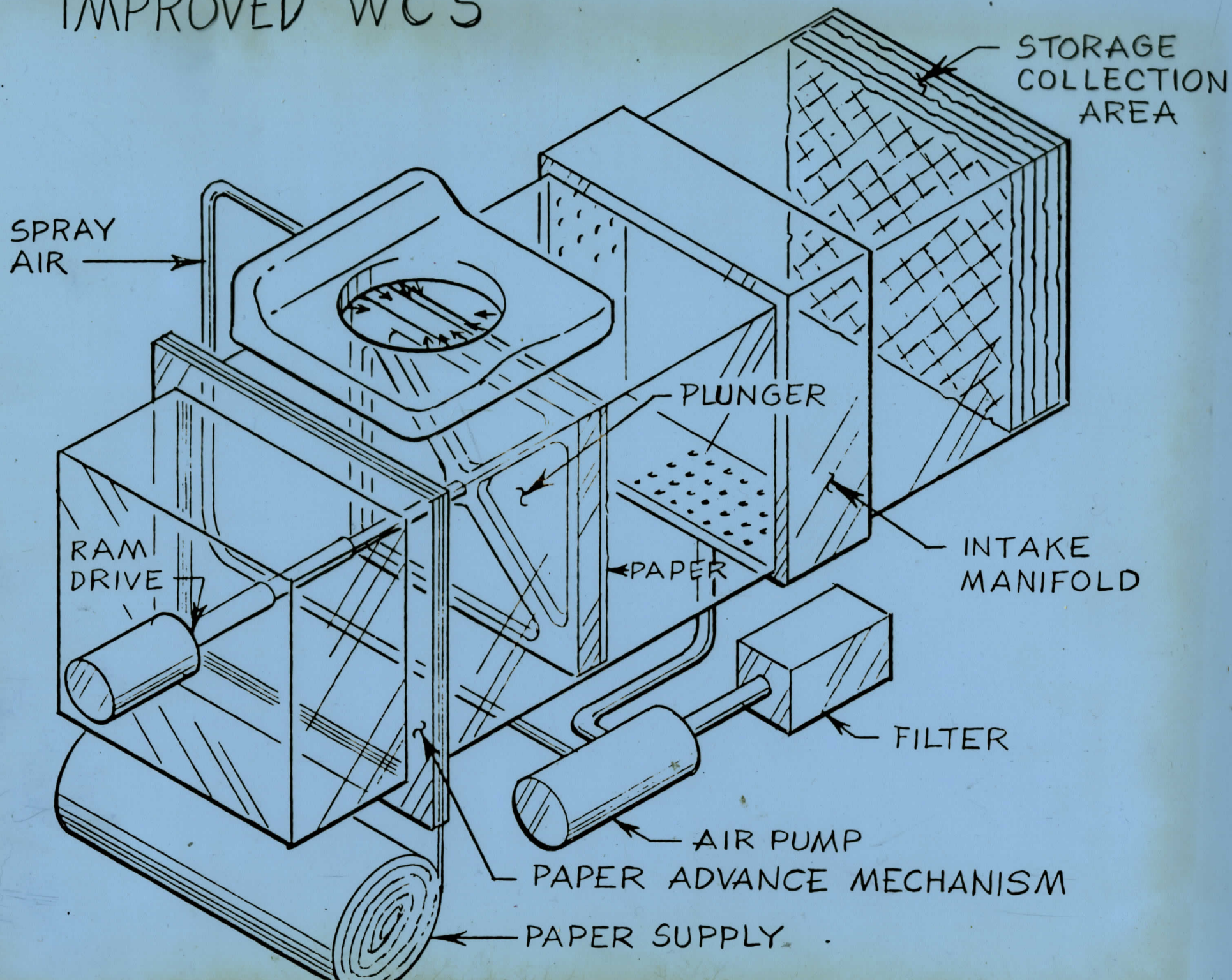


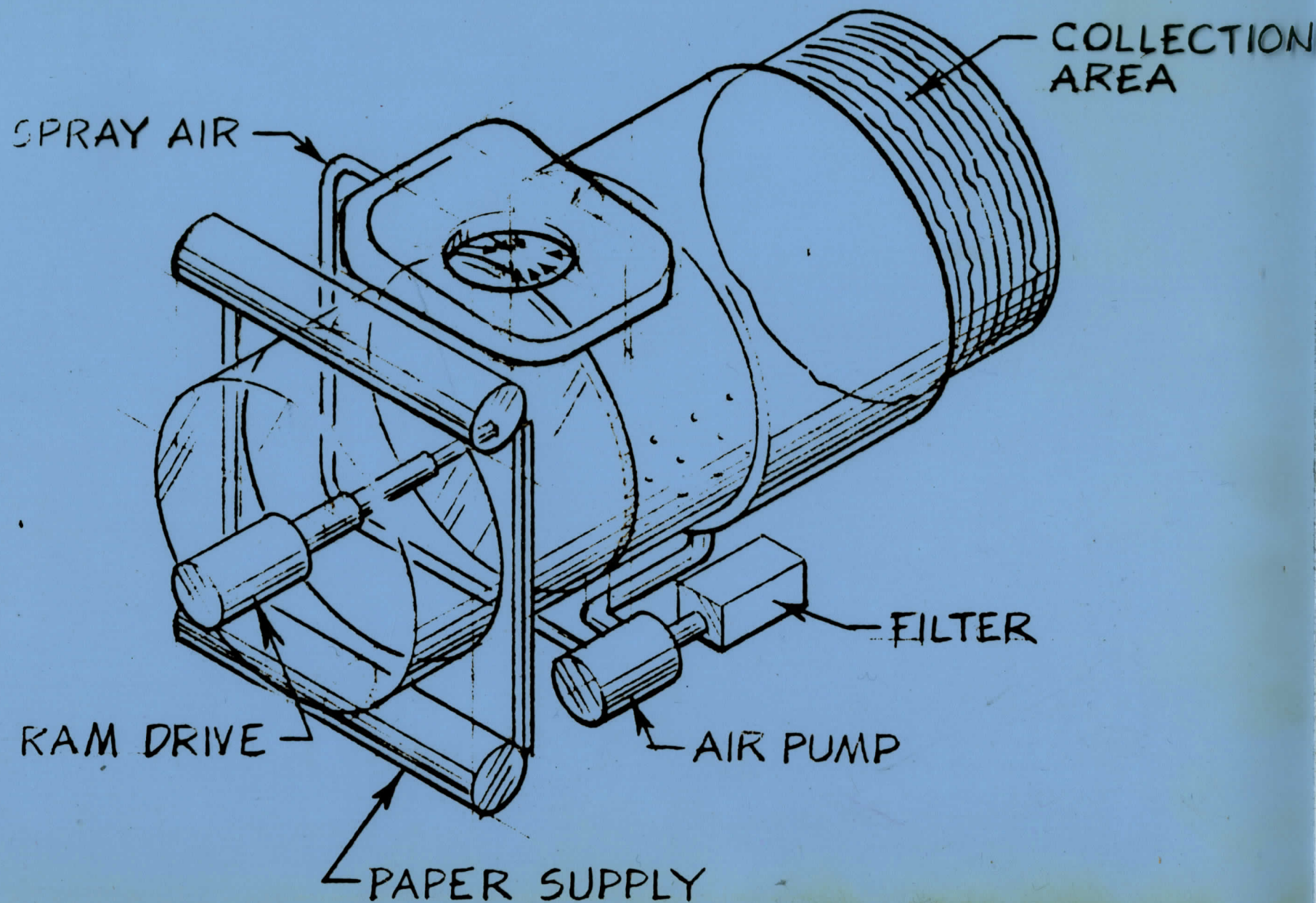
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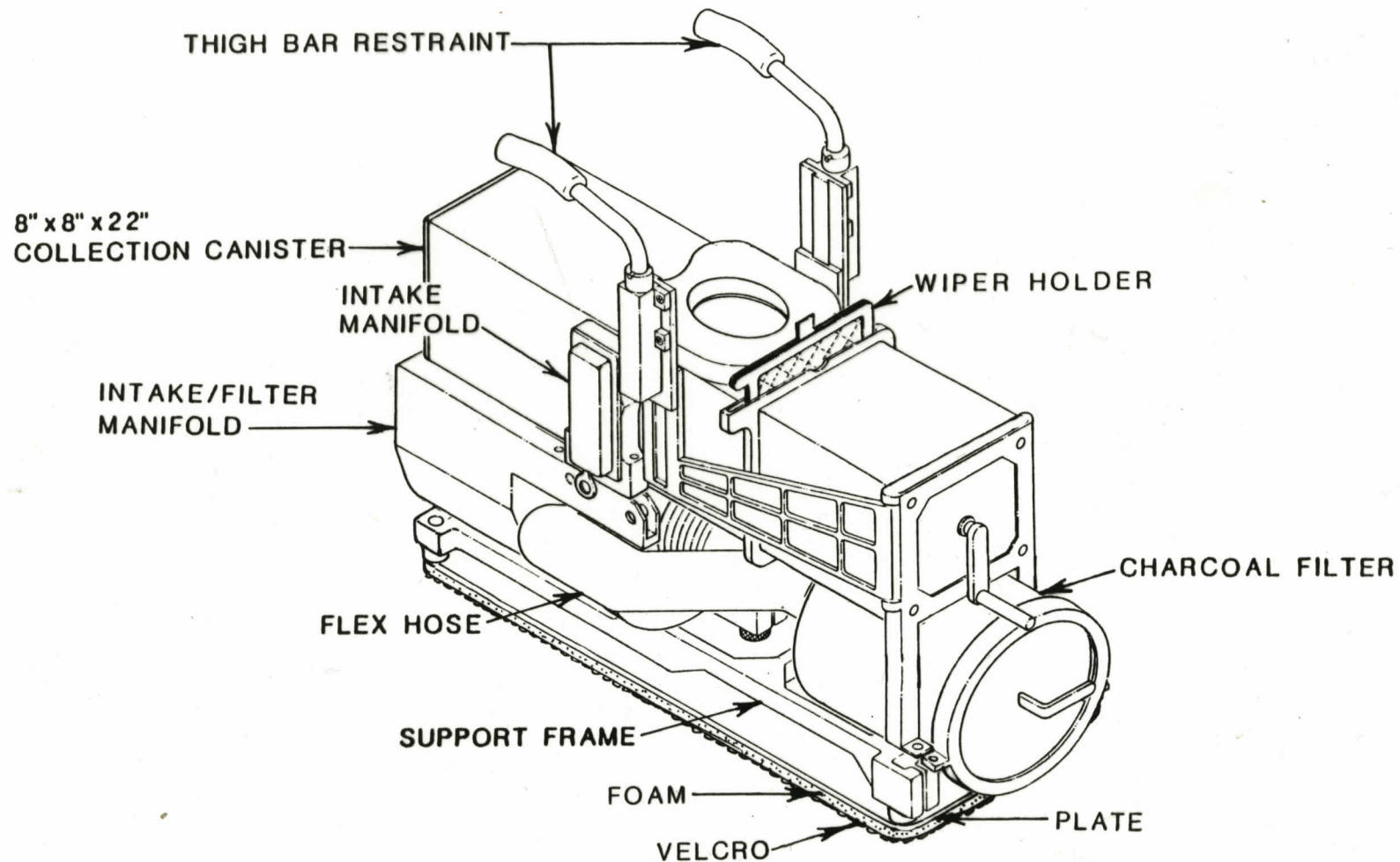


IMPROVED WCS



IMPROVED WCS



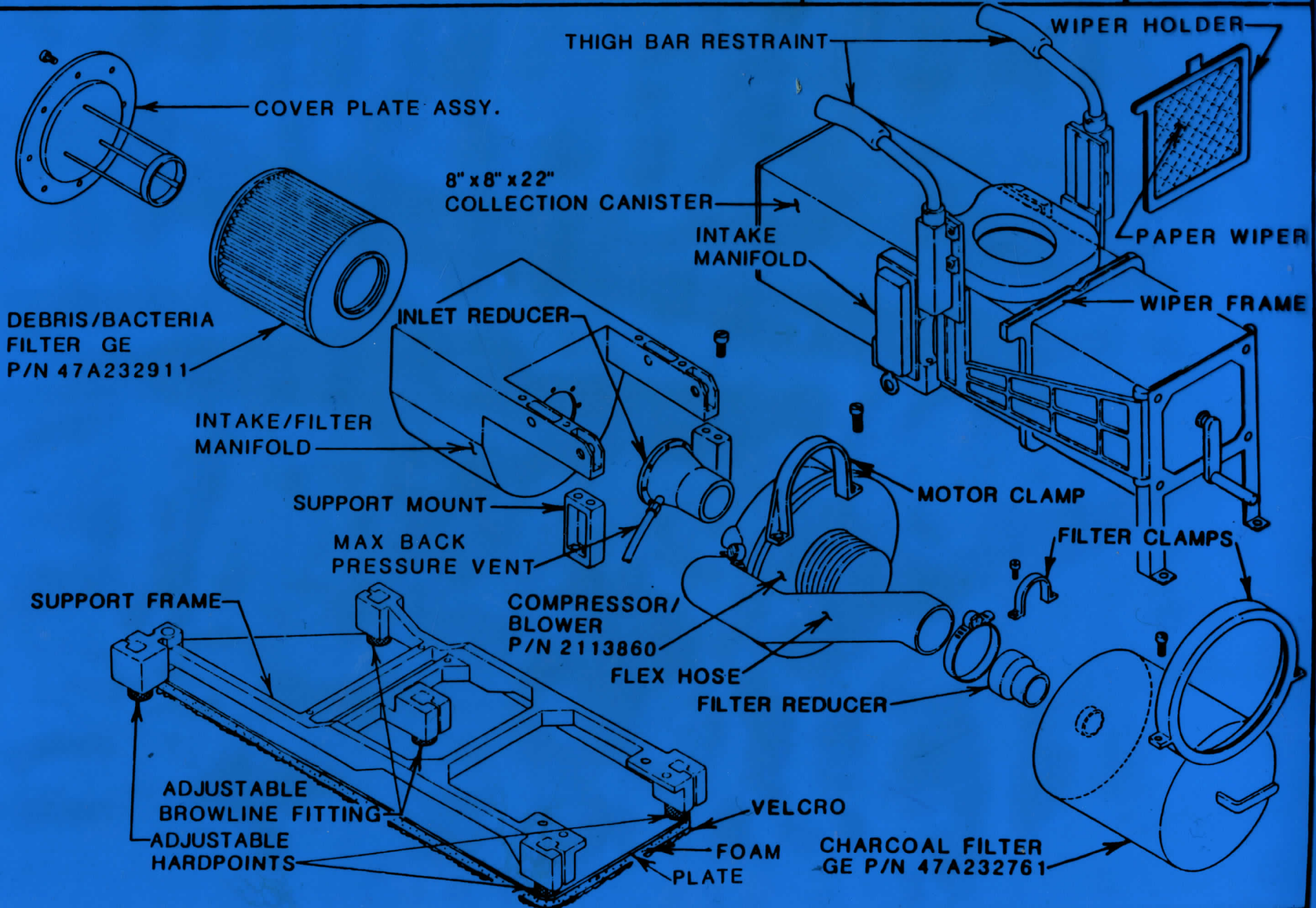
**IWCS INTEGRATION HARDWARE
CRITICAL DESIGN REVIEW****GFE PROJECT OFFICE****MICHAEL WITHEY****11/27/85**

**IWCS INTEGRATION HARDWARE
CRITICAL DESIGN REVIEW**

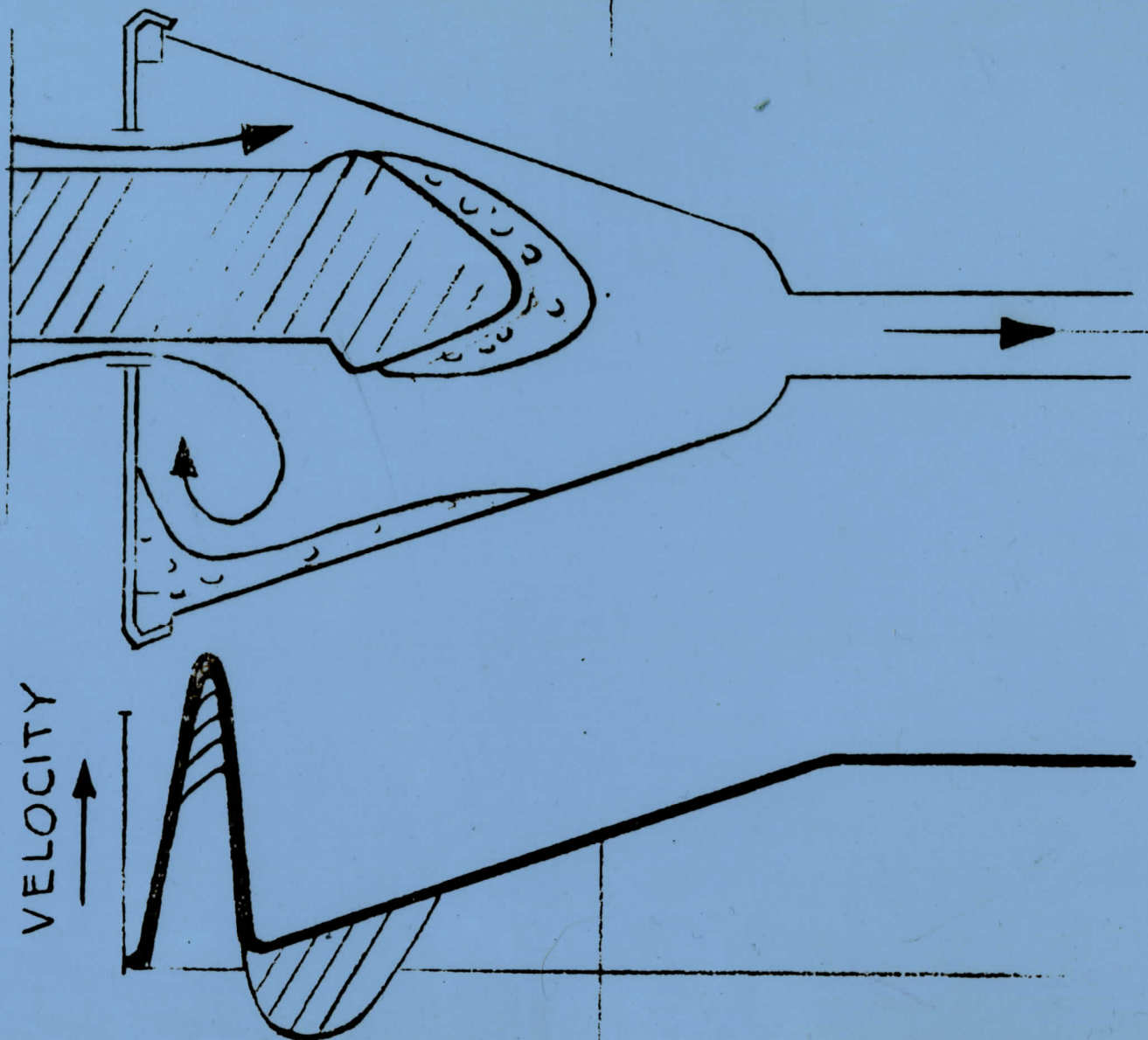
CSD

MICHAEL WITHEY

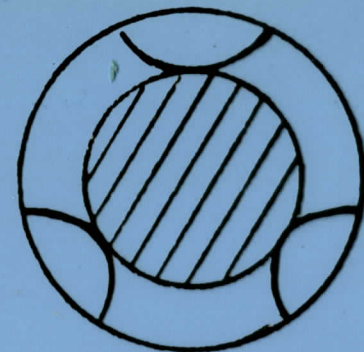
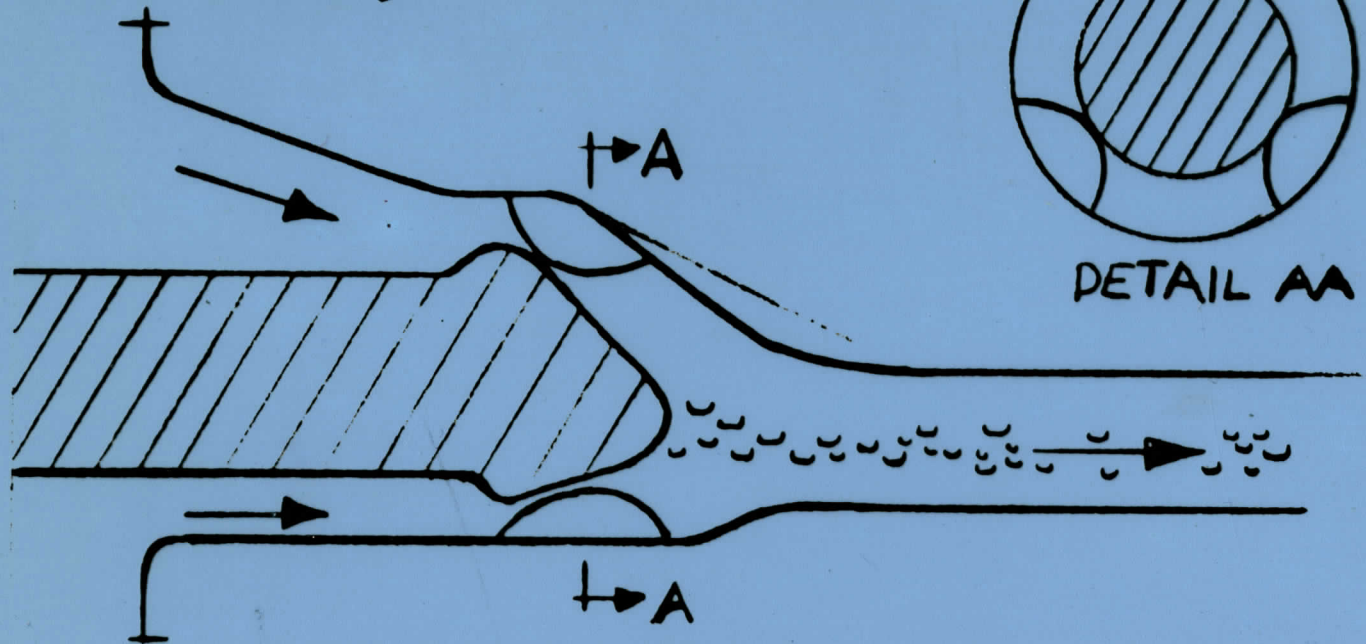
11/27/85



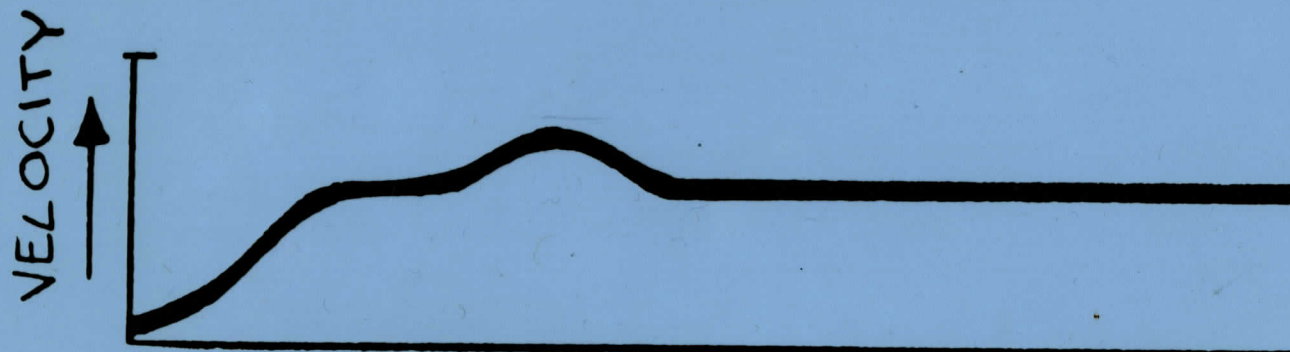
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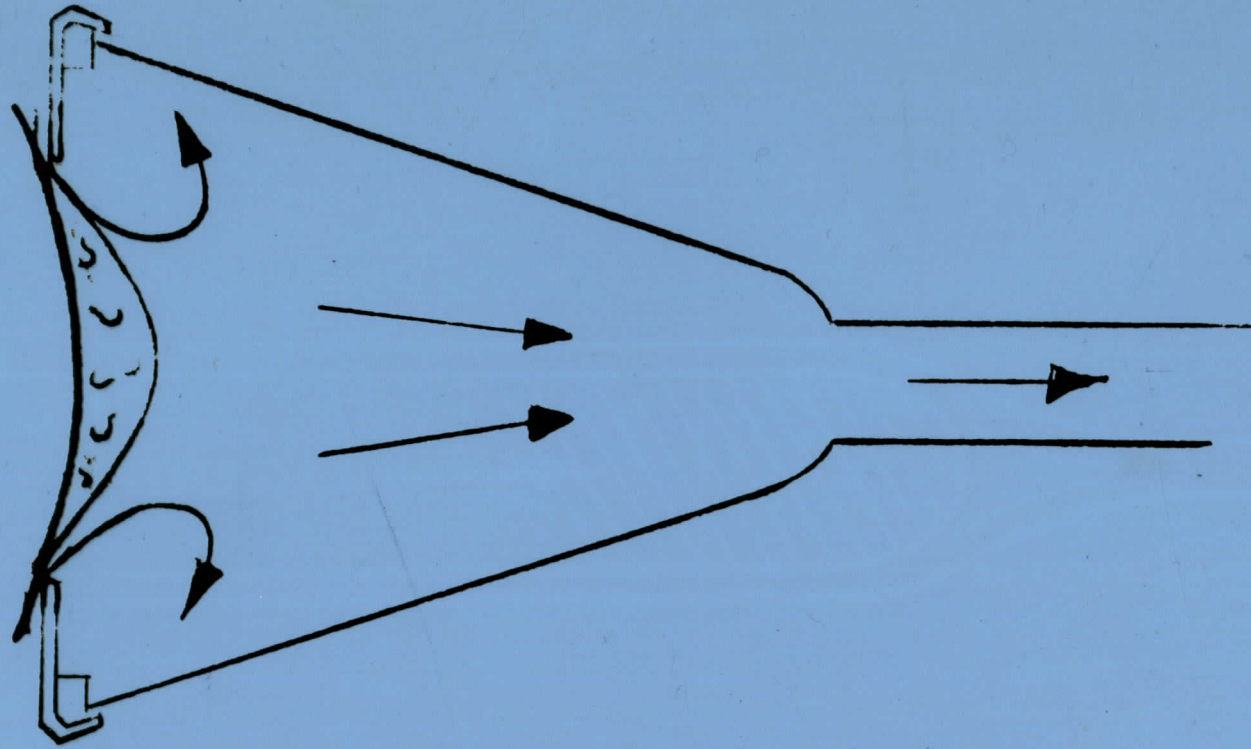
PROPOSED



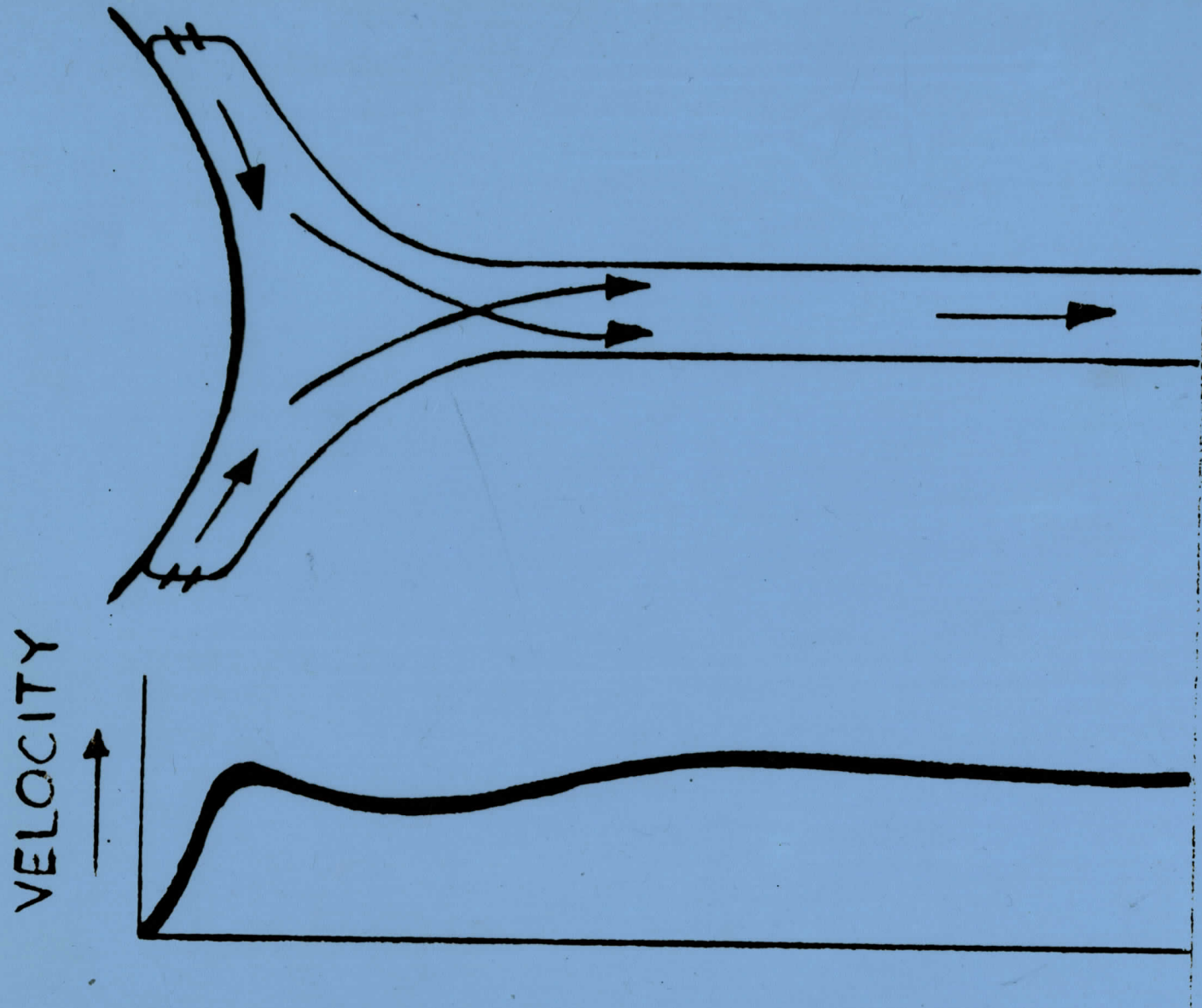
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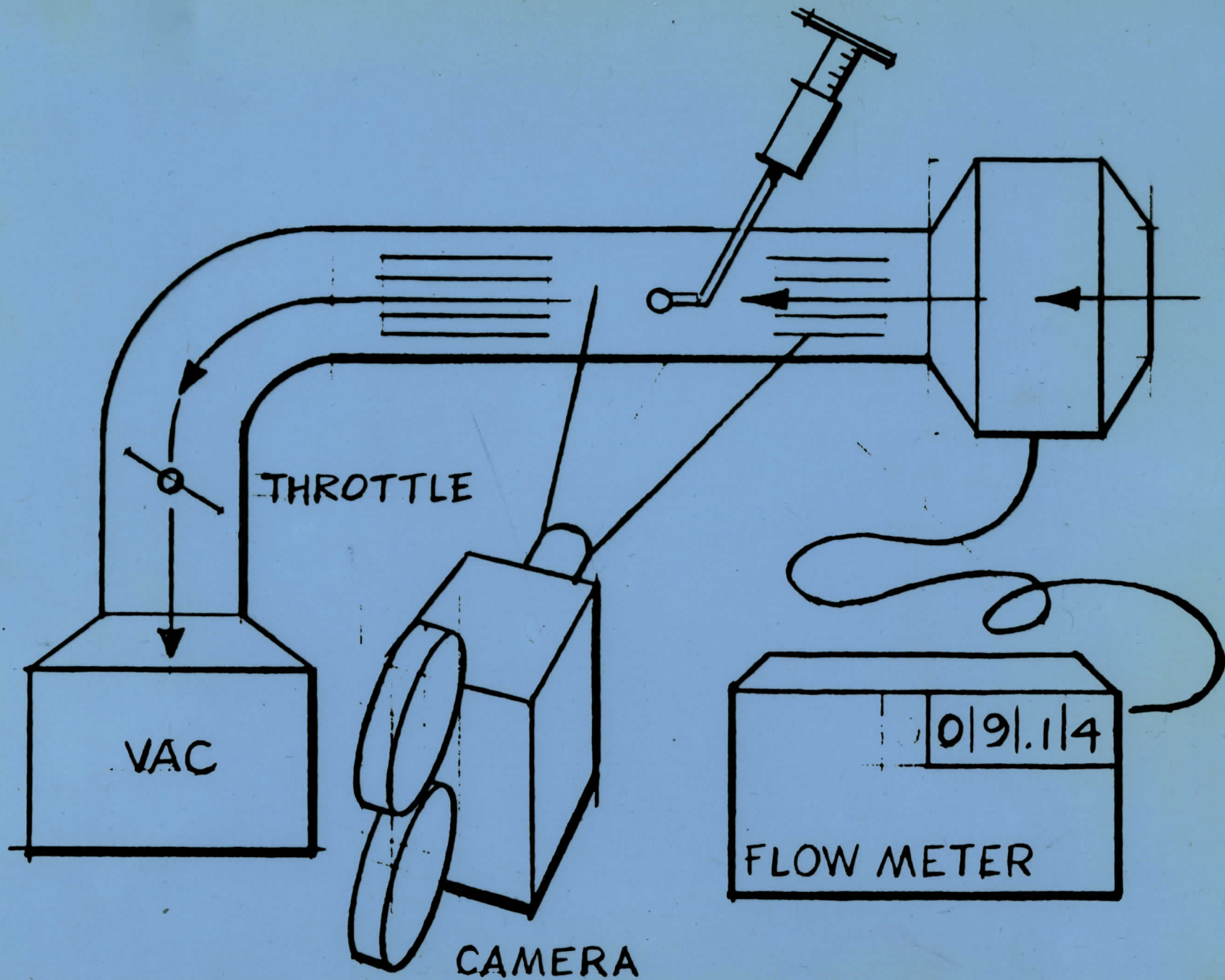


PRESENT



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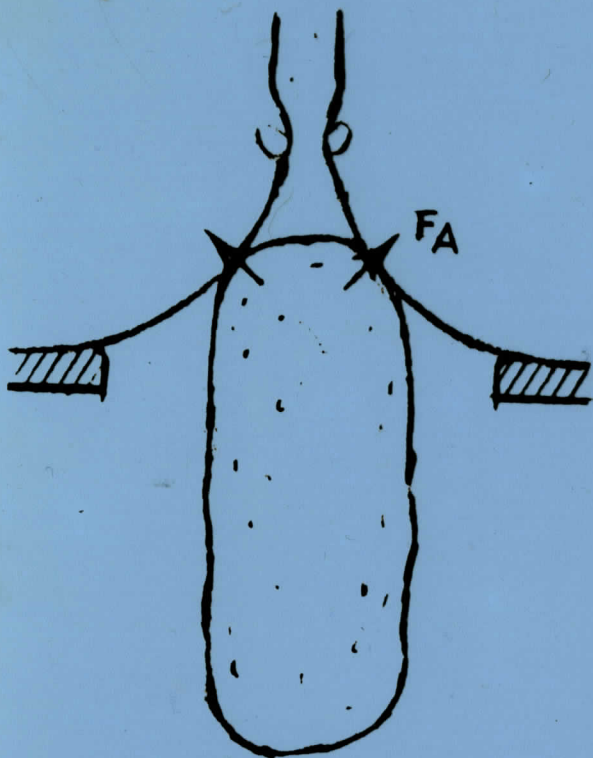




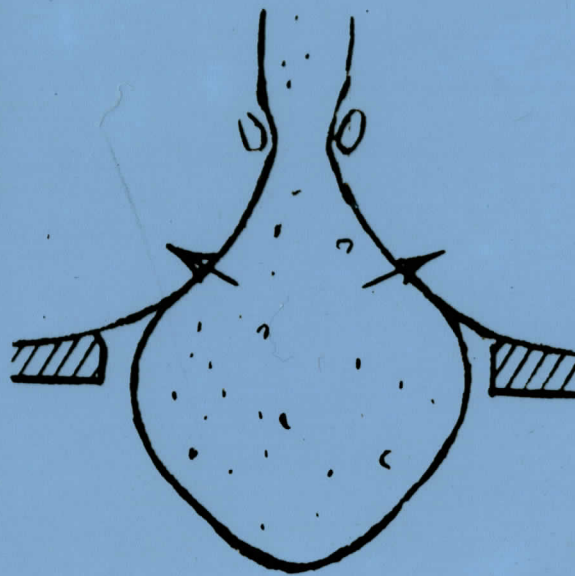
NORMAL VARIATION

FORCES

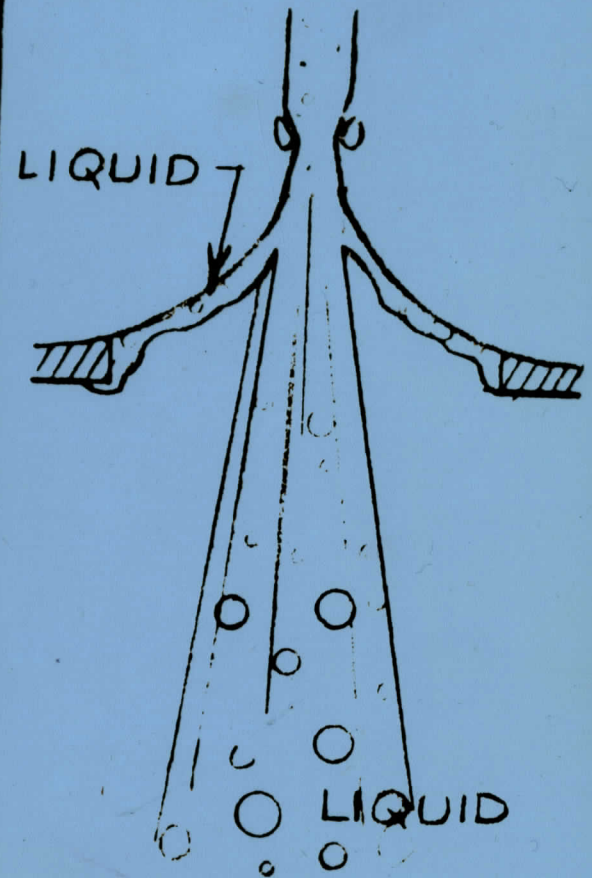
- ADHESION
- VISCOSITY
- PLASTICITY



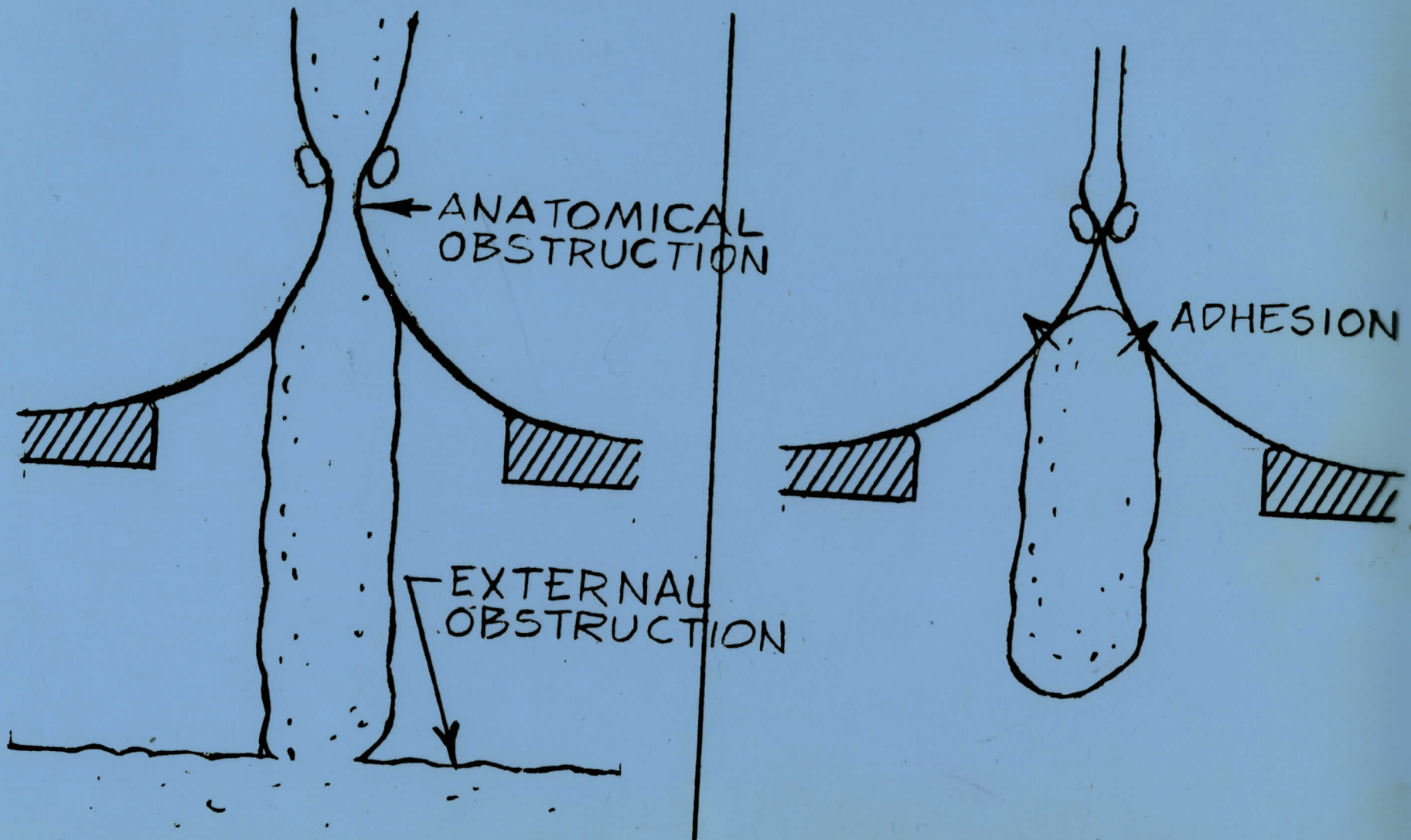
SOLID

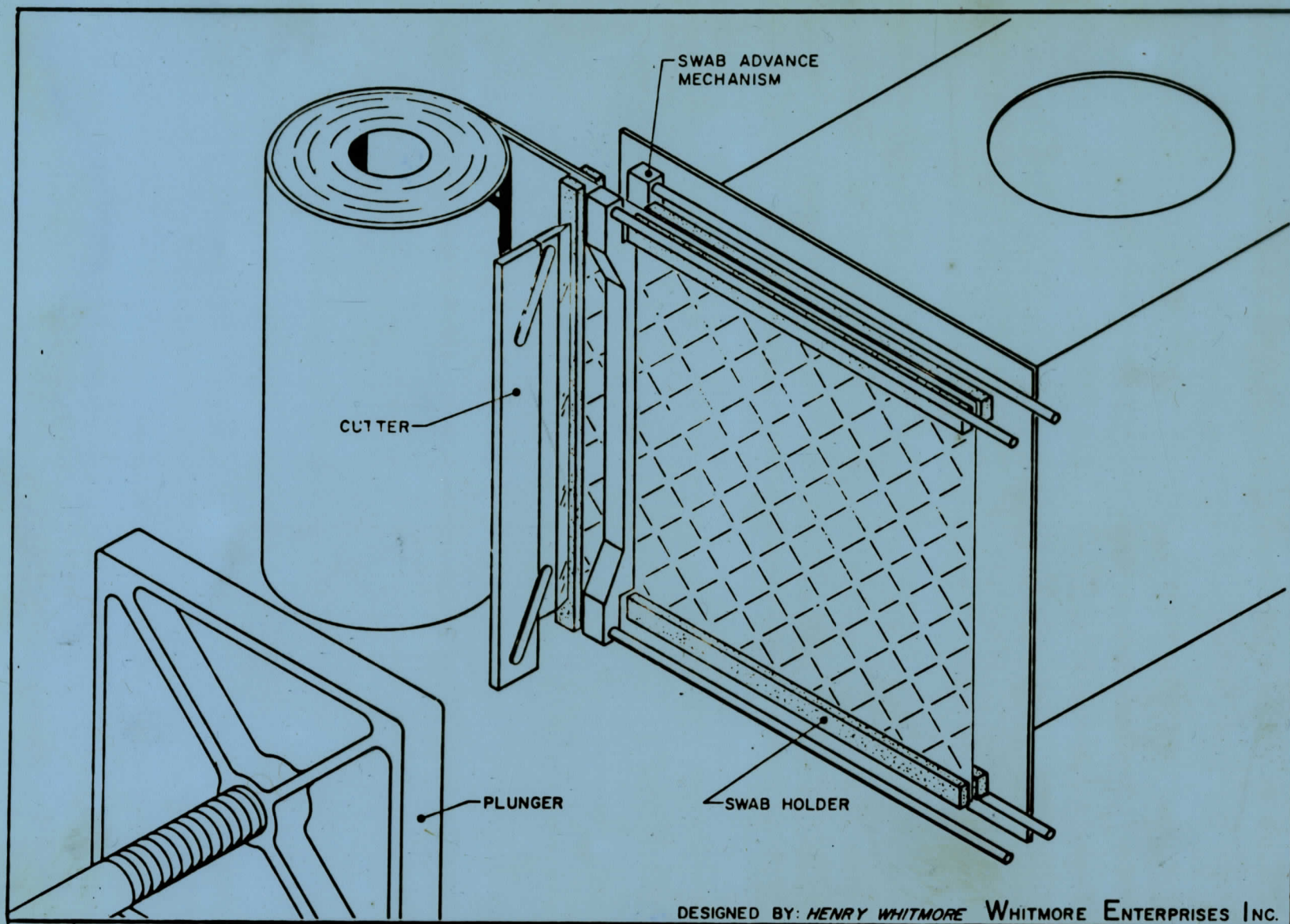


SEMI-LIQUID

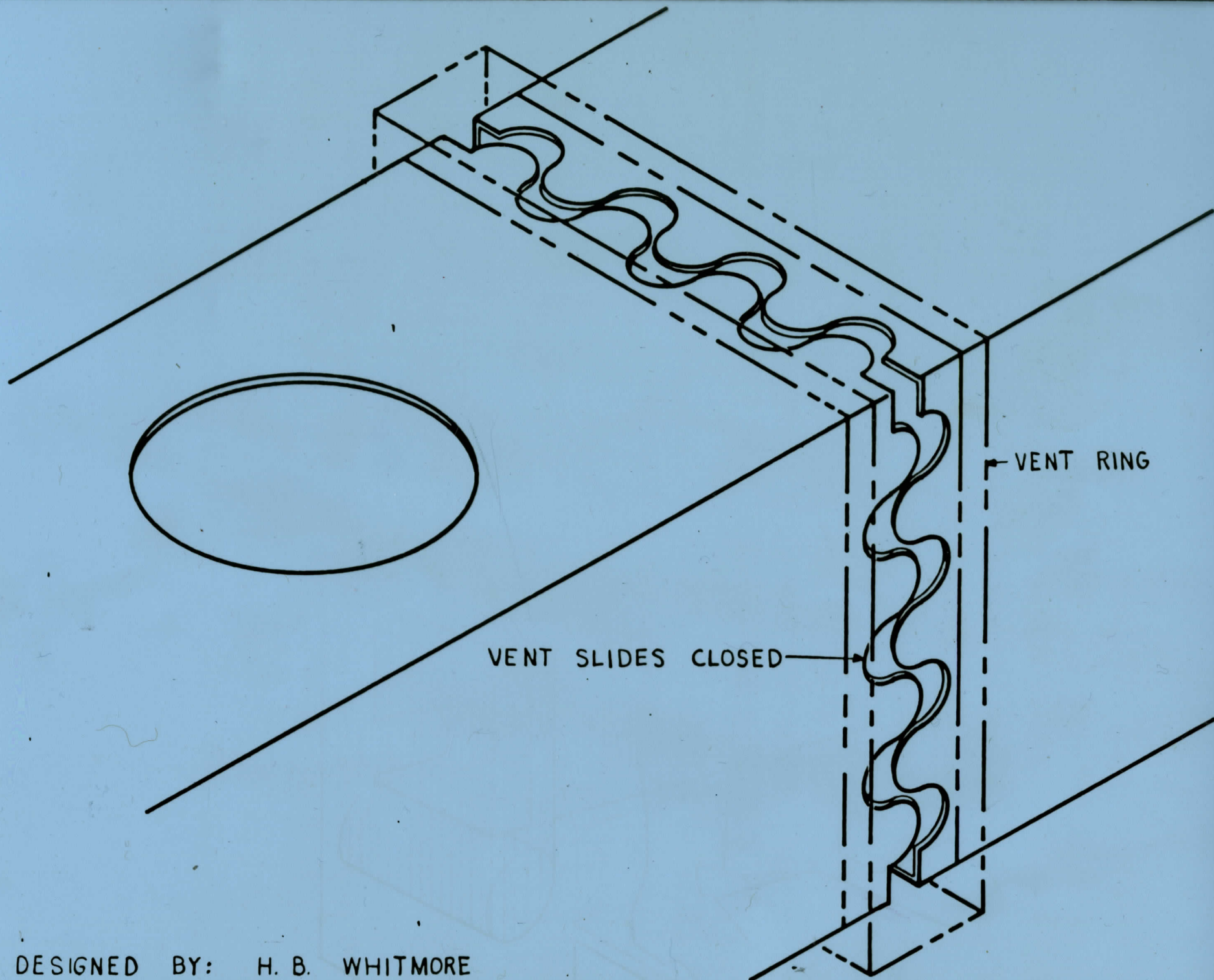


SEPARATION PROBLEMS-FLIGHT

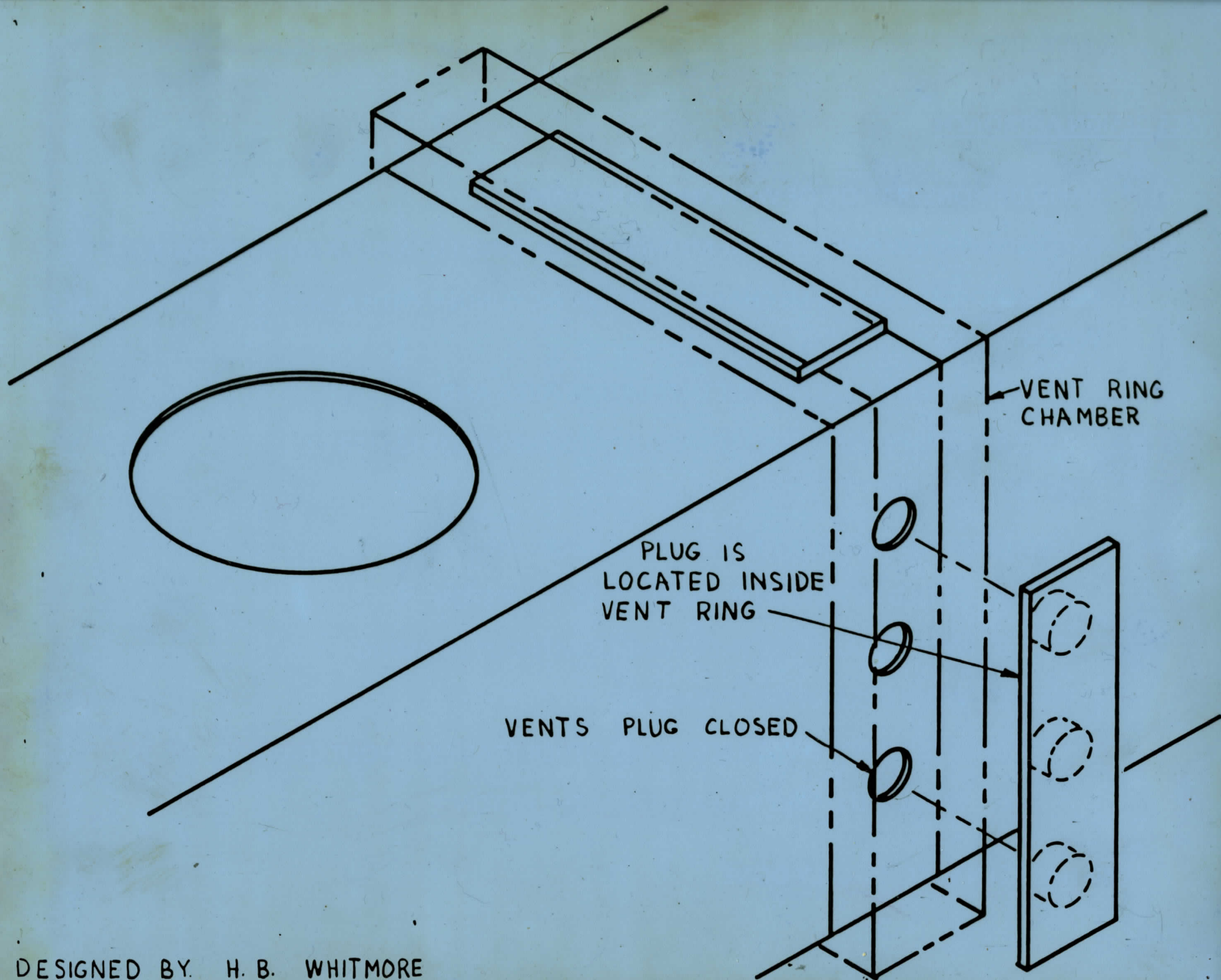




DESIGNED BY: HENRY WHITMORE WHITMORE ENTERPRISES INC.

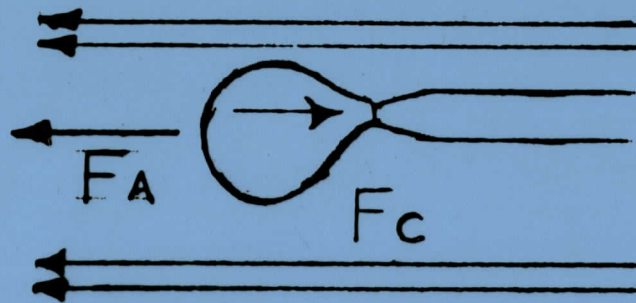


DESIGNED BY: H. B. WHITMORE



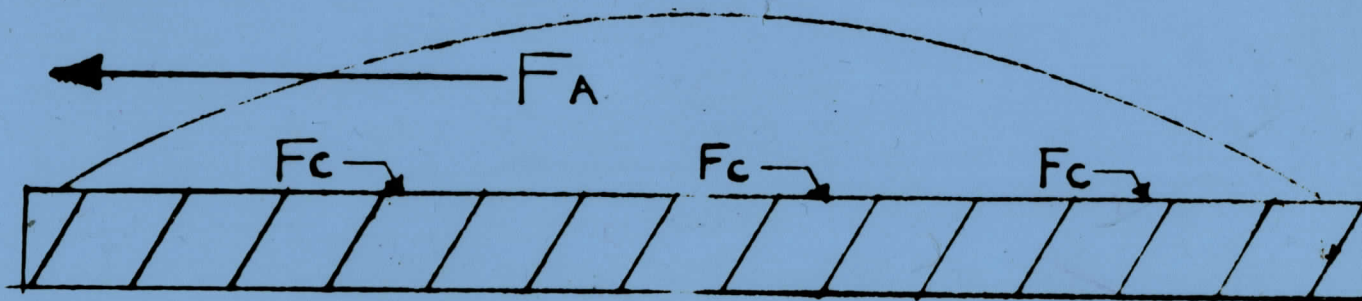
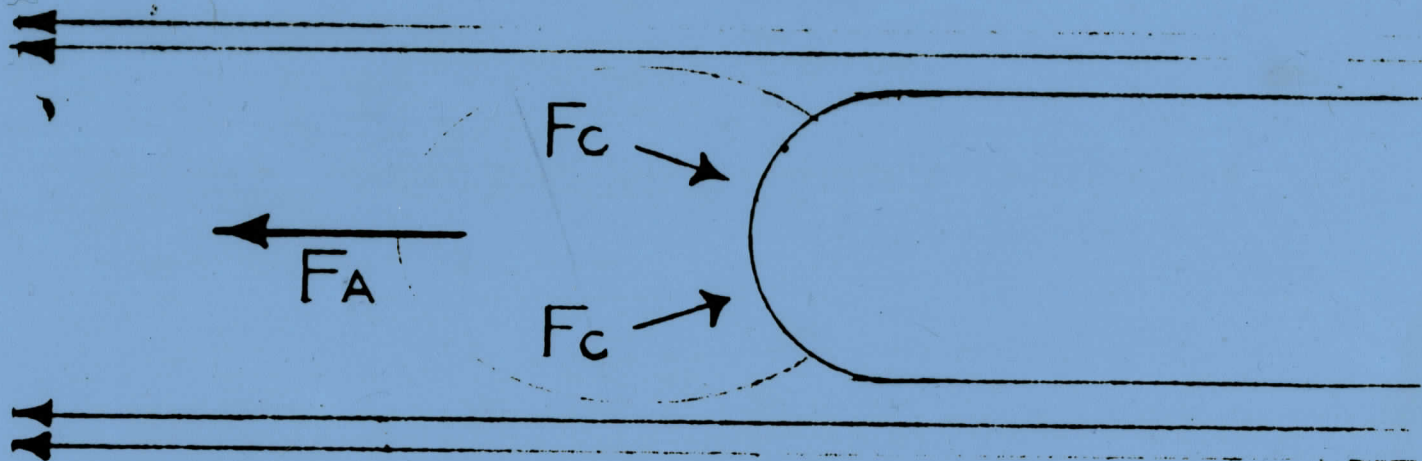
DESIGNED BY H. B. WHITMORE

BASIC FORCES

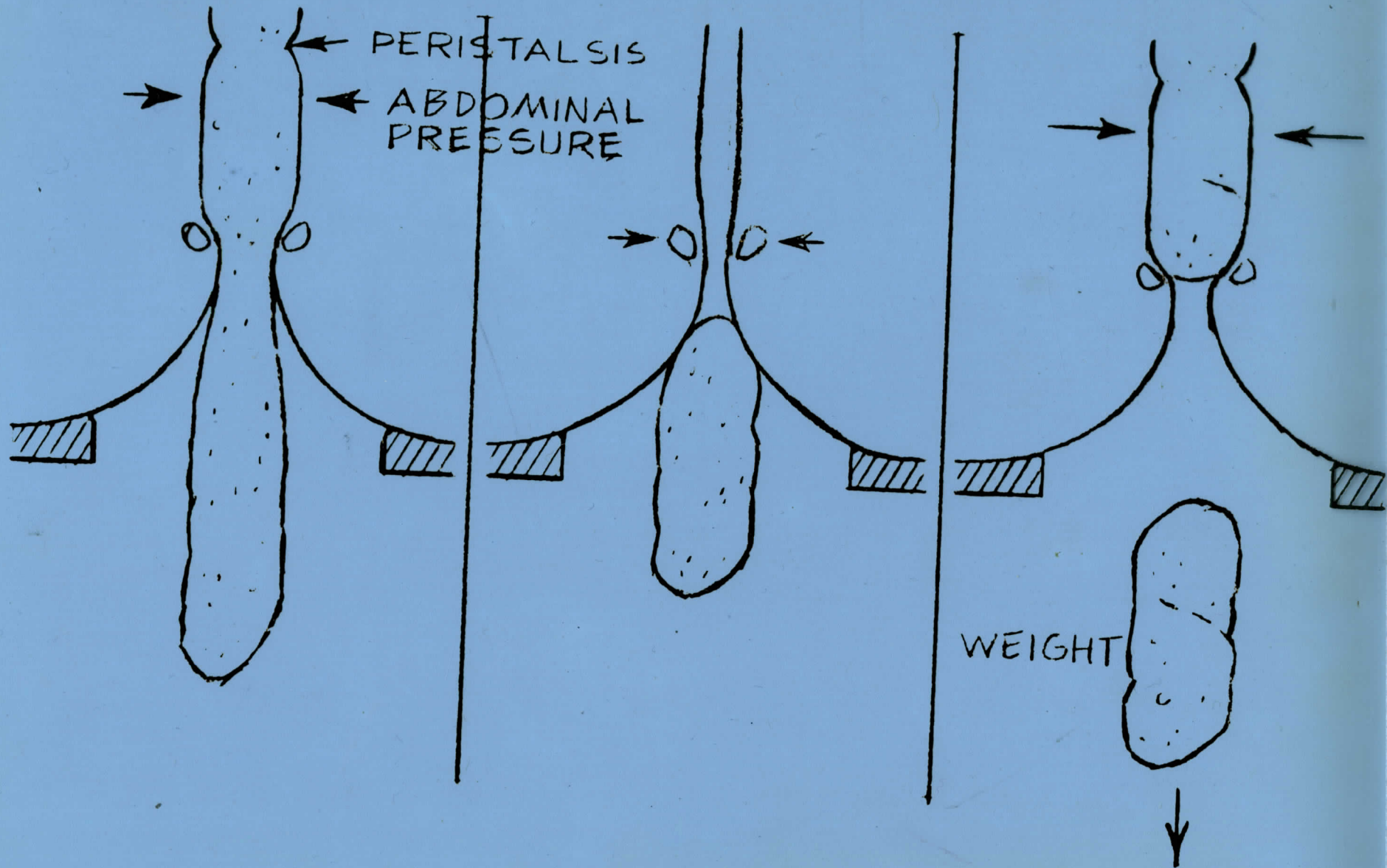


$$F_A = F(\text{velocity})$$

$$F_c = F(\text{liquid, surface shape})$$



NORMAL



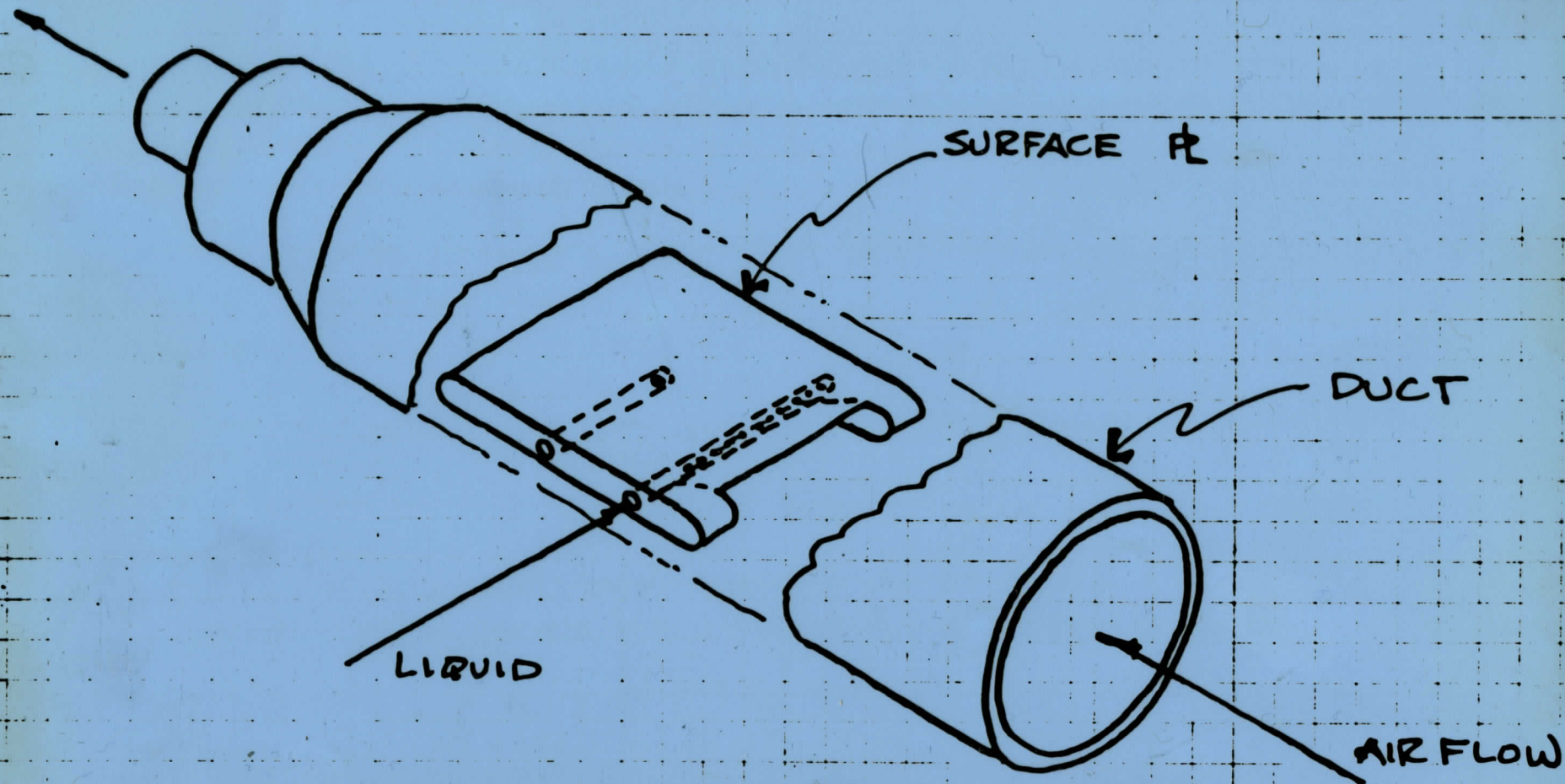
EXHAUST

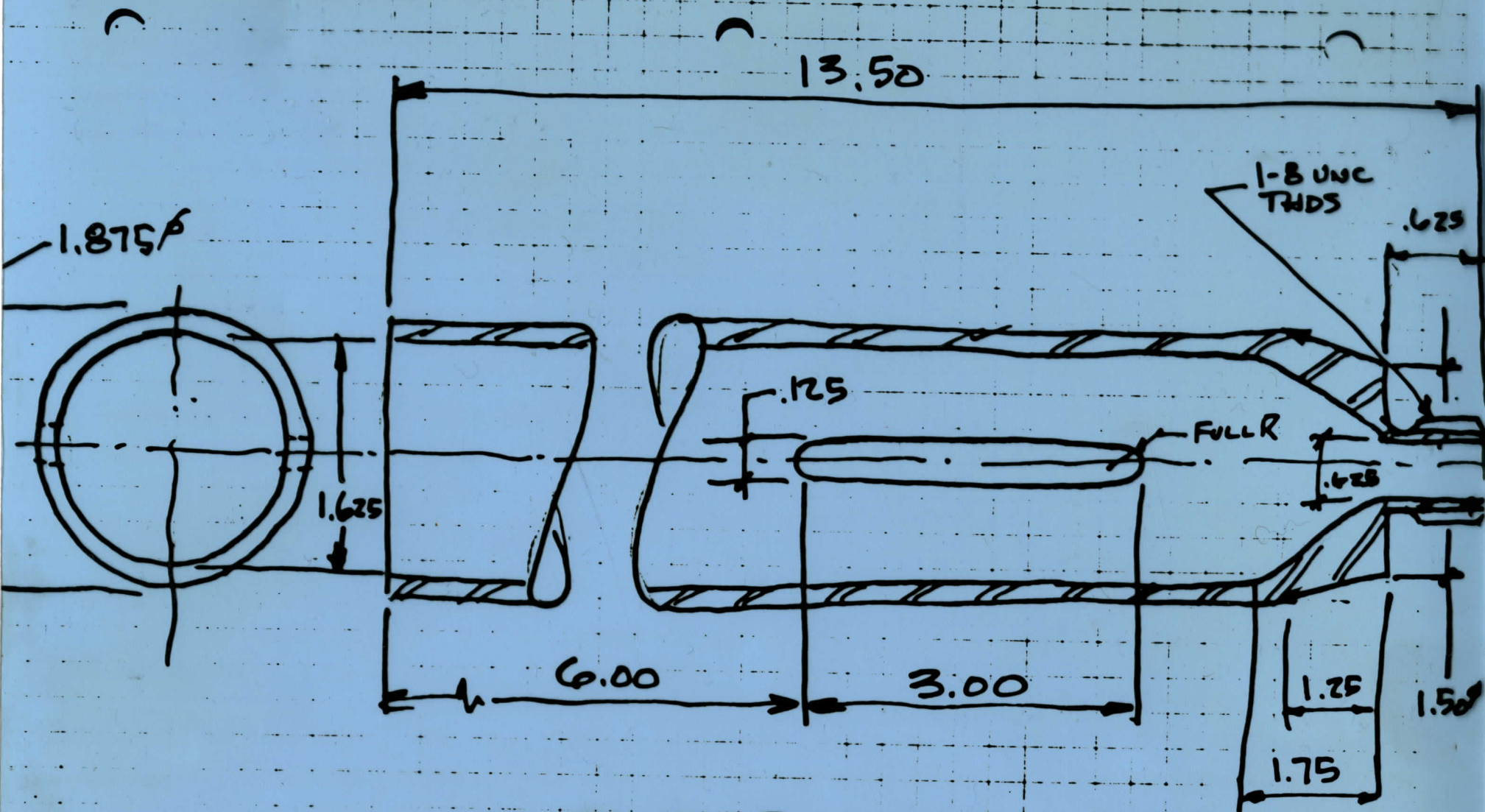
SURFACE μ

DUCT

LIQUID

AIR FLOW

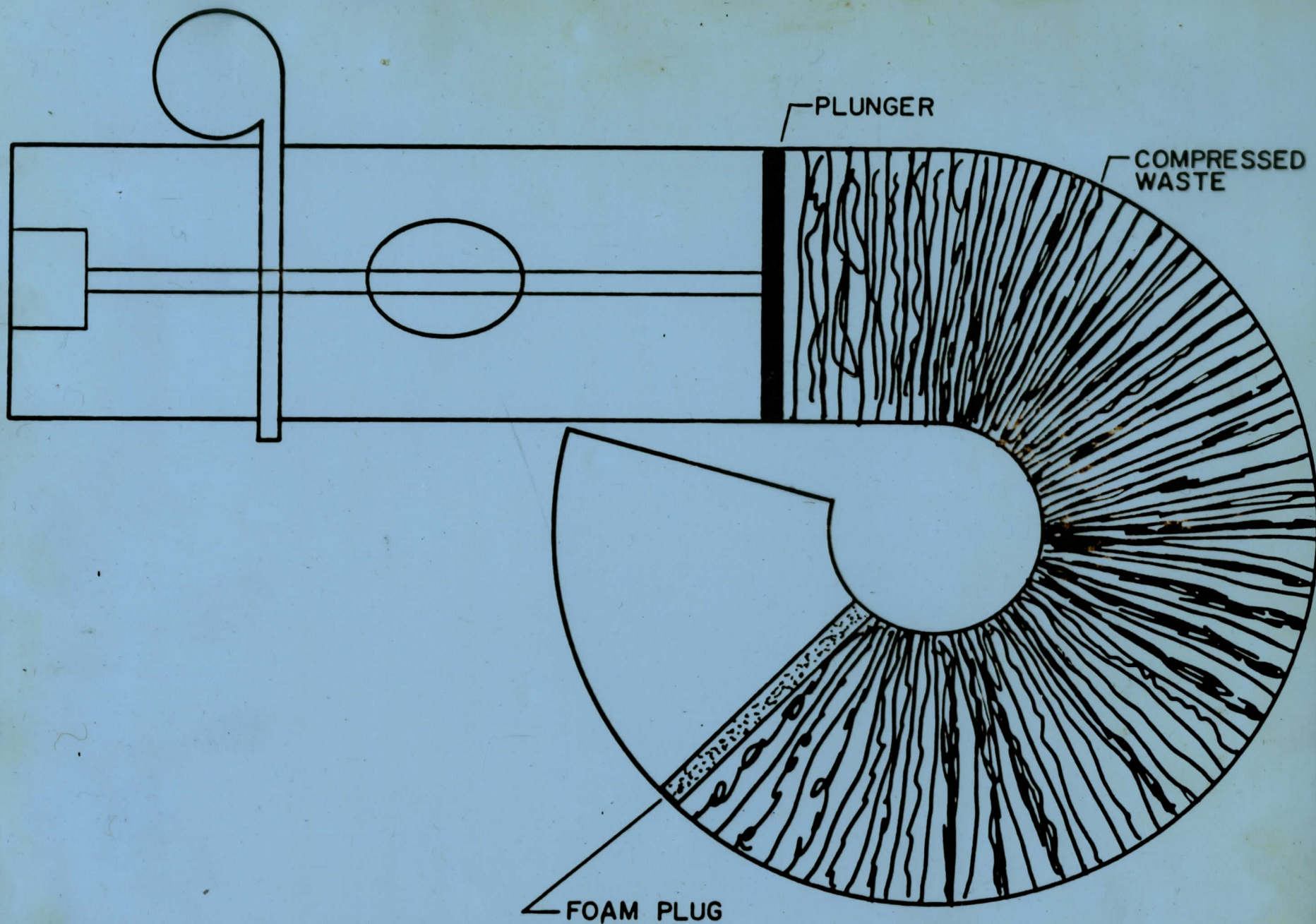




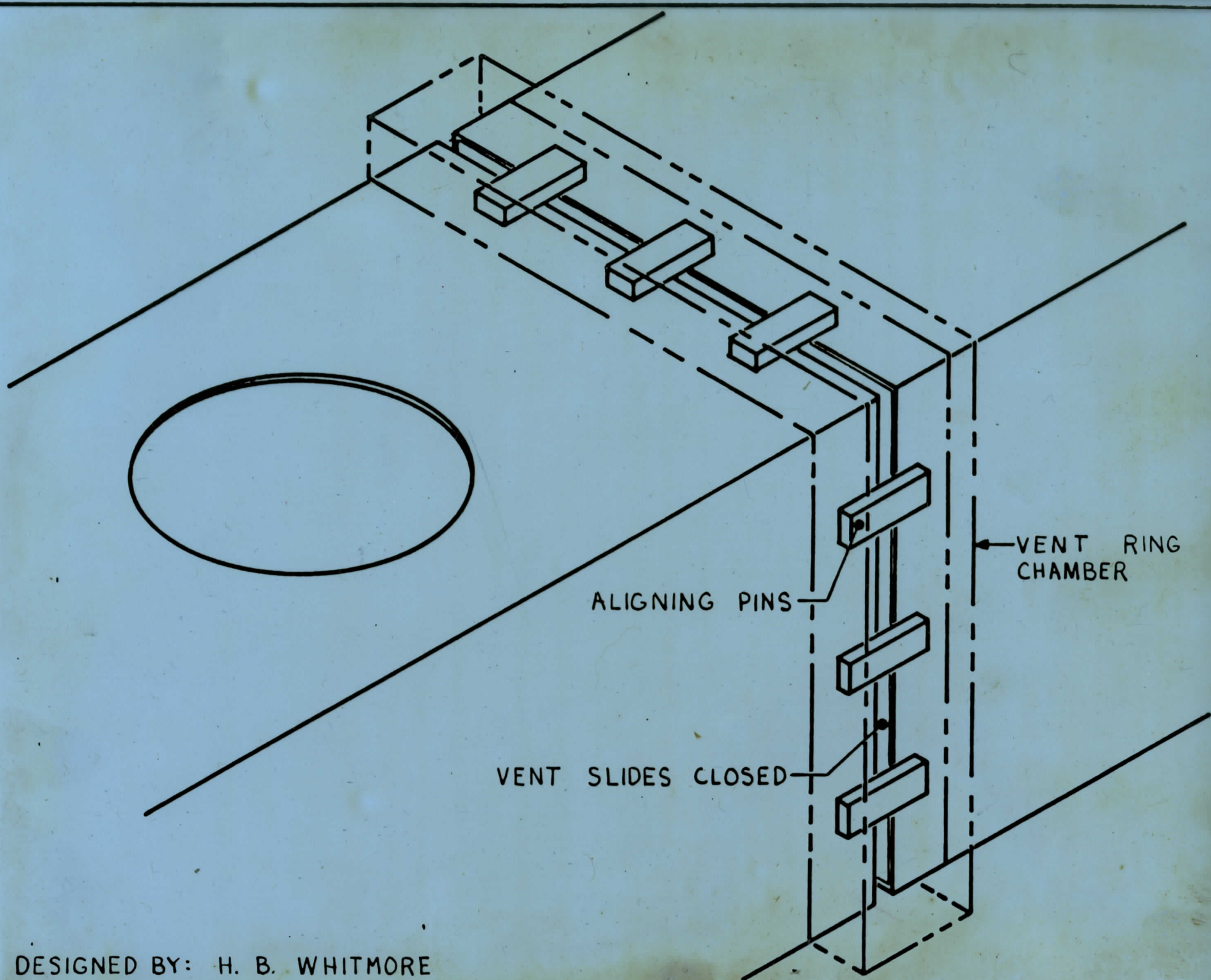
-001 FLOW TUBE

MATL LEXAN, PLEXIGLAS, LUCITE, etc

MUST BE POLISHED INSIDE
+ OUT FOR PHOTO COVERAGE



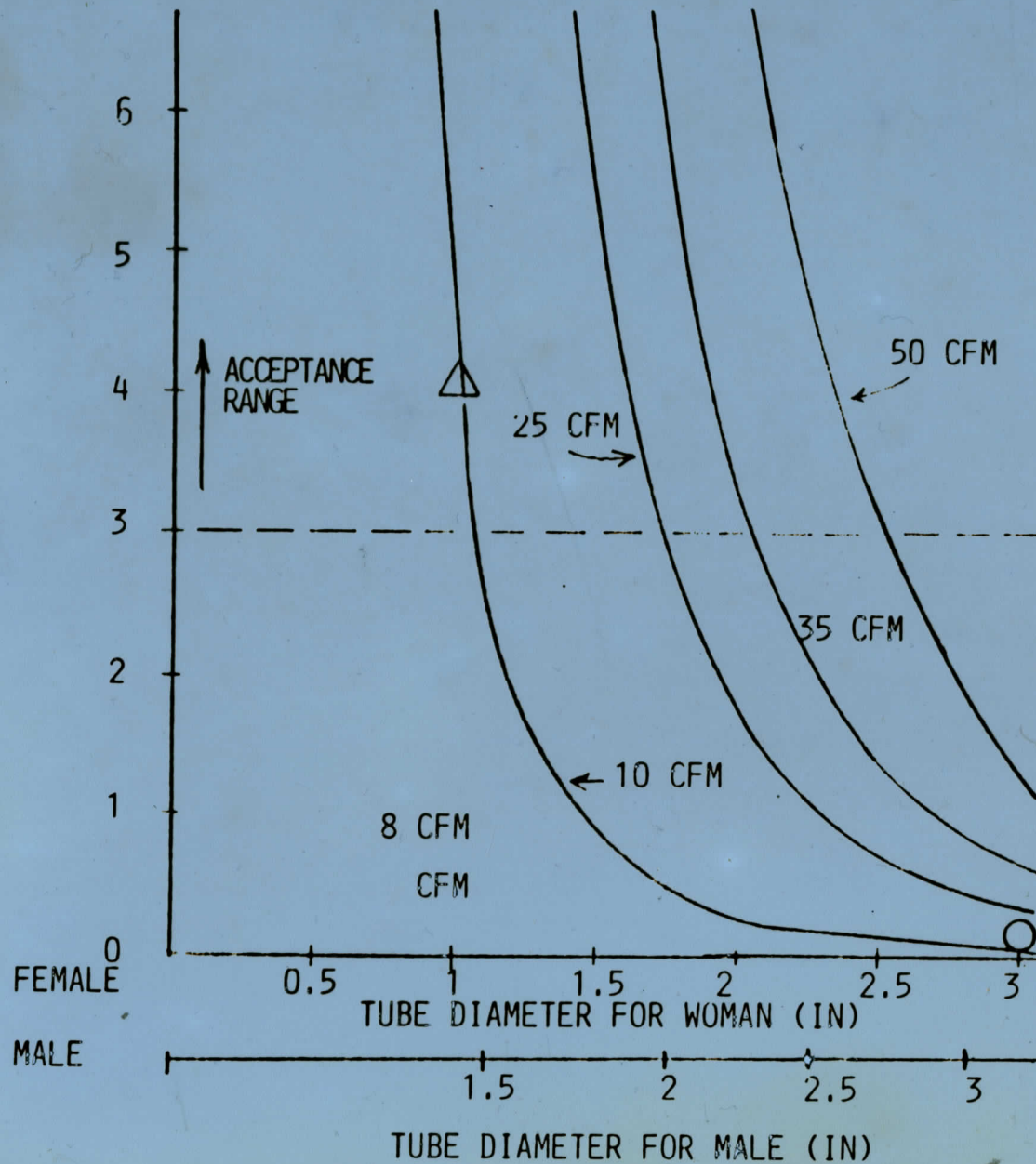
DESIGNED BY: H. B. WHITMORE



DESIGNED BY: H. B. WHITMORE

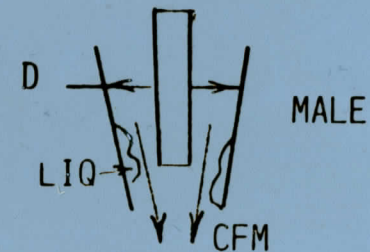
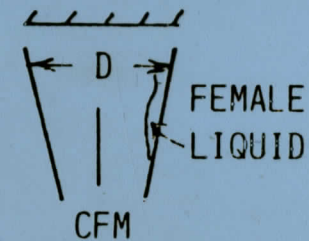
LIQUID SEPARATION FROM WALL SENSITIVITY TO AIR FLOW AND TUBE DIAMETER

$$N_W = \frac{\rho_L V^2 \text{AIRS}}{\sigma} = \frac{C \rho_L \dot{V}^2 \delta}{D^4 \sigma}$$



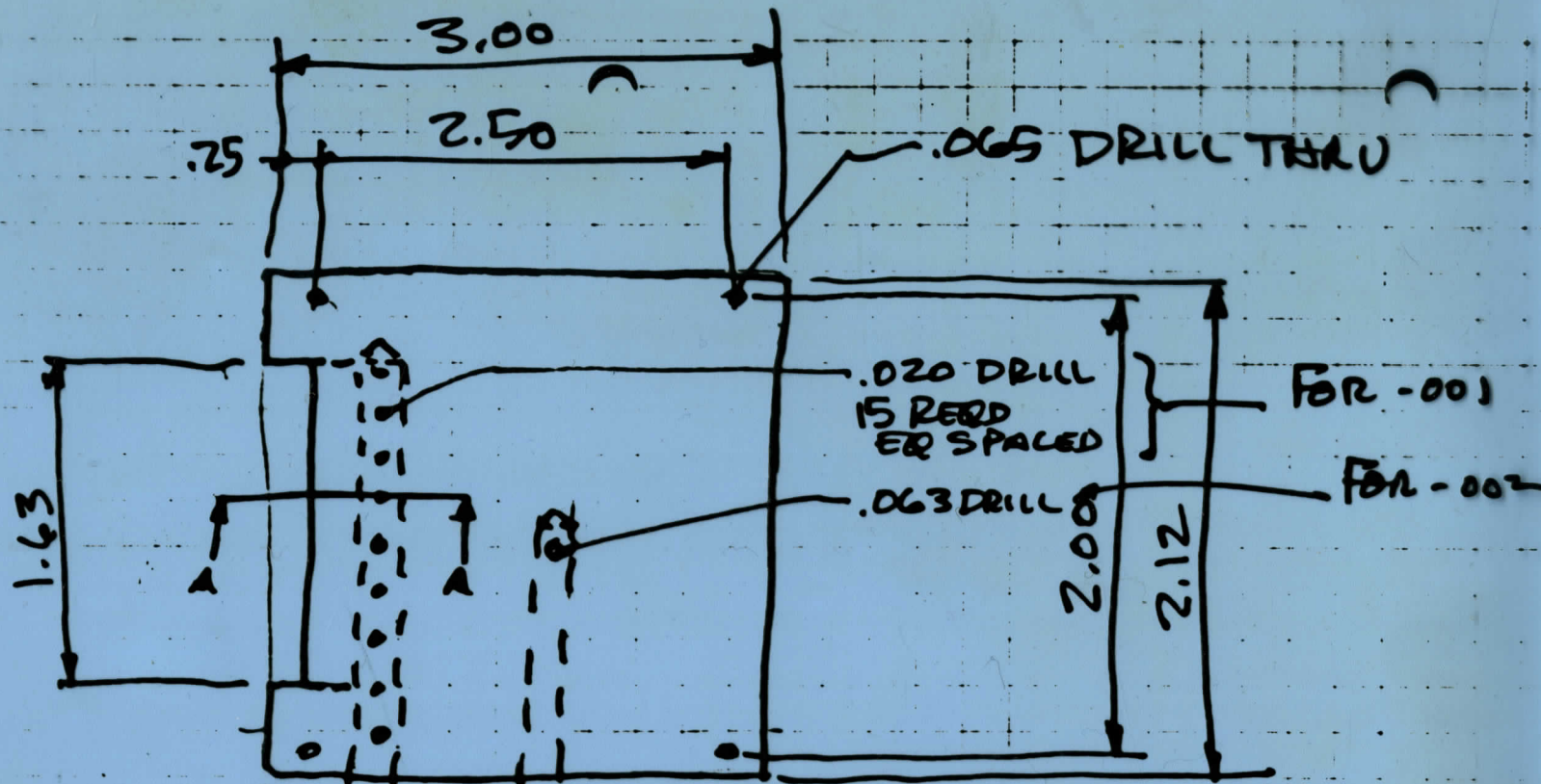
\dot{V} - VOLUMETRIC FLOW

D - CHARACTERISTIC DIAMETER

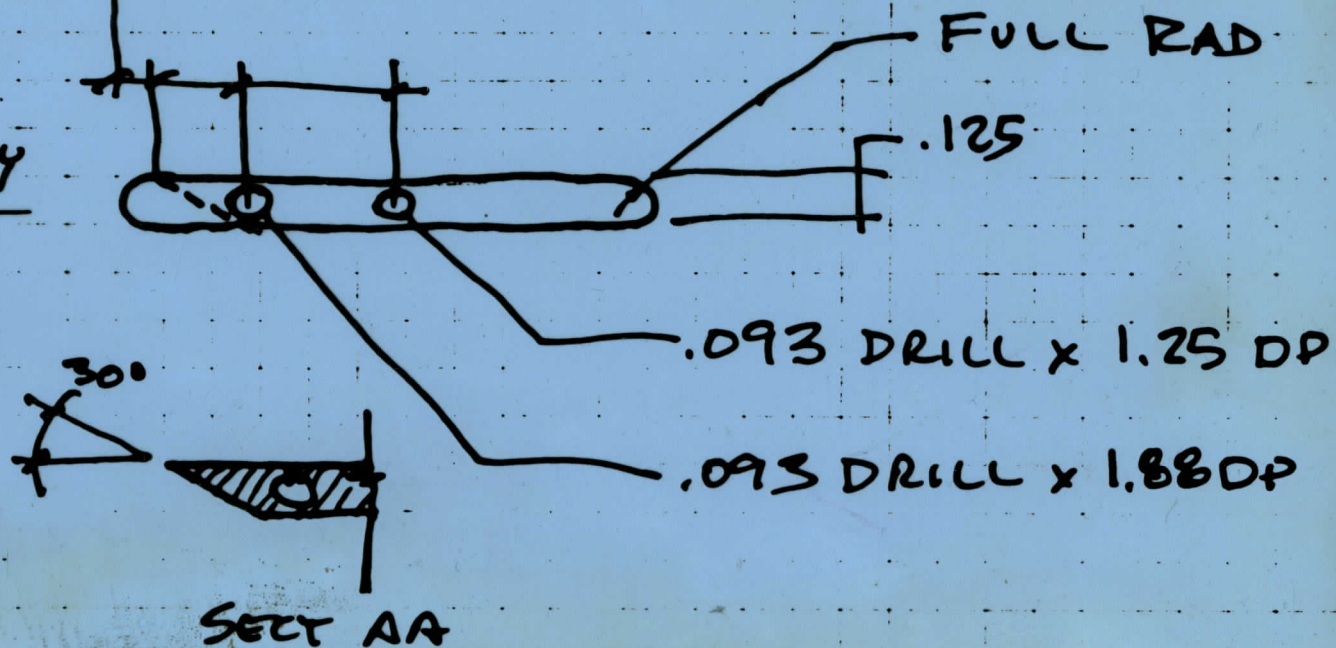


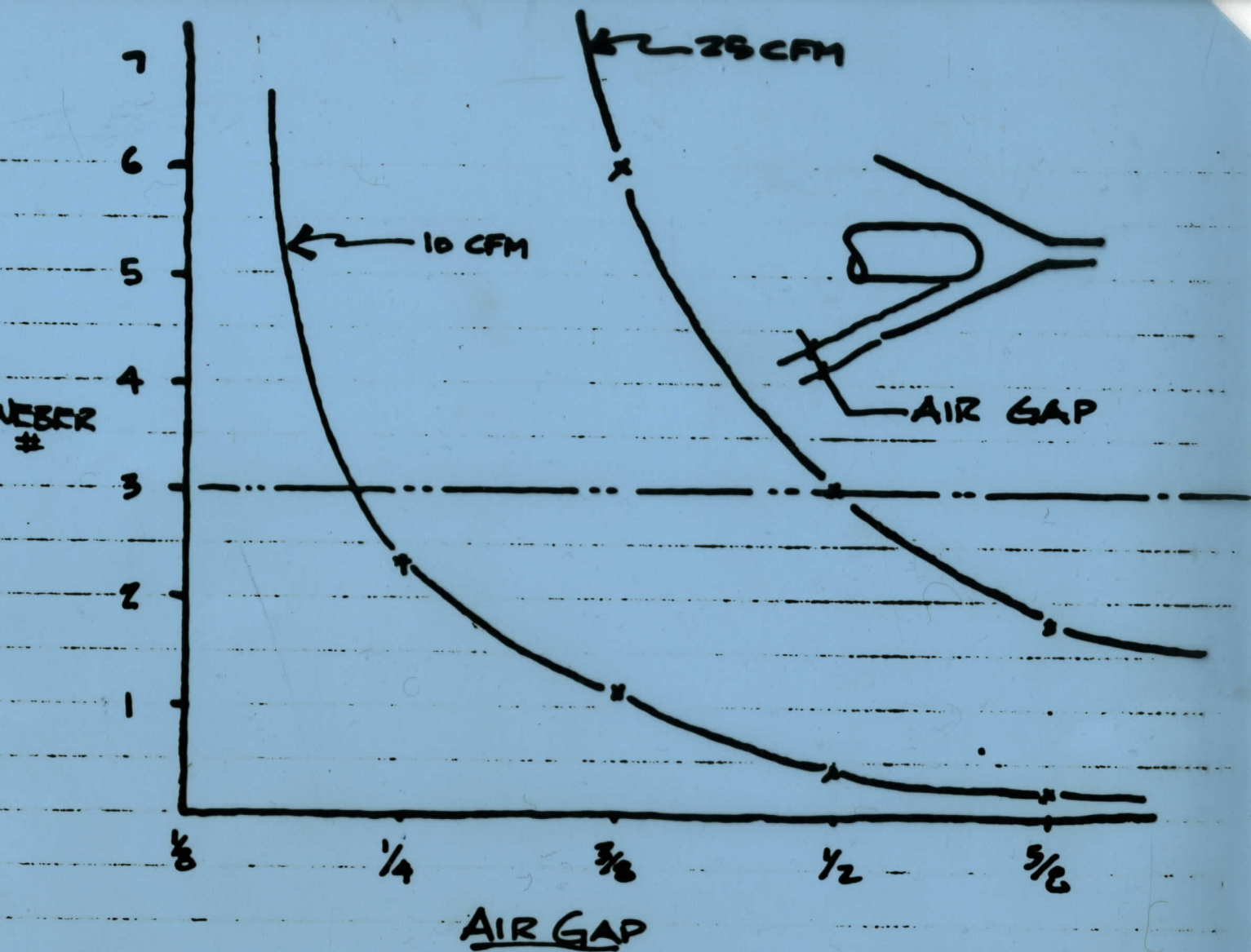
Δ - PIPE WALL

\bigcirc - COLLECTOR WALL



-002 PLATE
 -001 PLATE
 6061-T6 ALUMALY

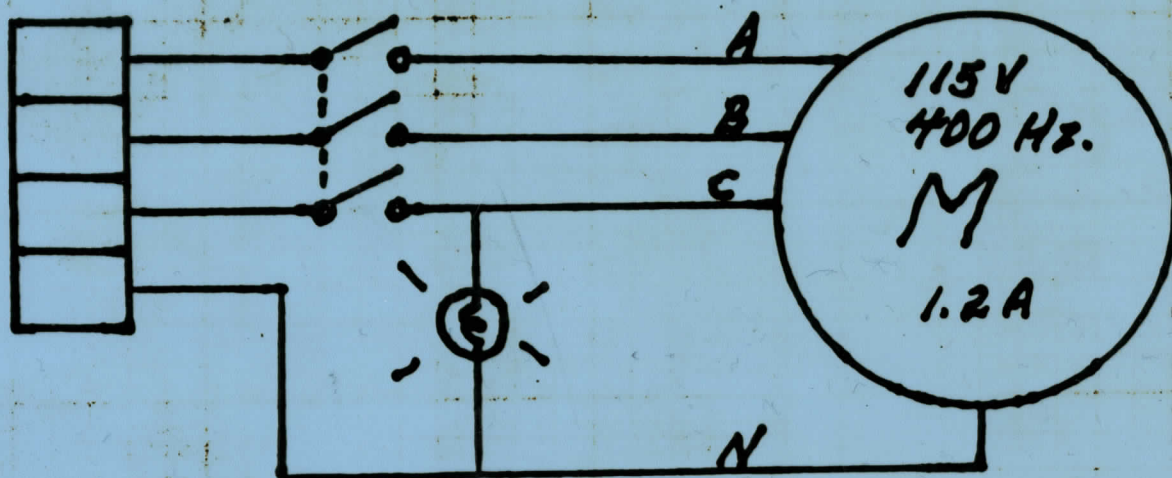




AIR GAP	ANGLE	AREA	EQUIV. DIA.	WEBER NUMBER	
				10CFM	25CFM
1/8	10	.44	.74	↑	↑
1/4	10	.97	1.11	2.3	12
3/8	10	1.60	1.43	1.1	6
1/2	10	2.32	1.72	.44	3
5/8	10	3.14	2.00	.25	1.8
1/8	20	.42	.73	SAME	
1/4	20	.92	1.18		
3/8	20	1.52	1.39		
1/2	20	2.21	1.68		
5/8	20	3.00	1.95		

1WCS

Electrical



ESSENTIAL FEATURES, IWCS.

- **COLLECTION & COMPACTION OF FECES AND PAPER, LEAVING AREA CLEAN.**
- **HANDS OFF OPERATION.**
- 1. COMPACTION OF FECES & WASTE PAPER**
 - **DRIVE MECHANISM
MANUAL
AUTOMATIC**
 - **PISTON FACING
MANUAL
AUTOMATIC**

IWCS FEATURES (CONT'D).

2. COLLECTION/CONTAINMENT FECES, WASTE PAPER, ODORS

- **AIR CIRCULATION
BLOWER
OCCLUSION VALVE
PARTICLE FILTER
ODOR FILTER**
- **IMPROVED SEPARATION/ENTRAINMENT**
- **GAS VENT (TO VACUUM)**

IWCS FEATURES (CONT'D).

3. INTEGRATION, INTERFACE

- **INTEGRAL
STRUCTURE
MECHANISM**
- **SPACECRAFT
LAUNCH
OPERATION
RETURN**
- **MAN MACHINE
SEAT**

TESTING TO DATE

PICK UP, TRANSPORT AND RELEASE OF PISTON INTERFACE.

PICK UP, TRANSPORT AND PACKING OF PAPER & SIMULATED FECES.

PICK UP, TRANSPORT AND PACKING OF PAPER & FECES.

TEST OF AUTOMATIC PAPER INTERFACE.

FLOW TEST OF OCCLUSION VALVE.

GAS GENERATION TEST.

MOCKUP INTERFACE TEST IN 1G TRAINER.

VELCRO MOCKUP STUDY.

FAN EMI TEST.

OPERATIONAL TEST OF:

OCCLUSION VALVE

SEAT VALVE

COMPACTER DRIVE

TO BE DONE

PROPERLY DONE GAS GENERATION TEST?

SUB SYSTEMS ACCEPTANCE TEST.

SYSTEM ACCEPTANCE TEST.

SYSTEM OPERATION TESTS.

INTERFACE TEST.

CREW OPERATIONS & TRAINING.

OUTGASSING.

FLIGHT HARDWARE FUNCTIONAL TESTS.

IMPROVED WASTE COLLECTION SYSTEM (IWCS)

GOALS:

- PROVIDE A CLEAN, ADEQUATELY SIZED VOLUME FOR DEFECATION AND ASSOCIATED CLEANING MATERIALS.
- STOW THE WASTES IN THE SMALLEST VOLUME POSSIBLE IN AN ISOLATED AND STABLE FORM.

* * * * *

IT IS ASSUMED THAT:

- UNIT MUST BE RELIABLE
- ENTRAPMENT AIRFLOW WILL BE IMPROVED OVER CURRENT DESIGN
- THERE WILL BE A REDUCTION IN SIZE AND IN COMPLEXITY OF SERVICING
- SINGLE-BUTTON, AUTOMATIC OPERATION WITH MANUAL OVERRIDE
- METHOD WILL HAVE ANY DESIRED CAPACITY
- ODOR, GAS CONTROL WILL BE AN INTEGRAL PART OF DESIGN

SECOND TASK: TO DESIGN AND BUILD A 1-G PROTOTYPE TO DEMONSTRATE THE SUCCESSFUL OPERATION OF ALL ESSENTIAL FEATURES INCLUDING:

- AUTOMATIC OPERATION OF PISTON FACING MECHANISM
- AUTOMATION AND INTEGRATION OF MECHANICS INCLUDING: PISTON DRIVE, FACING OPERATION & OPERATION OF VENTS & OPENINGS
- AIR 'SPRAY' AND CIRCULATION SYSTEM
- SEAT ARRANGEMENT
- MECHANICAL INTERFACE WITH SPACECRAFT
- NECESSARY VENTING, FILTRATION AND ISOLATION FOR ODOR CONTROL
- ADEQUATE STORAGE SPACE WITH MEANS FOR RAPID SERVICING
- MANUAL OVERRIDE OF ALL KEY FUNCTIONS

N.B. TECHNIQUES USED WILL BE CONSISTENT WITH FLIGHT QUALIFICATION IN LATER MODELS. MOTORS, ETC., MAY USE STANDARD POWER BUT WILL REMAIN WITHIN POWER CONSTRAINTS OF THE ORBITER. EXTENSIVE 1-G OPERATION WILL BE PERFORMED TO INSURE THAT FLIGHT GOALS CAN BE MET.

THIRD TASK: TO BUILD AND DEMONSTRATE A FLIGHT PROTOTYPE. THIS UNIT WOULD BE CAPABLE OF BEING ADAPTED TO THE SHUTTLE WCS CONSTRAINTS BUT WOULD PRIMARILY BE DESIGNED FOR INFLIGHT DEMONSTRATION OF ALL KEY FEATURES USING FLIGHT HARDWARE; I.E., THE DEVICE WOULD BE FLOWN IN ADDITION TO THE STANDARD UNIT, LOCATED IN THE AIRLOCK OR A SPACELAB.

IWCS DESIGN APPROACH

- RAPID DEMONSTRATION OF WORKING HARDWARE
- EXTENSIVE REVIEW OF POTENTIAL METHODS INCLUDING ENCAPSULATION, HYDRAULIC, ETC.
- METHOD CHOSEN WAS A MECHANICAL PISTON & CYLINDER WITH A DISPOSABLE PISTON FACE WHICH
 - A. SWEEPS & CLEANS THE DEFECATION AREA AND
 - B. COMPRESSES, ISOLATES AND BONDS THE WASTE MATERIAL.

INITIAL TASK: TO DEMONSTRATE THAT A DISPOSABLE FACE

- A. COULD BE PICKED UP AND HELD BY THE PISTON
- B. WOULD TRAVERSE THE CYLINDER WITHOUT JAMMING
- C. WOULD CLEAN THE CYLINDER
- D. WOULD BOND WITH FECES AND OTHER TRASH WITHOUT LEAKAGE
- E. WOULD RELIABLY RELEASE FROM THE PISTON

THIS HAS BEEN SUCCESSFULLY DONE.