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~~J. Lamb~~ T. Bennett / 1034A

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52-566
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INTER-COMPANY CORRESPONDENCE

(INSERT NAME) COMPANY CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation

LOCATION Post Office Box P
OAK RIDGE, TENN.

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TO LOCATION Mr. S. H. Smiley

DATE July 28, 1950

F27933

ANSWERING LETTER DATE

ATTENTION

COPY TO Messrs. D. C. Brater
B. A. Kress

SUBJECT Tower Reactor Studies
KDD-212

In compliance with your request, the undersigned submit a summary of preliminary studies concerning the tower reactor for conversion of UF_4 to UF_6. The small amount of experimental data available indicates that the tower reactor may prove to be an economical and efficient means of reacting fluorine with UF_4. It may well be that this reactor can be developed to the point that it satisfies the following goal: To introduce stoichiometric amounts of UF_4 and fluorine into a simple reactor and obtain as off-gas relatively pure UF_6, with only small amounts of unreacted UF_4 remaining in the off-gas and ash. Such UF_6 might be liquefied by compression or fed as a gas directly from the reactor into the cascade after removal of residual dust.

Several schemes were considered (Drawing S-1339) in an attempt to show how the tower reactor might be employed. Also, some of the experimental data needed and some anticipated advantages and disadvantages for each scheme were outlined (Table I). Lack of experimental data prevents complete evaluation of any one scheme at the present time. Data are required for study of the following problems:

1. Reaction rates under various conditions of flow, temperature, concentrations and excesses of reactants.

2. The effect on the reaction of UF_6, O_2 and H_2 as diluents in the fluorine.

3. Means for charging and discharging the UF_4 without plugging the reactor where use of a minimum of diluent gas is desired.

4. Means for fluorine cleanup in case it is necessary to operate the tower reactor with much greater than stoichiometric amounts of fluorine.

5. The problem of dust in the off-gas and methods for dust removal.

It is recommended that initial experimental studies be carried out in the more simply arranged tower, such as reactor arrangements 1 and 2 (Drawing S-1339). Reactor arrangement 1 employs countercurrent flow of powder and gas, and in reactor arrangement 2 the flows are concurrent. Most of the information needed for evaluating the other reactors probably can be obtained with these two arrangements.

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This document has been approved for release to the public by: 1/31/96
Technical Information Officer
Oak Ridge K-25 Site

Carbide and Carbon Chemicals Corporation, Operating Contractor for the U.S. Atomic Energy Commission.

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In case it develops that the lengths of reactor arrangements 1 and 2 would be excessive, or that the fluorine losses would be high, recycling of gas to increase the reaction rate might be tried, as shown for arrangements 3 and 4. Flows in the cleanup and main reaction sections are countercurrent and concurrent, respectively.

If bringing the powder and gas together as in a jet increases the reaction rate, reactor arrangements 5, 6 and 7 may prove advantageous. Gas and powder flows may be concurrent or countercurrent in the cleanup section of each reactor, with the flow being concurrent in each main reactor section. Additional data would be required for selection of the best of the three arrangements.

By recycling the powder, an excess of UF_4 would be maintained throughout reactor arrangements 8 and 9 to increase tower efficiency. In arrangement 8 the flows are countercurrent, and in arrangement 9 the flows are concurrent.

Vibrating trays for fluorine cleanup would be used with the towers in reactor arrangements 10 and 11. Flows through the tower would be concurrent, and flows through the trays could be either concurrent or countercurrent.

Reactor arrangements 12 and 13 would utilize a vibrating tray, paddle, or other type reactor following the tower for both powder and fluorine cleanup.

It is expected that many of the schemes presented will be shown to be impractical as additional experimental data are obtained; therefore, it is assumed that these and other proposals will be re-evaluated continually as the experimental work progresses.

J. Jacobson

J. Jacobson

J E Moore

J. E. Moore

JJ:JEM:lee
Attachment

(J.E.Moore - K25RC)

TABLE I

COMPARISON OF TOWER REACTOR APPLICATIONS

FOR CONVERSION OF UF_4 TO UF_6

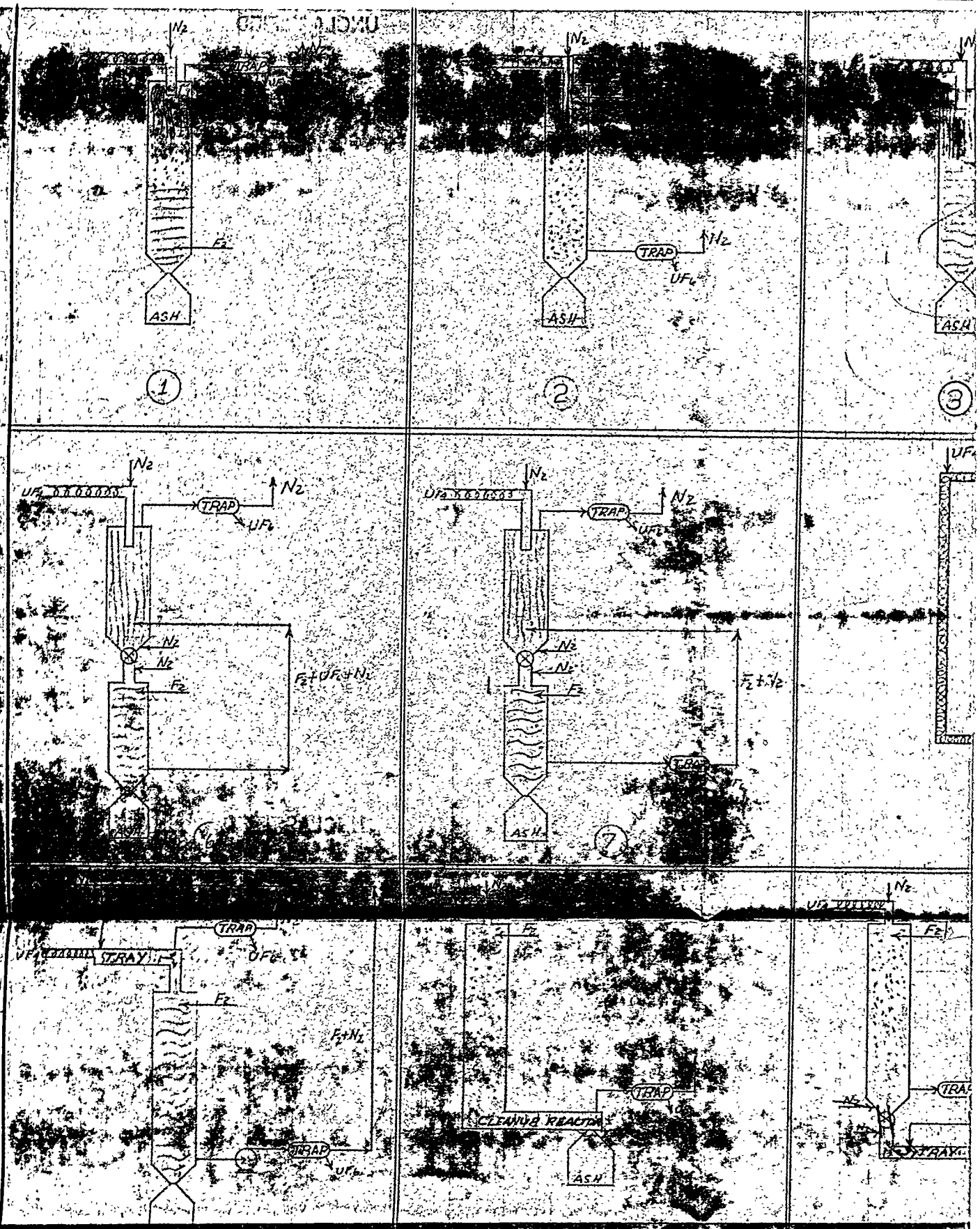
Reactor Arrangement	Experimental Data Needed	Auxiliary Equipment Required (Partial List)	Anticipated Advantages	Anticipated Disadvantages	Remarks
1	Countercurrent reaction of F_2 and UF_4 in approximately stoichiometric quantities. Effect of powder dispersion.	1 Dust Collector 1 Cold Trap	Concentrated UF_6 obtained. Simple apparatus. No gas recycle. No powder recycle. Minimum of buffer gas required.	Relatively high dust burden in gas. Tower may be too long to be practical.	Reactor may be used to study quantities of reactants other than stoichiometric, diluted as well as concentrated. Countercurrent flow may distribute the reaction zone over the whole tower.
2	Concurrent reaction of F_2 and UF_4 in approx. stoichiometric quantities. Effect of various types of jets.	1 Dust Collector 1 Cold Trap	Concentrated UF_6 obtained. Simple apparatus. No gas recycle. No powder recycle. Minimum of buffer gas required. Low dust burden.	Tower may be excessively long for acceptably complete reaction.	Reactor may be used to study quantities of reactants other than stoichiometric, diluted as well as concentrated. Reaction zone may be restricted to immediate vicinity of the jet.
3	Countercurrent reaction of a deficient amount of F_2 (diluted with UF_6) and UF_4 (F_2 cleanup). Concurrent reaction of an excess of F_2 (diluted with UF_6) and UF_4 (powder cleanup).	2 Dust Collectors 1 Cold Trap 1 Pump	Concentrated UF_6 obtained. Smaller reactor than Nos. 1 and 2. No powder recycle. Minimum of buffer gas required.	High dust burden in clean-up gas. Additional equipment required. Gas recycle.	Effect of UF_6 dilution may be studied in comparison with tests in reactor 4.
4	Countercurrent reaction of a deficient amount of F_2 (diluted with N_2 and O_2) and UF_4 (F_2 cleanup). Concurrent reaction of an excess of F_2 (diluted with O_2 and N_2) and UF_4 (powder cleanup).	2 Dust Collectors 2 Cold Traps 1 Pump	Dust burden less than No. 3. No powder recycle. Minimum of buffer gas required.	Dilute UF_6 obtained. Two product take-off points required.	This arrangement closely parallels Phase I plant design.
5	Concurrent reaction of a deficient amount of F_2 (diluted with N_2) and UF_4. Concurrent reaction of an excess of F_2 (diluted with N_2 and UF_6) and UF_4. Investigate whether powder adheres to tapered walls.	2 Dust Collectors 2 Cold Traps 1 Pump	Incorporates two jets in a compound reactor. No powder recycle. Minimum of buffer gas required.	Plugging of tapered section. Dust burden in F_2 cleanup section (top part) may be high. Apparatus design may be critical. Two product take-off points required.	
6	Countercurrent (or concurrent) reaction of a deficient amount of F_2 (diluted with N_2 and UF_6) and UF_4 (F_2 cleanup). Concurrent reaction of UF_4 and excess of F_2 (powder cleanup).	2 Dust Collectors 1 Cold Trap 1 Set of Powder Transfer Equipment	One product take-off point required. No gas recycle equipment required.	Three buffer points required. Additional powder transfer equipment required. High dust burden at product take-off.	Concurrent or countercurrent flow may be used in top section of reactor. Concentration of UF_6 obtained at product take-off depends upon amount of buffer gas required.

TABLE I

COMPARISON OF TOWER REACTOR APPLICATIONS

FOR CONVERSION OF UF_4 TO UF_6

Reactor Arrangement	Experimental Data Needed	Auxiliary Equipment Required (Partial List)	Anticipated Advantages	Anticipated Disadvantages	Remarks
7	Countercurrent (or concurrent) reaction of a deficient amount of F_2 (diluted with N_2) and UF_4 (F_2 cleanup). Concurrent reaction of UF_4 and excess of F_2 (powder cleanup).	2 Dust Collectors 2 Cold Traps 1 Set of Powder Transfer Equipment	Lower gas flow in F_2 cleanup section. Less dust burden than in No.6.	Three buffer points required. Powder transfer equipment needed. Two product take-off points required.	See remarks - No. 6.
8 and 9	Countercurrent or concurrent reaction with a deficient amount of F_2.	1 Dust Collector 1 Cold Trap 1 Set of Powder Recycling Equip.	High F_2 utilization. Concentrated UF_6 obtained. No gas recycle. One product take-off point.	High dust burden at product take-off. Powder recycle problem. Periodic shutdown for ash cleanup. Radiation problems. Two buffer points required.	Dust burden in No. 8 may be more than in No. 9.
10 and 11	Concurrent or countercurrent reaction of a deficient amount of F_2 (diluted with N_2) and UF_4 in tray reactors (F_2 cleanup; data are available). Concurrent reaction of UF_4 and an excess of F_2 in the tower (powder cleanup).	2 Dust Collectors 2 Cold Traps 1 Pump 1 Tray Reactor	Overall height of reactor reduced. High dust burden.	Two types of reactors required. Two product take-off points required. Diluted F_2 in tower reactor section.	Closely parallels Phase I design. Gas flow in tray depends upon efficiency of tower reactor.
12	Concurrent reaction of UF_4 and stoichiometric F_2 in tower reactor. Concurrent reaction of a deficient amount of F_2 (diluted with UF_6) and UF_4 in tray, paddle, or other type reactor.	1 Dust Collector 1 Cold Trap 1 Cleanup Reactor	One product take-off point. Concentrated UF_6 obtained. Minimum buffer gas.	Two types of reactors required. Caking problem in cleanup reactor. High dust burden at product take-off point. Radiation problem. Batch operation of cleanup reactor.	UF_4 excess can be maintained in cleanup section.
13	Concurrent reaction of UF_4 and stoichiometric F_2 in tower. Concurrent reaction of stoichiometric amounts of UF_4 and F_2 (diluted with N_2) in tray reactor.	2 Dust Collectors 2 Cold Traps 1 Cleanup Reactor 1 Powder Transfer Device	Low UF_6 content in cleanup section (in case UF_6 inhibits reaction.)	Two types of reactors and powder transfer device required. Three buffer points required. Two product take-off points required.	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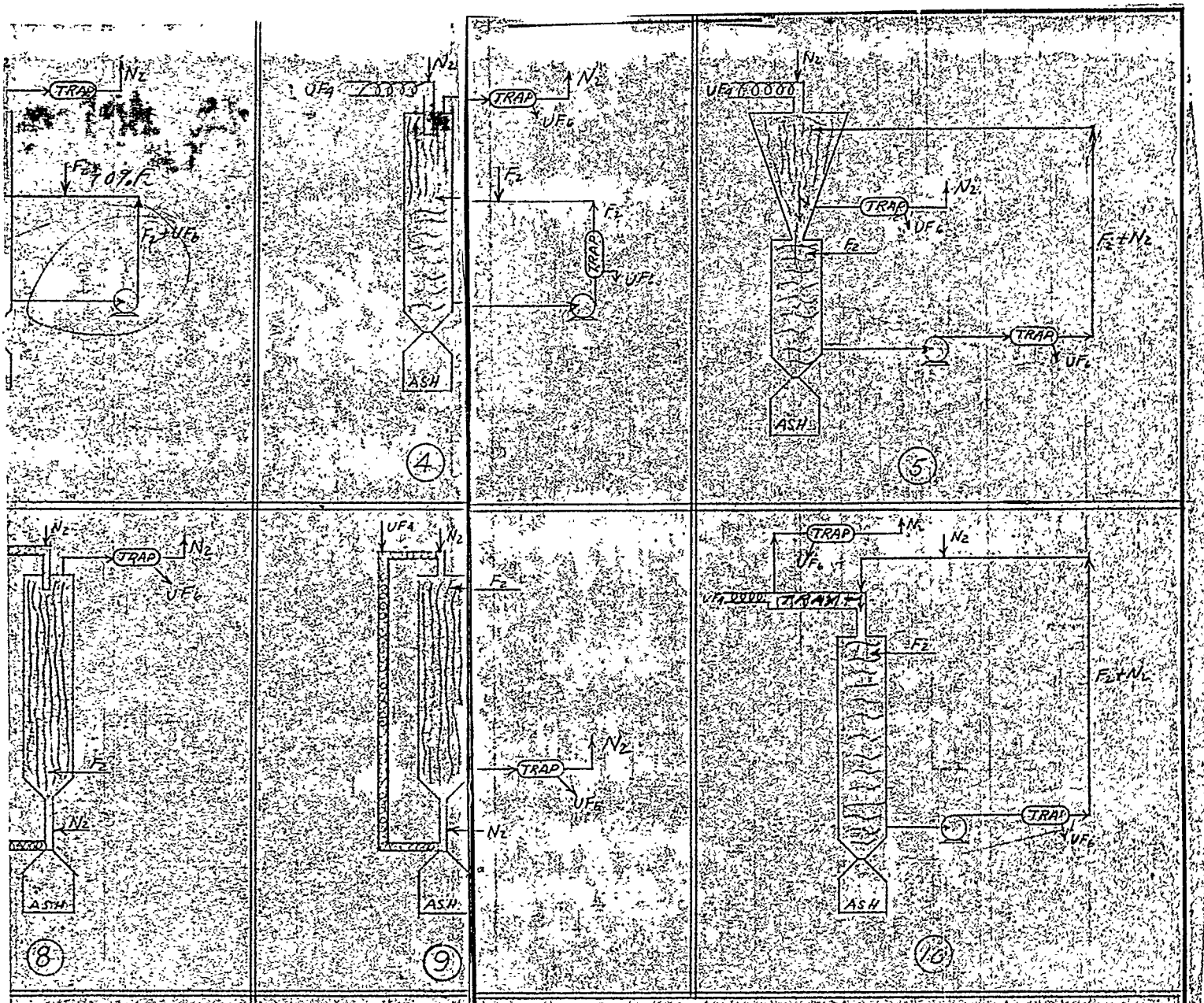

NO.	DESCRIPTION	
	REVISIONS	K-25 ENGINEERING DEVELOPMENT DIVISION
1	ADDED: LEGEND & NOTES; ADDED: SYMBOLS TO DWG.	CARBIDE AND CARBON CHEMICALS CORPORATION
		POWER REACTOR ARRANGEMENTS
		DRAWN BY: J. JACOBSON APPV'D BY:
		CHECKED BY: J.E. Moore DATE: 7-24-50

7-28-50

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