THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Elmer John Forsberg for the degree of Mechanical Engineer They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Mechanical Engineer.

John J. Flather
Chairman

Frank B. Rowley

E. L. Tuve

Date June 24, 1922

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John J. Flather
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E. L. Tuve

Date June 24, 1922

# The Effect of the Length of Pipe on the Distribution of Air in the Test of Fans and Blowers

A Thesis

Submitted to the Faculty of the

Graduate School

of the

University of Minnesota

by

Clarence John Eddy

Elmer John Forsberg

in Partial Fulfillment of the

Requirements for the degree of

Mechanical Engineer

June

1922

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ACKNOWLEDGEMENT

We take pleasure in acknowledging Professor J. J. Flather for the assistance and helpful criticisms given in the thesis.

We also wish to thank Professor F. B. Rowley and Mr. G. L. Tuve for their helpful advice, also, the Assistants in the laboratory for their assistance in setting up the apparatus and for the use of the equipment.

# INTRODUCTION

The effect of the length of pipe on the distribution of air in the test of blowers.

This thesis work, of which Professor J.J. Flather was the advisor, was undertaken by Mr. C.J. Eddy and Mr. E.J. Forsberg to determine the effect of the length used with the distribution of air in that pipe and to devise some method by which the distribution would be equalized. Mr. G. Tuve performed some tests during the summer months of 1921 on the same blower without using the equalizers. Our testswere conducted on the balcony of the Experimental Engineering Building while Mr. Tuve's were conducted in the power plant of the Electrical Engineering Building. Mr. Tuve's tests were conducted using various openings and different sized pulleys on the blower as were ours, but were not carried out with the purpose of equalizing the distribution of the air in the pipe; special attention being paid to the efficiency of the fan and the design of blades and aprons for the blower.

In order to get the most possible out of this work it was thought necessary to spend considerable time looking up information which would have a direct bearing on the work. This information was secured from the libraries of the University and City from books, magazines, journals, and bulletins. Considerable time was spent on material concerning the use of the pitot tube which was very necessary since the largest part of this work consisted of pitot tube readings. After a method of procedure was decided upon and a number of preliminary tests had been run, however, an article was published in the Journal of the American Society of Heating and Ventilating Engineers entitled "Methods of Measuring Fan Delivery" by E.N. Fales, of Dayton, Ohio who was an aeronautical engineer at McCook Field; the tests being run under the war department air service. The fans used in these tests, however, were what was called a Simmons 4 blade fan and was not a rotary fan such as the type used in the research work which is included in this cover.

## OBJECT

The object of this research was pointed out in the introduction. In order to accomplish this work a definite procedure was decided upon and carried out. As has been stated Mr. Tuve carried out a number of experiments along the same line paying more particular attention to the design of blades and aprons for the blower itself. His results were available for us to use but were of little or no value to us as a source of comparison since the tests Mr. Tuve ran were run on the apparatus when it was set up in the forge shop and the Electrical Building with which a different motor was used and also different ammetersand voltmeters. The differential gages used were the same in both cases as was also the special A B C pitot tube.

## APPARATUS

Centrifugal Air Fan manufactured by the Hackney manufacturing Compnay of St. Paul.

Direct Current motor No. 33977 (Northern)

Form C Amperes 19 Speed 1150

Volts 230 H.P. 5

Fort Wayne Electric Works of the General Electric Company Fort Wayne, Indiana.

Rheostat No. 114024 starting service.

H.P. 20 Volts 230

General Electric Compnay U.S.A.

Rheostat No. 43633 Field Servie.

Ohms 75 Amperes 2-4 volts 250

General Electric Company U.S.A.

Field Rheostat

Two Ellison Differential Draft Gages 0-1.5" Pressure.

One Ellison Differential Draft Gae 0-1.0" pressure.

Two pulleys 15" and 24" in diameter for use on the blower.

Pipe 23' - 8" long and 34 inches in diameter with a rectangular fan outlet attachment 2'-1½" by 2'-8¾" and 2'-2'-3" long.

Milli-voltmeter No. 3299

Shunt 25 Ampere

Voltmeter No. 3381

Tubing for draft gages ash shown on the photograph.

Fan outlet openings of approximately 1/2, 5/8, 3/4, and 7/8 of the total area of the opening.

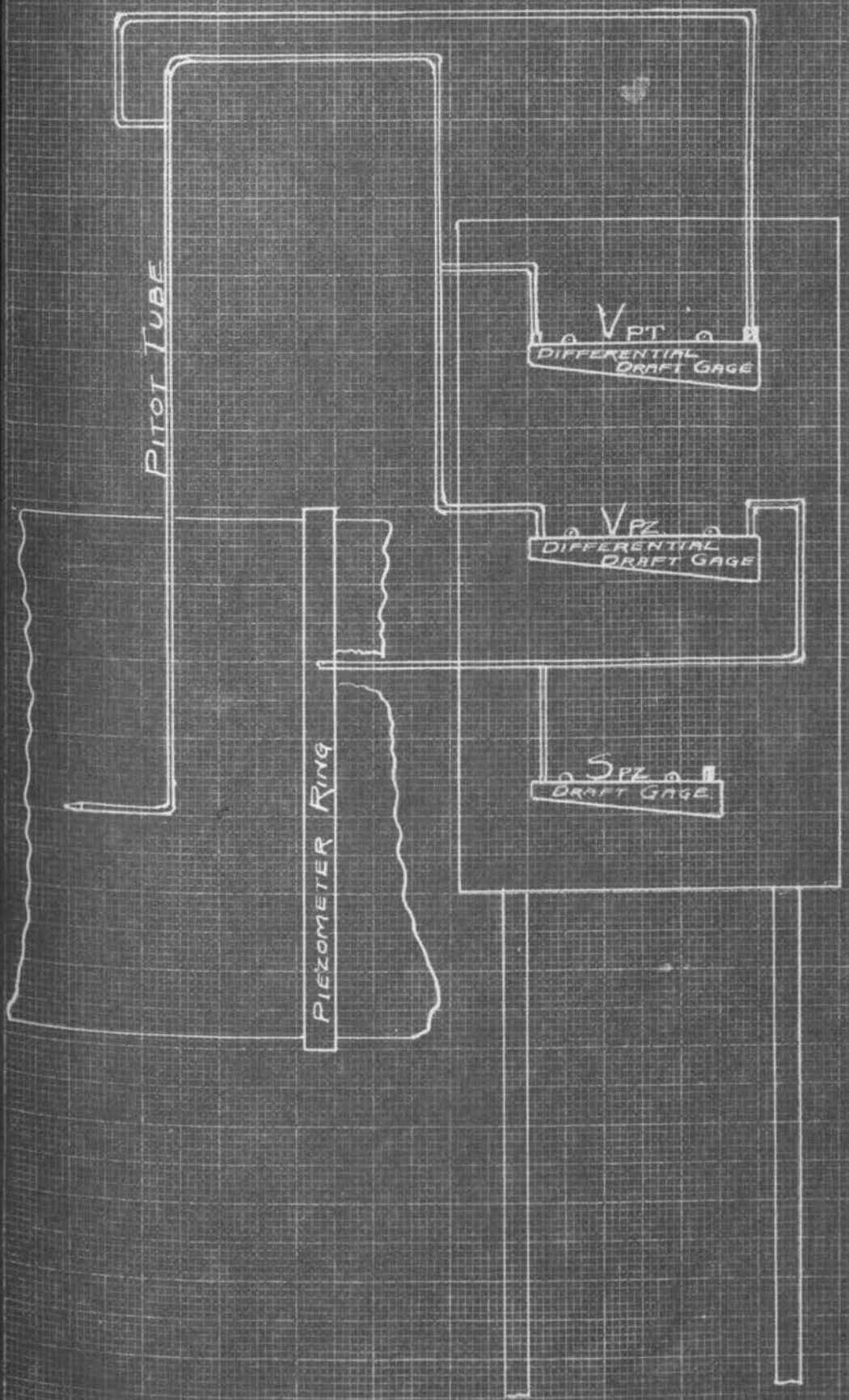
Attachments for pitot tubes with marked distances on them showing the distance that the pitot tube has been inserted in the pipe.

Revolution counter and stop watch.

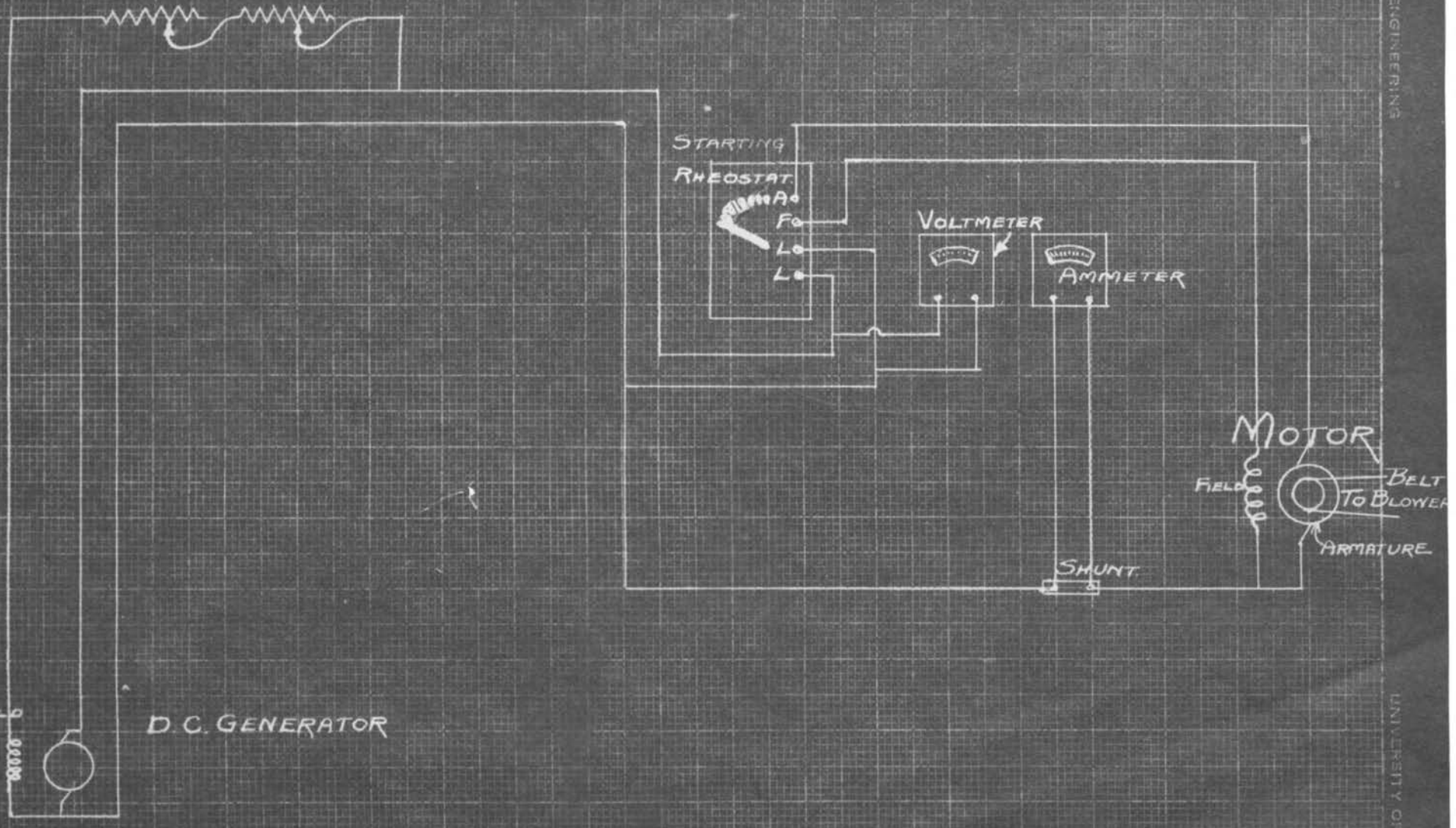
Two equalizers as shown in photograph.

Pitot tube arrangement with draft gages and pipe layout, with wiring diagrams as shown in blue prints.

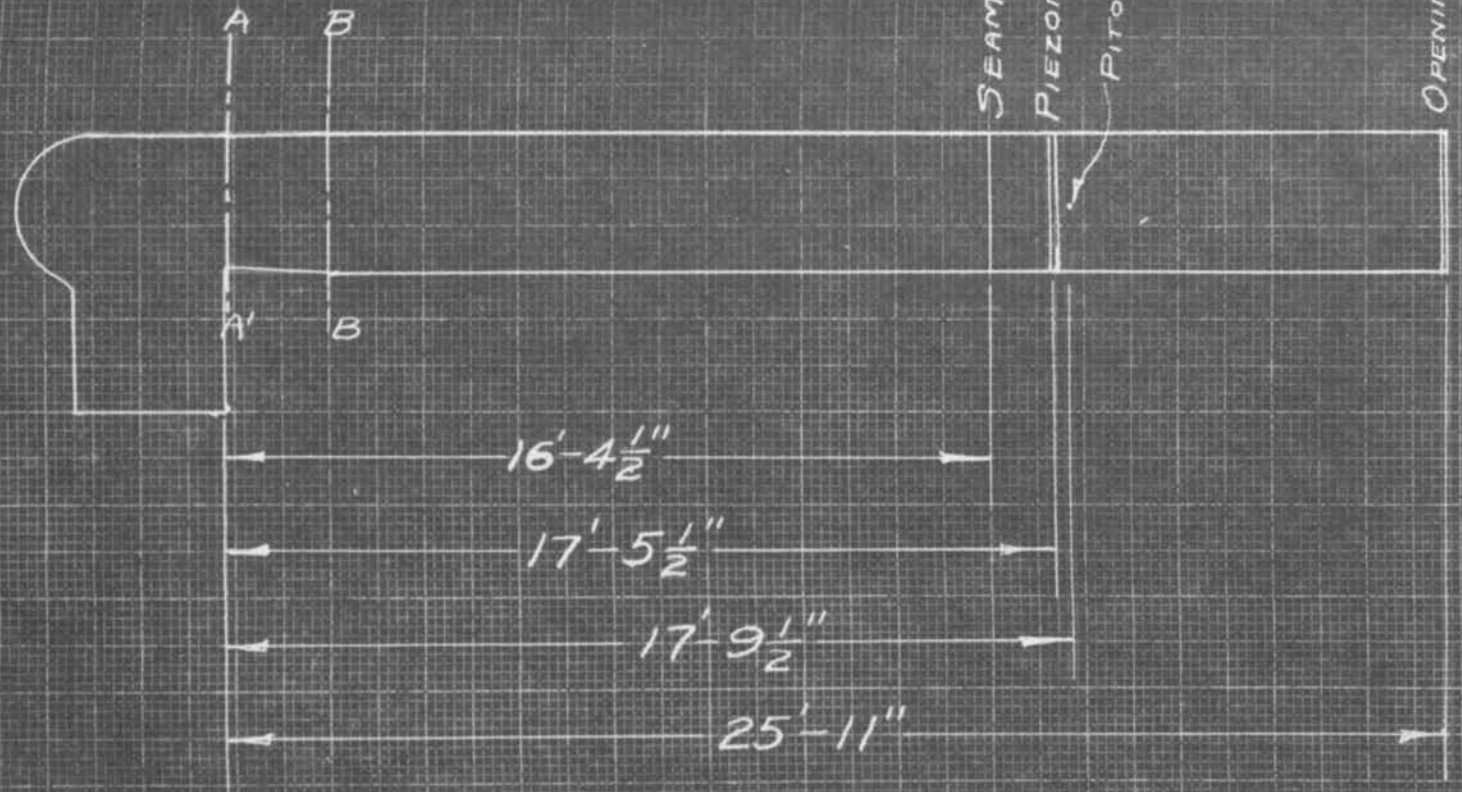
# ARRANGEMENT OF PITOT TUBE AND DRAFT GAGES.



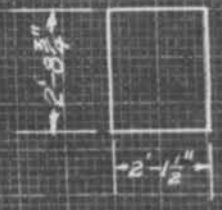
# WIRING DIAGRAM.



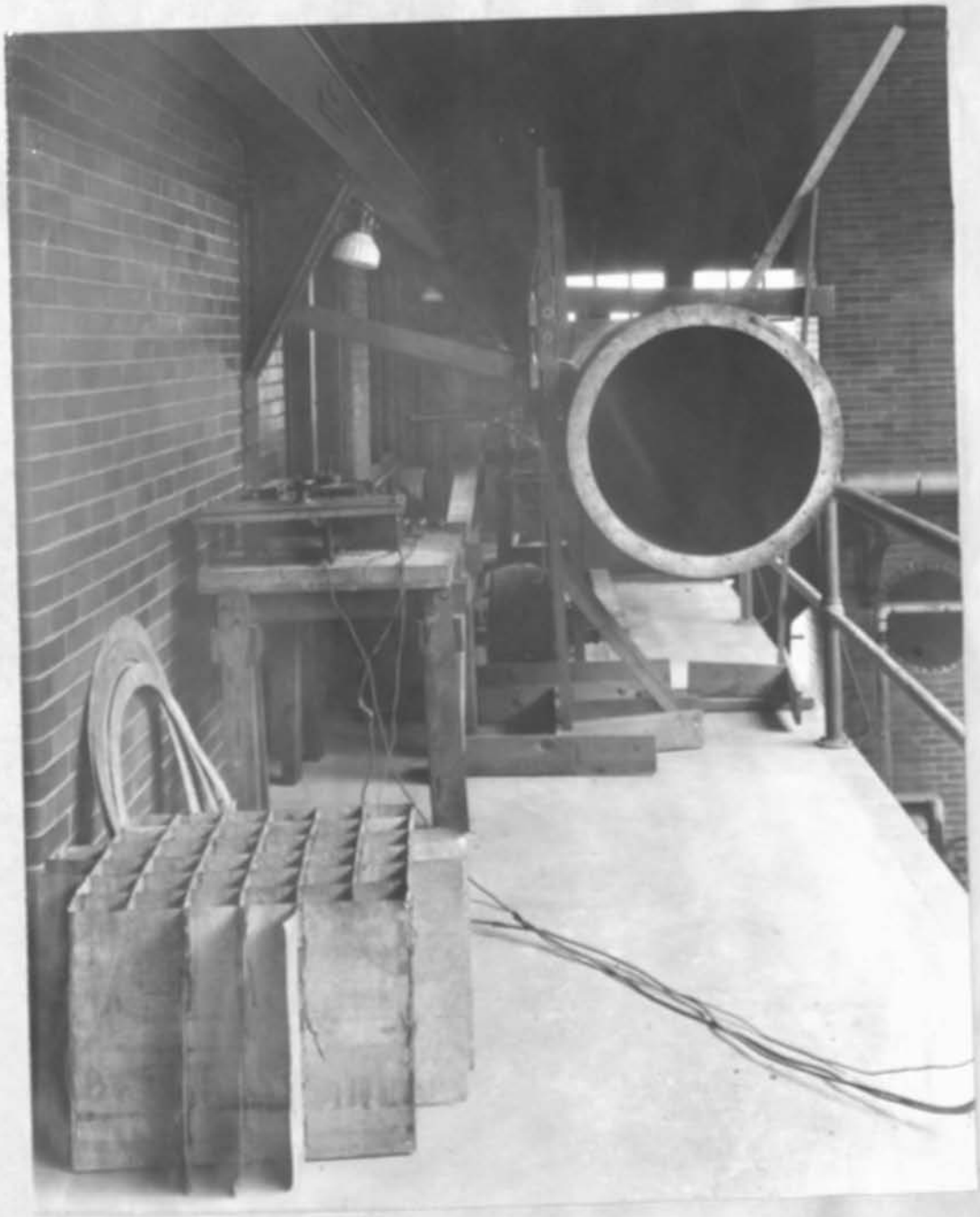
# PIPE LAYOUT FULL LENGTH

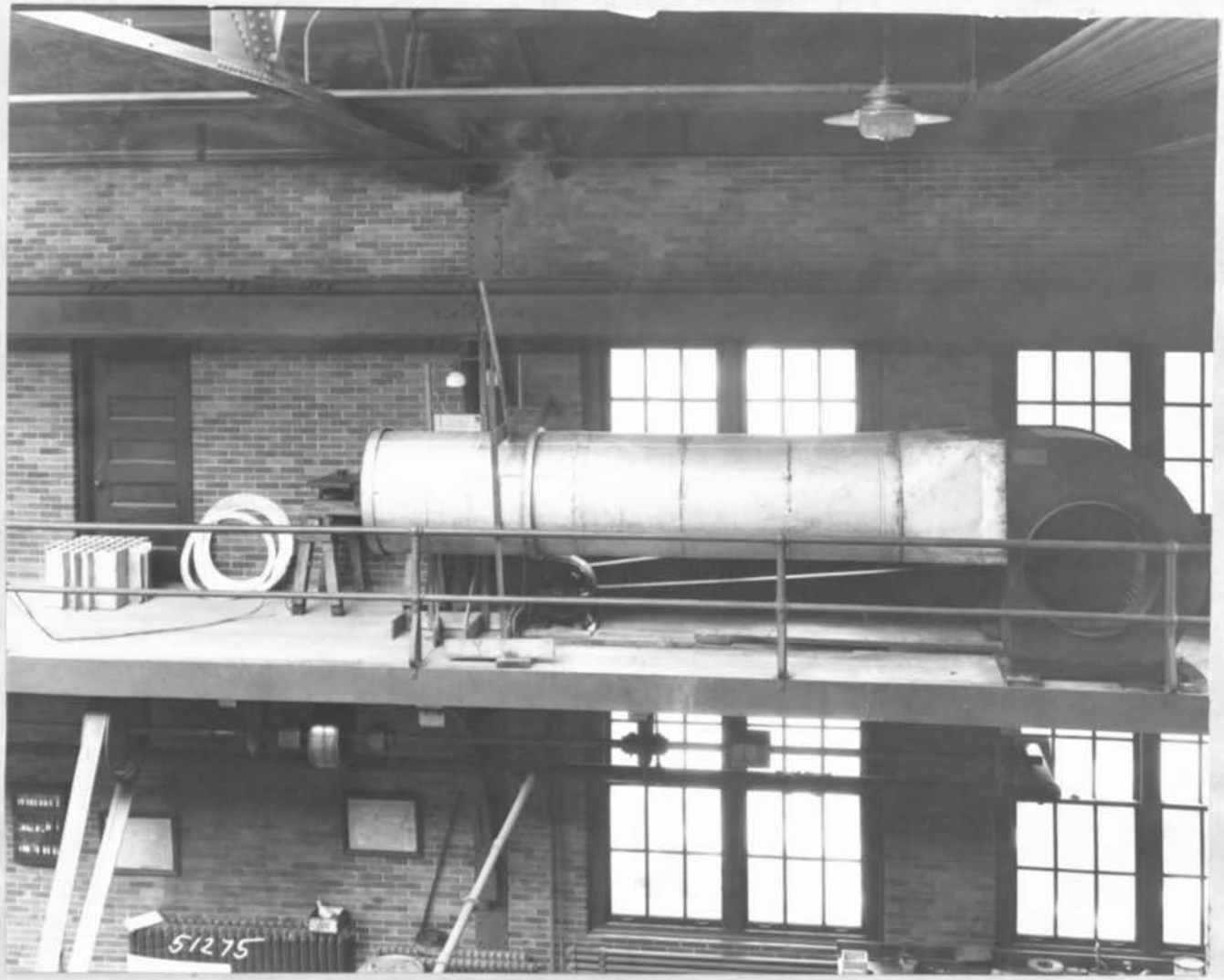



SECTION AA

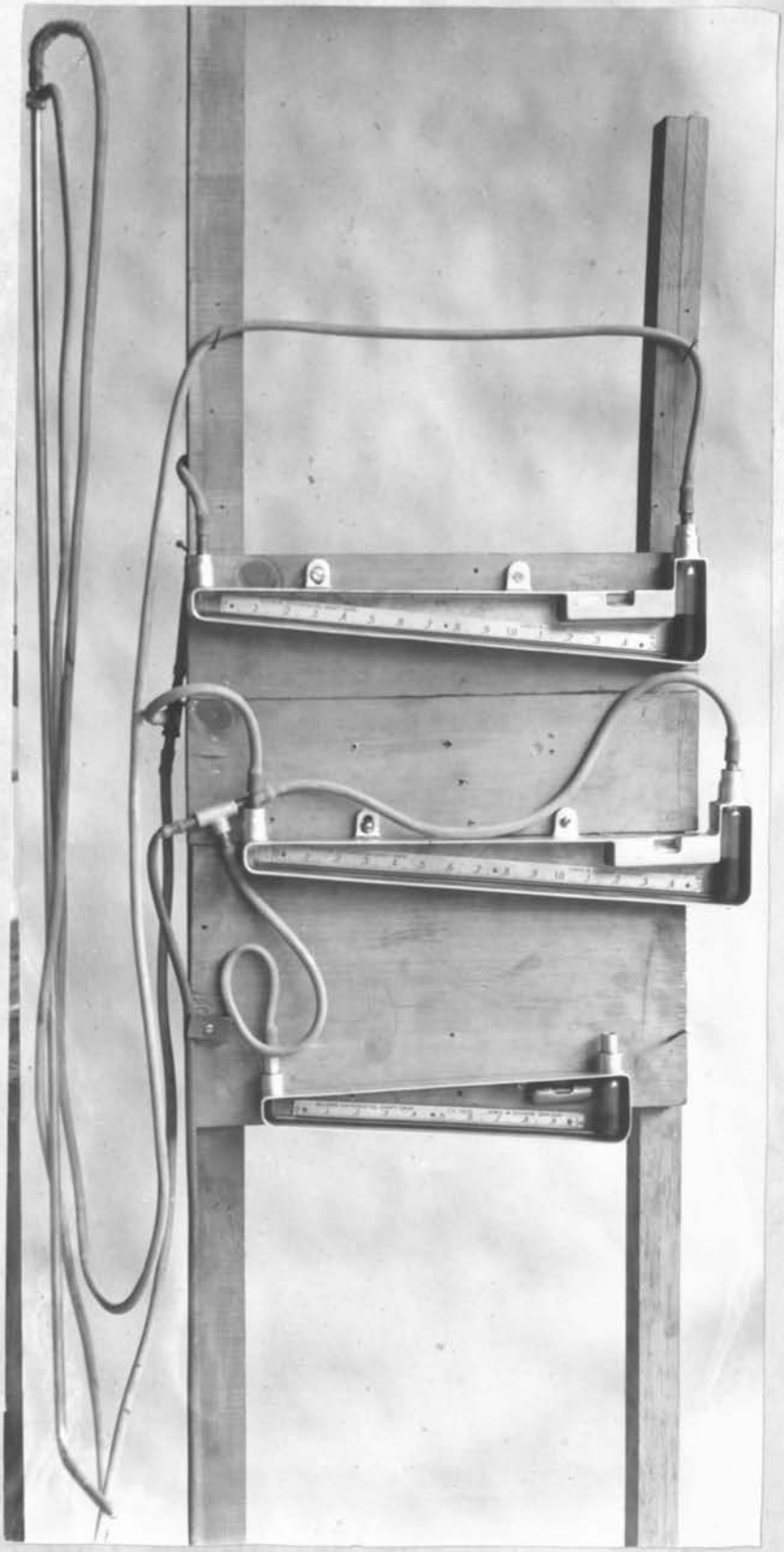


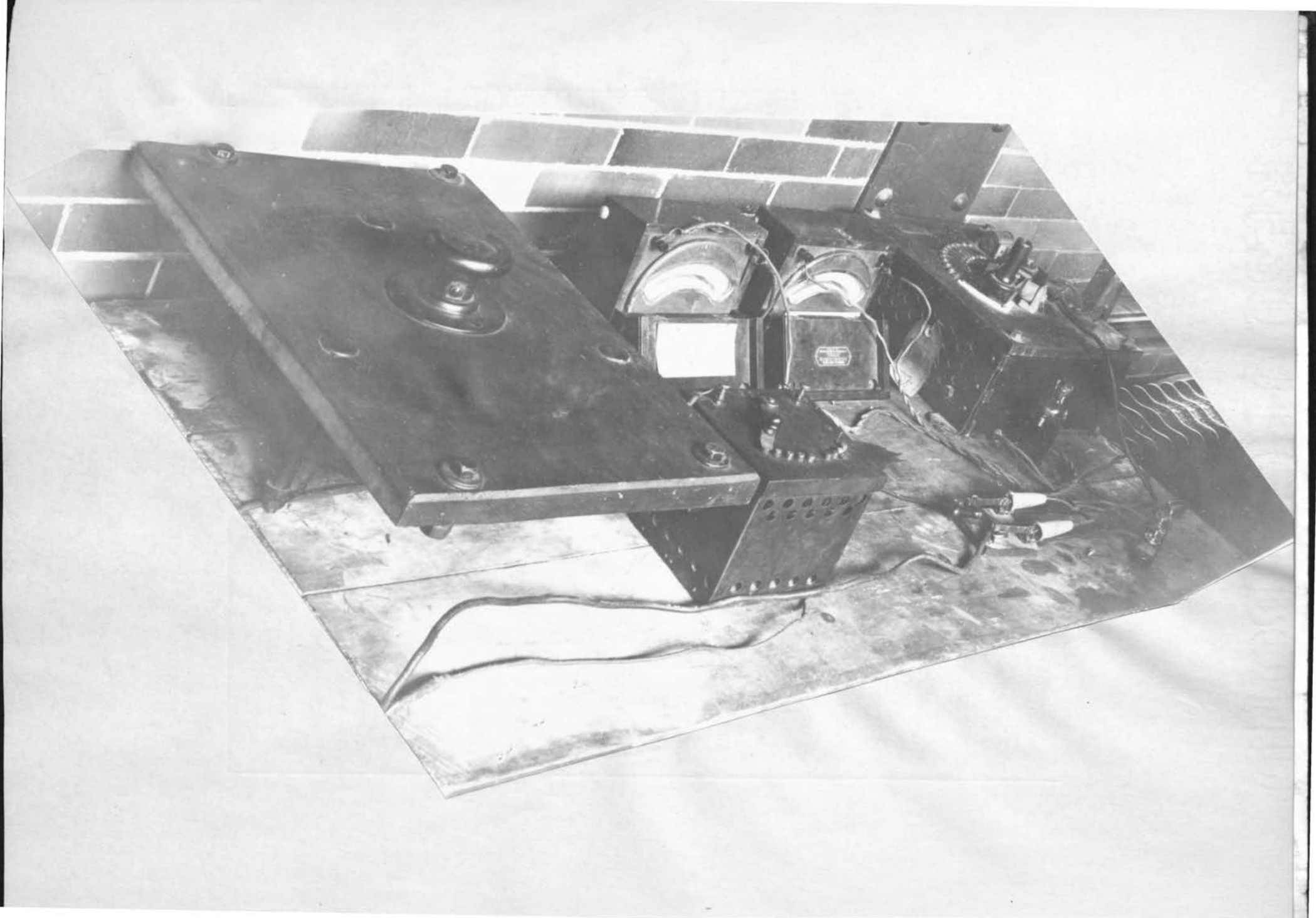

SECTION BB




51275

EQUALIZER.





## GENERAL DESCRIPTION OF TESTS CONDUCTED

The length of pipe necessary for an even distribution of air in that pipe varies from 10 to 40 diameters. By an even distribution of air is meant a distribution so arranged that the maximum velocity is at the center of the pipe and it gradually decreases toward the outside of the pipe. Different authorities give different values for the distance required for this even distribution. In the discussion # by Mr. Taylor it is stated that 10 diameters are required for an even distribution. In his work, Mr. Taylor used some small brass tubes 5/8" (1.58cm), 7/8" (2.22cm), and 1½" (3.81 cm) in diameter. The velocity distribution became constant at a distance of about 200 cm. using these tubes. Using the 3.81 cm tube as a basis of reference a length of tube of approximately 50 diameters would be required in this case. The maximum velocity at the center increased with increasing distance from the fan outlet. This can plainly be seen from the curves which were given for distances of 78.6, 154.5 and 230.7 cm from the fan outlet.

# The Flow of Air Through Small Brass Tubes
T.S. Taylor A.S.M.E. 1920 P. 121

The length of pipe used was 243.6 cm. The velocity at the walls of the tubes dropped off very rapidly and could not be observed. The ratio of the average velocity to the maximum velocity at the distances given above was.82 to .85. This ratio was decreased by the presence of dirt or other material. The coefficient of friction is higher for the low velocities. In an article # published by J.E. Emswiller ~~he~~ states that the velocity at the center is ahead at 40 diameters.

An article # published in the Heating and Ventilating Magazine states that the pitot tube should be placed from 10 to 20 diameters from the fan outlet and the center reading should be multiplied by.8 to get the average velocity. This is about the same constant above referred to using a length of from 10 to 20 diameters.

As stated in Mr. Taylors article an even distribution is obtained by using the 50 diameter pipe. In our work if we used a 40 diameter pipe to give an even distirbution it would require a 1360" pipe or 113.3'

#A.S. H. & V. E. Vol. 22 P. 537 J.E. Emswiller

# Heating and Ventilating Magazine Feb. 1919 Vol. 16.

This length of pipe would be very expensive and cumbersome to handle. Our problem, then, was to devise some method by which an even distribution could be obtained using a shorter length of pipe. The method which was decided upon upon and finally used was that of using a honeycombed arrangement which was made of 24 gage sheet metal (as shown in the photographs) to break and distribute the air in the pipe. The honey combed arrangement consisted of 4" squares with a lengthof 18". There were approximately six of these squares to a side making a 24" square with a diameter of 34". The three center pices had projecting ends on them.

The pitot tube is the most reliable and accurate instrument for the measurement of the velocity of the air in the pipe. This method is more reliable and accurate than the anemometer method. The anemometer may show an inaccuracy of 10% due to dryness of the bearings. If an anemometer were used it would have to be frequently calibrated. There is no inaccuracy due to the tips of the pitot tube.

Readings were taken of the velocity of the air in the pitot tube using the static in the pitot tube, velocity of air in the pitot tube using the piezometer ring as static, and the static of the piezometer ring. If only one side of the two upper draft gages were used and only the straight connection of the pitot tube the draft gages would record the total pressure. Since the other side of the two upper draft gages were attached to the static of the piezometer ring and pitot tube the differential gages read the velocity of the piezometer and pitot tube. The lower draft gage had only one connectionso that it read only the static of the piezometer ring. This piezometer ring encircles the blower pipe, which has holes inserted in it, so that the static air flowing from the pipe into this piezometer ring is recorded by the draft gage. Twenty readings were taken for each opening. Ten readings were taken across one section of the pipe and ten at right angles to these readings. The openings we used in running these tests were approximately ½ 5/8, ¾ and 7/8.

Readings were taken at equal areas in the pipe. A very simple method # of obtaining the diameters of these areas is by dividing the diameter of the pipe by the square root of twice the number of readings from the center to the outside of the pipe and multiplying by the square root of three, five, etc. for the second, third, etc. readings. Since our pipe was 34" in diameter the first diameter would be 34 divided by the square root of two times five or 10.76". The second diameter would be 10.76 times the square root of three or 18.6".

The blower speed, motor voltage, and amperage were also recorded. The static pressure of the pitot tube may be obtained by adding the static and velocity pressures of the piezometer ring and subtracting the velocity of the pitot tube. In reducing to standard conditions the static pressure varies as the R.P.M. squared. The velocity pressure varies directly as the R.P.M. The horse power at the fan pulley varies as the R.P.M. cubed.

Friction in inches $= \frac{\text{Velocity " times length in feet}}{40 \text{ times diameter in feet}}$

# Measurement of Air in Fan Work C.H. Treat A.S.M.E. P. 1019 Vol. 34 1912

The pressure on the pitot tube equals $\frac{Wv^2}{2g}$ where W is the weight of a cubic foot of air, v is the velocity in feet per second, and g is the acceleration of gravity equals 32.174. One cubic foot of water weighs 62.37 pounds. If i is the manometer reading in inches

$$\frac{Wv^2}{2g} = \frac{i \text{ times } 62.37}{12}$$

$$v^2 = \frac{2i \text{ times } 32.174 \text{ times } 62.37}{12\ W}$$

$v = 18.29\sqrt{\frac{i}{W}}$ Feet per second

$v = 60$ Times $18.29\sqrt{\frac{i}{W}}$ Feet per minute

W, the weight of air, depends upon the pressure, temperature, and moisture content.

A graphical method # of obtaining the mean velocity across any section in the pipe is included in this thesis

Since Mr. Tuve's tests were run under different conditions as above outlined it was deemed wise after a consultation with Professor Flather to run some tests using the full length of pipe with no equalizer as a

# Eng. News By R. Burnham Vol. 54 P. 660

basis of reference. This was done using four different openings of approximately ½, 5/8, 3/4, and 7/8 all at the same fan speed.

After this first series of tests ~~were~~ was made considerable time was spent waiting for the first equalizer which finally came and the second series of tests run were with the full length of pipe and with the equalizer placed 5' 1" from the fan opening.

The next test conducted was with the long length of pipe and with one equalizer placed 7' 1" from the fan opening. These tests were all made with the original length of pipe of 25' 11" and since the investigation being carried on is to find out the effect of the length of pipe on airflow it was next decided to shorten the length of pipe to a 14' 2½" length or about five times the diameter of the pipe.

This was done and a series of tests made; the first being a test with no equalizers in the pipe which could be used as a basic test or for something to refer to.

The next test run was with the short length of pipe with one equalizer placed 5' 1" from the mouth of the fan.

The results from these tests not thought to satisfy the requirements and after another consultation with Professor Flather it was decided that another equalizer would be made and the series of tests with two equalizers run. An order was made for another equalizer but due to financial stringencies of the firm who was to furnish the equipment a lengthy delay occured which slowed up the progress of the investigation, but meanwhile the apparatus was changed back from the short length of pipe to the long length, and a series of tests run with a smaller diameter of pulley on the blower which changed the speed considerably.

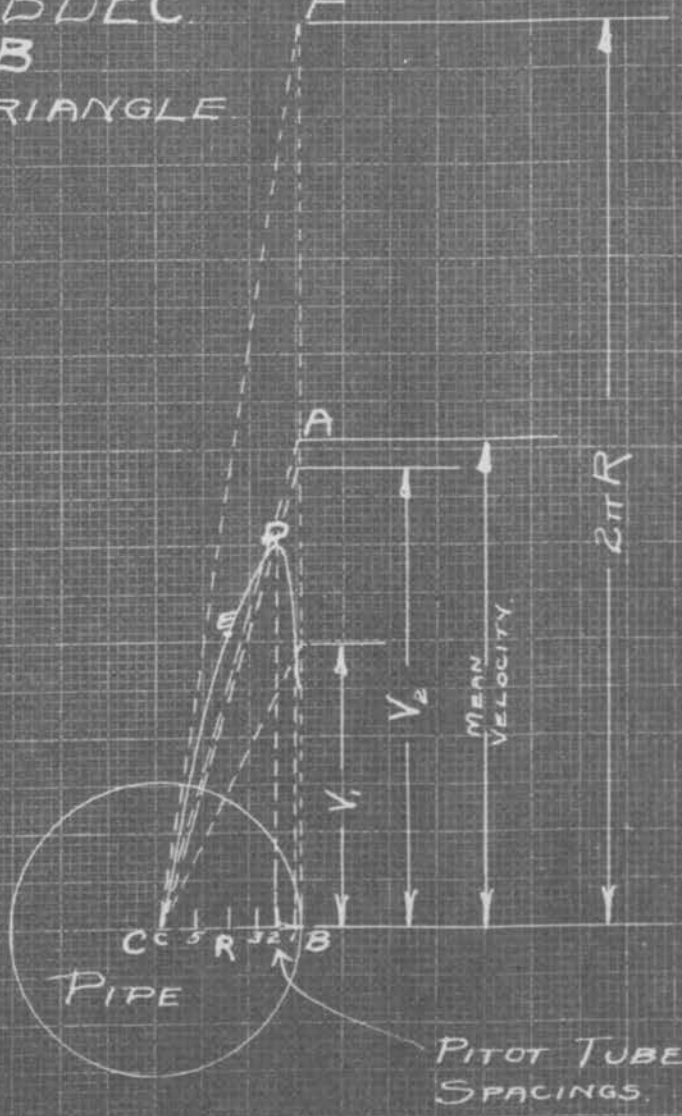
The first test run with the higher speed, as before were basic tests with no equalizers. By this time the second equalizer had been completed so that the next test that was run was a test with two equalizers placed 5' 1" and 13' 2" from the mouth of the blower.

Another set of tests ~~were~~ who run partly for the purpose of checking former results. This set of tests was run with a short length of pipe. Four tests being made with no equalizer, four with equalizers spaced 2' 3" from fan opening, four with equalizers spaced 6'7" from fan opening and final four tests being run with two equalizers the first being spaced 2' 3" from fan opening, the second 6' 7" from fan opening. All four openings were used in these tests and both top and side readings were taken and plotted on graphs. A set of readings was taken with the equalizer blades placed parallel to the fan blades, at an angle of 19 degrees, and at an angle of 45 degrees. The results of these tests were also plotted. In running the set of tests with the two equalizers the blades of the equalizer nearest the fan opening were placed at an angle of 45 degrees while the blades of the second equalizer were left parallel to the fan blades. This was done to get the maximum effect of the distribution of air. This was also done with the set using one equalizer at 45 degrees.

# Graphical Method of Determining The Mean Velocity.

$V_1$, $V_2$, etc. are the Velocity Readings at Points 1, 2, etc. in the Pipe

Area ACB = Area BDEC.
Mean Velocity = AB
Altitude of Triangle
$BF = 2\pi R$.
Area $BCF = \pi R^2$



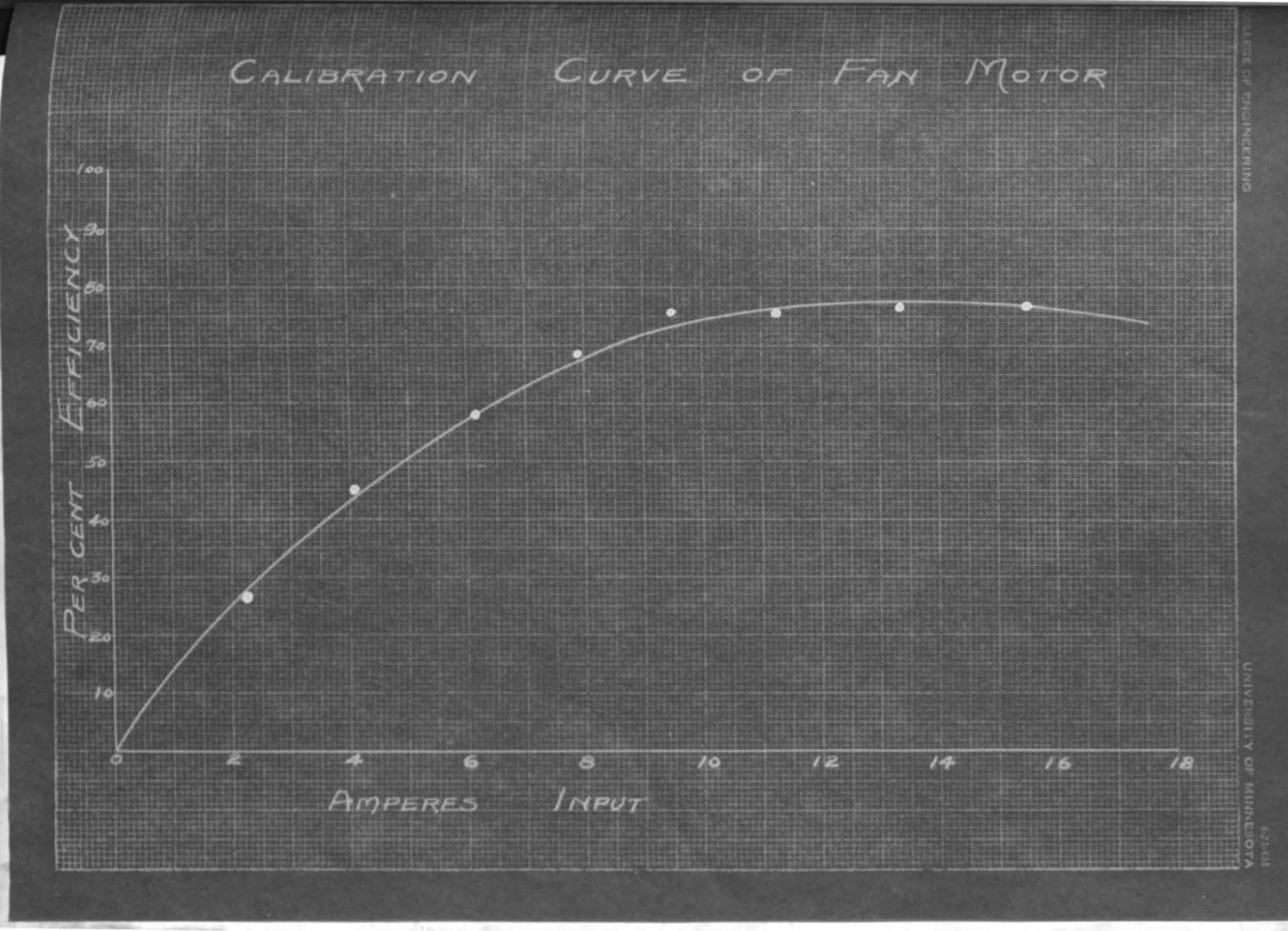

Engineering News Vol. 54 p. 660

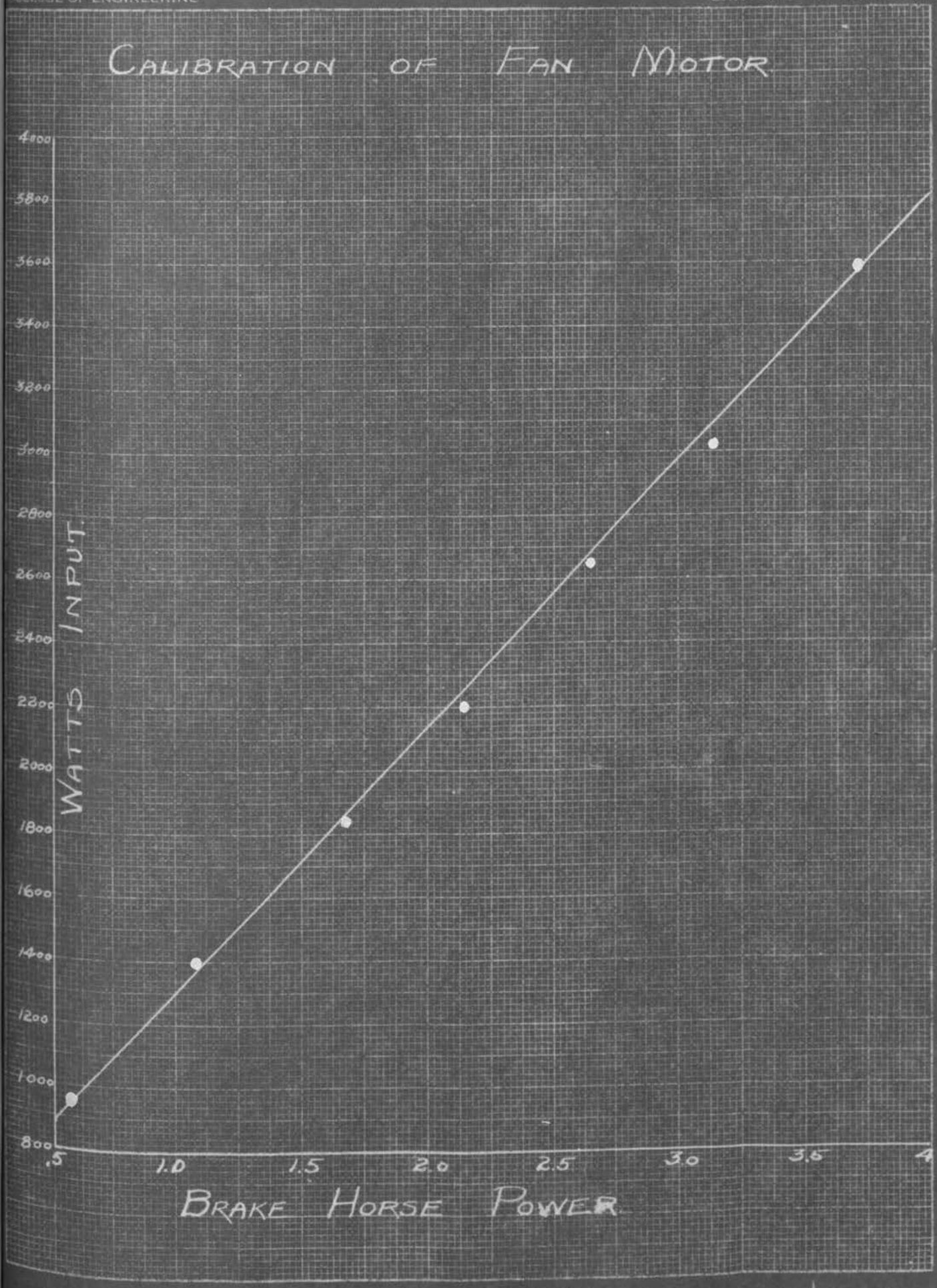
## DATA SHEET FOR MOTOR CALIBRATION

Average Tare Weight 8.86 lbs.

| | R.P.M. | Net Wt. lbs. | Volts Obs. | volts Cor. | Amps. Obs. | Amps. Cor. |
|---|---|---|---|---|---|---|
| 1 | 1090 | 1.00 | 228 | 230.55 | 4.03 | 4.125 |
| 2 | 1085 | 2.00 | 229 | 231.35 | 6.00 | 6.072 |
| 3 | 1095 | 3.00 | 230 | 232.20 | 7.75 | 7.92 |
| 4 | 1078 | 4.00 | 231 | 233.15 | 9.42 | 9.50 |
| 5 | 1058 | 5.00 | 228 | 230.55 | 11.17 | 11.28 |
| 6 | 1060 | 6.00 | 229 | 231.35 | 13.17 | 13.345 |
| 7 | 1060 | 7.00 | 230 | 232.20 | 15.32 | 15.412 |

| | Watts | E.H.P. | W.N. | B.H.P. | Eff. |
|---|---|---|---|---|---|
| 1 | 950 | 1.276 | 1090 | .545 | 42.7 |
| 2 | 1400 | 1.878 | 2170 | 1.085 | 57.8 |
| 3 | 1840 | 2.47 | 3285 | 1.642 | 66.30 |
| 4 | 2210 | 2.97 | 4312 | 2.156 | 75.8 |
| 5 | 2650 | 3.48 | 5290 | 2.645 | 76.0 |
| 6 | 3080 | 4.13 | 6360 | 3.180 | 77.0 |
| 7 | 3580 | 4.80 | 7420 | 3.710 | 77.3 |


CALIBRATION CURVE OF FAN MOTOR
PER CENT EFFIGIENCY
100
90
80
70
60
50
40
30
20
10
0
2
4
6
8
10
12
14
16
18
AMPERES INPUT
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA


CALIBRATION OF FAN MOTOR
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
WATTS INPUT
.5
1.0
1.5
2.0
2.5
3.0
3.5
4
BRAKE HORSE POWER

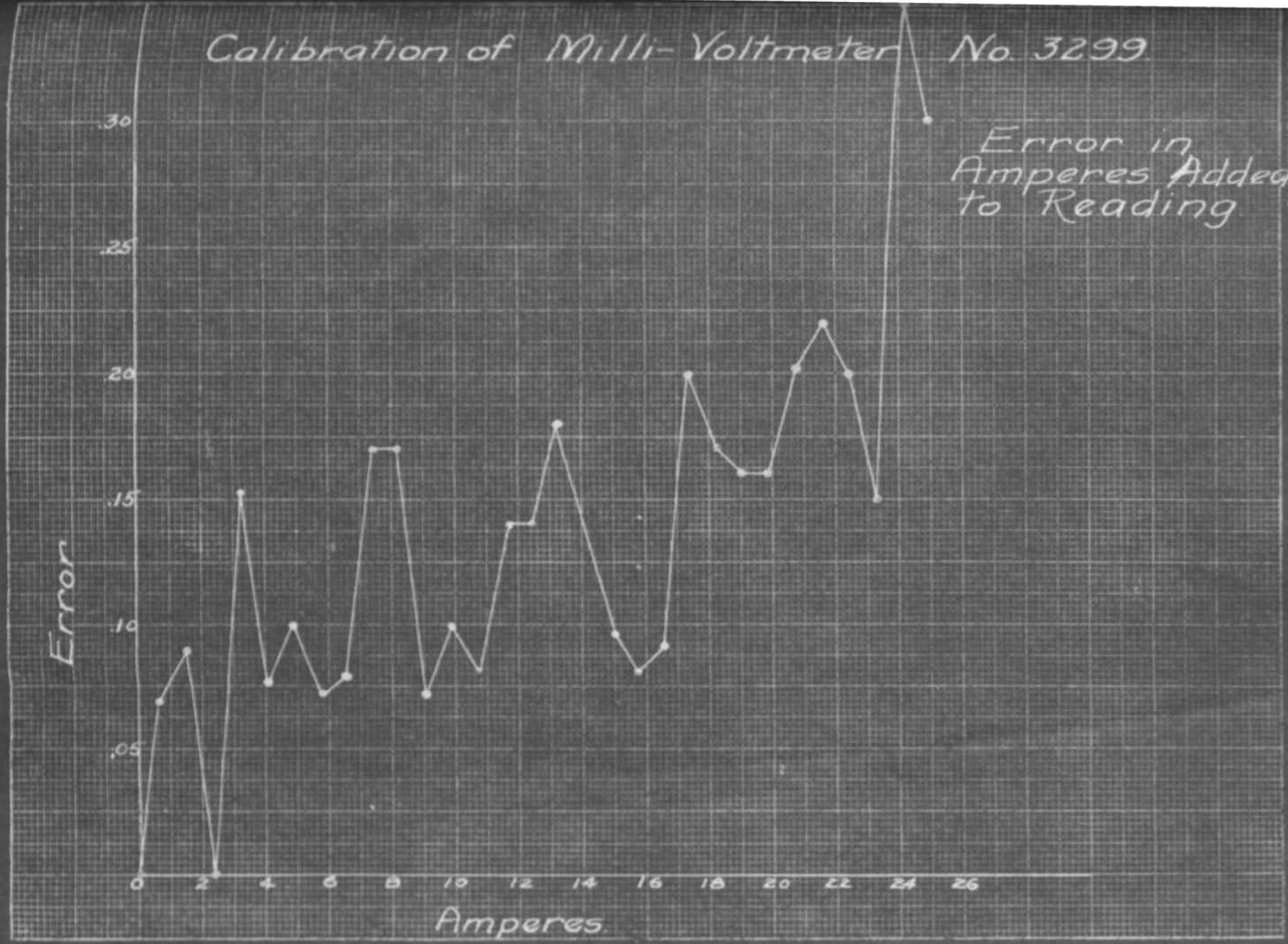
## Calibration of Instruments

Ammeter # 3299

| Standard | #3299 | Error |
|---|---|---|
| .9 | 10 | .067 |
| 1.75 | 20 | .087 |
| 2.50 | 30 | 000 |
| 3.35 | 40 | .015 |
| 4.25 | 50 | .080 |
| 5.10 | 60 | .100 |
| 5.90 | 70 | .070 |
| 6.75 | 80 | .080 |
| 7.67 | 90 | .170 |
| 8.50 | 100 | .170 |
| 9.25 | 110 | .070 |
| 10.10 | 120 | .100 |
| 10.90 | 130 | .080 |
| 11.80 | 140 | .140 |
| 12.64 | 150 | .140 |
| 13.50 | 160 | .180 |
| 14.30 | 170 | .140 |

30 ampere shunt #8349 56-10

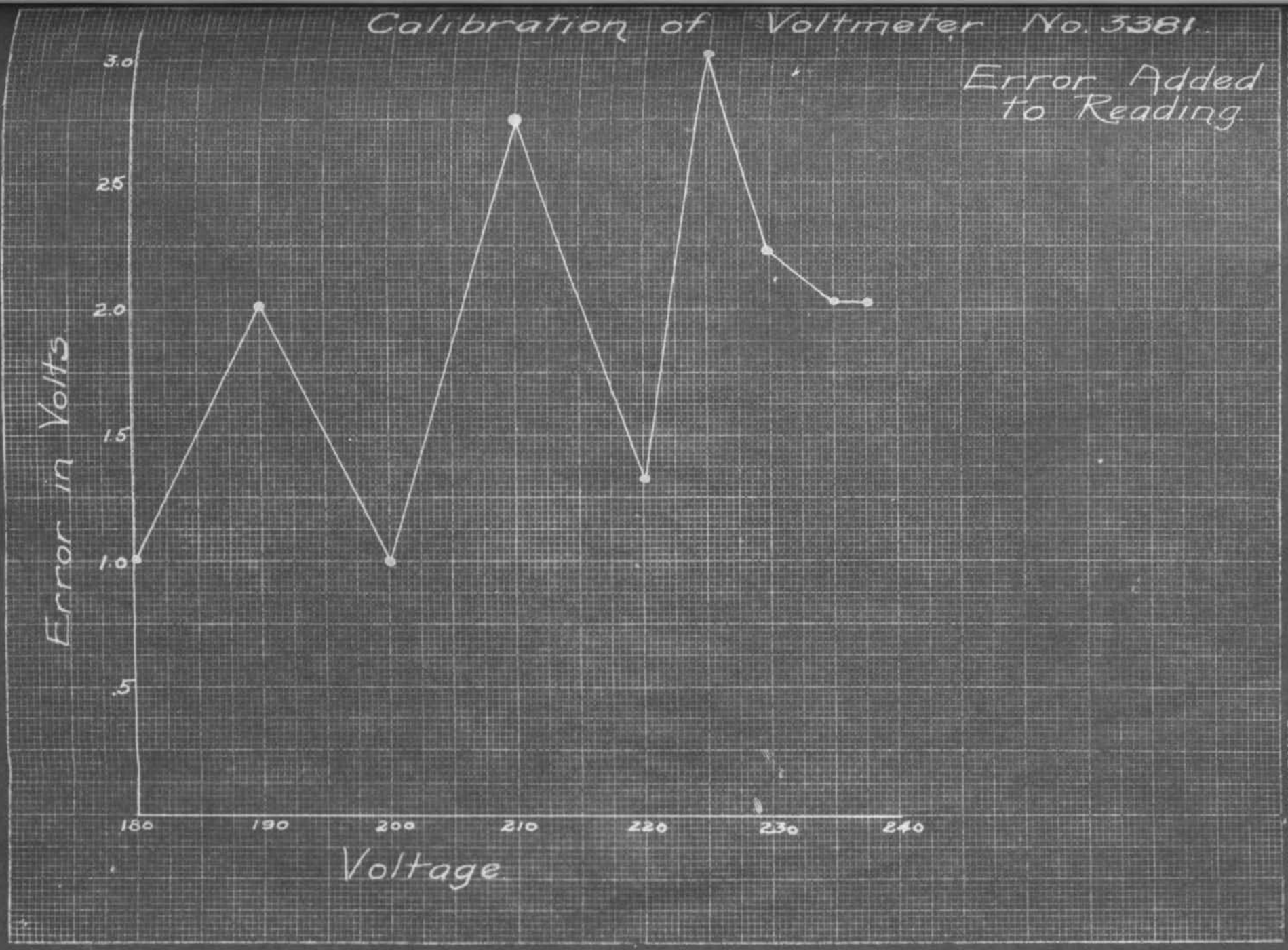
| Standard | #3299 | Error |
|---|---|---|
| 15.10 | 180 | .100 |
| 15.90 | 190 | .080 |
| 16.76 | 200 | .090 |
| 17.70 | 210 | .200 |
| 18.50 | 220 | .170 |
| 19.33 | 230 | .160 |
| 20.16 | 240 | .160 |
| 21.00 | 250 | ..20 |


Calibration of Milli-Voltmeter No. 3299
Error in Amperes Added to Reading
Error
.30
.25
.20
.15
.10
.05
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Amperes
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA

Calibration of Instruments (con't)

Voltmeter #3381

| Standard | #3381 | Error |
|---|---|---|
| 201 | 200 | 1.0 |
| 212.7 | 210 | 2.7 |
| 221.3 | 220 | 1.3 |
| 232.2 | 230 | 2.2 |
| 240.0 | 238 | 2.0 |
| 237.0 | 235 | 2.0 |
| 228.0 | 225 | 3.0 |
| | | |
| 192.0 | 190 | 2.0 |
| 181.0 | 180 | 1.0 |


Calibration of Voltmeter No. 3381.
Error Added to Reading
Error in Volts
3.0
2.5
2.0
1.5
1.0
.5
180
190
200
210
220
230
240
Voltage
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA

FAN TEST NUMBER 1 May 8, 1922.

1/2 Opening Length of pipe 23 ft.

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 230 | 210/12 | 395 |
| 2nd | 230 | 210/12 | 395 |
| Av. | 230 | 17.5 | 395 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.002 | +.001 | .000 | | -.002 | +.001 | .000 |
| 1 | .166 | .195 | 1.500 | 1 | .130 | .132 | 1.542 |
| 2 | .196 | .222 | 1.501 | 2 | .175 | .166 | 1.538 |
| 3 | .219 | .238 | 1.501 | 3 | .191 | .181 | 1.543 |
| 4 | .228 | .247 | 1.502 | 4 | .200 | .198 | 1.544 |
| 5 | .230 | .244 | 1.503 | 5 | .215 | .207 | 1.543 |
| 6 | .171 | .176 | 1.500 | 6 | .230 | .212 | 1.543 |
| 7 | .136 | .140 | 1.504 | 7 | .221 | .220 | 1.539 |
| 8 | .125 | .129 | 1.506 | 8 | .218 | .206 | 1.535 |
| 9 | .124 | .140 | 1.502 | 9 | .200 | .190 | 1.539 |
| 10 | .081 | .103 | 1.500 | 10 | .150 | .162 | 1.543 |

FAN TEST NUMBER 2 May 9, 1922

5/8 Opening Length of pipe 23 ft.

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 228 | 240/12 | 390 |
| 2nd | 228 | 243/12 | 392 |
| Av. | 228 | 20.25 | 391 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.002 | -.001 | .000 | | -.002 | -.001 | .000 |
| 1 | .300 | .325 | 1.230 | 1 | .314 | .325 | 1.252 |
| 2 | .290 | .310 | 1.228 | 2 | .386 | .394 | 1.255 |
| 3 | .284 | .286 | 1.229 | 3 | .340 | .331 | 1.250 |
| 4 | .270 | .280 | 1.231 | 4 | .310 | .300 | 1.253 |
| 5 | .275 | .281 | 1.231 | 5 | .300 | .272 | 1.250 |
| 6 | .284 | .271 | 1.231 | 6 | .270 | .240 | 1.250 |
| 7 | .270 | .265 | 1.228 | 7 | .230 | .200 | 1.257 |
| 8 | .245 | .250 | 1.230 | 8 | .195 | .282 | 1.258 |
| 9 | .220 | .230 | 1.232 | 9 | .186 | .199 | 1.261 |
| 10 | .150 | .140 | 1.219 | 10 | .190 | .211 | 1.251 |

FAN TEST NUMBER 3 May 8, 1922

3/4 Opening Length of pipe 23 ft.

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 235 | 282/12 | 391 |
| 2nd | 234 | 282/12 | 393 |
| Av. | 234.5 | 23.5 | 392 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.002 | -.001 | .000 | | -.002 | -.001 | .000 |
| 1 | .382 | .462 | .918 | 1 | .391 | .421 | .933 |
| 2 | .412 | .460 | .920 | 2 | .431 | .447 | .933 |
| 3 | .372 | .397 | .930 | 3 | .462 | .460 | .937 |
| 4 | .358 | .388 | .923 | 4 | .461 | .451 | .938 |
| 5 | .403 | .413 | .929 | 5 | .461 | .437 | .938 |
| 6 | .410 | .390 | .917 | 6 | .372 | .328 | .938 |
| 7 | .357 | .347 | .920 | 7 | .349 | .315 | .938 |
| 8 | .342 | .345 | .922 | 8 | .310 | .309 | .940 |
| 9 | .287 | .321 | .924 | 9 | .341 | .369 | .939 |
| 10 | .202 | .202 | .952 | 10 | .297 | .337 | .932 |

FAN TEST NUMBER 4 May 9, 1922.

7/8 Opening Length of pipe 23 ft.

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 229 | 285/12 | 375 |
| 2nd | 225 | 292/12 | 375 |
| Av. | 227 1/2 | 24.33 | 375 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.001 | -.001 | .000 | | -.001 | -.001 | .000 |
| 1 | .510 | .565 | .593 | 1 | .415 | .442 | .602 |
| 2 | .520 | .558 | .594 | 2 | .490 | .495 | .608 |
| 3 | .480 | .492 | .593 | 3 | .490 | .498 | .607 |
| 4 | .470 | .472 | .596 | 4 | .500 | .471 | .603 |
| 5 | .485 | .470 | .591 | 5 | .520 | .490 | .603 |
| 6 | .440 | .350 | .597 | 6 | .450 | .395 | .609 |
| 7 | .390 | .330 | .596 | 7 | .410 | .475 | .609 |
| 8 | .350 | .341 | .597 | 8 | .408 | .408 | .610 |
| 9 | .290 | .335 | .598 | 9 | .420 | .454 | .610 |
| 10 | .230 | .258 | .598 | 10 | .310 | .370 | .603 |

FAN TEST NUMBER 5 December 15, 1921.

Full Opening Length of pipe 23 ft.

Test run with 1 equalizer 34" from fan opening

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 225 | 142.5/12 | 257 |
| 2nd. | 222 | 142.5/12 | 257 |
| Av. | 223½ | 11.89 | 257 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V. pz. | S pz. | V. pt. | V pz. | S. pz |
| Zero | -.013 | +.030 | +.020 | -.013 | +.030 | +.020 |
| 1 | .113 | .161 | .038 | .541 | .563 | .038 |
| 2 | .139 | .176 | .083 | .491 | .513 | .039 |
| 3 | .155 | .184 | .038 | .407 | .431 | .039 |
| 4 | .200 | .231 | .038 | .310 | .330 | .039 |
| 5 | .221 | .251 | .038 | .230 | .255 | .039 |
| 6 | .211 | .241 | .038 | .227 | .262 | .040 |
| 7 | .282 | .310 | .039 | .291 | .320 | .040 |
| 8 | .310 | .330 | .039 | .408 | .442 | .041 |
| 9 | .303 | .320 | .039 | .440 | .467 | .041 |
| 10 | .181 | .281 | .039 | .377 | .403 | .041 |

FAN TEST NUMBER 6 FEBRUARY 20, 1922

½ Opening Length of pipe 23 ft.

One Equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 92/12 | 280.25 |
| 2nd. | 230.5 | 94/12 | 283 |
| Av. | 230.25 | 7.83 | 281.5 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | −.013 | −.030 | +.020 | −.013 | −.030 | +.020 |
| 1 | .032 | .120 | .695 | .100 | .171 | .697 |
| 2 | .032 | .190 | .691 | .120 | .179 | .696 |
| 3 | .037 | .105 | .686 | .097 | .169 | .697 |
| 4 | .032 | .108 | .689 | .089 | .160 | .698 |
| 5 | .036 | .110 | .688 | .091 | .169 | .698 |
| 6 | .119 | .194 | .686 | .064 | .136 | .697 |
| 7 | .164 | .240 | .692 | .071 | .147 | .692 |
| 8 | .168 | .242 | .692 | .099 | .170 | .698 |
| 9 | .168 | .241 | .692 | .096 | .171 | .699 |
| 10 | .143 | .213 | .699 | .071 | .146 | .707 |

FAN TEST NUMBER 7 FEBRUARY 20, 1922.

5/8 Opening. Length of Pipe 23 ft.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 109/12 | 282 |
| 2nd. | 230 | 109/12 | 283 |
| Av. | 230 | 8.08 | 282.5 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S. pz. | V pt. | V pz. | S pz. |
| Zero | -.013 | +.030 | +.020 | -.013 | +.030 | +.020 |
| 1 | .097 | .171 | .612 | .069 | .147 | .610 |
| 2 | .103 | .178 | .613 | .125 | .194 | .606 |
| 3 | .120 | .199 | .613 | .117 | .197 | .611 |
| 4 | .125 | .201 | .612 | .107 | .192 | .596 |
| 5 | .150 | .230 | .614 | .116 | .196 | .608 |
| 6 | .120 | .200 | .617 | .140 | .225 | .614 |
| 7 | .139 | .217 | .612 | .165 | .248 | .612 |
| 8 | .179 | .251 | .617 | .171 | .259 | .600 |
| 9 | .195 | .269 | .615 | .230 | .319 | .605 |
| 10 | .140 | .209 | .620 | .158 | .235 | .610 |

FAN TEST NUMBER 8 FEBRUARY 20, 1922.

3/4 Opening Length of pipe 23 ft.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 219 | 112/12 | 266 |
| 2nd. | 219 | 112/12 | 266 |
| Av. | 219 | 9.33 | 266 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | −.013 | +.03 | +.02 | −.013 | +.03 | +.02 |
| 1 | .091 | .153 | .419 | .135 | .192 | .418 |
| 2 | .103 | .163 | .419 | .172 | .240 | .412 |
| 3 | .105 | .161 | .420 | .190 | .250 | .412 |
| 4 | .142 | .197 | .420 | .200 | .262 | .415 |
| 5 | .149 | .209 | .420 | .170 | .224 | .414 |
| 6 | .164 | .222 | .420 | .154 | .208 | .419 |
| 7 | .171 | .231 | .421 | .160 | .220 | .418 |
| 8 | .197 | .251 | .420 | .182 | .243 | .417 |
| 9 | .219 | .281 | .423 | .266 | .321 | .419 |
| 10 | .150 | .210 | .420 | .242 | .300 | .416 |

FAN TEST NUMBER 9 FEBRUARY 20, 1922.

7/8 Opening Length of pipe 23 ft.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 229 | 130/12 | 272 |
| 2nd. | 230 | 131/12 | 276 |
| Av. | 229½ | 10.83 | 274 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | -.013 | +.030 | +.02 | −.013 | +.030 | +.02 |
| 1 | .262 | .311 | .318 | .119 | .153 | .314 |
| 2 | .310 | .357 | .321 | .119 | .153 | .314 |
| 3 | .283 | .330 | .321 | .128 | .168 | .313 |
| 4 | .284 | .332 | .321 | .133 | .173 | .314 |
| 5 | .221 | .261 | .321 | .171 | .213 | .313 |
| 6 | .199 | .239 | .321 | .229 | .271 | .315 |
| 7 | .245 | .286 | .322 | .259 | .301 | .316 |
| 8 | .282 | .327 | .322 | .276 | .320 | .316 |
| 9 | .308 | .351 | .322 | .290 | .339 | .317 |
| 10 | .295 | .342 | .322 | .187 | .227 | .317 |

FAN TEST NUMBER 10 FEBRUARY 23, 1922.

½ Opening Length of pipe 23 ft.

One equalizer spaced 7' 1" from fan opening

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 234 | 93/12 | 284 |
| 2nd. | 234 | 98/12 | 280 |
| Av. | 234 | 7.95 | 282 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | o | +.026 | +.029 | o | +.026 | +.029 |
| 1 | .088 | .177 | .699 | .036 | .134 | .679 |
| 2 | .088 | .177 | .700 | .050 | .150 | .682 |
| 3 | .100 | .191 | .704 | .066 | .164 | .677 |
| 4 | .091 | .175 | .706 | .060 | .153 | .678 |
| 5 | .120 | .210 | .699 | .069 | .168 | .688 |
| 6 | .050 | .148 | .701 | .124 | .223 | .698 |
| 7 | .048 | .132 | .704 | .128 | .223 | .690 |
| 8 | .048 | .132 | .703 | .166 | .260 | .689 |
| 9 | .036 | .128 | .705 | .150 | .248 | .688 |
| 10 | .030 | .119 | .690 | .159 | .240 | .699 |

FAN TEST NUMBER 11 FEBRUARY 23, 1922.

5/8 Opening Length of pipe 23 ft.

One equalizer spaced 7' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 225 | 97/12 | 263 |
| 2nd. | 220 | 97/12 | 264 |
| Av. | 222.5 | 7.91 | 263.5 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | −.003 | +.019 | +.019 | −.003 | +.019 | +.019 |
| 1 | .070 | .149 | .517 | .114 | .192 | .530 |
| 2 | .070 | .150 | .520 | .120 | .202 | .527 |
| 3 | .065 | .147 | .525 | .134 | .217 | .527 |
| 4 | .077 | .156 | .520 | .108 | .184 | .529 |
| 5 | .110 | .192 | .522 | .118 | .198 | .530 |
| 6 | .089 | .170 | .520 | .112 | .192 | .523 |
| 7 | .103 | .187 | .522 | .103 | .180 | .533 |
| 8 | .103 | .187 | .521 | .132 | .216 | .530 |
| 9 | .148 | .231 | .530 | .150 | .230 | .531 |
| 10 | .082 | .162 | .521 | .188 | .263 | .525 |

FAN TEST NUMBER 12 FEBRUARY 23, 1922.

¾ Opening Length of pipe 23 ft.

One equalizer spaced 7' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 222 | 108/12 | 262 |
| 2nd. | 219 | 108/12 | 260 |
| Av. | 220.5 | 9 | 261 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | −.003 | +.019 | +.019 | −.003 | +.019 | +.019 |
| 1 | .115 | .170 | .423 | .108 | .163 | .421 |
| 2 | .127 | .174 | .422 | .195 | .253 | .422 |
| 3 | .083 | .140 | .426 | .210 | .268 | .424 |
| 4 | .090 | .152 | .428 | .186 | .243 | .421 |
| 5 | .122 | .188 | .428 | .203 | .261 | .420 |
| 6 | .150 | .224 | .427 | .141 | .199 | .425 |
| 7 | .186 | .249 | .425 | .130 | .189 | .424 |
| 8 | .170 | .230 | .425 | .174 | .230 | .423 |
| 9 | .175 | .236 | .429 | .193 | .247 | .422 |
| 10 | .103 | .168 | .426 | .242 | .301 | .427 |

FAN TEST NUMBER 13 FEBRUARY 23, 1922.

7/8 Opening Length of pipe 23 ft.

One equalizer spaced 7' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 229 | 126/12 | 270 |
| 2nd. | 226 | 125/12 | 270 |
| Av. | 227.5 | 10.45 | 270 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz | V pt. | V pz. | S pz. |
| Zero | 0 | +.023 | +.028 | −.003 | +.019 | +.019 |
| 1 | .172 | .212 | .311 | .2 | .25 | .312 |
| 2 | .180 | .222 | .311 | .278 | .326 | .315 |
| 3 | .118 | .157 | .312 | .270 | .315 | .317 |
| 4 | .122 | .162 | .312 | .220 | .260 | .316 |
| 5 | .140 | .182 | .312 | .230 | .270 | .317 |
| 6 | .215 | .261 | .310 | .188 | .221 | .315 |
| 7 | .272 | .320 | .310 | .170 | .213 | .315 |
| 8 | .253 | .297 | .310 | .269 | .310 | .315 |
| 9 | .259 | .302 | .310 | .352 | .392 | .315 |
| 10 | .165 | .201 | .310 | .391 | .429 | .315 |

FAN TEST NUMBER 14 May 11, 1922.

1/2 Opening Length of pipe 23 ft.

First equalizer spaced 5' 1" from fan opening.

Second equalizer spaced 13' 2" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 227 | 187/12 | 384 |
| 2nd | 217 | 182/12 | 374 |
| Av. | 222 | 15.37 | 379 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.003 | -.001 | .000 | | -.003 | -.001 | .000 |
| 1 | .069 | .097 | 1.286 | 1 | .224 | .204 | 1.303 |
| 2 | .079 | .102 | 1.300 | 2 | .198 | .304 | 1.309 |
| 3 | .084 | .110 | 1.298 | 3 | .216 | .312 | 1.304 |
| 4 | .097 | .117 | 1.298 | 4 | .216 | .312 | 1.308 |
| 5 | .099 | .122 | 1.295 | 5 | .188 | .200 | 1.316 |
| c | .170 | .196 | 1.295 | c | .146 | .170 | 1.312 |
| 6 | .247 | .280 | 1.288 | 6 | .115 | .122 | 1.308 |
| 7 | .247 | .285 | 1.277 | 7 | .115 | .126 | 1.309 |
| 8 | .258 | .250 | 1.276 | 8 | .160 | .166 | 1.309 |
| 9 | .242 | .232 | 1.276 | 9 | .135 | .148 | 1.310 |
| 10 | .121 | .193 | 1.296 | 10 | .079 | .080 | 1.305 |

FAN TEST NUMBER 15 May 10, 1922.

5/8 Opening Length of pipe 23 ft.

First equalizer spaced 5' 1" from fan opening.

Second equalizer spaced 13' 2" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 230 | 214/12 | 384 |
| 2nd | 228 | 214/12 | 382 |
| Av. | 229 | 17.83 | 383 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.002 | .000 | -.002 | | +.002 | .000 | .000 |
| 1 | .192 | .228 | 1.115 | 1 | .180 | .151 | 1.130 |
| 2 | .205 | .239 | 1.117 | 2 | .128 | .157 | 1.129 |
| 3 | .232 | .274 | 1.117 | 3 | .150 | .186 | 1.133 |
| 4 | .275 | .267 | 1.119 | 4 | .174 | .209 | 1.137 |
| 5 | .277 | .292 | 1.111 | 5 | .200 | .240 | 1.139 |
| c | .222 | .231 | 1.109 | c | .220 | .251 | 1.136 |
| 6 | .230 | .250 | 1.107 | 6 | .250 | .290 | 1.140 |
| 7 | .304 | .330 | 1.107 | 7 | .218 | .261 | 1.140 |
| 8 | .302 | .320 | 1.110 | 8 | .270 | .309 | 1.139 |
| 9 | .305 | .321 | 1.110 | 9 | .232 | .290 | 1.144 |
| 10 | .252 | .247 | 1.131 | 10 | .152 | .208 | 1.140 |

FAN TEST NUMBER 16 May 12, 1922.

3/4 Opening Length of pipe 23 ft.

First equalizer spaced 5' 1" from fan opening.

Second equalizer spaced 13' 2" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 239 | 268/12 | 394 |
| 2nd | 230 | 260/12 | 389 |
| Av. | 234.5 | 22.0 | 391.5 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.003 | -.001 | +.002 | | -.003 | -.001 | +.022 |
| 1 | .305 | .291 | .907 | 1 | .152 | .122 | .931 |
| 2 | .332 | .338 | .918 | 2 | .142 | .112 | .942 |
| 3 | .310 | .322 | .920 | 3 | .163 | .166 | .941 |
| 4 | .370 | .379 | .918 | 4 | .181 | .182 | .949 |
| 5 | .357 | .364 | .916 | 5 | .224 | .221 | .948 |
| c | .268 | .278 | .914 | c | .266 | .272 | .947 |
| 6 | .250 | .252 | .915 | 6 | .352 | .362 | .942 |
| 7 | .272 | .282 | .916 | 7 | .318 | .321 | .950 |
| 8 | .380 | .378 | .914 | 8 | .408 | .417 | .952 |
| 9 | .408 | .402 | .914 | 9 | .337 | .350 | .952 |
| 10 | .295 | .322 | .922 | 10 | .222 | .231 | .950 |

FAN TEST NUMBER 17 May 9, 1922.

7/8 Opening Length of pipe 23 ft.

First equalizer spaced 5' 1" from fan opening.

Second equalizer spaced 13' 2" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 234 | 280/12 | 379 |
| 2nd | 230 | 282/12 | 372 |
| Av. | 232 | 23.5 | 375.5 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.002 | .000 | -.002 | | +.002 | .000 | -.003 |
| 1 | .352 | .322 | .589 | 1 | .232 | .213 | .578 |
| 2 | .390 | .378 | .582 | 2 | .195 | .162 | .578 |
| 3 | .383 | .368 | .583 | 3 | .239 | .227 | .578 |
| 4 | .446 | .432 | .582 | 4 | .254 | .201 | .580 |
| 5 | .428 | .420 | .582 | 5 | .277 | .290 | .581 |
| c | .320 | .306 | .580 | c | .315 | .330 | .580 |
| 6 | .335 | .330 | .580 | 6 | .415 | .421 | .580 |
| 7 | .341 | .340 | .586 | 7 | .403 | .403 | .580 |
| 8 | .450 | .458 | .587 | 8 | .480 | .499 | .583 |
| 9 | .546 | .542 | .589 | 9 | .421 | .435 | .582 |
| 10 | .462 | .462 | .589 | 10 | .282 | .292 | .581 |

FAN TEST NUMBER 18 MARCH 7, 1922.

½ Opening Length of pipe 14 Ft.2"

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 87/12 | 279 |
| 2nd. | 230 | 88/12 | 279 |
| Av. | 230 | 7.30 | 279 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | .076 | .10 | .674 | .065 | .106 | .713 |
| 2 | .090 | .119 | .674 | .080 | .122 | .710 |
| 3 | .107 | .130 | .676 | .086 | .122 | .709 |
| 4 | .118 | .142 | .679 | .099 | .133 | .707 |
| 5 | .130 | .149 | .680 | .109 | .130 | .708 |
| 6 | .068 | .080 | .670 | .142 | .171 | .705 |
| 7 | .050 | .068 | .677 | .163 | .193 | .706 |
| 8 | .050 | .070 | .688 | .160 | .196 | .713 |
| 9 | .050 | .071 | .692 | .168 | .200 | .701 |
| 10 | .025 | .053 | .688 | .132 | .174 | .710 |

FAN TEST NUMBER 19 MARCH 8, 1922

5/8 Opening Length of Pipe 14' 2".

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 108/12 | 279 |
| 2nd | 229 | 107/12 | 282 |
| Av. | 229.5 | 8.91 | 280.5 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | .091 | .107 | .662 | .082 | .090 | .661 |
| 2 | .095 | .096 | .661 | .123 | .138 | .665 |
| 3 | .096 | .098 | .661 | .139 | .153 | .668 |
| 4 | .103 | .107 | .660 | .138 | .150 | .670 |
| 5 | .131 | .138 | .668 | .142 | .152 | .671 |
| 6 | .125 | .133 | .668 | .140 | .150 | .670 |
| 7 | .117 | .125 | .665 | .141 | .158 | .668 |
| 8 | .112 | .123 | .664 | .160 | .178 | .674 |
| 9 | .110 | .127 | .663 | .200 | .225 | .674 |
| 10 | .087 | .100 | .667 | .212 | .232 | .678 |

FAN TEST NUMBER 20 MARCH 8, 1922.

¾ Opening Length of pipe 14' 2"

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 118/12 | 281 |
| 2nd. | 230 | 119/12 | 279 |
| Av. | 230 | 9.87 | 280 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | .172 | .169 | .506 | .080 | .072 | .502 |
| 2 | .145 | .138 | .506 | .120 | .106 | .506 |
| 3 | .132 | .113 | .516 | .130 | .100 | .503 |
| 4 | .140 | .119 | .500 | .174 | .140 | .507 |
| 5 | .179 | .158 | .502 | .195 | .170 | .504 |
| 6 | .219 | .208 | .507 | .192 | .179 | .503 |
| 7 | .223 | .220 | .507 | .185 | .186 | .505 |
| 8 | .220 | .219 | .507 | .214 | .222 | .502 |
| 9 | .200 | .200 | .508 | .248 | .269 | .509 |
| 10 | .130 | .139 | .504 | .272 | .293 | .508 |

FAN TEST NUMBER 21 March 7, 1922.

7/8 Opening Length of pipe 14' 2"

Test run with no equalizer.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 128/12 | 277 |
| 2nd. | 231 | 129/12 | 279 |
| Av. | 230.5 | 10.70 | 278 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | .278 | .270 | .348 | .130 | .090 | .344 |
| 2 | .203 | .173 | .343 | .129 | .069 | .338 |
| 3 | .195 | .171 | .345 | .150 | .080 | .341 |
| 4 | .173 | .127 | .343 | .170 | .092 | .348 |
| 5 | .232 | .186 | .343 | .251 | .188 | .340 |
| 6 | .297 | .257 | .349 | .242 | .212 | .340 |
| 7 | .302 | .273 | .349 | .271 | .251 | .341 |
| 8 | .293 | .270 | .348 | .300 | .292 | .345 |
| 9 | .289 | .285 | .348 | .307 | .312 | .345 |
| 10 | .152 | .156 | .349 | .280 | .290 | .347 |

FAN TEST NUMBER 22 May 22, 1922.

1/2 Opening Length of pipe 14 ft. 2 in.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 230 | 193/12 | 389 |
| 2nd | 228 | 195/12 | 389 |
| Av. | 229 | 16.16 | 389 |

Top Readings

| | V pt. | V pz. | S pz. |
|---|---|---|---|
| Zero | +.002 | -.002 | -.004 |
| 1 | .058 | .130 | 1.377 |
| 2 | .067 | .127 | 1.375 |
| 3 | .055 | .105 | 1.360 |
| 4 | .049 | .079 | 1.350 |
| 5 | .061 | .101 | 1.340 |
| c | .149 | .200 | 1.375 |
| 6 | .207 | .227 | 1.380 |
| 7 | .270 | .270 | 1.360 |
| 8 | .299 | .359 | 1.350 |
| 9 | .271 | .300 | 1.355 |
| 10 | .233 | .283 | 1.375 |

Side Readings

| | V pt. | V pz. | S pz. |
|---|---|---|---|
| | +.024 | -.015 | -.010 |
| 1 | .170 | .220 | 1.365 |
| 2 | .243 | .250 | 1.350 |
| 3 | .240 | .220 | 1.345 |
| 4 | .200 | .200 | 1.350 |
| 5 | .165 | .140 | 1.360 |
| c | .100 | .120 | 1.355 |
| 6 | .054 | .074 | 1.360 |
| 7 | .053 | .062 | 1.357 |
| 8 | .080 | .087 | 1.360 |
| 9 | .100 | .130 | 1.350 |
| 10 | .100 | .127 | 1.345 |

FAN TEST NUMBER 23 May 22, 1922.

5/8 Opening Length of pipe 14 ft. 2 in.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 229 | 257/12 | 389 |
| 2nd | 231 | 239/12 | 397 |
| Av. | 230 | 19.83 | 393 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.003 | -.015 | .000 | | -.002 | -.012 | .000 |
| 1 | .210 | .250 | 1.143 | 1 | .123 | .173 | 1.190 |
| 2 | .248 | .295 | 1.153 | 2 | .182 | .213 | 1.175 |
| 3 | .265 | .300 | 1.180 | 3 | .182 | .215 | 1.155 |
| 4 | .301 | .309 | 1.175 | 4 | .227 | .257 | 1.160 |
| 5 | .260 | .280 | 1.160 | 5 | .230 | .280 | 1.165 |
| c | .251 | .289 | 1.165 | c | .251 | .301 | 1.170 |
| 6 | .268 | .318 | 1.175 | 6 | .222 | .272 | 1.170 |
| 7 | .238 | .288 | 1.180 | 7 | .188 | .218 | 1.175 |
| 8 | .273 | .313 | 1.195 | 8 | .205 | .255 | 1.180 |
| 9 | .305 | .355 | 1.185 | 9 | .265 | .315 | 1.195 |
| 10 | .255 | .300 | 1.180 | 10 | .220 | .270 | 1.190 |

FAN TEST NUMBER 24 May 24, 1922.

3/4 Opening Length of pipe 14 ft. 2 in.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 230 | 272/12 | 391 |
| 2nd | 230 | 272/12 | 391 |
| Av. | 230 | 22.66 | 391 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.003 | -.016 | .000 | | +.003 | -.017 | .000 |
| 1 | .330 | .380 | .850 | 1 | .123 | .173 | .852 |
| 2 | .423 | .473 | .855 | 2 | .152 | .202 | .851 |
| 3 | .432 | .480 | .852 | 3 | .173 | .223 | .850 |
| 4 | .409 | .450 | .847 | 4 | .180 | .230 | .845 |
| 5 | .350 | .375 | .850 | 5 | .207 | .257 | .850 |
| c | .257 | .300 | .855 | c | .332 | .382 | .851 |
| 6 | .216 | .250 | .860 | 6 | .407 | .440 | .855 |
| 7 | .210 | .260 | .855 | 7 | .356 | .400 | .852 |
| 8 | .270 | .320 | .845 | 8 | .330 | .347 | .848 |
| 9 | .314 | .364 | .850 | 9 | .333 | .372 | .851 |
| 10 | .336 | .386 | .845 | 10 | .342 | .382 | .852 |

FAN TEST NUMBER 25 May 24, 1922

7/8 Opening · Length of pipe 14 ft. 2 in.

One equalizer spaced 5' 1" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 230 | 307/12 | 388 |
| 2nd | 230 | 307/12 | 388 |
| Av. | 230 | 25.6 | 388 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.030 | -.020 | .000 | | +.003 | -.017 | .000 |
| 1 | .480 | .485 | .560 | 1 | .152 | .192 | .559 |
| 2 | .562 | .570 | .557 | 2 | .167 | .205 | .558 |
| 3 | .531 | .551 | .556 | 3 | .182 | .220 | .556 |
| 4 | .523 | .540 | .553 | 4 | .210 | .250 | .557 |
| 5 | .400 | .410 | .553 | 5 | .245 | .280 | .557 |
| c | .304 | .310 | .555 | c | .337 | .377 | .556 |
| 6 | .300 | .307 | .554 | 6 | .460 | .500 | .559 |
| 7 | .402 | .410 | .557 | 7 | .507 | .547 | .560 |
| 8 | .509 | .510 | .556 | 8 | .498 | .535 | .560 |
| 9 | .643 | .649 | .555 | 9 | .490 | .530 | .559 |
| 10 | .594 | .600 | .557 | 10 | .510 | .550 | .557 |

FAN TEST NUMBER 26 May 20, 1922.

1/2 Opening Length of pipe 14 ft. 2 in.

First equalizer spaced 3' 9" from fan opening.

Second equalizer spaced 7' 7" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 235 | 195/12 | 401 |
| 2nd | 239 | 195/12 | 403 |
| Av. | 237 | 16.25 | 402 |

Top Readings

| | V pt. | V pz. | S pz. |
|---|---|---|---|
| Zero | -.01 | +.002 | -.012 |
| 1 | .090 | .180 | 1.410 |
| 2 | .082 | .172 | 1.400 |
| 3 | .063 | .143 | 1.395 |
| 4 | .050 | .130 | 1.390 |
| 5 | .038 | .118 | 1.392 |
| c | .080 | .160 | 1.390 |
| 6 | .133 | .913 | 1.397 |
| 7 | .241 | .321 | 1.392 |
| 8 | .240 | .320 | 1.395 |
| 9 | .251 | .341 | 1.397 |
| 10 | .221 | .311 | 1.400 |

Side Readings

| | V pt. | V pz. | S pz. |
|---|---|---|---|
| | -.01 | +.002 | -.012 |
| 1 | .281 | .371 | 1.390 |
| 2 | .333 | .423 | 1.392 |
| 3 | .272 | .362 | 1.397 |
| 4 | .236 | .326 | 1.402 |
| 5 | .112 | .190 | 1.400 |
| c | .036 | .103 | 1.397 |
| 6 | .023 | .100 | 1.395 |
| 7 | .060 | .142 | 1.400 |
| 8 | .173 | .263 | 1.410 |
| 9 | .105 | .195 | 1.397 |
| 10 | .160 | .250 | 1.405 |

FAN TEST NUMBER 27 May 19, 1922.

5/8 Opening Length of pipe 14 ft. 2 in.

First equalizer spaced 3' 9" from fan opening.

Second equalizer spaced 7' 7" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 232 | 228/12 | 386 |
| 2nd | 230 | 224/12 | 383 |
| Av. | 231 | 18.83 | 384.5 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.001 | +.01 | -.006 | | -.003 | +.01 | -.003 |
| 1 | .175 | .238 | 1.165 | 1 | .233 | .295 | 1.162 |
| 2 | .200 | .250 | 1.170 | 2 | .300 | .325 | 1.165 |
| 3 | .192 | .220 | 1.167 | 3 | .260 | .310 | 1.170 |
| 4 | .280 | .340 | 1.170 | 4 | .288 | .316 | 1.175 |
| 5 | .330 | .365 | 1.176 | 5 | .290 | .355 | 1.172 |
| c | .380 | .375 | 1.167 | c | .296 | .385 | 1.162 |
| 6 | .248 | .300 | 1.175 | 6 | .185 | .230 | 1.165 |
| 7 | .268 | .340 | 1.170 | 7 | .156 | .213 | 1.172 |
| 8 | .150 | .200 | 1.172 | 8 | .181 | .226 | 1.170 |
| 9 | .192 | .212 | 1.175 | 9 | .124 | .290 | 1.170 |
| 10 | .128 | .178 | 1.170 | 10 | .216 | .264 | 1.168 |

FAN TEST NUMBER 28 May 19, 1922.

3/4 Opening Length of pipe 14 ft. 2 in.

First equalizer spaced 3' 9" from fan opening.

Second equalizer spaced 7' 7" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 227 | 270/12 | 387 |
| 2nd | 228 | 268/12 | 387 |
| Av. | 227.5 | 22.42 | 387 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | -.001 | -.01 | +.006 | | -.001 | -.01 | +.006 |
| 1 | .309 | .379 | .867 | 1 | .457 | .507 | .871 |
| 2 | .378 | .458 | .872 | 2 | .412 | .462 | .870 |
| 3 | .340 | .410 | .875 | 3 | .348 | .408 | .869 |
| 4 | .428 | .460 | .878 | 4 | .252 | .278 | .870 |
| 5 | .380 | .440 | .877 | 5 | .246 | .306 | .869 |
| c | .340 | .396 | .875 | c | .450 | .510 | .868 |
| 6 | .190 | .250 | .879 | 6 | .391 | .451 | .871 |
| 7 | .191 | .251 | .876 | 7 | .286 | .340 | .869 |
| 8 | .124 | .184 | .875 | 8 | .304 | .360 | .868 |
| 9 | .139 | .199 | .874 | 9 | .321 | .380 | .867 |
| 10 | .121 | .191 | .875 | 10 | .292 | .362 | .866 |

FAN TEST NUMBER 29 May 19, 1922.

7/8 Opening Length of pipe 14 ft. 2 in.

First equalizer spaced 3' 9" from fan opening.

Second equalizer spaced 7' 7" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 231 | 310/12 | 387 |
| 2nd | 232 | 310/12 | 391 |
| Av. | 231.5 | 25.83 | 389 |

| | Top Readings | | | | Side Readings | | |
|---|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | | V pt. | V pz. | S pz. |
| Zero | +.005 | +.008 | -.009 | | +.005 | +.006 | -.009 |
| 1 | .441 | .491 | .547 | 1 | .471 | .497 | .550 |
| 2 | .584 | .644 | .550 | 2 | .447 | .479 | .552 |
| 3 | .519 | .560 | .552 | 3 | .332 | .382 | .555 |
| 4 | .630 | .680 | .555 | 4 | .285 | .345 | .560 |
| 5 | .462 | .502 | .556 | 5 | .263 | .313 | .557 |
| c | .495 | .545 | .557 | c | .592 | .627 | .559 |
| 6 | .355 | .400 | .555 | 6 | .553 | .603 | .558 |
| 7 | .308 | .329 | .558 | 7 | .432 | .482 | .559 |
| 8 | .210 | .250 | .559 | 8 | .390 | .392 | .560 |
| 9 | .221 | .270 | .560 | 9 | .413 | .415 | .561 |
| 10 | .170 | .196 | .561 | 10 | .405 | .455 | .561 |

FAN TEST NUMBER 30 JUNE 6, 1922

½ Opening Length of pipe 14 ft 2"

Test run with no equalizer.

Barometer 28.92 Temperature 91.3 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 231 | 207/12 | 410 |
| 2nd | 232 | 216/12 | 1212 |
| Av. | 231.5 | 17.62 | 411 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | -.003 | -.006 | -.000 | -.003 | -.006 | -.009 |
| 1 | .123 | .213 | 1.420 | .149 | .241 | 1.380 |
| 2 | .150 | .233 | 1.420 | .203 | .357 | 1.380 |
| 3 | .183 | .261 | 1.420 | .221 | .371 | 1.375 |
| 4 | .199 | .269 | 1.444 | .247 | .392 | 1.370 |
| 5 | .232 | .292 | 1.430 | .282 | .427 | 1.370 |
| c | .277 | .317 | 1.430 | .253 | .380 | 1.385 |
| 6 | .283 | .330 | 1.435 | .163 | .273 | 1.380 |
| 7 | .301 | .351 | 1.435 | .130 | .257 | 1.385 |
| 8 | .321 | .379 | 1.435 | .137 | .263 | 1.385 |
| 9 | .323 | .397 | 1.450 | .113 | .245 | 1.380 |
| 10 | .233 | .310 | 1.445 | .097 | .241 | 1.380 |

FAN TEST NUMBER 31 JUNE 6, 1922

5/8 Opening Length of pipe 14' 2"

Test run with no equalizer.

Barometer 28.92 Tmeperature 91.3 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 225/12 | 406 |
| 2nd. | 231 | 225/12 | 406 |
| Av. | 230.5 | 18.75 | 406 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | v pt. | v pz. | S pz. | v pt. | v pz. | S pz. |
| Zero | -.003 | -.006 | -.017 | 1.000 | -.006 | -.003 |
| 1 | .152 | .192 | 1.22 | .310 | .398 | 1.220 |
| 2 | .120 | .140 | 1.23 | .331 | .401 | 1.210 |
| 3 | .138 | .152 | 1.230 | .287 | .340 | 1.215 |
| 4 | .193 | .213 | 1.230 | .266 | .320 | 1.220 |
| 5 | .250 | .271 | 1.220 | .280 | .331 | 1.210 |
| c | .290 | .320 | 1.230 | .280 | .330 | 1.218 |
| 6 | .293 | .327 | 1.240 | .250 | .302 | 1.210 |
| 7 | .310 | .353 | 1.215 | .240 | .292 | 1.220 |
| 8 | .370 | .422 | 1.235 | .230 | .286 | 1.210 |
| 9 | .412 | .462 | 1.240 | .230 | .289 | 1.220 |
| 10 | .445 | .502 | 1.245 | .200 | .265 | 1.220 |

FAN TEST NUMBER 32 JUNE 6, 1922

3/4 Opening Length of pipe 14' 2"

Test run with no equalizer

Barometer 28.92 Temperature 91.3 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 231 | 290/12 | 405 |
| 2nd | 230 | 293/12 | 408 |
| Av. | 230.5 | 24.3 | 406.5 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | v pt. | v pz. | S pz. |
| Zero | .001 | .000 | .000 | -.006 | -.005 | -.005 |
| 1 | .396 | .216 | .959 | .375 | .430 | .932 |
| 2 | .142 | .142 | .945 | .360 | .410 | .910 |
| 3 | .170 | .130 | .930 | .280 | .301 | .909 |
| 4 | .221 | .167 | .937 | .261 | .271 | .915 |
| 5 | .312 | .257 | .939 | .307 | .297 | .905 |
| c | .411 | .382 | .940 | .357 | .321 | .909 |
| 6 | .400 | .397 | .940 | .402 | .382 | .915 |
| 7 | .412 | .421 | .940 | .381 | .371 | .913 |
| 8 | .467 | .487 | .940 | .351 | .347 | .910 |
| 9 | .542 | .577 | .942 | .310 | .336 | .910 |
| 10 | .562 | .610 | .945 | .265 | .317 | .920 |

FAN TEST NUMBER 33 JUNE 6, 1922

7/8 Opening Length of pipe 14' 2"

Barometer 28.92 Temperature 91.3 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st | 231 | 320/12 | 401 |
| 2nd | 229 | 315/12 | 399 |
| Av. | 230 | 26.45 | 400 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | -.004 | -.014 | -.006 | -.003 | -.004 | -.003 |
| 1 | .211 | .192 | .642 | .487 | .541 | .605 |
| 2 | .212 | .161 | .645 | .501 | .531 | .600 |
| 3 | .231 | .141 | .638 | .443 | .443 | .600 |
| 4 | .268 | .135 | .639 | .377 | .341 | .602 |
| 5 | .382 | .232 | .632 | .401 | .347 | .611 |
| c | .482 | .372 | .635 | .445 | .365 | .615 |
| 6 | .492 | .400 | .637 | .503 | .403 | .610 |
| 7 | .532 | .479 | .637 | .455 | .365 | .603 |
| 8 | .620 | .592 | .642 | .371 | .310 | .597 |
| 9 | .645 | .640 | .645 | .342 | .337 | .600 |
| 10 | .506 | .506 | .641 | .205 | .235 | .604 |

FAN TEST NUMBER 34 June 7 1922

½ Opening Length of pipe 14' 2"

1 Equalizer spaced 2 feet 3 in. from fan opening.

| Barometer | Temperature | Rel. Humid. |
|---|---|---|
| | Volts | Amperes | R.P.M. |
| 1st. | 230 | 210/12 | 413 |
| 2nd. | 231 | 215/12 | 415 |
| Av. | 230.5 | 17.87 | 414 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | V pt. | v pz. | S pz. | V pt. | v pz. | Spz. |
| Zero | -.003 | -.006 | -.009 | -.003 | -.006 | -.010 |
| 1 | .068 | .140 | 1.420 | .193 | .280 | 1.400 |
| 2 | .079 | .148 | 1.415 | .230 | .315 | 1.395 |
| 3 | .070 | .135 | 1.390 | .240 | .328 | 1.390 |
| 4 | .058 | .126 | 1.415 | .210 | .296 | 1.395 |
| 5 | .049 | .118 | 1.400 | .170 | .258 | 1.400 |
| c | .103 | .170 | 1.405 | .128 | .209 | 1.405 |
| 6 | .200 | .273 | 1.395 | .074 | .150 | 1.400 |
| 7 | .260 | .341 | 1.390 | .100 | .180 | 1.380 |
| 8 | .282 | .358 | 1.400 | .150 | .233 | 1.365 |
| 9 | .278 | .350 | 1.390 | .190 | .276 | 1.375 |
| 10 | .240 | .310 | 1.385 | .172 | .251 | 1.390 |

FAN TEST NUMBER 35b June 7, 1922

5/8 Opening Length of Pipe 14' 2"

One equalizer spaced 2' 3" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 228 | 248/12 | 406 |
| 2nd. | 229 | 260/12 | 404 |
| Av. | 228.5 | 21.15 | 405 |

Top Readings Side Readings
Equal. blades par. to fan blades 19 to horizontal

| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
|---|---|---|---|---|---|---|
| Zero | -.003 | -.006 | -.010 | -.005 | -.006 | -.015 |
| 1 | .262 | .320 | 1.160 | .109 | .170 | 1.160 |
| 2 | .270 | .325 | 1.185 | .158 | .213 | 1.150 |
| 3 | .266 | .320 | 1.200 | .143 | .203 | 1.170 |
| 4 | .280 | .333 | 1.200 | .161 | .212 | 1.150 |
| 5 | .268 | .320 | 1.195 | .190 | .250 | 1.150 |
| c | .230 | .280 | 1.210 | .270 | .339 | 1.160 |
| 6 | .200 | .244 | 1.180 | .260 | .328 | 1.175 |
| 7 | .150 | .200 | 1.180 | .280 | .349 | 1.165 |
| 8 | .148 | .190 | 1.195 | .260 | .329 | 1.170 |
| 9 | .160 | .215 | 1.180 | .290 | .352 | 1.165 |
| 10 | .118 | .169 | 1.165 | .280 | .342 | 1.140 |

FAN TEST NUMBER 35b June 7 1922

5/8 Opening Length of pipe 14' 2"

one equalizer spaced 2' 3" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 235 | 260/12 | 410 |
| 2nd. | 231 | 252/12 | 406 |
| Av. | 233 | 21.33 | 408 |

Side readings

| | Equalizer blades 45 to Hor. | | | Side Readings Equal. blades par. to Hor. | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
| Zero | -.005 | -.006 | -.015 | -.005 | -.006 | -.015 |
| 1 | .135 | .210 | 1.165 | .111 | .171 | 1.13 |
| 2 | .171 | .215 | 1.165 | .131 | .187 | 1.15 |
| 3 | .164 | .230 | 1.170 | .163 | .230 | 1.18 |
| 4 | .183 | .253 | 1.175 | .183 | .251 | 1.18 |
| 5 | .201 | .281 | 1.170 | .183 | .252 | 1.18 |
| c | .271 | .350 | 1.160 | .281 | .351 | 1.165 |
| 6 | .251 | .325 | 1.150 | .260 | .327 | 1.150 |
| 7 | .251 | .325 | 1.150 | .253 | .325 | 1.150 |
| 8 | .261 | .341 | 1.130 | .263 | .340 | 1.155 |
| 9 | .305 | .385 | 1.130 | .290 | .360 | 1.150 |
| 10 | .295 | .367 | 1.140 | .281 | .357 | 1.155 |

FAN TEST NUMBER 36 June 7 1922

3/4 Opening Length of pipe 14' 2"

One equalizer spaced 2' 3" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 229 | 285/12 | 101 |
| 2nd | 233 | 286/12 | 404 |
| Av. | 231 | 23.80 | 402.5 |

Top Readings Side Readings
Equlizer blades parallel to horizontal

| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
|---|---|---|---|---|---|---|
| Zero | -.002 | .002 | -.004 | -.006 | -.006 | -.006 |
| 1 | .380 | .443 | .860 | .163 | .207 | .851 |
| 2 | .420 | .491 | .859 | .193 | .231 | .850 |
| 3 | .390 | .462 | .868 | .174 | .210 | .860 |
| 4 | .420 | .491 | .872 | .153 | .193 | .862 |
| 5 | .360 | .420 | .873 | .153 | .193 | .865 |
| c | .330 | .378 | .879 | .257 | .307 | .861 |
| 6 | .270 | .328 | .870 | .371 | .420 | .850 |
| 7 | .254 | .311 | .879 | .395 | .445 | .862 |
| 8 | .310 | .366 | .873 | .367 | .417 | .870 |
| 9 | .310 | .378 | .864 | .412 | .462 | .862 |
| 10 | .220 | .280 | .863 | .413 | .463 | .867 |

FAN TEST NUMBER 37 June 8 1922.

7/8 Opening Length of pipe 14' 2"

One equalizer spaced 2' 3" from fan opening.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| lst. | 232 | 320/12 | 397 |
| 2nd. | 232 | 320/12 | 397 |
| Av. | 232 | 26.66 | 397 |

Top Readings Side Readings

Equalizer blades 45 to horizontal

| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
|---|---|---|---|---|---|---|
| Zero | .000 | .002 | -.012 | -.006 | -.005 | -.005 |
| 1 | .549 | .581 | .549 | .192 | .217 | .541 |
| 2 | .573 | .613 | .547 | .211 | .241 | .531 |
| 3 | .603 | .643 | .550 | .211 | .231 | .535 |
| 4 | .583 | .620 | .552 | .187 | .207 | .533 |
| 5 | .423 | .453 | .550 | .222 | .242 | .535 |
| c | .357 | .392 | .553 | .351 | .371 | .533 |
| 6 | .372 | .412 | .550 | .483 | .507 | .531 |
| 7 | .387 | .423 | .556 | .482 | .502 | .539 |
| 8 | .452 | .482 | .553 | .505 | .535 | .537 |
| 9 | .468 | .497 | .557 | .505 | .531 | .536 |
| 10 | .384 | .410 | .567 | .521 | .551 | .540 |

FAN TEST NUMBER 38 June 8 1922

1/2 Opening Length of pipe 14' 2"

One equalizer spaced 6 feet 7 Inches from fan opening

Barometer 28.90 Temperature 75.7 Rel. Humi .

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 231 | 220/12 | 410 |
| 2nd. | 230 | 222/12 | 408 |
| Av. | 230.5 | 18.5 | 409 |

Top Readings Side Readings
Equalizer blades 45 to horizontal.

| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
|---|---|---|---|---|---|---|
| Zero | .002 | .001 | -.020 | .002 | .001 | -.020 |
| 1 | .112 | .330 | 1.360 | .189 | .322 | 1.355 |
| 2 | .120 | .238 | 1.370 | .242 | .382 | 1.355 |
| 3 | .139 | .260 | 1.360 | .223 | .353 | 1.345 |
| 4 | .157 | .271 | 1.345 | .221 | .356 | 1.345 |
| 5 | .170 | .289 | 1.350 | .231 | .371 | 1.365 |
| c | .269 | .388 | 1.370 | .221 | .357 | 1.355 |
| 6 | .250 | .370 | 1.365 | .089 | .223 | 1.345 |
| 7 | .330 | .449 | 1.370 | .073 | .207 | 1.340 |
| 8 | .282 | .398 | 1.365 | .060 | .200 | 1.355 |
| 9 | .331 | .446 | 1.380 | .060 | .200 | 1.360 |
| 10 | .269 | .376 | 1.375 | .060 | .200 | 1.365 |

FAN TEST NUMBER 39 June 9, 1922

5/8 Opening Length of pipe 14' 2"

One equalizer spaced 6' 7" from fan opening.

Barometer 28.90 Temperature 75.7 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 255/12 | 399 |
| 2nd | 230 | 250/12 | 401 |
| Av. | 230 | 21.04 | 400 |

Top Readings Side Readings
Equalizer blades 45 to horizontal

| | V pt. | V pz. | S pz. | V pt. | V pz. | Spz. |
|---|---|---|---|---|---|---|
| Zero | .002 | .001 | -.020 | .002 | .001 | -.020 |
| 1 | .161 | .277 | 1.175 | .271 | .371 | 1.165 |
| 2 | .192 | .285 | 1.175 | .271 | .371 | 1.145 |
| 3 | .202 | .286 | 1.170 | .227 | .327 | 1.155 |
| 4 | .209 | .289 | 1.170 | .183 | .281 | 1.175 |
| 5 | .231 | .326 | 1.165 | .207 | .305 | 1.170 |
| c | .217 | .305 | 1.160 | .249 | .349 | 1.170 |
| 6 | .286 | .381 | 1.160 | .231 | .329 | 1.155 |
| 7 | .310 | .402 | 1.180 | .179 | .286 | 1.170 |
| 8 | .317 | .410 | 1.175 | .183 | .289 | 1.180 |
| 9 | .357 | .453 | 1.175 | .172 | .272 | 1.180 |
| 10 | .321 | .407 | 1.165 | .186 | .291 | 1.180 |

FAN TEST NUMBER 40 June 9, 1922

3/4 Opening Length of pipe 14' 2"

One equalizer spaced 6' 7" from fan opening.

Barometer 28.90 Temperature 75.7 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 273/12 | 392 |
| 2nd. | 230 | 279/12 | 396 |
| Av. | 230 | 23.0 | 394 |

Top Readings Side Readings
Equalizer blades 45 to horizontal

| | V pt. | V pz. | S pz. | V pt. | V pz. | S pz. |
|---|---|---|---|---|---|---|
| Zero | .002 | .001 | -.015 | .001 | .000 | -.015 |
| 1 | .170 | .232 | .881 | .384 | .451 | .862 |
| 2 | .200 | .262 | .880 | .351 | .421 | .867 |
| 3 | .207 | .266 | .870 | .312 | .380 | .865 |
| 4 | .219 | .223 | .875 | .237 | .299 | .862 |
| 5 | .305 | .364 | .878 | .230 | .296 | .860 |
| c | .267 | .328 | .880 | .280 | .356 | .863 |
| 6 | .280 | .349 | .871 | .342 | .410 | .862 |
| 7 | .370 | .440 | .878 | .313 | .393 | .860 |
| 8 | .380 | .448 | .880 | .351 | .421 | .859 |
| 9 | .500 | .462 | .882 | .310 | .379 | .859 |
| 10 | .460 | .507 | .884 | .357 | .430 | .855 |

FAN TEST NUMBER 41 June 9, 1922

7/8 Opening Length of pipe 14' 2"

One equalizer spaced 6' 7" from fan opening.

Barometer 28.90 Temperature 75.7 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 280/12 | 381 |
| 2nd | 228 | 290/12 | 379 |
| Av. | 229 | 23.75 | 380 |

Top Readings Side Readings
Equalizer blades 45 to horizontal.

| | V pt. | V pz. | S pz. | V pt. | V pz. | Spz. |
|---|---|---|---|---|---|---|
| Zero | .001 | .000 | -.014 | .001 | .000 | -.015 |
| 1 | .203 | .236 | .550 | .549 | .569 | .549 |
| 2 | .259 | .291 | .551 | .530 | .559 | .548 |
| 3 | .241 | .278 | .555 | .424 | .453 | .549 |
| 4 | .249 | .280 | .558 | .278 | .307 | .550 |
| 5 | .317 | .347 | .552 | .264 | .292 | .549 |
| c | .286 | .317 | .556 | .300 | .333 | .548 |
| 6 | .402 | .427 | .551 | .357 | .393 | .553 |
| 7 | .446 | .476 | .553 | .425 | .456 | .555 |
| 8 | .442 | .471 | .552 | .460 | .597 | .554 |
| 9 | .552 | .581 | .551 | .438 | .466 | .556 |
| 10 | .486 | .502 | .557 | .470 | .510 | .556 |

FAN TEST NUMBER 42 June 8, 1922

½ Opening Length of pipe 14' 2"

One equalizer spaced 2' 3" out. Blades 45 to Hor.

Other equalizer spaced 6' 7" out. Blades Par. to fan.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 230 | 206/12 | 406 |
| 2nd. | 230 | 212/12 | 408 |
| Av. | 230 | 17.41 | 407 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | V pz. | S pz. | V pt. | V pz. | Spz. |
| Zero | -.003 | .000 | .014 | .000 | .002 | .015 |
| 1 | .080 | .154 | 1.40 | .200 | .289 | 1.380 |
| 2 | .087 | .163 | 1.385 | .260 | .356 | 1.375 |
| 3 | .064 | .141 | 1.410 | .171 | .263 | 1.385 |
| 4 | .033 | .118 | 1.395 | .239 | .327 | 1.370 |
| 5 | .039 | .117 | 1.395 | .181 | .272 | 1.400 |
| c | .130 | .214 | 1.390 | .130 | .220 | 1.400 |
| 6 | .160 | .237 | 1.387 | .083 | .170 | 1.420 |
| 7 | .210 | .298 | 1.400 | .070 | .159 | 1.415 |
| 8 | .300 | .374 | 1.390 | .170 | .257 | 1.395 |
| 9 | .313 | .396 | 1.390 | .173 | .260 | 1.385 |
| 10 | .180 | .240 | 1.408 | 1.246 | .340 | 1.410 |

FAN TEST NUMBER 43 June 8, 1922

5/8 Opening Length of pipe 14' 2"

First equalizer spaced 2' 3" out. Blades 45 to Hor.

Second Equalizer spaced 6' 7" out. Blades Par. to fan.
Barometer 28.95 Temperature 76.7 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 229 | 242/12 | 395 |
| 2nd | 229 | 245/12 | 395 |
| Av. | 229 | 20.29 | 395 |

| | Top Readings | | | Side Readings | | |
|---|---|---|---|---|---|---|
| | V pt. | v pz. | S pz. | v pt. | v pz. | S pz. |
| Zero | -.002 | .000 | .015 | -.003 | .000 | .020 |
| 1 | .141 | .220 | 1.180 | .167 | .251 | 1.170 |
| 2 | .247 | .321 | 1.170 | .212 | .292 | 1.170 |
| 3 | .207 | .271 | 1.160 | .162 | .239 | 1.160 |
| 4 | .249 | .321 | 1.160 | .189 | .279 | 1.170 |
| 5 | .301 | .377 | 1.165 | .247 | .331 | 1.160 |
| c | .283 | .367 | 1.165 | .347 | .430 | 1.170 |
| 6 | .312 | .382 | 1.175 | .273 | .353 | 1.160 |
| 7 | .206 | .281 | 1.170 | .197 | .277 | 1.160 |
| 8 | .252 | .327 | 1.170 | .265 | .342 | 1.165 |
| 9 | .319 | .397 | 1.175 | .259 | .341 | 1.160 |
| 10 | .203 | .261 | 1.180 | .313 | .383 | 1.160 |

FAN TEST NUMBER 44 June 8, 1922.

3/4 Opening Length of pipe 14' 2"

First equalizer spaced 3' 3" out. Blades 45 to Hor.

Second equalizer spaced 6'7" out. Blades horizontal
Barometer 28.95 Temperature 76.7 Rel. Humid.

| | Volts | Amperes | R.P. . |
|---|---|---|---|
| 1st. | 232 | 275/12 | 398 |
| 2nd. | 230 | 281/12 | 400 |
| Av. | 231 | 23.15 | 399 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | v pt. | v pz. | S pz. | v pt. | v pz. | Spz. |
| Zero | -.003 | -.001 | -.005 | -.003 | -.001 | -.006 |
| 1 | .352 | .402 | .882 | .230 | .285 | .873 |
| 2 | .410 | .465 | .882 | .270 | .330 | .869 |
| 3 | .320 | .373 | .883 | .220 | .278 | .873 |
| 4 | .390 | .445 | .882 | .140 | .192 | .860 |
| 5 | .410 | .467 | .881 | .150 | .208 | .869 |
| c | .260 | .312 | .880 | .300 | .358 | .868 |
| 6 | .280 | .328 | .882 | .357 | .420 | .862 |
| 7 | .235 | .284 | .879 | .275 | .332 | .870 |
| 8 | .290 | .343 | .875 | .410 | .461 | .872 |
| 9 | .418 | .469 | .869 | .400 | .463 | .860 |
| 10 | .320 | .360 | .879 | .440 | .500 | .862 |

FAN TEST NUMBER 45 June 8, 1922

7/8 Opening Length of pipe 14' 2"

First Equalizer spaced 2' 3" out. Blades 45 to hor.

Second equalizer spaced 6' 7" out. Blades horizontal.
Barometer 28.95 Temperature 76.7 Rel. Humid.

| | Volts | Amperes | R.P.M. |
|---|---|---|---|
| 1st. | 228 | 300/12 | 389 |
| 2nd | 227 | 302/12 | 389 |
| Av. | 227.5 | 25.08 | 389 |

| | Top Readings | | | Side Readings. | | |
|---|---|---|---|---|---|---|
| | v pt. | v pz. | Spz. | v pt. | v Pz. | Spz. |
| Zero | .002 | -.002 | .000 | .002 | .000 | .000 |
| 1 | .440 | .450 | .549 | .231 | .246 | .550 |
| 2 | .586 | .606 | .555 | .240 | .257 | .550 |
| 3 | .520 | .522 | .557 | .160 | .174 | .551 |
| 4 | .540 | .551 | .560 | .151 | .168 | .549 |
| 5 | .542 | .475 | .558 | .198 | .212 | .549 |
| c | .232 | .350 | .558 | .410 | .423 | .550 |
| 6 | .260 | .278 | .559 | .440 | .463 | .557 |
| 7 | .290 | .309 | .559 | .350 | .368 | .553 |
| 8 | .415 | .425 | .560 | .491 | .509 | .554 |
| 9 | .522 | .538 | .561 | .445 | .466 | .553 |
| 10 | .369 | .381 | .564 | .530 | .522 | .559 |

## METHOD OF CALCULATIONS

The zero readings of each gage were recorded in each case, the readings being as constant as possible to obtain were taken. The zero readings were added or subtracted as indicated by the signs. An R.P.M. Correction to a constant speed 337 R.P.M. was made by multiplying the velocity pressure reading of the pitot tube by the ratio $\frac{337}{\text{R.P.M.}}$. This R.P.M. used in the denominator being the observed R.P.M.

We checked the static pressure using high and low speed by squaring the corresponding R.P.M. of the high and low speeds and multiplying the low speed static pressure by the R.P.M. squared of the high speed divided by the R.P.M. squared of the low speed.

## CORRECTIONS TO STANDARD CONDITIONS

Test # 1

Length of pipe 23 ft.

½ Opening

No equalizer

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .168 | .143 | .132 | .111 |
| 2 | .198 | .169 | .177 | .151 |
| 3 | .221 | .188 | .193 | .164 |
| 4 | .230 | .196 | .202 | .172 |
| 5 | .232 | .198 | .217 | .185 |
| 6 | .173 | .147 | .232 | .197 |
| 7 | .138 | .117 | .223 | .190 |
| 8 | .127 | .108 | .220 | .187 |
| 9 | .126 | .107 | .202 | .172 |
| 10 | .083 | .071 | .152 | .129 |

Test # 2

Length of pipe 23 ft.

5/8 Opening

No equalizer

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .302 | .258 | .316 | .270 |
| 2 | .292 | .249 | .388 | .331 |
| 3 | .286 | .244 | .342 | .292 |
| 4 | .272 | .232 | .312 | .266 |
| 5 | .277 | .236 | .302 | .258 |
| 6 | .286 | .244 | .272 | .232 |
| 7 | .272 | .232 | .232 | .198 |
| 8 | .247 | .210 | .197 | .168 |
| 9 | .222 | .189 | .188 | .160 |
| 10 | .152 | .130 | .192 | .164 |

## CORRECTIONS TO STANDARD CONDITIONS

| | Test # 3 | | | | | Test # 4 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Length of pipe 23 ft. | | | | | Length of pipe 23 ft. | | | |
| | 3/4 Opening | | | | | 7/8 Opening | | | |
| | No equalizer | | | | | No equalizer | | | |
| | Side readings | | Top readings | | | Top readings | | Side readings | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .393 | .338 | .384 | .330 | 1 | .511 | .458 | .416 | .374 |
| 2 | .433 | .372 | .414 | .356 | 2 | .512 | .468 | .491 | .441 |
| 3 | .464 | .399 | .374 | .321 | 3 | .481 | .432 | .491 | .441 |
| 4 | .463 | .398 | .360 | .309 | 4 | .471 | .423 | .501 | .450 |
| 5 | .463 | .398 | .405 | .348 | 5 | .486 | .436 | .521 | .467 |
| 6 | .374 | .321 | .412 | .354 | 6 | .441 | .395 | .451 | .405 |
| 7 | .351 | .302 | .359 | .308 | 7 | .391 | .351 | .411 | .369 |
| 8 | .312 | .268 | .341 | .296 | 8 | .351 | .315 | .409 | .368 |
| 9 | .343 | .295 | .289 | .248 | 9 | .291 | .261 | .420 | .377 |
| 10 | .299 | .257 | .204 | .175 | 10 | .231 | .208 | .310 | .278 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 6 | | | | Test # 7 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 23 ft. | | | | Length of pipe 23 ft. | | | |
| ½ Opening | | | | 5/8 Opening | | | |
| 1 Equalizer | | | | 1 Equalizer | | | |
| Top readings | | Side Readings | | Top Readings | | Side Readings | |
| Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .045 | .053 | .113 | .135 | 1 .110 | .131 | .082 | .098 |
| 2 .045 | .053 | .133 | .159 | 2 .116 | .138 | .138 | .165 |
| 3 .050 | .060 | .110 | .132 | 3 .133 | .159 | .130 | .155 |
| 4 .045 | .053 | .102 | .122 | 4 .138 | .165 | .120 | .143 |
| 5 .049 | .059 | .104 | .125 | 5 .163 | .194 | .129 | .154 |
| 6 .132 | .158 | .077 | .092 | 6 .133 | .159 | .153 | .183 |
| 7 .177 | .212 | .084 | .100 | 7 .152 | .182 | .178 | .212 |
| 8 .181 | .216 | .112 | .134 | 8 .192 | .230 | .184 | .220 |
| 9 .181 | .216 | .109 | .130 | 9 .208 | .248 | .243 | .290 |
| 10 .156 | .187 | .084 | .100 | 10 .153 | .183 | .171 | .204 |

## CORRECTION TO STANDARD CONDITIONS

| Test # 8 | | | | Test # 9 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 23 ft. | | | | Length of pipe 23 ft. | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| 1 Equalizer | | | | 1 Equalizer | | | |
| Top Readings | | Side Readings | | Top Readings | | Side Readings | |
| Zero Cor, | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .104 | .1317 | .148 | .1875 | 1 .275 | .338 | .132 | .162 |
| 2 .116 | .1470 | .185 | .234 | 2 .323 | .397 | .132 | .162 |
| 3 .118 | .1492 | .203 | .257 | 3 .296 | .364 | .141 | .173 |
| 4 .155 | .1965 | .213 | .270 | 4 .297 | .365 | .146 | .179 |
| 5 .162 | .2050 | .183 | .232 | 5 .234 | .288 | .184 | .226 |
| 6 .177 | .224 | .167 | .212 | 6 .212 | .261 | .242 | .297 |
| 7 .184 | .233 | .173 | .219 | 7 .258 | .317 | .272 | .334 |
| 8 .210 | .266 | .195 | .247 | 8 .295 | .363 | .289 | .355 |
| 9 .232 | .294 | .279 | .354 | 9 .321 | .395 | .303 | .372 |
| 10 .163 | .206 | .255 | .323 | 10 .308 | .379 | .200 | .246 |

## CORRECTIONS TO STANDARD CONDITIONS

Test # 10

Length of pipe 23 ft.

½ Opening

1 Equalizer

| | Top Readings | | Side Readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor | R.P.M. Cor. |
| 1 | .088 | .105 | .036 | .043 |
| 2 | .088 | .105 | .050 | .059 |
| 3 | .100 | .119 | .066 | .078 |
| 4 | .091 | .109 | .060 | .071 |
| 5 | .120 | .143 | .069 | .082 |
| 6 | .050 | .059 | .124 | .148 |
| 7 | .048 | .057 | .128 | .153 |
| 8 | .048 | .057 | .166 | .198 |
| 9 | .036 | .043 | .150 | .179 |
| 10 | .030 | .035 | .159 | .190 |

Test # 11

Length of pipe 23 ft.

5/8 Opening

1 Equalizer

| | Top Readings | | Side Readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .073 | .093 | .117 | .150 |
| 2 | .073 | .093 | .123 | .157 |
| 3 | .068 | .087 | .137 | .175 |
| 4 | .080 | .102 | .111 | .142 |
| 5 | .113 | .145 | .121 | .155 |
| 6 | .092 | .118 | .115 | .147 |
| 7 | .106 | .136 | .106 | .136 |
| 8 | .106 | .136 | .135 | .173 |
| 9 | .151 | .193 | .153 | .196 |
| 10 | .085 | .109 | .191 | .245 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 12 | | | | Test # 13 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 23 ft. | | | | Length of pipe 23 ft. | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| 1 Equalizer | | | | 1 Equalizer | | | |
| Top readings | | Side Readings | | Top readings | | Side Readings | |
| Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .118 | .152 | .111 | .1432 | 1 .172 | .215 | .203 | .254 |
| 2 .130 | .1677 | .198 | .2560 | 2 .180 | .225 | .281 | .351 |
| 3 .086 | .111 | .213 | .275 | 3 .118 | .147 | .273 | .341 |
| 4 .593 | .120 | .189 | .244 | 4 .122 | .152 | .223 | .279 |
| 5 .125 | .161 | .206 | .266 | 5 .140 | .175 | .233 | .291 |
| 6 .163 | .210 | .144 | .186 | 6 .215 | .269 | .191 | .239 |
| 7 .189 | .244 | .133 | .171 | 7 .272 | .340 | .173 | .216 |
| 8 .173 | .224 | .177 | .229 | 8 .253 | .316 | .272 | .340 |
| 9 .178 | .230 | .196 | .253 | 9 .259 | .324 | .355 | .443 |
| 10 .106 | .137 | .245 | .316 | 10 .165 | .206 | .394 | .492 |

## CORRECTIONS TO STANDARD CONDITIONS

### Test # 14

Length of pipe 23 ft.

½ Opening

2 Equalizers

| | Top Readings | | Side teadings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .072 | .064 | .227 | .202 |
| 2 | .082 | .073 | .201 | .178 |
| 3 | .087 | .077 | .219 | .194 |
| 4 | .100 | .089 | .219 | .194 |
| 5 | .102 | .907 | .191 | .170 |
| c | .173 | .154 | .149 | .132 |
| 6 | .250 | .222 | .118 | .105 |
| 7 | .256 | .227 | .118 | .105 |
| 8 | .261 | .232 | .163 | .145 |
| 9 | .245 | .218 | .138 | .123 |
| 10 | .124 | .110 | .082 | .073 |

### Test # 15

Length of pipe 23 ft.

5/8 Opening

2 Equalizers

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor | Zero Cor. | R.P.M. Cor. |
| 1 | .190 | .226 | .178 | .212 |
| 2 | .203 | .242 | .126 | .150 |
| 3 | .230 | .274 | .148 | .176 |
| 4 | .273 | .325 | .172 | .205 |
| 5 | .275 | .326 | .198 | .236 |
| c | .220 | .262 | .218 | .260 |
| 6 | .228 | .272 | .248 | .296 |
| 7 | .302 | .361 | .216 | .258 |
| 8 | .300 | .358 | .268 | .320 |
| 9 | .303 | .361 | .230 | .274 |
| 10 | .250 | .298 | .150 | .179 |

## CORRECTIONS TO STANDARD CONDITIONS

### Test # 16

Length of pipe 23 ft.

3/4 Opening

2 Equalizers

| | Top readings Zero Cor. | Top readings R.P.M. Cor. | Side readings Zero Cor. | Side readings R.P.M. Cor. |
|---|---|---|---|---|
| 1 | .308 | .265 | .155 | .1336 |
| 2 | .335 | .289 | .145 | .1250 |
| 3 | .313 | .270 | .166 | .143 |
| 4 | .373 | .321 | .184 | .1587 |
| 5 | .360 | .310 | .227 | .196 |
| c | .271 | .234 | .269 | .232 |
| 6 | .253 | .218 | .355 | .306 |
| 7 | .275 | .237 | .321 | .277 |
| 8 | .383 | .330 | .411 | .354 |
| 9 | .411 | .354 | .340 | .293 |
| 10 | .298 | .257 | .225 | .194 |

### Test # 17

Length of pipe 23 ft.

7/8 Opening

2 Equalizers

| | Top readings Zero Cor. | Top readings R.P.M. Cor. | Side readings Zero Cor. | Side readings R.P.M. Cor. |
|---|---|---|---|---|
| 1 | .350 | .314 | .230 | .207 |
| 2 | .388 | .349 | .193 | .173 |
| 3 | .381 | .342 | .237 | .213 |
| 4 | .444 | .399 | .252 | .226 |
| 5 | .426 | .382 | .275 | .247 |
| c | .318 | .286 | .313 | .281 |
| 6 | .333 | .299 | .413 | .371 |
| 7 | .339 | .305 | .401 | .360 |
| 8 | .448 | .402 | .478 | .430 |
| 9 | .544 | .489 | .419 | .376 |
| 10 | .460 | .413 | .280 | .251 |

## CORRECTIONS TO STANDARD CONDITIONS

### Test # 18

Length of pipe 14 ft. 2in.

½ Opening

No Equalizer

| | Top readings Zero Cor. | R.P.M. Cor. | Side readings Zero Cor. | R.P.M. Cor. |
|---|---|---|---|---|
| 1 | .076 | .092 | .065 | .079 |
| 2 | .090 | .184 | .080 | .097 |
| 3 | .107 | .129 | .086 | .138 |
| 4 | .118 | .143 | .099 | .119 |
| 5 | .130 | .157 | .109 | .132 |
| 6 | .068 | .082 | .142 | .172 |
| 7 | .050 | .060 | .163 | .192 |
| 8 | .050 | .060 | .160 | .194 |
| 9 | .050 | .060 | .168 | .203 |
| 10 | .025 | .030 | .132 | .160 |

### Test # 19

Length of pipe 14 ft. 2In.

5/8 Opening

No Equalizer

| | Top readings Zero Cor. | R.P.M. Cor. | Side readings Zero Cor. | R.P.M. Cor. |
|---|---|---|---|---|
| 1 | .091 | .109 | .082 | .096 |
| 2 | .095 | .114 | .123 | .149 |
| 3 | .096 | .116 | .139 | .168 |
| 4 | .103 | .124 | .138 | .166 |
| 5 | .131 | .158 | .142 | .172 |
| 6 | .117 | .141 | .140 | .169 |
| 7 | .112 | .135 | .141 | .170 |
| 8 | .110 | .133 | .160 | .193 |
| 9 | .087 | .105 | .200 | .242 |
| 10 | .087 | .185 | .212 | .256 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 20 | | | | Test # 21 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | Length of pipe 14'2" | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| No equalizer | | | | No equalizer | | | |
| | Top readings | | Side readings | | Top readings | | Side readings |
| | Zero Cor | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .172 | .207 | .076 | .092 | .278 | .336 | .130 | .157 |
| 2 | .145 | .175 | .120 | .145 | .203 | .245 | .129 | .156 |
| 3 | .132 | .159 | .130 | .156 | .195 | .236 | .150 | .181 |
| 4 | .140 | .169 | .174 | .210 | .173 | .209 | .170 | .206 |
| 5 | .179 | .216 | .195 | .235 | .232 | .281 | .251 | .303 |
| 6 | .219 | .264 | .192 | .231 | .297 | .359 | .242 | .293 |
| 7 | .223 | .268 | .185 | .223 | .302 | .365 | .271 | .327 |
| 8 | .220 | .265 | .214 | .258 | .293 | .354 | .300 | .363 |
| 9 | .200 | .241 | .248 | .298 | .289 | .349 | .307 | .371 |
| 10 | .130 | .156 | .272 | .328 | .152 | .184 | .280 | .338 |

## CORRECTIONS TO STANDARD CONDITIONS

### Test # 22

Length of pipe 14 ft. 2 In

½ Opening

1 Equalizer

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .056 | .048 | .146 | .126 |
| 2 | .065 | .056 | .219 | .190 |
| 3 | .053 | .046 | .216 | .187 |
| 4 | .047 | .040 | .176 | .152 |
| 5 | .059 | .051 | .141 | .122 |
| c | .147 | .127 | .076 | .065 |
| 6 | .205 | .178 | .030 | .026 |
| 7 | .268 | .232 | .029 | .025 |
| 8 | .297 | .257 | .056 | .048 |
| 9 | .269 | .232 | .076 | .065 |
| 10 | .231 | .200 | .276 | .065 |

### Test # 23

Length of pipe 14 ft. 2 In.

5/8 Opening

1 Equalizer

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .207 | .178 | .125 | .107 |
| 2 | .245 | .210 | .184 | .158 |
| 3 | .262 | .224 | .184 | .158 |
| 4 | .298 | .256 | .229 | .197 |
| 5 | .257 | .220 | .232 | .199 |
| c | .248 | .212 | .253 | .217 |
| 6 | .265 | .227 | .224 | .192 |
| 7 | .235 | .202 | .190 | .163 |
| 8 | .270 | .232 | .207 | .178 |
| 9 | .302 | .259 | .267 | .229 |
| 10 | .252 | .216 | .222 | .190 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 24 | | | | | Test # 25 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length of pipe 14 ft. 2 In. | | | | | Length of pipe 14 ft. 2 In. | | | | |
| 3/4 Opening | | | | | 7/8 Opening | | | | |
| 1 Equalizer | | | | | 1 Equalizer | | | | |
| Top readings | | Side readings | | | Top readings | | Side readings | | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .327 | .282 | .120 | .103 | 1 | .450 | .391 | .149 | .129 |
| 2 | .420 | .362 | .149 | .229 | 2 | .532 | .462 | .164 | .142 |
| 3 | .429 | .371 | .170 | .147 | 3 | .501 | .435 | .179 | .156 |
| 4 | .406 | .350 | .177 | .153 | 4 | .493 | .427 | .207 | .180 |
| 5 | .347 | .299 | .204 | .176 | 5 | .370 | .322 | .242 | .210 |
| c | .254 | .219 | .329 | .284 | c | .274 | .248 | .334 | .290 |
| 6 | .212 | .183 | .404 | .348 | 6 | .270 | .234 | .457 | .397 |
| 7 | .207 | .178 | .353 | .304 | 7 | .372 | .322 | .504 | .438 |
| 8 | .267 | .230 | .327 | .282 | 8 | .479 | .416 | .495 | .430 |
| 9 | .311 | .268 | .330 | .385 | 9 | .613 | .532 | .487 | .423 |
| 10 | .333 | .287 | .339 | .292 | 10 | .564 | .490 | .507 | .440 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 26 | | | | Test # 27 | | | | |
|---|---|---|---|---|---|---|---|---|
| Length of pipe 14 ft. 2 In | | | | Length of pipe 14 ft. 2 In. | | | | |
| ½ Opening | | | | 5/8 Opening | | | | |
| 2 Equalizers | | | | 2 Equalizers | | | | |
| Top readings | | Side readings | | Top Readings | | Side Readings | | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .100 | .084 | .291 | .244 | 1 | .174 | .152 | .236 | .207 |
| 2 | .092 | .077 | .343 | .288 | 2 | .199 | .174 | .303 | .266 |
| 3 | .073 | .061 | .282 | .236 | 3 | .191 | .168 | .263 | .230 |
| 4 | .060 | .050 | .246 | .206 | 4 | .279 | .245 | .291 | .255 |
| 5 | .048 | .040 | .122 | .102 | 5 | .329 | .289 | .293 | .256 |
| c | .090 | .075 | .046 | .038 | c | .379 | .333 | .299 | .262 |
| 6 | .143 | .120 | .033 | .027 | 6 | .247 | .217 | .188 | .165 |
| 7 | .251 | .210 | .070 | .059 | 7 | .267 | .235 | .159 | .139 |
| 8 | .250 | .210 | .115 | .096 | 8 | .149 | .131 | .184 | .161 |
| 9 | .261 | .218 | .183 | .153 | 9 | .191 | .168 | .127 | .111 |
| 10 | .231 | .193 | .170 | .143 | 10 | .127 | .112 | .219 | .192 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 28 | | | | | Test # 29 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length of pipe 14 ft. 2 In. | | | | | Length of pipe 14 ft. 2 In. | | | | |
| 3/4 Opening | | | | | 7/8 Opening | | | | |
| 2 Equalizers | | | | | 2 Equalizers | | | | |
| | Top readings | | Side readings | | | Top readings | | Side readings | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .310 | .270 | .458 | .399 | 1 | .436 | .378 | .466 | .404 |
| 2 | .379 | .330 | .413 | .360 | 2 | .579 | .502 | .442 | .384 |
| 3 | .341 | .297 | .349 | .304 | 3 | .513 | .447 | .327 | .284 |
| 4 | .429 | .374 | .253 | .220 | 4 | .625 | .543 | .280 | .243 |
| 5 | .381 | .332 | .247 | .215 | 5 | .457 | .396 | .258 | .224 |
| c | .341 | .297 | .451 | .392 | c | .490 | .426 | .587 | .510 |
| 6 | .191 | .166 | .392 | .341 | 6 | .350 | .304 | .548 | .477 |
| 7 | .192 | .167 | .287 | .250 | 7 | .303 | .263 | .427 | .371 |
| 8 | .125 | .109 | .305 | .265 | 8 | .205 | .178 | .385 | .335 |
| 9 | .140 | .122 | .322 | .280 | 9 | .216 | .187 | .408 | .355 |
| 10 | .122 | .106 | .293 | .255 | 10 | .165 | .143 | .400 | .348 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 30 | | | | Test # 31 | | | |
|---|---|---|---|---|---|---|---|
| Lenth of pipe 14' 2" | | | | Length of pipe 14' 2" | | | |
| ½ Opening | | | | 5/8 Opening | | | |
| No Equalizer | | | | No Equalizer | | | |
| | Top readings | | Side readings | | Top readings | | Side readings |
| | Zero R.P.M. | | Zero R.P.M. | | Zero R.P.M. | | Zero R.P.M. |
| | Cor. | Cor. | Cor. | Cor. | Cor. | Cor. | Cor. | Cor. |
| 1 | .126 | .103 | .152 | .240 | 1 .155 | .129 | .310 | .258 |
| 2 | .153 | .125 | .206 | .169 | 2 .105 | .087 | .331 | .274 |
| 3 | .186 | .152 | .224 | .184 | 3 .141 | .117 | .287 | .238 |
| 4 | .202 | .166 | .250 | .205 | 4 .196 | .163 | .266 | .221 |
| 5 | .235 | .193 | .285 | .234 | 5 .253 | .210 | .280 | .232 |
| c | .280 | .230 | .256 | .210 | c .293 | .243 | .280 | .232 |
| 6 | .286 | .234 | .166 | .136 | 6 .296 | .246 | .250 | .208 |
| 7 | .304 | .250 | .133 | .109 | 7 .313 | .260 | .240 | .199 |
| 8 | .324 | .266 | .140 | .115 | 8 .373 | .310 | .230 | .191 |
| 9 | .326 | .268 | .116 | .095 | 9 .415 | .344 | .230 | .191 |
| 10 | .236 | .194 | .100 | .082 | 10 .448 | .372 | .200 | .166 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 32 | | | | Test # 33 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | Length of pipe 14' 2" | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| No Equalizer | | | | No Equalizer | | | |
| | Top readings | | Side readings | | Top readings | | Side readings |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M Cor. |
| 1 | .195 | .162 | .381 | .316 | .215 | .181 | .490 | .412 |
| 2 | .141 | .117 | .366 | .304 | .216 | .182 | .504 | .424 |
| 3 | .169 | .140 | .286 | .237 | .235 | .198 | .446 | .376 |
| 4 | .220 | .182 | .267 | .221 | .272 | .229 | .380 | .320 |
| 5 | .311 | .258 | .313 | .260 | .386 | .325 | .404 | .340 |
| c | .410 | .340 | .363 | .301 | .486 | .410 | .448 | .378 |
| 6 | .399 | .331 | .408 | .339 | .496 | .418 | .506 | .426 |
| 7 | .411 | .341 | .387 | .321 | .536 | .452 | .458 | .386 |
| 8 | .466 | .387 | .357 | .296 | .624 | .525 | .374 | .314 |
| 9 | .541 | .449 | .316 | .262 | .649 | .546 | .345 | .290 |
| 10 | .561 | .465 | .271 | .225 | .510 | .430 | .208 | .175 |

CORRECTIONS TO STANDARD CONDITIONS

| Test # 34 | | | | Test # 35b | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | Length of pipe 14' 2" | | | |
| 1/2 Opening | | | | 5/8 Opening | | | |
| One Equalizer 2' 3" out | | | | One equalizer 2' 3" out | | | |
| Top readings | | Side readings | | Top readings | | Side readings | |
| Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .071 | .058 | .196 | .160 | 1 .140 | .115 | .116 | .095 |
| 2 .082 | .066 | .233 | .190 | 2 .176 | .145 | .136 | .102 |
| 3 .073 | .059 | .243 | .198 | 3 .169 | .140 | .168 | .139 |
| 4 .061 | .050 | .213 | .173 | 4 .188 | .155 | .188 | .155 |
| 5 .052 | .042 | .173 | .141 | 5 .206 | .170 | .188 | .155 |
| c .106 | .086 | .132 | .107 | 6 .276 | .224 | .286 | .236 |
| 6 .203 | .165 | .077 | .063 | 6 .256 | .212 | .265 | .219 |
| 7 .263 | .214 | .103 | .084 | 7 .256 | .212 | .258 | .213 |
| 8 .285 | .232 | .153 | .124 | 8 .266 | .220 | .268 | .222 |
| 9 .282 | .230 | .193 | .157 | 9 .310 | .256 | .295 | .244 |
| 10 .243 | .198 | .175 | .142 | 10 .300 | .448 | .286 | .236 |

CORRECTIONS TO STANDARD CONDITIONS

Test # 35a

Length of pipe 14' 2"

5/8 Opening

One equalizer 2' 3" out 45

| | Top readings | | Side readings | |
|---|---|---|---|---|
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .065 | .220 | .114 | .195 |
| 2 | .273 | .227 | .148 | .123 |
| 3 | .269 | .224 | .163 | .136 |
| 4 | .283 | .235 | .166 | .138 |
| 5 | .271 | .225 | .195 | .162 |
| c | .233 | .194 | .275 | .229 |
| 6 | .203 | .169 | .265 | .220 |
| 7 | .153 | .127 | .285 | .237 |
| 8 | .151 | .126 | .265 | .220 |
| 9 | .163 | .136 | .295 | .246 |
| 10 | .121 | .101 | .285 | .237 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 36 | | | | Test # 37 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | Length of pipe 14' 2" | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| One equalizer 2' 3" out | | | | One equalizer 2' 3" out | | | |
| Top readings | | Side readings | | Top Readings | | Side readings | |
| Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .382 | .320 | .169 | .142 | 1 .549 | .465 | .198 | .168 |
| 2 .422 | .363 | .199 | .165 | 2 .573 | .486 | .217 | .184 |
| 3 .392 | .328 | .180 | .151 | 3 .603 | .512 | .217 | .184 |
| 4 .422 | .353 | .159 | .133 | 4 .583 | .495 | .193 | .164 |
| 5 .362 | .303 | .159 | .133 | 5 .423 | .360 | .228 | .193 |
| c .332 | .378 | .263 | .220 | c .357 | .303 | .357 | .303 |
| 6 .272 | .228 | .377 | .316 | 6 .372 | .316 | .489 | .415 |
| 7 .256 | .214 | .401 | .336 | 7 .387 | .328 | .488 | .414 |
| 8 .312 | .262 | .373 | .312 | 8 .452 | .384 | .511 | .434 |
| 9 .312 | .262 | .418 | .350 | 9 .468 | .398 | .511 | .434 |
| 10 .222 | .186 | .419 | .351 | 10 .384 | .326 | .527 | .447 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 38 | | | | | Test # 39 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | | Length of pipe 14' 2" | | | | |
| 1/2 Opening | | | | | 5/8 Opening | | | | |
| One equalizer 6' 7" out | | | | | One equalizer 6'7" out | | | | |
| | Top readings | | Side readings | | | Top readings | | Side readings | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .110 | .094 | .187 | .154 | 1 | .159 | .134 | .269 | .227 |
| 2 | .118 | .097 | .240 | .198 | 2 | .190 | .160 | .269 | .227 |
| 3 | .137 | .113 | .221 | .182 | 3 | .200 | .169 | .225 | .190 |
| 4 | .155 | .128 | .219 | .180 | 4 | .207 | .174 | .181 | .153 |
| 5 | .168 | .138 | .229 | .189 | 5 | .229 | .183 | .205 | .173 |
| c | .267 | .220 | .219 | .180 | c | .215 | .181 | .205 | .173 |
| 6 | .248 | .204 | .087 | .072 | 6 | .284 | .239 | .229 | .193 |
| 7 | .328 | .270 | .071 | .059 | 7 | .308 | .260 | .177 | .149 |
| 8 | .280 | .231 | .058 | .048 | 8 | .315 | .265 | .181 | .152 |
| 9 | .329 | .271 | .058 | .048 | 9 | .355 | .315 | .170 | .143 |
| 10 | .267 | .220 | .058 | .048 | 10 | .319 | .268 | .184 | .155 |

## CORRECTIONS TO STANDARD CONDITIONS

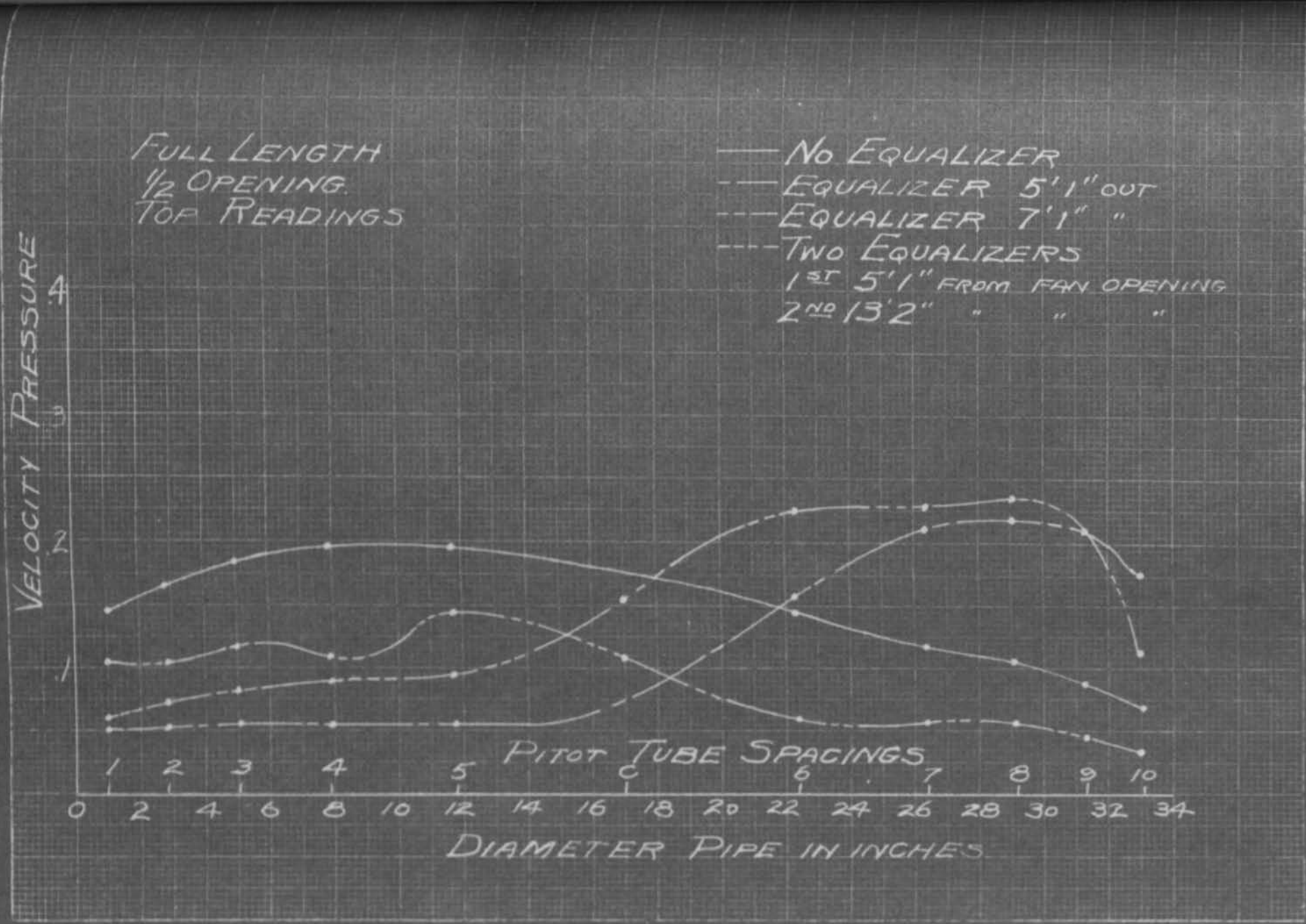
| Test # 40 | | | | Test # 41 | | | | |
|---|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | Length of pipe 14' 2" | | | | |
| 3/4 Opening | | | | 7/8 Opening | | | | |
| One equalizer 6' 7" out | | | | One equalizer 6' 7" out | | | | |
| Top readings | | Side readings | | Top readings | | Side readings | | |
| | Zero Cor | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .168 | .144 | .380 | .325 | 1 | .202 | .179 | .548 | .486 |
| 2 | .198 | .169 | .350 | .300 | 2 | .258 | .229 | .529 | .469 |
| 3 | .205 | .175 | .311 | .266 | 3 | .240 | .213 | .423 | .375 |
| 4 | .217 | .186 | .236 | .202 | 4 | .248 | .220 | .277 | .246 |
| 5 | .303 | .259 | .229 | .197 | 5 | .316 | .280 | .263 | .233 |
| c | .265 | .226 | .279 | .239 | c | .285 | .252 | .299 | .265 |
| 6 | .278 | .238 | .341 | .292 | 6 | .401 | .356 | .356 | .316 |
| 7 | .368 | .315 | .312 | .267 | 7 | .445 | .394 | .424 | .376 |
| 8 | .378 | .324 | .350 | .300 | 8 | .441 | .391 | .459 | .407 |
| 9 | .498 | .426 | .309 | .264 | 9 | .551 | .488 | .437 | .387 |
| 10 | .458 | .392 | .356 | .304 | 10 | .485 | .430 | .469 | .415 |

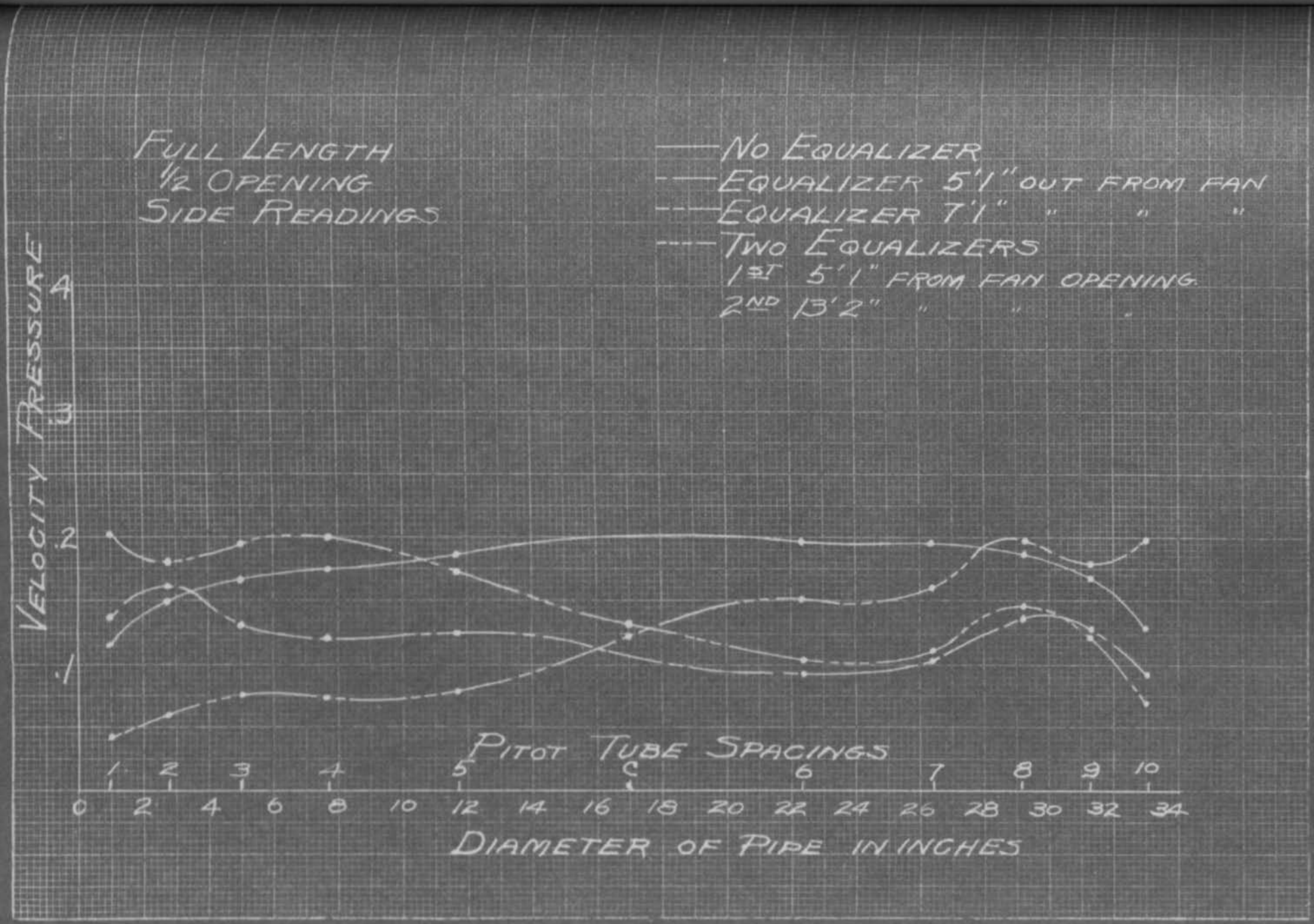
CORRECTIONS TO STANDARD CONDITIONS

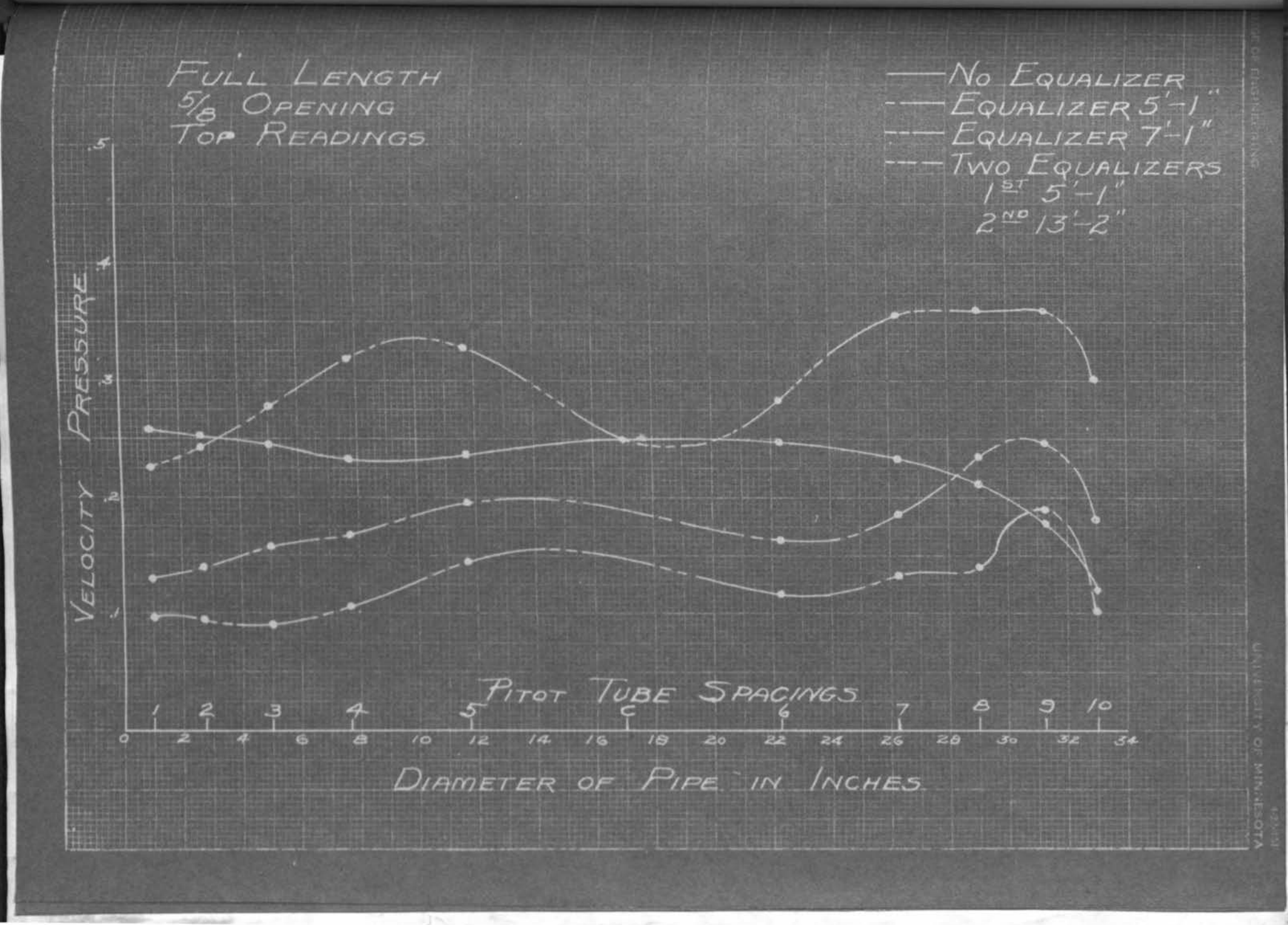
| | Test # 42 | | | | | Test # 43 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Length of pipe 14' 2" | | | | | Length of pipe 14' 2" | | | | |
| | 1/2 Opening | | | | | 5/8 Opening | | | |
| Two equalizers 2' 3" & 6' 7" out | | | | | | | | | |
| | Top readings | | Side readings | | | Top readings | | Side readings | |
| | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 | .082 | .068 | .200 | .166 | 1 | .143 | .122 | .170 | .145 |
| 2 | .089 | .074 | .260 | .216 | 2 | .249 | .212 | .215 | .183 |
| 3 | .066 | .055 | .171 | .142 | 3 | .204 | .178 | .165 | .141 |
| 4 | .035 | .029 | .239 | .198 | 4 | .251 | .214 | .192 | .164 |
| 5 | .041 | .034 | .181 | .150 | 5 | .303 | .268 | .250 | .213 |
| c | .132 | .109 | .130 | .108 | c | .285 | .243 | .350 | .298 |
| 6 | .162 | .134 | .083 | .069 | 6 | .314 | .268 | .278 | .236 |
| 7 | .212 | .176 | .070 | .058 | 7 | .208 | .178 | .200 | .171 |
| 8 | .302 | .250 | .170 | .141 | 8 | .254 | .266 | .268 | .228 |
| 9 | .315 | .261 | .173 | .143 | 9 | .321 | .274 | .262 | .224 |
| 10 | .182 | .151 | .246 | .204 | 10 | .205 | .175 | .316 | .270 |

## CORRECTIONS TO STANDARD CONDITIONS

| Test # 44 | | | | Test # 45 | | | |
|---|---|---|---|---|---|---|---|
| Length of pipe 14 ' 2" | | | | Length of pipe 14' 2" | | | |
| 3/4 Opening | | | | 7/8 Opening | | | |
| Two equalizers 2' 3" and 6' 7" from fan openings | | | | | | | |
| Top readings | | Side readings | | Top readings | | Side readings | |
| Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. | Zero Cor. | R.P.M. Cor. |
| 1 .385 | .300 | .233 | .197 | 1 .438 | .380 | .229 | .198 |
| 2 .413 | .349 | .273 | .231 | 2 .584 | .505 | .538 | .206 |
| 3 .323 | .273 | .223 | .188 | 3 .518 | .450 | .158 | .234 |
| 4 .393 | .332 | .143 | .121 | 4 .538 | .467 | .149 | .129 |
| 5 .413 | .249 | .153 | .129 | 5 .450 | .390 | .196 | .170 |
| c .263 | .220 | .303 | .256 | c .330 | .286 | .408 | .354 |
| 6 .283 | .239 | .360 | .304 | 6 .258 | .224 | .438 | .380 |
| 7 .238 | .201 | .278 | .334 | 7 .288 | .250 | .348 | .302 |
| 8 .293 | .248 | .413 | .349 | 8 .413 | .358 | .489 | .424 |
| 9 .421 | .356 | .403 | .340 | 9 .520 | .451 | .443 | .384 |
| 10 .323 | .273 | .443 | .374 | 10 .367 | .318 | .528 | .458 |


FULL LENGTH
1/2 OPENING
TOF READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT
EQUALIZER 7'1" "
TWO EQUALIZERS
1ST 5'1" FROM FAN OPENING
2ND 13'2" " " "
VELOCITY PRESSURE
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 C 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER PIPE IN INCHES


FULL LENGTH
1/2 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
EQUALIZER 7'1" " " "
TWO EQUALIZERS
1ST 5'1" FROM FAN OPENING
2ND 13'2" " "
VELOCITY PRESSURE
4
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 C 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES


FULL LENGTH
5/8 OPENING
TOP READINGS
No Equalizer
Equalizer 5'-1"
Equalizer 7'-1"
Two Equalizers
1st 5'-1"
2nd 13'-2"
VELOCITY PRESSURE
.5
.4
.3
.2
.1
PITOT TUBE SPACINGS
1
2
3
4
5
C
6
7
8
9
10
0
2
4
6
8
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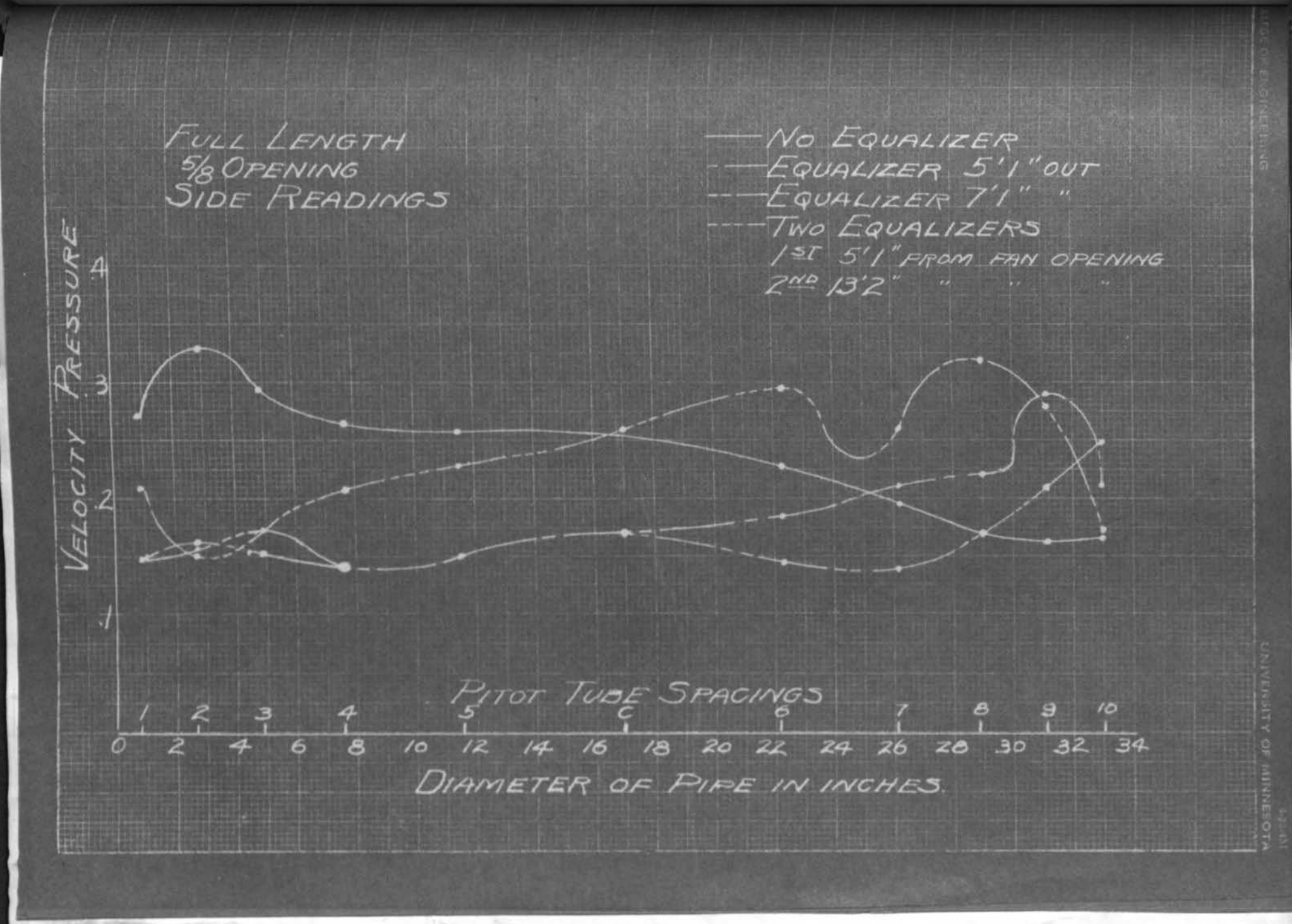
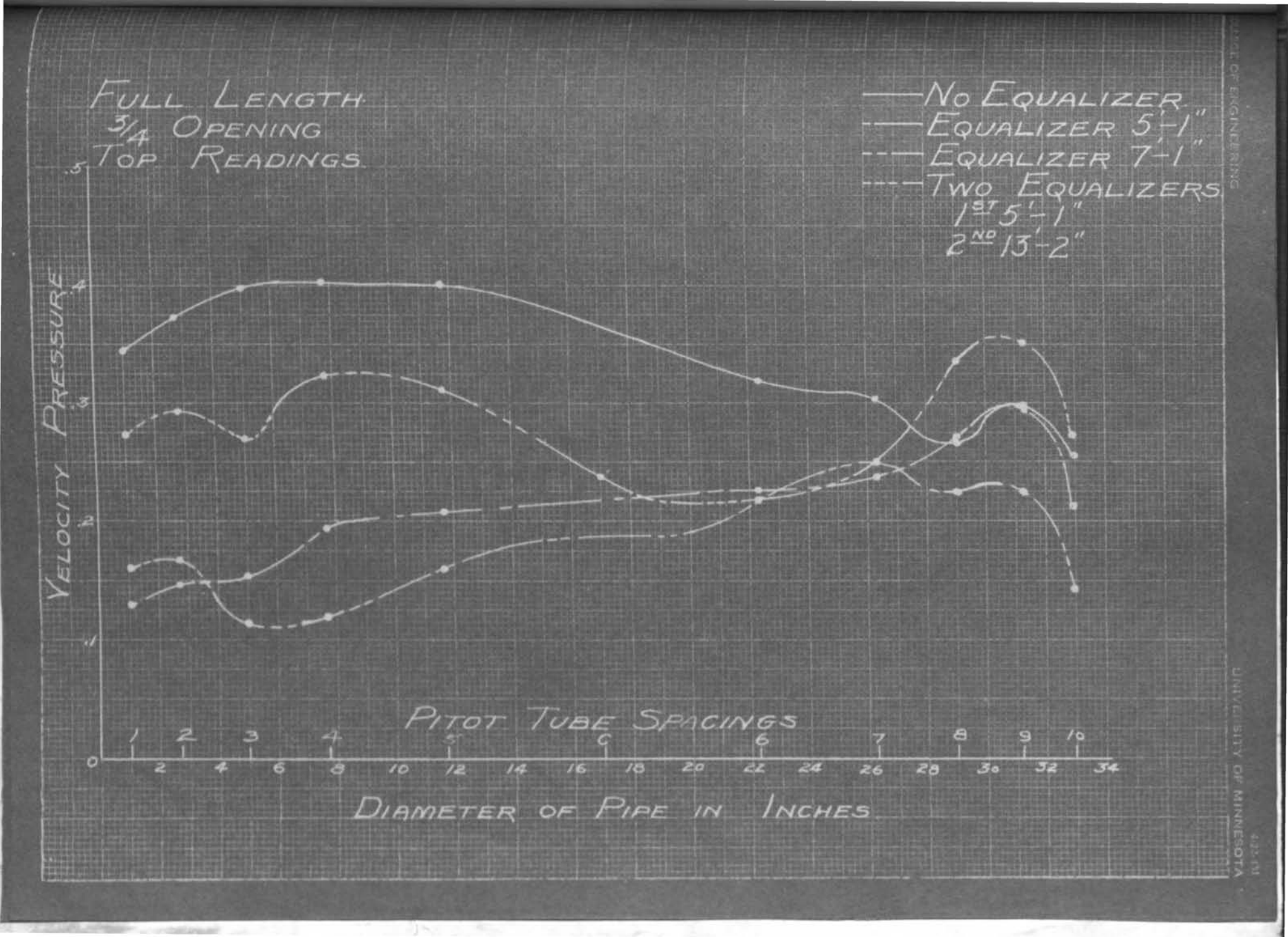
14
16
18
20
22
24
26
28
30
32
34
DIAMETER OF PIPE IN INCHES.


FULL LENGTH
5/8 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT
EQUALIZER 7'1" "
TWO EQUALIZERS
1ST 5'1" FROM FAN OPENING
2ND 13'2" " " "
VELOCITY PRESSURE
4
3
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 C 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES
UNIVERSITY OF MINNESOTA


FULL LENGTH
3/4 OPENING
TOP READINGS.
NO EQUALIZER
EQUALIZER 5'-1"
EQUALIZER 7'-1"
TWO EQUALIZERS
1ST 5'-1"
2ND 13'-2"
VELOCITY PRESSURE
.5
.4
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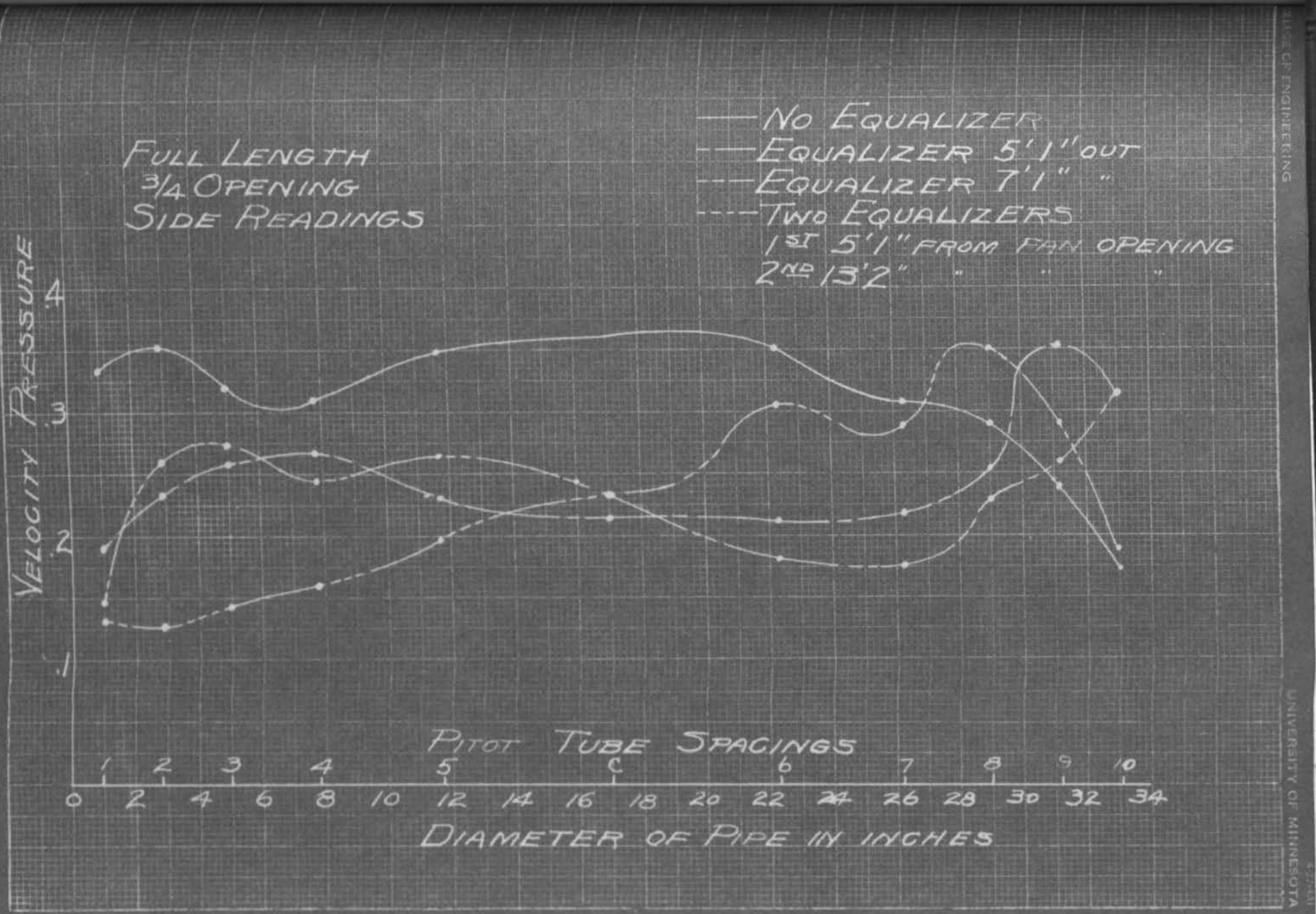
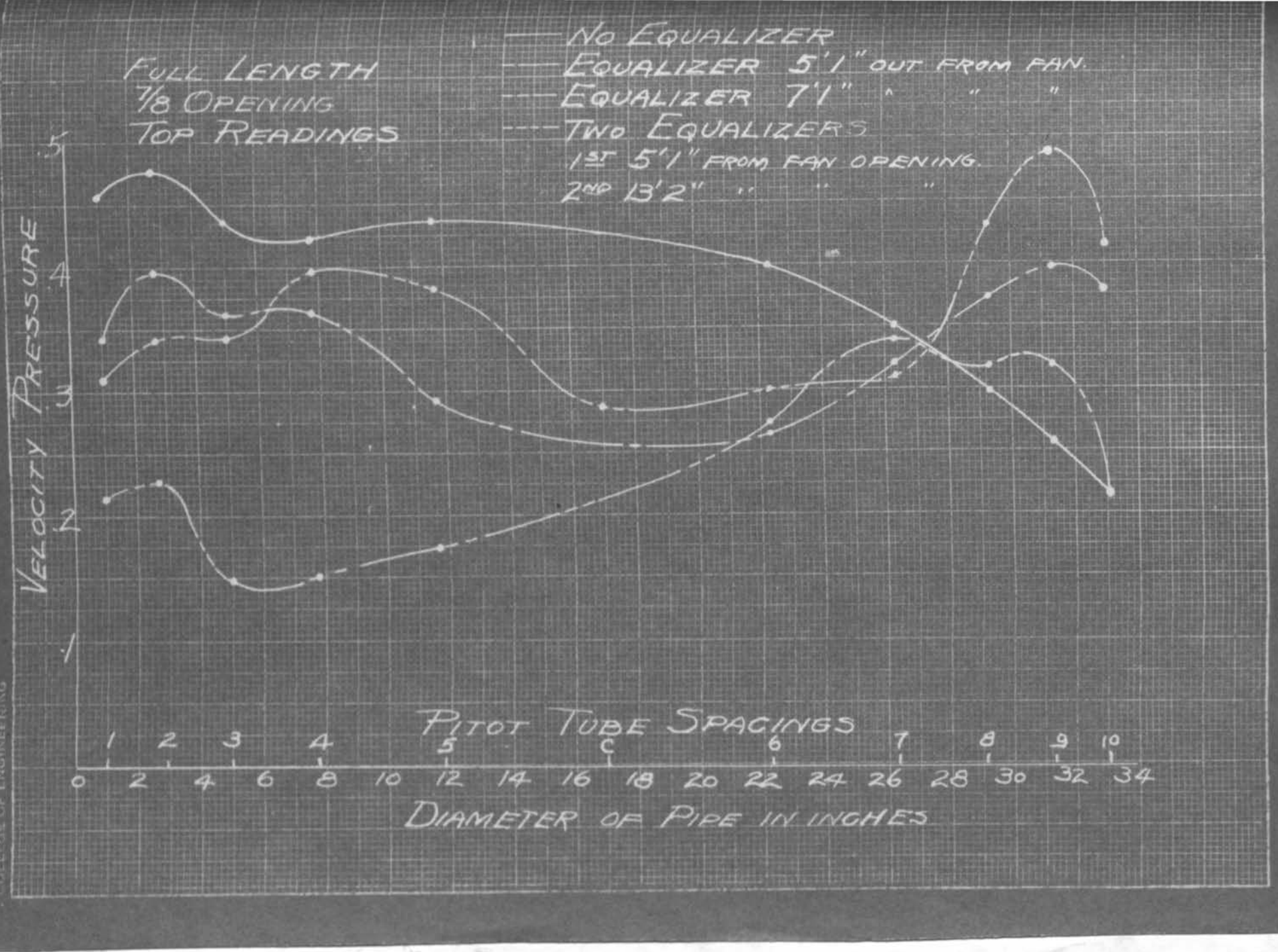
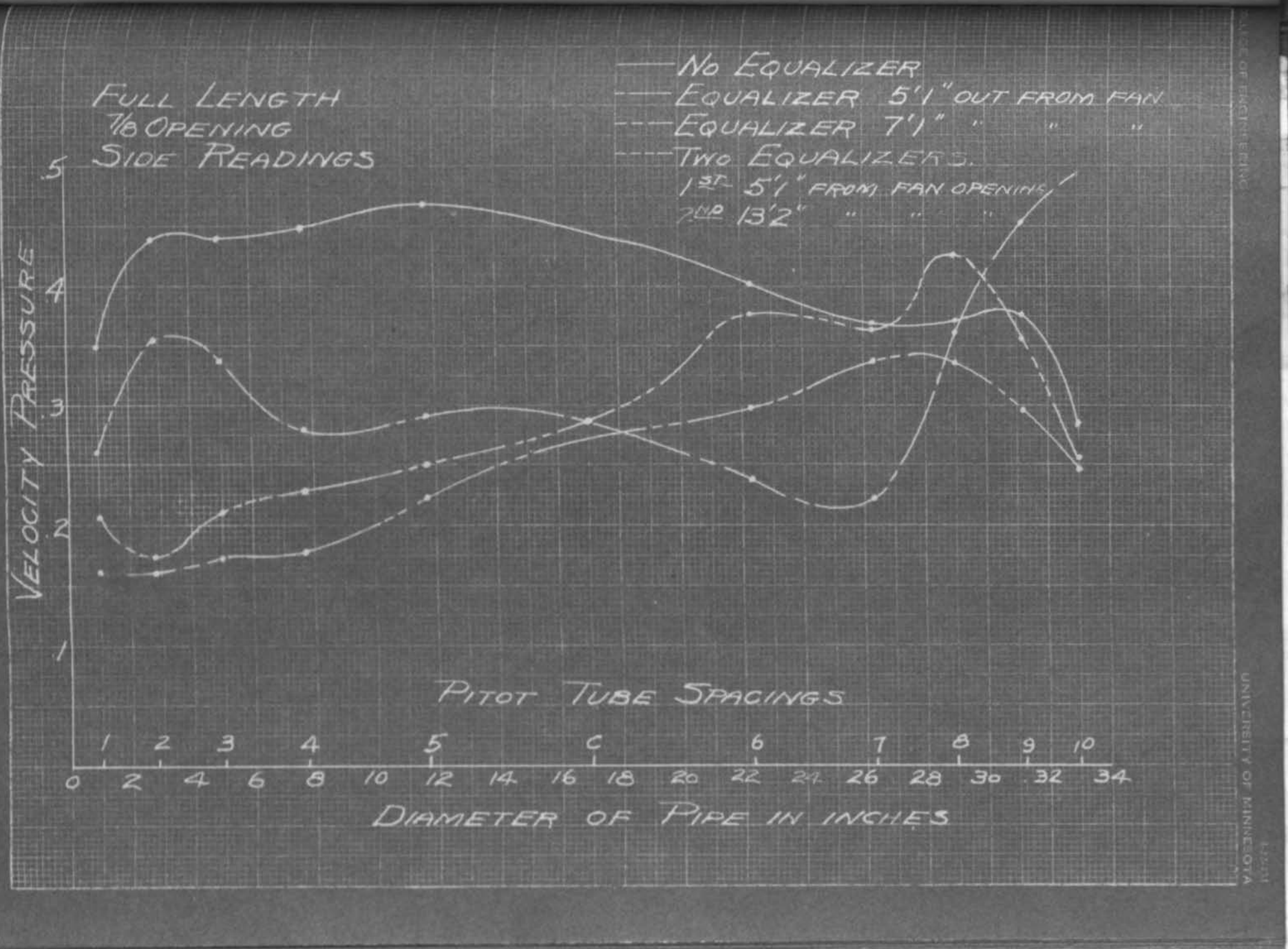
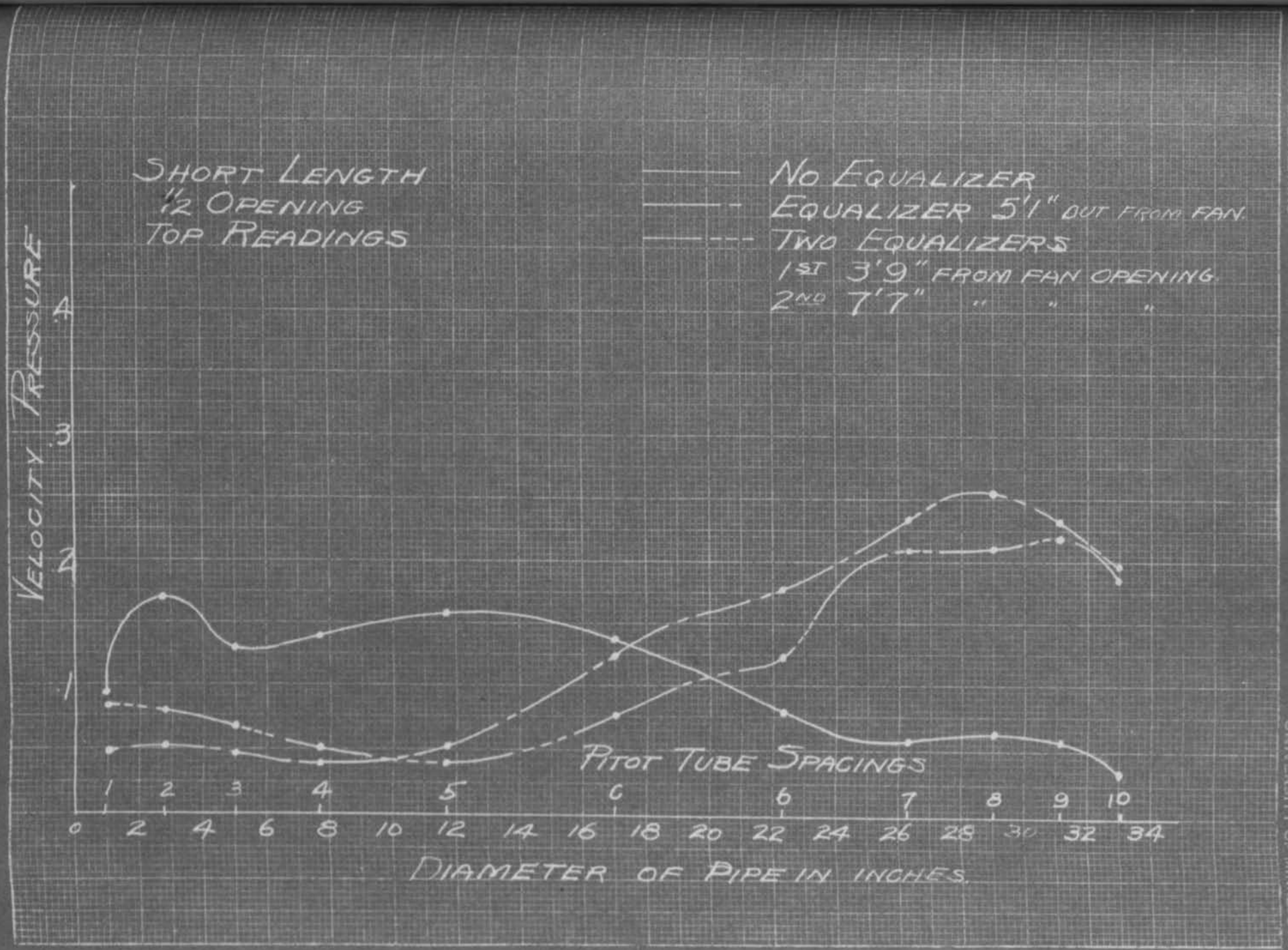
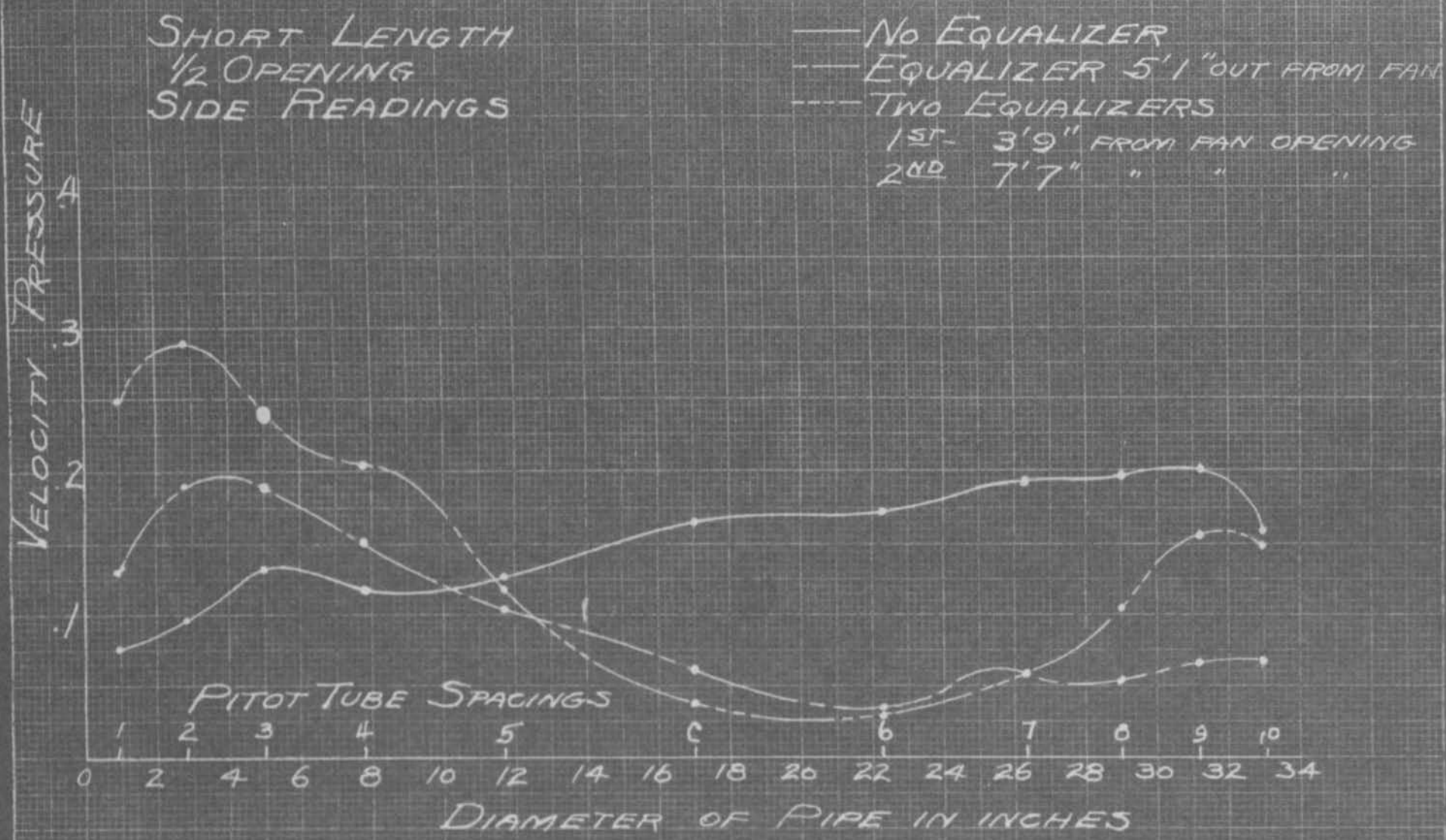
.2
.1
0
PITOT TUBE SPACINGS
1 2 3 4 5 6 6 7 8 9 10
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA


FULL LENGTH
3/4 OPENING
SIDE READINGS
—— NO EQUALIZER
– – EQUALIZER 5'1" OUT
– – – EQUALIZER 7'1" "
– – – – TWO EQUALIZERS
1ST 5'1" FROM FAN OPENING
2ND 13'2" " " "
VELOCITY PRESSURE
.1
.2
.3
.4
PITOT TUBE SPACINGS
1 2 3 4 5 C 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES



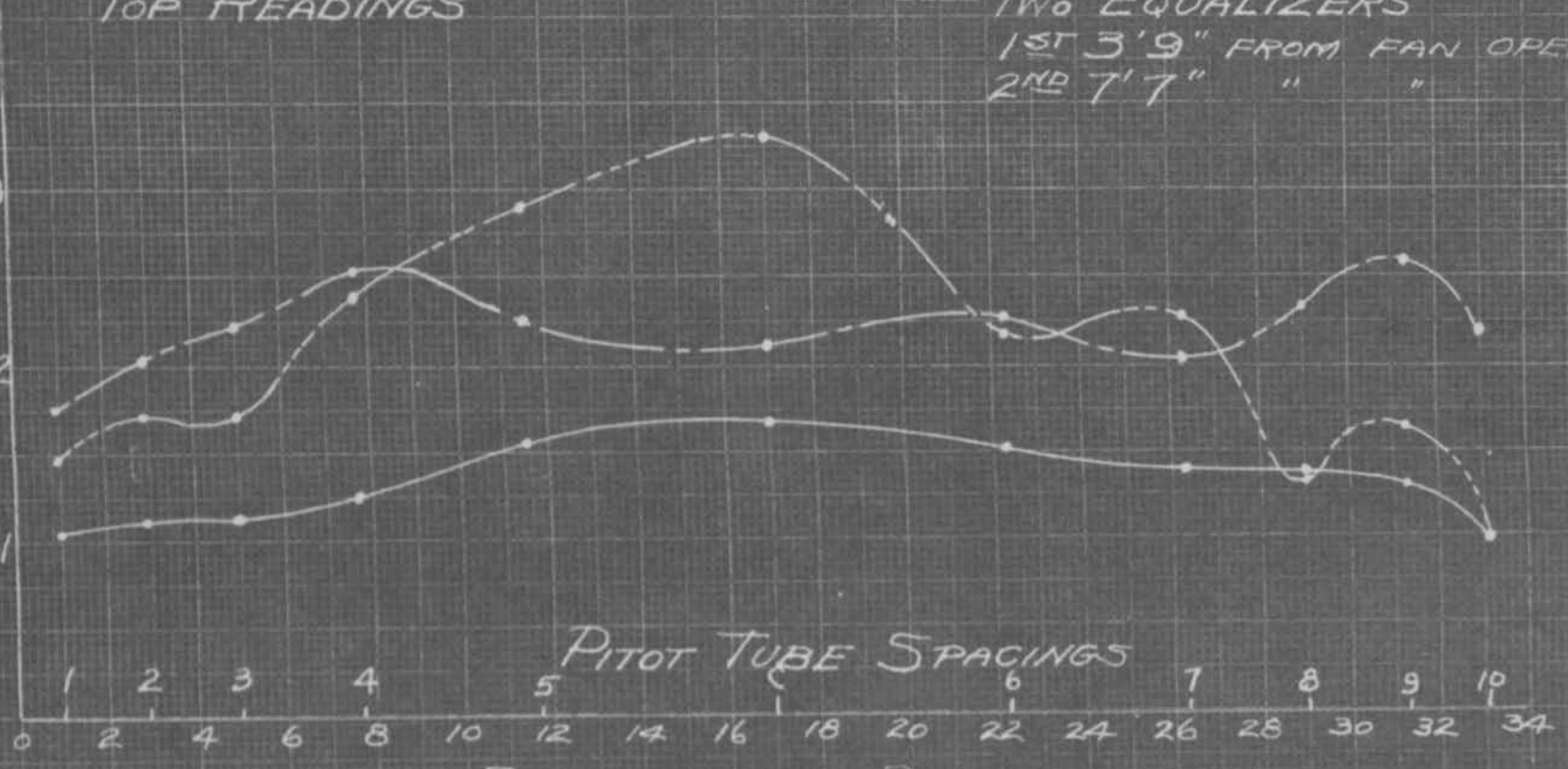

FULL LENGTH
1/8 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
EQUALIZER 7'1" " " "
TWO EQUALIZERS.
1ST 5'1" FROM FAN OPENING
2ND 13'2" " " "
VELOCITY PRESSURE
5
4
3
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 C 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA





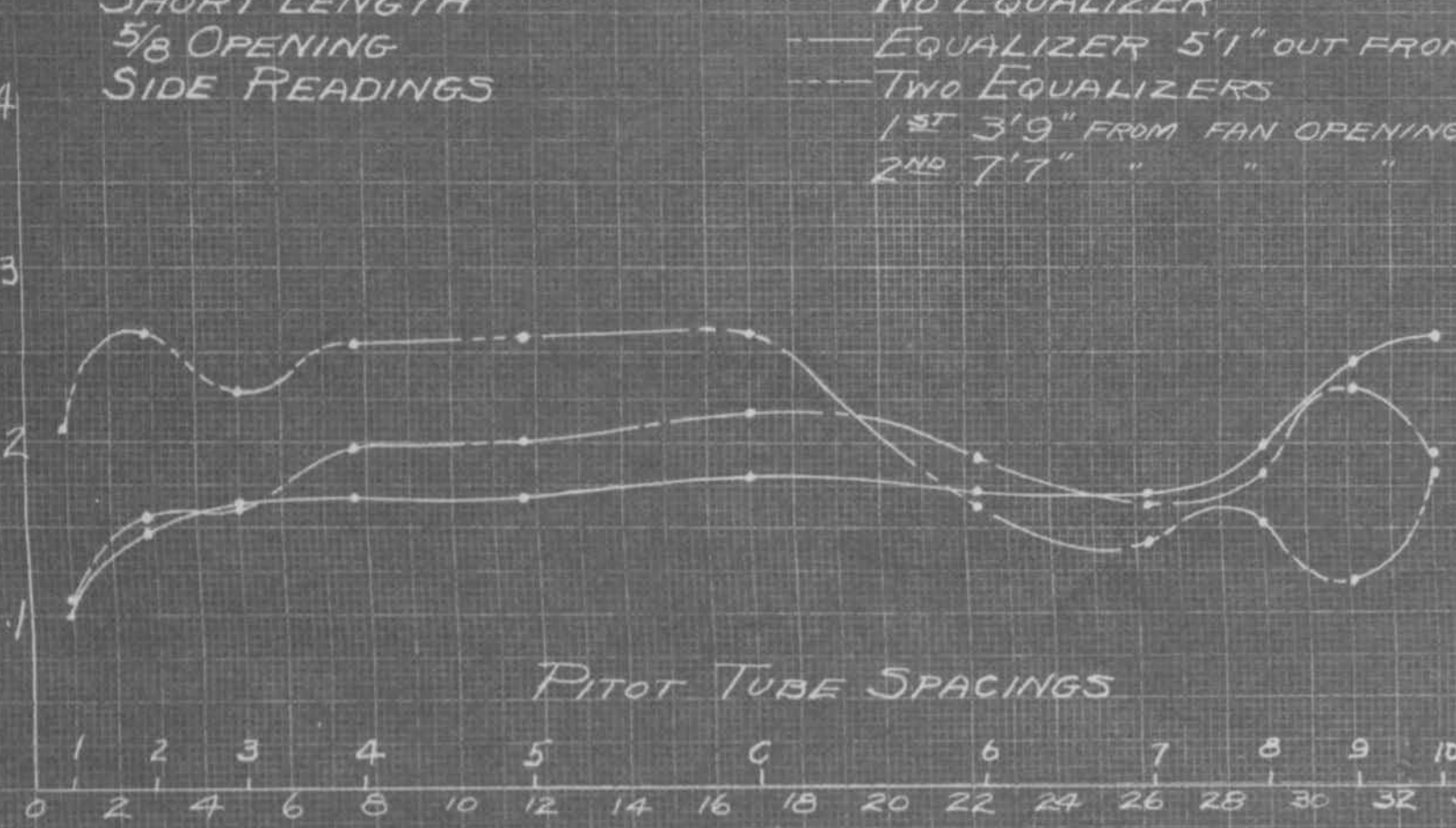
SHORT LENGTH
5/8 OPENING
TOP READINGS

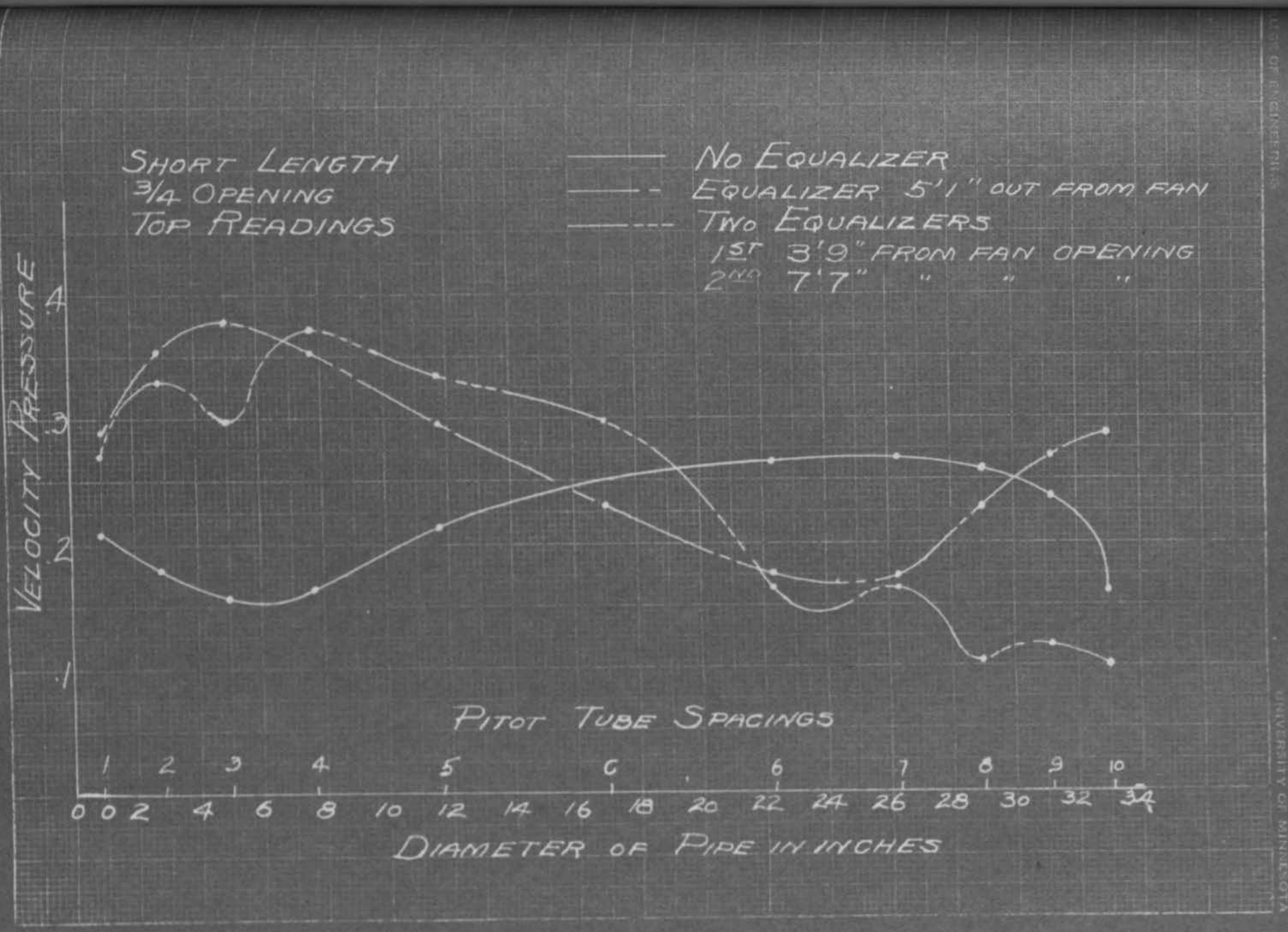
—— NO EQUALIZER
– – EQUALIZER 5'1" OUT FROM FAN
- - - TWO EQUALIZERS
1ST 3'9" FROM FAN OPENING
2ND 7'7" " " "

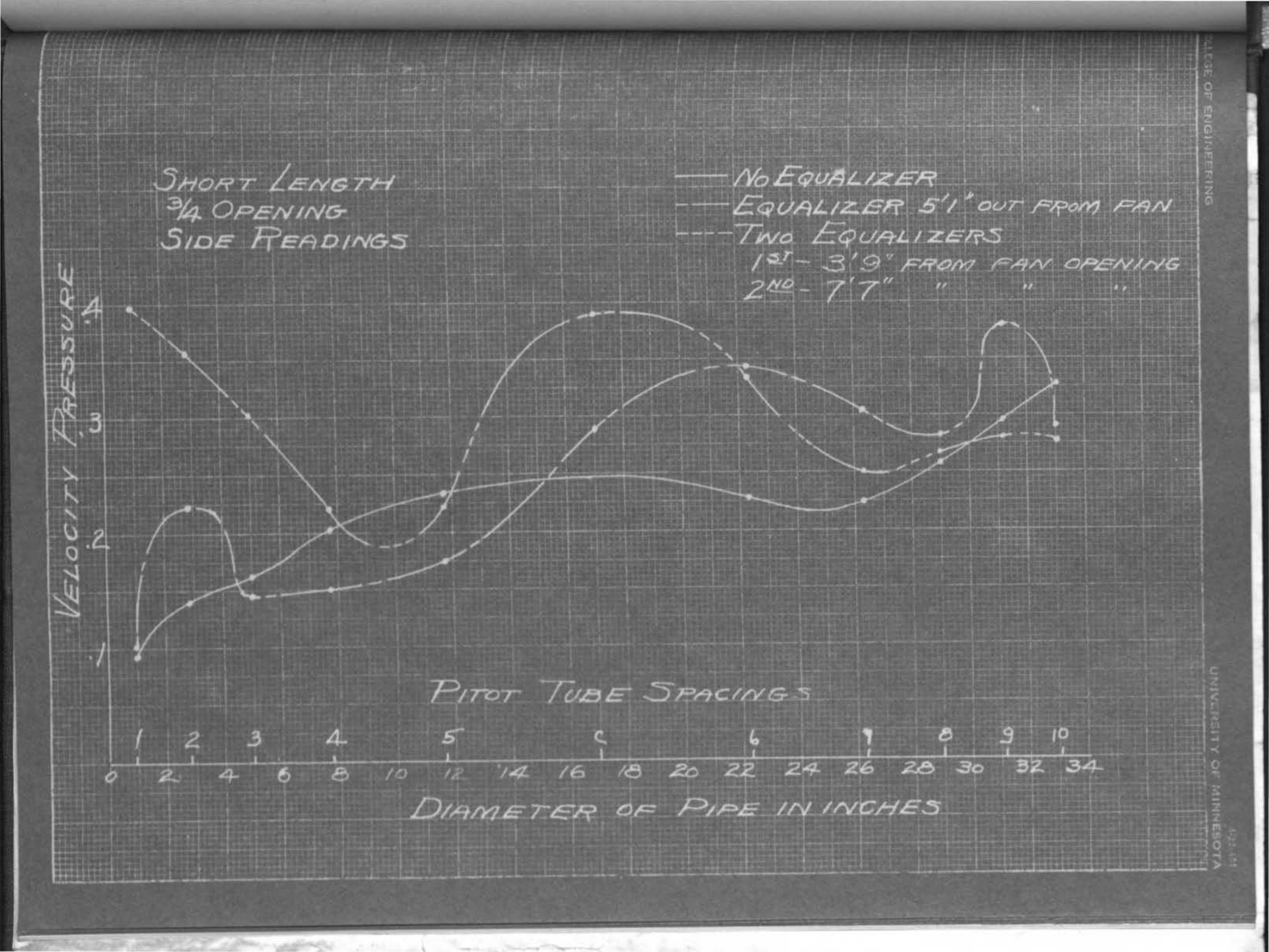


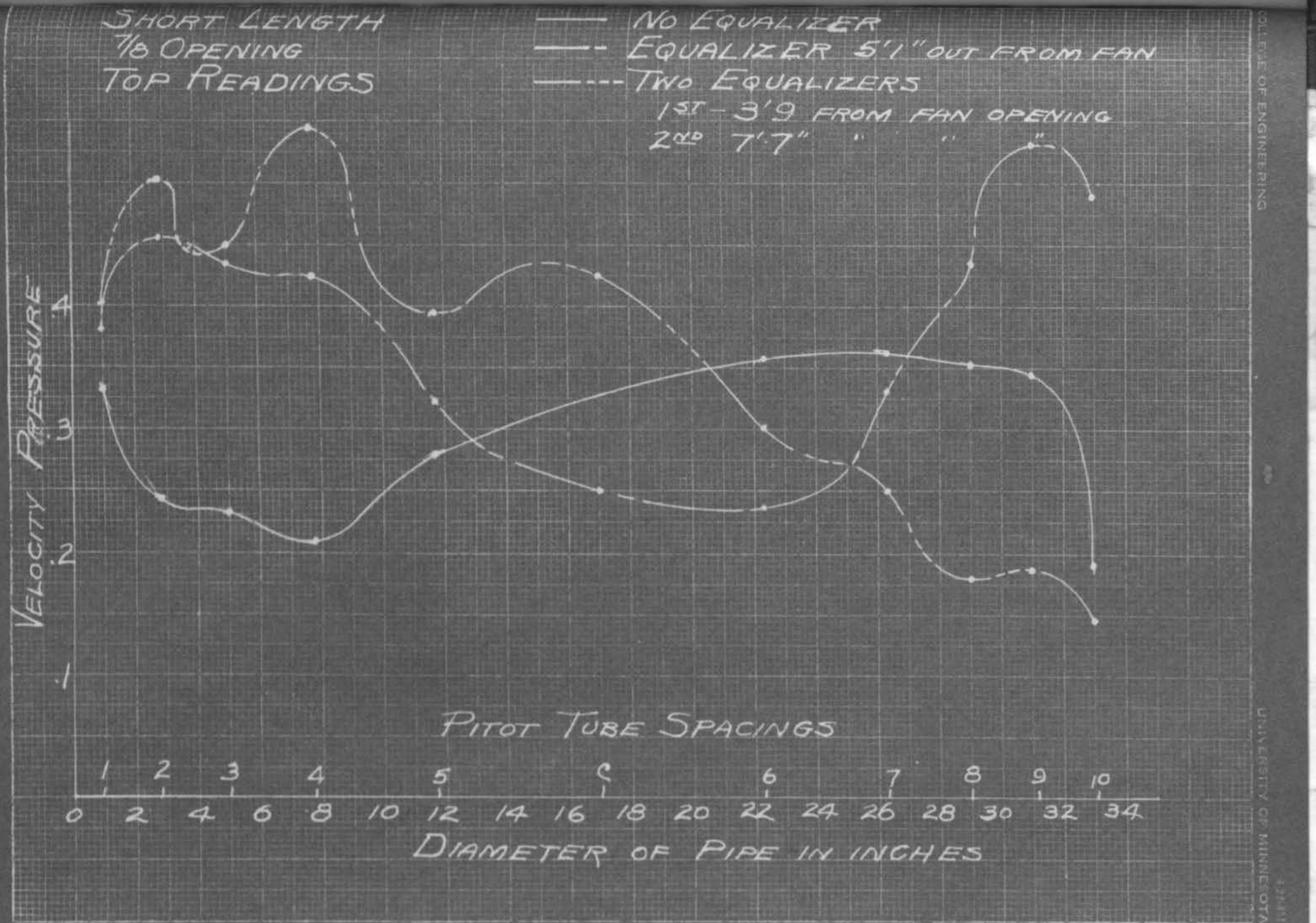
SHORT LENGTH
5/8 OPENING
SIDE READINGS

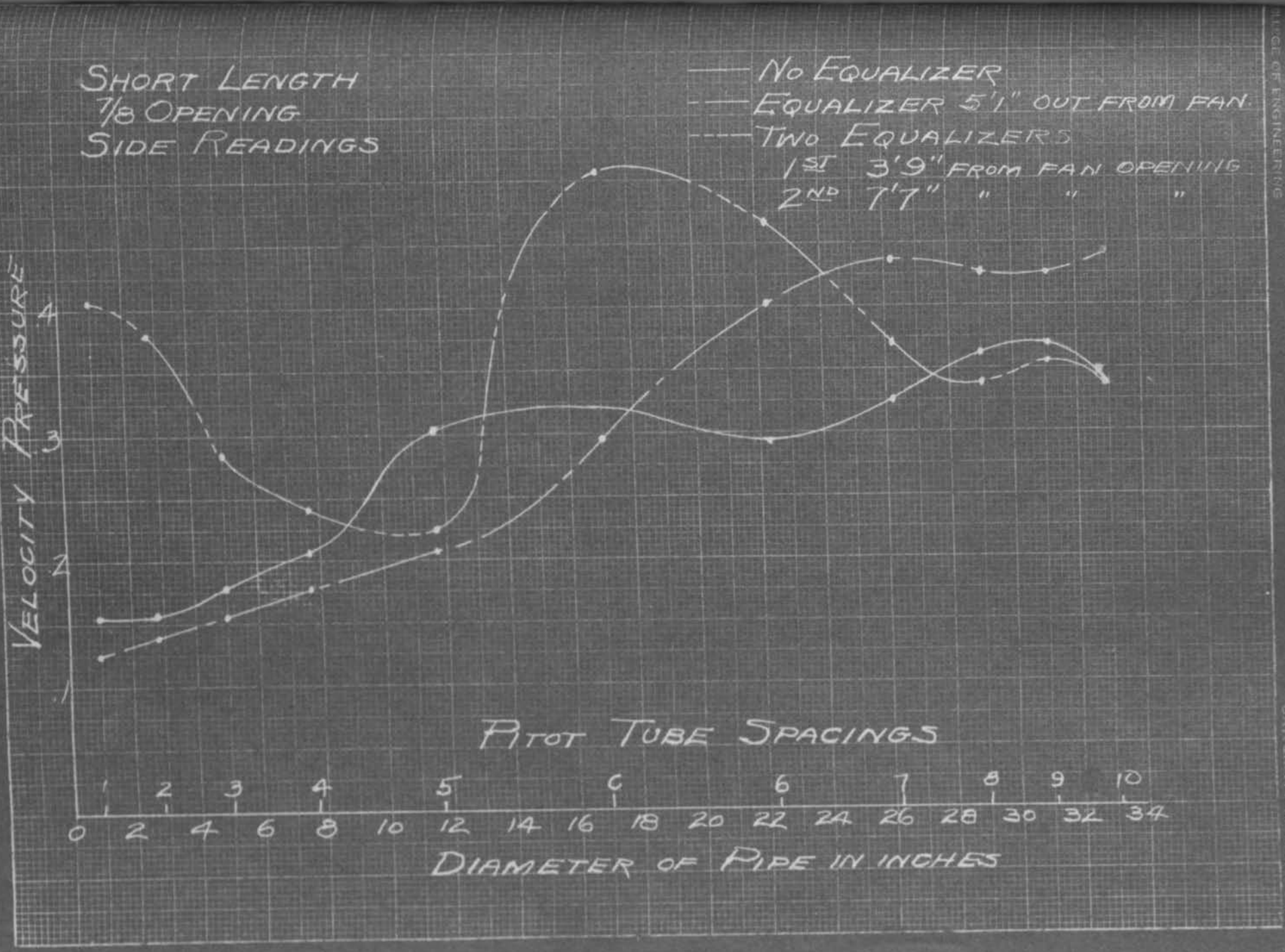
—— NO EQUALIZER
- - - EQUALIZER 5'1" OUT FROM FAN
---- TWO EQUALIZERS
1ST 3'9" FROM FAN OPENING
2ND 7'7" " " "




SHORT LENGTH
3/4 OPENING
TOP READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
TWO EQUALIZERS
1ST 3'9" FROM FAN OPENING
2ND 7'7" " " "
VELOCITY PRESSURE
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES

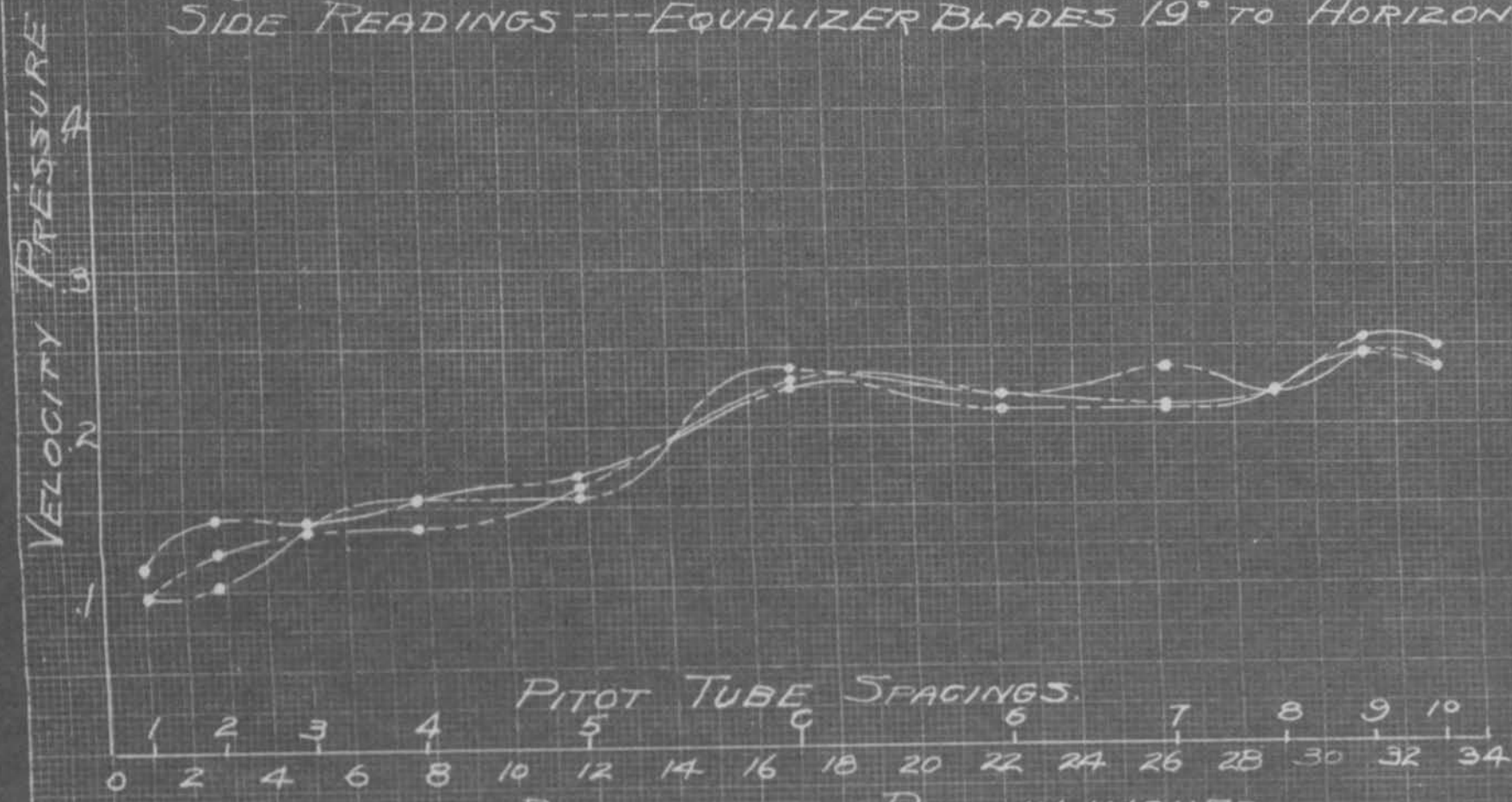

SHORT LENGTH
3/4 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
TWO EQUALIZERS
1ST - 3'9" FROM FAN OPENING
2ND - 7'7" " " "
VELOCITY PRESSURE
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA

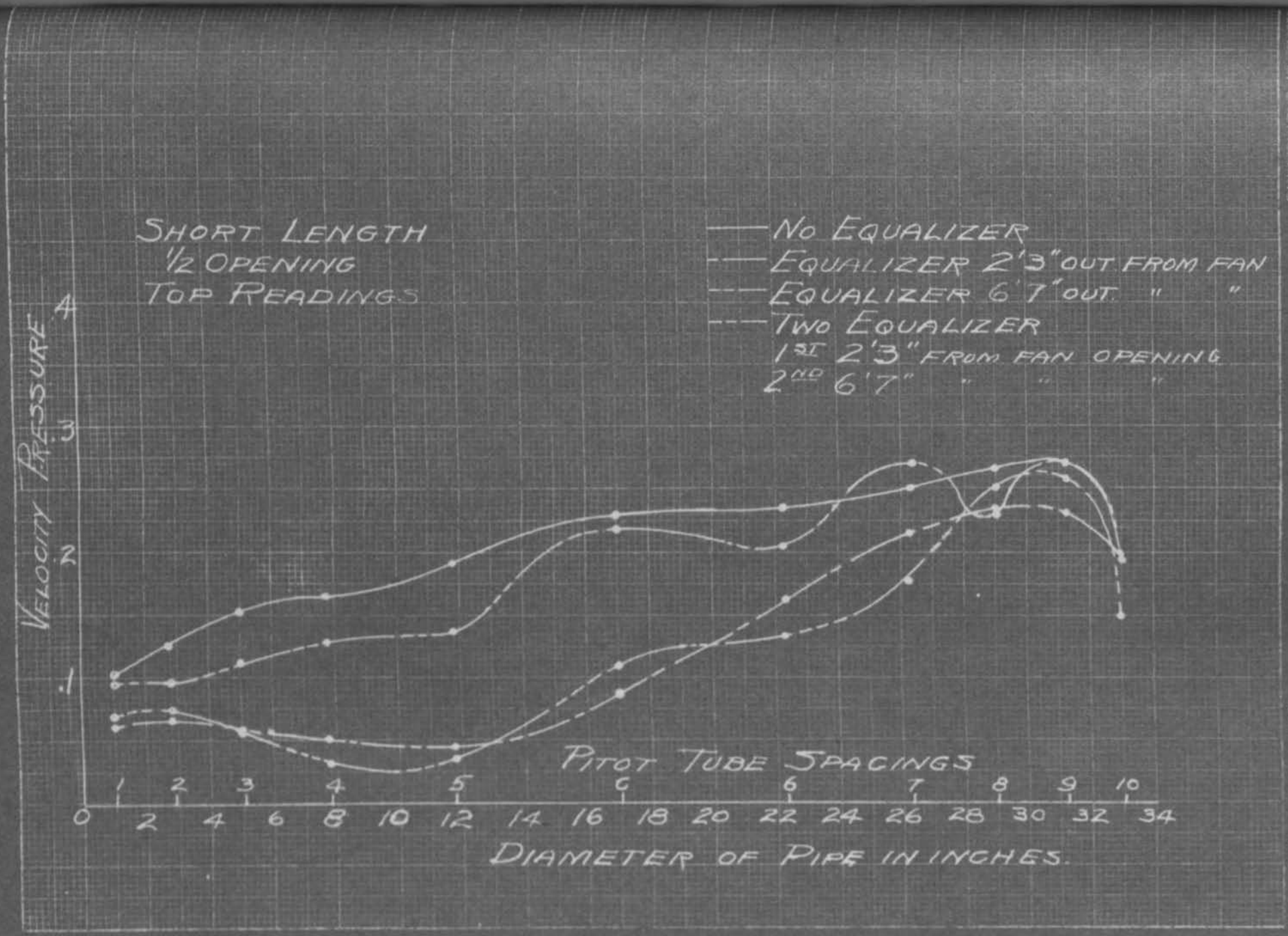

SHORT LENGTH
7/8 OPENING
TOP READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
TWO EQUALIZERS
1ST - 3'9 FROM FAN OPENING
2ND 7'7" " "
VELOCITY PRESSURE in. W
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 ℄ 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES

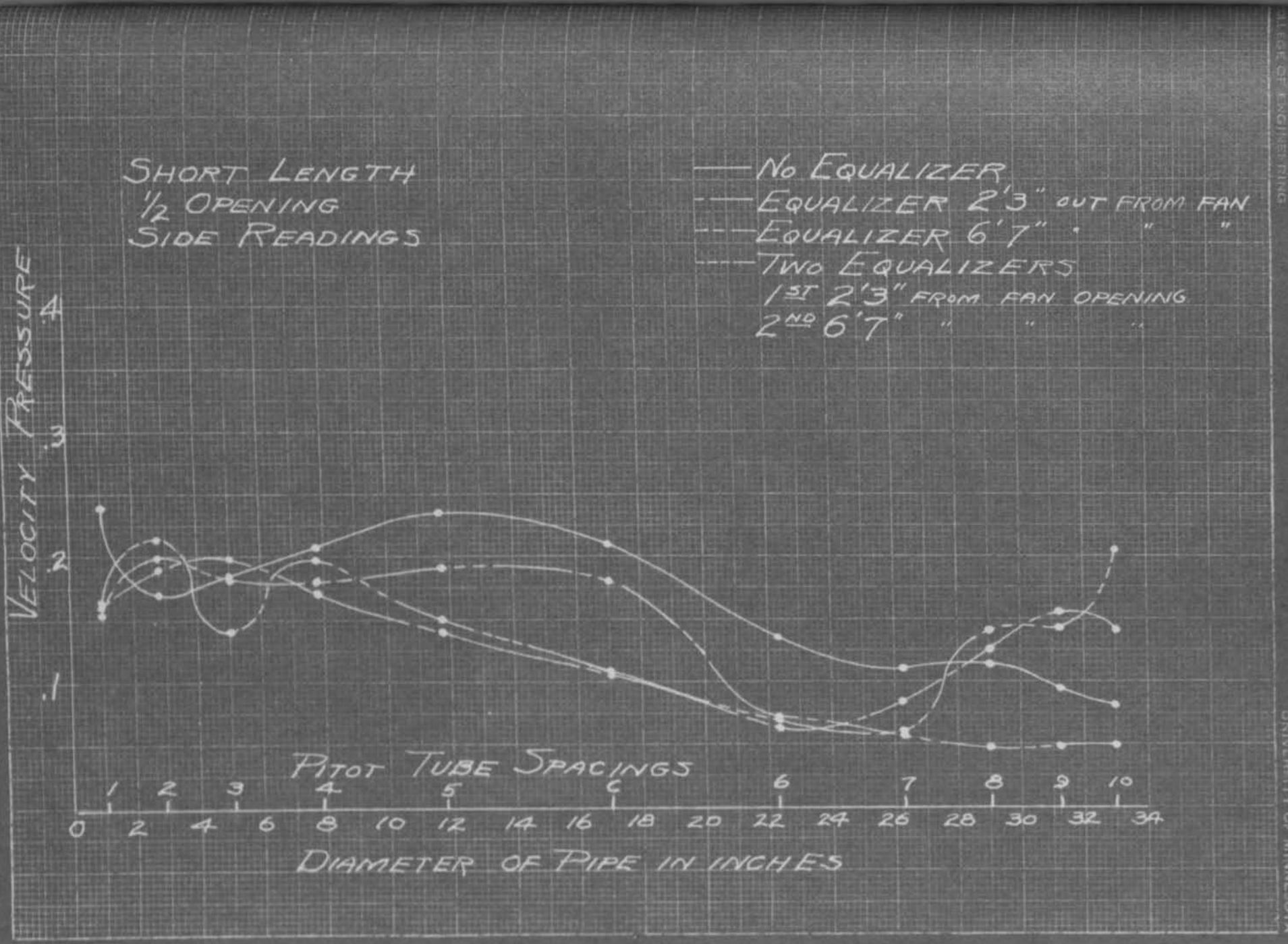

SHORT LENGTH
1/8 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 5'1" OUT FROM FAN
TWO EQUALIZERS
1ST 3'9" FROM FAN OPENING
2ND 7'7" " " "
VELOCITY PRESSURE
4
3
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES
UNIVERSITY OF MINNESOTA

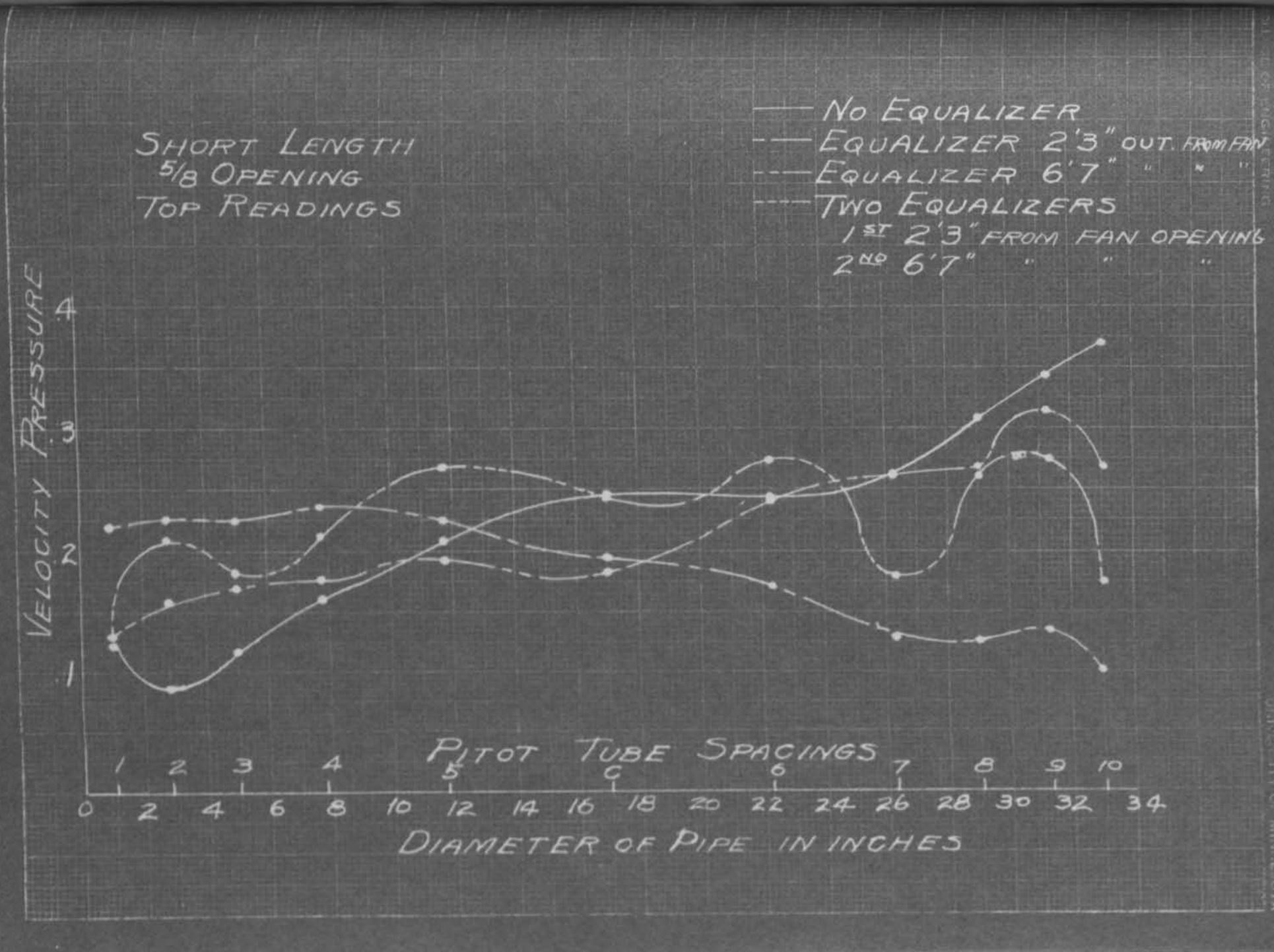
# EFFECT OF TURNING EQUALIZER IN PIPE

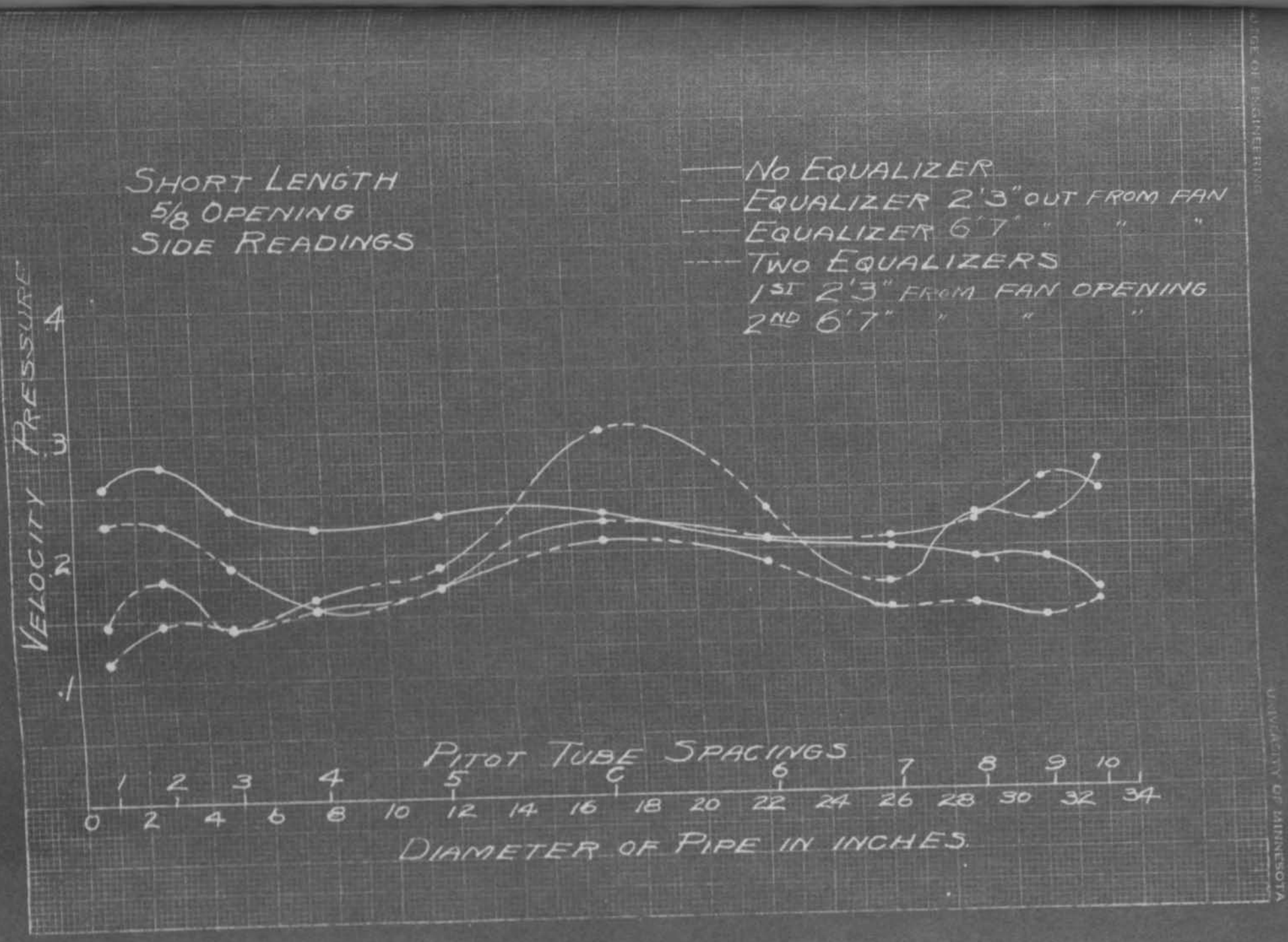
SHORT LENGTH — EQUALIZER BLADES 45° TO HORIZONTAL
5/8 OPENING --- EQUALIZER BLADES PARALLEL TO FAN BLADES
SIDE READINGS ---- EQUALIZER BLADES 19° TO HORIZONTAL.

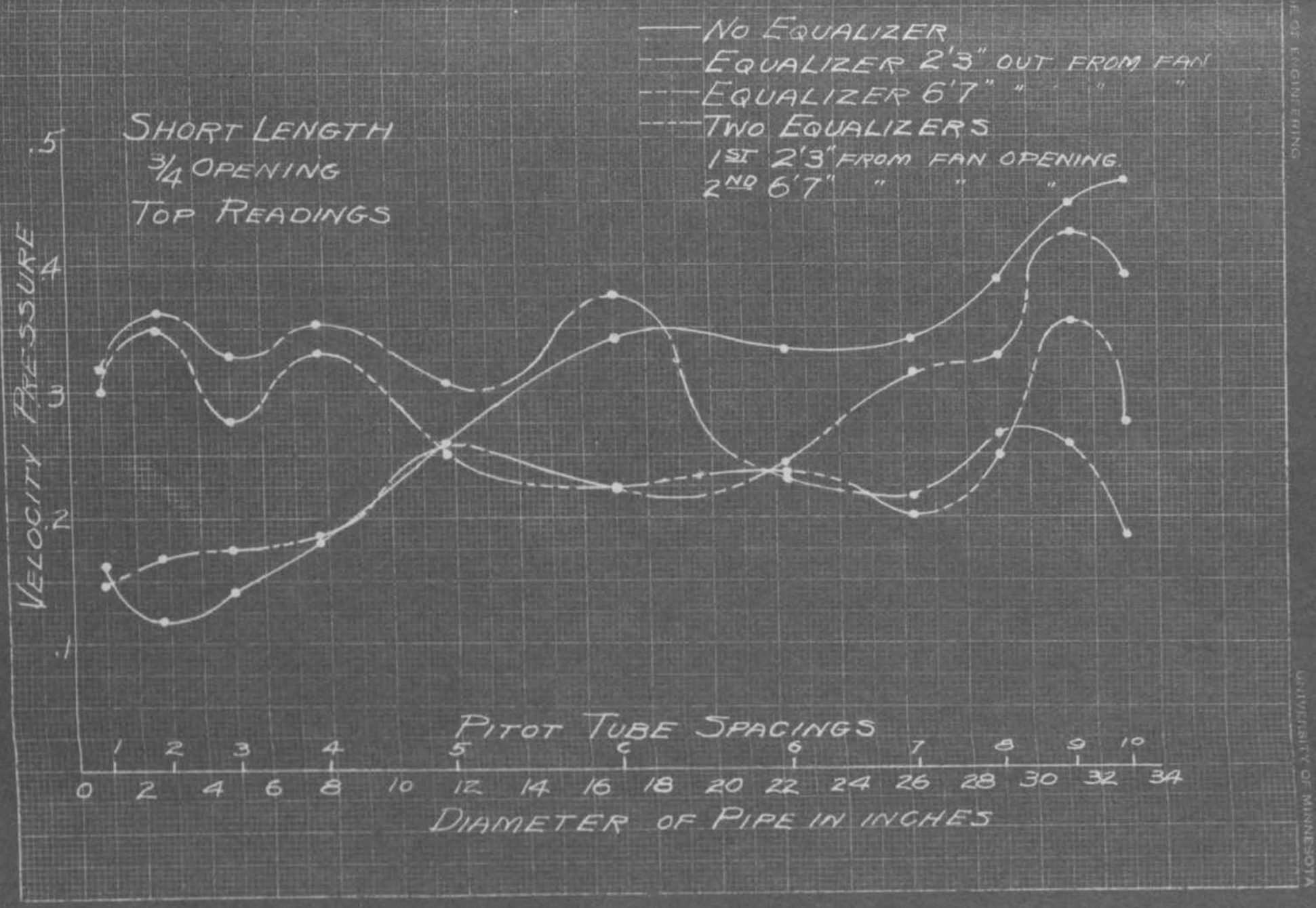


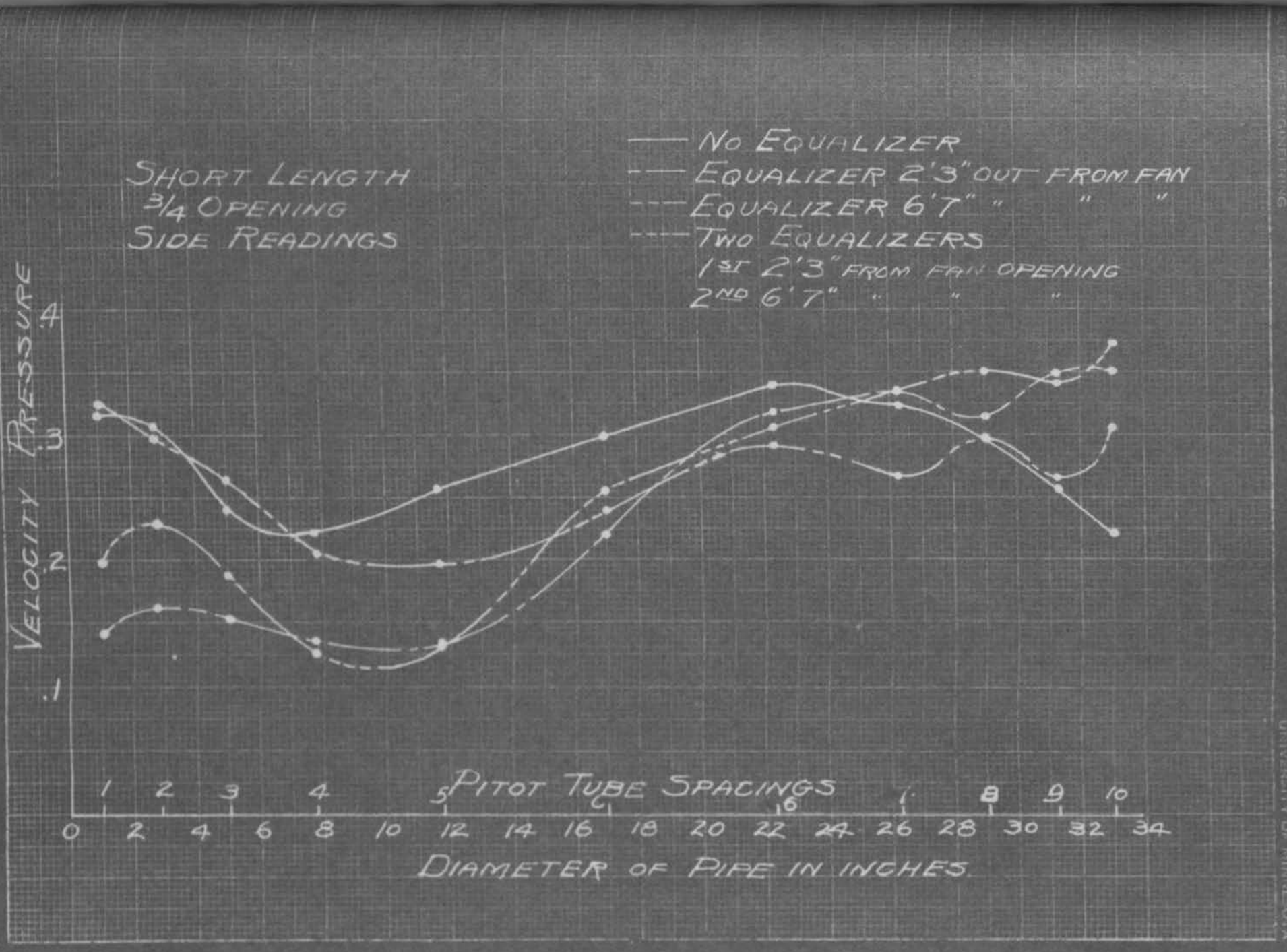

SHORT LENGTH
1/2 OPENING
TOP READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT FROM FAN
EQUALIZER 6'7" OUT " "
TWO EQUALIZER
1ST 2'3" FROM FAN OPENING
2ND 6'7" " " "
VELOCITY PRESSURE
4
3
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 6 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES.

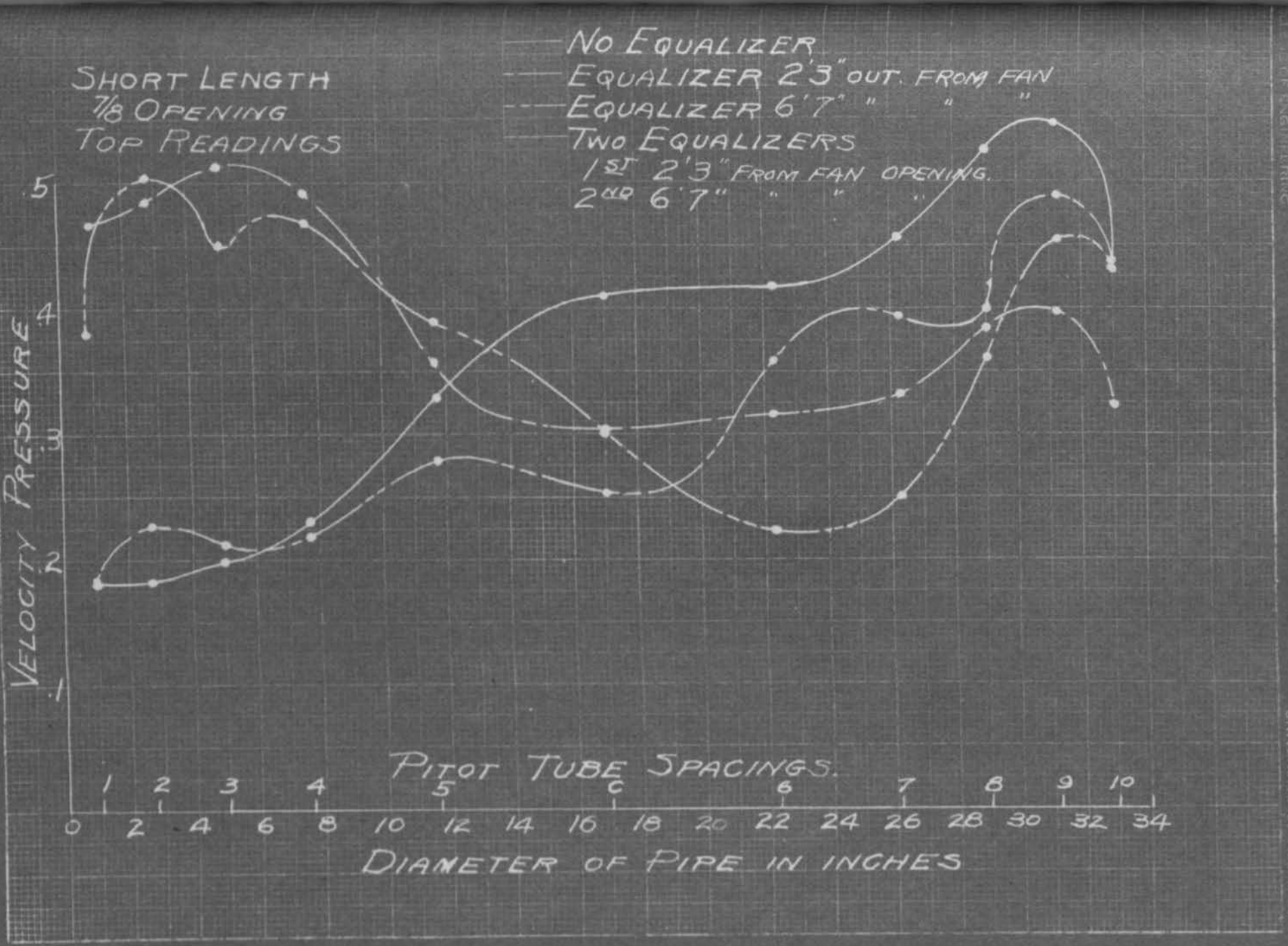

SHORT LENGTH
1/2 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT FROM FAN
EQUALIZER 6'7" " "
TWO EQUALIZERS
1ST 2'3" FROM FAN OPENING
2ND 6'7" " "
VELOCITY PRESSURE
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES

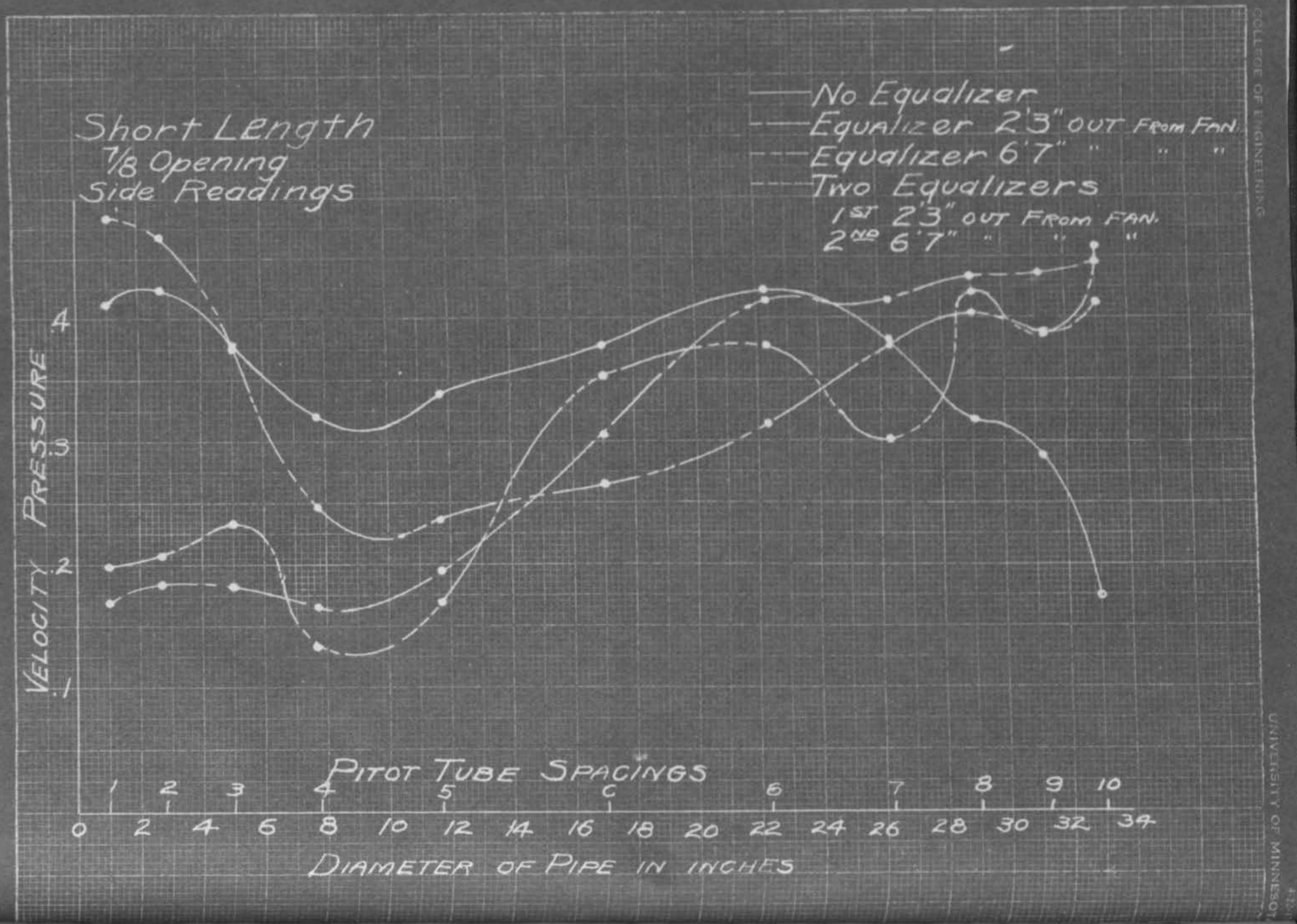

SHORT LENGTH
5/8 OPENING
TOP READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT FROM FAN
EQUALIZER 6'7" " " "
TWO EQUALIZERS
1ST 2'3" FROM FAN OPENING
2ND 6'7" " " "
VELOCITY PRESSURE
4
3
2
1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES


SHORT LENGTH
5/8 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT FROM FAN
EQUALIZER 6'7" " " "
TWO EQUALIZERS
1ST 2'3" FROM FAN OPENING
2ND 6'7" " " "
VELOCITY PRESSURE
.4
.3
.2
.1
PITOT TUBE SPACINGS
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES.
COLLEGE OF ENGINEERING
UNIVERSITY OF MINNESOTA


No Equalizer
Equalizer 2'3" out from fan
Equalizer 6'7" " " "
Two Equalizers
1st 2'3" from fan opening
2nd 6'7" " " "
Short Length
3/4 Opening
Top Readings
Velocity Pressure
.5
.4
.3
.2
.1
Pitot Tube Spacings
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Diameter of Pipe in inches


SHORT LENGTH
3/4 OPENING
SIDE READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT FROM FAN
EQUALIZER 6'7" " " "
TWO EQUALIZERS
1ST 2'3" FROM FAN OPENING
2ND 6'7" " " "
VELOCITY PRESSURE
.4
.3
.2
.1
1 2 3 4 5 6 7 8 9 10
PITOT TUBE SPACINGS
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES


SHORT LENGTH
7/8 OPENING
TOP READINGS
NO EQUALIZER
EQUALIZER 2'3" OUT. FROM FAN
EQUALIZER 6'7" " " "
TWO EQUALIZERS
1ST 2'3" FROM FAN OPENING.
2ND 6'7" " " "
VELOCITY PRESSURE
.5
.4
.3
.2
.1
PITOT TUBE SPACINGS.
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
DIAMETER OF PIPE IN INCHES


Short Length
1/8 Opening
Side Readings
No Equalizer
Equalizer 2'3" out from Fan.
Equalizer 6'7" " " "
Two Equalizers
1st 2'3" out from Fan.
2nd 6'7" " " "
Velocity Pressure
.1
.2
.3
.4
Pitot Tube Spacings
1 2 3 4 5 6 7 8 9 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Diameter of Pipe in Inches
College of Engineering
University of Minnesota

## CONCLUSION

When two equalizers were used it was difficult to obtain constant values of the velocity pressure at each point in the pipe because of the effect of the equalizers distributing the air in the pipe. The second equalizer was placed at an angle to the first equalizer (with reference to the side of the pipe). These readings show clearly that one or two equalizers do not give an even distribution of the air in the pipe using the short or long length of pipe. The curves given in Mr. T. S. Taylor's discussion for 50 diameters of pipe shows a very good distribution at that distance. Our tests, however, were made using only 8 diameters for the long length and 5 diameters for the short length.

The curves given show the effect of varying the distance of the equalizer from the mouth of the blower. An even distribution is not obtained but the velocity increases at one, two or three points in the pipe. A different curve was obtained (as might be ex-

pected) with the equalizer at a greater distance from the mouth of the blower because the air distributes itself with increasing distance from the mouth of the blower.

The curve given shows the effect of the angle of the blades of the equalizer to the blades of the fan. The velocity is practically the same throughout the pipe. The same general curve is obtained at all angles. This test to determine the effect of the angle that the equalizer is placed at, was run because of the effect of the equalizer in changing the velocity in the pipe. to a maximum at a point where it was near a minimum before as is shown by a study of the curves.

A study of the curves will also show that the majority of the curves have a greater or equal average or mean velocity with no equalizer than with an equalizer placed in the fan. This is because of the effect of the equalizer in distributing the air and causing friction against the sides of the 4" squares of the equalizer.

It is impossible to obtain an even distribution

such as that obtained with a 40 diameter pipe as is shown by all these tests. The effect of the two equalizers at different spacings in the short and long length of pipe are clearly shown by the curves. The air passes through the equalizers and does not cause a distribution such as that desired. This may easily be seen by comparing the top and side readings. The top reading might be a maximum at one side of the pipe while the side reading might be a maximum at the 7th, 8th, 9th or 10th reading. The maximum velocity is around the outside of the pipe. The equalizers break up the air in the pipe and cause a maximum velocity at one, two, three, or more points as shown. This may be seen by comparing the equalizer curves with those of no equalizer.

It is therefore clearly seen by the above discussion that it is impossible to get an even distribution of the air in the pipe of this size by using equalizers. We therefore recommend that ~~N~~ (in any other tests to be carried on in the future) ~~that~~ in the first place, either a larger or smaller fan be used with similar equalizers or, in the second place, another kind

of equalizer used such as a blade of some kind which could rotate, such as a propeller blade on an airplane. Still another method to be recommended is that of applying the Venturi principle in the construction of the delivery pipe.

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