NATIONAL BUREAU OF STANDARDS REPORT

7409

PERFORMANCE TEST OF A "CONOMATIC" AIR FILTER
MODEL 3-C90, WITH AUTOMATIC RENEWABLE MEDIA B-1-A

manufactured by
Continental Air Filters, Inc.
Louisville, Kentucky

by

C. W. Coblentz and P. R. Achenbach

Report to

Public Buildings Service
General Services Administration
Washington 25, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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C. W. Coblentz and P. R. Achenbach
Mechanical Systems Section
Building Research Division

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1. Introduction

At the request of the Public Building Service, General Services Administration, the performance characteristics of a "Conomatic" automatic renewable media air filter were determined. The scope of this examination included the determination of the arrestance and the dust holding capacity per unit area of filter medium when operated at the rated face velocity of 500 ft/min and at a pressure drop not exceeding 0.5 in. W.G. using Cottrell precipitate and lint as the aerosol. The arrestance of the filter media was also determined for steady state conditions using the laboratory air as the aerosol.

2. Description of Test Specimen

The test specimen was supplied by Continental Air Filters, Inc., of Louisville, Kentucky. The mechanical part of the test specimen was a "Conomatic", Model 3-C90 which had been modified for installation in the N.B.S. air filter test apparatus. It was the same device that had been used in testing other filter media in 1958, as described in N.B.S. Report #6250.

The stock Conomatic apparatus had been enclosed in a sheet metal housing and equipped with suitable transition sections so that when it was installed in the air filters test apparatus no air could enter the test system except through the measuring orifice and all air had to pass through a 2 ft square area of the filter media. A roll of clean media was mounted in the upper portion of the housing and was unrolled as needed by a driven spool in the lower part of the housing. This lower spool was connected to a 1/6HP electric motor through a reduction drive. The motor was controlled by a differential pressure switch built by the Republic Auto Gas Corporation. This switch started the motor when the pressure drop across the filter media reached 0.5 in. W.G. and stopped it at a pressure difference of about 0.45 in. W.G. The motor turned the lower spool at about 1 RPM winding up the loaded media at a speed ranging from 1 ft/min to 3 ft/min, depending on how much media had been wound up on the spool.

The filter media used for this test was manufactured by the Owens-Corning Fiberglas Corporation of Newark, Ohio, and was identified as the Continental type B-1-A. The mat was approximately 2 inches thick and was reinforced by a 4-mesh cotton netting placed near the middle. The media was treated with an adhesive, said to be a mineral oil with the trade name "PUROCO". The weight of the media was approximately 41 grams per square foot. A microscopic examination of the glass fibers indicated that most were between 30 and 50 microns in diameter.

3. Test Method and Procedure

The filter was tested at a face velocity of 500 ft/min, corresponding to an air flow rate of 2,000 cfm. The arrestance determinations were made using the NBS Dust Spot Method described in a paper by R. S. Dill entitled "A Test Method for Air Filters" (ASHVE Transactions, Vol. 44, p. 379, 1938). The filter under test was installed in the test apparatus and carefully sealed to prevent any by-pass of air or air entry into the test apparatus, except through the measuring orifice. After establishing the correct air flow rate through the filter, samples of air were drawn from the center points of the test duct 2 feet upstream and 8 feet downstream of the test specimen at equal rates and passed through known areas of Whatman No. 41 filter paper. Arrestance determinations were made with the particulate matter in the laboratory air as the aerosol and also with Cottrell precipitate injected into the air stream at a ratio of 1 gram per 1,000 cu ft of air.

The light transmission of the sampling papers was measured before and after the test on the same area of each paper and the two sampling papers used for any one arrestance determination were selected to have the same light transmission when clean.

For determining the arrestance of the particulate matter in the laboratory air, equal sampling areas were used in the upstream and downstream samplers. A similar increase of the opacity of the two sampling papers was obtained by passing the sampling air through the upstream paper only part of the time while operating the downstream sampler continuously. This was accomplished by installing one solenoid valve in the upstream sampling line and another one in a line by-passing the sampler. The solenoid valves were operated by an electric timer and a relay so that one was open while the other one was closed during any desired percentage of the 5-minute timer cycle, reversing the position of the two valves during the remainder of the cycle. The arrestance, A (in percent), was then determined with the formula:

$$A = 100 - T \times \frac{\Delta D}{\Delta U}$$

where T is the percentage of time during which air was drawn through the upstream sampler, and ΔU and ΔD are the observed changes in the opacity of the upstream and downstream sampling papers, respectively.

For determining the arrestance of the filter with Cottrell precipitate as the test dust, different size areas of sampling paper were used upstream and downstream of the filter in order to obtain a similar increase of opacity on both sampling papers. The arrestance was then calculated by the formula:

$$A = \left(1 - \frac{S_D}{S_U} \times \frac{\Delta D}{\Delta U}\right) \times 100$$

where the symbols A, ΔU, and ΔD are the same as indicated above and S_U and S_D are the upstream and downstream sampling areas.

During the course of the test, the filter media was loaded with a mixture of 96 parts by weight of Cottrell precipitate and 4 parts by weight of cotton linters.

Arrestance determinations were made at the beginning and at the end of the test using Cottrell precipitate only, while cotton linters were added during alternate time periods. The Cottrell precipitate had been previously sifted through a 100-mesh screen and the lint was prepared by grinding No. 7 cotton linters through a Wiley mill with a 4-millimeter screen.

The pressure drop across the filter was recorded at the beginning of the test, after each arrestance determination, and after every 20-gram increment of Cottrell precipitate that was introduced into the test duct.

The movement of the filter medium was determined by observing the vertical height of a small wire attached to the mat. This wire was visible through a window in the duct and the change of its position was noted after each movement relative to a yard stick installed on the equipment wall adjacent to the edge of the medium. The length of the individual as well as the cumulative advances over a 2 ft length of the mat could be observed to the nearest 1/2 inch.

The movement of 41 in. of the filter media starting about 6 ft from the end of the roll was observed, originally. In order to determine the degree of uniformity of the roll of media another section of 33 in. near the middle of the roll was tested in the same way after winding approximately 20 ft of clean mat upon the lower spool.

The amount of Cottrell precipitate received per unit area of filter media during the period when the media was being advanced at fairly regular intervals was called the "Dust Holding Capacity" and provided a useful criterion for the consumption of filter media during actual use. The steady state operation of the filter mat was considered to commence when the mat had advanced more than one half of the exposed height after the clean start. The dust holding capacity was determined by plotting the movement of the filter media against the amount of dust introduced into the test apparatus and finding the slope of the straight line that best fitted the individual points of observation, representing essentially steady operation of the system.

4. Test Results

Table 1 shows the arrestance and pressure drop values observed on both sections of the medium when clean and at steady operating conditions. It will be noted that the arrestance values determined with Cottrell precipitate for the clean mat were 71.9 and 71.6 percent and at steady operating conditions, 86.4 and 86.2 percent, respectively. The arrestance of the particulate matter of the laboratory air was only determined for the first section and was 13.4 percent, at steady operating conditions. Each of these reported arrestance values is an average of two successive arrestance determinations.

Table 1

Arrestance, Dust Load, and Pressure Drop
Conomatic Model 3-C90 with Media B-1-A

Dust Load g/ft width	Pressure Drop in. W. G.	Arrestance %	Aerosol *
		Section One	
8	0.170	71.9	C
840	0.458	86.4	C
840	0.464	13.4	A
		Section Two	
8	0.162	71.6	C
678	0.429	86.2	C

* Aerosol A - Particulate matter in the laboratory air.
C - Cottrell precipitate in laboratory air.

Note: Each arrestance value is an average of two successive arrestance determinations.

Tables 2 and 3 give the observed values for the mat travel, dust load, and pressure drop before and after each advance of the filter medium for the two sections of media tested. The pressure drop was observed to only 2 digits for the first half of the section No. 01 and to 3 digits, i.e. to the nearest 1/1000 in. W.G., during the rest of the test. The average pressure drop at the start of the last eight mat advances of the first section was 0.496 in. W.G. and that at the end was 0.443 in. W.G., indicating an average differential of 0.053 in. W.G. The first advance was 4 1/2 in. whereas all successive advances, except one of 1 1/2 in., were between 2 in. and 2 1/2 in.

The second section of the mat was operated at an average pressure drop of 0.478 in. W.G. at the start of advancement of the media and of 0.418 in. W.G. at the end of the movements, corresponding to a differential of 0.060 in. W.G. The individual mat advance distances ranged from 2 to 5 in., with the first movement being the longest, and averaging about 2.6 in. The adjustment of the pressure switch was not changed during the entire test.

Table 2

Mat Travel, Dust Load, and Pressure Drop
Before and After Advance of Filter Medium
Conomatic, Model 3-C90 with Media B-1-A

Section No. 1

Dust Load g/ft width	Travel of Mat, in. Advance	Travel of Mat, in. Total	Pressure Drop, in. W.G. Before Advance	Pressure Drop, in. W.G. After Advance
0	0	0	0.165	---
218	4 1/2	4 1/2	0.50	0.45
260	2 1/2	7	0.50	0.45
291	2	9	0.50	0.45
321	2	11	0.50	0.45
343	2 1/2	13 1/2	0.50	0.45
374	2	15 1/2	0.50	0.45
405	2	17 1/2	0.50	0.45
436	2	19 1/2	0.50	0.45
467	2	21 1/2	0.50	0.45
508	1 1/2	23	0.50	0.45
550	2	25	0.497	0.445
591	2 1/2	27 1/2	0.498	0.440
633	2	29 1/2	0.497	0.442
664	2	31 1/2	0.495	0.440
705	2 1/2	34	0.496	0.439
737	2	36	0.495	0.441
768	2 1/2	38 1/2	0.496	0.441
809	2 1/2	41	0.494	0.442

Table 3

Mat Travel, Dust Load and Pressure Drop
Before and After Advance of Filter Medium
Conomatic, Model 3-C90 with Media B-1-A

Section No. 2

Dust Load g/ft width	Travel of Mat, in. Advance	Travel of Mat, in. Total	Pressure Drop, in. W.G. Before Advance	Pressure Drop, in. W.G. After Advance
0	0	0	0.160	---
218	5	5	0.484	0.420
240	3	8	0.481	0.419
280	2 1/2	10 1/2	0.470	0.410
332	3	13 1/2	0.483	0.424
363	2 1/2	16	0.474	0.424
394	2 1/2	18 1/2	0.475	0.410
436	2	20 1/2	0.470	0.415
467	2	22 1/2	0.469	0.411
508	2	24 1/2	0.480	0.421
550	2	26 1/2	0.480	0.420
591	3	29 1/2	0.483	0.419
633	2	31 1/2	0.480	0.421
674	2 1/2	33	0.482	0.420

In spite of the differences in the pressures at initiation and completion of the media movements for the two sections, no significant difference in the dust holding capacity were observed for the two sections. Figure 1 and 2 show graphs of the mat travel after an initial total advance of approximately 16in. plotted against the dust load of the medium, expressed in grams per foot width. Section No. 1, according to Figure 1, was fed 837-378 = 459 grams of dust while advancing from 16 to 42 in., a distance of 26 in. The dust holding capacity for the first section, then, was:

$$459 \times \frac{12}{26} = 212 \text{ g/sq ft}$$

The corresponding value of the dust fed to the second section of the mat, as plotted in Figure 2, was 677-358 = 319 grams/ft width, while the medium advanced from 16 to 34 = 18in. The dust holding capacity for the second section was:

$$319 \times \frac{12}{18} = 213 \text{ g/sq ft}$$

Mat Travel vs. Dust Load

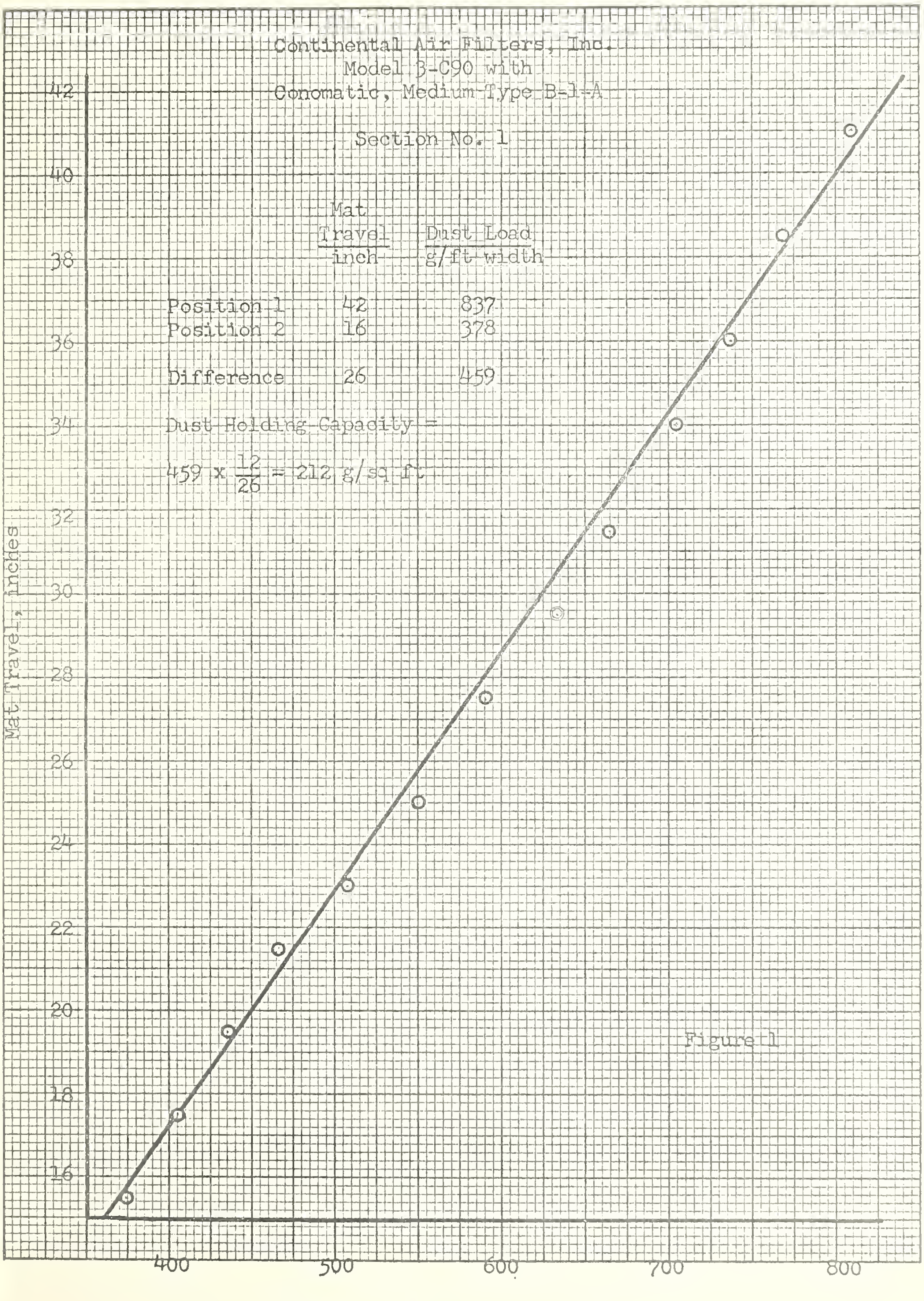
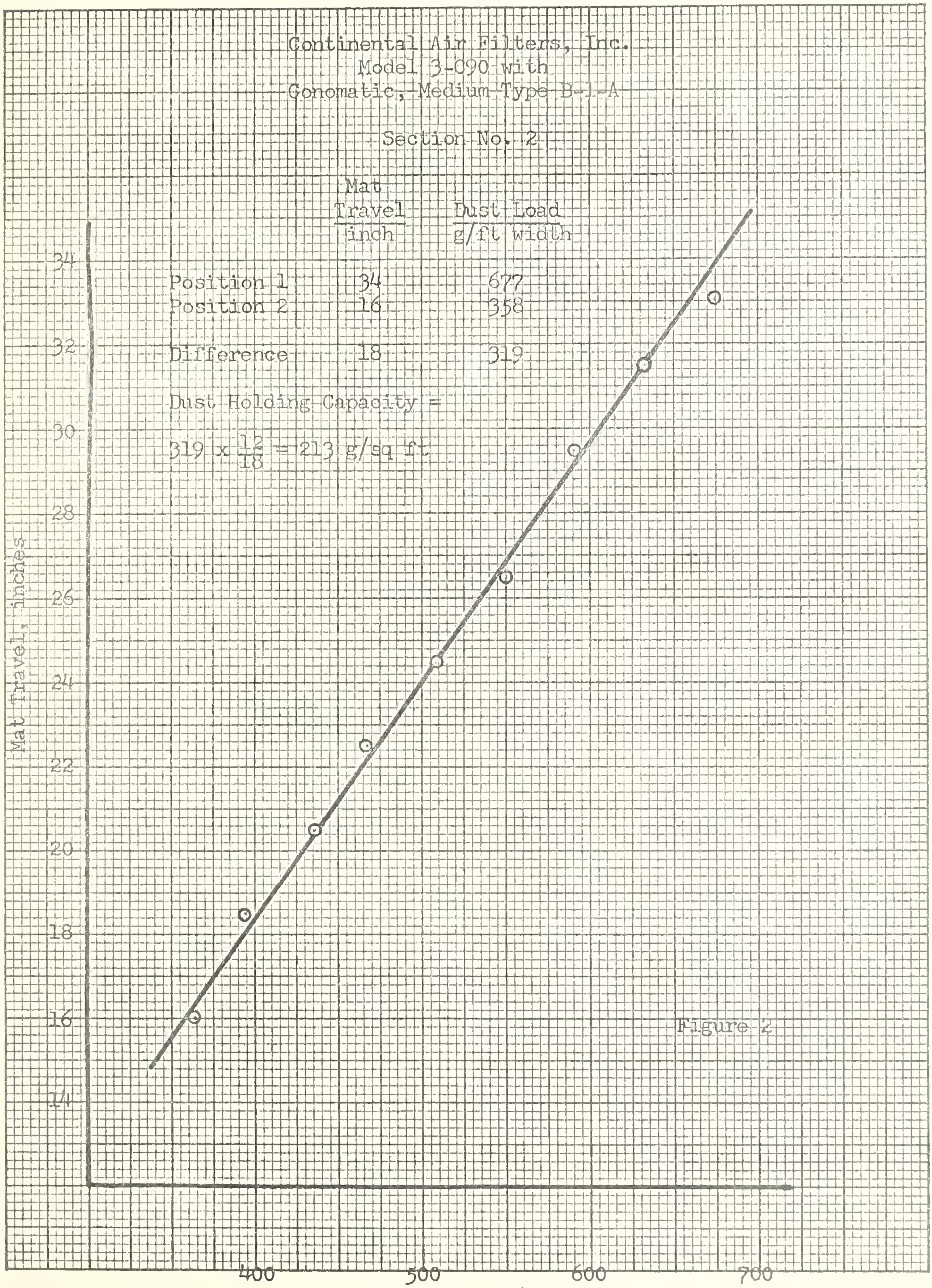


Figure 1

Dust Load, grams per foot width

Mat Travel vs. Dust Load



Dust Load, grams per square foot

U. S. DEPARTMENT OF COMMERCE
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The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

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Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

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Office of Weights and Measures.

BOULDER, COLO.

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