NATIONAL BUREAU OF STANDARDS REPORT

6404

PERFORMANCE TESTS OF
FOUR CLEANABLE IMPINGEMENT AIR FILTERS
TYPES 44 (TWO THICKNESSES), FS 304 AND FS 504

MANUFACTURED BY
THE FARR COMPANY
LOS ANGELES, CALIFORNIA

by

Carl W. Coblentz and Paul R. Achenbach

Report to

Bureau of Yards and Docks
Office of the Chief of Engineers
Headquarters, U. S. Air Force
Washington, D. C.

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Carl W. Coblentz and Paul R. Achenbach
Air Conditioning, Heating, and Refrigeration Section
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PERFORMANCE TESTS OF FOUR FARR COMPANY AIR FILTERS, TYPES 44 (1 IN. AND 2 IN. THICK), FS 304 (1 IN. THICK) and FS 504 (2 IN. THICK)

by

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1. Introduction

The performance characteristics of a group of cleanable viscous impingement type air filters was determined to provide information for evaluating the relative economy of cleanable versus throw-away types of filters. This investigation was requested by the Defense Department through the Tri-Service program of research and development at the National Bureau of Standards to obtain required data for the preparation of new air filter specifications.

The results presented in this report were obtained on 4 new filters and include determination of the arrestance and pressure drop as a function of the specific dust load for face velocities of 360 and 540 ft/min, and information on the cleanability of the specimens.

2. Description of Test Specimens

The test specimens were of the cleanable viscous impingement type and were manufactured and supplied for this test by the Farr Company of Los Angeles, California.

The filters were identified as types 44, 1-in. thick and 2-in. thick, type FS 304, 1-in. thick, and type FS 504, 2-in. thick. The filters measured 19 1/2 in. square on the outside and the face area of the media was 18 1/4 in. square, giving them a net face area of 2.31 sq ft. The types 44 had an actual thickness of 1 in. and 2 in., respectively; type FS 304 was 7/8 in. thick and type FS 504 was 1 7/8 in. thick. The type 44 was also marked "Industrial Filter".

The frames of all filters were made of aluminum sheet pressed into U-shaped channels. The thickness of the material in the frame of the type 44, 2 in. thick, filter was 0.070 in.; all other frames were made of 0.044 in. thick sheet.

The filtering media of the 1-in. thick type 44 filter consisted of 9 layers of V-crimped 14-mesh screen wire, the crimps running at 90 degrees to each other in adjacent layers. The weight of the new filter was 6 lbs (2718 g), oiled and ready for use.

The media of the 2 in. thick type 44 filter was made of 2-in. wide strips of V-crimped and flat screen wire piled up in alternate layers with approximately four layers of each kind per inch of thickness. The weight of this filter, oiled and ready for use, was 10 lbs 6 oz (4725 g), new.

The 1-in. thick FS 304 type had 2 layers of V-crimped 14-mesh screen wire placed with the crimps at 90 degrees to each other in the two layers and with a flat layer of the same material on the downstream side.

The filter media of the 2-in. thick FS 504 type consisted of 3 layers of V-crimped 14-mesh screen wire, with the crimps running at 90 degrees to each other in adjacent layers, followed by one layer of V-crimped 8-mesh screen wire and a layer of flat 14-mesh screen wire, on the downstream side.

An adhesive, furnished by the manufacturer and designated as "Green B Loom 100", was used for all tests. The filters were immersed in the liquid and then drained for at least 16 hours before starting a test.

3. Test Method and Procedure

The performance of the filters was determined at 360 ft/min and 540 ft/min face velocity corresponding air flow rates of 816 cfm and 1224 cfm, respectively. The initial pressure drop at each air velocity was measured and then the initial arrestance at the air velocity desired for that test was determined using the NBS "Dust Spot Method" as described in the paper, "A Test Method for Air Filters," by R. S. Dill, (ASHVE Transactions, Vol. 44, p. 379, 1938).

The aerosol used for the arrestance determinations was an air-suspension of Cottrell precipitate which had been sifted through a 100-mesh wire screen. In order to simulate actual operating conditions when loading the filters, four percent by

weight of No. 7 cotton linters, previously ground in a Wiley mill with a four-millimeter screen were fed simultaneously with the Cottrell precipitate.

The pressure drop of the filter was recorded after each increment of 20 grams of dust introduced into the apparatus.

Whereas the arrestance measurements were made with 100 percent Cottrell precipitate, cotton linters were added to retain a ratio of four parts by weight to every 96 parts of Cottrell precipitate, including that amount used for the arrestance measurements.

Arrestance determinations were made at the beginning and at the end of the loading period for each filter and at several intermediate load conditions. The filters were loaded with a dust concentration of approximately 1 gram in 1000 cu ft of air until the pressure drop reached 0.5 in. W.G. for the 360 ft/min face velocity tests and 0.8 in. W.G. in the tests with 540 ft/min face velocity.

After the filters had been loaded to capacity they were cleaned with water and allowed to dry; then, oiled again as previously described, weighed and installed in the test apparatus for determining any change in pressure drop and in some cases for a new performance test.

4. Test Results

Tables 1 through 8 show the observed pressure drops and the arrestance values for the four filters. The asterisks (*) behind values of arrestance indicate that these values are the average of two test runs.

Table 1

Performance of Type 44 Filter (2 in. thick) at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.045	-
3	0.046	59*
54	0.067	61*
122	0.092	63
173	0.130	64
223	0.198	68
274	0.319	-
315	0.515	80*

Table 2

Performance of Type 44 Filter (2 in. thick) at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.117	-
3	0.118	60*
49	0.156	63*
139	0.218	68*
220	0.335	74
265	0.480	75
310	0.710	81*
325	0.855	81*

Table 3

Performance of Type 44 Filter (1 in. thick) at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.070	-
3	0.073	60*
54	0.160	66
84	0.275	-
105	0.417	77
125	0.610	83*

Table 4

Performance of Type 44 Filter (1 in. thick) at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.143	-
7	0.148	63*
49	0.260	71
94	0.485	76
116	0.725	-
133	0.883	82*

Table 5

Performance of Type FS 504 Filter (2 in. thick) at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.040	-
3	0.042	49*
54	0.065	50
105	0.102	57
156	0.168	63
207	0.325	70
233	0.535	77*

Table 6

Performance of Type FS 504 Filter (2 in. thick) at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.075	-
5	0.076	50*
68	0.136	55
123	0.215	60
177	0.330	62
231	0.518	64
272	0.815	65*

Table 7

Performance of Type FS 304 Filter (1 in. thick) at 360 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.022	-
3	0.023	42*
37	0.042	47
80	0.085	50
126	0.156	55
168	0.340	66
190	0.575	77*

Table 8

Performance of Type FS 304 Filter (1 in. thick) at 540 ft/min Face Velocity

Load g/sq ft	Pressure Drop in. W.G.	Arrestance %
0	0.055	-
3	0.055	43*
57	0.110	48
114	0.215	48
159	0.395	52
177	0.515	53
204	0.835	57

The preceding tables show the arrestance values and the pressure drop as a function of dust load per square foot of net filter area at face velocities of 360 ft/min and 540 ft/min. Fig. 1 to 4 present these same values graphically using smooth curves to approximately fit the individual points of observation.

Fig. 1 to 4 show that both the pressure drop and the arrestance of all four models increased with increasing dust load, but the rate of increase varied considerably.

The dust load indicated by these graphs at 0.5 in. W.G. pressure drop for 360 ft/min face velocity and at 0.8 in. W.G. for 540 ft/min face velocity have been tabulated in Table 9 as

Dust Holding Capacity. Also shown in this table are the mean arrestance values for each filter and each face velocity during the period in which the capacity dust load was being deposited.

Table 9

Dust Holding Capacity and Mean Arrestance

Type of Filter	44		44		FS 504		FS 304	
Thickness of Filter, inch	2		1		2		1	
Face Velocity, ft/min	360	540	360	540	360	540	360	540
Final Pressure Drop, in. W.G.	0.5	0.8	0.5	0.8	0.5	0.8	0.5	0.8
Dust Holding Capacity, grams/sq ft	315	318	113	124	233	270	187	200
Mean Arrestance, %	66	70	69	73	59	59	54	49

This table shows that the dust holding capacity of the 2-in. thick filters is higher than that of the 1-in. thick ones. The difference, though, is considerably greater for the two Type 44 filters where the mean arrestance of the 1 in. specimen was a little higher than that of the 2 in. filter. This is probably the result of differences in the construction of the two filters. Whereas the 2-in. thick filter media provided for dust collection in the whole depth of the filter, the 1-in. Type 44 collected a heavy surface layer of lint that increased the pressure drop rather rapidly but also improved its arrestance. The Type FS filters contained fewer layers of screen wire than the Type 44 filters which caused a larger amount of the dust introduced into the duct to pass the filters. The fact that the arrestance determined on the Type 44 filters was higher at 540 ft/min face velocity than at 360 ft/min indicates that this type is well suited for the higher velocity. The FS 504 (2 in. thick) showed equal arrestance at the two face velocities. The arrestance of the FS 304 type (1 in. thick) decreased from 54 percent at 360 ft/min to 49 percent at 540 ft/min perhaps because the higher velocity carried more of the dust particles through the two layers of crimped wire screen and one layer of flat screen comprising its media.

The cleanability of the filters is indicated by comparing the weights and pressure drops after several loading and cleaning cycles with the original values when new. Table 10 shows these values for the oiled and drained filters for both face velocities.

Table 10

Cleanability of Filters

Type and Condition of Filter	Weight grams	Pressure Drop, in. W.G. 360 ft/min	540 ft/min
Type 44 (2 in. thick)			
New	4725	0.045	0.095
After 1 loading and cleaning	4763	0.046	0.105
After 2 loadings and cleanings	4867	0.052	0.105
Type 44 (1 in. thick)			
New	2718	0.070	0.140
After 1 loading and cleaning	2740	0.070	0.135
After 2 loadings and cleanings	2748	0.070	0.143
Type FS 504 (2 in. thick)			
New	2677	0.041	0.083
After 1 loading and cleaning	2687	0.036	0.075
After 2 loadings and cleanings	2687	0.040	0.080
Type FS 304 (1 in. thick)			
New	1622	0.023	0.046
After 1 loading and cleaning	1652	0.022	0.055
After 2 loadings and cleanings	1640	0.023	0.055

All filters increased in weight by about one percent as a result of two loadings and two cleanings. This increase ranged from 18 to 42 grams for the four specimens. In some cases the pressure drop increased a little after two loadings and two cleanings and in other cases it did not increase.

FARR TYPE 44 (2 INCH THICK)

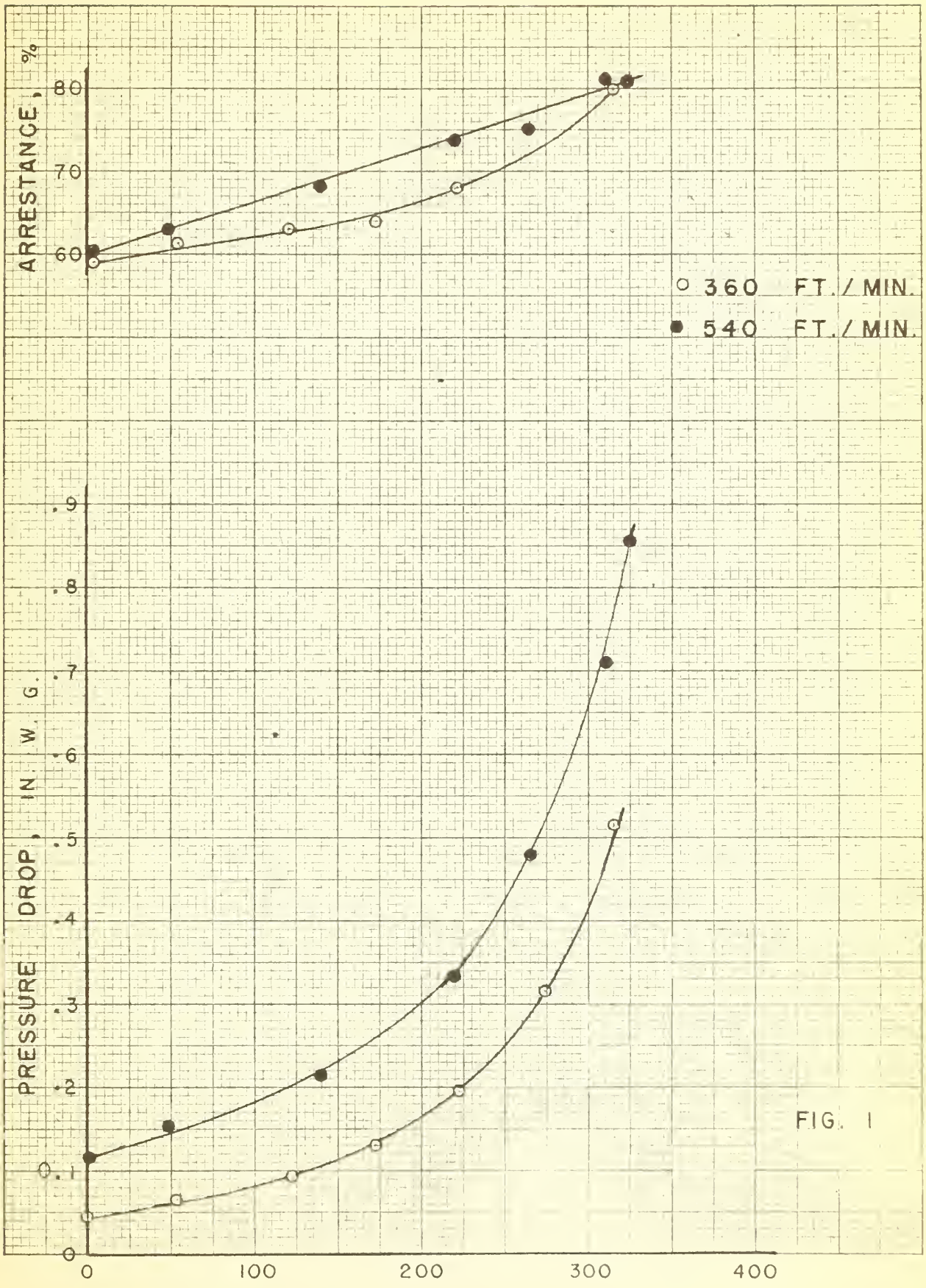


FIG. 1

FARR TYPE 44 (| INCH THICK)

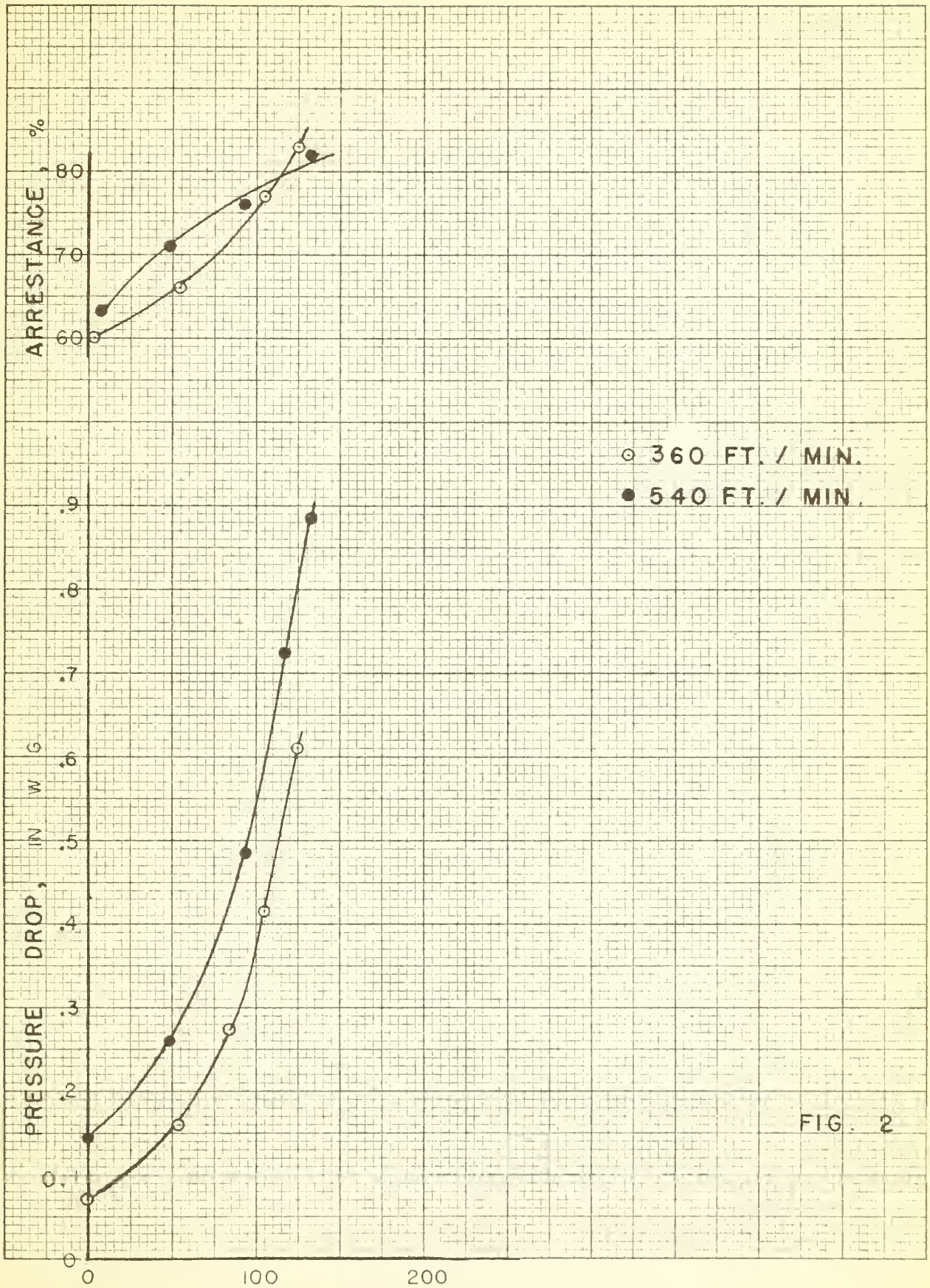


FIG. 2

FARR TYPE F-S 504 (2 INCH THICK)

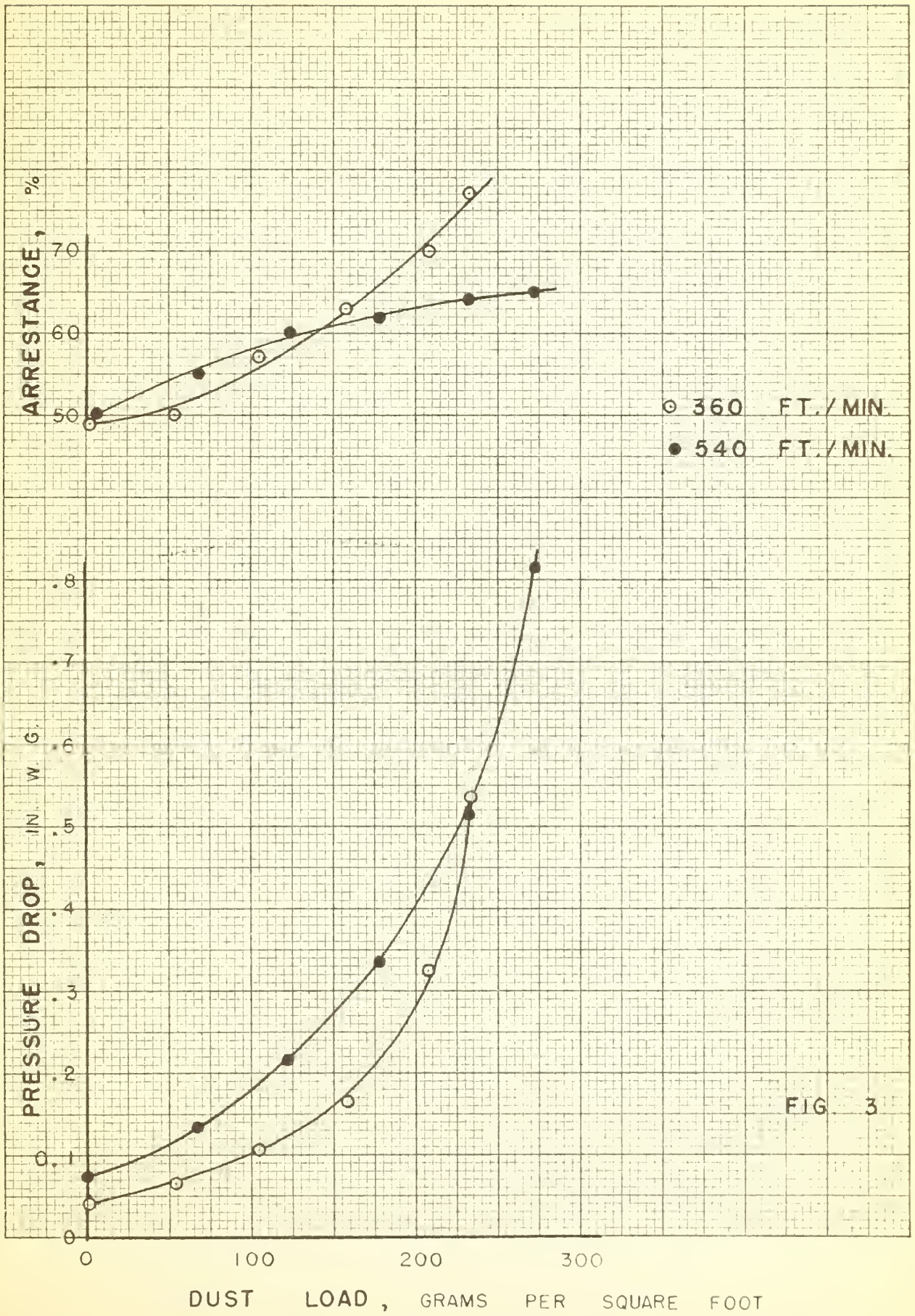
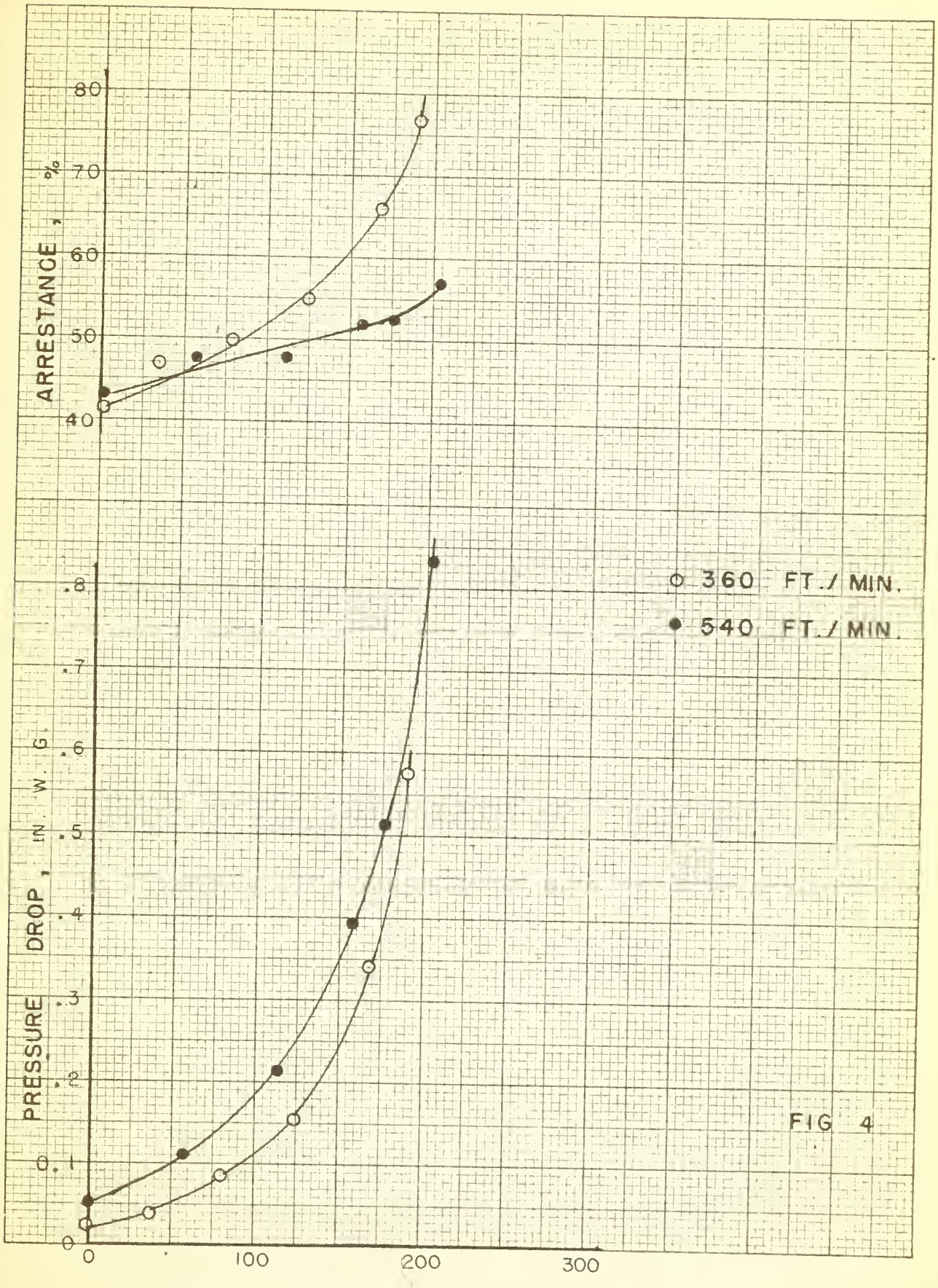


FIG. 3

FARR TYPE F-S 304 (1 INCH THICK)



DUST LOAD, GRAMS PER SQUARE FOOT

FIG 4

U. S. DEPARTMENT OF COMMERCE
Lewis L. Strauss, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

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Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

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