[redacted]

4

AEC RESEARCH AND DEVELOPMENT REPORT

ORNL-2209
Technology-Feed Materials

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0350445 6

FEED MATERIALS PROCESSING STATUS REPORT FOR OCTOBER, 1956

R. E. Blanco
W. K. Eister

LIBRARY LC

DO NOT TRANSFER TO ANOTHER PERSON

If you wish someone else to see this document, send in name with document and the library will arrange a loan.

This document contains Confidential Restricted Data relating to Civilian Applications of Atomic Energy.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
A Division of Union Carbide and Carbon Corporation
UCC
POST OFFICE BOX X · OAK RIDGE, TENNESSEE

[redacted]

[redacted]

Printed in USA. Charge 30 cents. Available from the U. S. Atomic Energy Commission, Technical Information Extension, P. O. Box 1001, Oak Ridge, Tennessee. Please direct to the same address inquires covering the procurement of other classified AEC reports.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

[redacted]

Report Number: ORNL-2209

CLASSIFICATION CHANGED TO: DECLASSIFIED
BY AUTHORITY OF: TID-1149
BY: R. Morrison 7/25/57

Contract No. W-7405, eng 26

CHEMICAL TECHNOLOGY DIVISION

FEED MATERIALS PROCESSING STATUS REPORT

FOR OCTOBER, 1956

R. E. Blanco

W. K. Eister

[redacted]

DATE ISSUED

JAN 18 1957

OAK RIDGE NATIONAL LABORATORY
Operated by
CARBIDE AND CARBON CHEMICALS COMPANY
A Division of Union Carbide and Carbon Corporation
Post Office Box X
Oak Ridge, Tennessee

[redacted]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0350445 6

INTERNAL DISTRIBUTION

1. C. E. Center
2. Biology Library
3. Health Physics Library
4-5. Central Research Library
6. Reactor Experimental Engineering Library
7-11. Laboratory Records Department
12. Laboratory Records, ORNL R.C.
13. A. M. Weinberg
14. L. B. Emlet (K-25)
15. J. P. Murray (Y-12)
16. J. A. Swartout
17. E. H. Taylor
18. E. D. Shipley
19. M. L. Nelson
20-21. F. L. Culler
22. W. H. Jordan
23. C. P. Keim
24. J. H. Frye, Jr.
25. S. C. Lind
26. A. H. Snell
27. A. Hollaender
28. K. Z. Morgan
29. M. T. Kelley
30. T. A. Lincoln
31. R. S. Livingston
32. A. S. Householder
33. C. S. Harrill
34. C. E. Winters
35. D. W. Cardwell
36. E. M. King
37. W. K. Eister
38. F. R. Bruce
39. D. E. Ferguson
40. R. B. Lindauer
41. H. E. Goeller
42. D. D. Cowen
43. R. A. Charpie
44. J. A. Lane
45. M. J. Skinner
46. R. E. Blanco
47. G. E. Boyd
48. W. E. Unger
49. R. R. Dickison
50. A. T. Gresky
51. E. D. Arnold
52. C. E. Guthrie
53. J. W. Ullmann
54. K. B. Brown
55. K. O. Johnsson
56. H. M. McLeod
57. J. C. Bresee
58. W. E. Clark
59. O. C. Dean
60. C. W. Hancher
61. R. F. Hibbs (Y-12)
62. I. R. Higgins
63. A. F. Rupp
64. J. E. Savolainen
65. J. C. Suddath
66. C. D. Watson
67. W. W. Weinrich (consultant)
68. M. D. Peterson (consultant)
69. D. L. Katz (consultant)
70. G. T. Seaborg (consultant)
71. M. Benedict (consultant)
72. C. E. Larson (consultant)
73. ORNL - Y-12 Technical Library, Document Reference Section

EXTERNAL DISTRIBUTION

74-81 Atomic Energy Commission, Washington (1 copy each to E. Anderson, R. C. Dalzel, S. G. English, F. Kerze, Jr., M. B. Kratzer, W. N. Munster, R. E. Pahler, and S. B. White)

82-83 Atomic Energy Commission, Oak Ridge (1 copy each to D. F. Cope and R. B. Martin)

84 C. Slansky, Phillips Petroleum Company

85. C. L. Peterson , Battelle Memorial Institute

86. Division of Research and Development, AEC, ORO

87-346. Given distribution as shown in M-3679 under Technology-Feed Materials category

[redacted]

CONTENTS

		Page
1.0	Metallex Process	4
2.0	Fluorox Process	4
3.0	Excer Process	7
4.0	Ore Processing	9

OTHER REPORTS IN THIS SERIES

CF-56-5-100 for May (30¢)
CF-56-6-100 for June (30¢)
CF-56-7-100 for July (30¢)
CF-56-8-100 for August (30¢)
CF-56-9-100 for September (30¢)
ORNL-2227 for November (25¢) in preparation

All studies reported here are preliminary and conclusions are subject to change. The information is published as a formal report only to permit ready dissemination of data to interested persons.

ABSTRACT

Metallex Process. Niobium was neither amalgamated nor dissolved by boiling in mercury at 356°C or by heating in fused $ZnCl_2$-KCl-NaCl matrix, containing $HgCl_2$, over mercury.

In eight batch runs, made to produce thorium quasi amalgam for metallurgical examination, a total of 2740 g of thorium metal, as amalgam, was produced with an average yield of 84.5%.

Fluorox Process. Oxidation at 600°C or higher of UF_4 produced by the Excer process, which has a high specific surface area at 25°C, resulted in rapid sintering.

Pelleting tests and two-stage reduction and hydrofluorination runs in moving-bed equipment with ore concentrate feed have been scheduled. In fluidization tests in which Excer UF_4 was oxidized, 60-150 mesh particles were the most satisfactory size.

Excer Process. The density of $UF_4 \cdot 3/4H_2O$ was increased from about 1 g/cc to about 3 g/cc by pressing and grinding. The uranium decontamination by electrolysis was as good when UF_4 was precipitated after electrolysis by adding HF to the UCl_4 electrolytic product as it was when the HF was present in the electrolytic cell and reduction and precipitation were simultaneous.

The slurry-mercury separation equipment of the electrolytic cell was redesigned. Results of dehydration runs showed that about 80% water removal is possible with present equipment.

Ore Processing. In preliminary tests high-pressure carbonate leaching resulted in extraction of more uranium and less silica than low-pressure.

[redacted]

[redacted]

1.0 METALLEX PROCESS

In the Metallex process, thorium is recovered from $ThCl_4$ by reduction of the chloride with sodium amalgam; concentration of the thorium amalgam thus formed; and separation by distilling off the mercury to leave sintered thorium.

1.1 Laboratory-scale Studies (O. D. Dean, C. P. Johnston)

Initial scouting efforts to dissolve metallic niobium in mercury or fused salts failed. In one experiment degreased metallic niobium was heated in boiling mercury at 356°C for 24 hr with no loss in weight. In a second experiment metallic niobium was heated in a molten salt mixture of $ZnCl_2$-KCl-NaCl-$HgCl_2$ at 210°C over mercury, then digested in hot mercury for 24 hr. There was no amalgamation of the sample, either in boiling mercury or in the fused salt--mercury mixture. There was no visible attack or weight loss.

1.2 Larger-scale Studies (J. C. Suddath)

Thorium quasi amalgam for metallurgical evaluation was produced in eight batch runs, each with 100% excess of stoichiometric sodium. Seven runs were made with 3.5 M Na(Hg) and 700 g of $ThCl_4$ and one (run 2) with 1.8 M Na(Hg) and 200 g of $ThCl_4$. The average yield was 84.5%:

Run No.	Quasi Amalgam Yield (kg)	Th in Quasi Amalgam (wt %)	Thorium Yield (g)	Yield (%)
1	8.52	4.88	416	95.6
2	3.01	3.24	98	45.0
3	7.49	4.76	356	82.1
4	14.68	2.88	423	97.4
5	8.86	2.95	261	60.2
6	15.48	2.88	446	103
7	10.27	4.24	436	100
8	9.95	3.05	304	69.9
	78.26		2740	84.5

In runs 1, 2, and 8 unreacted thorium salt and product NaCl were washed from the amalgam with 3 M HCl. In runs 3-7 the 3 M HCl wash contained 5 g of hydrazine hydrochloride per liter.

Preliminary results are available from the pressing and sintering operations. The product from run 1 was pressed with some tendency to extrude from the die and cracked when sintered. The run 8 product cracked when removed from the die but was reslurried with mercury and re-pressed with no further difficulty.

2.0 FLUOROX PROCESS

In the Fluorox process, UF_4 is prepared by simultaneously reducing and hydrofluorinating uranium oxide. The UF_4 product of this reaction may be either reduced to metal or oxidized to UF_6.

[redacted]

2.1 Laboratory-scale Studies (J. E. Savolainen, L. M. Ferris)

UF_4 of low specific surface area is oxidized by dry oxygen very slowly at temperatures below 700°C. It was therefore conjectured that a high rate might be obtained at lower temperatures with a high-surface-area UF_4, but results of experiments did not confirm this: UF_4 powder from the Excer process has a high specific surface area, 1-2 m^2/g at room temperature as measured by nitrogen adsorption. However, as the temperature of Excer UF_4 of specific surface area 1.24 m^2/g was raised, the powder sintered rapidly:

Temp. (°C)	Conditions	Specific Surface Area (m^2/g)
600	Heated to temperature and quenched	0.375
	Heated to temperature and retained 1 hr	0.18
	Heated to temperature and retained 5 hr	0.21
700	Heated to temperature and quenched	0.19
	Heated to temperature and retained 1 hr	0.12
	Heated to temperature and retained 5 hr	0.10
800	Heated to temperature and quenched	0.16
	Heated to temperature and retained 1 hr	0.08
	Heated to temperature and retained 5 hr	0.11

The experiments were made with 15-g samples of UF_4, which were heated in a stream of helium.

A report, "Laboratory Development of the Fluorox Process. II. Thermogravimetric Study of the Chemical Kinetics for the Reaction of UF_4 with Dry Oxygen," by L. M. Ferris and E. G. Carter, ORNL-2216, is in preparation.

2.2 Larger-scale Studies (J. C. Breese, J. B. Adams)

Reduction-Hydrofluorination. Modification of the reduction-hydrofluorination moving-bed reactor equipment, for reduction of ore concentrates with H_2 or NH_3 followed by hydrofluorination with HF as two separate process steps, is nearly complete. The unit (CF-56-6-100, Fig. 1) was designed for simultaneous starch reduction and hydrofluorination of UO_3 to UF_4. Since the equipment is not in a closed facility, special provisions are required for hazards involved in the use and disposal of hydrogen-bearing gases. The reactor and associated piping are being leak-tested at 15 psig pressure, although in ordinary operation reactor pressure will be only a few inches of mercury. Excess hydrogen-bearing gases will be diluted with large amounts of air to reduce the hydrogen concentration of the discharged gas to well below explosive amounts.

Initial tests will be made with NH_3 gas, with cracking in the reactor. Based on information from other sites, indications are that, for reduction of UO_3, undissociated ammonia is probably as effective as dissociated ammonia.

The use of ammonia will simplify process control and reduce fire and explosion hazards by eliminating hydrogen storage problems and restricting the hydrogen gas to a small part of the system where holdup capacity is low and an active reactant, UO_3, is present.

A dummy run was made with alundum pellets and nitrogen gas to determine approximate heater settings for maintenance of reactor temperatures in the 500-600°C range. The unit, loaded with alundum pellets but without nitrogen flow, was allowed to approach thermal equilibrium over an 18-hr period. Approximate heater settings were chosen early in the run based on the temperature profile developed the first few hours. After the 18-hr warm-up period, gas flow was started at a rate that would simulate the sensible heat requirements of a flow of 10 lb of UO_3 per hour reduced with 100% excess hydrogen, present as dissociated ammonia. Heats of reaction were not considered. Over a 4-hr period the reactor temperature dropped slightly.

When solids flow was attempted, difficulties were encountered. Bridging occurred easily, and hammering was required to induce movement of the pellets. Constant vibration was unsuccessful, probably because it tended to pack the pellets more closely. Sharp blows resulted in erratic flow and temperature jumps as cold solids entered and moved down the reactor. However, this method appeared to allow the bed to remain in a looser (higher void volume) configuration. Once the whole column of solids was obtained in this condition, flow occurred more easily. It is to be expected that rough-surfaced nonuniform UO_3 pellets undergoing reduction to UO_2 may cause at least as much trouble as these relatively smooth, uniform-sized spherical alundum pellets. A mitigating factor is that UO_3 pellets shrink in size on reduction to UO_2. Higher solids flow rates than were used with the alundum pellets will also aid flow properties of the moving bed.

Oxidation. Installation of the UF_6 hydrolysis and scrubbing column is now complete. Volatile contents of the cold trap will be removed through the column after preliminary testing. Installation of the experimental fluidized bed equipment is also complete.

In preliminary studies with sand and with $UF_4 \cdot 3/4H_2O$, in nitrogen in a 3-in.-dia glass column, fluidization was excellent with 40 x 60 mesh $UF_4 \cdot 3/4H_2O$ and with a -40 mesh aand containing 14 wt % -200 mesh material:

N_2 Flow Rate ($lb/hr.ft^2$)	Sand		$UF_4.3/4H_2O$	
	$\Delta p(lb/ft^2)$	Bed Ht.(in.)	$\Delta p(lb/ft^2)$	Bed Ht.(in.)
24.2	8.9	---	10.7	2.15
40.4	14.0	2.35	13.8	2.2
53.8	15.3	---	15.1	---
66.4	15.1	2.65	14.8	2.35
78.9	15.3	2.80	13.5	---
91.4	13.8	---	14.0	---
104.0	15.1	2.90	15.3	2.6
107.2	15.1	---	16.1	---
131.7	15.1	3.00	15.3	2.8

The average charge weighed 0.75 lb. The gas rate at initial fluidization was 40 $lb/hr.ft^2$ for sand and 48 $lb/hr.ft^2$ for $UF_4.3/4\ H_2O$. Best results were obtained with a gas distributor of fine filter cloth on 200 mesh screen, on 80 mesh screen. A porous fritted glass filter, the combined 80 and 200 mesh screens without a filter cloth, and a lucite model cone closely approximating the cone gas distributor used in the inconel reactor itself were less effective, causing channeling and slugging to occur more readily.

A closely sized coarse fraction of sand, 28 x 32 mesh, could not be fluidized successfully. Intense slugging occurred at all bed depths and gas velocities investigated. Fluidization of a widely sized fraction of $UF_4.3/4H_2O$ containing 63% -200 mesh was also unsuccessful. Channeling was encountered with thin beds and slugging with deep beds.

3.0 EXCER PROCESS

In the Excer process, uranium solutions are converted by ion exchange to a form suitable for electrolysis and are electrolytically reduced in a cation-exchange membrane cell and then dehydrated. When the process is applied to ore leach pulps, the unfiltered pulp may be fed directly to the ion-exchange column. In some cases the ion exchange step may be omitted and the ore solution electrolyzed directly.

3.1 Laboratory-scale Studies (I. R. Higgins, W. J. Neill)

$UF_4.3/4H_2O$ produced by electrolytic reduction of UO_2Cl_2 solution to UCl_4, followed by addition of HF outside the cell, was very fluffy. The tap density was greatly increased by pressing the product into a billet and regrinding:

Run No.	Pressure (tsi)	$UF_4.3/4H_2O$ Density (g/cc) Initial Tap	Billet	Final Tap
1	20	1.2	4.3	2.8
2	40	1.0	4.9	3.6
3	50	1.2	5.1	3.2

Runs 1 and 3 were made with a mercury cathode; run 2 was made with a lead cathode, and the UF_4 product was digested 5 hr at 95°C before drying. Even with 0.5 hr digestion the product was filtered and washed rapidly although the tap density was low. The UO_2Cl_2 solution was obtained from Vitro Laboratories, where it had been prepared by solvent extraction of a sulfate ore leach. Ionic contamination of the product UF_4 was in all cases low:

Contaminant	Feed	Amount (ppm U)			
			Hg Cathode		Pb Cathode,
		Ion-exchange UO_2Cl_2 Product	Pptn in Cell	Pptn outside Cell	Pptn outside Cell
Fe	48,500	32,000	81	33	4
Cr	--	--	0.8	2	0.5
Mo	43,500	--	5.6	0.5	3.3
V	5,240	3,590	N.D.	N.D.	N.D.
Al	41,800	--	35	25	15
Ca	3,670	1,740 (?)	62	300	295
Ni	--	--	2.9	1.7	N.D.
Mg	--	--	11	0.2	0.3
Na	1,700	43	<65	107	44
Cu	--	--	5	1.7	4.8
K	232	94	N.D.	--	--
PO_4	8,130	--	14	--	--
Pb	--	--	25	N.D.	22
B	--	--	8.6	12	1.8
Si	--	--	0.6	N.D.	--
Ti	--	--	0.4	--	--
Zr	--	--	0.3	--	--
Ag	--	--	0.7	0.3	--
Mn, Hg, R, E's			N.D.		

When the mercury-cathode cell was equipped with a continuous mercury cleanup system, there was no scum formation on the cathode screen.

3.2 Larger-scale Studies (C. W. Hancher, V.C.A. Vaughen, G. K. Ellis)

Electrolytic Reduction. The electrolytic reduction cell has been redesigned to provide stability of the mercury cathode, adequate separation of the UF_4 hydrate product and mercury as they leave the cell, and reaction temperatures of 90°C or higher. Pumps and flow meters for HF and UO_2F_2 solutions are being added.

The cathode screen material is nickel, this having shown the best resistance to corrosion by the 1 M HF catholyte. In operation the mercury falls over the screen, which has been previously wetted by electrolytic deposition of mercury while in the cell. However, after a sustained run of 6-8 hr, UF_4 hydrate begins to deposit directly on the nickel screen, and finally covers

it completely, increasing the cell resistance to a value too high for satisfactory operation. In the new design, the mercury circulation rate is doubled or tripled, and the slit area in the header through which the mercury flows is decreased to about 75% of the cross-sectional flow area through the header tube. These modifications should result in more even mercury flow across the screen, minimizing the possibility of UF_4 hydrate formation on the screen. Another cathode has been designed (Fig. 1) on which the mercury would be held by gravity and which would have no irregular surface to promote adherence of a UF_4 hydrate particle.

Mercury and UF_4 hydrate product are expected to be separated as they leave the cell by a settler and a thickener, which will be added, together with provision for recycling approximately 5% of the fine particles for seeding the cell (Fig. 2). Previously, the entire separation was accomplished in a standard pipe tee. The settler will utilize a bubble cap to maintain the mercury at a specified level. The UF_4 hydrate product will be floated off into the thickener, from which the product will be drawn as the underflow, the overflow being pumped to mix with the feed through a jet eductor.

A heat exchanger will be installed in the return leg of the mercury cycle to aid in keeping the reaction temperature above 90°C.

Dehydration. About 260 lb of $UF_4 \cdot 3/4H_2O$ has been dehydrated in the nickel ribbon-flite dehydrator (Fig. 3), with an average product water content of less than 0.5% (Table 1). Proper correlation of data is difficult because of the number of experimental variables:

Feed rate	0.4-4.4 lb/hr	Exit gas temperature	100-180°C
Batch sizes	5-30 lb	Dryer temperature	125, 250, 375°C to 200, 300, 400°C in zones 1, 2, 3
N_2 flow rate	20-60 ft^3/hr		

4.0 ORE PROCESSING

4.1 High-pressure Carbonate Leaching (C. W. Hancher, L. A. Jobe)

Excessive dissolution of silica from the ore during the conventional long leachings at 120°C may be responsible for the filtration difficulties with carbonate leaches. In tests on high-pressure carbonate leaching as a means of controlling the relative rates of solution of uranium and silica, the silica content of samples leached under 1000 psi oxygen for up to 68 hr was less than 1 ppm. Although data are incomplete, uranium extraction appeared to increase with increasing pressure:

ORNL-LR-Dwg.-16715
UNCLASSIFIED

UNCLASSIFIED

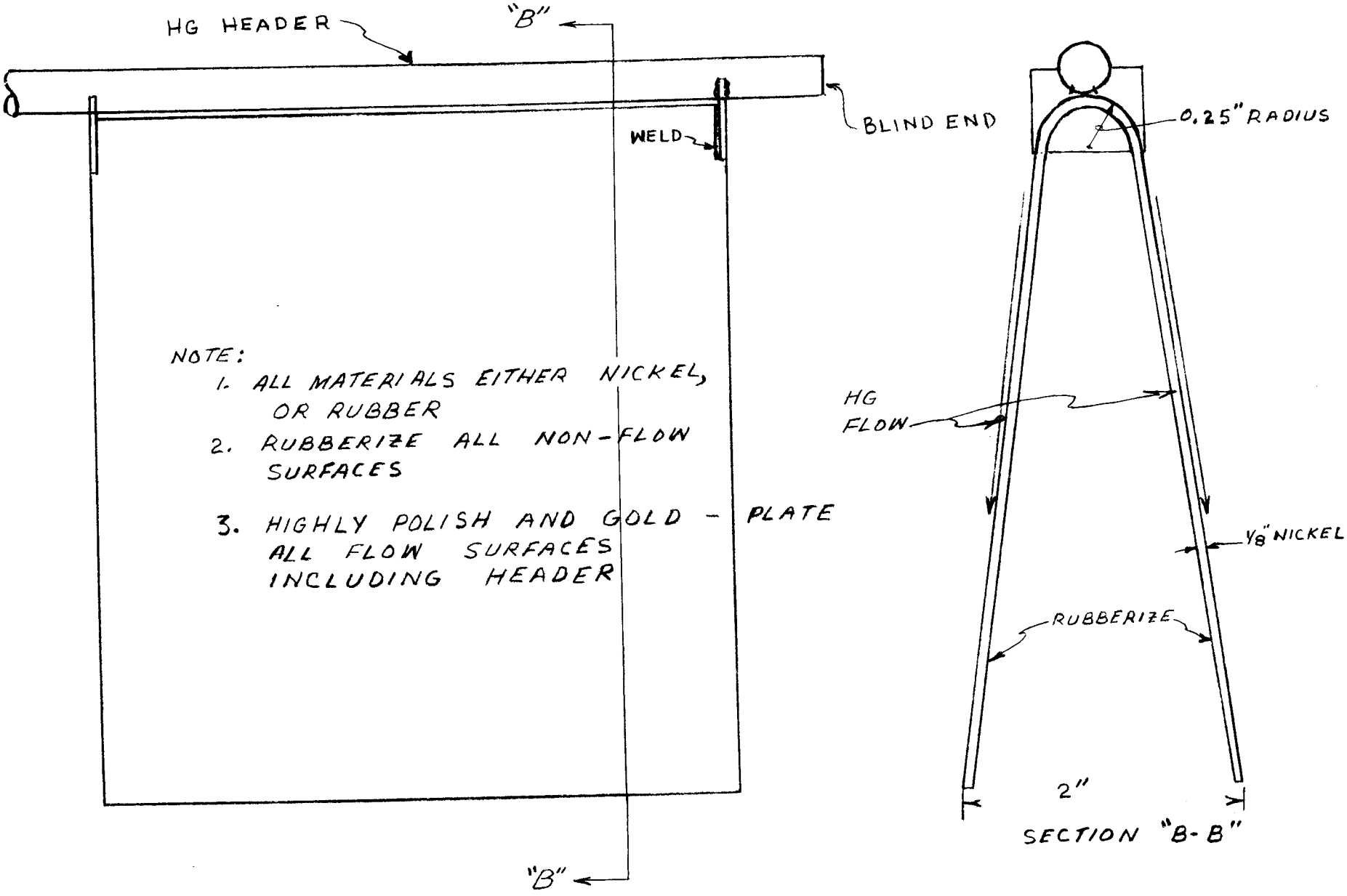

FIG. 1. PROPOSED CATHODE FOR EXCER CELL

UNCLASSIFIED

[redacted]

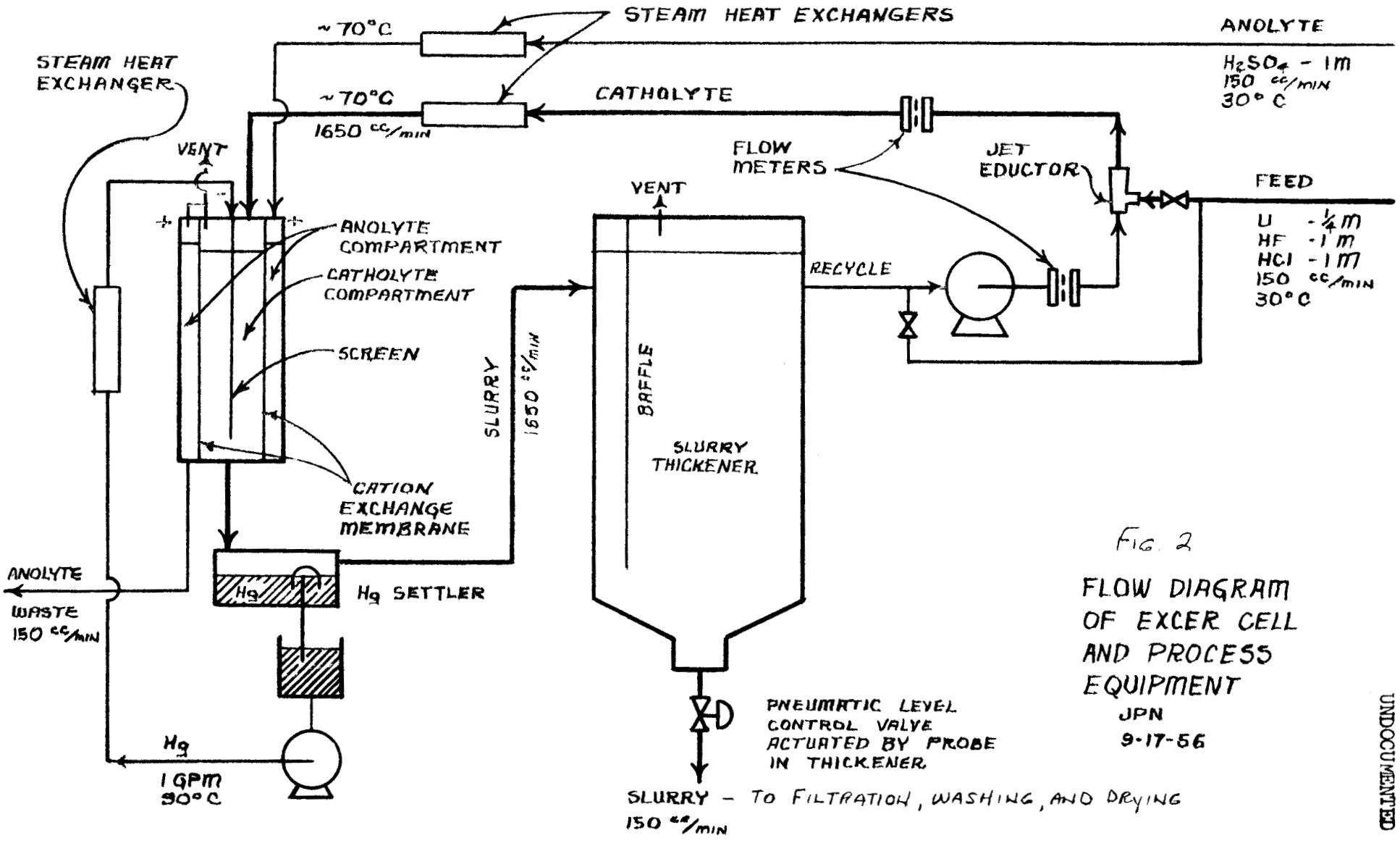

FIG. 2

FLOW DIAGRAM OF EXCER CELL AND PROCESS EQUIPMENT

JPN
9-17-56

ORNL-LR-Dwg.-16695
CONFIDENTIAL
UNDOCUMENTED

[redacted]

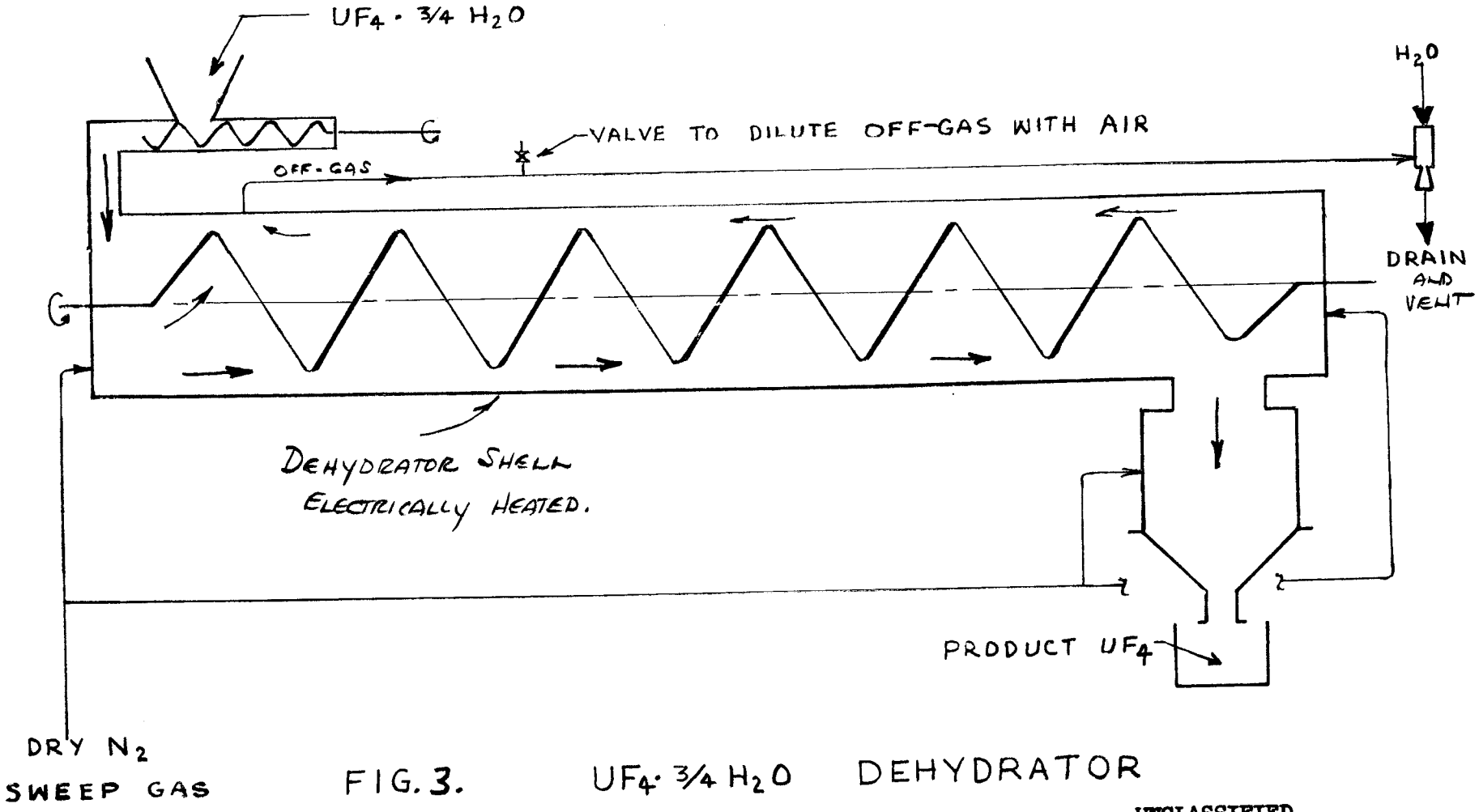

FIG. 3. $UF_4 \cdot 3/4\ H_2O$ DEHYDRATOR

ORNL-LR-Dwg.-16696
UNCLASSIFIED

Time (hr)	U_3O_8 Extracted (%) -40 mesh, 3 psi	+60 mesh, 1000 psi	-325 mesh 3 psi	-325 mesh 1000 psi
		Utex B (reduced ore)		
0.33	12.5	22.0	24.3	44.0
2.5	24.8	--	39.2	--
3.5	28.3	37.3	48.8	69.0
25	--	70.8	--	98.9
68	52.5	--	80.9	--
		Uravan (carnotite ore)		
0.33	1.1	1.6	3.8	11.3
3.5	3.0	4.1	14.4	16.3
25	--	10.7	--	53.5
68	14.4	--	41.6	--

The samples were leached with 5% Na_2CO_3--2% $NaHCO_3$ solution without agitation.

Early in the leaching Utex B was leached to a much higher extent, but the overall leaching of Uravan was higher. For both ores the effect of temperature on the percentage of uranium leached was erratic; in some cases the amount extracted even appeared to decrease with increasing temperature. Agitation of the mixture substantially increased the extraction. The effects of partial pressure of carbon dioxide and of particle size were inconclusive. The ores had the composition:

Component	Amount (wt %) 20/40	40/60	60/80	80/100	150/200	200/325	-325	Composite	Y-12 Analyses
				Utex B					
U_3O_8	0.495	0.295	0.247	0.247	0.247	0.377	0.495	0.311	0.30
V_2O_5	0.286	0.339	0.305	0.286			1.143		1.0
SiO_2									--
CaO									64
CO_2									5.1
Fe_2O_3									1.2
Mo									0.01
C									<0.1
				Uravan					
U_3O_8	0.118	0.071		0.071	0.247	0.589	0.455	0.165	0.15
V_2O_5		0.840		1.178	2.27		1.09		1.9
SiO_2									87
CaO									1.1
MgO									0.85
CO_2									0.8
Fe_2O_3									0.89
Al_2O_3									3.24
P_2O_5									0.1

The leaching equipment (Fig. 4) included a Minneapolis-Honeywell temperature recorder (Fig. 5) to continuously trace the temperature inside the reaction bomb.

Table 1. Excer Dehydration Data

Sweep gas: 0.4 cfm

Run No. DR	Feed[a] Rate (lb/hr)	U (%)	U(IV) (%)	F (%)	H_2O (%)	AOI[b] (%)	Temperature (°C) Zone 1	Zone 2	Zone 3	Product[a] Wt (lb)	U (%)	U(IV) (%)	F (%)	AOI[b] (%)	H_2O (%)
19	0.4	71.3	69.4	22.3	3.7	0.51	188	310	400	2.5	74.9	66.9	22.2	0.20	0.84
20	0.4	--	--	--	--	--	195	325	390	2.5	73.9	69.7	22.4	1.38	0.38
21	3.5	70.5	69.6	21.7	4.1	0.50	200	300	390	5.1	73.9	67.8	21.8	0.55	0.46
22	3.9	--	--	--	--	--	200	300	400	2.9	75.0	72.5	23.3	0.10	0.59
23	3.9	69.9	70.1	22.3	5.4	0.10	195	300	400	4.6	74.3	72.6	23.2	0.25	0.55
24	3.1	70.7	70.1	22.4	5.5	0.14	210	300	390	9.1	74.0	73.4	23.3	0.35	0.54
25	3.7	71.3	70.0	22.4	3.8	0.78	210	300	370	8.4	74.4	67.4	22.3	0.22	0.70
26	2.7	70.7	71.1	22.4	3.9	0.56	210	300	390	13.4	73.6	72.6	23.2	0.23	0.36
27	--	73.4	69.8	22.1	0.1	0.06	205	305	385	12.7	73.6	71.4	22.3	1.3	0.04
28	4.0	68.0	69.2	22.0	3.3	3.5	210	275	390	20.2	73.8	73.4	22.9	2.3	0.18
29	3.0	67.4	68.7	22.0	3.6	3.7	220	300	390	14.0	--	72.6	23.3	1.7	0.49

[a]Pure UF_4 = 75.8% U(IV), 24.2%F
Pure $UF_4 \cdot 3/4H_2O$ = 72.7% U(IV), 23.2%F, 4.1% H_2O

[b]Ammonium oxalate insoluble.

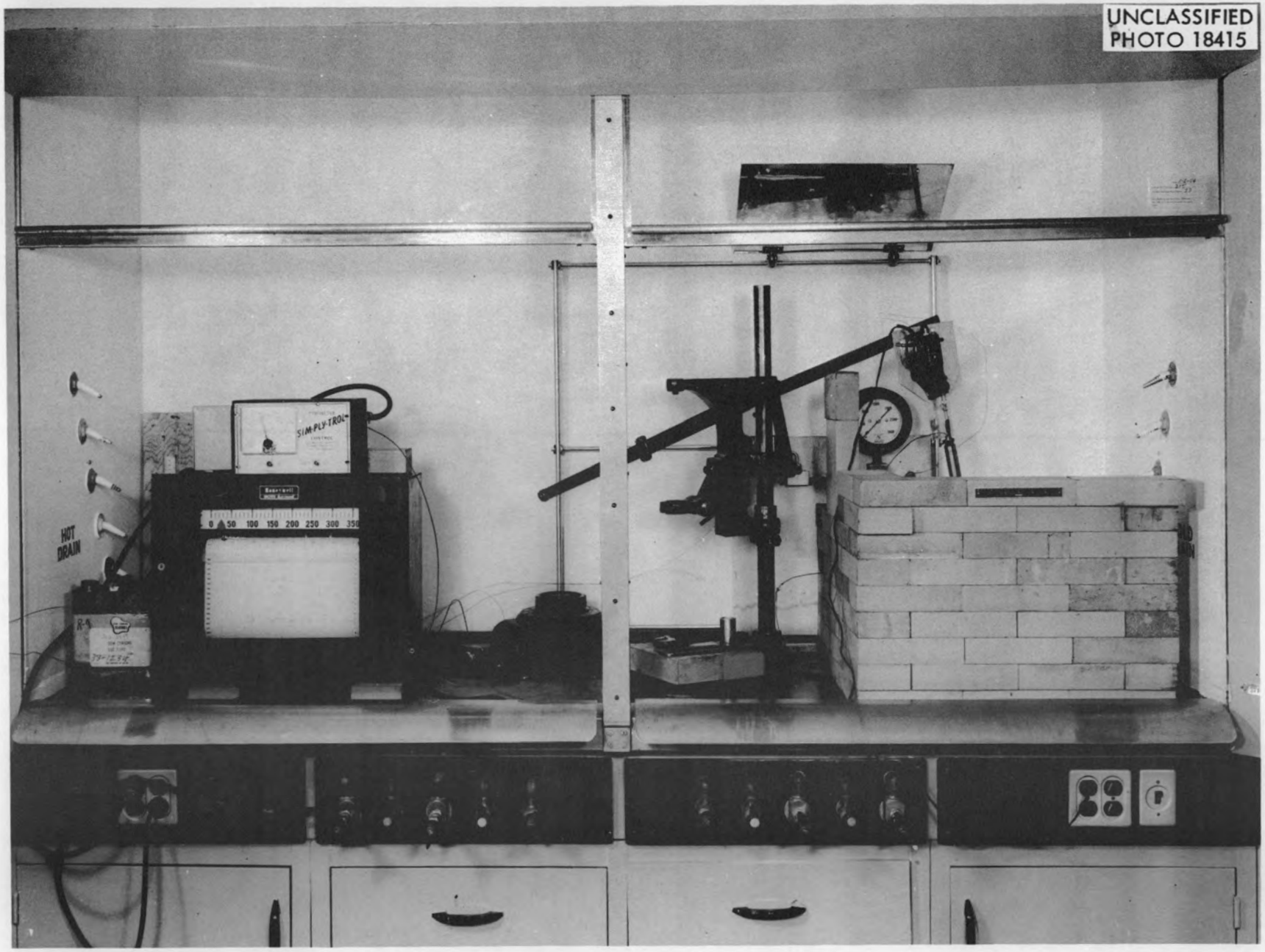

Fig. 4. High Pressure Carbonate Leaching Equipment.

UNCLASSIFIED
PHOTO 18414

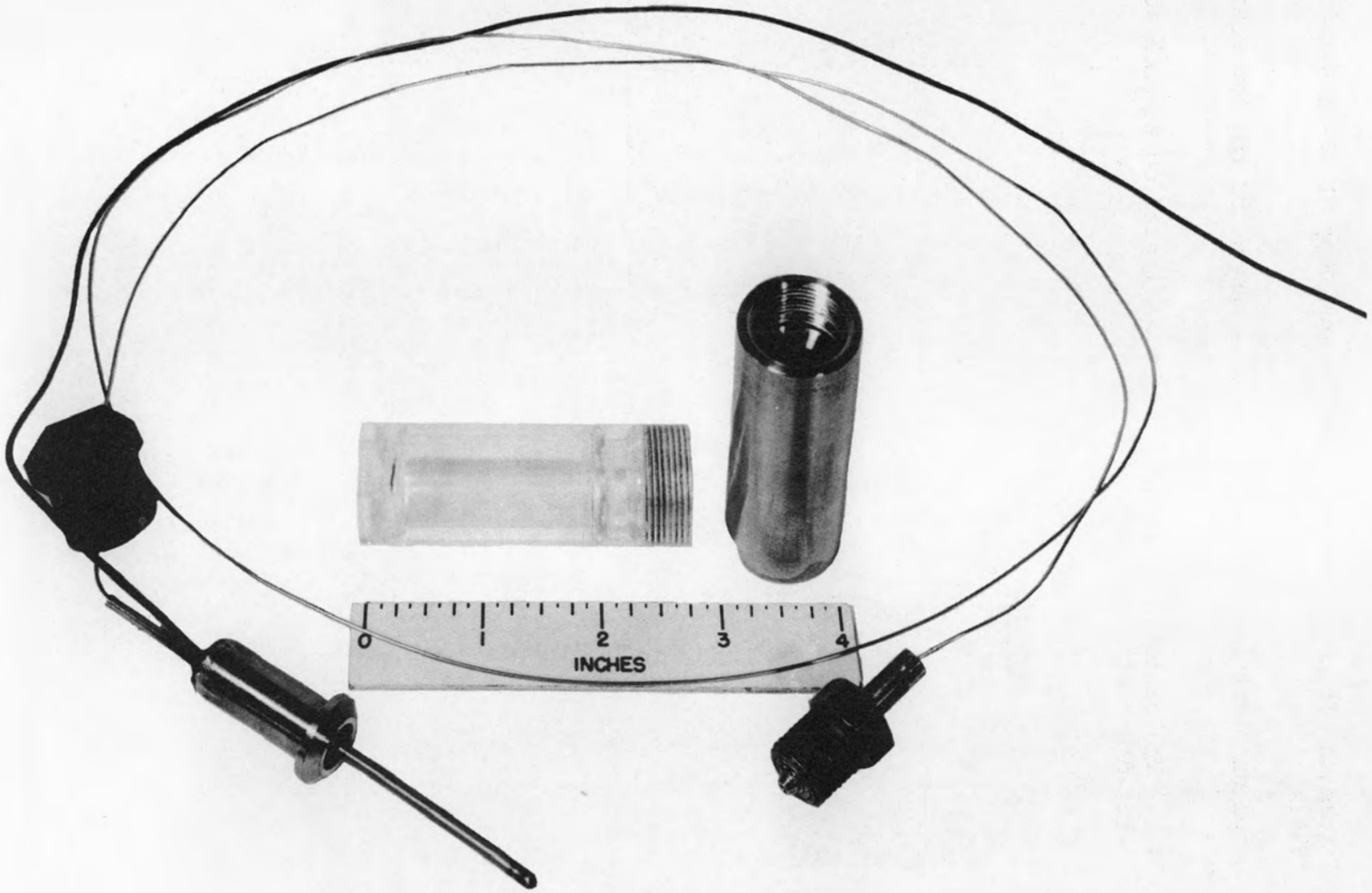

Fig. 5. Details of High Pressure Bomb.

ERRATA

Please make the following corrections in your copy of CF-56-9-100 (Sept. 15, 1956).

p. 6, paragraph on electrolytic reduction: The numbers for the tap densities are reversed.

p. 7, Sec. 4.1: The cationic phosphoric resin was tested on a bench scale, not in the 2-in.-dia contactor.

p. 13, Sec. 4.3: 36-in.-dia column, not 26-in.