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Final Report

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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

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ABSTRACT

Apparatus and methods have been developed for evaluating grease interceptors of the type used over cooking ranges. They have been applied to an interceptor which is in common use in ships' galleys as well as restaurants. The tests include evaluation of resistance to airflow, efficiency in removing airborne grease droplets, and effectiveness of the internal cleaning mechanism. These tests are intended to be an aid in developing specifications for grease interceptors.

Key Words: Aerosol interceptor; droplet interceptor; filter; grease; grease interceptor

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1. Introduction

At the request of the Commander, Naval Ship Systems Command, tests were performed on a grease interceptor of the type used in kitchens and galleys. The scope of the tests included determination of resistance to airflow and efficiency in removing grease droplets from the air. Tests of the effectiveness of the internal washing mechanism of the device were also made.

2. Description of Grease Interceptor

The grease interceptor in these tests was an inertial type of cleaning device. When air was drawn through it in normal operation, grease droplets were deposited on its internal baffles. A manufacturer's diagram of a cutaway side view of the apparatus is shown in Figure 1. The particular model tested was four feet wide.

The grease interceptor was equipped with an internal washing system in which water entered through a connection in the back and fed a number of spray jets inside the device. The position of the jets is indicated in Figure 1 as projections on baffles 2 and 4, but they are not labelled.

3. Description of Test Apparatus and Test Methods

A transition and upper chamber were mounted over the take-off collar of the grease interceptor. A working diagram of this part of the apparatus is shown in Figure 2. In operation the filter medium was drawn against the wire cloth backing with a tight seal. The reinforcing rods and filter support wires in the actual apparatus were oriented 90° in the horizontal plane from the position shown in Figure 2. A photograph of the test apparatus is shown in Figure 3. The apparatus was connected to a test duct by a flexible trunk shown at the left in this figure.

a. Determination of Resistance to Airflow

Flow velocity was measured by means of an 11-inch (27.9 cm) orifice plate mounted 7 feet (2.1 m) downstream from the entrance to the duct. Pressure drop across the orifice was measured with an inclined manometer which was calibrated against a Hook gage. Measurements were repeated using a 7-inch (17.8 cm) orifice and a flow nozzle respectively as flow measuring devices instead of the 11-inch orifice. This provided an independent check of flow in regions where the flow ranges of the three devices overlapped.

Four pressure taps were placed symmetrically on the two sides and the front and back of the lower transition shown in Figure 2, at a level 1 1/2 inches (3.8 cm) above the take-off collar of the grease interceptor. The average pressure at these taps was compared with the atmospheric pressure in the room as a measure of resistance to airflow.

b. Determination of Efficiency

In a National Bureau of Standards Report of March 18, 1954, Coblentz and Achenbach noted that droplets produced by a paint spray apparatus were similar in size to those collected in an actual cooking operation aboard ship. Since a paint spray gun affords an easy way to produce a comparatively high delivery rate of droplets, one was used for the present tests. A picture of the device is shown in Figure 4. A special clamp and holder which is shown in the figure was mounted on the spray gun to hold it in the open position. A diagram of the various components of the gun is shown in Figure 5.

The gun was mounted in a laboratory built heater which consisted essentially of a nichrome wire wound on a Teflon spacer mounted in the annular space between two brass cylinders. It was insulated at the top and bottom with dense fiber glass and surrounded the reservoir of the spray gun with a clearance of about 1 mm. The heater may be seen in the lower left portion of Figure 3 partially obscured by the nitrogen tank. The temperature of the heater was controlled by means of a Micromax* temperature controller which responded to a copper-constantan thermocouple mounted in the inner surface of the heater. The temperature of the grease was measured by a thermocouple mounted directly in the grease. The grease interceptor was operated at room temperature which is cooler than in a normal cooking operation.

Compressed nitrogen was used to disperse the grease in the efficiency measurements. However, it was felt that the difference between the use of nitrogen and air was minimal, and compressed air was used for loading the interceptor prior to the washing tests. The spray was directed horizontally (from left to right in Figure 3) across the front of the device. A mercury manometer was used to measure the spray pressure, since the pressures, which were of the order of 15 to 30 cm of mercury, were less than those normally used in paint spray operation.

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* Certain commercial materials and instruments are identified in this report in order to specify experimental procedure adequately. Such identification does not imply recommendation or indorsement by the National Bureau of Standards, nor does it imply that the equipment or material identified is necessarily the best for the purpose.

The amount of grease fed during a single test was determined by weighing the reservoir at the beginning and end of each measurement. Twelve minutes were arbitrarily selected as the time for each grease feeding operation. The grease passing through the interceptor was captured on an Owens-Corning* PF 105 fiber glass medium which was weighed at the beginning and end of each measurement.

c. Washing Tests

A tee similar to that shown in Figure 6, with 3 valves and a pressure gage, was attached to the grease interceptor. Water temperature was measured by means of a copper-constantan thermocouple in the line. The washing procedure consisted of successive two-minute periods in which water of controlled temperature and pressure was flushed through the interceptor, and an inspection was made after each washing period. All tests were performed without a detergent.

4. Results

a. Flow Resistance

The average pressure drop across the grease interceptor as a function of airflow rate is given in Table 1, and the data are presented graphically in Figure 7. Pressure drop was also measured in the upper part of the grease interceptor (transition area in Figure 1), and it was usually about 4 to 8 percent less than the values given in Table 1 which were measured 1 1/2 inches (3.8 cm) above the take-off collar. At the rated velocity of 1000 cfm (28.3 m^3/min.) the pressure drop was approximately 1.5 inches W. G. (.0025 bars).

b. Efficiency

The efficiency data are summarized in Table 2. As explained in the footnote at the bottom of the table, the uncorrected efficiency is based on the fraction of grease fed which is not captured by the back-up filter. The corrected efficiency treats that fraction of the grease which settles on the floor and sides of the grease interceptor up to a height of about 1 ft as grease which was never fed to the device. It was felt that this

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fraction of the grease might be more responsive to feed rate and method of feeding than grease encountered in normal operation.

Most of the uncorrected efficiency values were between 93 and 96 percent while the correct values were almost a percent less. The measurements were made at flow velocities of 1000, 1100, and 1200 cfm. There was evidence of a slight increase in efficiency with increasing air speed, but the differences were close to normal experimental error.

It should be noted that there was considerable variation in the feed rate from run to run as shown in Table 2. This was primarily because the feed rate was very responsive to small changes in the setting of the trigger of the spray gun. It is possible that for this particular application some simpler device might be constructed which would have fewer adjustments than a commercial paint spray gun. However, with the exception of one value which was obtained at a very low rate of feed, differences in feed rate of the magnitude shown in the table did not appear to have a significant effect on efficiency.

In three separate runs a high volume sampler with high efficiency glass fiber paper was placed in the port of the upper chamber of the test apparatus shown in Figure 2. Samples were collected to determine whether there was escape of droplets through the back-up filter. The data indicated that less than 0.1 percent of the grease droplets fed into the interceptor passed the back-up filter.

c. Effectiveness of Washing

The results of the washing tests are shown in Table 3. At 30 psi and water temperature of 160 - 165 °F all heavy deposits of grease were removed within the first two minutes, while at 135 - 137 °F at the same pressure, an additional two minute washing period was required. At water temperature of 118 - 124 °F and a pressure of 15 psi, deposits remained after five washing periods, and the cleaning was not fully effective when the pressure was raised to 30 psi. These latter measurements were made to observe cleaning performance below manufacturer's recommended temperature and pressure.

There was a thin deposit of grease near the take-off collar which was out of the range of the washing sprays in all measurements. However, it is probable that under the conditions of operation when the unit is operated hot as in cooking, there would be little deposit here.

Table 1

Resistance to Airflow - Pressure Drop as a Function of Flow Velocity through the Grease Interceptor

	Flow Rate (cfm)	Δp Across Interceptor (in. W. G.)*
11" Orifice	860	1.16
	1020	1.62
	1100	1.86
	1245	2.33
7" Orifice	760	0.81
	940	1.28
	1000	1.50
10" Nozzle	908	1.36
	1060	1.81

* W. G. = water gage

Table 2

Efficiency of Grease Hood in Intercepting Grease Dispersed by Paint Spray Apparatus

Efficiency[b] (percent)	Efficiency[b] Corrected (percent)	Average Feed Rate (g/hr)	Average Temperature of Grease in Spray Gun °F
1000 cfm			
93.1	91.8	102	193 - 198
95.2	94.6	73	--
93.9	93.1	122	197 - 198
average 94.1	93.2		
1100 cfm			
95.0	94.9	87	199
94.7	93.8	68	198 - 202
94.3	93.8	127	199 - 200
95.1	94.2	67	200 - 202
94.8	94.3	102	200 - 202
average 94.8	94.3		
1200 cfm			
95.0	93.6	58	197
93.8	91.9	65	198
94.9	94.4	220	198 - 201
96.4	95.8	134	199 - 200
96.5	95.9	79	198 - 200
96.5	96.0	85	196 - 197
95.6	94.0	137	203
96.3	95.6	95	199 - 200
98.3[c]	96.5[c]	47	196 - 198
average 95.6	94.5		

b Efficiency $= \frac{W_d - W_f}{W_d} \times 100$

W_f = wt. gain of back-up filter

W_d = wt. of grease dispersed

$$\text{Efficiency}_{\text{corrected}} = \frac{(W_d - C) - W_f}{W_d - C} \times 100$$

C = wt. grease collected on floor of grease interceptor and on sides up to 1 ft

c Omitted from average because of slow feed rate and large amount of grease collected on walls and floor of hood

Table 3

Schedule of Washing Tests and Results

1st Washing Test @ 330 g grease fed to grease hood prior to test.

2 minute Washing Period	Temperature ^{o}F	Pressure psi	Observations
1st	162 - 165	30	All heavy deposits of grease removed in 1st 2 minutes.
2nd	161 - 163	30	
3rd	159 - 161	30	

2nd Washing Test @ 360 g grease fed to grease hood prior to test.

1st	135	30	Two deposits of grease, one 7 mm in diameter and one 1.5 mm remained after 1st 2 minutes. Removed in 2nd 2 minute period.
2nd	136 - 137	30	

3rd Washing Test @ 270 g grease fed to grease hood prior to test.

1st	118	15	There was some reduction in amount of grease, but significant deposits remained after the first five 2-minute periods. One deposit, 5 cm in diameter remained even after the 10th 2 minute washing period.
2nd	119	15	
3rd	120 - 121	15	
4th	120	15	
5th	121 - 122	15	
6th	123	20	
7th	123 - 124	20	
8th	123 - 124	25	
9th	122 - 123	30	
10th	122	30	

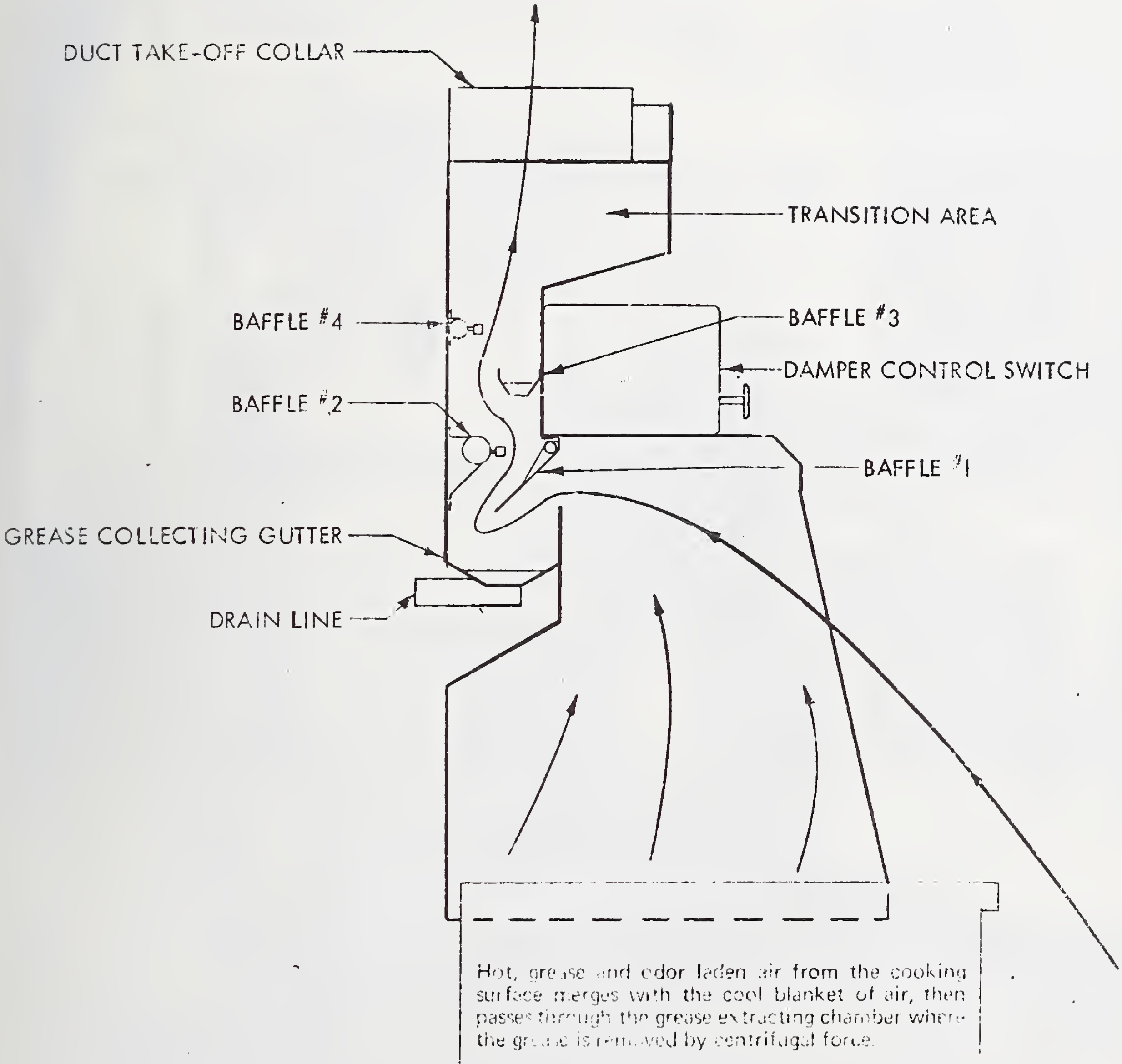

Figure 1 Manufacturer's Diagram of Cutaway Side View of Grease Interceptor

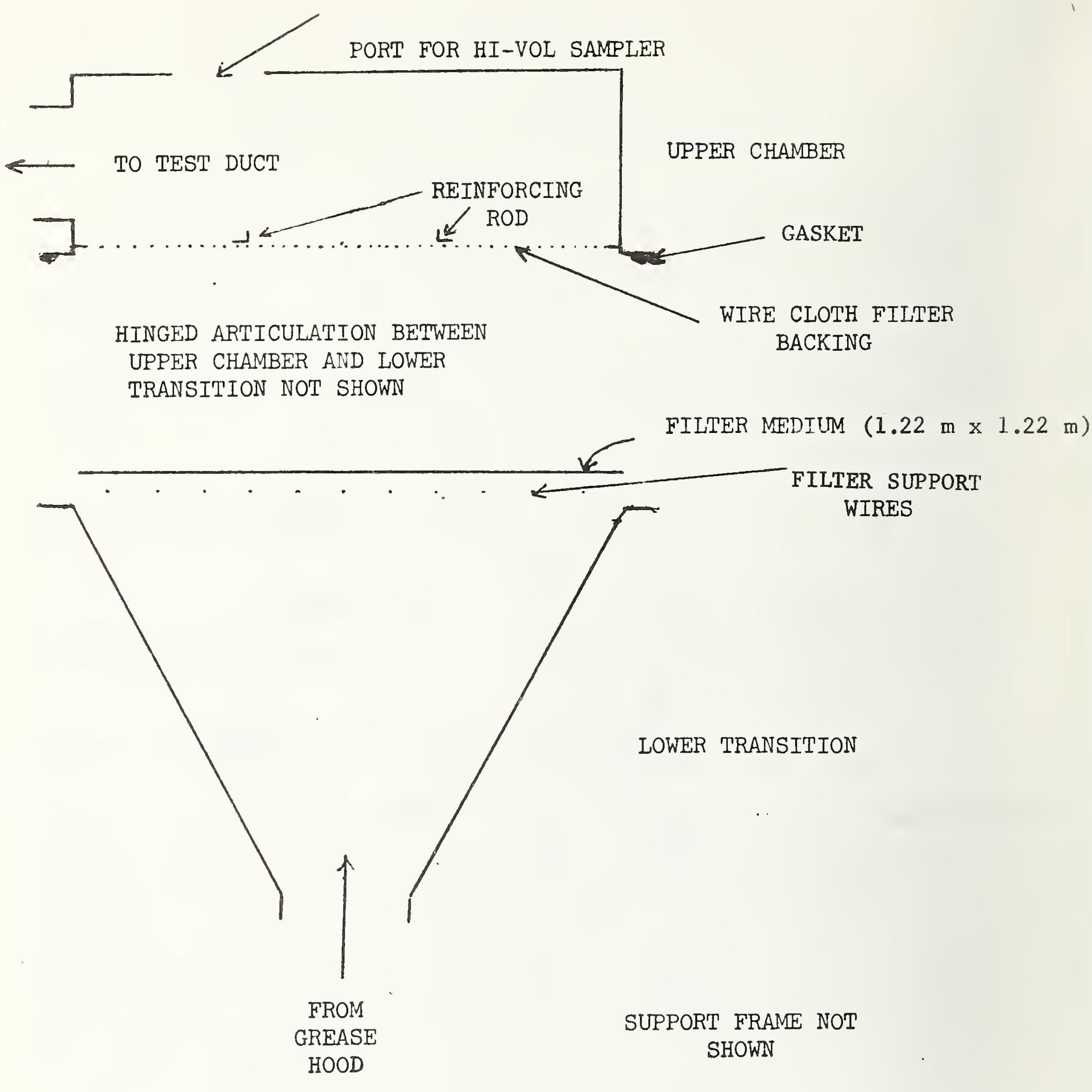

Figure 2 Diagram of Apparatus for Capturing Grease From Grease Hood

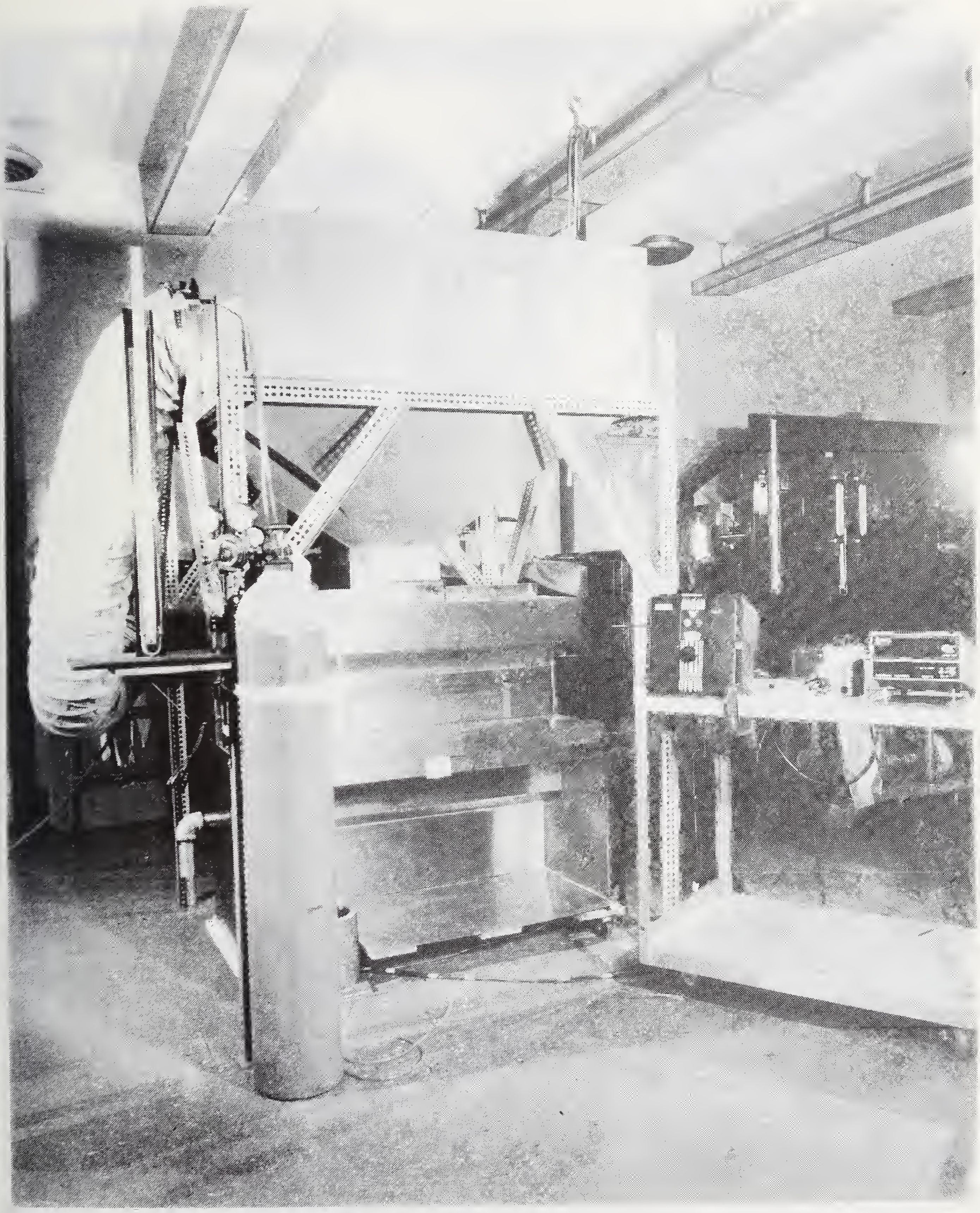

Figure 3 Picture of Grease Interceptor Mounted in the Test Apparatus

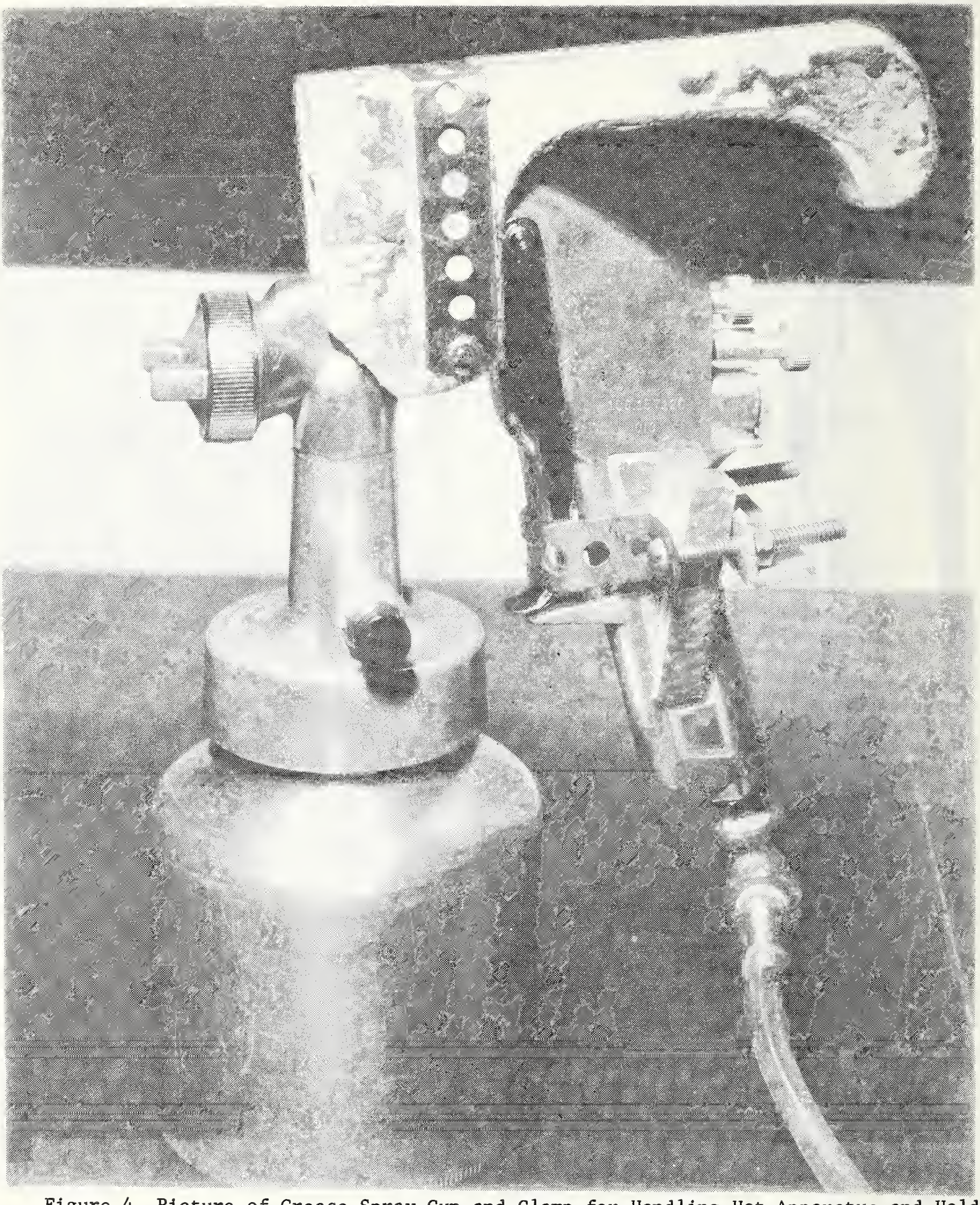

Figure 4 Picture of Grease Spray Gun and Clamp for Handling Hot Apparatus and Holding Spray Trigger in Open Position

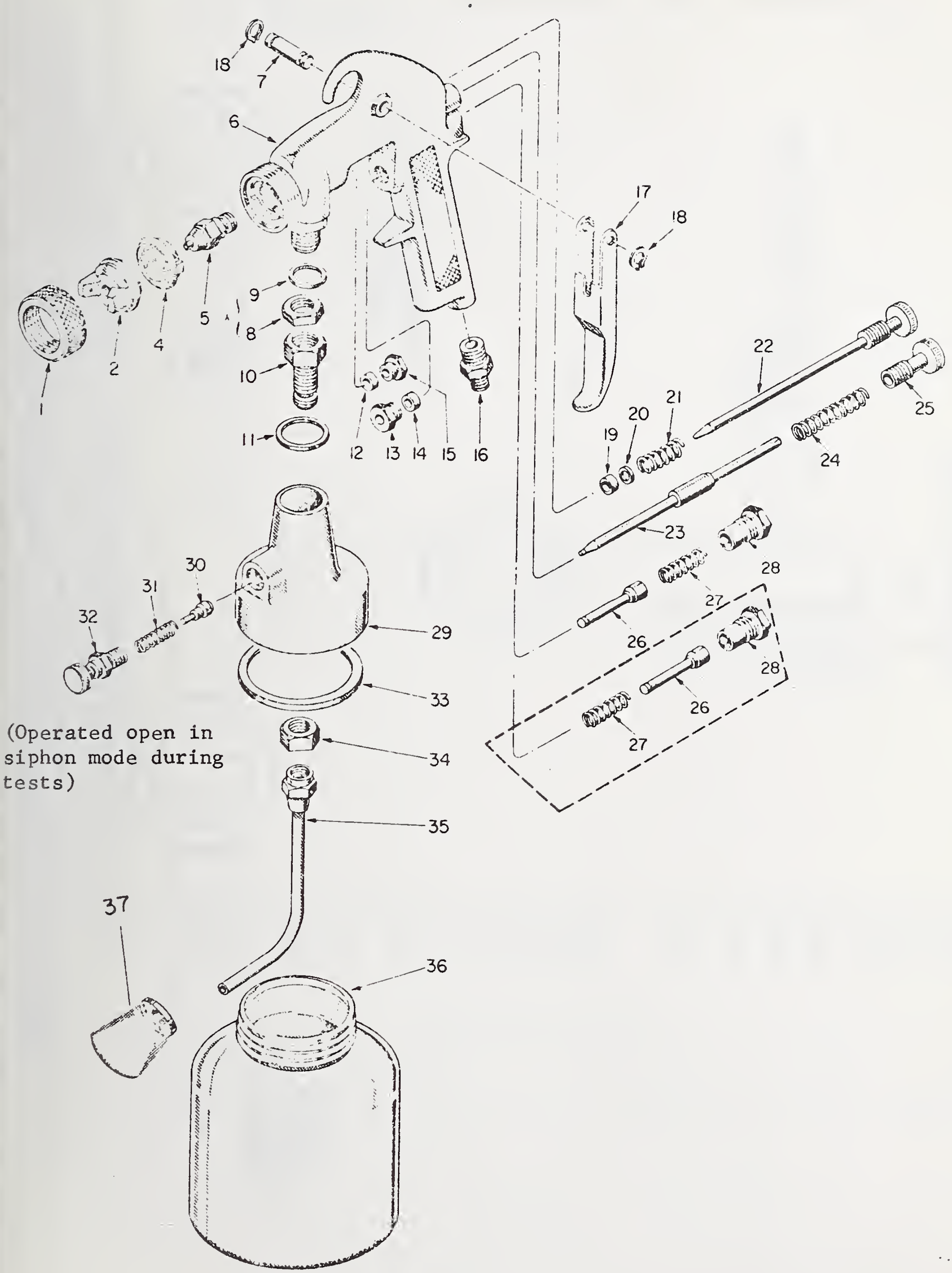

Figure 5 Diagram of Components of Spray Gun

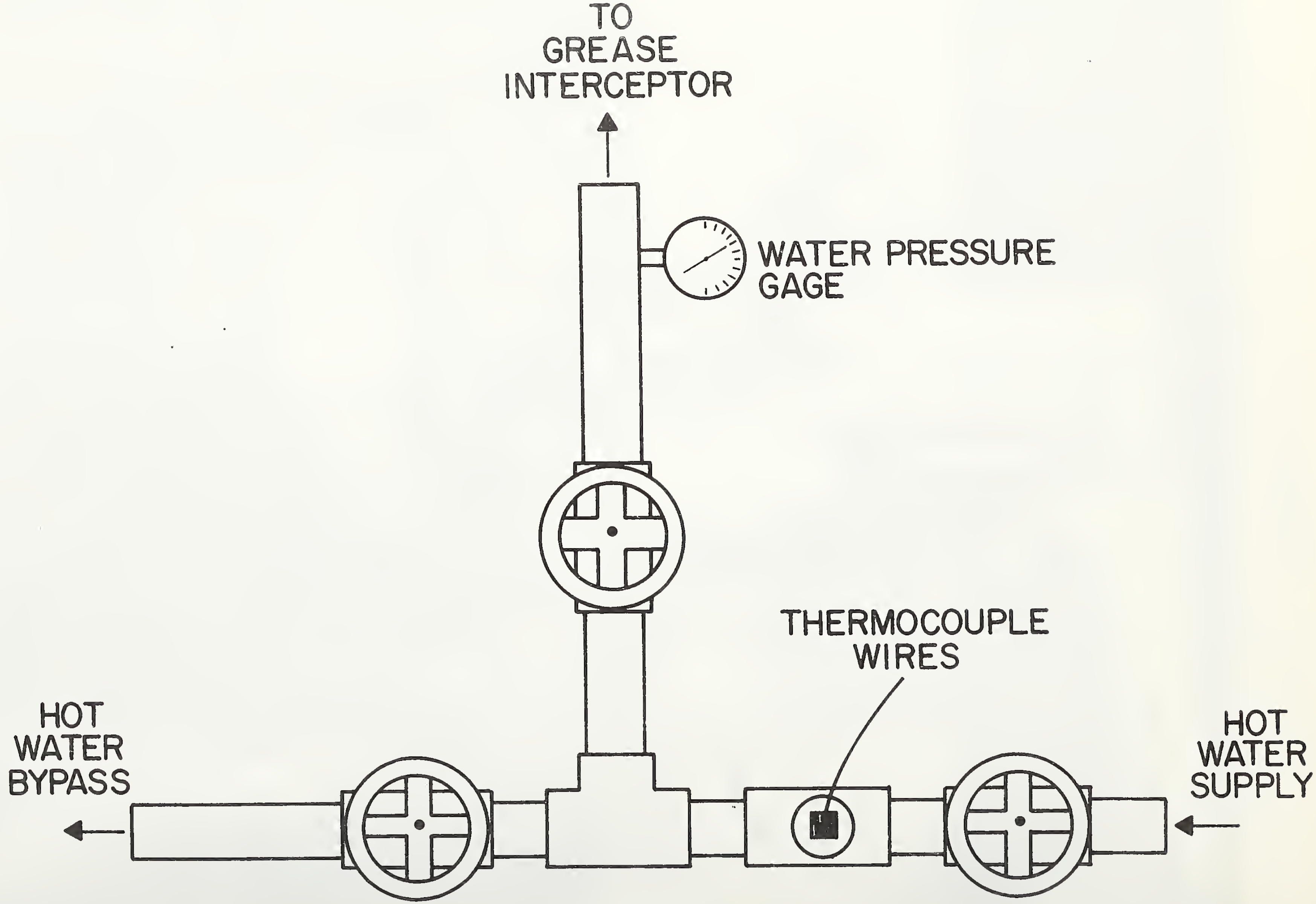

Figure 6 Tee Used to Introduce Hot Water Into Washing Port of Grease Interceptor at Controlled Temperature and Pressure (Components Not Drawn to Scale)

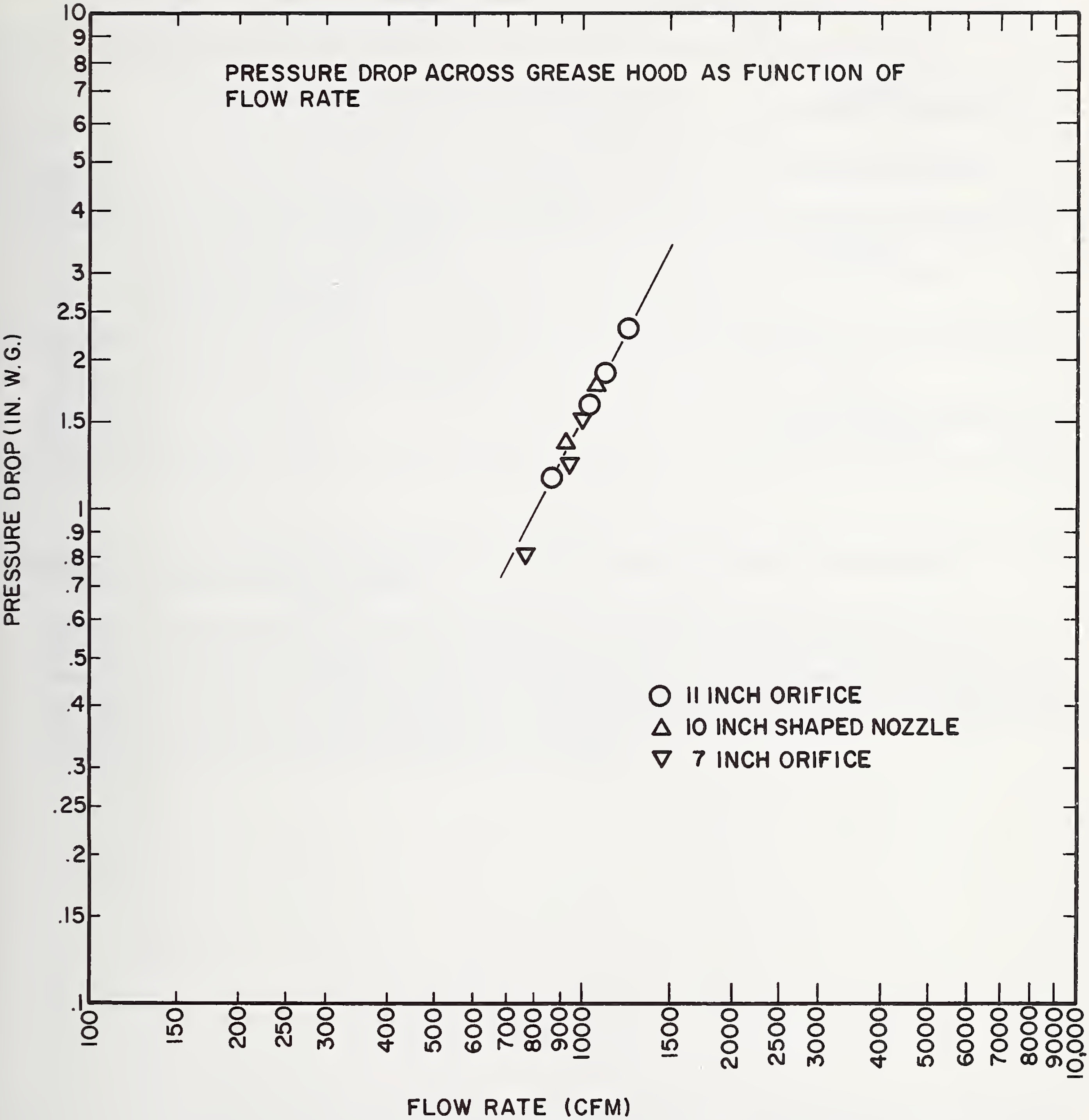

Figure 7 Pressure Drop Across Grease Interceptor as a Function of Flow Rate

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

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17. KEY WORDS (Alphabetical order, separated by semicolons) aerosol interceptor; droplet interceptor; filter; grease; grease interceptor

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