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NATIONAL BUREAU OF STANDARDS REPORT

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GAYLORD CLEARAIR VENTILATOR

by

Carl W. Coblentz
Paul R. Achenbach

Report to

Bureau of Ships
Department of the Navy

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Heating and Air Conditioning Section
Building Technology Division

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Abstract

As a part of the study of methods for testing and rating grease filters undertaken for the Bureau of Ships performance tests were made of a specimen Gaylord Clearair Ventilator manufactured by Gaylord Industries. This device depended primarily on centridugal force to remove droplets of grease from the effluent air stream over a cooking range. The tests indicated that the efficiency of the Gaylord ventilator ranged from about 70% to 90% for a range of loading rates from 1 to 50 grams of grease per hour with the efficiency values increasing as the loading rate was increased. A thermostatic fire-detector in the grease extractor operating on the rate-of-rise of temperature and a selected constant temperature closed the inlet damper to the extractor and stopped the exhaust blower automatically if a fire occurred on the range top. Limited tests indicated that this device would prevent ignition of accumulated grease in the extractor or exhaust ducts. The static pressure drop through the ventilator was higher than that for impingement filters at the rated air flow rate and it would probably be necessary to remove grease accumulations by wiping operations for the specimen tested.

I. INTRODUCTION

As a part of the study of testing and rating methods for grease filters being conducted at the National Bureau of Standards for the Bureau of Ships, performance tests were made of a specimen Gaylord Clearair Ventilator manufactured by the Gaylord Industries, Portland, Oregon. The Gaylord ventilator is a sheet metal device that is mounted at the rear side of the cooking surface. It is designed to remove the grease from the air drawn over the stove surface by impingement and centrifugal force.

The conventional method for removing grease from the effluent air over cooking surfaces is to place impingement type filters, usually with a metallic filtering media, at the entrance to the exhaust ducts over the range. The grease, dust, and lint accumulate on these filters necessitating that they be cleaned at intervals. This type filter can be re-used a number of times after cleaning, but eventually must be replaced because of clogging or damage to the filter media. The Gaylord ventilator operates on a different principle in that no filtering media is employed and no replacement elements are required.

Tests were made to evaluate the efficiency of the Gaylord Clearair Ventilator as a grease trap for a range of air velocities and a range of grease content in the effluent air. The pressure loss in the device was measured for a range of air flow rates and tests were made of the fire detector incorporated in the ventilator.

II. DESCRIPTION OF TEST SPECIMEN

Fig. 1 shows a schematic drawing of the Gaylord ventilator which was designed for mounting at the back side of the cooking surfaces. This sytem does not use any filters. The grease and lint reach the extractor chamber through the ventilator throat and are separated from the air by impingement and centrifugal action. The ventilator throat was 2 inches wide and extended the full length of the apparatus. The grease and lint are collected on the wells of the extractor chamber, on the baffles and on the extractor plate. Some portion of the deposits flowed down into the grease trough. The extractor plate was hinged and could be operated either manually or automatically by a thermostat which served as a fire detector. The closing of the fire trap would shut off the blower motor automatically. A transition piece above the extractor chamber served as a plenum for the exhaust duct system. The manual operating lever of the thermostatic fire detector can be seen above the shelf of the ventilator in Fig. 2.

III. TEST APPARATUS AND PROCEDURE

A simulated cooking range was built with a 3x4 ft cooking surface on which the ventilator was mounted. The 1/4-inch thick top plate of hot-rolled steel was heated with a gas burner of approximately 70,000 BTU/hr capacity. The experimental cooking range and gas burner, the specimen ventilator, and the exhaust duct at the ventilator outlet can be seen in Fig. 2. The ventilator was connected to an exhaust blower driven by a variable speed motor allowing the air flow rate through the ventilator to be varied in the range from 900 CFM to 1500 CFM.

A sampling tube containing glass wool was installed in the exhaust adapter above the transition piece. It had been previously determined that this kind of sampler could be considered an absolute filter, for all practical purposes. The air flow through this sampler was measured with a gas meter and the value of the air volume indicated on the gas meter during the test was corrected for the vacuum observed downstream of the sampler. If V_G was the volume of air drawn through the sampler as indicated by the gas meter and p_m was the pressure difference between the atmosphere and the gas meter inlet, in cm Hg, then the actual volume of air drawn through the sampler at atmospheric pressure was:

$$V_S = \frac{76 - p_m}{76} \times V_G$$

The amount of grease collected in the extractor was determined by wiping the extractor chamber, the trough and the fire damper with soft paper tissue and determining the weight increase of these tissues to one hundredth of a gram. By multiplying the weight increase of the sampler by the ratio of the total air drawn through the ventilator to the air volume drawn through the sampler the amount of grease that passed through the extractor could be determined for each test.

$$W_E = W_S \times \frac{V_V}{V_S}$$

Where W_E = weight of grease passing through ventilator, grams

W_S = weight increase of sampler, grams

V_V = air drawn through ventilator, Cu. Ft.

V_S = air drawn through sampler, Cu. Ft.

The efficiency of the ventilator, then, was the ratio of the weight of the grease collected in the extractor to the total amount of grease introduced into the grease trap, i.e. the grease that escaped through the ventilator plus that retained in the extractor.

$$E = \frac{W_V}{W_V + W_E} \times 100$$

Where E = efficiency, percent

W_V = weight of grease retained in ventilator, grams

W_E = weight of grease that passed through ventilator, grams

Another efficiency value called the "apparent efficiency" was determined which did not credit the ventilator for the amount of grease splattered on the floor and that evaporated from the hot cooking surface. The "apparent efficiency" is defined as the ratio of the grease collected in the ventilator during the test to the difference between the total grease dissipated and the grease wiped from the endplates, backplate, and shelf and from the cooking surface.

$$E_A = \frac{W_V}{W_T - W_O} \times 100$$

Where E_A = apparent efficiency, %

W_V = weight of grease retained in ventilator, grams

W_T = total grease dissipated, grams

W_O = grease wiped from end plates, backplate, shelf, and cooking surface, grams

The amount of grease splattered on the cooking surface and evaporated could never be fully accounted for. Therefore, it was expected that the apparent efficiency would always be lower than the actual efficiency, the difference depending on the intensity of splattering.

Three different methods were used for the generation of grease vapor or mist.

1. Fig. 2 shows a photograph of two baking trays, 9 x 15 in. and 2 in. high, filled with grease approximately 1/2 in. and heated on the cooking surface. A loop of 1/4 in. copper tubing with 0.020 in. holes was placed on the bottom of the trays through which air was blown to accelerate the volatilization of the grease. At a grease temperature of approximately 320°F a total of 10 grams could be volatilized per hour from two grease trays and it was found that only about one-third of this amount reached the ventilator throat, two-thirds being lost by splattering. Since grease dissipation rates as high as 90 g/hr had been observed in actual operation in the galley of the U.S.S. Tarawa it appeared that the results to be obtained with this apparatus would be indicative of only a limited part of the operating conditions likely to be encountered.

2. Vats 15 x 15 in. and 8 in. high were also tried and Fig. 3 shows how two such vats were located on the cooking surface. The loading rate obtained with this method was higher than that observed with the shallower trays and the rate of splattering was lower. However, it was impossible to

reach a grease dissipation rate approaching 90 g/hr so this method was not used during any of the tests which have been employed for the evaluation of the specimen ventilator.

3. A small paint sprayer was then used as shown in Fig. 4. It was mounted at the left front corner of the cooking surface and the grease, heated to about 200°F, was sprayed diagonally across the cooking surface. The grease particles, atomized by the paint sprayer, were examined on a microscopic slide and it appeared that they were similar in size to those collected on slides in actual cooking on board the U.S.S. Tarawa. With a continuous spray of grease into the air stream the grease dissipation rate was regulated to values in the range from 20 to 60 g per hour. By directing the spray cone towards the separator throat the amount of splattering was reduced considerably and this method was used for the majority of the tests made.

At the beginning, tests were made over a six hour period, but the length of test was later reduced to three hours. The following measurements were made during each test:

1. The total amount of grease dispersed was determined as the difference of the weight of the grease-containing vessels before and after each test.

2. The amount of grease collected on the walls of the ventilator facing the cooking surface and splattered on the cooking surface by wiping off these surfaces with soft paper tissues and determining the weight increase of these tissues.

3. The amount of grease collected in the ventilator was likewise obtained by cleaning the extractor chamber, the trough and the fire damper and determining the weight increase of the paper tissues.

4. The air flow rate through the ventilator was observed by means of an orifice flow meter which had been previously used for the grease filter test apparatus. As the straight length of pipe approaching the orifice had to be shortened for this installation the flow coefficients quoted in the A.S.M.E. Research Publication on Fluid Meters were no longer applicable. The orifice meter was, therefore, empirically calibrated for the desired flow rates by means of a Pitot tube.

5. The pressure drop across the ventilator was observed on an inclined manometer as the difference between the static pressure in the transition piece and atmospheric pressure.

6. The total air flow through the sampler tube was observed with a gas meter. The flow rate was adjusted to approximate the desired value by means of an orifice flow meter and maintained at a steady rate for each test. The determination of the actual air flow rate was considered to be more accurately measured with a calibrated gas meter than with an orifice flow meter because the air pressure in the transition piece changed with the air flow rate of the ventilator. This would have made it necessary to calibrate the orifice flow meter for each ventilator air flow rate.

7. The amount of grease retained in the sampler tube was determined as the weight change of the sampler during the test. The samplers were dried in a desiccator for at least three days before each weighing and each weight was determined to ±0.1 milligram.

8. The pressure drop across the sampler tube was determined with an U-tube manometer as the difference of the static pressure at the outlet of the sampler and that in the transition piece.

The effluent air temperature was maintained at 105°F±2°F at a point 1 ft above the ventilator during all tests by regulating the temperature of the stove plate. The temperature of the grease was also observed but it was found that variations in grease temperature caused no noticeable effect on the operation of the apparatus. All observations were made very 30 minutes.

IV. TEST RESULTS

From the observed data the following values were computed:

1. The corrected air flow rate through the sampler was calculated as described earlier.

2. The computation of the amount of grease that escaped through the ventilator has also been described.

3. The weight of grease lost by splattering was the difference between the total amount of grease dissipated and the grease that escaped through the ventilator plus the grease retained in the extractor and on the walls facing the cooking surface. The grease lost by splattering was also calculated in percent of the amount of grease dispersed during each test.

4. The loading rate of the ventilator was the weight of grease wiped from the inside of the extractor divided by the duration of the test.

5. The computation of the actual and the apparent efficiencies was explained earlier in this report.

Table 1 is a summary of the observed and computed results from 26 tests which were considered to be indicative of the performance of the apparatus.

The actual efficiency was plotted against the loading rate in Fig. 5 and a curve of the least mean distances was drawn. The scattering of the different points of observation is attributed to the limited accuracy possible in this kind of tests and to some variations in the air flow through both the ventilator and the sampler. The weight increase of the sampler tube was as low as 4.6 mg during one test and a cumulative error of only 0.2 mg made in weighting before and after the test could cause a difference of approximately 9% in the calculated weight of the grease that escaped through the ventilator. The magnitude of these deviations was of a smaller order for these tests than during the tests of impingement type filters.

The changes in the air flow rate through the ventilator ranging from 900 CFM to 1500 CFM did not cause any noticeable change of the efficiency as indicated by the fact that all the observed values of efficiency fall into the same pattern in Fig. 5.

The negative values of "grease lost by splattering" in four tests shows that the total amount of grease accounted for as wiped off the inside and outside wells of the ventilator plus the amount calculated as escaped through the ventilator was larger than the weight of grease dispersed during that test. This discrepancy ranged from 0.6g to 2.7g or 0.5% to 2.0% of the total grease dispersed and was caused by observation errors or through unequal cleaning of the extractor after each test.

The average percentage of grease lost by splattering was 33.3% in tests where trays were used for the grease dispersion and only 10.1% when the atomizer was used. The differences between the apparent efficiency and the actual efficiency were correspondingly smaller in those tests where the atomizer was used.

Fig. 6 shows a graph of the pressure drop across the ventilator plotted against the air flow rate and reveals an almost linear increase of the pressure drop from 0.6 in. W.G. at 900 CFM to 1.4 in. W.G. at 1500 CFM air flow.

The apparatus was operated approximately 250 hrs and only a very slight film of grease could be noticed in the transition piece just above the separator after this time.

A test was also conducted on the automatic operation of the fire trap. The sensing bulb of the fire detector was installed in the transition and, in case of a fire closed an electric circuit to a relay that released a trigger and shut the fire trap. Thus the damper interrupted the flames entering the extractor and prevented the grease accumulated there and in the ducts from igniting. The release of this trigger mechanically opened a switch which cut off the exhaust blower circuit. The operation of the fire trap could also be accomplished manually with the same effect on the exhaust blower. By manually opening the fire trap the blower switch was closed again.

The thermostat was a "Fenwall rate-of-rise and constant-temperature fire detector" and was set for 350°F. In a test preliminary to its installation in the ventilator it was immersed in a grease bath that was heated up at a rate of approximately 5°F per minute and it was observed that the contacts closed at 347°F.

Two tests were made with different intensities of stove fires in which the temperature rise of the effluent air was observed adjacent to the thermostat and the time determined for closing the fire trap. Table 2 shows the results obtained in these tests.

Table 2

Tests of Fire Detector

	Air Temperature °F Start	Air Temperature °F End	Time Required for Closing Trap Min	Rate of Air Temp. Rise °F/Min
Test 1	112	265	5	31
Test 2	106	305	2	100

It might have been expected that at the higher rate of temperature rise the trap would close at a lower temperature. However, due to the mass of the thermostat it is apparent that its temperature lagged behind the ambient air temperature.

Fig. 7 shows the grease fires used to test the operation of the fire detection device.

V. DISCUSSION AND CONCLUSION

The test results showed that the filtering efficiency of the Gaylord ventilator was equal or slightly better than the average observed on impingement type filters for the range of loading rates from 1 to 50 g/hr.

A 1000 CFM air flow rate was recommended for the 4 ft. long test specimen. The air flow rate through a 20x20 in. impingement filter at 400 ft/min face velocity is 895 CFM. Since it had been observed in the galley of the U.S.S.Tarawa that one such filter was installed for approximately each 4 ft of cooking frontage it is believed that the ventilator will supply ample ventilation.

The pressure drop across the ventilator at an air flow rate of 1000 CFM was 0.77 in. W.G. which is about 10 times as high as that of a clean impingement type filter. However, the pressure drop of the Gaylord ventilator did not increase with the grease load accumulated in the extractor which assured equal ventilation of the galley at all times, whereas the ventilation always decreased as the impingement filters loaded up or became clogged up.

The inherent advantage of the Gaylord ventilator is the absence of expendable components, as the impingement filters must be considered to be. Since the ventilator replaces the conventional hood and can be installed along the walls as well as between double-row or island-style cooking facilities there does not appear to be any difficulty with regard to space requirement and the weight of the ventilator is less than that of a conventional hood. The connection of the exhaust ducts to the ventilator can be accomplished in several different ways.

The grease collected in the separator of the test specimen had to be wiped out with a cleaning rag or paper tissue after removal of the clean-out panel at the back. The clean-out panel can be arranged so that the trough and the rest of the separator are accessible either from the rear or from the front of the cooking surface. For shipboard use only accessibility from the cooking surface would be acceptable.

The fact that the grease retained in the extractor of the test specimen had to be wiped out makes it unsuited to Navy use in its present form.

It is believed that the model tested could be modified and a means provided for continuous removal of the grease collected in the separator and trough but this was not attempted during the tests.

Item	16	17	18	19	20	21
Observed Va						
Mode of gre	A	A	A	A	A	A
Duration of	3.0	3.0	3.0	3.0	3.0	3.
Total greas	119.9	113.7	138.5	99.3	71.6	166.
Grease wipe	16.7	15.7	15.3	6.6	6.2	17.
Grease reta	76.3	70.8	108.4	67.9	54.2	131.
Airflow thr	1500	1500	1500	1000	1000	100
Pressure dr	1.41	1.42	1.37	0.76	0.77	0.7
Air flow th	541	549	548	526	569	53
Grease reta	25.2	23.0	31.4	23.8	20.0	50.4
Pressure dr	10.7	8.0	8.7	8.0	6.8	7.8
Calculated						
Sampler air	2.58	2.73	2.69	2.61	2.93	2.68
Grease esca	14.63	12.63	17.50	9.13	6.83	18.80
Grease lost	12.3	14.6	-2.7	15.7	4.4	- 0.9
Grease lost	10.3	12.8	-2.0	15.8	6.1	- 0.5
Loading rat	25.4	23.6	36.1	22.6	18.1	43.8
Apparent ef	73.9	72.3	87.8	73.2	82.8	87.9
Actual effi	84.0	84.8	86.0	88.2	88.8	87.4

*

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TABLE 1

SUMMARY OF TEST RESULTS

Gaylord Clearair Ventilator
Test No.

Item	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Observed Values																
Mode of grease dispersion	*	A	A	A	T	T	A	A	T	T	T	T	T	A	A	A
Duration of test	hrs	6.0	5.0	6.5	7.0	7.0	7.0	7.0	3.5	3.5	3.0	3.5	3.0	3.0	3.0	3.0
Total grease dissipated	g	384.3	80.0	235.0	23	62	107.3	141.4	48	38	24	25	41	111.2	153.3	109.7
Grease wiped from walls	g	29.0	4.7	15.5	5.9	16.2	6.2	7.5	25.2	18.5	6.7	9.2	9.5	13.8	37.5	13.4
Grease retained in ventilator	g	317.1	51.8	165.9	11.9	15.6	62.2	94.5	5.7	8.5	4.5	4.2	8.6	54.2	92.4	68.9
Airflow through ventilator	CFM	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1295	1295
Pressure drop across ventilator	in.W.G.	-	-	-	-	-	0.75	0.76	0.75	0.77	0.80	0.77	0.77	0.77	1.17	1.18
Air flow through gas meter	cu.ft.	1055	844	1133	1204	1191	1248	1228	634	613	529	634	525	536	539	551
Grease retained in sampler	mg	105.8	33.2	94.2	8.8	16.2	54.2	75.4	4.6	6.4	5.6	4.2	10.4	19.8	21.4	19.6
Pressure drop across sampler	cm Hg	7.7	5.1	5.9	6.6	7.2	10.1	6.8	7.7	7.7	5.5	7.7	5.4	6.2	7.3	8.8
Calculated Values																
Sampler air flow, corrected	CFM	2.63	2.63	2.68	2.61	2.53	2.57	2.66	2.71	2.62	2.73	2.72	2.72	2.73	2.70	2.71
Grease escaped through ventilator	g	40.2	12.6	35.1	3.37	6.40	21.1	28.3	1.70	2.44	2.05	1.55	3.82	7.24	10.26	9.36
Grease lost by splattering	g	- 2.0	10.9	18.5	1.8	23.8	17.7	11.2	15.4	8.6	10.8	10.1	19.1	36.0	13.1	18.1
Grease lost by splattering	%	- 0.5	13.6	7.9	7.8	38.4	16.5	7.9	32.1	22.6	45.0	40.4	46.5	32.4	8.5	16.5
Loading rate of ventilator	g/hr	52.9	10.4	25.5	1.7	2.2	8.9	13.5	1.6	2.4	1.5	1.2	2.9	18.1	30.8	23.0
Apparent efficiency	%	89.4	68.8	75.6	69.8	34.0	61.5	70.6	25.0	43.3	25.8	26.7	27.3	55.6	79.8	71.6
Actual efficiency	%	88.7	80.4	82.6	78.0	70.8	74.8	77.0	77.1	77.5	68.5	73.2	69.4	88.2	90.0	88.1

Item	Unit	16	17	18	19	20	21	22	23	24	25	26
Observed Values												
Mode of grease dispersion	*	A	A	A	A	A	A	A	A	A	A	A
Duration of test	hrs	3.0	3.0	3.0	3.0	3.0	3.0	6.0	1.25	3.17	3.0	3.0
Total grease dissipated	g	119.9	113.7	138.5	99.3	71.6	166.9	102.6	44.3	70.9	119.4	70.6
Grease wiped from walls	g	16.7	15.7	15.3	6.6	6.2	17.6	9.8	3.1	11.1	8.6	7.0
Grease retained in ventilator	g	76.3	70.8	108.4	67.9	54.2	131.4	71.5	26.5	49.6	80.1	54.4
Airflow through ventilator	CFM	1500	1500	1500	1000	1000	1000	1000	1000	1000	900	900
Pressure drop across ventilator	in.W.G.	1.41	1.42	1.37	0.76	0.77	0.77	0.77	0.77	0.77	0.60	0.60
Air flow through gas meter	cu.ft.	541	549	548	526	569	539	1149	237	580	533	542
Grease retained in sampler	mg	25.2	23.0	31.4	23.8	20.0	50.4	39.2	14.5	21.0	36.1	30.2
Pressure drop across sampler	cm Hg	10.7	8.0	8.7	8.0	6.8	7.8	5.8	10.4**	8.2	5.5	5.6
Calculated Values												
Sampler air flow, corrected	CFM	2.58	2.73	2.69	2.61	2.93	2.68	2.94	2.74	2.72	2.75	2.75
Grease escaped through ventilator	g	14.63	12.63	17.50	9.13	6.83	18.80	13.33	5.29	7.72	11.82	9.90
Grease lost by splattering	g	12.3	14.6	-2.7	15.7	4.4	- 0.9	8.0	9.4	2.5	18.9	-0.6
Grease lost by splattering	%	10.3	12.8	-2.0	15.8	6.1	- 0.5	7.8	21.2	3.5	15.8	-0.8
Loading rate of ventilator	g/hr	25.4	23.6	36.1	22.6	18.1	43.8	11.9	21.2	15.65	26.7	18.1
Apparent efficiency	%	73.9	72.3	87.8	73.2	82.8	87.9	77.0	64.3	82.7	72.3	85.2
Actual efficiency	%	84.0	84.8	86.0	88.2	88.8	87.4	84.4	83.4	86.6	87.1	84.5

* Mode of grease dispersion
A = atomizer (spray gun)
T = 2 trays, 9" x 15" x 2"

** Glass filter paper was used instead of sampling tube

16	17	18	19	20	21	22	23	24	25	26
A	A	A	A	A	A	A	A	A	A	A
3.0	3.0	3.0	3.0	3.0	3.0	6.0	1.25	3.17	3.0	3.0
119.9	113.7	138.5	99.3	71.6	166.9	102.6	44.3	70.9	119.4	70.6
16.7	15.7	15.3	6.6	6.2	17.6	9.8	3.1	11.1	8.6	7.0
76.3	70.8	108.4	67.9	54.2	131.4	71.5	26.5	49.6	80.1	54.4
1500	1500	1500	1000	1000	1000	1000	1000	1000	900	900
1.41	1.42	1.37	0.76	0.77	0.77	0.77	0.77	0.77	0.60	0.60
541	549	548	526	569	539	1149	237	580	533	542
25.2	23.0	31.4	23.8	20.0	50.4	39.2	14.5	21.0	36.1	30.2
10.7	8.0	8.7	8.0	6.8	7.8	5.8	10.4**	8.2	5.5	5.6
2.58	2.73	2.69	2.61	2.93	2.68	2.94	2.74	2.72	2.75	2.75
14.63	12.63	17.50	9.13	6.83	18.80	13.33	5.29	7.72	11.82	9.90
12.3	14.6	-2.7	15.7	4.4	- 0.9	8.0	9.4	2.5	18.9	-0.6
10.3	12.8	-2.0	15.8	6.1	- 0.5	7.8	21.2	3.5	15.8	-0.8
25.4	23.6	36.1	22.6	18.1	43.8	11.9	21.2	15.65	26.7	18.1
73.9	72.3	87.8	73.2	82.8	87.9	77.0	64.3	82.7	72.3	85.2
84.0	84.8	86.0	88.2	88.8	87.4	84.4	83.4	86.6	87.1	84.5

26
A
3.0
70.6
7.0
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900
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542
30.2
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2.75
9.90
).6
).8
3.1
5.2
4.5

GAYLORD VENTILATOR

SCHEMATIC

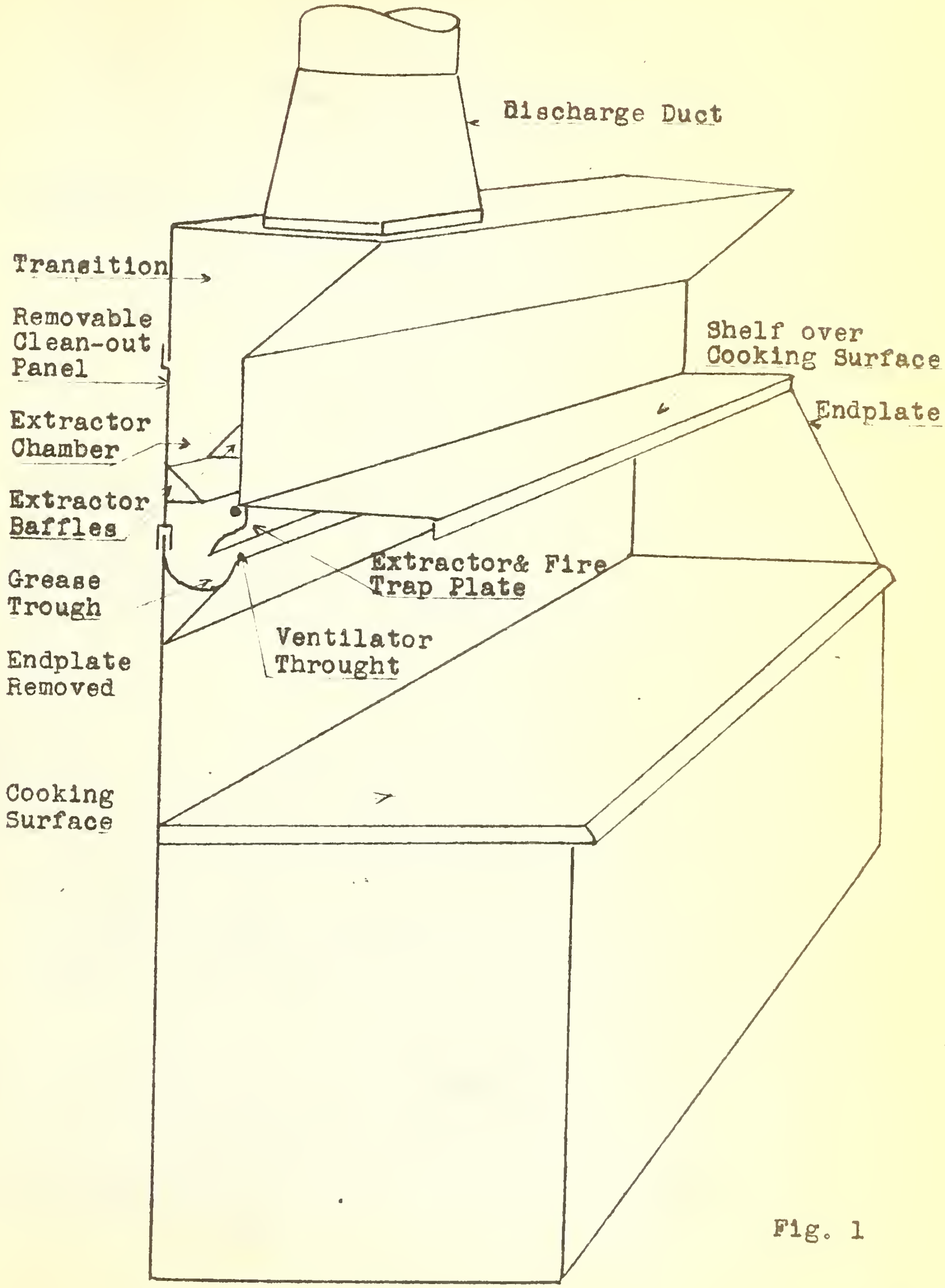


Fig. 1

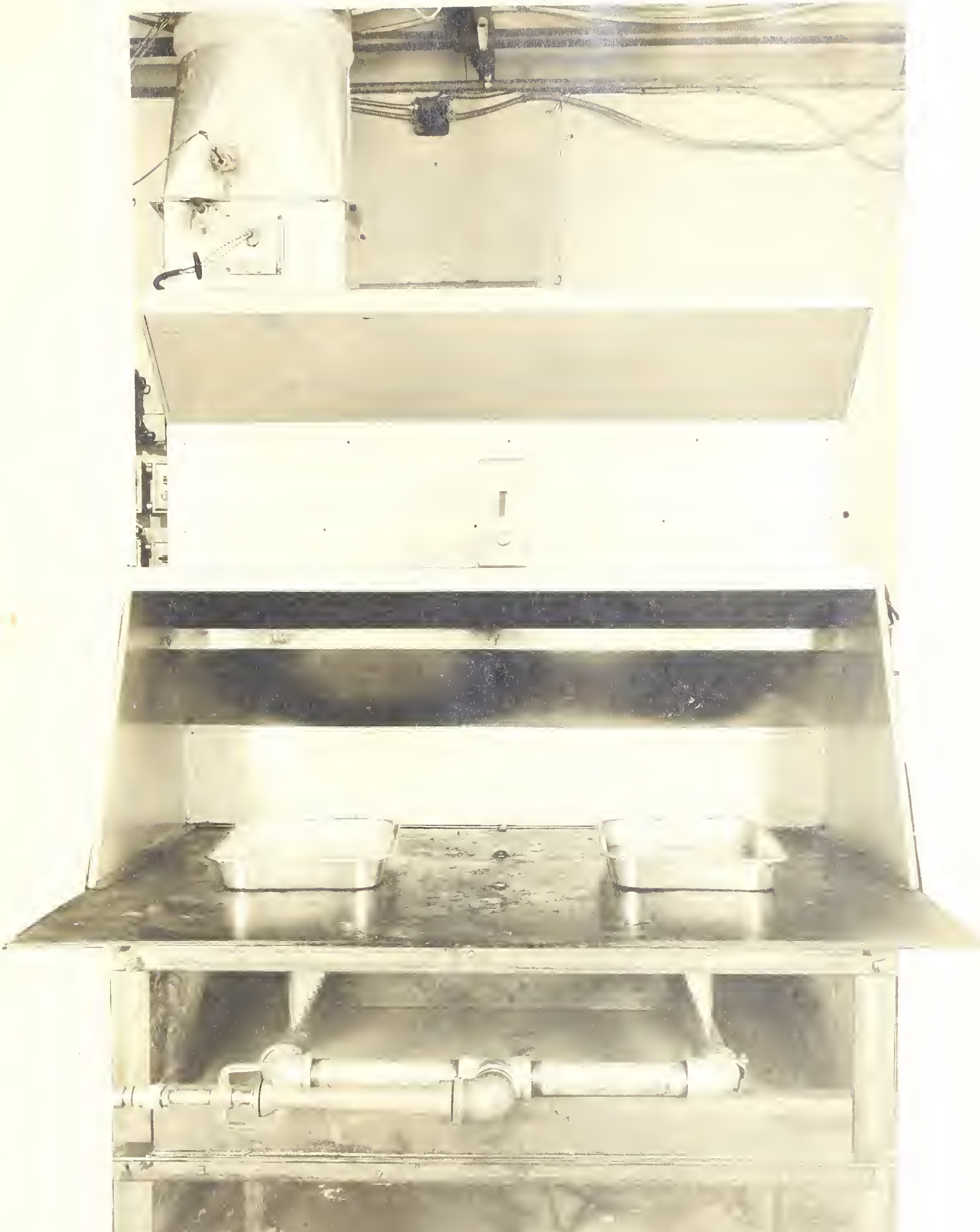


FIG. 2

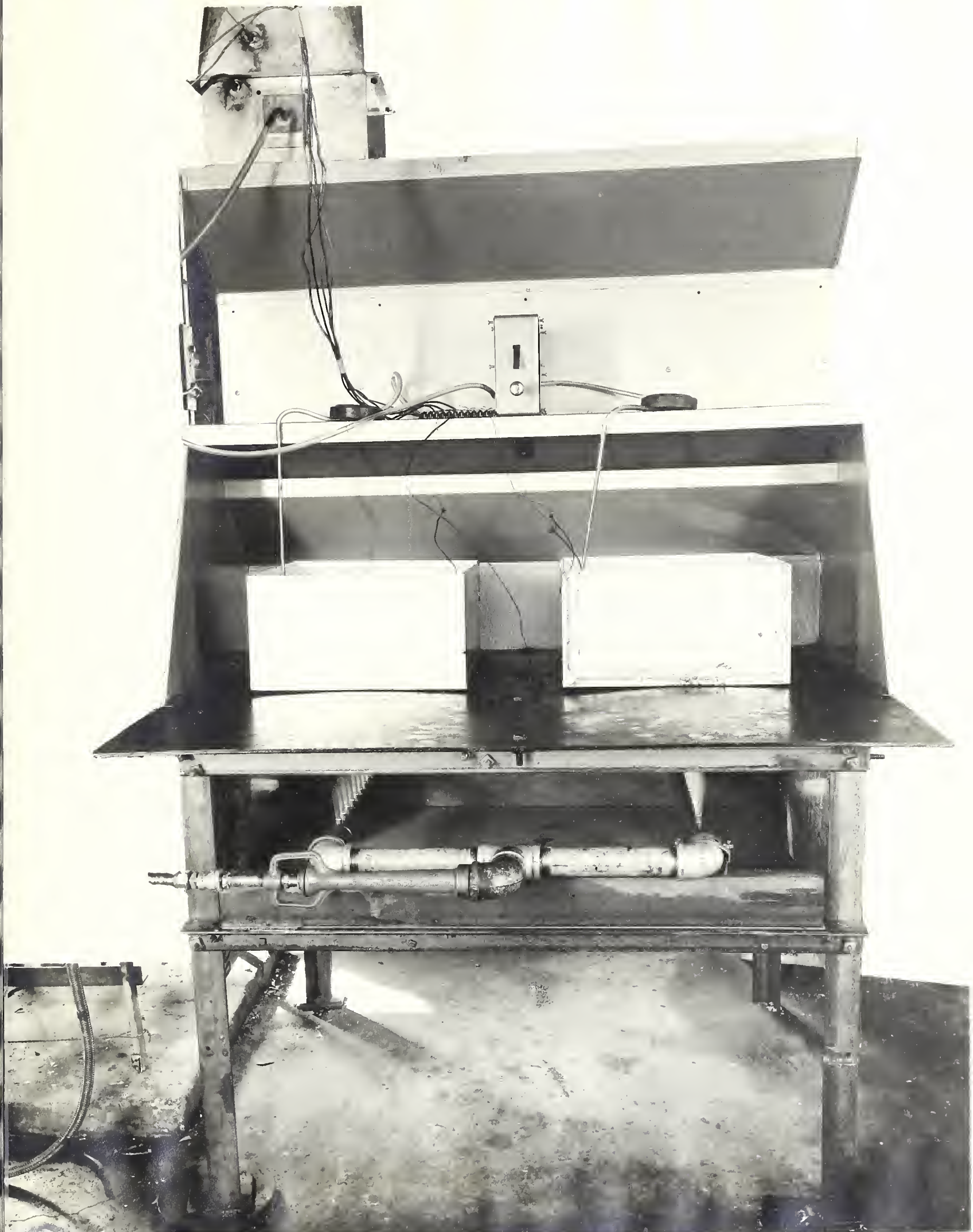


FIG. 3

FIG. 4

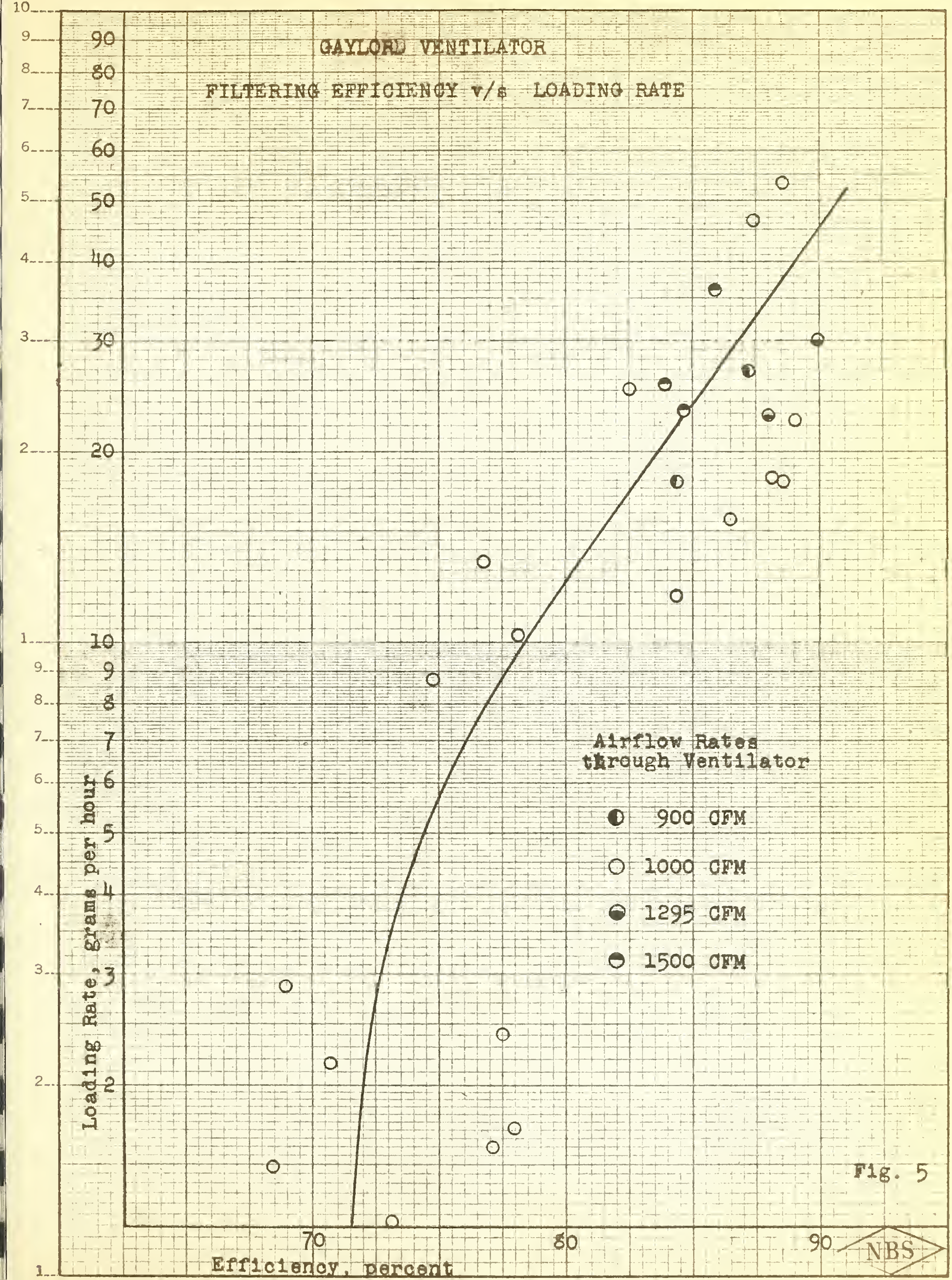

GAYLORD VENTILATOR
FILTERING EFFICIENCY v/s LOADING RATE
Airflow Rates through Ventilator
900 CFM
1000 CFM
1295 CFM
1500 CFM
Loading Rate, grams per hour
Efficiency, percent
70
80
90
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
NBS

Fig. 5

GAYLORD VENTILATOR

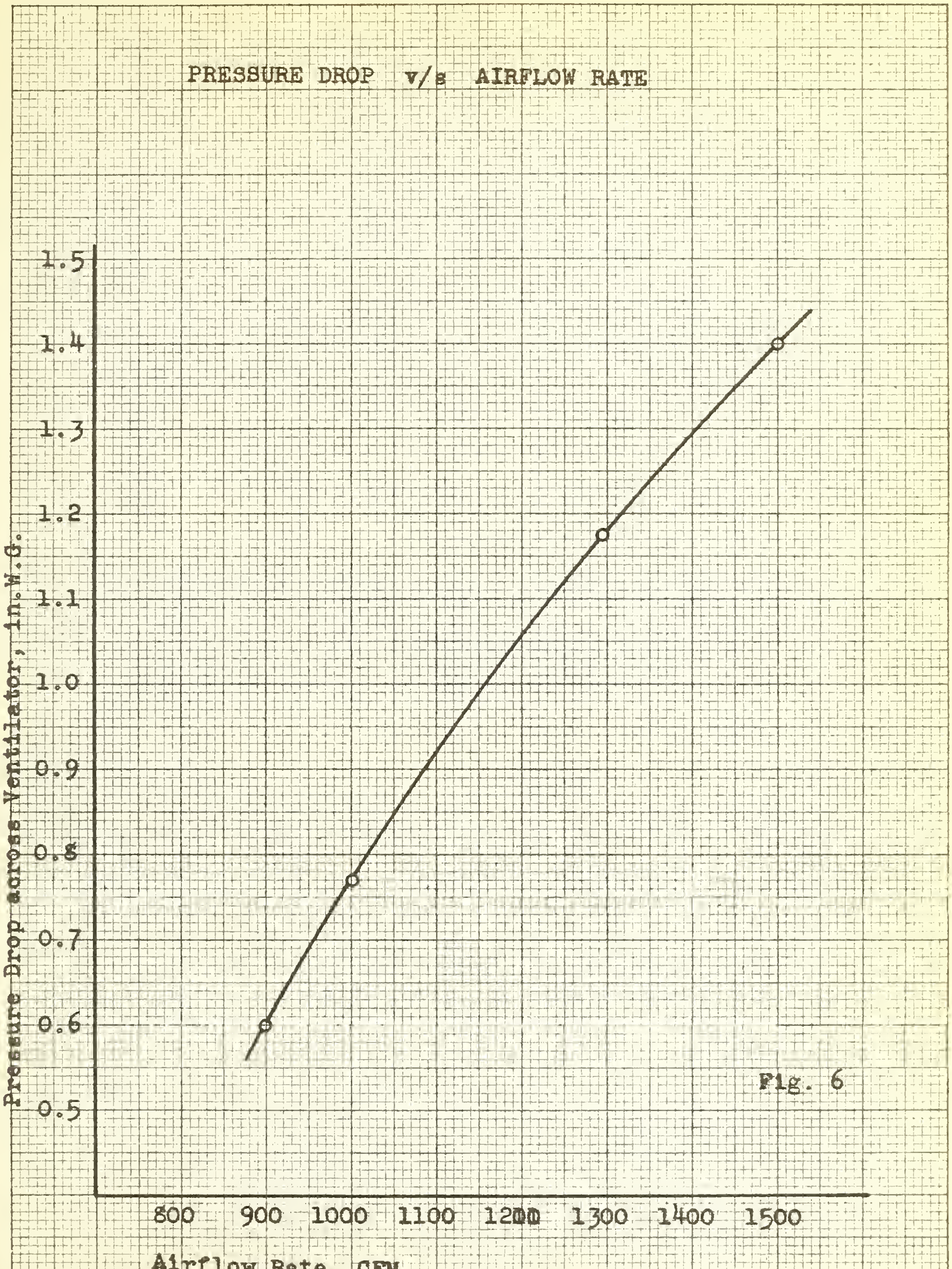
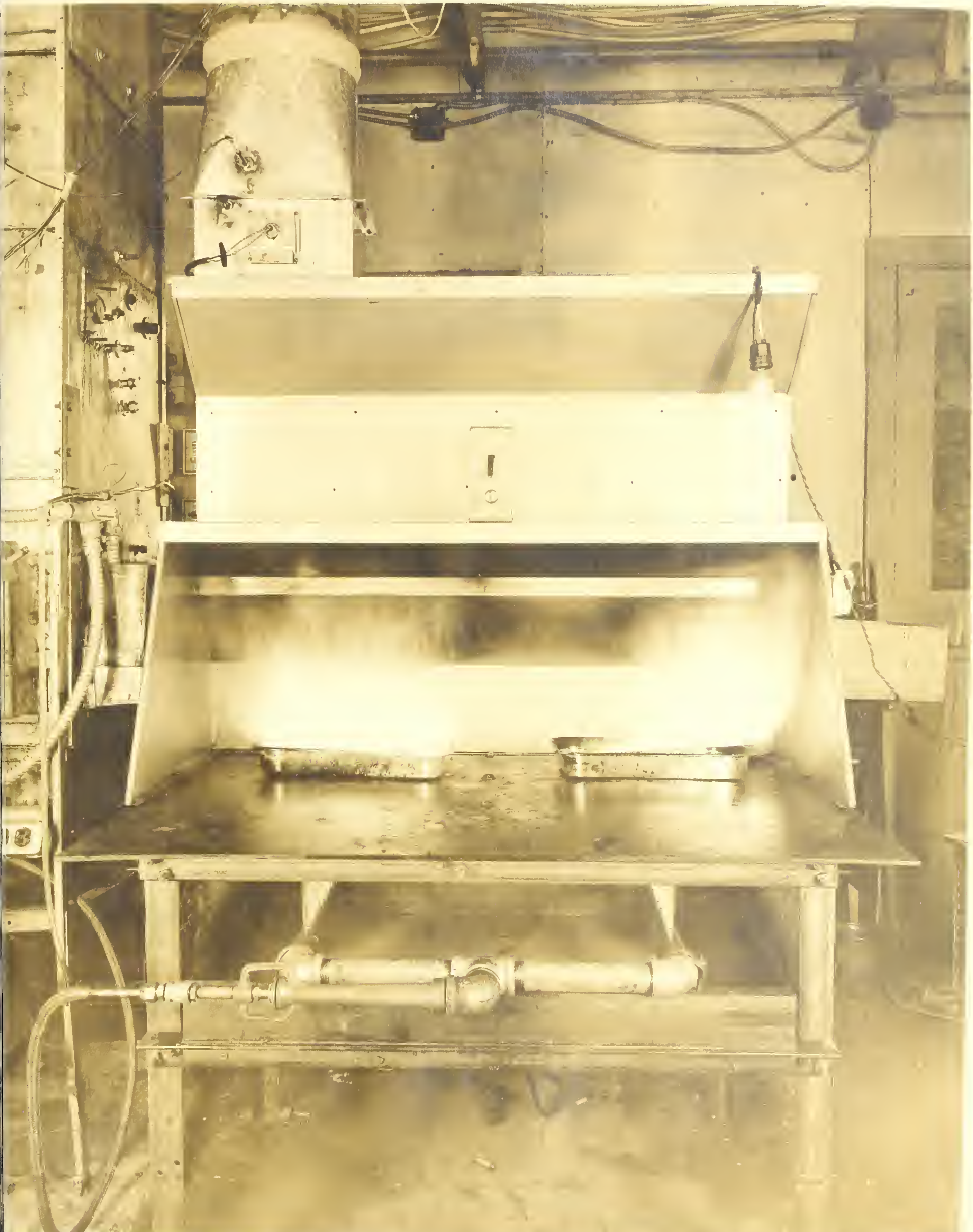


Fig. 6



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