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SECURITY CLASSIFICATION OPEN

SUBJECT AIRFLOW TESTS IN A MODEL OF No. 2 CELL, ENGINE LABORATORY, N.R.C.

PREPARED BY H.S. Fowler.

ISSUED TO

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AIRFLOW TESTS IN A MODEL OF No. 2 CELL, ENGINE LABORATORY, N.R.C.

INTRODUCTION

It is intended to test a VTO turbine rig in No. 2 cell of the Engine Laboratory. This unit consists of a tip turbine on the periphery of the VTO fan. In the turbine test rig the fan will be used as a brake to absorb the power of the turbine, and possibly to measure it. The air flow into the fan must therefore be uniform and steady, and the exit airflow must be unobstructed and not give rise to eddying and pressure fluctuations in the test cell. Since the air flows in the cell would be large (400 lbs/sec estimated maximum cell throughput), and there were certain possible obstructions in the cell, it was considered advisable to run airflow tests on a model of the cell. Experience has shown that satisfactory correlation with full-scale observations is obtained with models of 1" = 1' scale. A plywood model with one "Lucite" wall was therefore built to this scale, and a dummy fan unit, incorporating an external compressed air supply and an ejector pump, was mounted in it. Tests on possible fan positions, and on various possible modifications to the cell, were then made, plotting the air flow by means of cotton tails on a probe and by injecting quantities of dust. These tests showed that relatively simple modifications would provide a satisfactory flow pattern in the cell.

DESCRIPTION OF MODEL

The model test cell (See Fig. 1) was built to a scale of 1" = 1', using 1" and 1/2" plywood, with the southeast wall of 1/4" Lucite. The model of the turbine and fan unit was built from brass and copper tube to the same scale. The fan unit could be moved up and down in the cell. The front-end half-wall of the cell was removable, and, while the earlier tests were made with an open back end, the exit stack and various arrangements of exit-end curtain wall were fitted for later tests.

DESCRIPTION OF TESTS

Tests were carried out on 12 configurations, and a chart of the air flow in each case is given. In order to obtain comparable conditions in each case, the ejector air supply pressure was always set at 10 psig. However, tests over a range

from 5 to 50 psig. showed no changes in airflow pattern.

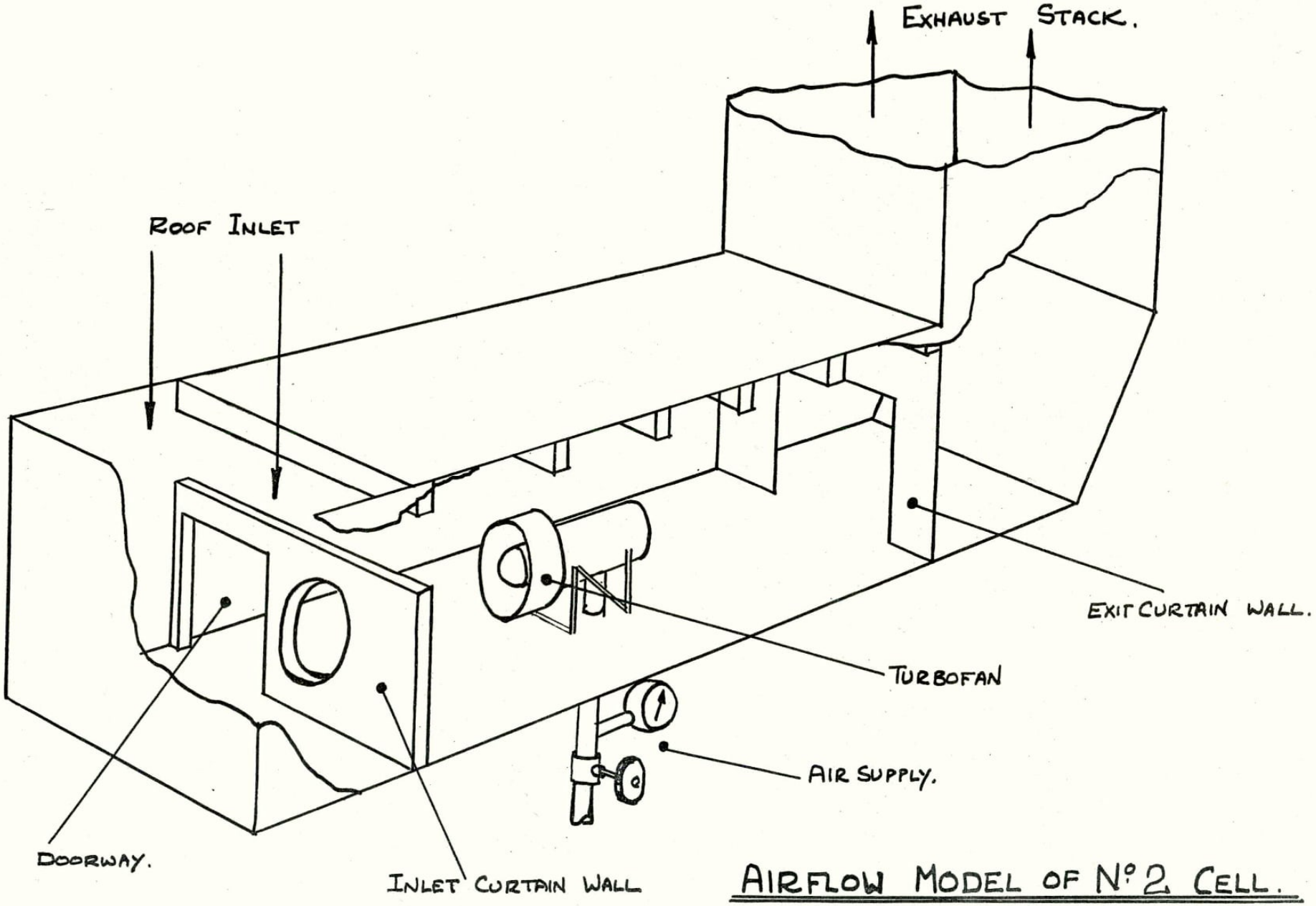
It was obviously desirable to modify the cell as little as possible; so the tests took the present arrangement as their basis and introduced modifications one by one, to determine their effects (See Table I and Figs. 2 to 13). Brief notes accompany each airflow chart, describing the modification tested and the results of this modification.

It becomes clear from the charts that the best configuration is that incorporating a new inlet wall, with a 9-foot-square window in it, and an open back end leading straight into the exit stack.

However, considering the amount of work required to modify the inlet wall to this standard, tests also show that the use of the present inlet wall, with the doors closed, will provide quite an acceptable air flow. This is reasonably symmetrical and stable. It is definitely necessary, however, to remove all the sheet covering of the exit-end curtain wall, although the girder framework may be allowed to remain, if so desired. The existing elbow in the stack increases the recirculation if left in position, although it protects the back wall from direct blast. However, to minimize the circulation of exhaust gas into the fan intake, it should be moved to the side of the stack, where it causes little disturbance.

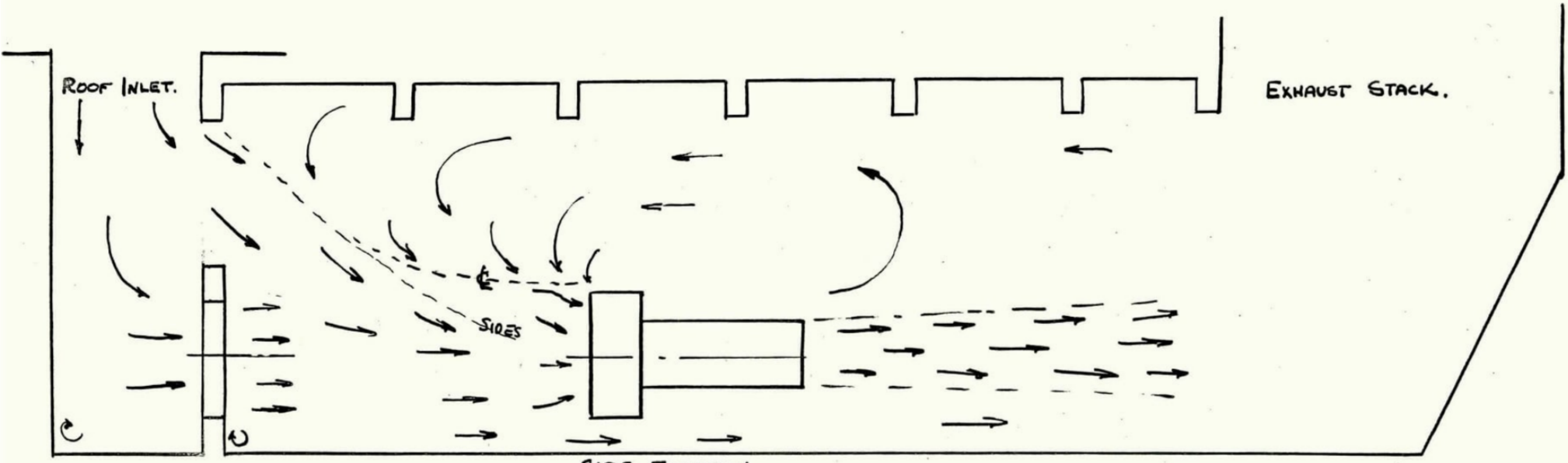
CONCLUSIONS

Various configurations of Cell 2, with a dummy VTO fan installation, have been tested. While not giving the best possible air flow, it has been shown that a readily available configuration will give a satisfactory air flow for testing the turbofan unit. The inlet wall is left in its present condition, with its doors closed. The turbofan unit is mounted at the rear edge of the shaft from Cell 3, with its ℄ 5'0" above the floor. The exit-end curtain wall is removed, the duct elbow is moved to one side of the stack. It is thought advisable to protect the sloping rear wall of the stack for some 12' up, as this area will be heavily scrubbed by the exhaust. This will not be too hot, but will have an erosive effect.

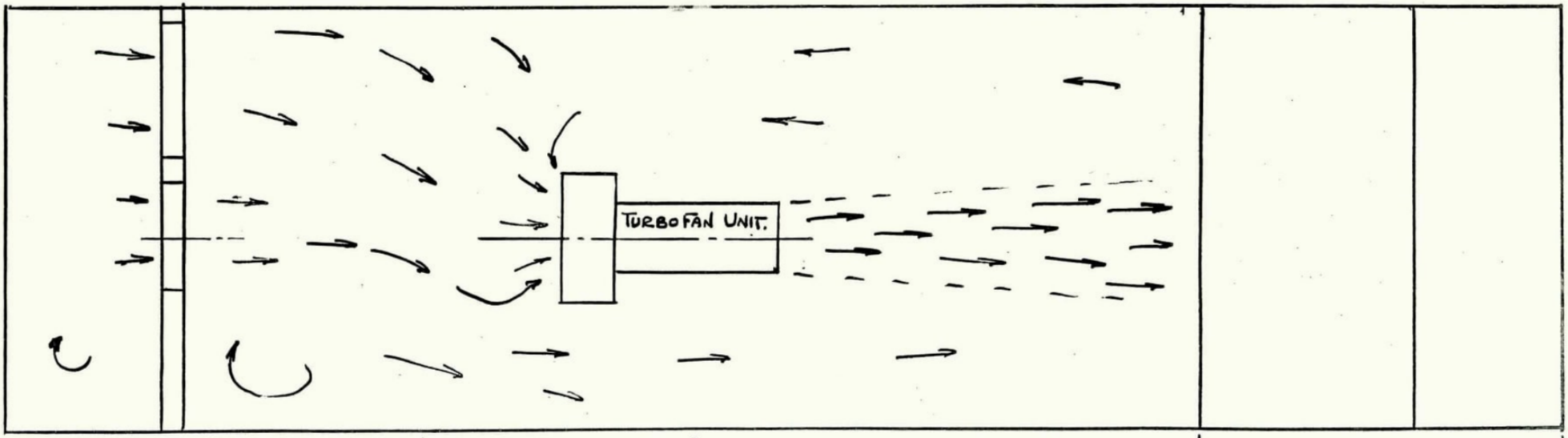


AIRFLOW MODEL OF Nº 2. CELL.
ENGINE LABORATORY.

FIG. 1.



SIDE ELEVATION.



PLAN.

THIS PART FITTED ONLY FOR TESTS 9 AND 10

TEST Nº 1

CONFIGURATION.

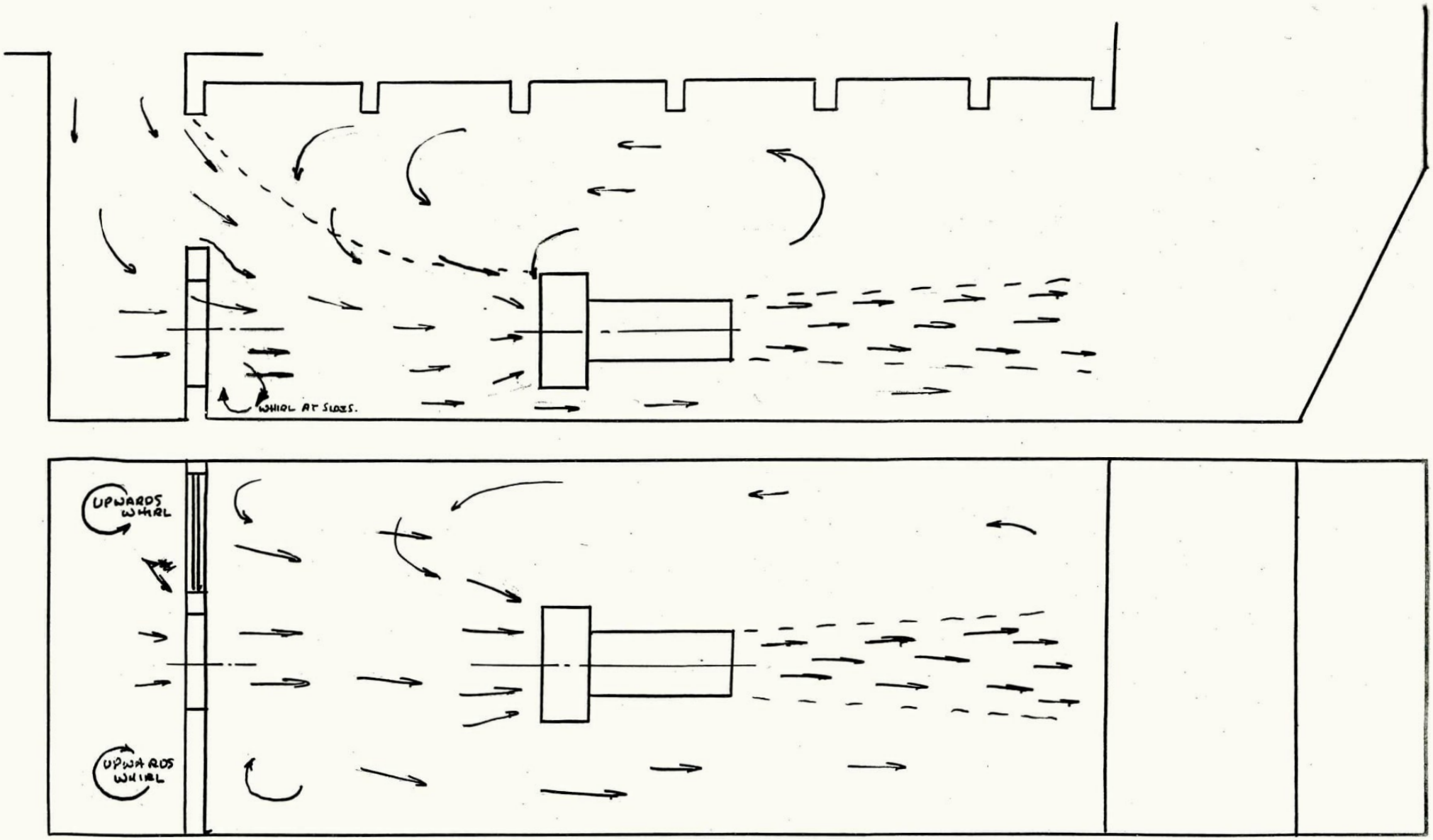
UNMODIFIED INLET CURTAIN WALL, DOOR OPEN, FAN 5'-0" UP FROM FLOOR, EXIT END OPEN, NO STACK.

REMARKS.

CROSS FLOW NEAR INTAKE, DUE TO OPEN DOOR.
SOME REVERSE FLOW, NOTABLY ABOVE ENGINE & ON CONTROL-ROOM SIDE.

FLOW STABLE NEAR INTAKE & EXHAUST.

FIG 2



TEST Nº 2

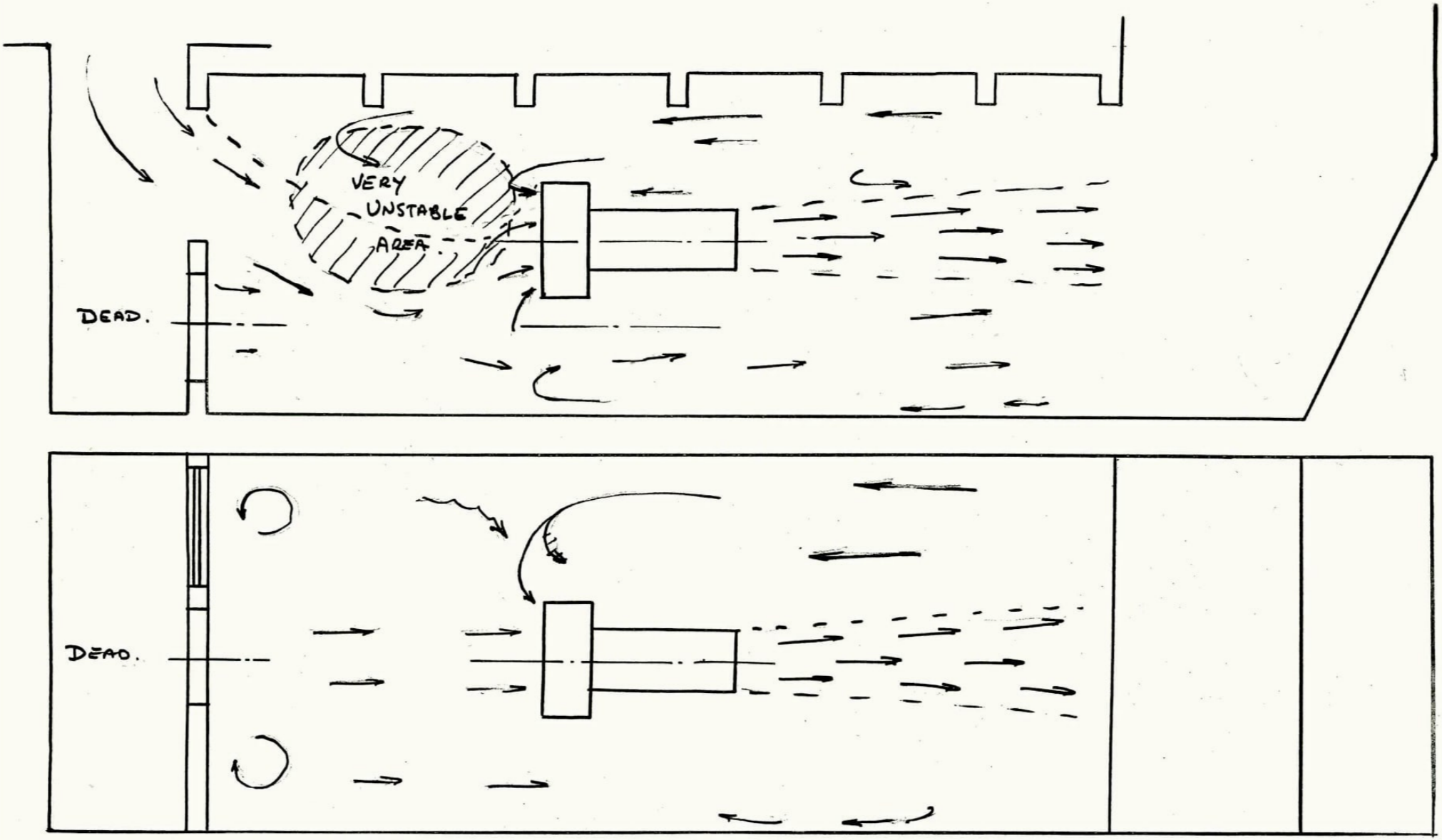
CONFIGURATION.

UNMODIFIED INLET CURTAIN WALL, DOOR CLOSED, FAN 5'-0" UP, EXIT END OPEN, NO STACK.

REMARKS.

AS IN TEST 1, BUT CROSS FLOW AT FAN INLET VIRTUALLY ELIMINATED. REVERSE FLOW STILL MAINLY ON CONTROL-ROOM SIDE.

FIG 3



TEST Nº 3.

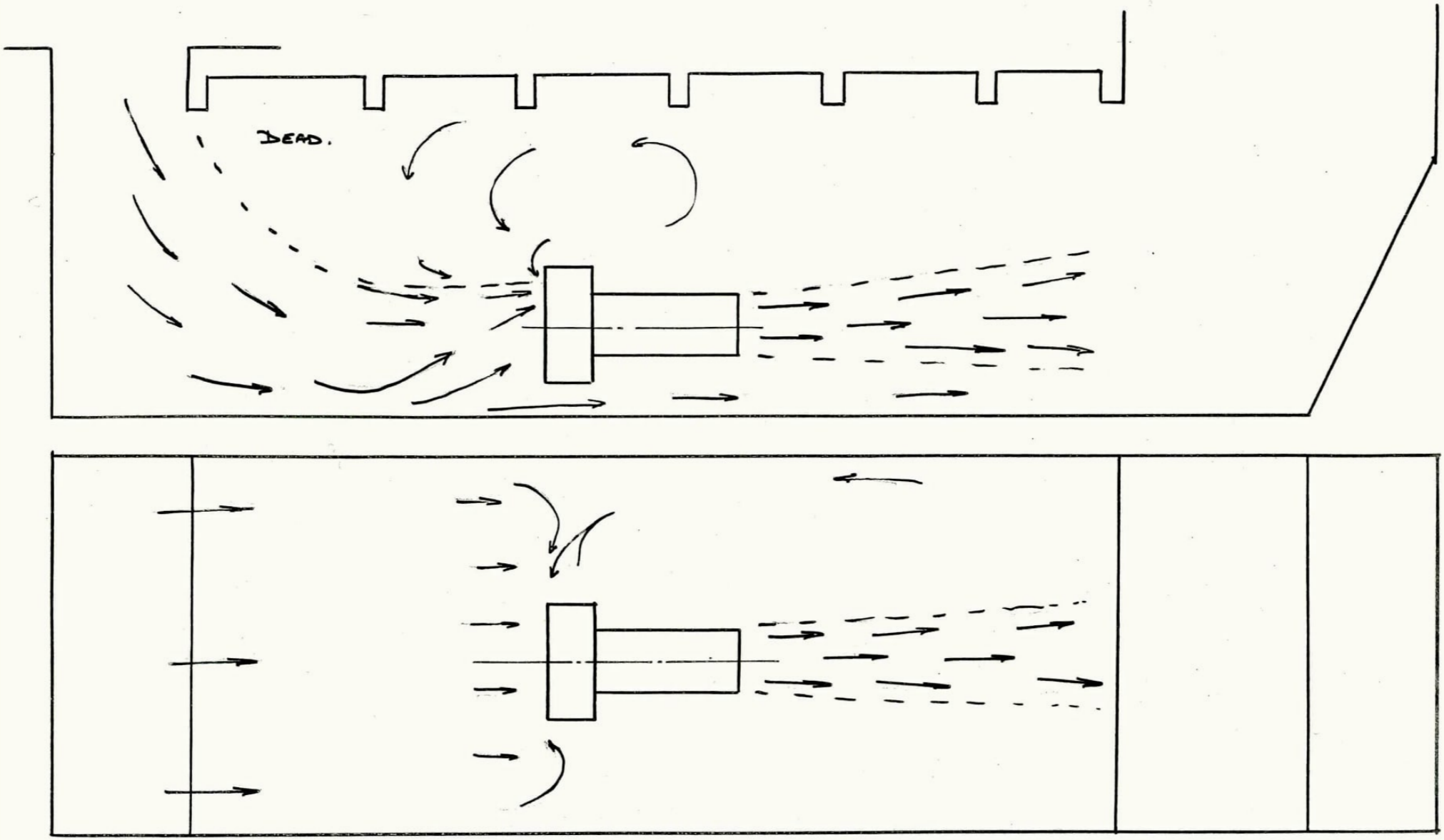
CONFIGURATION.

UNMODIFIED INLET CURTAIN WALL
DOOR CLOSED, FAN 9'-0" UP
EXIT END OPEN, NO STACK.

REMARKS.

FAN INLET FLOW VERY ASSYMETRIC, & VERY UNSTABLE.
CONSIDERABLE REVERSE FLOW ALL ROUND [redacted] CELL.

FIG 4.



TEST Nº 4.

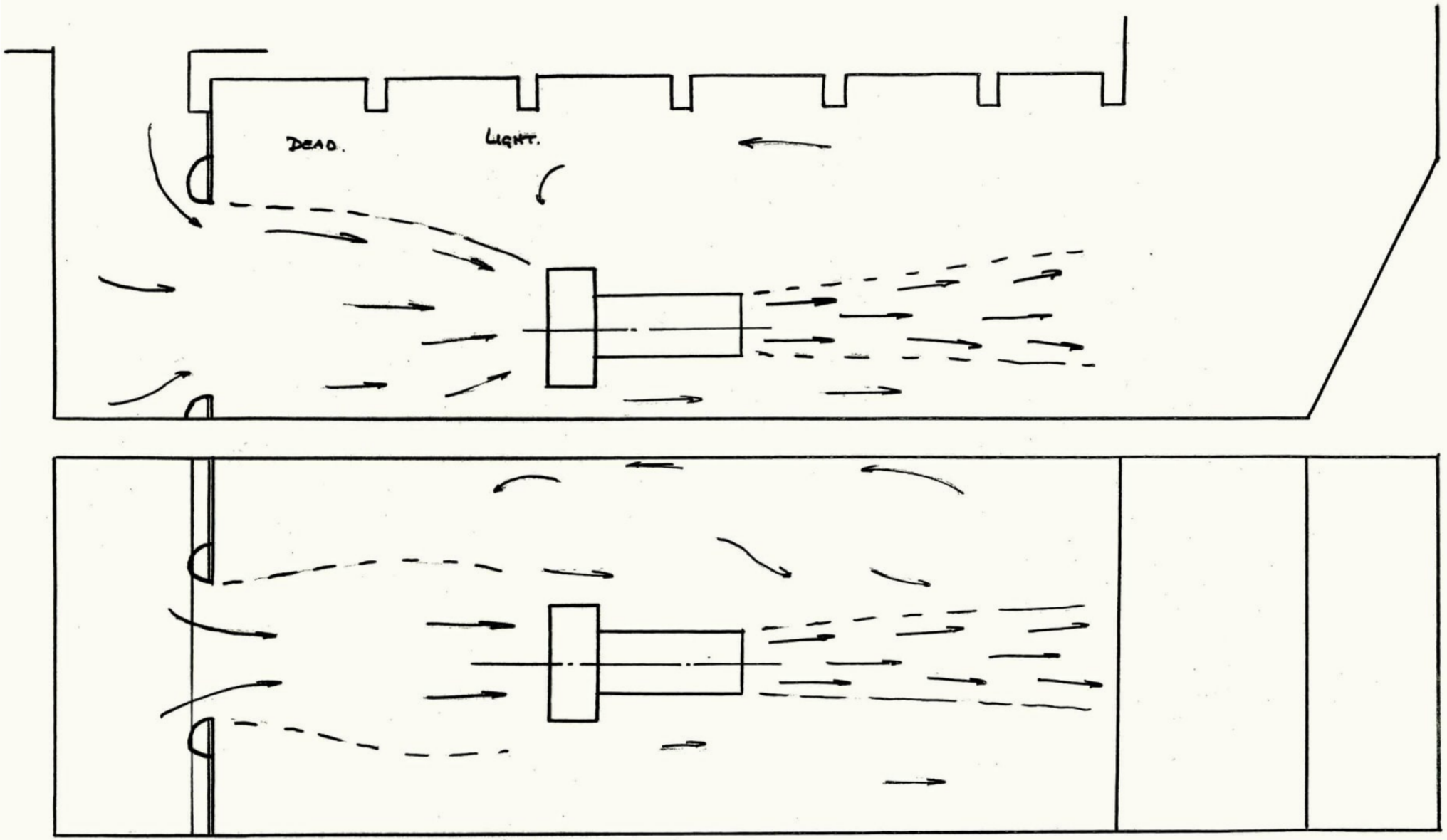
CONFIGURATION.

FRONT CURTAIN WALL REMOVED.
FAN 5'-0" UP.

REMARKS.

FLOW SWEEPS DOWN, HITS FLOOR, AND BOUNCES UP INTO FAN INTAKE, IN VERY ASSYMETRIC MANNER.

FIG. 5.



TEST Nº 5.

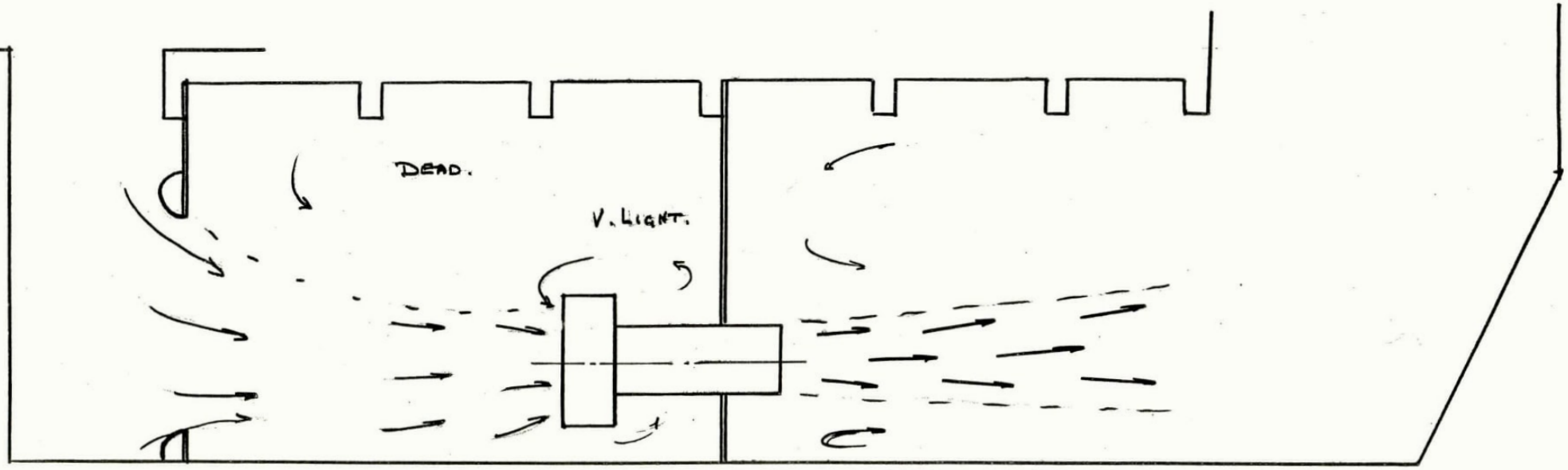
CONFIGURATION.

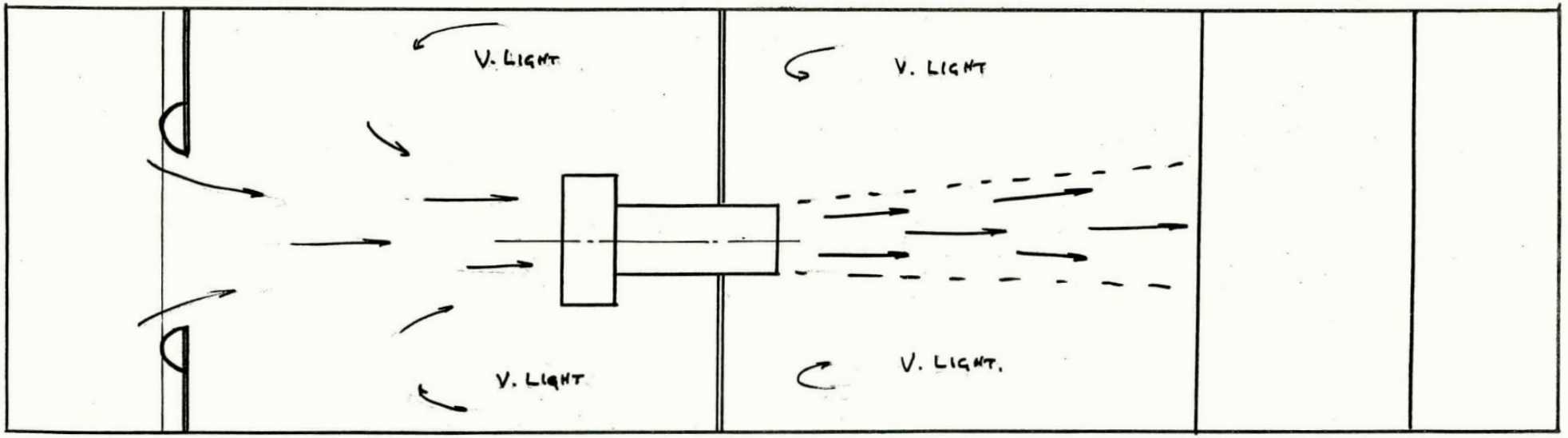
INLET WALL REPLACED BY WALL WITH 3'-0" SQUARE WINDOW WITH 1'-0" RAD. LIP ALL ROUND.
EXIT END OPEN, NO STACK.

REMARKS.

FLOW VERY STABLE & SYMMETRICAL AT INLET.
REVERSE FLOW REDUCED.

FIG.6.





TEST Nº 6.

CONFIGURATION.

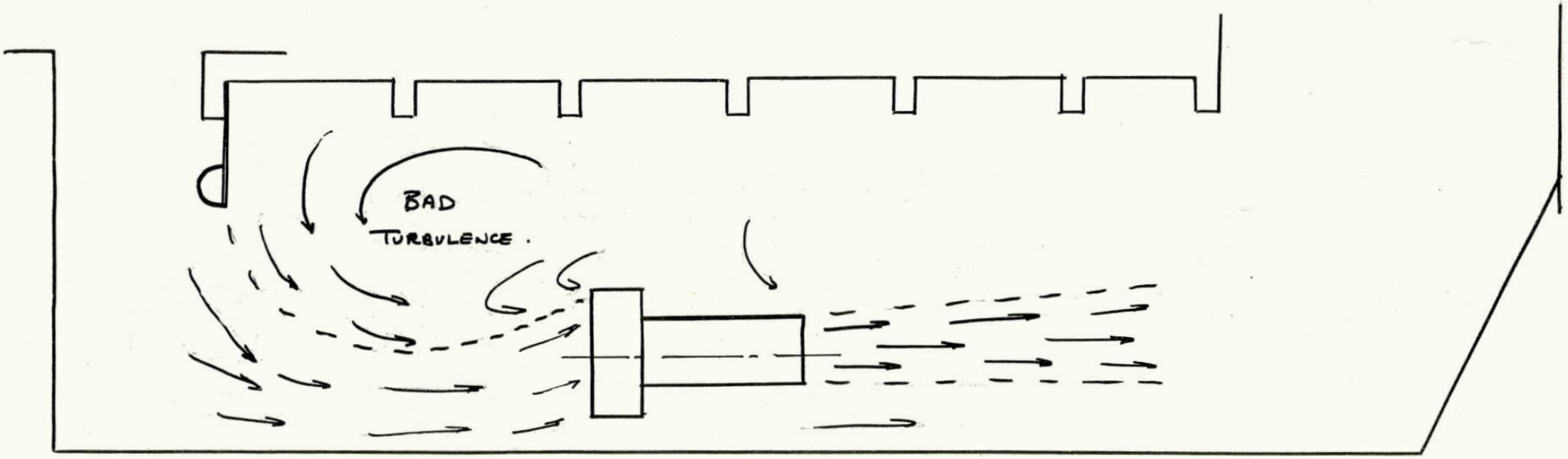
AS IN TEST 5, BUT WITH CURTAIN WALL ACROSS MIDDLE OF CELL

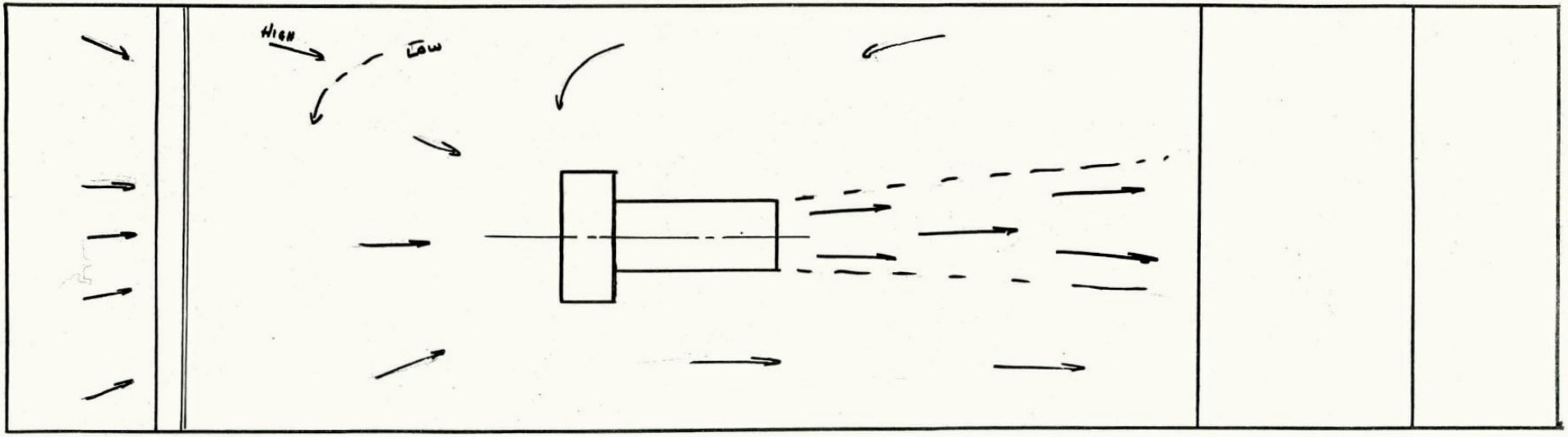
EXIT END OPEN, NO STACK.

REMARKS.

REDUCED ALREADY LIGHT REVERSE FLOW, BUT NOT COMPLETELY.

FIG. 8.7.





TEST Nº 7.

CONFIGURATION.

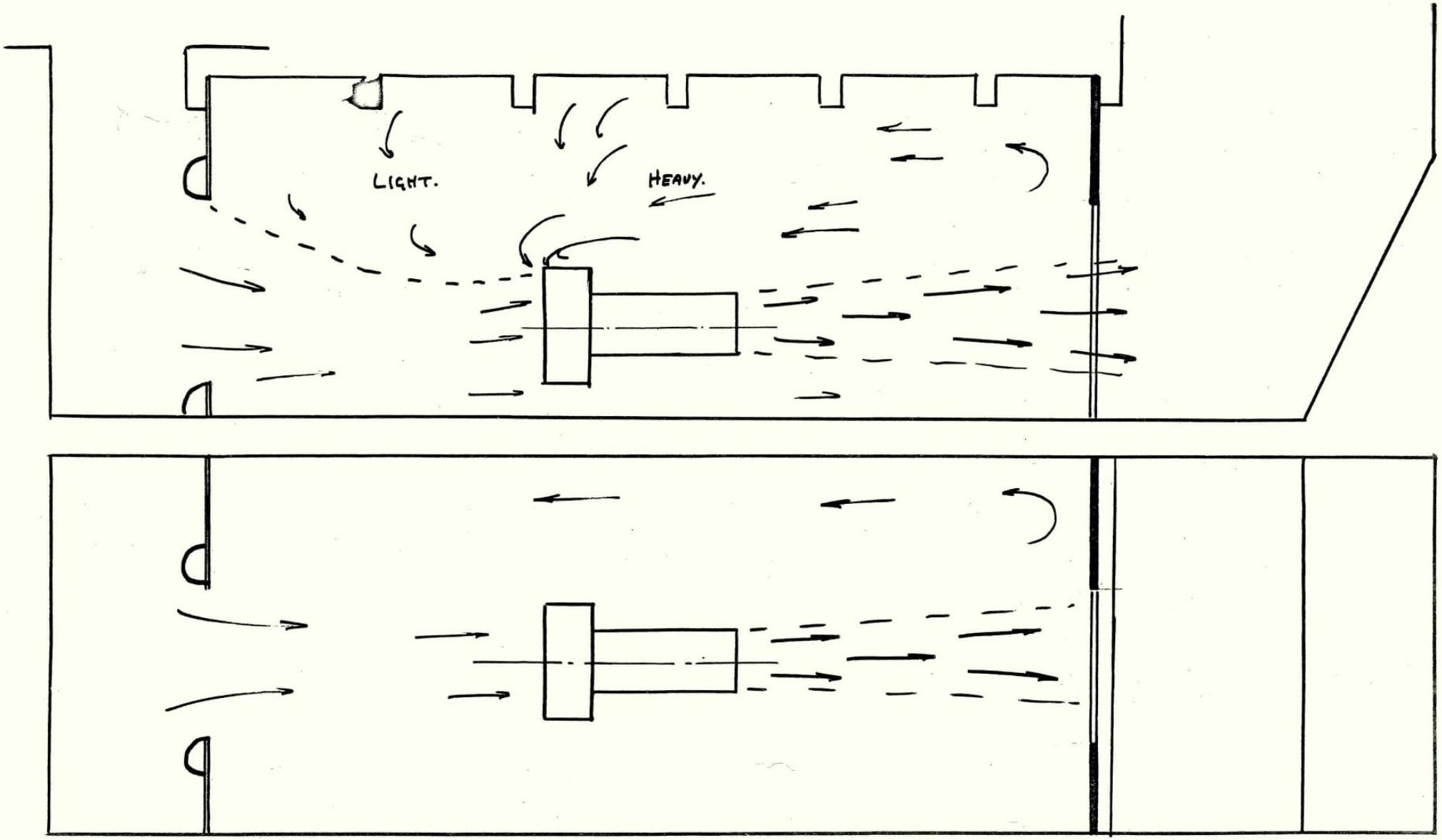
TOP HALF INLET WALL ONLY

NO EXIT END, WALL, NO STACK

REMARKS.

INLET END DOWN-FLOW WORSE THAN WITH ANY PREVIOUS CONFIGURATION.

FIG 8.



TEST Nº 8.

CONFIGURATION.

INLET WALL, WITH 9'SQ. WINDOW.

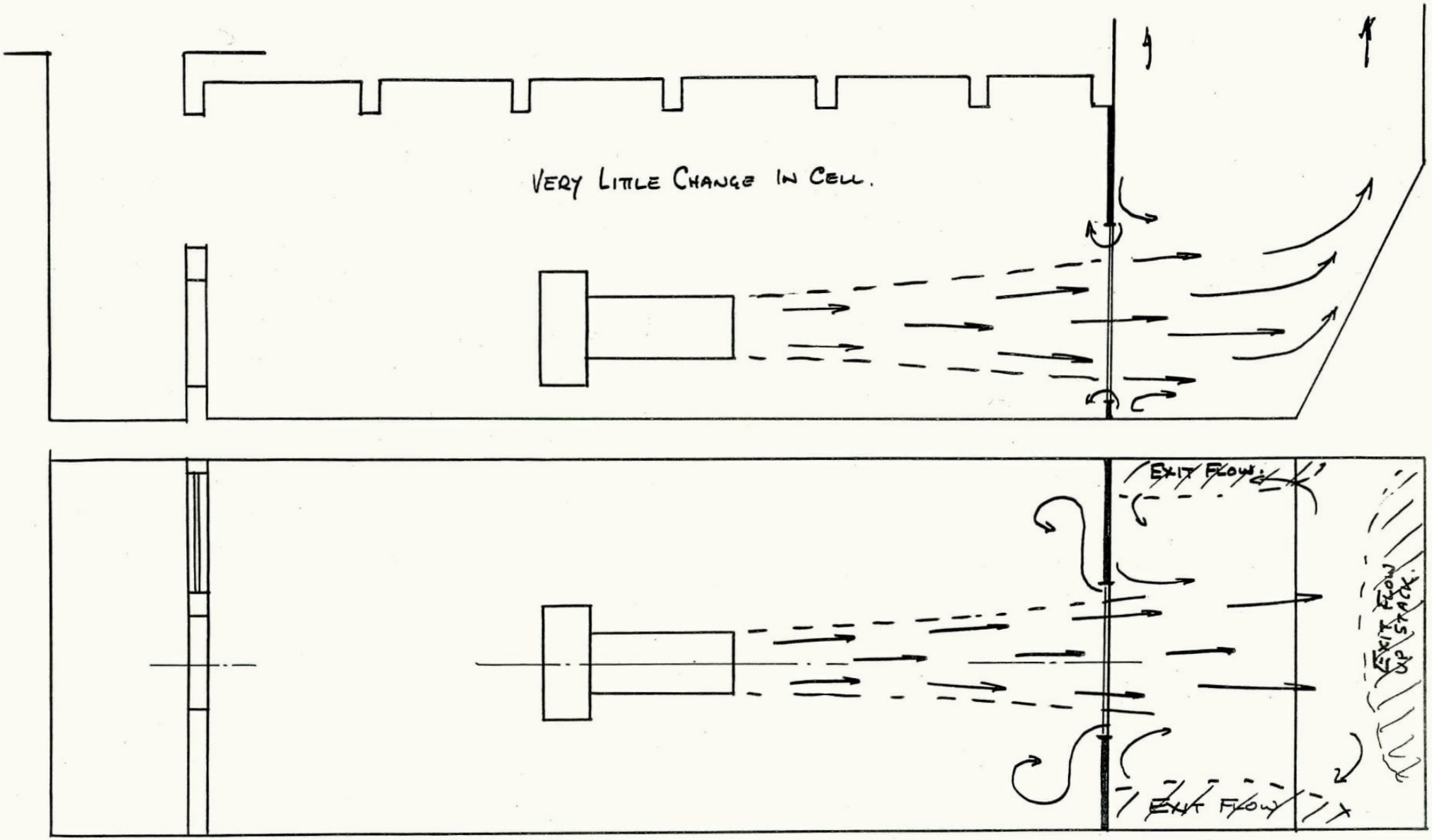
EXIT WALL, WITH 9'SQ. WINDOW.

NO EXIT STACK.

REMARKS.

REVERSE FLOW INCREASED, PARTICULARLY AT TOP OF FAN.

FIG.9.



TEST Nº 9.

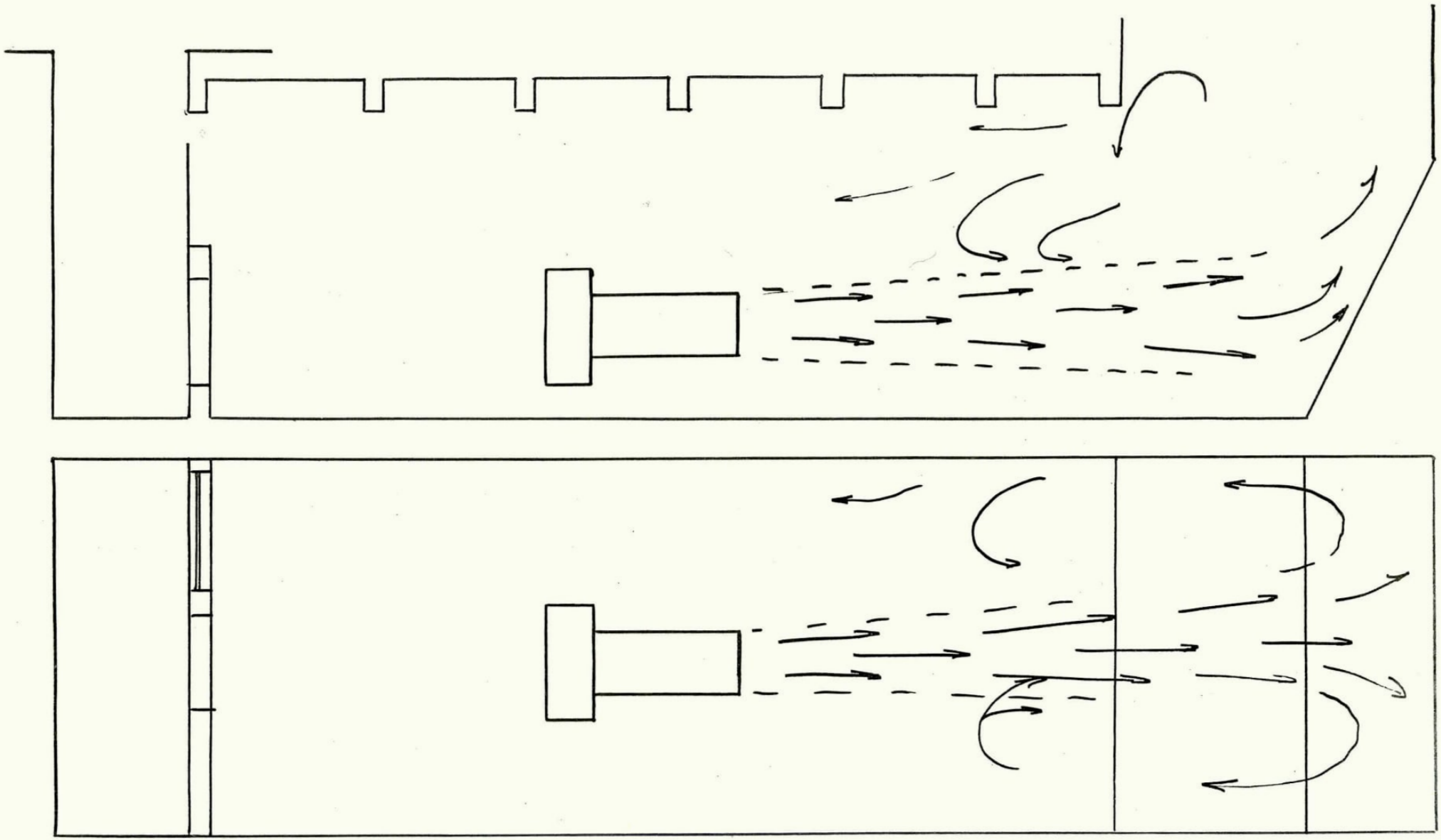
CONFIGURATION.

AS RUN 8, BUT WITH EXITSTACK

REMARKS.

FLOW IN CELL HARDLY MODIFIED. SLIGHTLY MORE REVERSE FLOW.
FLOW IN STACK REASONABLE.

FIG 10.



TEST No. 10.

CONFIGURATION.

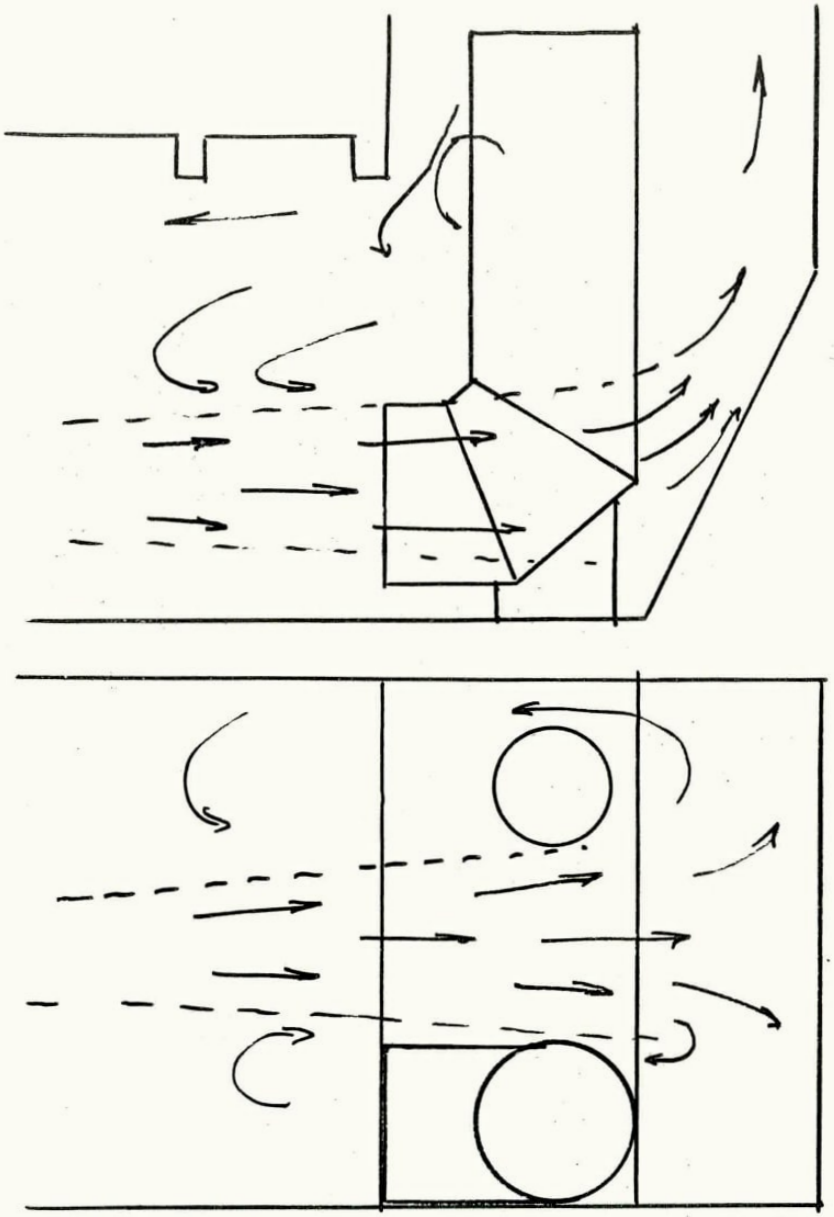
UNMODIFIED INLET WALL, DOOR CLOSED,
NO EXIT WALL, STACK PRESENT,
FAN 5'-0" UP.

REMARKS.

VERY SLIGHT INCREASE OF REVERSE FLOW
AT REAR OF CELL.

APPEARS A PRACTICAL ARRANGEMENT.

FIG. 11.



TEST N° 11.

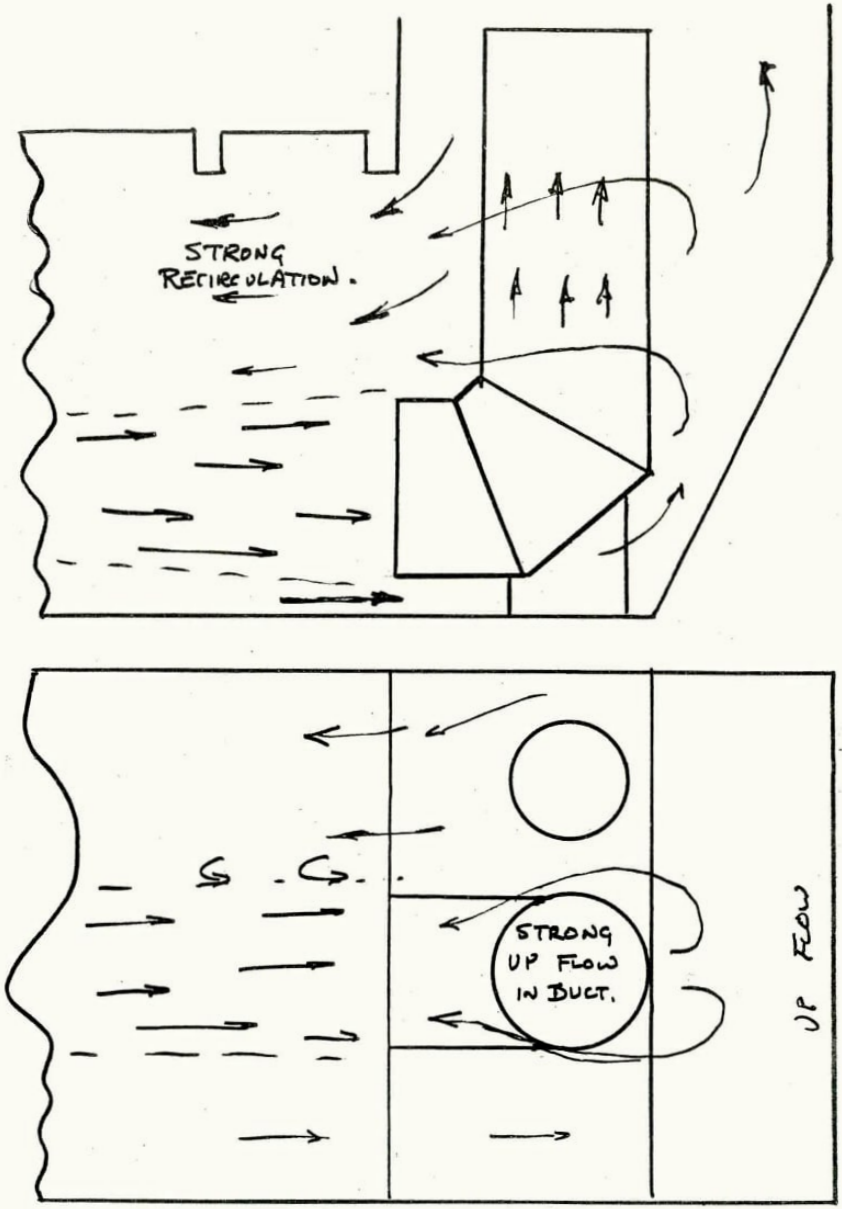
CONFIGURATION

EXIT ELBOW AT SIDE OF CELL..

REMARKS

HAS LITTLE INFLUENCE ON FLOW.

FIG .12.



TEST N° 12.

CONFIGURATION.

EXIT ELBOW IN NORMAL POSITION.

REMARKS.

PROTECTS REAR WALL, BUT CAUSES INCREASED RECIRCULATION.

FIG.13.

TEST SUMMARY.

TEST Nº	INLET CURTAIN WALL.	FAN POSITION.	CENTRE CURTAIN WALL.	EXIT CURTAIN WALL.	EXHAUST END.
1.	UNMODIFIED, DOOR OPEN.	℄ 5'-0" ABOVE FLOOR	NONE.	NONE.	OPEN. No STACK ON MODEL.
2.	UNMODIFIED, DOOR CLOSED.	"	"	"	"
3.	" "	℄ 9'-0" ABOVE FLOOR.	"	"	"
4.	ENTIRELY REMOVED.	℄ 5'-0" ABOVE FLOOR.	"	"	".
5.	CURTAIN FULLY BLOCKING END, WITH 9'×9' OPENING ON FAN ℄, WITH 1" RAD. LIP.	"	"	"	"
6.	"	"	COMPLETE CURTAIN WALL IN PLANE OF FAN	"	"
7.	CURTAIN DOWN FROM ROOF, TO 11' ABOVE FLOOR, WITH 1 RAD LIP, RIGHT ACROSS CELL	"	NONE.	"	"
8.	CURTAIN WITH 9'×9' OPENING AS IN (5) ABOVE	"	"	CURTAIN RIGHT ACROSS EXIT END, WITH 9'×9' OPENING ON FAN ℄, NO LIP.	"
9.	AS IN (2) ABOVE UNMODIFIED ORIGINAL INLET WALL, DOOR CLOSED.	"	"	"	MODEL OF STACK IN POSITION
10.	"	"	"	NONE.	"
11.	"	"	"	"	", ELBOW IN POSITION AT SIDE
12.	"	"	"	"	", ELBOW IN POSITION ON ℄.

TABLE 1.