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THE COLLECTION AND MEASUREMENT OF  
AIRBORNE MERCURY-I

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ABSTRACT

This report is the first in what is expected to be a series of internal reports on the sampling and analysis of airborne mercury. It is planned to consider both organic and inorganic forms and particulate as well as gaseous mercury.

Some preliminary information is given on a new method of sampling mercury on silver elements. This does not involve any liquid reagents and collection seems to be quantitative. The mercury, after collection, is desorbed from the silver collection by heat and the mercury vapor evolved is passed into a measuring cell for measurement of the ultra-violet absorption.

The measuring instrument is a Du Pont 400 photometric analyzer, the use of which is briefly described.

## INTRODUCTION

As mercury vapor exhibits a characteristic and analytically useful absorption in the ultra-violet, many analytical methods have been developed, based upon this property. Ultra-violet light is passed through a quartz windowed cell containing the mercury vapor to be analyzed and the absorption is measured by some form of photocell positioned at the other end. If ultra-violet absorbing materials other than mercury are present there will be more or less interference with the mercury measurement. The measuring instrument may be of single beam construction or double beam. In the latter case, there is opportunity to instrumentally blank out the absorbing substances which are not mercury. Calibration of all such instruments has depended in one way or another upon the absorption of known amounts or concentrations of mercury. The preparation of such accurately known quantities or concentrations has been attended with some difficulty. If the molar absorptivity of mercury were accurately known, once and for all, it should be possible to prepare glass standards of known absorbance equal to a known quantity of mercury. This constant was determined by Müller in 1930. Subsequent measurements by several other workers have not differed appreciably from Müller's value. The Du Pont 400 analyzer makes use of this by incorporating a standard glass filter as a calibration.

The Du Pont analyzer, being of single beam construction, can immediately be criticized as not discriminating sufficiently against other absorbing compounds which may also be present in the sample. This criticism is academic if other ultra-violet absorbing substances are absent from the sample under analysis. The criticism is also academic if the absorptivity of the possible interference is low as compared with mercury.

### INSTRUMENT CALIBRATION

Although, as mentioned, the Du Pont analyzer is provided with a built-in calibrating filter, it is of interest to also calibrate with known amounts of mercury; the material which the instrument is intended to measure. Calibration experiments were carried out in various ways. The best procedure was found to be the use of a static system. This consisted of a quantity of mercury metal in a pyrex reagent bottle. A serum cap was substituted for the usual glass stopper to allow the withdrawal, by syringe, of saturated mercury vapor. The bottles were maintained in a thermostatted water bath controlled to  $0.1^{\circ}\text{C}$  and ample time was allowed for the equilibration of the temperature and the saturation of the mercury in the container before any samples were withdrawn.

Using a gastight syringe, measured volumes of mercury vapor were injected into the instrument through a sampling manifold to be described later. The non-recirculating sampling mode was used. The response of the analyzer is given on a 5 millivolt recorder. Every injection experiment was carried out in triplicate and in all the data here presented it is to be understood that single values are the mean of three separate determinations.

Figure 1 shows triplicate readings, on the recorder chart, of varying fractional millilitre volumes of saturated mercury vapor. The sample volumes injected range from 0.02 ml. to 0.20 ml. The chart readings are arbitrary units, in this case chart divisions. Agreement between triplicates is seen to be good. Also to be observed, is the reading obtained by measuring the ultra-violet absorption of the standard filter, which is 80 arbitrary units. The same Hamilton gastight syringe

of 500 microlitre capacity was used for all standard injections and the temperature of the vapor was maintained at 25.0°C by the thermostat. The results of the same experiment are shown in Table I where the arbitrary units have been corrected to absorbance and the corresponding amount of mercury in nanograms.

For such an instrumental method to be practical, the response of the instrument must be stable during a working day and be the same from one working day to the next. The reproducibility with time was investigated over a period of three consecutive days. Table II shows that the reproducibility of 6 consecutive absorbance measurements of the same standard quantity is excellent for each of the three separate days and that the mean of each of the 6 daily determinations does not vary from one day to the next. This experiment was repeated, but, this time, 5 different measured quantities of mercury vapor were measured on two separate days, separated by an interval of one week. As may be seen, from Table III, the instrumental responses on these two separate occasions are identical.

To cover the practical range of laboratory operating temperatures, instrumental responses were determined at each of 7 standard controlled temperatures, to wit, 22.0, 23.0, 24.0, 24.5, 25.0, 26.0, and 28.0°C. It might have been suggested that the measurements at 24.5 could not have much validity since the effect of 0.5°C would not be noticeable. Careful scrutiny of the values for 24.0, 25.0 and 24.5 show that the latter values fall squarely between 24.0 and 25.0. If one were to analyze a sample of saturated mercury vapor held at fixed but unknown temperature,

the temperature may be deduced from the mercury values found. The relationship of volume, peak height, absorbance and weight at the selected fixed temperatures is given in Tables IV to X inclusive.

From the data, so far accumulated, a nomograph was constructed as shown in Figure 4. This multipurpose nomograph may be used in the following ways:

1. For the calibration of a Du Pont mercury analyzer, by injecting known volumes of mercury vapor over the operating temperature range of 22.0 to 28.0°C.
2. For the immediate conversion of peak heights, as measured in chart divisions, to the equivalent in absorbance, moles or nanograms
  - (a) In the ambient atmosphere on a continuous basis
  - (b) In the hot release of mercury vapor collected on silver mesh collectors
  - (c) In the hot release of mercury vapor present in solid geological samples.
3. To permit the calibration of any instrument which is designed to measure mercury.

For lower quantities of mercury, a similar nomograph was constructed as given by Figure 5 from the data given in Table XI.

#### AIR SAMPLING

In theory, the Du Pont analyzer can be operated either as a continuous direct reading and recording instrument, or as a laboratory instrument making separate or discontinuous measurements of air samples taken by some batch sampling procedure. It is obvious that the

continuous analyzer may not be able to function if the mercury in air concentrations are too low or less than 0.3 nanograms in the cell. When such low concentrations are encountered they can be measured by taking a sufficiently large sample of air to provide a sufficiently large instrumental signal. The question is how to take the sample. Experiments with various liquid and solid absorbents, adsorbents and filters were consistently unsatisfactory. We finally settled upon a silver gauze element mounted in a glass finger condenser. One version of this, model MCA-3, is illustrated in Figure 6. Borosilicate glass is used, though quartz would be better and may be used in subsequent construction. The silver element consists of one single piece of silver gauze cut in such a way that two cylinders are formed of different diameters. The end of the condenser is opened, the smaller silver cylinder is inserted inside the central tube, the outer silver cylinder is inserted in the annular space and the end of the glass tube is closed.

To test the effectiveness of these mercury samplers, the sampling manifold illustrated in Figure 7 was used. This shows two sample injection points upstream and downstream of the sampling unit. Provision is also included to pass the mercury standard through a magnesium perchlorate dryer or alternatively to bypass it.

The collection efficiency for known quantities of mercury was tested as shown on the recorder chart Figure 8. A is the normal reading given by the calibrating filter of the 400 analyzer. D is the instrumental response obtained when the mercury standard is injected directly into the analyzer. If the mercury standard is injected upstream of the absorber the mercury does not reach the analyzer as illustrated by C. If the absorber, containing the mercury, is now heated, the mercury absorbed is



completely released to give the peak illustrated by B. E and F show the response given by benzene vapor injected into the analyzer directly or into the analyzer by way of the silver absorber. There is little reason to expect benzene vapor to be present in ambient air, but if it were it would not be collected by the silver absorber.

Using three different carrier gas flow rates, 1000, 1500 and 2000 ml. per minute, six replicate experiments were carried out, to see how instrumental response might be affected. From these experiments, it was decided to standardize flow rates at 1500 ml. per minute. See Table XII.

Magnesium perchlorate is a very efficient drying agent and is of value in this application to prevent the ingress of water vapor into the system and into the measuring cell. It has also good absorbent properties for some organic vapors. Experiments were performed to ensure that mercury vapor was not being retained by the dryer. In Table XIII replicate mercury standards were analyzed with and without passage through the dryer. There is no evidence of mercury hold-up by magnesium perchlorate. A feature which has not been mentioned previously is that the measuring cell of the Du Pont analyzer is heated to 80°C with heating tape. This is intended to prevent the condensation of either water or mercury vapor on the walls or windows of the measuring cell.

Another experiment was performed to check the collection efficiency. 0.5 ml. of saturated mercury vapor, equal to 9.94 nanograms, was injected into the air stream flowing at 1500 ml. per minute. The following measurements were made:

- A The absorbance registered by the calibration filter
- B The absorbance produced by the untrapped mercury
- C The absorbance produced by the mercury liberated by heat
- D The absorbance produced by 9.94 nanograms of mercury.

The recording of this experiment is given by Figure 8. The actual percent recoveries of mercury were calculated. These are given by Table XIV from which it is seen that the average recovery for the 10 experiments is  $95.4 \pm 1.46$ . Subsequent experiments indicate that the collection efficiency is closer to 100%.

The silver gauze, as obtained from the laboratory supply houses, is quite dirty and it is necessary to clean it or "activate" it before incorporation into the absorbers. This is done by heating the silver gauze in a muffle furnace for 2 hours at 800°C. When the silver element has been used to collect mercury, the mercury is released from the silver by heat and by so doing the silver element is made ready to take further mercury samples.

In order to carry out a greater number of mercury assays under uniform and optimum conditions, a single sampler, made of quartz, was permanently mounted in the sampling manifold. The side arms of the sampler are connected by means of heat resistant "Man-o-lok" connectors, B<sub>1</sub> and B<sub>2</sub>, to two portions of polyethylene tubing C<sub>1</sub> and C<sub>2</sub>. The other end of C<sub>1</sub> is connected to the teflon "Versatube" element of the Varistaltic pump, D. The other side arm is connected through C<sub>2</sub> to a teflon tee with serum cap and the tee is further connected either directly or by means of an Elliptic valve bypass, to the absorption cell H. This alternative route is not shown on the diagram, Figure 10.

Using a gastight syringe, mercury vapor is injected into the silicone rubber diaphragm G from where it is carried by the standard constant air flow to the silver element collector. Here the mercury is absorbed on the activated silver gauze, I, while the Varistaltic pump rotates in the forward direction. To measure the mercury vapor absorbed, the direction of flow through the Varistaltic pump is reversed and, by means of heat, the mercury is released from the sample collector. Using the same carrier air flow rate, the mercury vapor is directed into the absorption cell for assay. In addition to releasing the mercury, the heat treatment reactivates the silver element at the same time and after cooling the collector with a hair dryer it is ready for the next assay in 20 seconds. When the pump is stopped, the whole channel is hermetically sealed off in both directions and the activated silver grid cannot be contaminated. Up until now, individual sample collectors have been reactivated and reused more than 75 times and there is no evidence that the sealed silver grids are likely to lose their ability to capture and release mercury vapor if used under the conditions described. Though there are likely to be some gaseous contaminants in the laboratory air, no catalyst poisoning was observed.

The Du Pont analyzer can easily cover the range of 0 to 12 nanograms of mercury per determination. One silver element collector can absorb up to 100 nanograms of mercury. If more than 12 nanograms are collected per sampling cycle, the recorder response will be off scale. Therefore, the maximum or optimum volume of air to be taken will have to be calculated on the basis of the presumed mercury concentration. One may, of course, guess wrong the first time. Alternatively, several samples of differing air volumes may be taken

simultaneously.

If the mercury concentration is suspected to be higher than 50 micrograms per cubic metre, the time cycle becomes too small for accurate measurement. To overcome this difficulty the following modification of the sampling procedure is suggested. Please refer to the diagram given in Figure 11.

Mercury sampling unit B is connected directly to a battery operated personal air sampler A. The carrier air is pre-purified by passage through a charcoal scrubber E. Air samples of 5 to 50 ml. volume may be collected in air tight disposable polyethylene syringes D. These air samples may be injected directly into the purified air stream through the soft rubber connection C and trapped on the silver absorber B. After trapping the mercury from the measured volume of air the silver collector is sealed and shipped to the laboratory for assay. The flow rate of the carrier air is unimportant in this instance.

#### CONCLUSIONS

The silver element absorber is a very satisfactory means of sampling airborne mercury. When experimenting with elemental mercury, the capacity of these samplers was found to be 100 nanograms of mercury. Under the conditions used, the samplers seem to be able both to trap and to desorb the mercury quantitatively. A given sampler is apparently reusable indefinitely.

After initial electronic faults were corrected, the DuPont 400 Analyzer has performed satisfactorily, the sensitivity per determination being 0.3 nanograms of mercury. Stability and precision are adequate.

The overall assembly is necessarily somewhat inflexible inasmuch as no more than 10 nanograms can be measured per determination. As a result, we can expect a considerable number of air samples to be off the scale of the instrument. Several air sampling mechanisms are suggested for obtaining samples within the present sensitivity range. We hope to be able to overcome this limitation, at the instrument, by the use of a recording digital voltmeter, which should allow us to get a value for those samples now off scale.

No interferences have been observed so far, but all possible interferences will be investigated in due course. The possible analytical differences in collection efficiency and desorption are being looked at, as between airborne particulate mercury (?), airborne particulate organomercury (?), airborne organomercury in the gas phase (?) and various other possibilities.

TABLE CAPTIONS

I	Instrumental sensitivity 0.40 to 3.94 nanograms mercury.
II	Reproducibility measurement over three day period.
III	Reproducibility measurement over eight day period.
IV	Analytical data, saturated mercury vapor at 22.0 °C.
V	Analytical data, saturated mercury vapor at 23.0 °C.
VI	Analytical data, saturated mercury vapor at 24.0 °C.
VII	Analytical data, saturated mercury vapor at 24.5 °C.
VIII	Analytical data, saturated mercury vapor at 25.0 °C.
IX	Analytical data, saturated mercury vapor at 26.0 °C.
X	Analytical data, saturated mercury vapor at 28.0 °C.
XI	Consolidation Tables IV to X, inclusive.
XII	Effect sampling flow rate on response.
XIII	Effect magnesium perchlorate dryer on response.
XIV	Per cent collection efficiency, 10 replicate experiments.

TABLE I  
SENSITIVITY, MERCURY DETERMINATION

<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Mean</u>	<u>Absorbance</u> <u>x 10<sup>3</sup></u>	<u>Hg</u> <u>Nanograms</u>
0.2	30.0	30.6 ± 0.7	14.2	3.94
	30.4			
	31.3			
0.1	15.5	15.5 ± 0.0	6.6	1.99
	15.5			
	15.5			
0.08	12.1	12.0 ± 0.2	5.4	1.59
	11.8			
	12.0			
0.06	9.5	9.3 ± 0.2	4.2	1.19
	9.2			
	9.3			
0.05	7.8	8.0 ± 0.2	3.6	1.00
	7.9			
	8.2			
0.04	6.2	5.9 ± 0.2	2.7	0.79
	5.8			
	5.8			
0.02	2.6	2.9 ± 0.2	1.3	0.40
	2.8			
	3.3			

TABLE II  
REPRODUCIBILITY MEASUREMENTS WITH TIME

ABSORBANCE X 10<sup>3</sup>

<u>Test</u>			
<u>No.</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>
1	28.4	27.8	28.8
2	27.9	27.4	28.8
3	27.9	28.8	27.9
4	28.8	28.1	27.9
5	28.1	28.1	27.5
6	28.4	27.7	27.6
Average	28.3 ± 0.4	28.0 ± 0.5	28.1 ± 0.6



TABLE III  
REPRODUCIBILITY OF STANDARD CURVE WITH TIME

<u>Mercury vapor</u> <u>Ml. injected</u>	<u>Day 1</u>		<u>Day 8</u>	
	<u>Peak Height in</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>x 10<sup>5</sup></u>	<u>Peak Height in</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>x 10<sup>5</sup></u>
0.5	67.0	30.2	66.2	29.8
	67.2	30.2	66.2	29.8
	67.7	<u>30.5</u>	65.5	<u>29.5</u>
	Average	30.3 ± 0.2		29.7 ± 0.2
0.4	54.2	24.4	54.3	24.4
	54.8	24.7	54.5	24.5
	55.2	<u>24.8</u>	54.8	<u>24.7</u>
	Average	24.6 ± 0.2		24.5 ± 0.2
0.3	41.0	18.5	41.2 <sup>1</sup>	18.5
	41.5	18.7	41.3	18.6
	42.1	<u>18.9</u>	41.8	<u>18.8</u>
	Average	18.7 ± 0.2		18.6 ± 0.2
0.2	26.1	11.7	26.2	11.8
	26.1	11.7	26.2	11.8
	26.3	<u>11.8</u>	26.3	<u>11.8</u>
	Average	11.7 ± 0.1		11.8 ± 0.0
0.1	14.3	6.4	14.3	6.4
	13.8	6.2	13.7	6.2
	13.5	<u>6.1</u>	13.8	<u>6.2</u>
	Average	6.2 ± 0.2		6.3 ± 0.1

TABLE IV

SATURATED MERCURY VAPOR. 22.0°C

WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
7.76	0.50	63.9	28.7
6.20	0.40	50.4	22.7
4.66	0.30	37.6	16.9
3.10	0.20	24.2	10.9
1.55	0.10	13.6	6.1
1.24	0.08	10.9	4.9
0.93	0.06	8.2	3.7
0.78	0.05	6.8	3.1
0.62	0.04	5.4	2.4
0.31	0.02	2.7	1.2
10.0	0.64	82.3	37.1
8.0	0.52	65.0	29.3
6.0	0.39	48.4	21.8
4.0	0.26	31.2	14.1
2.0	0.13	17.5	7.9
1.5	0.10	13.2	5.9
1.2	0.08	10.6	4.8
1.0	0.06	8.7	3.9
0.8	0.05	7.0	3.1
0.4	0.03	3.5	1.6

TABLE V  
SATURATED MERCURY VAPOR. 23.0°C  
WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
8.50	0.50	67.3	30.3
6.80	0.40	54.7	24.6
5.10	0.30	41.5	18.7
3.40	0.20	26.2	11.7
1.70	0.10	13.9	6.2
1.36	0.08	11.1	5.0
1.02	0.06	8.3	3.8
0.85	0.05	7.0	3.1
0.68	0.04	5.6	2.5
0.34	0.02	2.8	1.3
10.0	0.59	79.2	35.6
8.0	0.47	64.4	29.0
6.0	0.35	48.8	22.0
4.0	0.24	30.8	13.9
2.0	0.12	16.4	7.4
1.5	0.09	12.2	5.5
1.2	0.07	9.8	4.4
1.0	0.06	8.2	3.7
0.8	0.05	6.6	3.0
0.4	0.02	3.3	1.5

TABLE VI  
SATURATED MERCURY VAPOR. 24.0°C  
WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
9.14	0.50	71.2	32.0
7.31	0.40	56.4	25.4
5.48	0.30	43.3	19.4
3.66	0.20	28.1	12.6
1.83	0.10	14.0	6.3
1.46	0.08	11.2	5.0
1.10	0.06	8.4	3.8
0.91	0.05	7.0	3.2
0.73	0.04	5.6	2.5
0.37	0.02	2.8	1.3
10.0	0.55	77.9	35.1
8.0	0.44	61.7	27.8
6.0	0.33	47.3	21.3
4.0	0.22	30.7	13.8
2.0	0.11	15.3	6.9
1.5	0.08	11.5	5.2
1.2	0.07	9.2	4.1
1.0	0.05	7.7	3.5
0.8	0.04	6.1	2.8
0.4	0.02	3.0	1.4

TABLE VII  
SATURATED MERCURY VAPOR. 24.5°C  
WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
9.59	0.50	75.4	33.9
7.67	0.40	60.7	27.3
5.75	0.30	44.9	20.2
3.83	0.20	30.1	13.5
1.92	0.10	15.0	6.8
1.53	0.08	12.0	5.4
1.15	0.06	9.0	4.1
0.96	0.05	7.5	3.4
0.76	0.04	6.0	2.7
0.38	0.02	3.0	1.4
10.0	0.52	78.6	35.4
8.0	0.42	63.3	28.5
6.0	0.31	46.9	21.1
4.0	0.21	31.4	14.1
2.0	0.10	15.6	7.0
1.5	0.08	11.8	5.3
1.2	0.06	9.4	4.2
1.0	0.05	7.8	3.5
0.8	0.04	6.3	2.8
0.4	0.02	3.2	1.4

TABLE VIII

SATURATED MERCURY VAPOR. 25.0°C

WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
9.94	0.50	78.7	35.4
7.95	0.40	61.8	27.8
5.96	0.30	46.9	21.1
3.94	0.20	31.5	14.2
1.99	0.10	14.6	6.6
1.59	0.08	12.0	5.4
1.19	0.06	9.3	4.2
1.00	0.05	8.0	3.6
0.79	0.04	5.9	2.7
0.40	0.02	2.9	1.3
10.0	0.50	79.2	35.6
8.0	0.40	62.2	28.0
6.0	0.30	47.2	21.2
4.0	0.20	32.0	14.4
2.0	0.10	14.7	6.6
1.5	0.08	11.3	5.1
1.2	0.06	9.4	4.2
1.0	0.05	8.0	3.6
0.8	0.04	6.0	2.7
0.4	0.02	2.9	1.3

TABLE IX

SATURATED MERCURY VAPOR. 26.0°C

WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
10.74	0.50	81.7	36.8
8.59	0.40	65.2	29.3
6.44	0.30	50.3	22.6
4.29	0.20	33.6	15.1
2.15	0.10	16.1	7.2
1.72	0.08	12.9	5.8
1.29	0.06	9.7	4.3
1.07	0.05	8.1	3.6
0.86	0.04	6.4	2.9
0.43	0.02	3.2	1.5
10.0	0.47	76.1	34.2
8.0	0.37	60.7	27.3
6.0	0.28	46.9	21.1
4.0	0.19	31.2	14.1
2.0	0.09	15.0	6.7
1.5	0.07	11.3	5.1
1.2	0.06	9.0	4.0
1.0	0.05	7.6	3.4
0.8	0.04	5.9	2.7
0.4	0.02	3.0	1.3

TABLE X  
SATURATED MERCURY VAPOR. 28.0°C  
WEIGHT-VOLUME-PEAK HEIGHT-ABSORBANCE

<u>Elemental Hg</u> <u>Nanograms</u>	<u>Hg Vapor</u> <u>ml.</u>	<u>Peak Height</u> <u>Arbitrary Units</u>	<u>Absorbance</u> <u>X 10<sup>3</sup></u>
12.58	0.50	94.7	42.6
10.06	0.40	77.0	34.7
7.55	0.30	58.4	26.4
5.03	0.20	37.7	17.0
2.52	0.10	18.5	8.3
2.01	0.08	14.8	6.7
1.51	0.06	11.1	5.0
1.26	0.05	9.3	4.2
1.01	0.04	7.4	3.3
0.50	0.02	3.7	1.7
10.0	0.40	75.3	33.9
8.0	0.32	61.0	27.4
6.0	0.24	46.1	20.7
4.0	0.16	30.2	13.6
2.0	0.08	14.8	6.7
1.5	0.06	11.1	5.0
1.2	0.04	8.9	4.0
1.0	0.04	7.2	3.2
0.8	0.03	5.9	2.7
0.4	0.02	3.0	1.3



TABLE XI  
SATURATED MERCURY VAPOR  
NANOGRAMS MERCURY PER ML.

	<u>Temperature °C</u>						
<u>Hg Vapor</u> <u>ml.</u>	<u>22.0</u>	<u>23.0</u>	<u>24.0</u>	<u>24.5</u>	<u>25.0</u>	<u>26.0</u>	<u>28.0</u>
0.50	7.76	8.50	9.14	9.59	9.94	10.74	12.58
0.40	6.20	6.80	7.31	7.67	7.95	8.59	10.06
0.30	4.66	5.10	5.48	5.75	5.96	6.44	7.55
0.20	3.10	3.40	3.66	3.83	3.94	4.29	5.03
0.10	1.55	1.70	1.83	1.92	1.99	2.15	2.52
0.08	1.24	1.36	1.46	1.53	1.59	1.72	2.01
0.06	0.93	1.02	1.10	1.15	1.19	1.29	1.51
0.05	0.78	0.85	0.91	0.96	1.00	1.07	1.26
0.04	0.62	0.68	0.73	0.76	0.79	0.86	1.01
0.02	0.31	0.34	0.37	0.38	0.40	0.43	0.50

TABLE XII  
EFFECT OF FLOW RATE ON READINGS

ABSORBANCE X 10<sup>3</sup>

Test No.	<u>Flow rate ml. per minute</u>		
	<u>1000</u>	<u>1500</u>	<u>2000</u>
1	26.8	27.8	27.9
2	26.8	27.4	27.9
3	25.8	28.8	28.4
4	27.0	28.1	28.6
5	26.8	28.1	28.8
6	27.0	27.1	27.9
Average	26.7 ± 0.5	28.0 ± 0.5	28.3 ± 0.4

TABLE XIII  
EFFECT MAGNESIUM PERCHLORATE

<u>Dryer Bypassed</u>		<u>Through Dryer</u>	
<u>Peak Height</u>	<u>Absorbance x 10<sup>3</sup></u>	<u>Peak Height</u>	<u>Absorbance x 10<sup>3</sup></u>
80.8	36.4	79.4	35.7
81.2	36.5	82.7	37.2
81.4	36.6	82.3	37.0
83.4	37.5	83.8	37.7
86.0	38.7	83.1	37.4
80.8	36.4	81.2	36.5
<hr/>	<hr/>	<hr/>	<hr/>
82.8 ± 2.2	37.0 ± 0.9	82.1 ± 1.6	36.9 ± 0.7

TABLE XIV  
RECOVERY EXPERIMENT, PEAK HEIGHT

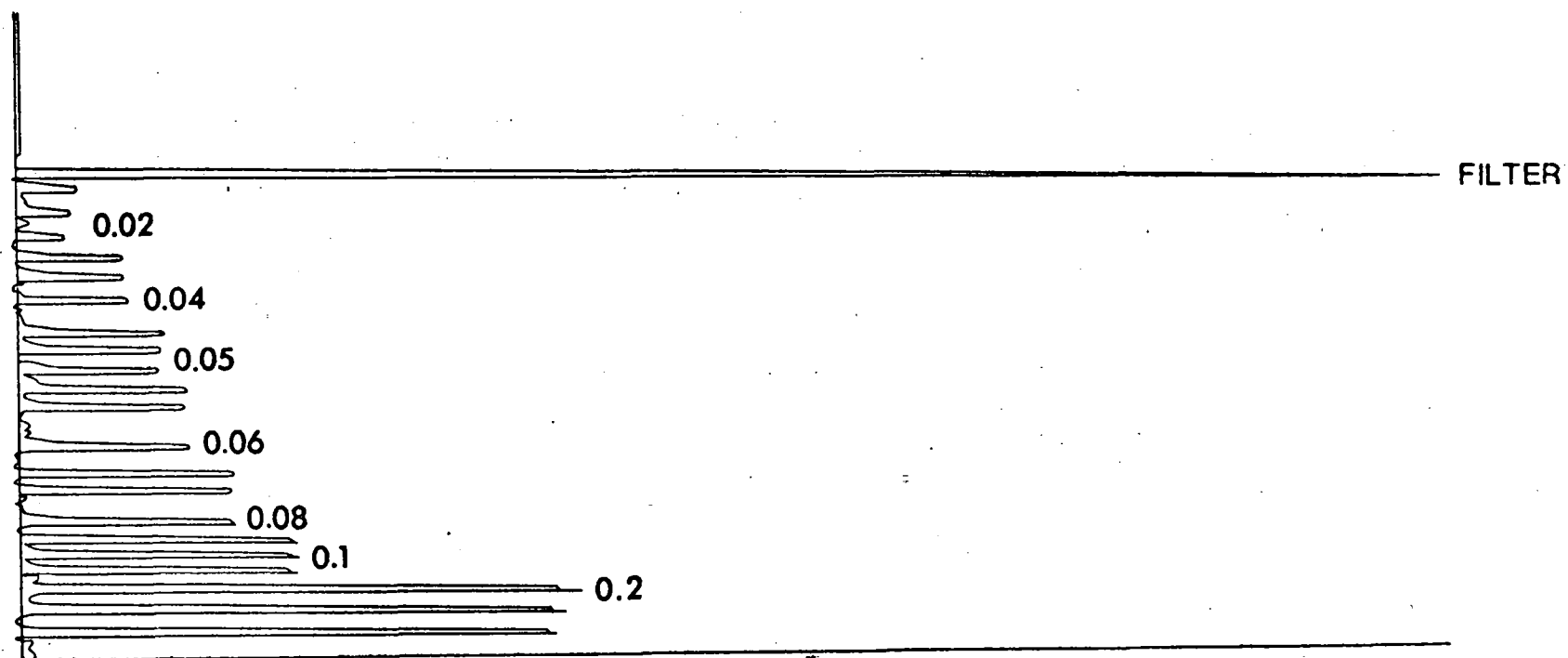
<u>Test No</u>	<u>Mercury Escaping</u>	<u>Mercury Liberated</u>	<u>% Recovery</u>
1	1.1	73.2	93.0
2	3.1	74.8	95.0
3	2.0	74.2	94.3
4	1.6	74.7	94.9
5	1.0	74.3	94.4
6	1.0	74.5	94.7
7	3.7	74.1	94.2
8	1.0	75.1	95.4
9	0.1	77.8	98.9
10	0.0	78.1	<u>99.2</u>

Mean             $95.4 \pm 1.5$

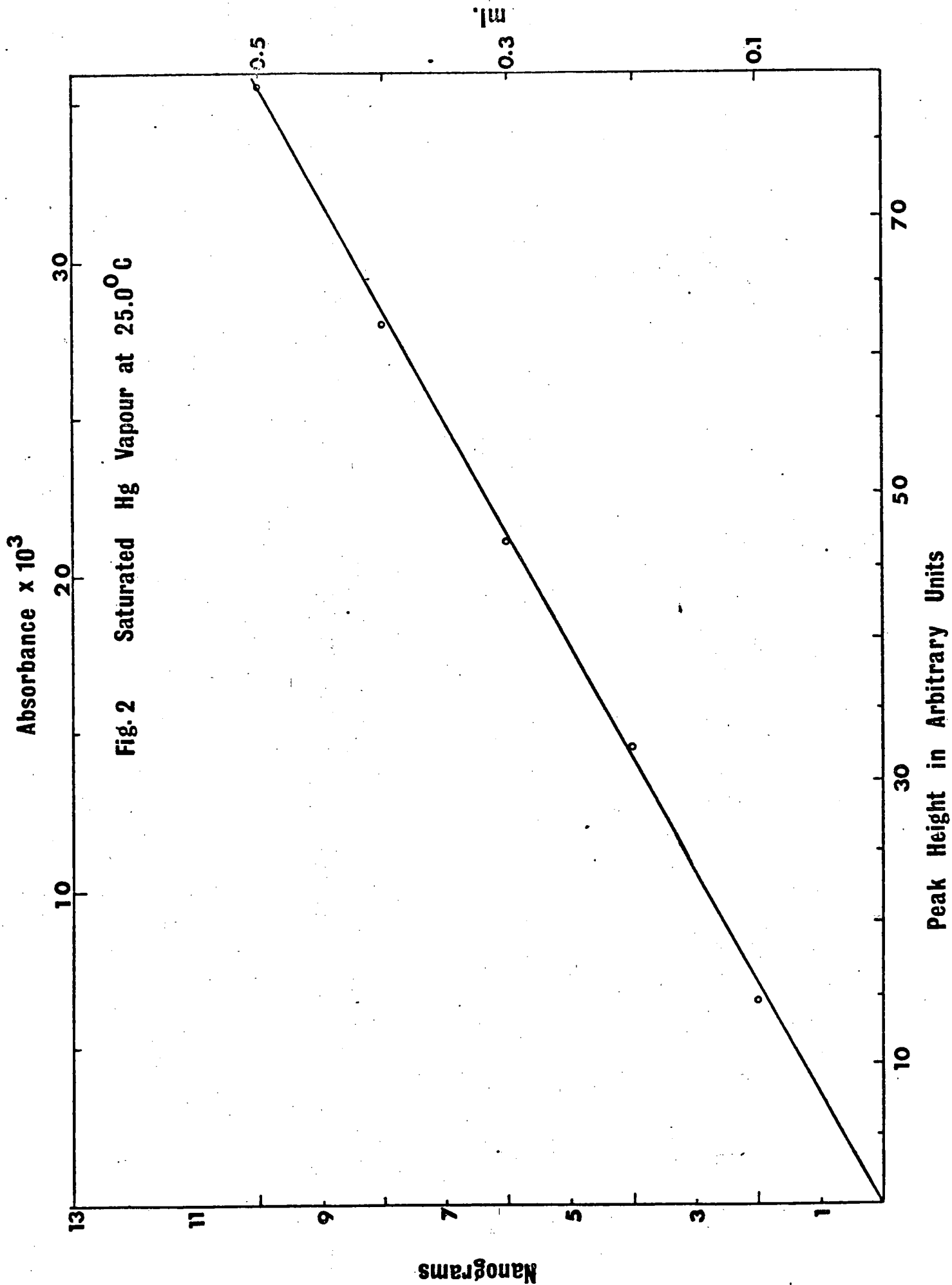
FIGURE CAPTIONS

- 1 Recorder chart showing sensitivity DuPont Analyzer.
- 2 Calibration curve for 0-10 nanograms mercury.
- 3 Calibration curve for 0-1.5 nanograms mercury.
- 4 Calculation nomograph for 0-10 nanograms mercury.
- 5 Calculation nomograph for 0-2.5 nanograms mercury.
- 6 Detail drawing silver element collector.
- 7 Non recirculating manifold for silver absorber.
- 8 Recorder chart showing collection efficiency silver element.
- 9 Recorder chart showing collection efficiency 10 replicate experiments.
- 10 Diagram of altered manifold.
- 11 Expedient to permit sampling at higher concentrations.

FIG. 1 SENSITIVITY OF Hg DETECTION



TEMP OF Hg VAPOUR 25.0°C  
INJECTION BY HAMILTON GASTIGHT SYRINGE 500 $\mu$ l  
FLOW RATE 1500 ml PER MIN - NON RECIRCULATING SYSTEM



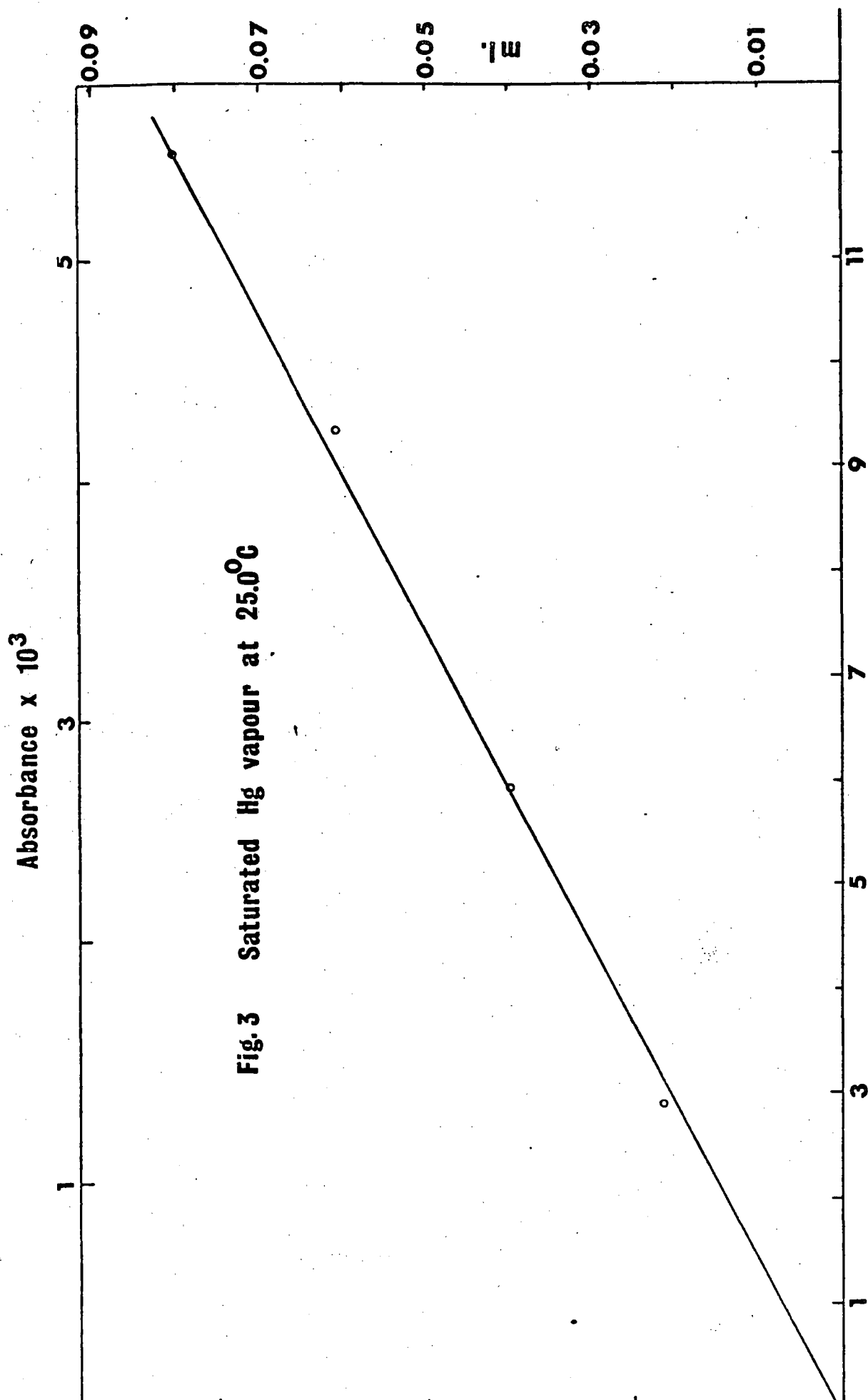
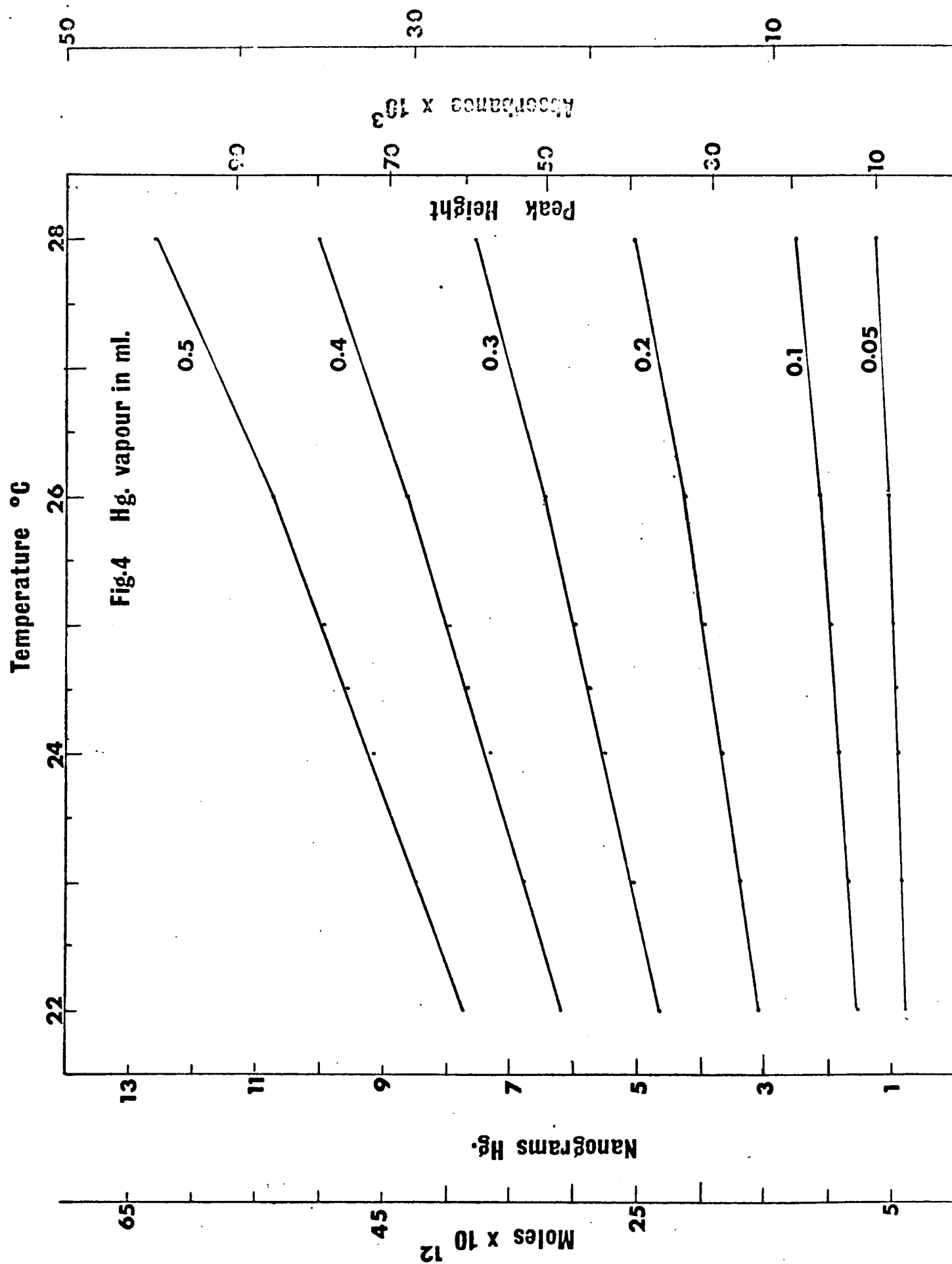
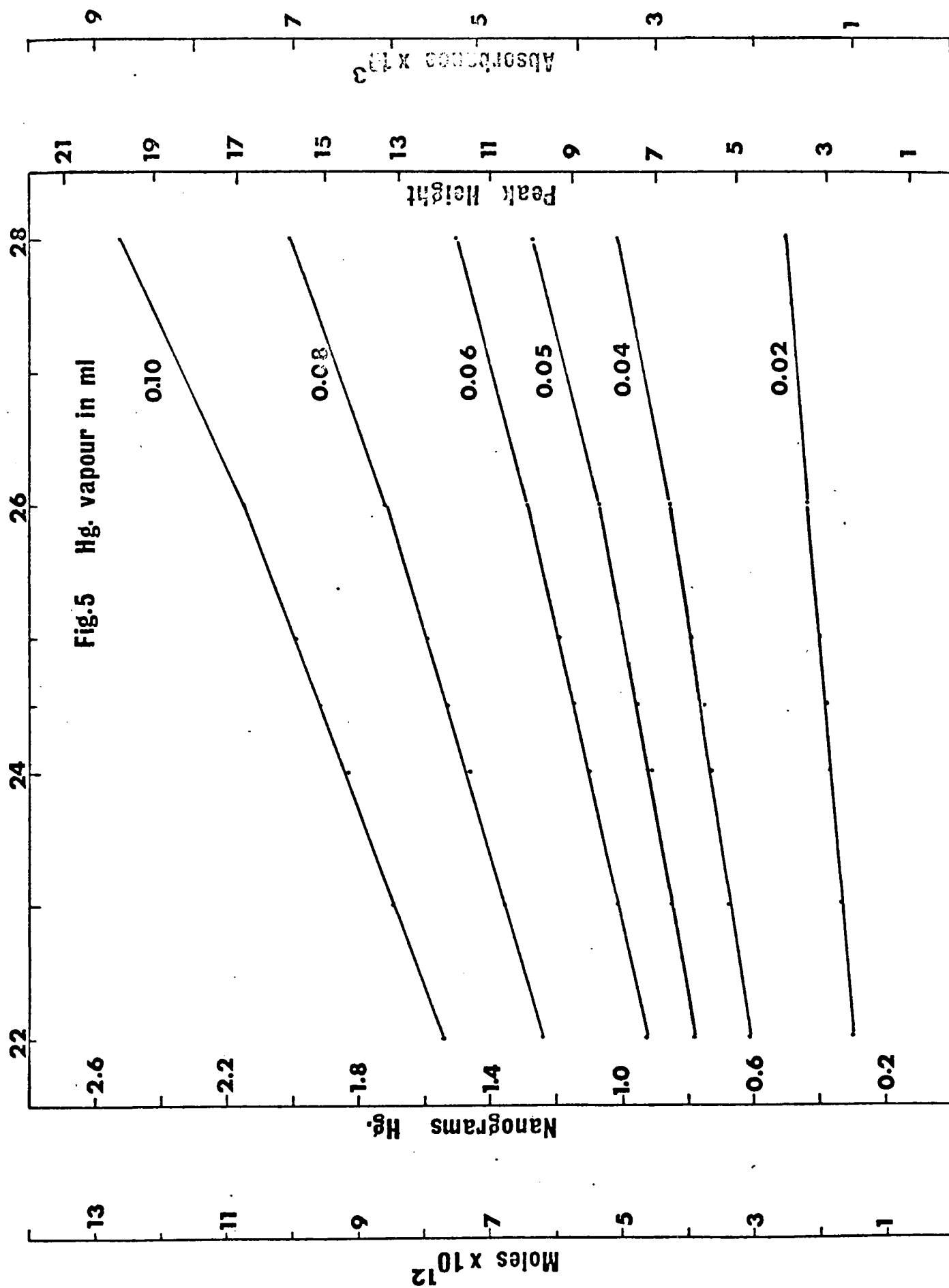


Fig.3 Saturated Hg vapour at 25.0°C

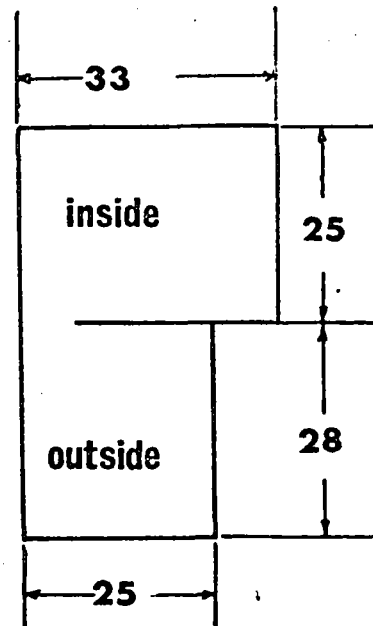
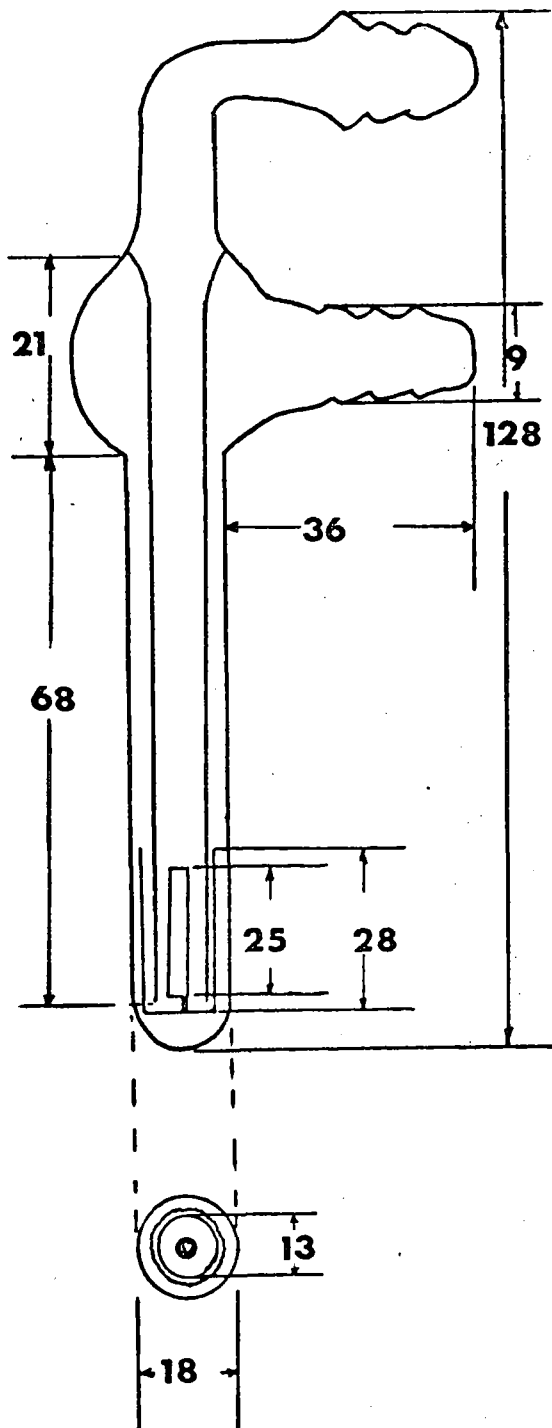
Peak Height in Arbitrary Units







**Fig.6 Mercury Vapour Sampler**



**Silver Grid 30-60 mesh**

**Dimensions in m.m.**

Fig.7 Elemental Mercury in Gas Samples Non Recirculating

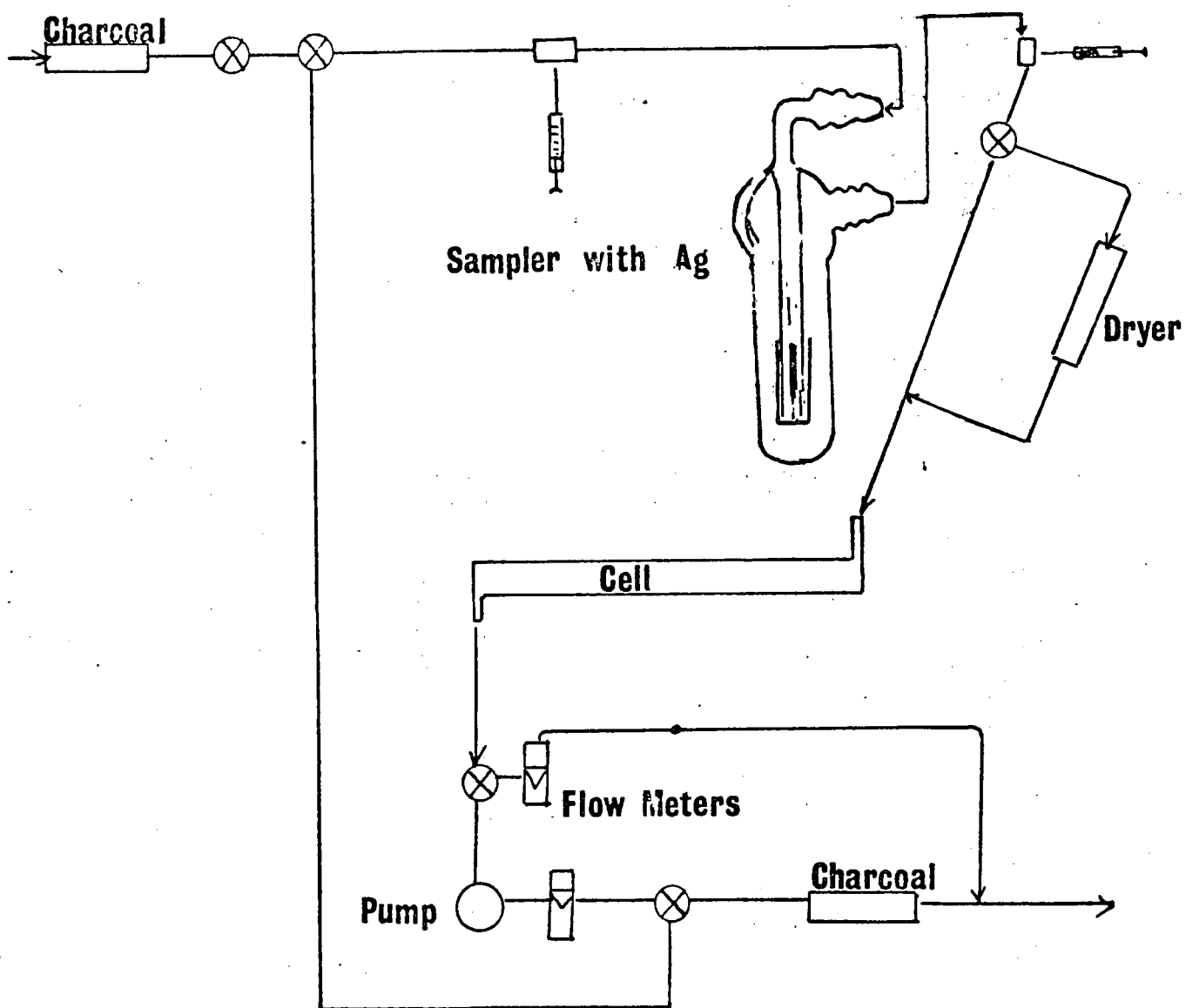


FIG. 8 SAMPLING EFFICIENCY

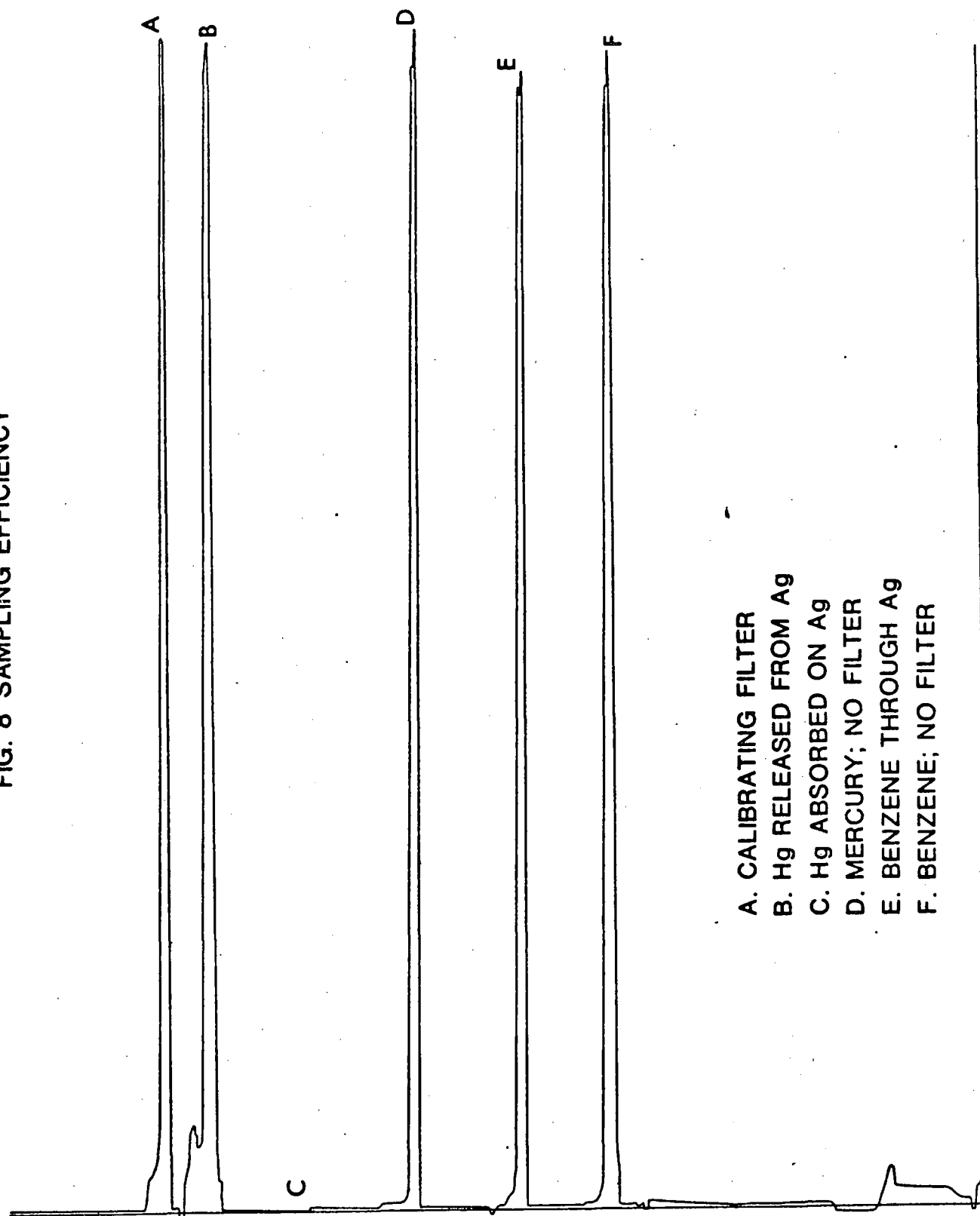
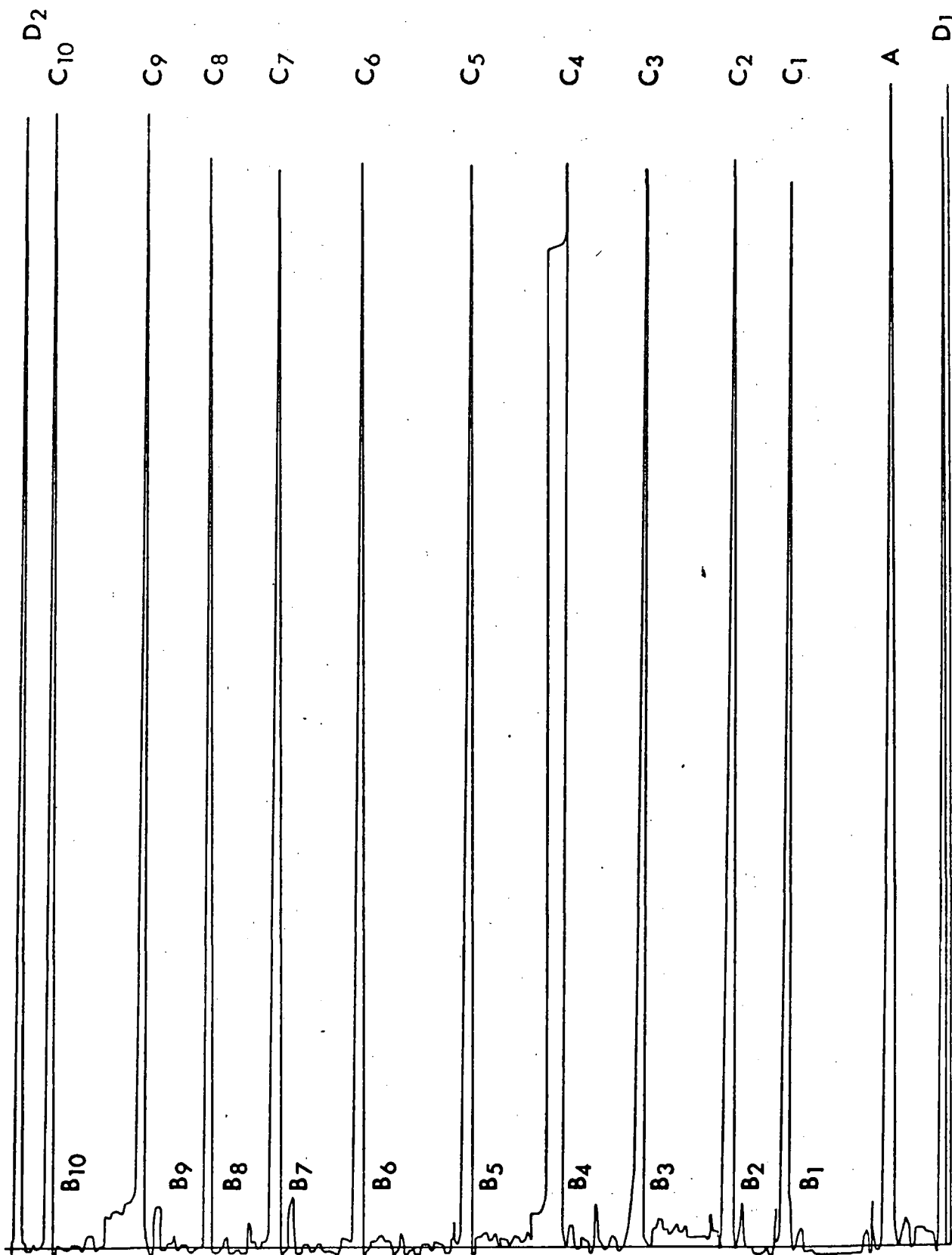


FIG. 9 SAMPLING EFFICIENCY



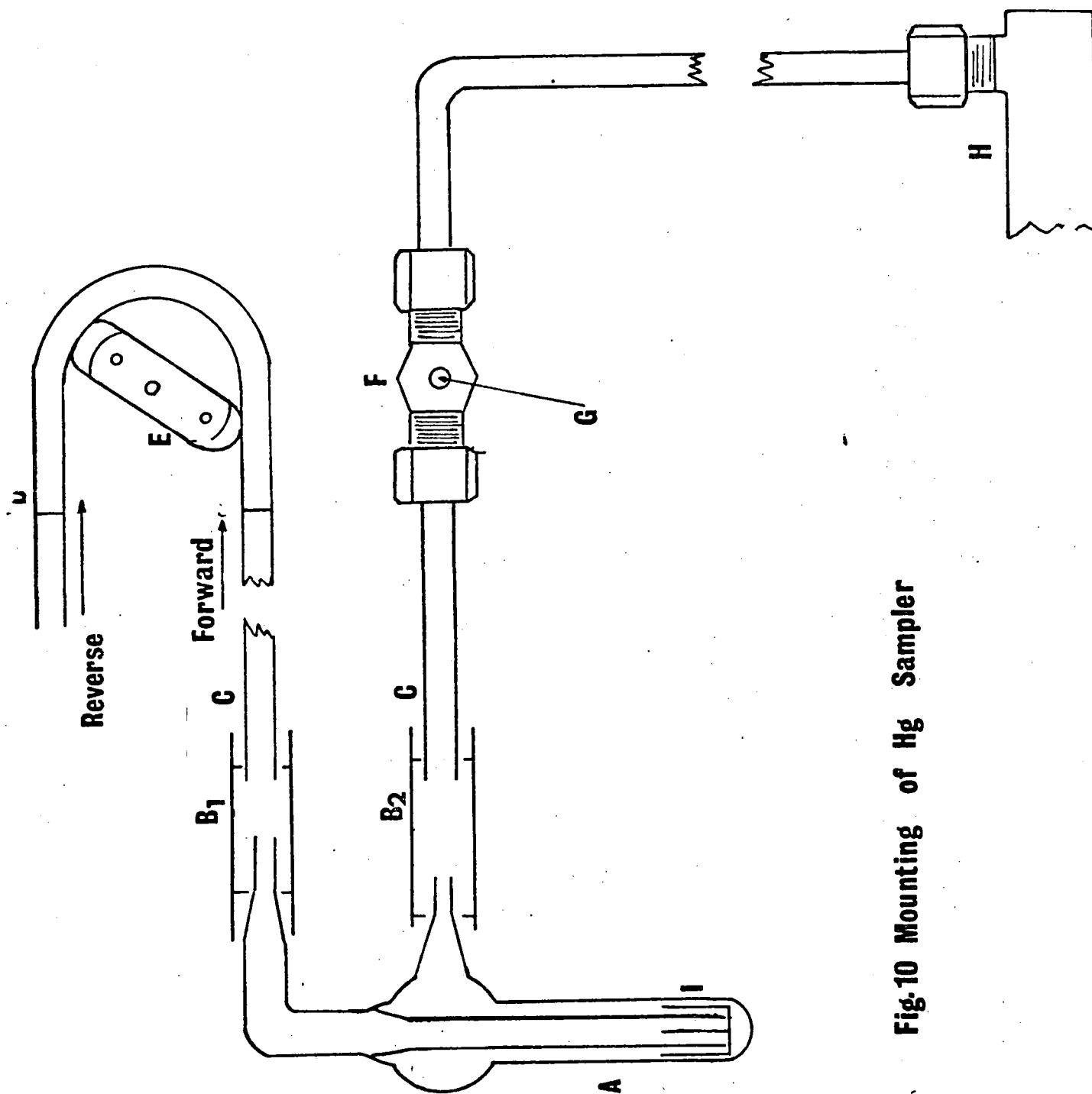
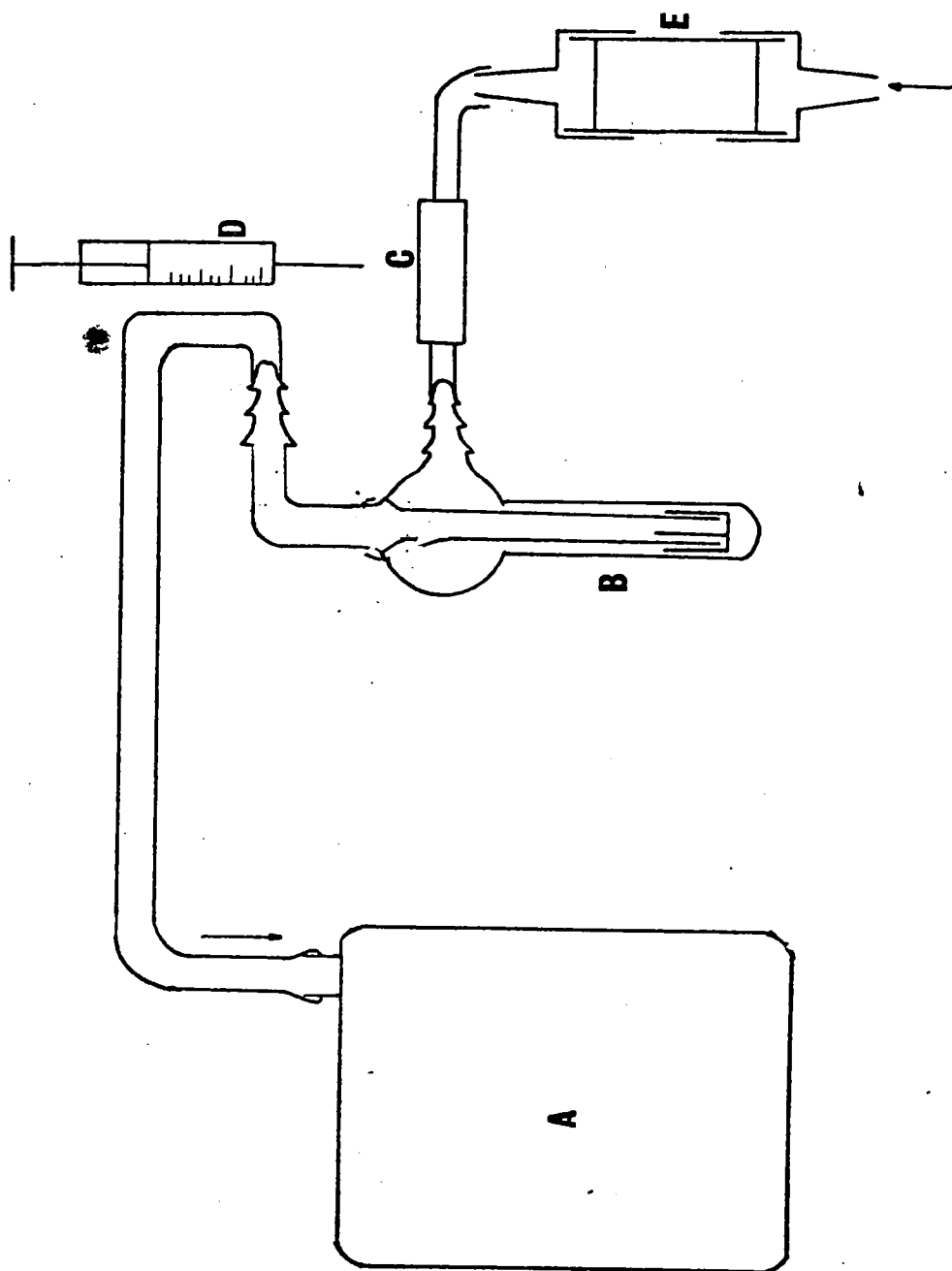


Fig.10 Mounting of Hg Sampler

Fig. 11 Air Sampling For Concentrations Higher Than  $50\mu\text{gmHg}/\text{m}^3$





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