15/05/003/001

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CONOCO INC.

DATE 2/11/92

MOBIL OIL CORPORATION

RESEARCH DEPARTMENT

TECHNICAL MEMORANDUM NO. 66-3

REVIEW OF GAS DISTRIBUTORS, MIST RECOVERY SYSTEMS AND RETORT DESIGNS USED DURING STAGE I WITH THE GAS COMBUSTION PROCESS

ANVIL POINTS OIL SHALE RESEARCH CENTER

Rifle, Colorado

May 25, 1966

Author:

E. E. Turner

Approval:

P. H. Cramer
Program Manager

NOTICE

25\05\003\001

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NOTICE

The primary object of the Anvil Points Oil Shale Research Center TECHNICAL MEMORANDUM is to advise authorized personnel employed by the Participating Parties[1] that various activities are in progress or that certain significant data have been obtained within the Research Center

These TECHNICAL MEMORANDA have been prepared to provide rapid, on-the-spot reporting of research currently in progress at Anvil Points. The conclusions drawn by project personnel are tentative and may be subject to change as work progresses. The TECHNICAL MEMORANDA have not been edited in detail.

[1] Mobil Oil Corporation, Project Manager

Humble Oil and Refining Company

Continental Oil Company
Pan American Petroleum Corporation
Phillips Petroleum Company
Sinclair Research, Inc.

REVIEW OF GAS DISTRIBUTORS, MIST RECOVERY SYSTEMS AND RETORT DESIGNS USED DUPING STAGE I WITH THE GAS COMBUSTION PROCESS

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REVIEW OF GAS DISTRIBUTORS, MIST RECOVERY SYSTEMS AND RETORT DESIGNS USED DURING STAGE I WITH THE GAS COMBUSTION PROCESS

Summary

There have been many changes in the air distributors, mist recovery systems and retort designs in Retorts No. 1 and No. 2 since the current project at Anvil Points was started. This information is contained in various reports and memoranda. This review is an attempt to consolidate the pertinent information for ready reference. Corrections, additions, or deletions are solicited.

These changes in hardware were made to improve operability and yields and to obtain process and engineering data for designing Retort No. 3 and for an understanding of the factors affecting the Gas Combustion retorting process. A companion report will be forthcoming to summarize the various conclusions from these changes.

Retort No. 1

The first runs in Retort No. 1 were made using the Bureau of Mines rocket type air distributor, retort and recovery system. These three items plus the recycle distributor comprise the major hardware items in the unit. A change in retort letter designation for Retort No. 1 reflects a change in the air distributor design. The different air distributors are given in Table 1 with an explanation for each retort letter type. The design for the Bureau of Mines rocket type air distributor is shown in Figure 1.

The mist recovery system has been changed from time to time to improve material balances and to test out various pieces of hardware in the recovery system. A summary of these systems is shown in Table 2. Schematic drawings of the recovery systems are presented in Figures 2 through 10.

Table 3 is a summary of the runs made in Retort No. 1 which shows the air distributor, mist recovery system and retort designs used. The air injection velocities are calculated on a standard condition of: 500 lbs/(hr)(ft^2), 5,000 SCF/T air rate (2/3 to peripheral - 1/3 to center) and 16,000 SCF/T recycle rate. To obtain the velocities for a particular run, it is necessary to use the conditions for that run. A rather wide range of injection velocities has been used (5 ft/sec to 215 ft/sec). Some of the velocities were even higher although they are not indicated on the table. It should be mentioned that the rocket type distributor used initially had a very low velocity (5 ft/sec).

Only two types of recycle gas distributors have been used in Retort No. 1. They are listed below:

Date	Drawing No.	Description	Cross Sectional Area, Sq. Ft.	Velocity ft/sec
12/18/64	RD-16	2" pipe with 1" X 3 5/16" slot pointing down	0.0230	130
--	--	4" pipe opening flush with wall (below the turntable into plenium chamber)	0.0884	35

Essentially all of the runs were made with the 4 inch pipe opening recycle distributor flush with the retort wall. However, the inlet was below the turntable which afforded a plenium chamber for gas distribution.

Retort No. 2

As in Retort No. 1, the first runs in Retort No. 2 were made using the Bureau of Mines type air distributor (Figure 11), retort (RB-I) and recovery system (B-1). A large number of changes have been made in these three systems to improve operations and yields and to obtain engineering data on different types of hardware. The changes in retort configuration are indicated by the letters RB followed by Roman Numerals. The different recovery systems are indicated by the letter "B" followed by numbers and the air distributors are designated by Roman Numerals.

Changes were made in the recovery system to improve material balances and to obtain experience and engineering data on various types of equipment. The major items in the mist recovery systems along with the changes are summarized in Table 5. Schematic drawings of the systems are presented in Figures 12 through 22.

The different type retorts used in these studies are given in Table 6. The significant changes in the retort were the elimination of the tapered section used by the Bureau of Mines and the installation of the stainless steel liner.

A more extensive study was made with air distributors in Retort No. 2 than in Retort No. 1. The various horizontal and riser distributors are given in Figure 23 (Drawing RD-40).

Table 4 summarizes the runs made in Retort No. 2. Pertinent data such as run number, date, retort number, recovery system, air distributor, cross sectional area, injection velocities and shale size are given in the table. The injection velocities are calculated at the same process conditions, namely: 500 lbs/(hr)(ft^2) shale rate, 4,500 SCF/T air rate and 16,000 SCF/T recycle gas rates. To get the actual injection velocity for a particular run the actual process conditions used in the run should be used. The injection velocities varied over a wide range (25 to 260 ft/sec).

Very limited studies have been made on recycle gas distributor design in Retort No. 2. Only one distributor has been used; however, recycle gas has been injected below the roll feeder, for a very short period, without any apparent adverse effect.

Pertinent data on the recycle distributor used in Retort No. 2 follows:

Date	Drawing No.	Description	Cross Sectional Area, Sq. Ft.	Velocity ft/sec
5/10/65	RE-20	30 - 19/32" holes in 6" pipe	0.0576	205

TABLE 1

RETORT TYPE DESIGNATIONS USED IN RETORT NO. 1

Retort No.	Description*	Figure or Drawing Number
D	Rocket type air distributor	(See Figure 1)
RD	12 - 3/8" peripheral injection points (flush with wall) 1 - 9/16" X 9/16" center injection points (9" above peripheral injection points)	RC-17
RD-1	12 - 3/8" peripheral injection points 1 - 9/16" X 9/16" center injection point	RC-17
RF	8 annular openings in peripheral points (to force more air into center distributor)	RC-17
RG	1/4" tubes installed in 3/8" peripheral points to force more air into center air distributor	RC-17
RH	12 - 1/4" peripheral injector points (into vessel 1") 1 - 9/16" X 9/16" center injection point (9" above peripheral injection points)	RC-23
RI	12 - 1/4" peripheral injection points (into vessel 1") 1 - 9/16" X 9/16" center injection point (2" above peripheral injection points)	RB-28
RJ	12 - 1/4" peripheral injection points (flush with wall) 1 - 9/16" X 9/16" center injection point (2" above peripheral injection points)	RC-23 RB-28
RJ-1 Cold Air Dist.	12 - 1/4" peripheral injection points (into vessel 1") 1 - 9/16" X 9/16" center injection point (2" above peripheral injection points)	RC-23 RB-28 and RB-71
Lower and Middle Hot Gas Dist.	12 - 1 1/2" peripheral injection points (flush with wall) 1 - 1 1/2" pipe with 1 1/2" X 3" slot	
Top Hot Gas Dist.	12 - 3/8" peripheral injection points (1" into vessel) flush with wall 1 - 1 1/2" pipe with 1" X 1" opening (2" above peripheral injection points)	

*All retort numbers had 20 inch stainless steel vessel.

EETurner
4/3/66

TABLE 2

RECOVERY SYSTEMS - RETORT NO. 1

Type Number	Description
M-1	Cyclone, demister, blower, cyclone skimmer in system in the order listed.
M-2	Same except for the addition of a skimmer before the blower.
M-6	Same as M-2 except a surge drum was installed before the retort cyclone.
M-7	Same as M-6 except an electrostatic precipitator was installed after the demister - also additional demister installed before the recycle blower. Order of recovery system is: surge drum, cyclone, demister, electrostatic precipitator, demister, blower, cyclone, and skimmer.
M-7A	Same as M-7 except a decanter was installed on the retort or low pressure cyclone.
M-8	Same as M-7 except an air cooled heat exchanger was installed in place of the electrostatic precipitator.
M-9	Same as M-8 except decanter placed in service with the low pressure cyclone.
M-10	Same as M-9 except the electrostatic precipitator placed in service instead of the air cooled heat exchanger.
M-11	Same as M-10 except all the make gas goes through vent purge condenser except the recycle gas. The recovery system line up is: surge drum, low pressure cyclone, decanter, demister, electrostatic precipitator, demister, recycle blower, high pressure cyclone, skimmer and vent purge for all make gas except for recycle gas.

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4/3/66

TABLE 5

RECOVERY SYSTEMS - RETORT NO. 2

Recovery System Number	Description
B-1	Low pressure cyclone, demister, blower, high pressure cyclone and skimmer recovery system in sequence given. By-pass gas returning to system just after retort outlet.
B-2	Same as B-1 except the electrostatic precipitator installed between the demister and the recycle blower.
B-3	Surge drum and air cooled heat exchanger added to system and electrostatic precipitator removed. System includes following, in order: Surge drum, low pressure cyclone, demister, air cooled heat exchanger, demister, blower, high pressure cyclone and skimmer.
B-4	Same as B-3 except electrostatic precipitator replaced the air cooled heat exchanger.
B-5	The demister before the electrostatic precipitator and the electrostatic precipitator removed from the train of the recovery system.
B-6	Demister, air cooled heat exchanger and electrostatic precipitator added to recovery system. By-pass gas returned to inlet of recycle blower.
B-7	Same as B-6 except system piped so that product could go either to the heat exchanger or to the electrostatic precipitator. All by-pass gas was returned to the top of the surge drum.
B-8	Recovery system in series as follows: Surge drum, low pressure cyclone, demister, electrostatic precipitator, recycle blower, high pressure cyclone and skimmer. By-pass gas returned to inlet of recycle blower.
B-9	Same as B-8 except the demister was removed from the train.
B-10	Same as B-9 except the low pressure cyclone was replaced by a multiclone.

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TABLE 6

RETORT DESIGNS USED IN RETORT NO. 2

Retort No.	Description	Drawing No.
RB-I	Bureau of Mines tapered section with exposed masonry inside the retort.	44 C 40008
RB-II	Tapered section removed from inside the retort.	RC-39 RB-37
RB-III	Stainless steel liner installed insde the retort. Offgas collectors (hats) installed.	RB-66 RC-52
RB-IV	Two degree tapered section installed from nine inches above air distributor extending three feet.	RB-82
RB-V	Two degree tapered section removed and new stainless steel liner installed.	RB-91
RB-VI	Offgas collectors (hats) removed from retort - offgas lines cut flush with wall.	RB-91 RC-52

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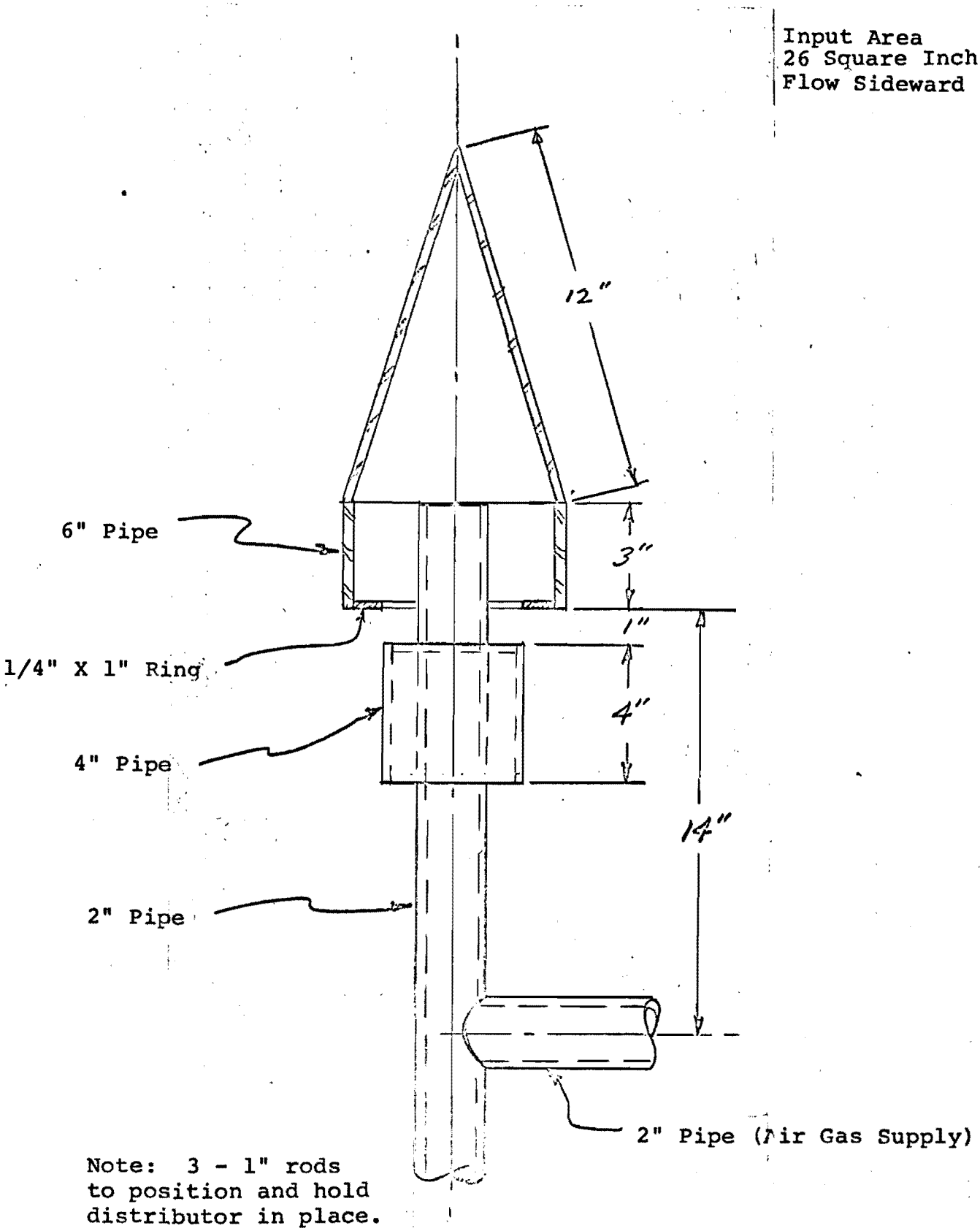
4/3/66

FIGURE 1

AIR GAS DISTRIBUTOR (ROCKET) - RETORT NO. 1

(For First Runs)



Note: 3 - 1" rods to position and hold distributor in place.

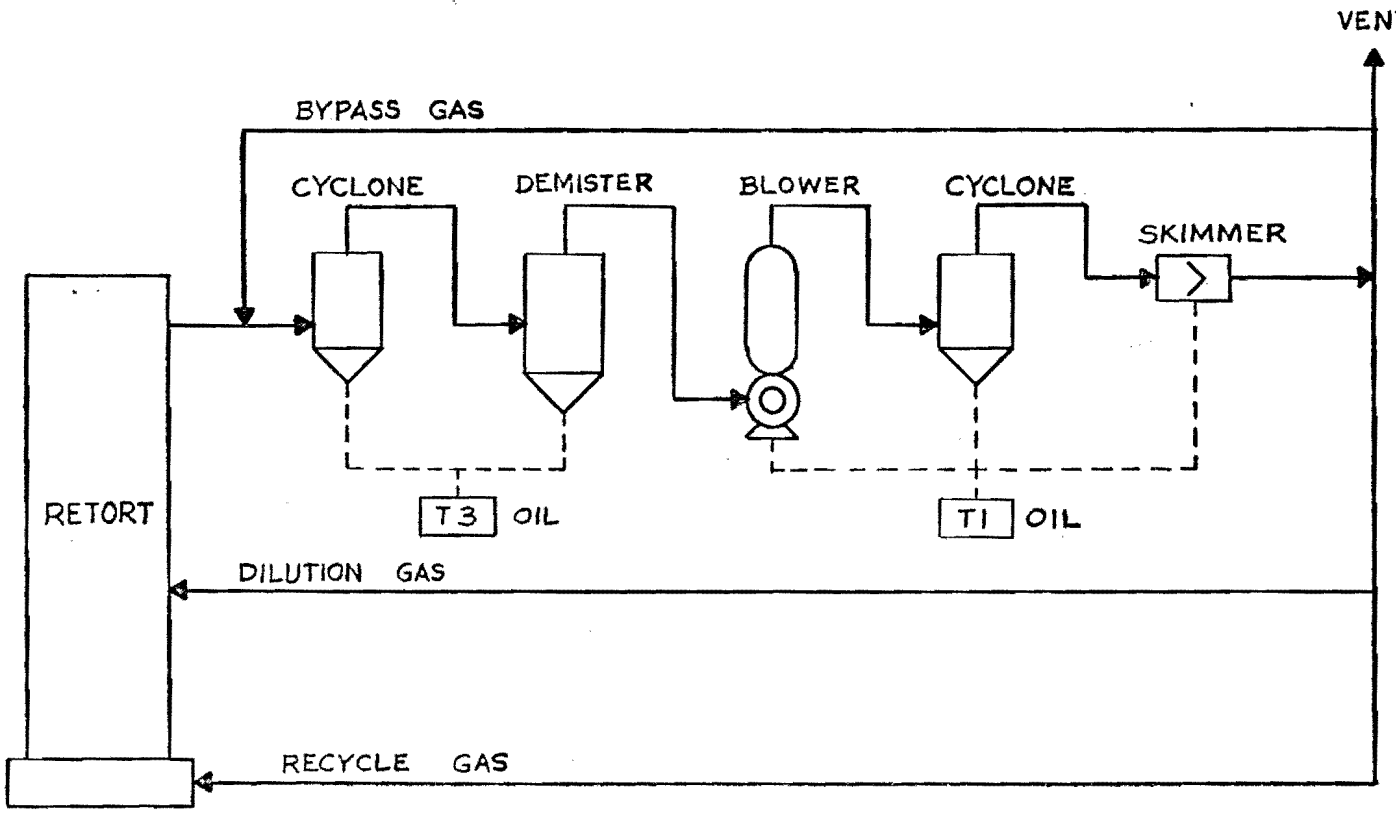


FIGURE 2

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JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Joe Hamilton

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO.1 RECOVERY SYSTEM
TYPE M-1

LOCATION

DRAWING NO. RE

D397 (8-55)

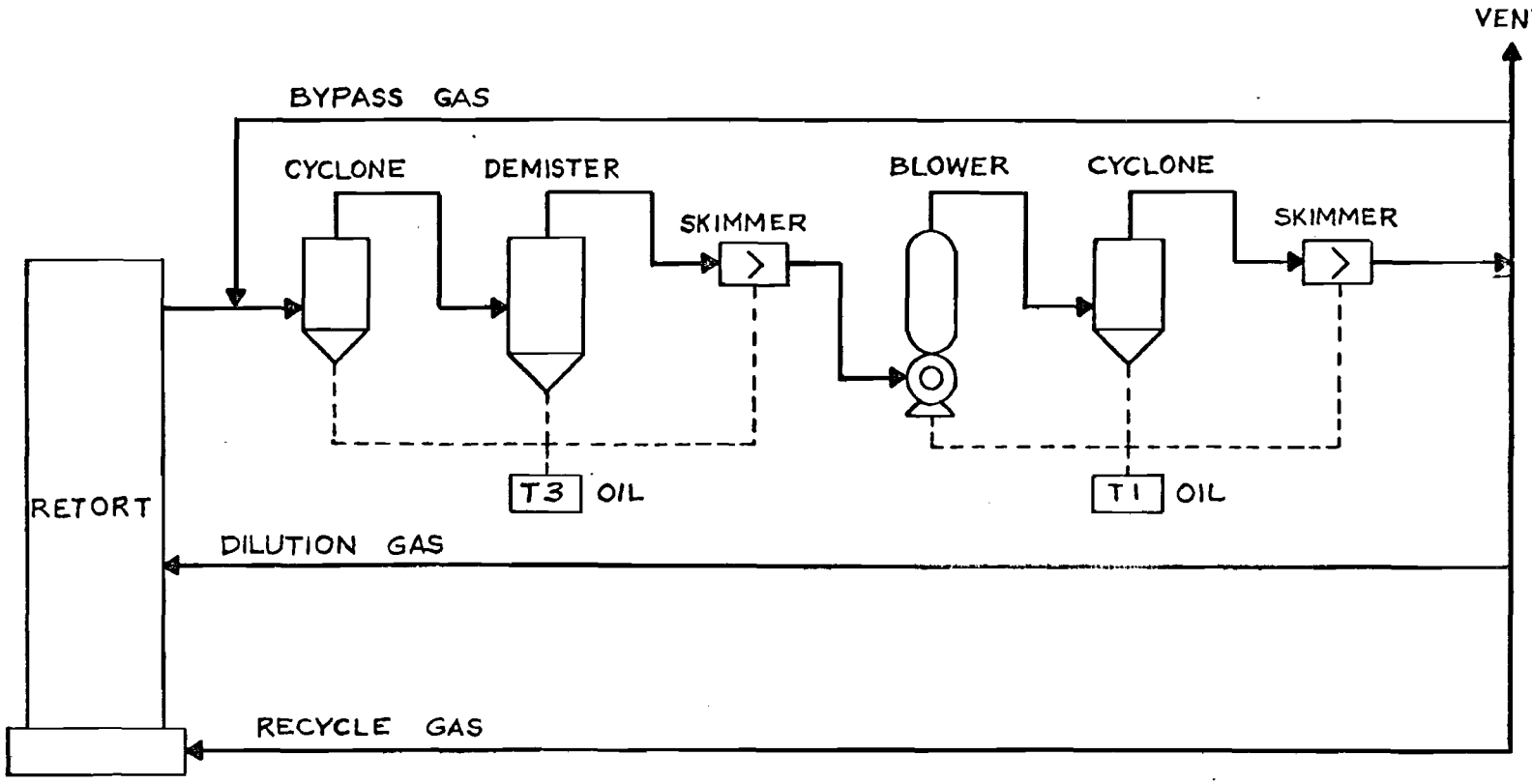

FIGURE 3

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Jos Hamilton

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO.1 RECOVERY SYSTEM TYPE M-2

LOCATION

DRAWING NO. RE

D397 (8-55)

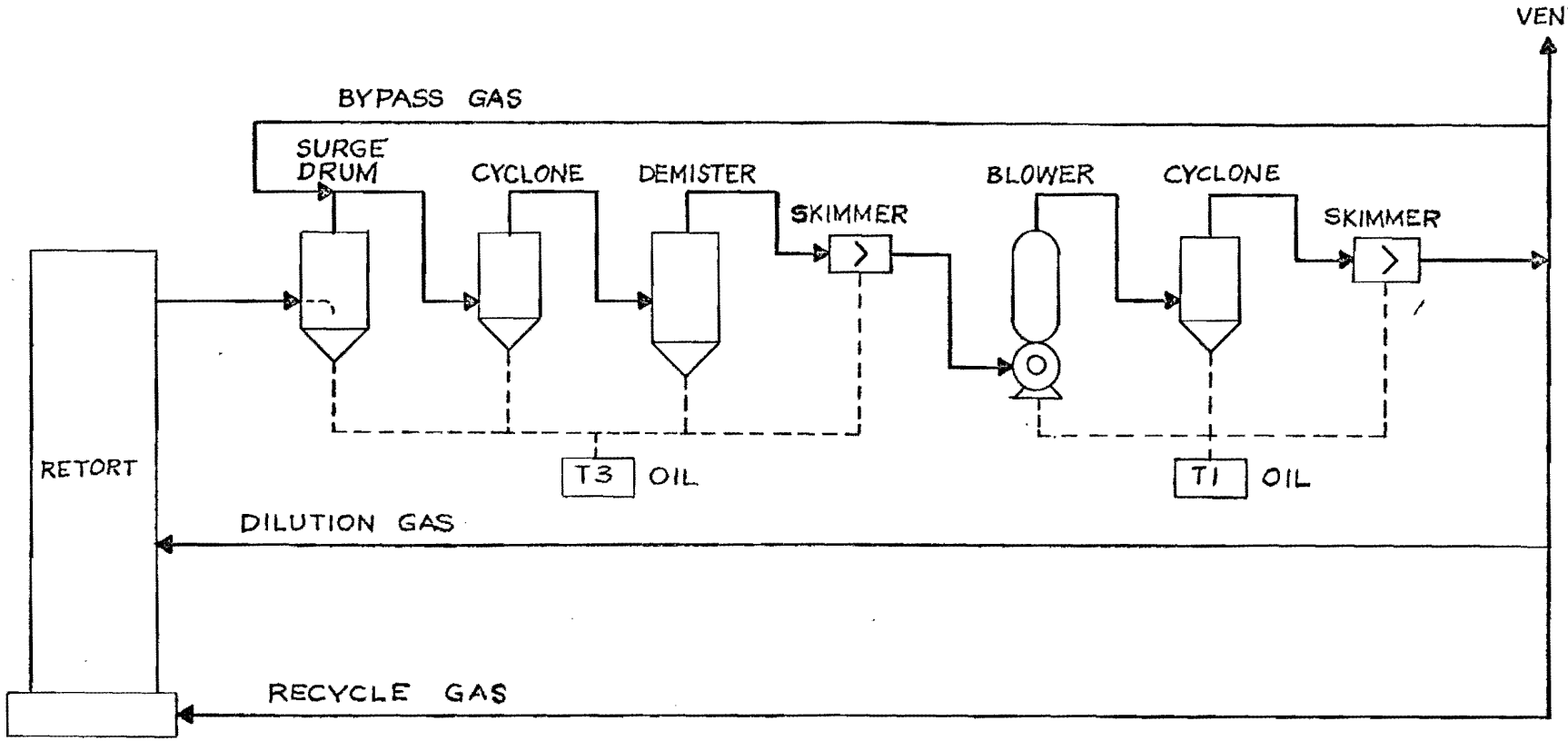

FIGURE 4

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY L. HAMILTON

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO. 1 RECOVERY SYSTEM
TYPE M-6

LOCATION

DRAWING NO. RE

D397 (8-55)

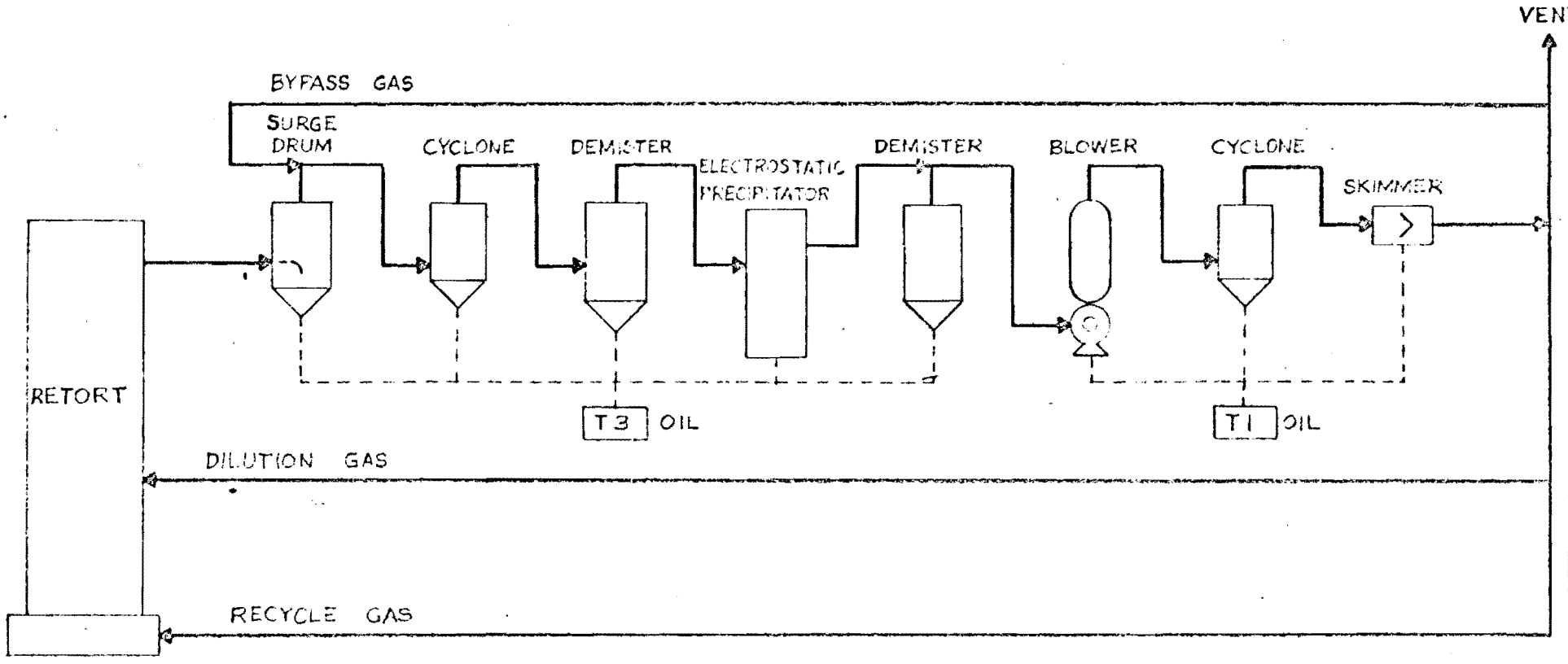

FIGURE 5

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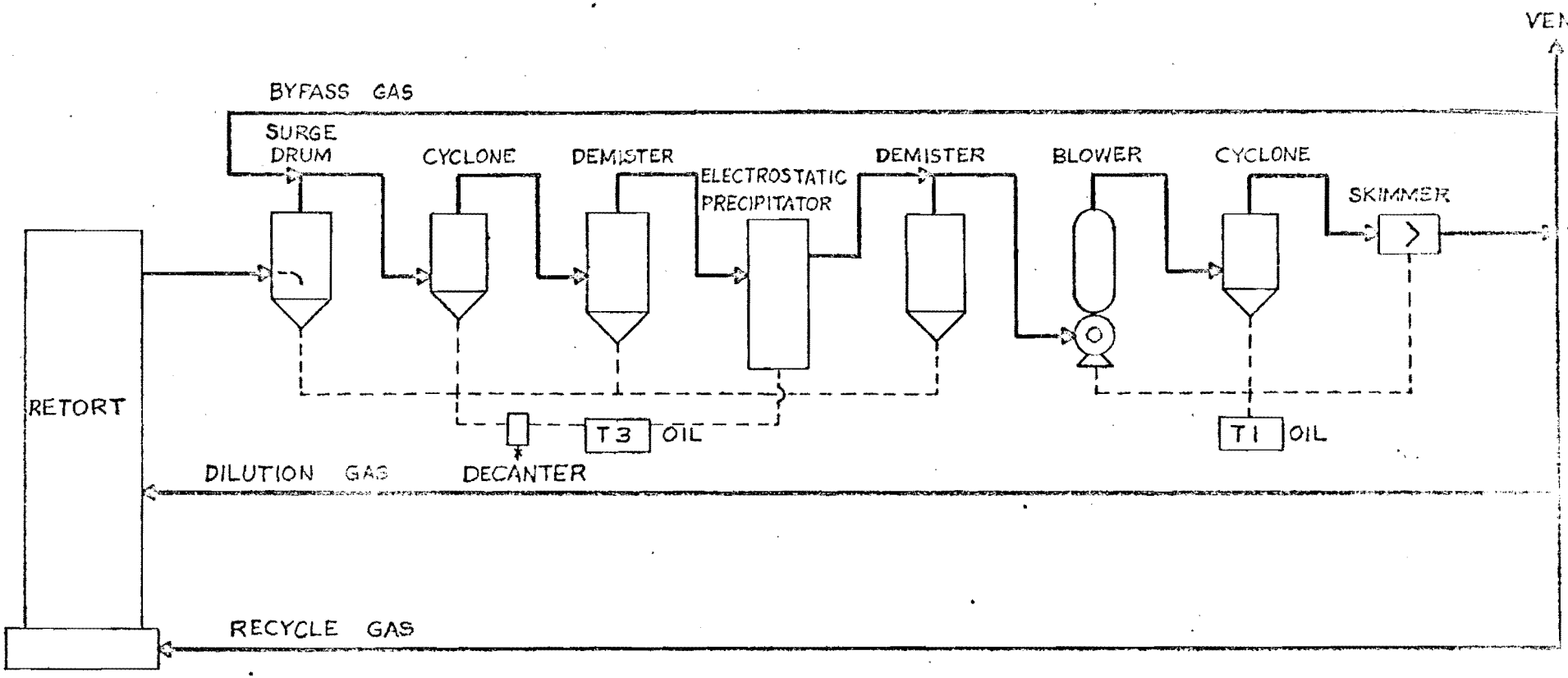
ROVED	PROCESS	DESIGN	SAFETY

SCALE ~
DRAWN BY
STARTED
COMPLETED
DIMENS. CHECK

RETORT NO.1 RECOVERY SYSTEM
TYPE M-7

LOCATION

DRAWING NO.
RE



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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Joe Hamilton

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO.1 RECOVERY SYSTEM
TYPE M-7A

LOCATION

DRAWING NO. RE

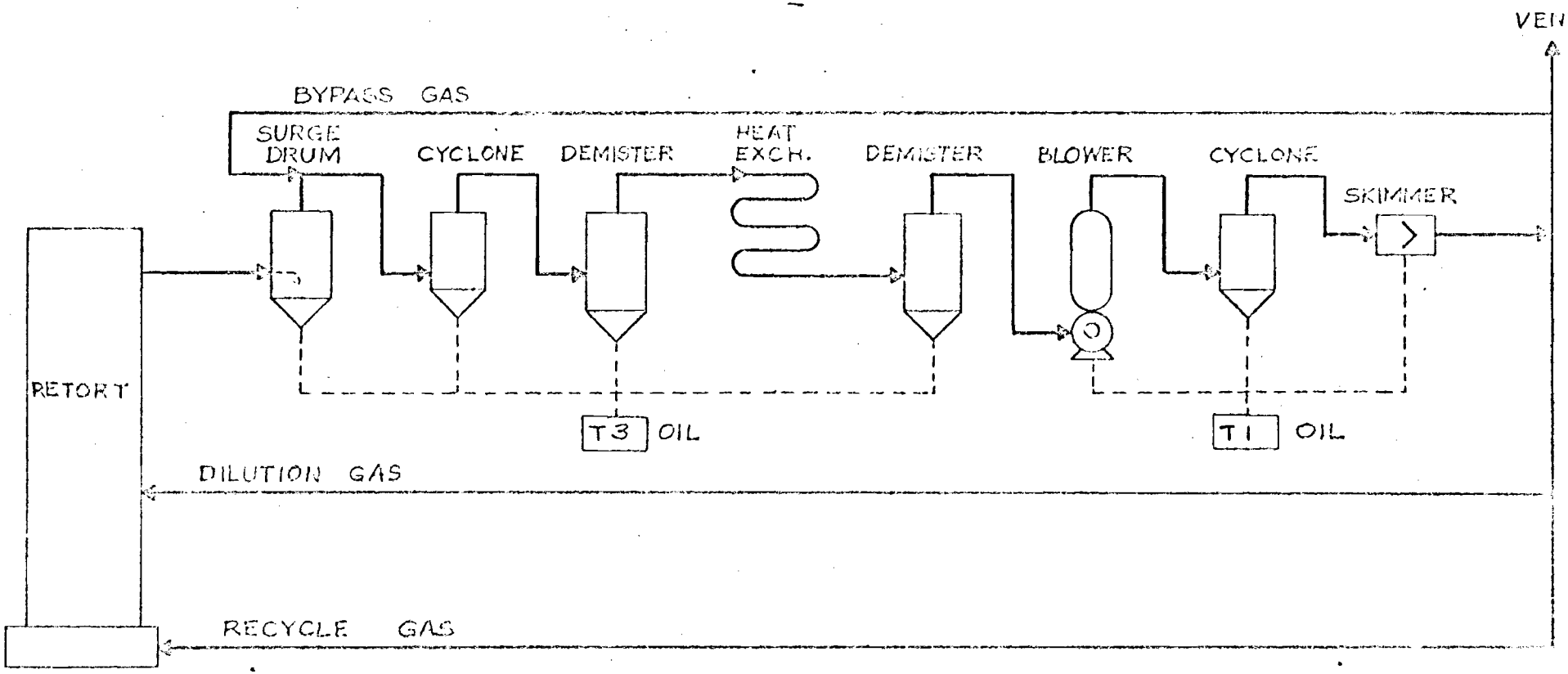

FIGURE 7

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE
DRAWN BY
STARTED
COMPLETED
DIMENS. CHECK

RETORT NO. 1 RECOVERY SYSTEM
TYPE M-8

LOCATION

DRAWING NO.
R.B.

307 (8-55)

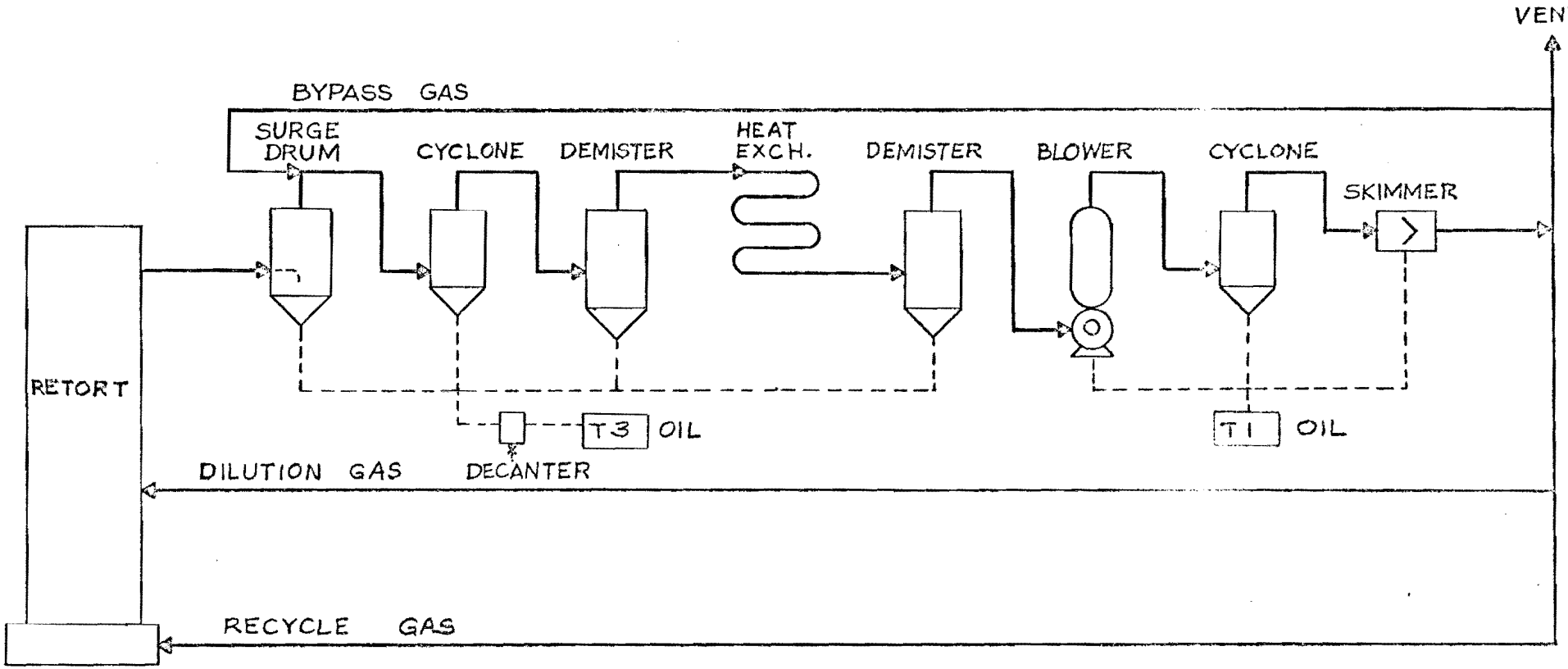

FIGURE 8

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE
DRAWN BY J. Hamilton
STARTED 2-5-65
COMPLETED 2-5-65
DIMENS. CHECK

RETORT NO. 1 RECOVERY SYSTEM
TYPE M-9

LOCATION

DRAWING NO. RE

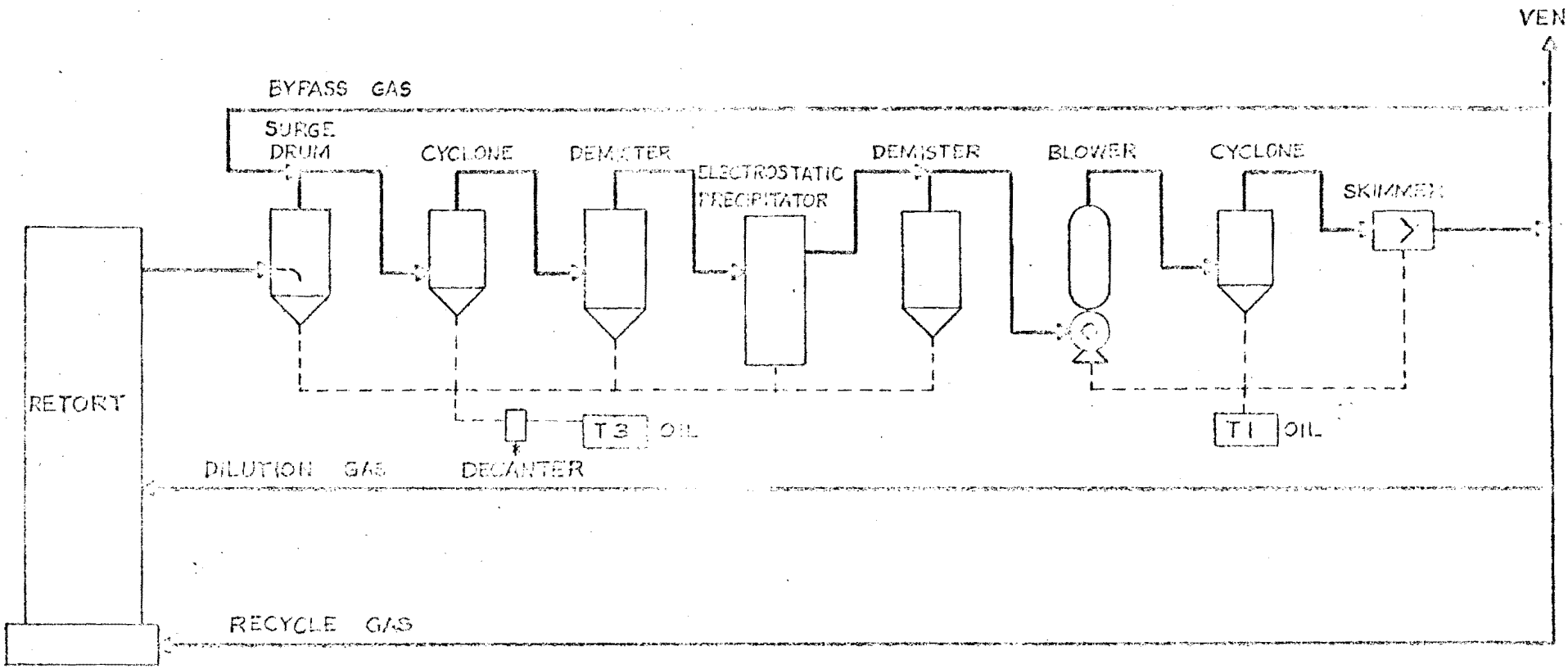

FIGURE 9

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY [illegible]

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO.1 RECOVERY SYSTEM
TYPE M-10

LOCATION

DRAWING NO. RB

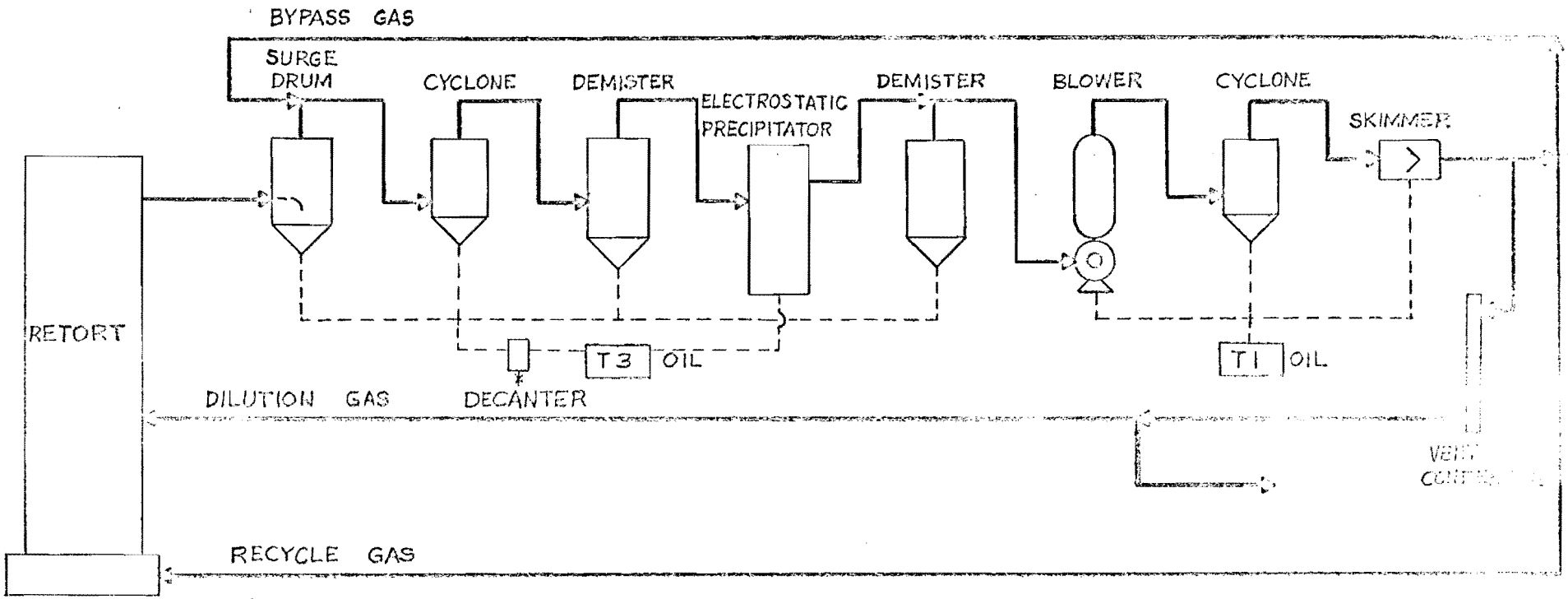

FIGURE 10

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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY J. Livingston

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

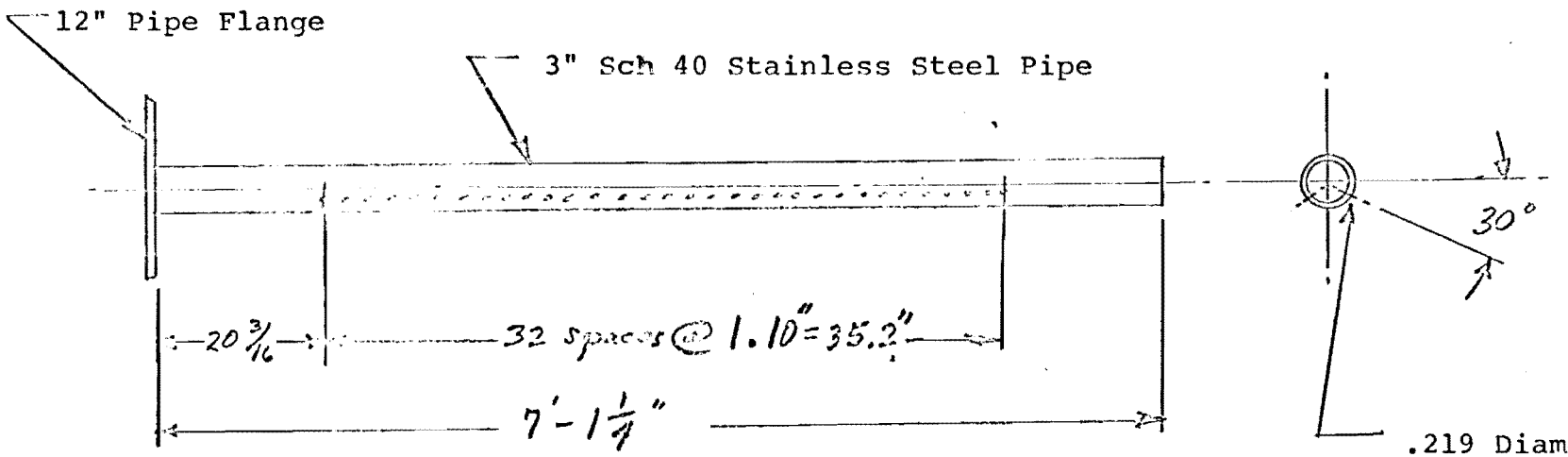
RETORT NO.1 RECOVERY SYSTEM
TYPE M-11

LOCATION

DRAWING NO. RE

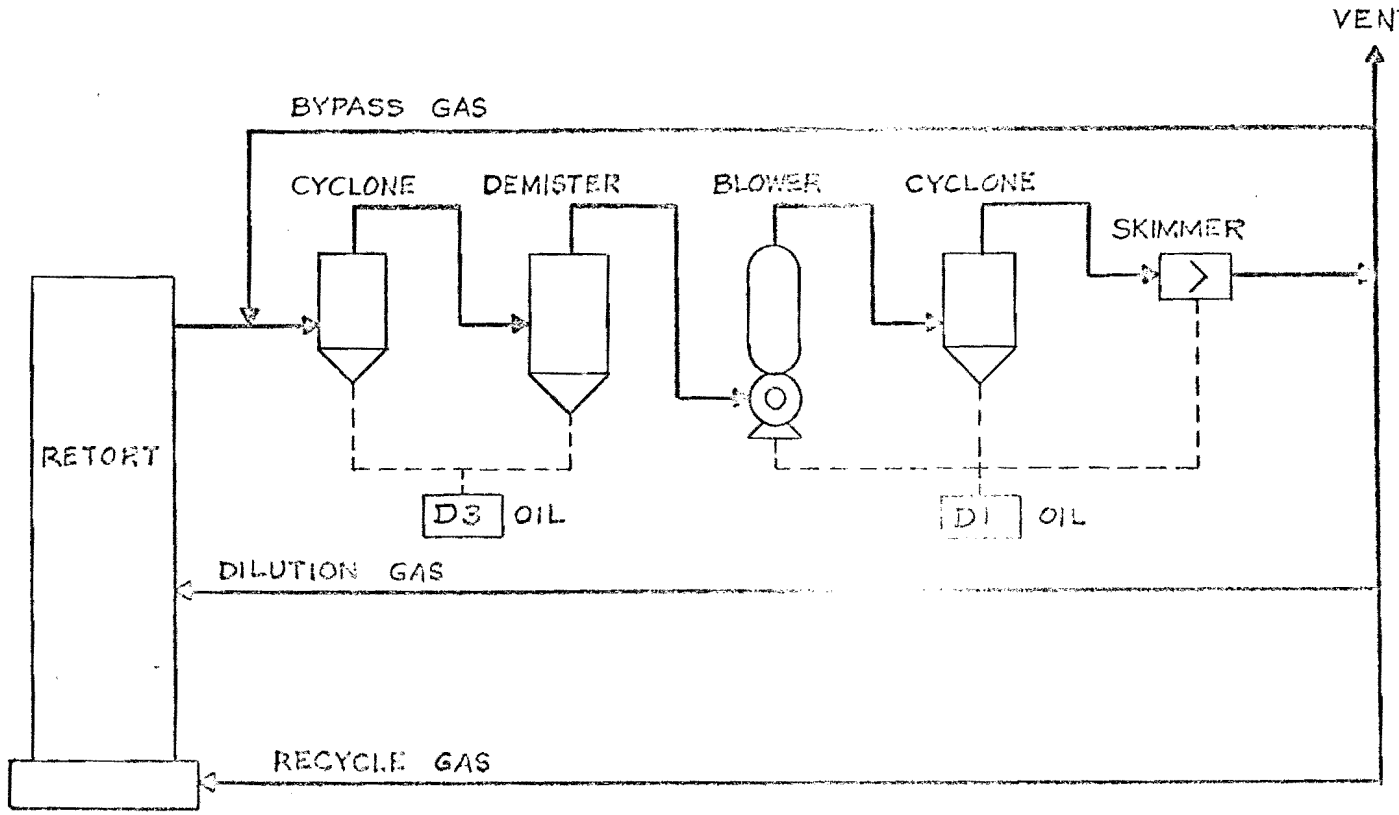
AIR GAS DISTRIBUTOR - RETORT NO. 2

(Distributor For First Run)



.219 Diameter Holes

33 on each side of pipe 30° off horizontal center line.



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APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~
DRAWN BY Jo Hamerton
STARTED 2-3-65
COMPLETED 2-5-65
DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-1

LOCATION	DRAWING NO.
	RE

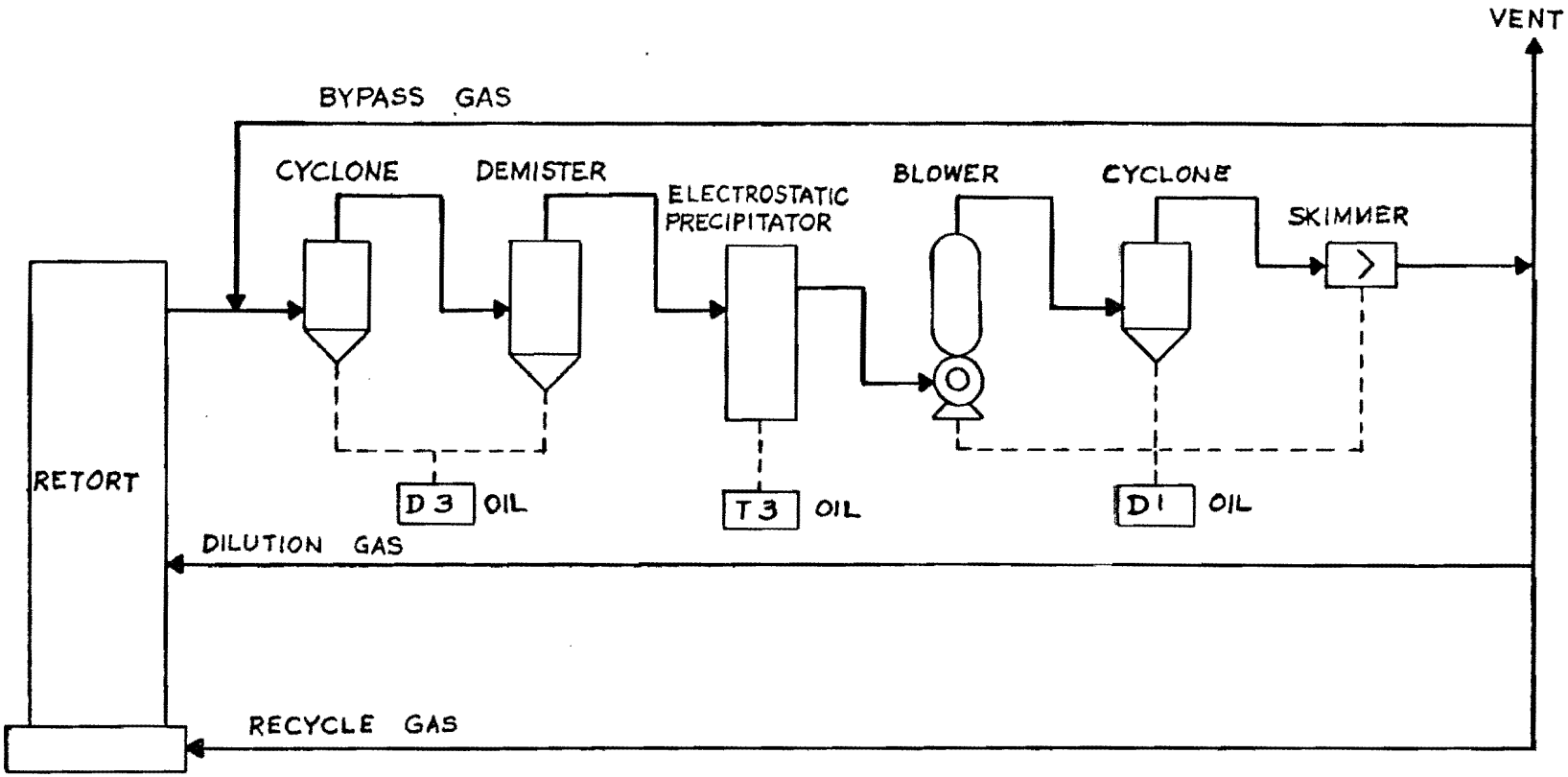

FIGURE 13

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JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY L. Hamilton

STARTED 2-5-65

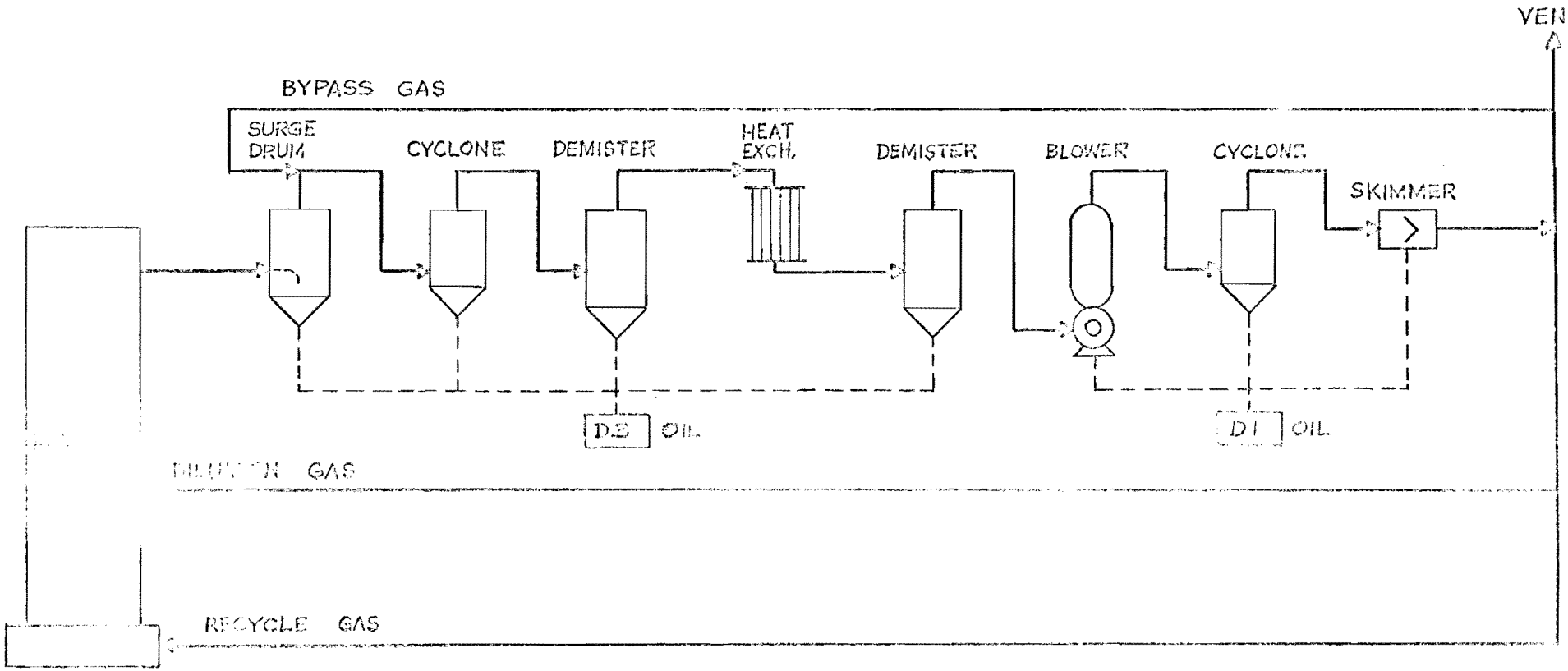
COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-2

LOCATION

DRAWING NO. RE



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JOB NO.	CHARGE

APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY L. Thomas

STARTED 2-5-65

COMPLETED 2-5-65

DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM TYPE B-3

LOCATION

DRAWING NO. RE

D397 (0-55)

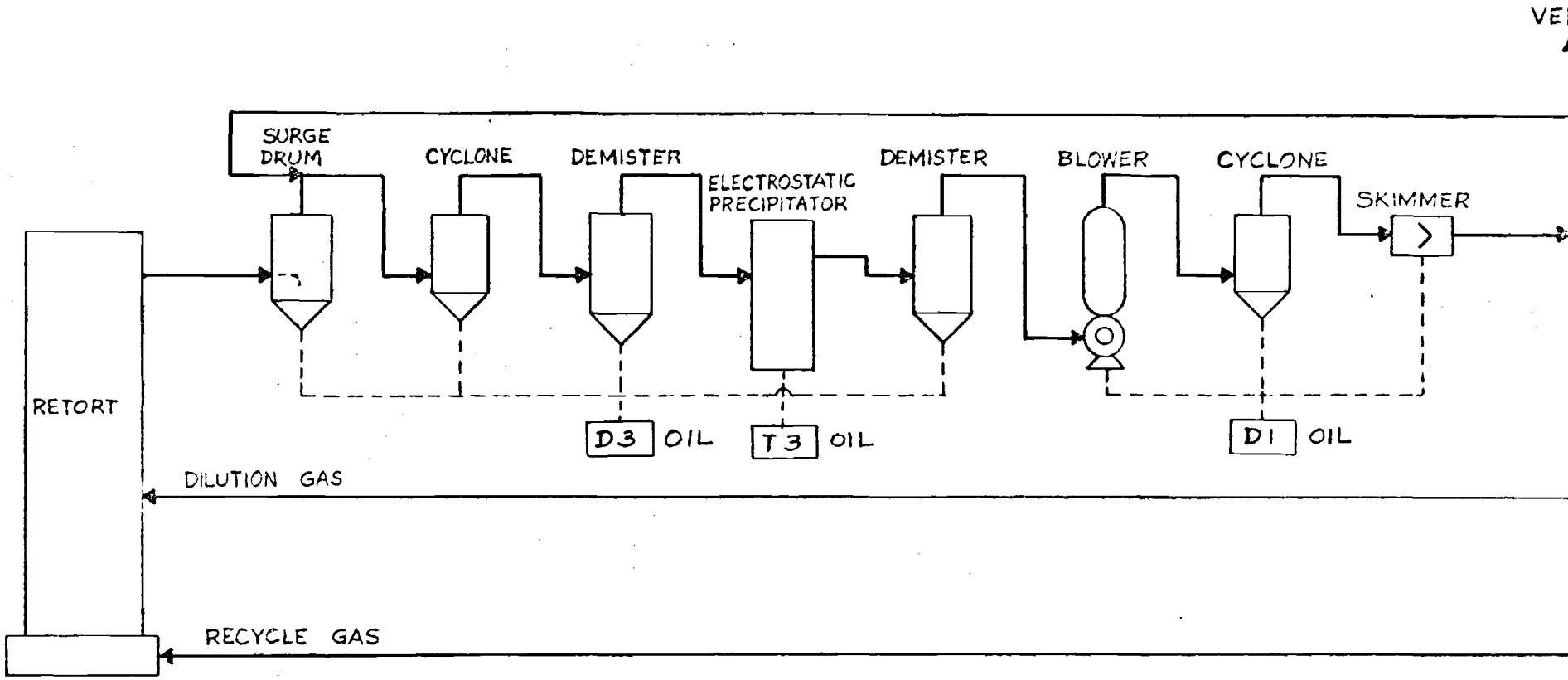

FIGURE 15

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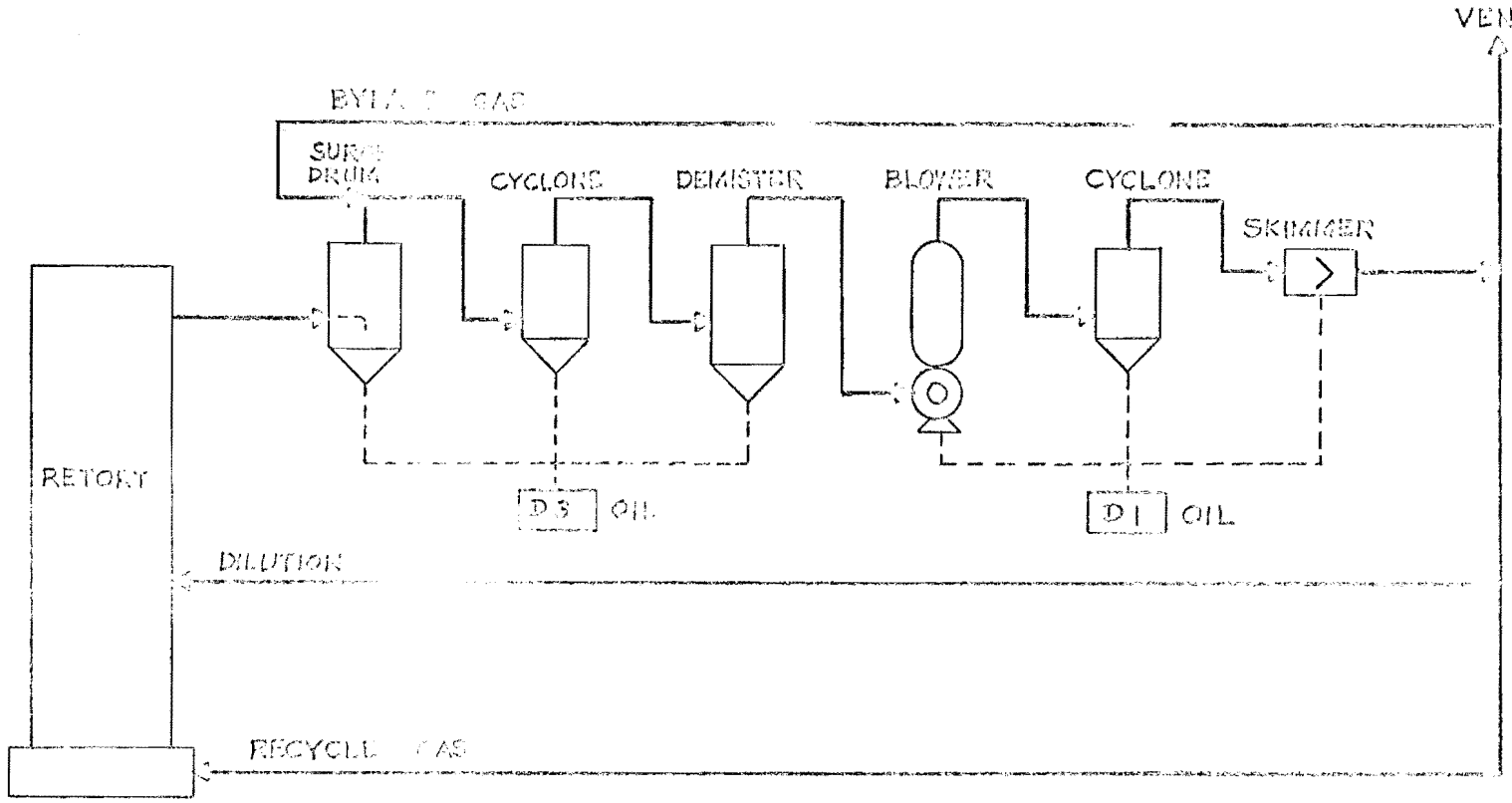
JOB NO.	CHARGE

APPROVED	PROCESS	DESIGN	SAFETY

SCALE	~
DRAWN BY	J. Hamilton
STARTED	2-5-63
COMPLETED	2-5-63
DIMENS. CHECK	

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-4

LOCATION	DRAWING NO.
	RE



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PROJECT MAI[illegible]ER-SOHIO MOBIL OIL CO., INC.

JOB NO.	CHARGE

APPROVED	PROGRESS	DESIGN	SAFETY

SCALE ~

DRAWN BY L. Hermanson

STARTED 2-6-65

COMPLETED [illegible]

DRWG. CHECKED

RETORT NO.2 RECOVERY SYSTEM
TYPE B-5

LOCATION

DRAWING NO. RB

D397 (8-65)

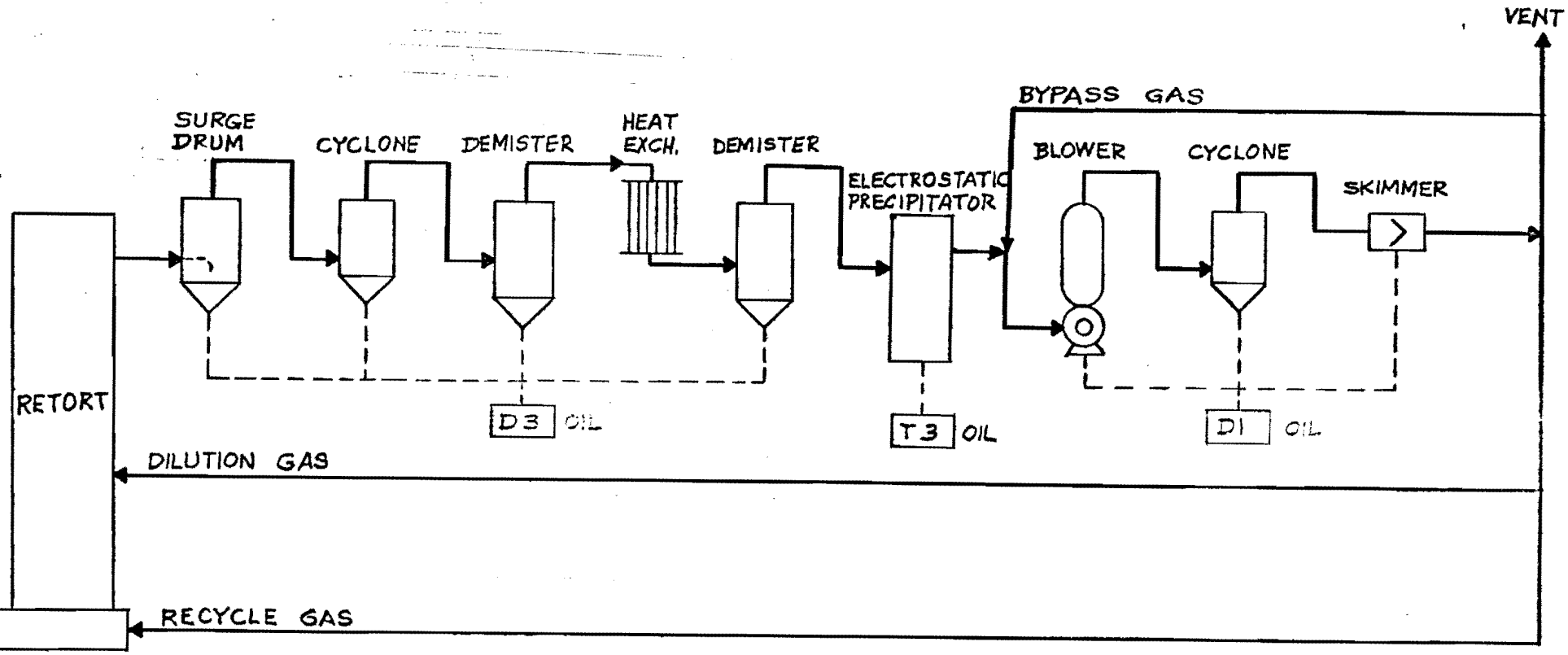

FIGURE 17

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JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Ja HAMILTON

STARTED 6-15-65

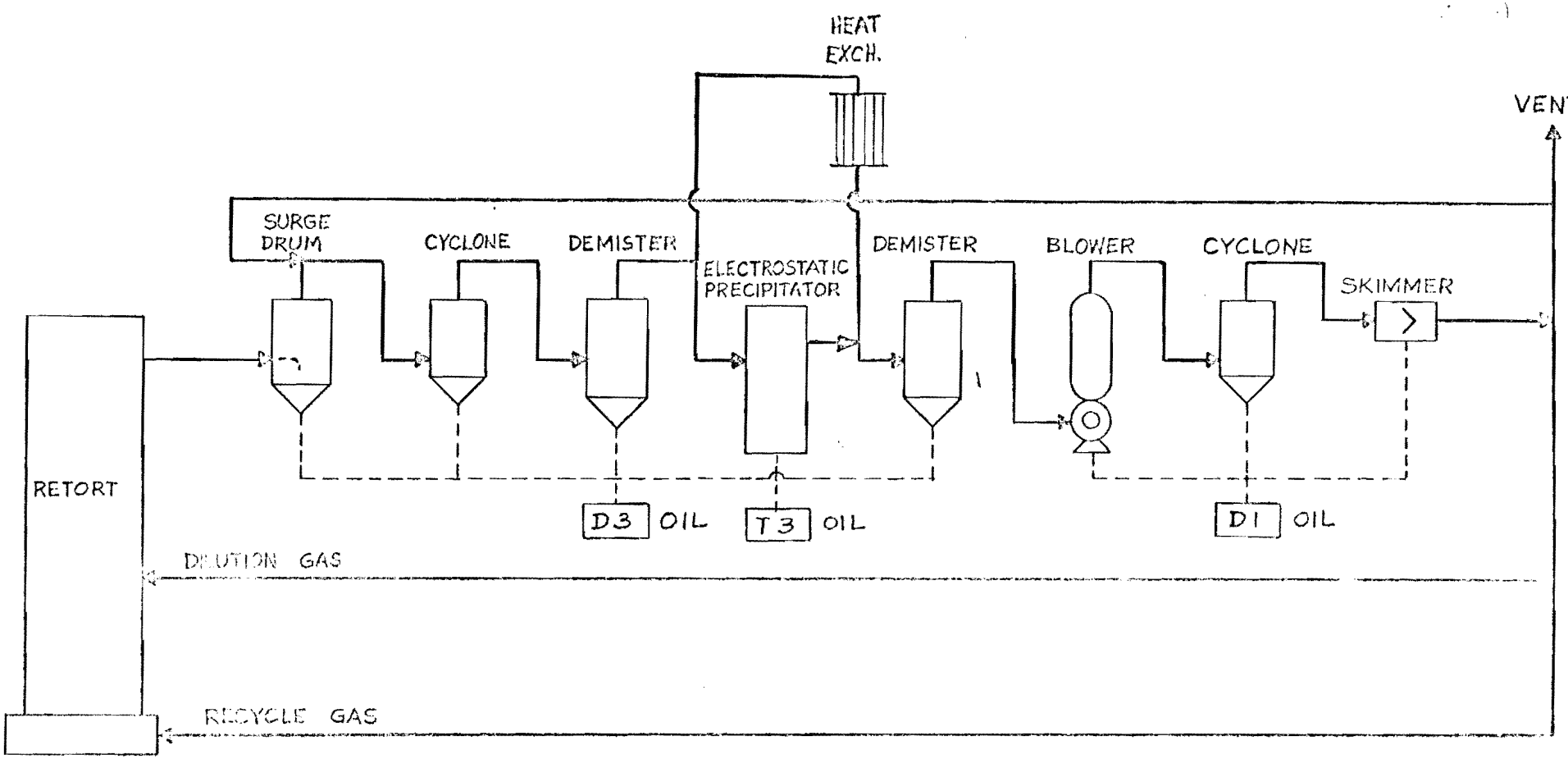
COMPLETED 6-15-65

DIMENS. CHECK

RETORT NO.2 RECOVERY SYSTEM TYPE B-6

LOCATION

DRAWING NO. RE



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ANVIL POINTS
OIL SHALE RESEARCH CENTER
RIFLE, COLO.
PROJECT MANAGER - SOCONY MOBIL OIL CO., INC.

JOB NO.	CHARGE

APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY

STARTED

COMPLETED

DRILLING CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-7

LOCATION

DRAWING NO.

RE

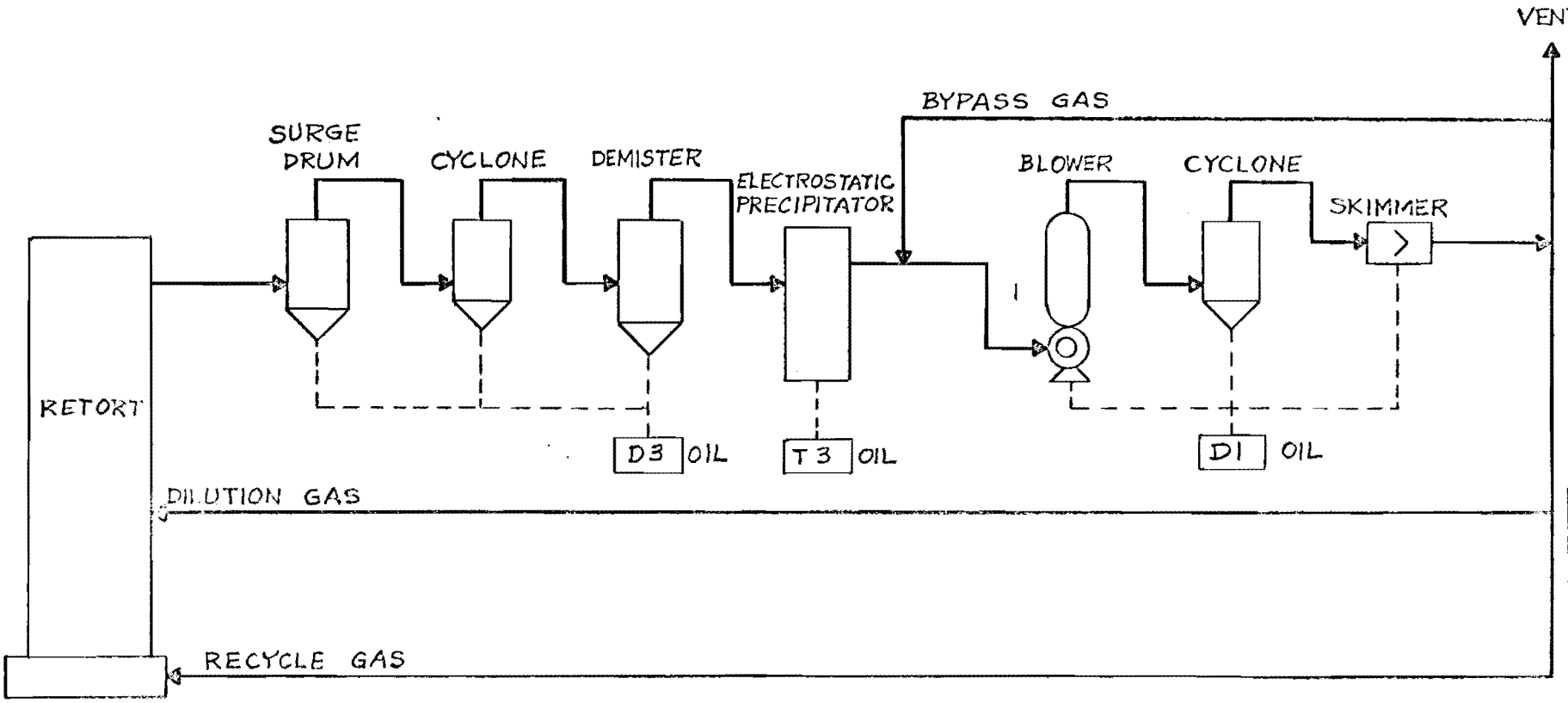

FIGURE 19

NO.	DATE	PRINT ISSUED TO

ANVIL POINTS
OIL SHALE RESEARCH CENTER
RIFLE, COLO.
PROJECT MANAGER - SOCONY MOBIL OIL CO., INC.

JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE
DRAWN BY Jo Harrison
STARTED 6-22-65
COMPLETED 6-25-65
DIMENS. CHECK

RETORT NO.2 RECOVERY SYSTEM
TYPE B-8

LOCATION

DRAWING NO. R2

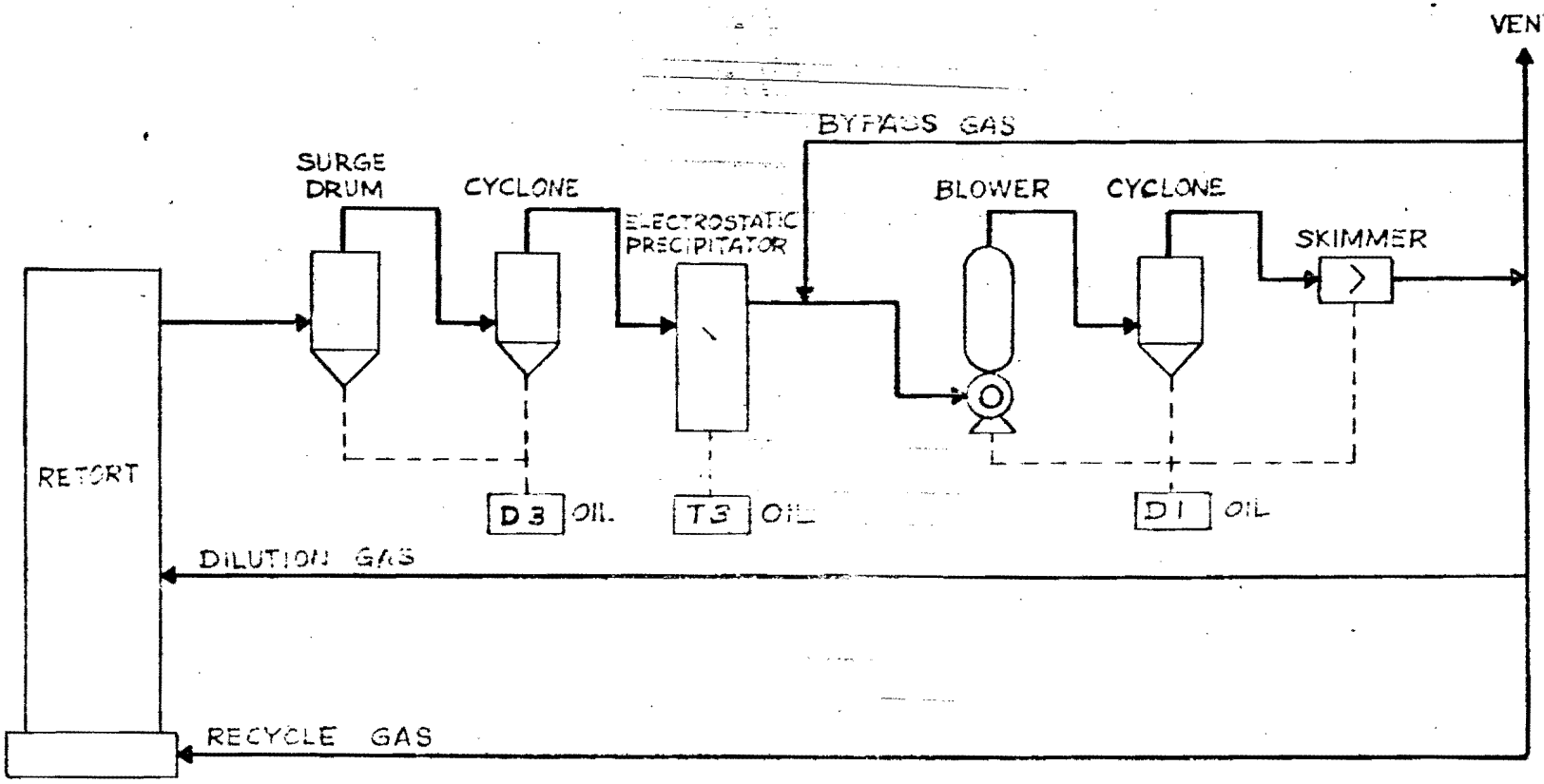

FIGURE 20

NO.	DATE	PRINT ISSUED TO

ANVIL POINTS
OIL SHALE RESEARCH CENTER
RIFLE, COLO.
PROJECT MANAGER - SOCONY MOBIL OIL CO., INC.

JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Joe HAMILTON

STARTED 8-11-65

COMPLETED 8-11-65

DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-9

LOCATION

DRAWING NO. RE

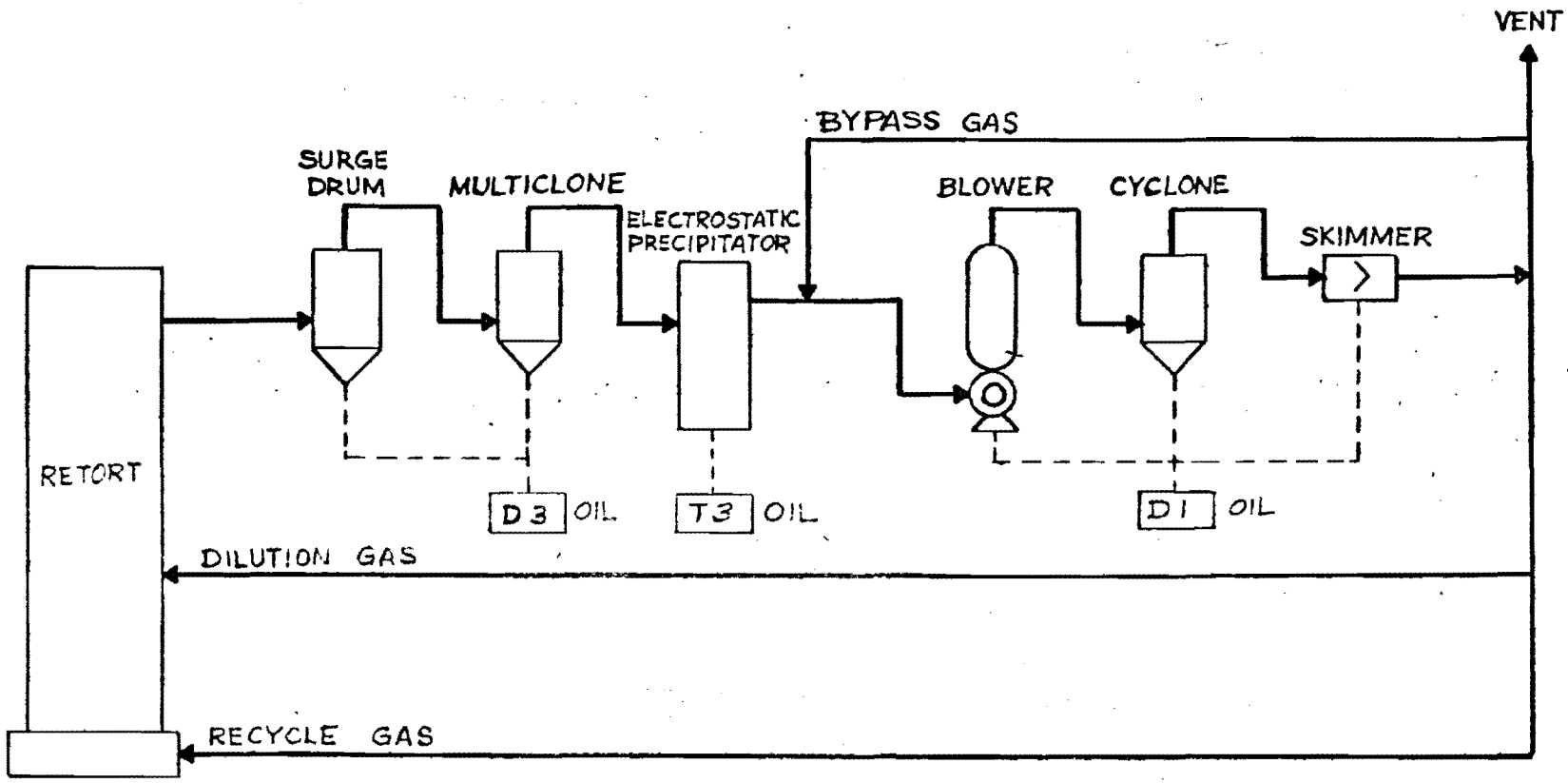

FIGURE 21

NO.	DATE	PRINT ISSUED TO

ANVIL POINTS
OIL SHALE RESEARCH CENTER
RIFLE, COLO.
PROJECT MANAGER - SOCONY MOBIL OIL CO., INC.

JOB NO.	CHARGE		
APPROVED	PROCESS	DESIGN	SAFETY

SCALE ~

DRAWN BY Joe Hamilton

STARTED 8-11-65

COMPLETED 8-11-65

DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-10

LOCATION

DRAWING NO. RE

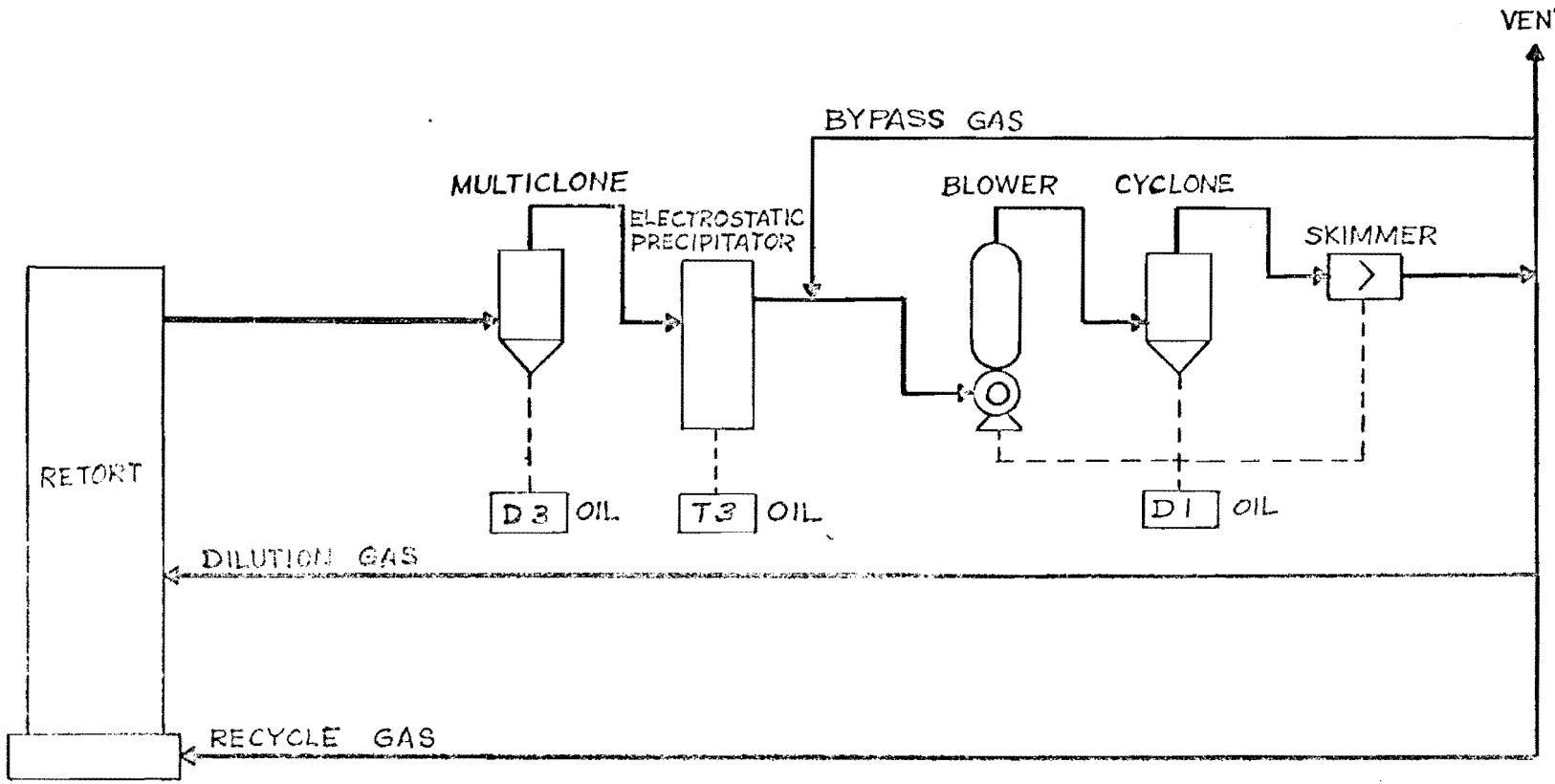

FIGURE 22

NO.	DATE	PRINT ISSUED TO

ANVIL POINTS
OIL SHALE RESEARCH CENTER
RIFLE, COLO.
PROJECT MANAGER - SOCONY MOBIL OIL CO., INC.

JOB NO.	CHARGE

APPROVED	PROCESS	DESIGN	SAFETY

SCALE
DRAWN BY Joe Hamilton
STARTED
COMPLETED
DIMENS. CHECK

RETORT NO. 2 RECOVERY SYSTEM
TYPE B-11

LOCATION

DRAWING NO.
RE