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A LABORATORY AND PILOT PLANT INVESTIGATION ON SILVER CONCENTRATE FROM COBALT REFINERY DIVISION, KAM-KOTIA MINES LIMITED, COBALT, ONTARIO

by

W. ARTHUR WALL

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

It has been demonstrated that, with a combination of grinding, screening and flotation, it is possible to produce a silver concentrate suitable for direct refining. The tests showed that a combined concentrate assaying nearly 16,000 oz Ag/ton and 3.0% cobalt with a recovery of 89% of the silver in the feed could be made. It was not possible by gravity concentration (cycloning, tabling or jigging) to produce a silver concentrate suitable for direct refining.

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* Scientific Officer, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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The smelter of Cobalt Refinery Limited which is now operating as Kam-Kotia Mines Limited, Cobalt Refinery Division, is located approximately six miles southwest of Cobalt, Ontario. The Cobalt Refinery purchases locally produced silver in the form of table and flotation concentrates and smelts these concentrates in their custom smelter to silver metal and cobalt, nickel and arsenic compounds.

Purpose of Investigation

Mr. J. N. Cram, General Manager of Cobalt Refinery Division, requested that an investigation be carried out to determine the feasibility of producing a high grade silver concentrate from the locally purchased table concentrates which would be suitable for direct silver refining. The following processes were suggested:

a) Concentration by a compound water cyclone.
b) Gravity concentration using either tables or jigs.
c) Grinding, screening and flotation.

The present method of treating table concentrates at the refinery results in the retention of silver values in the process for a considerable period of time. If the silver content of the concentrate could be raised to approximately 16,000 ounces silver per ton and the cobalt lowered to 3.0%, the silver extraction could be readily effected, without roasting and/or smelting, by direct silver refining at a considerable financial saving.

Shipments

A five hundred pound sample of table concentrate was received on July 20, 1966. This was prepared by Cobalt Refinery Division and was said to be as representative as possible of the table concentrate treated in the smelter. This shipment will be referred to as Lot A.

A three ton shipment of table concentrate was received on November 1, 1966 from Cobalt Refinery Division for a pilot plant investigation. This shipment will be referred to as Lot B.

Sampling and Analysis

The Lot A sample of table concentrate was sampled and assayed by Cobalt Refinery Division. The analysis of the head sample is shown in Table 1.

TABLE 1

Lot A Analysis

Silver	2,012 oz per ton
Cobalt	7.9%
Nickel	2.5%
Sulphur	6.0%
Arsenic	35.6%
Iron	20.3%
Silica	3.2%
Insoluble	17.1%

A duplicate head sample was screened, and the various size fractions assayed with the results shown in Table 2.

TABLE 2

Screen Analysis of Lot A

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+ 28	12.7	5,104.8	8.8	31.3	15.0
- 28+ 65	34.0	2,611.2	7.3	42.9	33.1
- 65+100	10.8	1,412.4	5.6	7.4	8.2
-100+200	22.6	983.6	6.2	10.7	18.7
-200	19.9	804.0	9.4	7.7	25.0
Total	100.0	2,071.0	7.5	100.0	100.0

The Lot B shipment of table concentrate was a composite of three lots of concentrate from Silverfields Mine and Hi Ho Mine with weights and assays as tabulated in Table 3.

TABLE 3

Weights and Assays of Lot B Shipment

Lot No.	Weight lb	Assays	
		Ag oz/ton	Co %
1	1000	2,705	8.95
2	3000	1,372	8.68
3	2000	2,430	6.50
Total	6000	1,947	8.00

A screen analysis of a duplicate head sample of this Lot B shipment is shown in Table 4.

TABLE 4

Screen Analysis

Mesh	Weight %
+ 20	3.9
- 20+ 28	11.1
- 28+ 35	12.1
- 35+ 48	10.3
- 48+ 65	10.2
- 65+100	10.7
-100+150	9.1
-150+200	13.8
-200+325	10.7
-325	8.1

RESULTS OF INVESTIGATION

The recovery of metallic silver from table concentrate as reported in Mines Branch Investigation Report IR 66-77 has been investigated further. It has been demonstrated both in the laboratory and in the pilot plant that up to 67% of the silver in the table concentrate can be recovered in a concentrate assaying between 15,000 and 22,000 ounces silver per ton by grinding and screening. It has been demonstrated further that it is possible, by flotation, to concentrate the silver in the screen undersize. The concentrate obtained by flotation assayed between 5,000 and 12,000 ounces silver per ton and contained between 21 and 51% of the silver in the original feed.

In laboratory Test 22, a combined concentrate assaying 15,937 ounces silver per ton and 2.73% cobalt was produced. This concentrate represented 11.6% of the weight and contained 89.0% of the silver in the head sample.

The metallic concentrates obtained in the five pilot plant runs assayed 22,191 ounces silver per ton and 0.82% cobalt in 4.4% of the weight of the heads and contained 51.5% of the silver in the heads. The flotation concentrate obtained from the -200 mesh material assayed 9,319 ounces silver per ton and 5.46% cobalt, in 6.9% of the weight of the heads and contained 34.0% of the silver in the heads. The combined concentrate assayed 14,327 ounces silver per ton and 3.65% cobalt in 11.3% of the weight of the heads and contained 85.5% of the total silver.

The test work carried out in an attempt to concentrate the silver in the table concentrate in a compound water cyclone did not produce satisfactory result . So little concentration of the silver was obtained that it was considered that further cyclone test work was not warranted.

Tabling produced a concentrate assaying 5,000 oz of silver per ton. This concentrate contained 34.4% of the silver (see Table 17) in the feed (Lot A). The grade of concentrate was not suitable for direct refining.

Jigging was also unsatisfactory (see Table 19).

DETAILS OF INVESTIGATION

Part A: Cyclone Concentration

Mr. Cram requested that the Compound Water Cyclone be tested to determine its effectiveness in concentrating the silver in the table concentrate.

The cyclone used in these tests was a Single Compound Water Cyclone (Type "S" cone) with a 4 inch wide vortex finder, manufactured by Cyclone Engineering Sales Ltd., Edmonton, Alberta. The cyclone was set up as illustrated in Figure 1. The cyclone was installed above the pump feed box into which both the cyclone underflow and overflow could discharge. Piping was so arranged that the pulp could be pumped either to the cyclone or to the pump feed box. By adjusting the valves in the pump discharge piping, the desired cyclone pressure was obtained.

In testing the cyclone, a pulp at the desired percent solids was prepared in the pump feed box by adding the correct weight of table concentrate and water. The pulp was pumped to the cyclone at the desired pressure. The cyclone overflow and underflow returned to the pump feed tank. After a bed had been established in the cyclone and conditions had become stabilized, simultaneous samples of the underflow and overflow were taken for exactly the same period of time. These samples were dried, weighed and sampled for analysis. A series of eight tests was made to determine the optimum operating conditions. The operating conditions and results are tabulated in Table 5.

It was considered that sized material might be more amenable to concentration in a cyclone than unsized material. Consequently, a test was carried out on material separated into plus and minus 65 mesh fractions. The screen analysis is tabulated in Table 6.

All cyclone testing was carried out on samples of Lot A Table Concentrate.

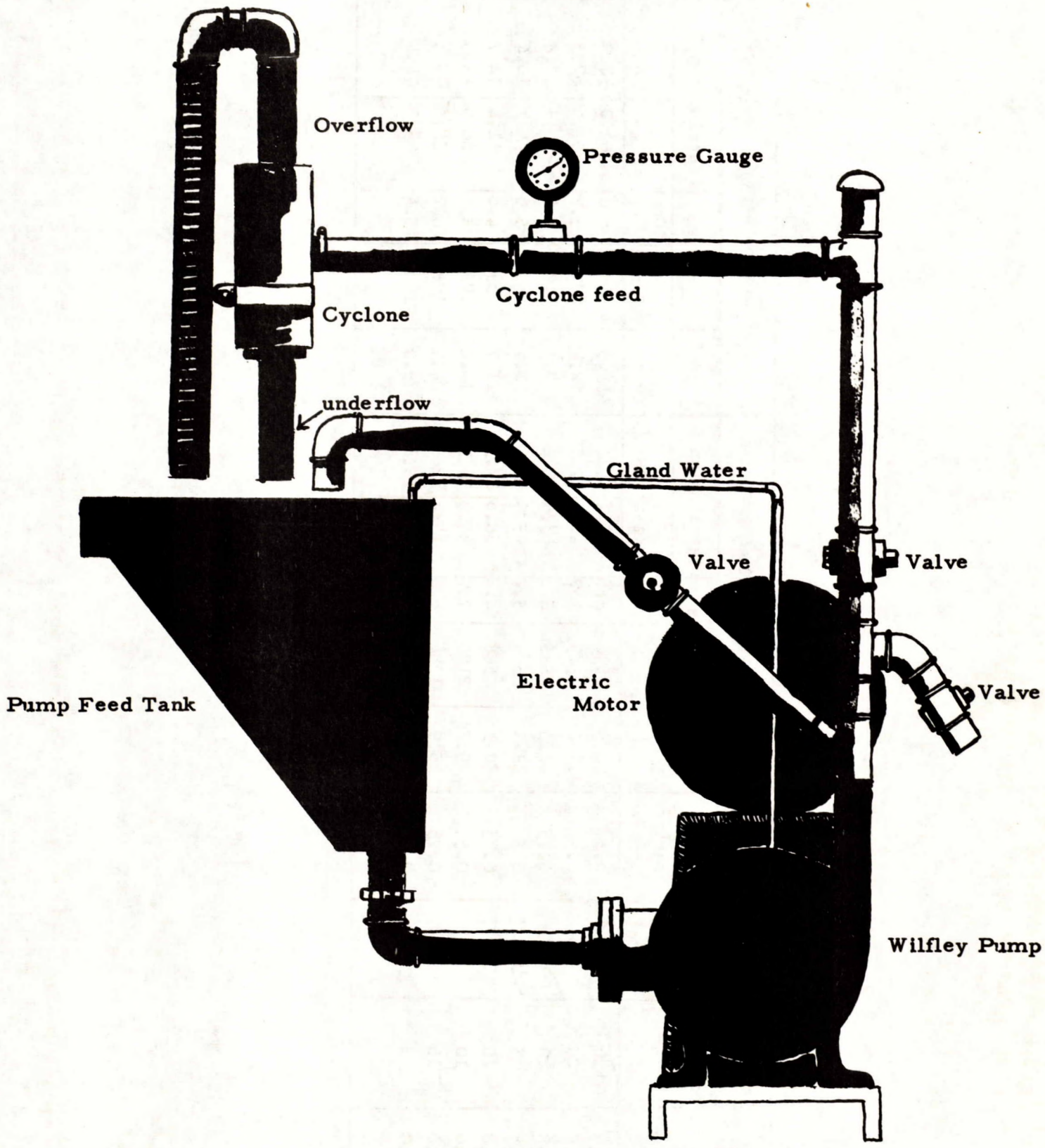

Figure 1. Cyclone Assembly

TABLE 5

Cyclone Tests Nos. 1 to 8

Test No.	Test Conditions				Underflow					Overflow				
	Solids %	Pressure psi	Vortex Finder Diameter in.	Vortex Finder Clearance in.	Weight %	Assays		Distribution %		Weight %	Assays		Distribution %	
						Ag oz/ton	Co %	Ag	Co		Ag oz/ton	Co %	Ag	Co
1	4.8	10	2	0.5	46.5	1536	8.6	39.1	65.1	53.5	2152	4.0	60.9	34.9
2	4.8	25	2	0.5	47.8	2323	3.7	42.6	37.5	52.2	2871	5.7	57.4	62.5
3	4.8	10	2	0.75	50.5	1888	8.6	63.5	51.2	49.5	1104	8.4	36.5	48.8
4	4.8	5	1.375	0.5	88.3	1688	5.7	95.9	89.6	11.7	540	5.0	4.1	10.4
5	4.8	10	1.375	0.75	88.3	548	4.2	88.6	87.3	11.7	530	4.6	11.4	12.7
6	15.0	10	2	0.5	29.8	2170	7.7	34.0	36.1	70.2	1788	5.8	66.0	63.9
7	15.0	16	2	0.75	15.9	1784	6.5	15.2	22.6	84.1	1880	4.2	84.8	77.4
8	15.0	22	2	0.5	22.0	1984	6.5	26.3	35.6	78.0	1568	5.4	73.7	74.4

TABLE 6

Screen Size of Sample of Lot A Test No. 9

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+65	55.1	1886	4.89	65.5	43.8
-65	44.9	1219	7.69	34.5	56.2
Total	100.0	1587	6.15	100.0	100.0

The two fractions were cycloned separately under the following conditions:

Per cent solids	-	15.0
Pressure lb/sq in.	-	10.0
Vortex Finder Diameter	-	2.0 inches
Vortex Finder Clearance	-	0.5 inches

The results are tabulated in Tables 7, 8 and 9.

TABLE 7

Cycloning +65 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Underflow	25.9	1,937	6.34	26.6	33.6
Overflow	74.1	1,868	4.38	73.4	76.4
+65 mesh	100.0	1,886	4.89	100.0	100.0

TABLE 8

Cycloning -65 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Underflow	26.3	1,590	8.68	34.3	29.7
Overflow	73.7	1,088	7.34	65.7	70.3
-65 mesh	100.0	1,219	7.69	100.0	100.0

TABLE 9

Combined Results Test No. 9

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Underflow	26.1	1,762	7.52	29.7	31.2
Overflow	73.9	1,479	5.86	70.3	68.8
Feed	100.0	1,553	6.29	100.0	100.0

Part B 1. Concentration by Tabling (Test No. 10)

An attempt was made to upgrade a sample of Lot A by tabling a sized product. A sample of Lot A was screened and the fractions assayed as shown in Table 10.

TABLE 10

Screen Analysis

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+ 48	38.5	3,192	8.86	64.6	42.1
+100	28.0	1,385	6.27	20.4	21.6
-100	33.5	854	8.77	15.0	36.3
Total	100.0	1,902	8.10	100.0	100.0

The +48 mesh fraction was tabled to produce a concentrate, a middling and tailing. The concentrate was tabled to produce a cleaner concentrate and a cleaner tailing. The results are shown in Table 11.

The middling product obtained in the previous test was tabled to give a cleaner concentrate and a cleaner tailing as shown in Table 12.

TABLE 11

Tabling +48 Mesh Fraction

Product	Weight %		Assays		Distribution %			
	This Test	Total	Ag oz/ton	Co %	This Test		Total	
					Ag	Co	Ag	Co
Cl conc	6.2	2.4	6,960	8.66	13.7	6.1	8.8	2.6
Cl tail	14.0	5.4	5,190	9.98	22.7	15.7	14.7	6.6
Ro conc	20.2	7.8	5,738	9.57	36.4	21.8	23.5	9.2
Midd.	64.5	24.8	3,104	10.42	62.7	75.8	40.5	31.9
Tail	15.3	5.9	196	1.36	0.9	2.4	0.6	1.0
+48 mesh	100.0	38.5	3,172	8.86	100.0	100.0	64.6	42.1

TABLE 12

Tabling of Middling Product

Product	Weight %		Assays		Distribution %			
	This Test	Total	Ag oz/ton	Co %	This Test		Total	
					Ag	Co	Ag	Co
Cl conc	18.9	7.3	4,380	9.98	25.9	21.3	16.8	9.0
Cl tail	45.6	17.5	2,575	10.62	36.8	54.5	23.7	22.9
Midd	64.5	24.8	3,104	10.42	62.7	75.8	40.5	31.9

The cleaner concentrates from the two previous tests were combined and the cleaner tailings were combined to produce the results shown in Table 13.

The -48+100 mesh fraction of the screen sizing was tabled with the results as shown in Table 14.

TABLE 13

Combined Results +48 Mesh Fraction

Product	Weight %		Assays		Distribution %			
					This Test		Total	
	This Test	Total	Ag oz/ton	Co %	Ag	Co	Ag	Co
Cl conc	25.2	9.7	5,022	9.65	39.6	27.4	25.6	11.5
Cl tail	59.5	22.9	3,190	10.45	59.5	70.3	38.4	29.5
Ro tail*	15.3	5.9	196	1.36	0.9	2.3	0.6	1.0
+48 mesh	100.0	38.5	3,192	8.86	100.0	100.0	64.6	42.0

* This term is used to indicate rougher tailing in this and subsequent Tables.

TABLE 14

Tabling -48+100 Mesh Fraction

Product	Weight %		Assays		Distribution %			
					This Test		Total	
	This Test	Total	Ag oz/ton	Co %	Ag	Co	Ag	Co
Conc	19.1	5.3	3,011	10.41	41.5	31.6	8.5	6.9
Midd	45.4	12.7	1,692	8.67	55.4	62.8	11.3	13.6
Tail	35.5	9.9	120	0.98	3.1	5.6	0.6	1.2
+100 mesh	100.0	27.9	1,385	6.27	100.0	100.0	20.4	21.7

The concentrate recovered by tabling the -48+100 mesh fraction of table concentrate was ground in a pebble mill for 10 minutes at 50% solids. The ground pulp was screened into + and -200 mesh fractions as tabulated in Table 15.

The -100 mesh fraction of the original sample was tabled with the results as shown in Table 16.

TABLE 15

Screening of Concentrate

Mesh	Weight %		Assays		Distribution %			
					This Test		Total	
	This Test	Total	Ag oz/ton	Co %	Ag	Co	Ag	Co
+200	45.3	2.4	5,596	8.98	84.3	39.1	7.1	2.7
-200	54.7	2.9	868	11.60	15.7	60.9	1.3	4.2
Conc	100.0	5.3	3,011	10.41	100.0	100.0	8.4	6.9

TABLE 16

Tabling -100 Mesh Fraction

Product	Weight %		Assays		Distribution %			
					This Test		Total	
	This Test	Total	Ag oz/ton	Co %	Ag	Co	Ag	Co
Conc	2.2	0.8	4,337	8.32	11.4	2.1	1.7	0.8
Midd	69.5	23.3	960	11.30	78.1	89.5	11.8	32.5
Tail	28.3	9.5	318	2.60	10.5	8.4	1.6	3.0
-100 mesh	100.0	33.6	854	8.77	100.0	100.0	15.1	36.3

The similar products obtained from tabling each of the three size fractions were combined as shown in Table 17. The concentrate is the sum of the cleaner concentrate shown in Table 13, the +200 mesh concentrate shown in Table 15 and the concentrate shown in Table 16. The middlings are the sum of the cleaner tail shown in Table 13, the middling shown in Table 14, the-200 mesh concentrate shown in Table 15 and the middling shown in Table 16. The tailings are the sum of the tailings shown in Tables 13, 14 and 16.

TABLE 17

Results of Combined Table Products (Test 10)

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Conc	12.9	5,090	9.45	34.4	15.0
Midd	61.8	1,931	10.46	62.8	79.8
Tail	25.3	212	1.68	2.8	5.2
Feed	100.0	1,902	8.10	100.0	100.0

Part B. 2. Concentration by Jigging

4,000 grams of the Lot A concentrate as received were treated in a Denver Mineral I-M Jig, with the following conditions.

Water flow rate	-	0.18 U.S. gals/min.
Stroke	-	1/8 inch
Bed screen	-	30 mesh
Bed	-	Steel shot
Feed rate	-	1600 grams per hour

The results of this test are shown in Table 18.

TABLE 18

Results of Jig Test No. 11

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Hutch	40.6	3,671	11.41	75.5	52.0
Bed	5.5	1,687	8.20	4.7	5.1
Tail	53.9	723	7.08	19.8	42.9
Feed	100.0	1,972	8.90	100.0	100.0

A second jig test was carried out under similar conditions on 4000 grams of Lot A concentrate which was ground in a rod mill for one hour. The jig bed consisted of 73 grams of steel shot and 110 grams of chromite ore. The results are shown in Table 19.

TABLE 19

Results of Jig Test No. 12

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Hutch	26.4	4,489	11.04	62.8	35.1
Bed	3.6	6,229	7.52	11.9	3.3
Tail	70.0	683	7.31	25.3	61.6
Feed	100.0	1,889	8.30	100.0	100.0

A third jig test was made on a sample of Lot A concentrate in a jig equipped with a means of removing concentrate from the top of the jig bed. The results are tabulated in Table 20.

TABLE 20

Results of Jig Test No. 13

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Conc	35.2	2,770	10.44	48.7	40.3
Hutch	13.7	3,488	10.74	23.9	16.2
Bed	5.5	3,109	8.95	8.6	5.4
Tail	45.6	823	7.61	18.8	38.1
Feed	100.0	2,000	9.11	100.0	100.0

Part C. Grinding, Screening and Flotation

In the previous investigation carried out on this material*, it was found that, by grinding and screening, the metallic silver was concentrated in the oversize fraction. In the following series of tests, a weighed amount of table concentrate was ground in the laboratory rod mill for the stated period of

* Mines Branch Investigation Report IR 66-77.

time. The ground pulp was screened on the designated screen and the + and - fractions were dried, weighed and assayed.

Test No. 14. (+65 Mesh)

2,000 grams of Lot A concentrate was screened on a 65 mesh screen. The +65 mesh fraction was ground in the rod mill for 30 minutes and screened on a 65 mesh screen. The +65 mesh material was dried, weighed and assayed. The -65 mesh material was screened on a 200 mesh screen. The +200 mesh fraction was ground in the rod mill for 45 minutes and screened on a 200 mesh screen. The screened fractions were dried, weighed and assayed. The results are tabulated in Table 21.

TABLE 21

Grinding and Screening at 65 Mesh

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+65	2.6	22,814	1.36	31.2	0.4
-65 +200	1.4	22,118	0.60	16.3	0.1
-200	96.0	1,041	8.90	52.5	99.5
Total	100.0	1,902	8.59	100.0	100.0

The -200 mesh fraction was pulped in a 2000 gram Denver cell and conditioned for one minute with:

Aerofloat 208	-	0.10 lb per ton
Aero Xanthate 301	-	0.10 lb per ton
Aerofloat 31	-	0.06 lb per ton

A concentrate was removed for 5 minutes. The concentrate was cleaned and recleaned. The results are tabulated in Table 22.

TABLE 22

Flotation of -200 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Cl conc	9.7	8,910	6.35	83.8	7.0
Cl tail	14.0	799	9.10	10.7	14.3
Ro tail	76.3	75	9.19	5.5	78.7
-200 mesh	100.0	789	8.77	100.0	100.0

Table 23 is a tabulation of the combined results obtained by grinding, screening and flotation of the -200 mesh fraction.

TABLE 23

Combined Results of Test No. 14

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 mesh	4.0	22,570	1.09	47.5	0.5
Cl conc	9.4	8,910	6.35	44.0	7.0
Total conc	13.4	12,988	4.78	91.5	7.5
Cl tail	13.4	799	9.10	5.6	14.2
Ro tail	73.2	75	9.19	2.9	78.3
Feed	100.0	1,902	8.59	100.0	100.0

Test No. 15

This test was a duplicate of Test No. 14 except that the pulp was screened on a 100 mesh screen instead of a 65 mesh screen and the -100+200 mesh fraction was ground for 30 minutes. Flotation of the -200 mesh fraction was carried out with the same reagents and conditions as in the previous test.

The screening test results are shown in Table 24, the flotation results in Table 25 and the combined results in Table 26.

TABLE 24

Grinding and Screening at 100 Mesh

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+100	5.3	19,783	3.00	52.6	1.9
-100+200	1.7	16,029	2.66	13.7	0.6
-200	93.0	722	8.59	33.7	97.5
Feed	100.0	1,993	8.19	100.0	100.0

TABLE 25

Flotation of -200 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Cl conc	11.1	5,459	7.00	83.7	9.0
Cl tail	17.5	447	9.92	11.0	20.3
Ro tail	71.4	52	7.91	5.3	70.7
-200 mesh	100.0	772	8.59	100.0	100.0

TABLE 26

Combined Results of Test No. 15

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 mesh	7.0	18,871	2.92	66.3	2.5
Cl conc	10.3	5,459	7.00	28.2	8.8
Cl tail	16.3	447	9.92	3.7	19.7
Ro tail	66.4	52	7.91	1.8	69.0
Feed	100.0	1,993	8.19	100.0	100.0

Test No. 16

In this test, the Lot A concentrate was ground in four stages (total time 1 hour 25 minutes). At the end of each grinding stage, the pulp was screened on a 200 mesh screen. The results are shown in Table 27.

TABLE 27

Grinding and Screening at 200 Mesh

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200	7.0	17,574	1.20	62.7	1.0
-200	93.0	789	8.77	37.3	99.0
Feed	100.0	1,969	8.24	100.0	100.0

The -200 mesh fraction was pulped in a 2000 gram Denver flotation cell and conditioned for one minute with:

Aerofloat 208	-	0.05 lb per ton,
Aero Xanthate 301	-	0.01 lb per ton,
Aerofloat 31	-	0.07 lb per ton.

A concentrate was removed for 5 minutes. The concentrate was cleaned 3 times. The flotation results are shown in Table 28 and the combined results in Table 29.

TABLE 28

Flotation of -200 Mesh

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Cl conc	9.4	6,592	6.92	78.3	7.4
Cl tail	30.8	432	8.01	16.9	28.1
Ro tail	59.8	65	9.46	4.8	64.5
-200 mesh	100.0	789	8.77	100.0	100.0

TABLE 29

Combined Results Test No. 16

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 Mesh	7.0	17,574	1.20	62.7	1.0
Cl conc	8.7	6,592	6.92	29.2	7.3
Cl tail	28.6	432	8.01	6.3	27.8
Ro tail	55.7	65	9.46	1.8	63.9
Feed	100.0	1,967	8.24	100.0	100.0

Cyclic Tests No. 17 to 21 Inclusive

A series of five flotation tests was carried out to determine the effect of cycling the silver cleaner tailing to the following rougher silver float and the cobalt cleaner tailing to the following rougher cobalt float.

2,000 grams of Lot A concentrate was ground in the rod mill for 30 minutes. The ground pulp was screened on a 200 mesh

screen. The +200 mesh fraction was ground for another 30 minutes. The ground pulp was screened on 200 mesh.

The +200 mesh fraction was dried weighed and assayed. The -200 mesh fraction was pulped in a 2000-gram Denver flotation cell and conditioned for one minute with:

Aerofloat 208	-	0.10 lb per ton,
Aerofloat 31	-	0.06 lb per ton,
Aero Xanthate 301	-	0.01 lb per ton.

A silver concentrate was removed for 4 minutes. The pulp was conditioned for one minute with:

Aero Xanthate 301	-	0.10 lb per ton,
Aerofloat 31	-	0.015 lb per ton.

A cobalt concentrate was removed for 4 minutes. Each of these concentrates was cleaned and recleaned.

A second batch of 2000 grams of Lot A concentrate was ground as outlined previously. The -200 mesh fraction was pulped in a Denver flotation cell. The silver cleaner tailing from the previous test was added to the flotation cell and the combined pulp conditioned for one minute with the same reagents as used in the previous test. After the silver concentrate was removed for 4 minutes, the cobalt cleaner tailing from the previous test was added to the flotation cell and the pulp conditioned for 1 minute with:

Aero Xanthate 301	-	0.10 lb per ton,
Aerofloat 31	-	0.015 lb per ton.

A cobalt concentrate was removed for 4 minutes. Each concentrate was cleaned and recleaned. The grinding, screening and flotation cycle was repeated 5 times. The results are tabulated in Table 30.

TABLE 30

Cyclic Test No. 17 to 21

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
No. 1 + 200 mesh	1.5	15,433	3.66	11.9	0.7
No. 2 + 200 mesh	0.7	23,508	0.60	8.9	0.1
No. 3 + 200 mesh	1.3	16,834	3.00	11.8	0.5
No. 4 + 200 mesh	2.0	12,076	4.58	12.4	1.1
No. 5 + 200 mesh	1.6	15,019	3.34	12.3	0.6
Total + 200 mesh	7.1	15,497	3.41	57.3	3.0

(cont'd on page 19)

TABLE 30 (concl'd)

Cyclic Test No. 17 to 21

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
No. 1 recl Ag conc	1.2	7,711	5.33	4.7	0.8
No. 2 recl Ag conc	1.4	10,770	5.00	8.0	0.9
No. 3 recl Ag conc	1.2	9,722	5.00	6.1	0.7
No. 4 recl Ag conc	2.4	6,088	6.00	7.5	1.7
No. 5 recl Ag conc	1.9	6,691	6.00	6.7	1.4
Total recl Ag conc	8.1	7,830	5.58	33.0	5.5
No. 1 recl Co conc	0.4	320	11.06	0.1	0.5
No. 2 recl Co conc	0.8	1,522	8.00	0.6	0.7
No. 3 recl Co conc	0.7	1,928	8.00	0.7	0.7
No. 4 recl Co conc	2.1	536	7.35	0.6	1.9
No. 5 recl Co conc	1.6	790	8.66	0.7	1.7
Total recl Co conc	5.6	914	8.14	2.7	5.5
No. 1 ro tail	10.1	48.4	8.00	0.2	9.9
No. 2 ro tail	16.6	88.8	9.00	0.8	18.2
No. 3 ro tail	15.7	101.6	8.66	0.8	16.6
No. 4 ro tail	13.3	112.4	9.34	0.8	15.1
No. 5 ro tail	15.3	95.6	8.66	0.8	16.1
Total ro tail	71.0	91.7	8.77	3.4	75.9
Recl Ag tail	0.7	2,281	8.66	0.9	0.8
Cl Ag tail	2.4	1,320	9.67	1.6	2.8
Total Ag tail	3.1	1,547	9.44	2.5	3.6
Recl Co tail	2.1	456	10.00	0.5	2.5
Cl Co tail	3.0	372	10.70	0.6	3.9
Total Co tail	5.1	406	10.41	1.1	6.4

(cont'd on page 20)

TABLE 30 (concl'd)

Cyclic Test No. 17 to 21

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Combined Results					
+200 mesh	7.1	15,497	3.41	57.3	3.0
Ag conc	8.1	7,830	5.58	33.0	5.5
Co conc	5.6	914	8.14	2.7	5.5
Ag tail	3.1	1,547	9.44	3.4	3.6
Co tail	5.1	406	10.41	2.5	6.4
Ro tail	71.0	91.7	8.77	1.1	76.0
Feed	100.0	1,925	8.20	100.0	100.0

Test No. 22

In this test, the Lot A concentrate was screened on 200 mesh. The +200 mesh fraction was dry ground in a pebble mill for 30 minutes and screened. The +200 mesh fraction was ground for 15 minutes and screened. The results are shown in Table 31.

TABLE 31

Screening on 200 Mesh

Mesh	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 Mesh	7.0	20,198	2.10	67.9	1.8
-200 Mesh	93.0	714	8.77	32.1	98.2
Feed	100.0	2,068	8.31	100.0	100.0

The -200 mesh fraction was pulped in a 1000 gram Denver flotation cell and conditioned for one minute with:

Aerofloat 208 - 0.10 lb per ton,
Aero Xanthate 301 - 0.01 lb per ton,
Aerofloat 31 - 0.06 lb per ton.

A concentrate was removed for 5 minutes. The concentrate was cleaned 4 times. The results are tabulated in Table 32.

TABLE 32

Flotation of -200 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Cl Ag conc	5.0	9,499	3.68	65.7	2.1
No. 1 cl tail	11.3	490	8.94	7.8	11.5
No. 2 cl tail	3.0	1,059	8.42	4.4	2.9
No. 3 cl tail	2.5	1,532	7.36	5.3	2.1
No. 4 cl tail	2.0	3,111	6.31	8.7	1.5
Ro tail	76.2	72.9	9.21	8.1	79.9
-200 mesh	100.0	714	8.77	100.0	100.0

TABLE 33

Combined Screening and Flotation

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 mesh	7.0	20,198	2.10	67.9	1.8
Cl Ag conc	4.6	9,499	3.68	21.1	2.0
Combined conc	11.6	15,937	2.73	89.0	3.8
Cl tail	17.5	1,002	8.40	8.4	17.6
Ro tail	70.9	73	9.20	2.6	78.6
Feed	100.0	2,068	8.31	100.0	100.0

Test No. 23

Test No. 23 was a duplicate of Test No. 22. 1000 grams of Lot A concentrate was screened on 200 mesh. The +200 mesh fraction was dry ground for 30 minutes in a pebble mill. The pulp was screened on 200 mesh. The +200 mesh fraction was ground for 15 minutes and screened on 200 mesh with the results as shown in Table 34.

The -200 mesh fraction was pulped in a 1000 gram Denver flotation cell and conditioned for 2 minutes at 25 per cent solids and pH 7.5 with:

Aerofloat 208	-	0.10 lb per ton,
Aero Xanthate 301	-	0.01 lb per ton,
Aerofloat 31	-	0.06 lb per ton.

TABLE 34

Screening and Grinding on 200 Mesh

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 mesh	7.2	18,590	2.72	68.0	2.5
-200 mesh	92.8	678	8.03	32.0	97.5
Feed	100.0	1,955	7.65	100.0	100.0

A concentrate was removed for 5 minutes. The concentrate was cleaned 5 times. The flotation results are given in Table 35 and the combined results in Table 36.

TABLE 35

Flotation of -200 Mesh Fraction

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
Cl Ag conc	5.2	9,020	10.40	69.6	6.7
No. 1 cl tail	17.0	204	10.90	5.1	23.1
No. 2 cl tail	7.6	405	10.90	4.6	10.3
No. 3 cl tail	4.3	667	10.00	4.3	5.4
No. 4 cl tail	3.0	1,380	10.90	6.2	4.1
No. 5 cl tail	1.9	2,241	9.10	6.1	2.1
Ro tail	61.0	45.2	6.36	4.1	48.3
-200 mesh	100.0	678	8.03	100.0	100.0

TABLE 36

Combined Results

Product	Weight %	Assays		Distribution %	
		Ag oz/ton	Co %	Ag	Co
+200 mesh	7.2	18,590	2.72	68.0	2.5
Cl Ag conc	4.8	9.020	10.40	22.3	6.6
Combined conc	12.0	14,732	5.82	90.3	9.1
Cl tail	31.4	525	10.69	8.4	43.9
Ro tail	56.6	45.2	6.36	1.3	47.0
Feed	100.0	1,955	7.65	100.0	100.0

PILOT PLANT INVESTIGATION

Outline of Investigation Procedure

Briefly, the procedure was to grind the table concentrate to -200 mesh. A high-grade silver concentrate would be collected in the ball mill as +200 mesh metallics. A second silver concentrate would then be recovered by treating the -200 mesh material by flotation concentration.

Five separate pilot plant tests were carried out. Except for minor changes, the same flowsheet was used in each test. Figure 2 illustrates the flowsheet used in Pilot Plant Tests No. 1 and 2. Figure 3 illustrates the flowsheet used in Pilot Plant Tests No. 3, 4 and 5.

The grinding circuit consisted of a 20 x 30 inch Hardinge ball mill operated in closed circuit with a Sweco screen fitted with a 200 mesh screen. The ball mill was equipped with an internal grate with 1/2 inch openings. This grate was located about six inches from the discharge trunion. Approximately 50% of the metallic silver in the table concentrate collected in this space between the grate and the end of the mill and was removed periodically through peripheral discharge ports. This mill was the same one used in a previous investigation on table concentrates for this company and is described and illustrated in Mines Branch Investigation Report IR 66-77. The ball mill was charged with approximately 500 pounds of 1 inch to 1 1/2 inch steel balls.

The -200 mesh ball mill discharge was pumped to a cone in which it was dewatered and stored. The maximum rate that the mill could grind this material to -200 mesh was 180 pounds per hour. The desired flotation rate was 400 pounds per hour. Consequently, it was necessary to grind and store the -200 mesh material ahead of flotation. The flotation rate of 400 pounds per hour was required to provide a sufficient volume of rougher concentrate for the repeated cleaning stages.

The rougher flotation was carried out in four No. 7 Denver Sub A cells and the cleaning was done in No. 5 Denver Sub A cells.

During the grinding and flotation stages, all products were sampled at 15-minute intervals. All final flotation products were collected, dried, weighed and sampled for analysis.

Pilot Plant Runs No. 1 and 2

For Pilot Plant Tests No. 1 and 2, the Lot B concentrate was fed to the ball mill at an average rate of 180 pounds per hour. A total of 2,170 pounds of Lot B concentrate was ground. After the feed to the ball mill was stopped, the mill was operated for an additional 2 hours to grind the coarse circulating load. During

the last half hour, the +200 mesh screen discharge was collected instead of being returned to the ball mill. At the end of the grinding period, the material remaining in the ball mill was washed out, collected, dried, weighed and sampled for analysis. The +200 mesh material was also sampled for analysis. The results are shown in Table 37.

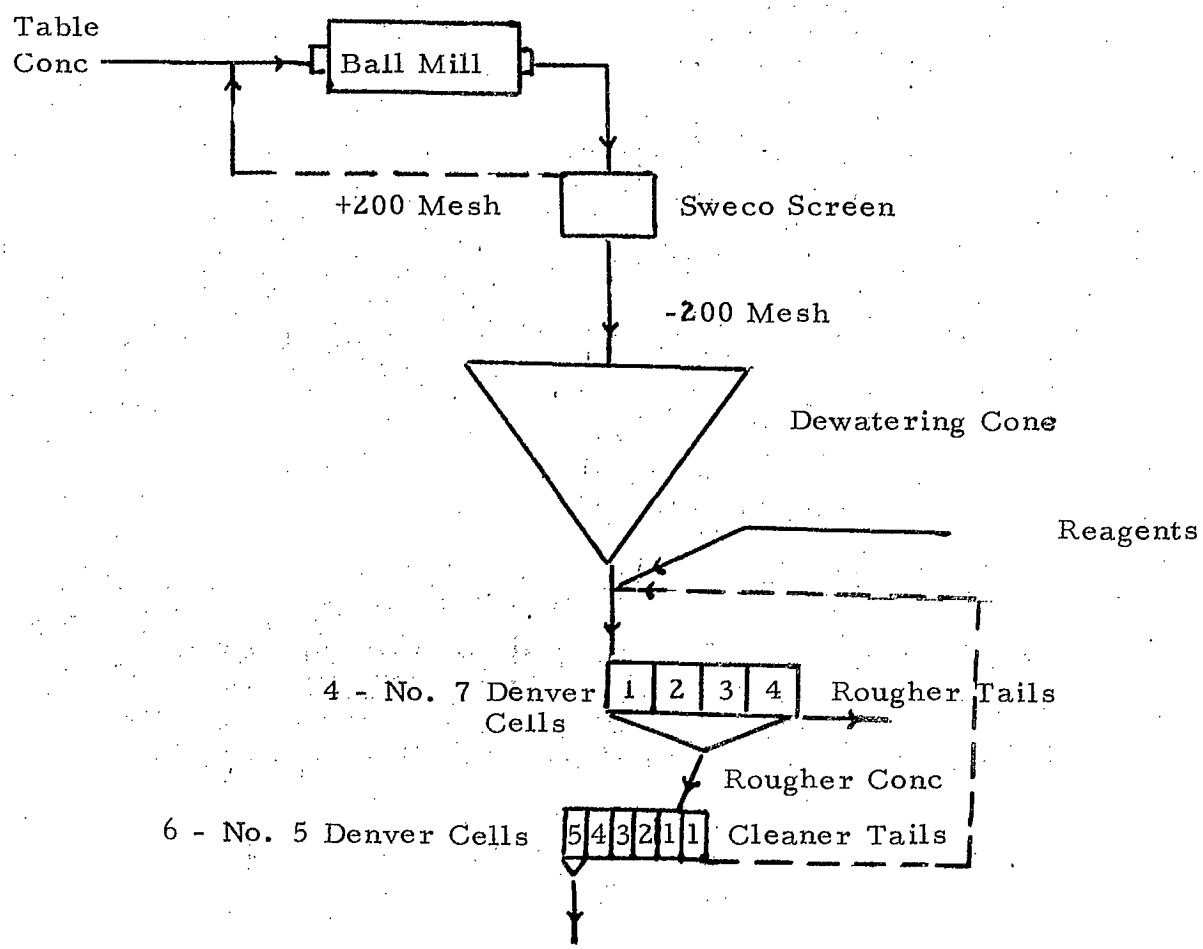

Figure 2. Flowsheet Pilot Plant Tests No. 1 and 2

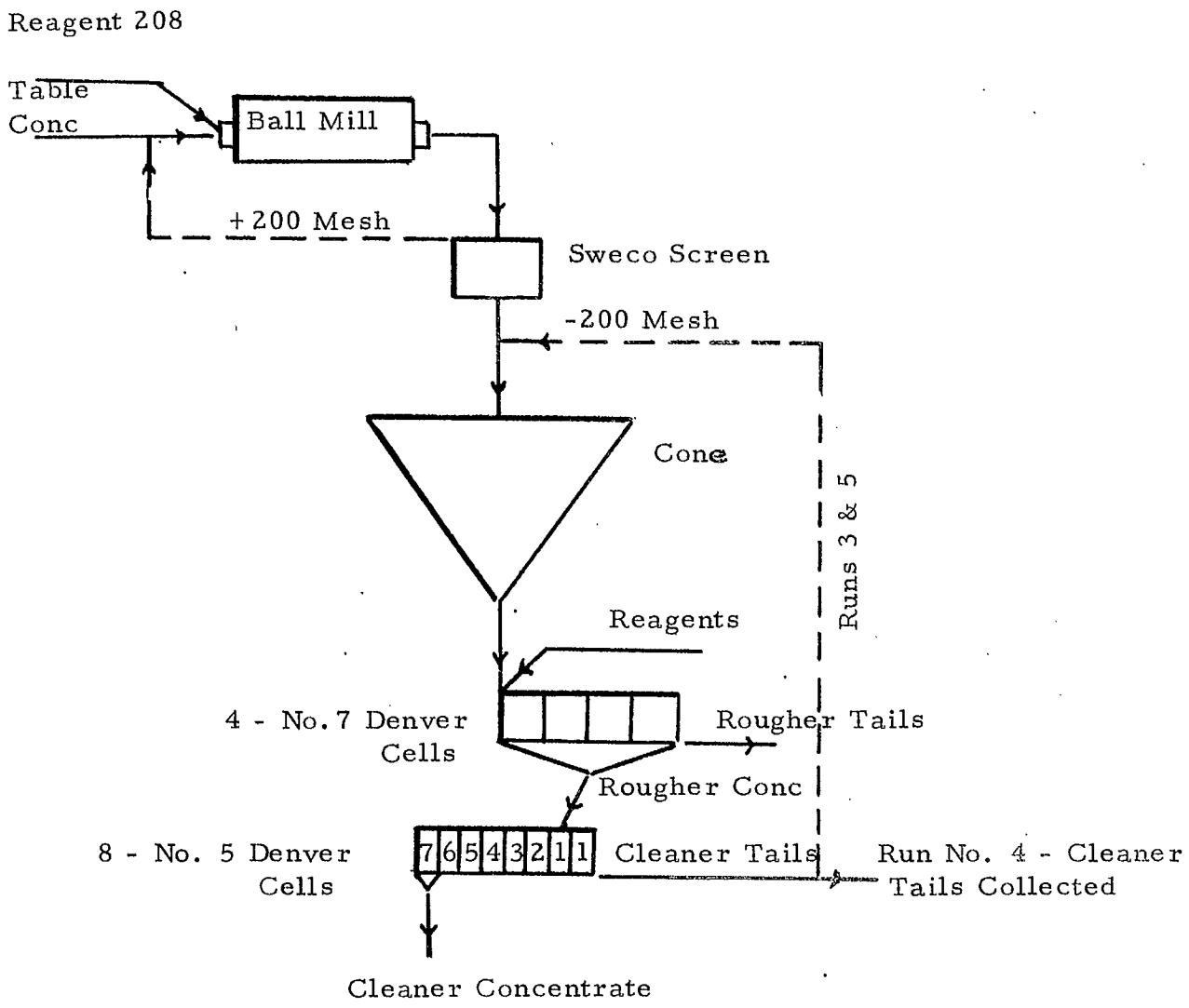

Figure 3. Flowsheet Pilot Plant Tests No. 3, 4 and 5

TABLE 37

Grinding for Pilot Plant Runs No. 1 and 2

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
+200 mesh metallics	10.20	0.5	13,747	Tr.	3.9	-
Ball mill metallics	71.25	3.3	23,088	1.36	45.8	0.6
Combined metallics	81.45	3.8	21,918	1.19	49.7	0.6
-200 mesh material	2088.55	96.2	869	7.37	50.3	99.4
Ball mill feed	2170.00	100.0	1,662	7.13	100.0	100.0

The thickened cone underflow (-200 mesh material) was pumped to the first cell of the No. 7 Denver Sub A cells at a rate of approximately 335 pounds per hour for 2.3 hours. The rougher tailing was collected, filtered, dried and stored. The rougher concentrate was cleaned 5 times. The cleaner tailing was pumped to the first rougher cell and refloated. The cleaned concentrate was dried, weighed and sampled for analysis. The flotation reagents were fed to the first rougher cell as shown in Table 38. The flotation results are shown in Table 39.

TABLE 38

Flotation Reagents and Conditions for Pilot Plant Test No. 1

Aerofloat 208	-	0.07 lb/ton
Aerofloat 242	-	0.06 lb/ton
Aero Xanthate 301	-	0.01 lb/ton
pH	-	8.3
Rougher cell density	-	25% solids

TABLE 39

Pilot Plant Test No. 1 Flotation Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Flot conc	31.25	4.0	3,801	8.44	66.5	5.1
Flot tail	740.00	96.0	80	6.66	33.5	94.9
Flot feed	771.25	100.0	229.6	6.73	100.0	100.0

The only change in procedure for Pilot Plant Test No. 2 was the substitution of Aerofloat Reagent 33 for Aerofloat 242. Reagents and conditions are shown in Table 40 and the flotation results in Table 41.

TABLE 40

Flotation Reagents and Conditions for Pilot Plant Test No. 2

Aerofloat 208	-	0.06 lb/ton
Aerofloat 33	-	0.07 lb/ton
Aero Xanthate	-	0.01 lb/ton
pH	-	8.3
Rougher cell density	-	25% solids
Flotation time	-	2. 3 hours

TABLE 41

Pilot Plant Test No. 2 Flotation Results

Product	Weight		Assays		Distribution %	
	lb.	%	Ag oz./ton	Co %	Ag	Co
Flot conc	44.7	5.7	12,794	3.32	89.6	2.0
Flot tail	740.0	94.3	90	10.00	10.4	98.0
Flot feed	784.7	100.0	814	9.62	100.0	100.0

Table 42 has been compiled by adding the similar products obtained in the flotation tests of Pilot Plant Runs No. 1 and 2.

TABLE 42

Pilot Plant Tests No. 1 and 2 Combined Flotation Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz./ton	Co %	Ag	Co
Flot conc	75.95	4.9	9,111	5.42	84.6	3.2
Flot tail	1480.00	95.1	85	8.33	15.4	96.8
Flot feed	1555.95	100.0	819	8.19	100.0	100.0

It will be observed that all the material ground in the ball mill and stored in the dewatering cone was not floated. If the recoveries as tabulated in Table 42 are applied to the total quantity of table concentrate used in this run, the results as shown in Table 43 would be obtained.

TABLE 43

Pilot Plant Tests No. 1 and 2
Calculated Total Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz /ton	Co%	Ag	Co
Metallics	81.5	3.8	21,918	1.19	50.1	0.1
Flot conc	101.9	4.7	14,924*	5.00*	42.2	3.3
Flot tail	1986.6	91.5	139*	7.52*	7.7	96.6
Ball mill feed	2170.0	100.0	1,662	7.13	100.0	100.0

* Calculated

Pilot Plant Tests No. 3 and 4

For Pilot Plant Tests No. 3 and 4, Lot B concentrate was fed to the ball mill at an average rate of 180 pounds per hour. A total of 2,080 pounds of table concentrate was ground. The -200 mesh material was pumped to and stored in the dewatering cone. After the feed to the ball mill was stopped, the mill was operated for 2 hours to grind the coarse circulating load. During the last half an hour, the +200 mesh material was collected instead of being returned to the ball mill. At the end of the grinding period, the material remaining in the ball mill was washed out, collected, dried, weighed and sampled for analysis. The +200 mesh material was dried, weighed and sampled for analysis. These results are tabulated in Table 44.

The thickened cone underflow (-200 mesh material) was pumped to the first cell of the No. 7 Denver Sub A cells at a rate of approximately 450 pounds per hour. Two additional stages of concentrate cleaning were installed making a total of seven stages. The primary cleaner tailing was pumped to the dewatering cone for dewatering before rougher flotation. The cleaner concentrate and flotation tailing were collected, dried, weighed, and sampled for analysis. Reagents and conditions are shown in Table 45. Flotation results are given in Table 46.

TABLE 44

Grinding for Pilot Plant Tests No. 3 and 4

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
+200 mesh metallics	15.5	0.8	19,556	0.50	8.8	0.1
Ball mill metallics	48.5	2.3	23,159	Tr	32.4	-
Combined metallics	64.0	3.1	22,284	0.12	41.2	0.1
-200 mesh material	2016.0	96.9	1,009	8.44	58.8	99.9
Ball mill feed	2080.0	100.0	1,664	8.18	100.0	100.0

TABLE 45

Pilot Plant Test No. 3 Flotation Reagents

Aerofloat 208	=	0.10 lb/ton to ball mill
Aerofloat 208	=	0.15 lb/ton first rougher cell
Aerofloat 33	=	0.12 lb/ton " " "
Aero Xanthate 301	=	0.01 lb/ton " " "
Dowfroth 250	=	0.01 lb/ton fed intermittently to third cleaner cell
pH	=	8.2
Pulp density	=	35% solids
Flotation time	=	3.25 hours

TABLE 46

Pilot Plant Test No. 3 Flotation Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Flot conc	67	8.5	7950	4.54	87.6	4.7
Flot tail	723	91.5	104	8.50	12.4	95.3
Flot feed	790	100.0	771	8.16	100.0	100.0

The only change in Pilot Plant Test No. 4 was the collection of the cleaner tailing instead of recycling to flotation. The cleaner tailing was collected, dried, weighed and sampled for analysis. Reagents and conditions were the same as shown in Table 45. Flotation time was 3 hours. The flotation results are shown in Table 47.

TABLE 47

Pilot Plant Test No. 4 Flotation Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Flot conc	49.75	4.7	12,267	2.76	45.8	1.9
Cl tail	356.00	33.4	1,820	6.00	48.3	29.6
Flot tail	660.00	61.9	120	7.50	5.9	68.5
Flot feed	1065.75	100.0	1,259	6.77	100.0	100.0

Table 48 has been compiled by adding the similar products from the flotation results of Pilot Plant Tests No. 3 and 4.

TABLE 48

Pilot Plant Runs No. 3 and 4
Flotation Results Combined

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Flot conc	116.75	6.3	9,800	3.77	58.8	3.2
Cl tail	356.00	19.2	1,820	6.00	33.3	15.6
Flot tail	1383.00	74.5	111	8.02	7.9	81.2
Flot feed	1855.75	100.0	1,050	7.37	100.0	100.0

It will be observed that all the material ground in the ball mill and stored in the dewatering cone was not floated. If the recoveries as shown in Table 46 are applied to the total quantity of table concentrate used in this test, the results would be as shown in Table 49.

TABLE 49

Pilot Plant Runs No. 3 and 4
Calculated Total Results

Product	Weight		Assays		Distribution %	
	lb.	%	Ag oz/ton	Co %	Ag	Co
Metallics	64.0	3.1	22,284	0.12	41.2	0.1
Flot conc	127.0	6.1	9,421*	4.28	34.6	3.2
Cl tail	387.1	18.6	1,751*	6.85	19.6	15.6
Flot tail	1501.9	72.2	107*	9.19	4.6	81.1
Ball mill feed	2080.0	100.0	1,664	8.18	100.0	100.0

* Calculated

Pilot Plant Test No. 5

In this pilot plant run, Lot B concentrate was fed to the ball mill at an average rate of 180 pounds per hour for approximately 10 hours. A total of 1,714 pounds of table concentrate was ground. The -200 mesh material was pumped to and stored in the dewatering cone. After the feed to the ball mill was stopped, the mill was operated for 2 hours to grind the coarse circulating load. During the last half an hour, the +200 mesh material was collected instead of being returned to the ball mill. At the end of the grinding period, the material remaining in the ball mill was washed out, collected, dried, weighed and sampled for assay. The +200 mesh material was dried, weighed and sampled for analysis. The results are shown in Table 50.

TABLE 50

Pilot Plant Test No. 5 Grinding

Product	Weight		Assays		Distribution %	
	lb.	%	Ag oz/ton	Co %	Ag	Co
+200 mesh metallics	13.0	0.8	18,145	1.00	6.0	0.1
Ball mill metallics	82.8	4.8	23,016	0.96	48.1	0.4
Combined metallics	95.8	5.6	23,355	0.97	54.1	0.5
-200 mesh material	1618.2	94.4	1,124	10.53	45.9	99.5
Ball mill feed	1714.0	100.0	2,310	10.00	100.0	100.0

The thickened cone underflow (-200 mesh material) was pumped to the first cell of the No. 7 Denver Sub A cells at a rate of approximately 450 pounds per hour. The primary cleaner tailing was pumped to the dewatering cone for dewatering. During the last hour of the run, the cleaner tailing was collected instead of being recycled.

Reagents and conditions are tabulated in Table 51. Flotation results are tabulated in Table 52.

TABLE 51

Pilot Plant Test No. 5 Flotation
Reagents and Conditions

Aerofloat 208	-	0.10 lb/ton to ball mill
Aerofloat 208	-	0.05 lb/ton to first ro cell
Aerofloat 33	-	0.12 lb/ton to first ro cell
Aero Xanthate 301	-	0.01 lb/ton to first ro cell
pH	-	8.3
Pulp density	-	35%
Flotation time	-	15 hours

TABLE 52

Pilot Plant Run No. 5 Flotation Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Flot conc	186.5	10.0	9,103	6.53	74.6	6.8
Cl tail	254.0	13.6	1,794	13.00	19.9	18.5
Flot tail	1429.0	76.4	90	9.35	5.5	74.7
Flot feed	1869.5	100.0	1,222	9.56	100.0	100.0

It will be observed that the quantity of material floated in this pilot plant run exceeded the weight of material ball-milled. The material floated included material which had accumulated in the dewatering cone. If the recoveries tabulated in Table 52 are applied to the correct weight of material, the results would be as tabulated in Table 53.

During pilot plant run No. 5, simultaneous grab samples of the rougher concentrates from each of the seven cleaner concentrates and the rougher tail were taken and assayed with the results as shown in Table 54.

TABLE 53

Pilot Plant Test No. 5 Calculated Total Results

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co %	Ag	Co
Metallics	95.8	5.6	22,355	0.97	54.1	0.5
Flot conc	161.3	9.4	8,470*	7.12*	34.2	6.7
Cl tail	219.9	12.8	965*	14.36*	9.1	18.4
Flot tail	1237.0	72.2	81*	10.30*	2.6	74.4
Ball mill feed	1714.0	100.0	2,310	10.00	100.0	100.0

* Calculated

TABLE 54

Sample Assays

Sample	Assays	
	Ag oz/ton	Co %
Rougher conc	2,042	8.20
No.1 cl conc	5,722	6.53
No.2 cl conc	8,657	5.35
No.3 cl conc	9,196	5.20
No.4 cl conc	9,975	4.60
No.5 cl conc	13,370	3.45
No.6 cl conc	14,799	2.65
No.7 cl conc	16,051	2.65
Rougher tail	124	10.02

Discussion of Results and Conclusions

If the similar products of the five pilot plant runs are combined, the calculated results of the pilot plant investigation would be as summarized in Table 55.

It should be pointed out that, in a commercial plant, there would be no final production of cleaner tailing as it would be recycled to flotation. Consequently, at least half of the silver in the cleaner tailing would report in the concentrate and increase the recovery to over 90%. This is illustrated in Pilot Plant Tests No. 1 and 2, which shows 92.3% recovery of the silver and in Pilot Plant Test No. 3 where the silver recovery is 92.9% (see Table 43 and Table 44 and 46).

TABLE 55

Combined Results of Pilot Plant Investigation

Product	Weight		Assays		Distribution %	
	lb	%	Ag oz/ton	Co%	Ag	Co
Metallics	241.3	4.4	22,191	0.82	51.5	0.4
Flot conc	379.2	6.9	9,319	5.46	34.0	4.7
Total conc	620.5	11.3	14,327	3.65	85.5	5.1
Cl tail	610.0	11.0	1,809	8.92	10.6	12.2
Ro tail	4,292.0	77.7	95	8.57	3.9	82.7
Ball mill feed	5,522.5	100.0	1,884	8.06	100.0	100.0

The combined metallics and flotation concentrates produced in Pilot Plant Tests No. 1 and 2 assayed 15,763 ounces silver per ton and 3.22% cobalt. Pilot Plant Tests No. 3 and 4 has a combined concentrate assaying 14,209 ounces silver per ton and 2.48% cobalt. Pilot Plant Test No. 5 had a combined concentrate assaying 13,600 ounces silver per ton and 4.64% cobalt.

The recovery of metallic silver from table concentrates as reported in Mines Branch Investigation Report IR 66-77 has been investigated further and improved recoveries obtained. This is illustrated by the results shown in Table 31. The +200 mesh metallics assayed 20,198 ounces silver per ton and 2.10% cobalt in a concentrate weighing 7.0% of the total weight and containing 67.9% of the silver and 1.8% of the cobalt in the feed to the test. The flotation concentrate from the -200 mesh fraction assayed 9,499 ounces silver per ton and 3.68% cobalt. These two concentrates combined to give a concentrate assaying 15,937 ounces silver per ton and 2.73% cobalt and representing 11.6% of the original weight. The silver recovery was 89.0% with only 3.8% of the cobalt in the test feed.

The combined pilot plant operation resulted in the production of a concentrate assaying 14,327 ounces silver per ton and 3.66% cobalt and with a recovery of 11.3% of the weight, 85.5% of the silver and 5.1% of the cobalt (see Table 55).

Each of these combined concentrates, the one produced in the laboratory and the one from the pilot plant, are suitable for direct treatment in the silver refinery.

Attempts to upgrade the table concentrate by cycloning, tabling and jigging were not successful. The results obtained in ten cycloning tests under various conditions were unsatisfactory and did not warrant further investigation. The results obtained by tabling showed some concentration (see Table 17) but the concentrate was not suitable for direct refining. Jigging resulted in an upgraded concentrate which was not suitable for direct refining.

Table 54 illustrates the feasibility of producing a flotation concentrate of a grade of silver and cobalt suitable for treatment in the silver refinery.

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WAW/dg