
+325	66.25	0.45	66.47	0.31	0.43	0.81	3.18	No
+500	68.39	0.21	68.71	0.14	0.29	1.76	3.18	No
-500	69.89	0.16	69.92	0.07	0.14	0.33	3.18	No
Total	68.28	0.07	68.26	0.09	0.09	0.36	3.18	No
% SiO ₂	4.22	0.08	4.17	0.09	0.10	0.83	3.18	No

Where:

$\bar{X}$ = Average

S = Standard Deviation of Particular Method

σ = Standard Deviation of Methods Combined

Student's t = Standard value used to test for significance. This t value was taken from tables for a one-sided t test at the 95% confidence level. When Student's t is greater than the t value calculated based on the difference of the mean values, that difference is not significant; and vice-versa.

TEST 1 - TABLE 2

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler (Sampling 1/2 Pipe)
to Hand Sampler (Sampling Total Pipe)

% Wt of Screen Fractions

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's t	Significant Difference ?
	$\bar{X}$	S	$\bar{X}$	S	σ	t		
+48	0.18	0.045	0.22	0.130	0.109	0.58	3.18	No
+65	0.26	0.055	0.16	0.055	0.061	2.58	3.18	No
+100	0.78	0.084	0.60	0.158	0.141	2.01	3.18	No
+150	1.74	0.152	1.70	0.173	0.182	0.35	3.18	No
+200	3.74	0.134	3.48	0.311	0.268	1.52	3.18	No
+325	9.52	0.409	10.20	1.447	1.189	0.90	3.18	No
+500	25.92	0.661	25.50	1.437	1.250	0.53	3.18	No
-500	57.54	0.627	58.14	0.847	0.833	1.14	3.18	No

TEST 1 - TABLE 3

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler (Sampling 1/2 Pipe)
to Hand Sampler (Sampling Total Pipe)

% Fe Distribution

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's t	Significant Difference ?
	$\bar{X}$	S	$\bar{X}$	S	σ	t		
+100	0.74	0.08	0.62	0.19	0.16	1.16	3.18	No
+150	1.48	0.12	1.42	0.12	0.13	0.71	3.18	No
+200	3.42	0.13	3.18	0.28	0.24	1.55	3.18	No
+325	9.24	0.40	9.90	1.24	1.02	1.01	3.18	No
+500	26.14	0.38	25.56	1.29	1.06	0.86	3.18	No
-500	58.98	0.65	59.32	0.69	0.75	0.72	3.18	No

TEST 2 - TABLE 1

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to Hand
Sampler (Both Sampling Through 1/2 Pipe Diameter)

% Fe Assay of Screen Fractions

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's	Significant
	$\bar{X}$	S	$\bar{X}$	S	σ	t	t	Difference ?
+150	23.82	0.89	23.20	0.35	0.76	1.30	3.18	No
+200	20.17	0.25	20.29	0.30	0.31	0.61	3.18	No
+325	24.73	2.73	23.28	1.59	2.50	0.92	3.18	No
+500	45.78	2.81	50.93	2.14	2.79	2.92	3.18	No
-500	66.70	0.26	66.65	0.53	0.47	0.17	3.18	No
Total	55.00	0.39	54.71	0.53	0.52	0.88	3.18	No
% SiO ₂	19.67	0.84	19.16	0.43	0.75	1.08	3.18	No
% Solids	47.29	0.40	47.05	0.05	0.32	1.19	3.18	No

TEST 2 - TABLE 2

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to Hand
Sampler (Both Sampling Through 1/2 Pipe Diameter)

% Wt of Screen Fractions

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's	Significant
	$\bar{X}$	S	$\bar{X}$	S	σ	t	t	Difference ?
+48	0.10	0.000	0.10	0.000	0.00	0.00	3.18	No
+65	0.10	0.000	0.10	0.000	0.00	0.00	3.18	No
+100	0.12	0.045	0.10	0.000	0.35	0.89	3.18	No
+150	0.60	0.141	0.62	0.164	0.17	0.18	3.18	No
+200	2.74	0.152	2.74	0.055	0.13	0.00	3.18	No
+325	12.24	0.279	12.34	0.195	0.27	0.59	3.18	No
+500	29.12	0.618	28.96	0.404	0.58	0.43	3.18	No
-500	54.98	0.952	55.04	0.434	0.83	0.11	3.18	No

TEST 2 - TABLE 3

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to
Hand Sampler (Both Sampling 1/2 Pipe)

% Fe Distribution

Mesh	Hand Sampler $\bar{X}$	S	Suspension Sampler $\bar{X}$	S	Comparison σ	t	Student's t	Significant Difference ?
+150	0.42	0.07	0.38	0.10	0.10	0.66	3.18	No
+200	1.04	0.08	1.00	0.00	0.06	1.00	3.18	No
+325	5.62	0.66	5.22	0.35	0.59	1.07	3.18	No
+500	24.78	1.01	26.78	0.83	1.03	3.06	3.18	No
-500	68.14	1.25	66.62	0.72	1.14	2.11	3.18	No

TEST 3 - TABLE 1

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to Hand Sampler
(Both Sampling Through Total Pipe Diameter)

% Fe Assay Screen Fractions

Mesh	Hand Sampler $\bar{X}$	S	Suspension Sampler $\bar{X}$	S	Comparison σ	t	Student's t	Significant Difference ?
+150	23.79	1.05	23.29	1.60	1.51	0.52	3.18	No
+200	21.27	1.29	21.16	0.30	1.05	0.17	3.18	No
+325	25.50	1.04	24.73	1.52	1.46	0.84	3.18	No
+500	50.62	2.01	53.11	2.44	2.50	1.58	3.18	No
-500	66.45	0.29	66.68	0.32	0.34	1.07	3.18	No
Total	55.07	0.09	55.24	0.07	0.09	2.98	3.18	No
% SiO ₂	19.32	0.32	19.45	0.61	0.54	0.38	3.18	No
% Solids	47.97	0.07	47.80	0.05	0.07	3.95	3.18	Yes

TEST 3 - TABLE 2

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to Hand Sampler
(Both Sampling Through Total Pipe Diameter)

% Wt of Screen Fractions

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's	Significant
	$\bar{X}$	S	$\bar{X}$	S	σ	t	t	Difference ?
+100	0.10	0.000	0.10	0.000	0.00	0.00	3.18	No
+150	0.62	0.045	0.66	0.134	0.07	0.57	3.18	No
+200	2.72	0.045	2.72	0.045	0.05	0.00	3.18	No
+325	11.96	0.134	11.88	0.130	0.15	0.86	3.18	No
+500	29.70	0.992	30.00	0.875	1.05	0.45	3.18	No
-500	54.90	0.889	54.56	0.770	0.93	0.58	3.18	No

TEST 3 - TABLE 3

Evaluation of Suspension Sampler

Statistical Comparison of Suspension Sampler to
Hand Sampler (Both Sampling Total Pipe)

% Fe Distribution

Mesh	Hand Sampler		Suspension Sampler		Comparison		Student's	Significant
	$\bar{X}$	S	$\bar{X}$	S	σ	t	t	Difference ?
+150	0.30	0.00	0.36	0.10	0.08	1.20	3.18	No
+200	1.04	0.08	1.04	0.05	0.07	0.00	3.18	No
+325	5.52	0.31	5.24	0.31	0.35	1.28	3.18	No
+500	27.18	1.26	28.42	1.46	1.52	1.29	3.18	No
-500	65.96	1.01	64.94	1.08	1.17	1.38	3.18	No

As back-up information for the above statistical analyses, and for purposes of thoroughness, the raw data obtained from the sampling programs is shown in the following tables:

TEST 1 - TABLE 4

Evaluation of Suspension Sampler

Comparison of Suspension Sampler (SS - Sampling Through 1/2 Pipe Diameter)
to Hand Sampler (HS - Sampling Through Total Pipe Diameter)

Raw Data

Mesh	HS #1		SS #1		HS #2		SS #2		HS #3		SS #3	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	0.2	-	0.1	-	0.2	-	0.1	-	0.1	-	0.2	-
+65	0.3	-	0.1	-	0.2	-	0.2	-	0.3	-	0.1	-
+100	0.7	40.89	0.4	42.94	0.7	40.56	0.6	41.81	0.8	41.48	0.5	42.29
+150	1.8	57.14	1.8	57.63	1.5	57.47	1.7	57.30	1.9	57.95	1.4	57.22
+200	3.8	61.97	3.4	62.63	3.8	61.89	3.2	62.47	3.5	62.63	3.2	62.23
+325	9.9	66.00	8.3	66.83	9.0	65.68	9.1	66.50	9.6	66.18	11.8	66.02
+500	26.2	68.57	26.9	68.84	26.0	68.41	27.1	68.68	26.7	68.60	23.8	68.60
-325	83.2	-	85.9	-	84.6	-	85.1	-	83.8	-	82.8	-
-500	57.1	69.86	59.0	70.05	58.6	69.94	58.0	69.89	57.1	69.97	59.0	69.89
% Fe	68.35		68.26		68.26		68.18		68.18		68.35	
% SiO ₂	4.12		4.04		4.17		4.25		4.24		4.24	

Mesh	HS #4		SS #4		HS #5		SS #5	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	0.2	-	0.3	-	0.2	-	0.4	-
+65	0.3	-	0.2	-	0.2	-	0.2	-
+100	0.9	43.99	0.7	44.87	0.8	42.45	0.8	43.38
+150	1.8	58.92	1.8	58.92	1.7	58.27	1.8	57.63
+200	3.8	63.27	3.7	63.03	3.8	65.13	3.9	62.46
+325	9.9	66.66	10.8	66.66	9.2	66.74	11.0	66.32
+500	25.8	68.25	24.9	68.86	26.0	68.12	24.8	68.57
-325	83.1	-	82.5	-	84.1	-	81.9	-
-500	57.3	69.62	57.6	69.91	58.1	70.05	57.1	69.86
% Fe	68.35		68.35		68.26		68.18	
% SiO ₂	4.21		4.18		4.34		4.12	

TEST 2 - TABLE 4

Evaluation of Suspension Sampler

Comparison of Suspension Sampler to
Hand Sampler (Roth Sampling 1/2 Pipe)

Raw Data

Mesh	HS #11		SS #11		HS #12		SS #12		HS #13		SS #13	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	0.1		0.1		0.1		0.1		0.1		0.1	
+65	0.1		0.1		0.1		0.1		0.1		0.1	
+100	0.1		0.1		0.2		0.1		0.1		0.1	
+150	0.5	25.19	0.5	23.57	0.7	23.86	0.5	23.37	0.5	23.78	0.8	22.97
+200	2.9	20.48	2.7	20.32	2.8	20.29	2.7	20.45	2.7	20.13	2.7	20.61
+325	12.0	23.73	12.4	24.06	12.7	29.22	12.0	22.40	12.1	25.16	12.4	21.59
+500	29.5	44.37	29.0	50.39	29.9	43.83	29.4	49.18	29.2	50.64	29.1	54.62
-325	84.3		84.1		83.4		84.5		84.4		83.8	
-500	54.8	66.64	55.1	66.64	53.5	67.04	55.1	66.06	55.2	66.87	54.7	66.95
% Fe	55.21		54.57		55.37		55.53		54.41		54.57	
% SiO ₂	19.43		19.45		20.18		18.54		20.71		19.29	
% Solids	46.81		46.97		47.07		47.08		47.87		47.02	

Mesh	HS #14		SS #14		HS #15		SS #15	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	0.1		0.1		0.1		0.1	
+65	0.1		0.1		0.1		0.1	
+100	0.1		0.1		0.1		0.1	
+150	0.8	22.72	0.8	22.72	0.5	22.54	0.5	23.37
+200	2.8	20.13	2.8	20.29	2.5	19.80	2.8	19.80
+325	12.3	23.37	12.5	25.65	12.1	22.16	12.4	22.72
+500	28.5	45.77	29.0	49.83	28.5	44.31	28.3	50.64
-325	83.8		83.6		84.6		84.0	
-500	55.3	66.55	54.6	67.36	56.1	66.39	55.7	66.22
% Fe	54.81		54.81		55.21		54.09	
% SiO ₂	19.57		18.92		18.47		19.60	
% Solids	47.41		47.09		47.29		47.08	

TEST 3 - TABLE 4

Evaluation of Suspension Sampler

Comparison of Suspension Sampler to
Hand Sampler (Both Sampling Total Pipe)

Raw Data

Mesh	HS #16		SS #16		HS #17		SS #17		HS #18		SS #18	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	Tr		Tr		Tr		0.1		Tr		0.1	
+65	Tr		Tr		Tr		0.1		Tr		Tr	
+100	0.1		0.1		0.1		0.1		0.1		0.1	
+150	0.6	23.60	0.8	23.52	0.6	25.64	0.8	24.74	0.7	23.44	0.6	24.50
+200	2.7	20.35	2.7	20.67	2.7	21.49	2.7	21.81	2.8	23.44	2.8	21.49
+325	12.1	25.55	12.0	25.23	11.8	24.25	11.7	26.61	11.9	26.21	12.0	25.07
+500	28.3	49.97	29.1	52.41	30.8	53.23	29.0	50.54	29.1	51.28	30.8	51.68
-325	84.5		84.4		84.8		84.4		84.5		84.4	
-500	56.2	66.00	55.3	66.57	54.0	66.49	55.4	66.41	55.4	66.80	53.6	66.90
% Fe	55.05		55.21		55.21		55.13		55.05		55.29	
% SiO ₂	19.52		19.36		19.44		19.62		19.66		20.40	
% Solids	47.99		47.80		48.02		47.75		47.85		47.88	

Mesh	HS #19		SS #19		HS #20		SS #20	
	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe	% Wt	% Fe
+48	Tr		Tr		Tr		Tr	
+65	Tr		Tr		Tr		Tr	
+100	0.1		0.1		0.1		0.1	
+150	0.6	23.24	0.5	22.92	0.6	23.05	0.6	20.75
+200	2.7	20.64	2.7	21.29	2.7	20.45	2.7	20.53
+325	11.9	24.71	11.9	24.24	12.1	26.78	11.8	22.48
+500	30.2	50.88	30.5	54.13	30.1	47.72	30.6	56.81
-325	84.7		84.8		84.5		84.8	
-500	54.5	66.48	54.3	67.13	54.4	66.47	54.2	66.39
% Fe	55.05		55.29		54.97		55.29	
% SiO ₂	18.93		18.98		19.04		18.98	
% Solids	47.99		47.72		48.00		47.77	

[illegible]

[illegible]

From the presentation of the foregoing data, it is evident that the sampling device of this invention does, in fact, readily obtain truly representative slurry samples.

We claim:

1. A suspension sampling device for taking periodic and timed samples of a liquid slurry of abrasive material flowing through a pipe, comprising a sampling tube, means for mounting said sampling tube in the wall of the pipe to permit fluid tight movement of said tube transversely into and out of said pipe, a single mechanical means for periodically inserting said tube into said pipe at timed intervals and for withdrawing said tube therefrom, said sampling tube being provided with an axial passage from a point adjacent the inner end of said tube to a point adjacent the outer end of said tube and an inlet port at the inner end of said tube and an outlet port at the outer end thereof, both ports communicating with the axial passage, said inlet port extending transversely of the axial passage and facing toward the flow of slurry in the pipe, and cap means composed of a resilient, abrasion resistant material at the inner end of said tube for engaging said mounting means when said tube is in the withdrawn position, said cap means having an outer concave cylindrical surface to conform

with the inner cylindrical surface of the pipe, said tube being mounted perpendicular to said pipeline at the point of sampling and so positioned as to permit discharge of a sample means of gravity flow of said liquid slurry from said sampling tube whereby uniform periodic, timed samples are obtained when said tube is inserted in the pipe and substantially uniform flow within the pipe is obtained when said tube is withdrawn, said tube further comprising a duct extending parallel to the axial passage in said tube and opening into said passage at the inner end thereof and communicating at the outer end of said tube with a source of flushing liquid and means for controlling the flow of flushing liquid through said axial passage when said tube is withdrawn from the pipe so as to remove any portions of the sample of slurry which may remain in said axial passage after withdrawn of said tube from the pipe.

2. A suspension sampling device as claimed in claim 1 wherein said duct comprises a passage within the wall of said tube.

3. A suspension sampling device as claimed in claim 1 wherein the duct comprises a tube attached to the wall of said axial passage in said sampling tube.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,747,411 Dated July 24, 1973

Inventor(s) William Francis McDermott et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The title of invention "SUSPENSION SAMPLING" should read -- SUSPENSION SAMPLING DEVICE --. Column 28, line 4, after "sample" insert -- by --; line 17, "withdrawn" should read -- withdrawal --.

Signed and sealed this 26th day of March 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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