THESIS

AN EXPERIMENTAL STUDY OF THE HEAT TRANSMISSION OF BUILDING MATERIAL

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AN EXPERIMENTAL STUDY OF THE HEAT TRANSMISSION OF BUILDING MATERIAL.

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THESIS

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INTRODUCTION.

In the present age people are beginning to realize the value of the determination of the heat loss through building material under variations of speed on both sides of the material. Tests have been run upon the transmission of heat through wood, concrete, glass, etc., with an assumption that the air on both sides was still. In order to get a better understanding of the method and object of this experiment a brief discussion of the transmission of heat through material may be given to a great advantage. Heat is a form of motion of the molecules of a substance, the more intense the heat the more the velocity of vibration of the molecules of the body. Heat is transferred in three ways namely, by radiation, conduction and convection. Radiant heat is considered similar to the light that is ridiated from some object as a lamp. There is always a transfer of heat from a body of higher temperature to one of colder temperature by radiation. Radiation is dependable upon the temperature difference between the bodies and the substance of which they are composed. Conduction is a form of heat transmission through the object itself or it may be condicted from one body to another when they are placed in contact with each other. The heat transferred by conduction is proportional to the difference in temperatures between the two sides of a body and inversely proportional to the thickness. It is also proportional to the kind of material composing the object. Convection is loss by con-

tact with air or any other form of gas. When air or gas comes into contact with a hot body it is heated and carries the heat away, this carrying away of the heat is called convection. Convection is dependable upon the form, difference of temperature between the air or gas and the body, and the velocity of the air or gas over the body. For each of the three described methods of heat transmission there is a constant which varies with the material. Due to the fact that experimental data are lacking for radiation and convection coefficients of various materials, a coefficient for the combined radiation and convection is used in common practice. The coefficient of conductivity with the combined coefficient is used in determining the total heat passing from a hot body through the air and then through another body to a colder body on the other side. The combined coefficient is represented by K and the conductive coefficient by C. The reciprocal of the reciprocals of the coefficients added together gives the total heat transmitted per sq. ft. per hour, per degree difference in temperature of the air on the two sides. Since the amount of heat received by the inside wall surface, the amount conducted through the wall and the amount emitted by the outside surface must evidently be equal. The following equation is generally used:

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{X}{C}}$$

Where X is the thickness of the material, K_1 and K_2 the combined coefficient of radiation and convection for the inside and outside wall surface respectfully, C the coefficient of conductivity.

OBJECT OF TEST.

The object of the test or the heat transmission of building material is to determine the amount of heat that will pass through a given piece of material per square foot, per degree difference in temperature per hour under varying conditions of velocity of the air on the two sides of the test piece.

DESCRIPTION & METHOD OF PROCEDURE.

The piece of tin to be tested was placed in a box 34 feet 6 inches long, and with an opening 11-1/2 inches by 12 inches. The twelve inch sides were split so as to insert the tin and were clamped together by 1/4 inch mild steel bolts being tightened upon some 2 inch by 4 inch planks. Twelve thermometers were used in six groups, thus allowing one thermometer on one side of the test piece and one on the other side just opposite. Two fans were used-- one took air from the room and the other fan took air from outdoors. When running parallel the two fans were blowing the air in at the same opening of the box while in counter flow one fan was taken to the opposite end of the box and the air was sent in opposite to the original flow. Two funnels were made and two diffusion vanes. The funnels were used to increase the size of the pipe from the fan to the box, to the size of the box opening. The diffusion vanes broke up all eddy currents thus

making a steady and uniform flow of air through the box. Six inch stove pipe was used to bring the air from the outside to the fan. The velocity of one fan was varied only by choking the inlet opening, thus decreasing the quantity of air. The other was varied by choking and increasing the size of the driving pully.

After having the box ready I put the thermometers into their positions and started my motors. Readings were taken from the thermometers every five minutes, and a new combination of velocities used. The velocities were obtained by means of air anemometer by taking a two minute reading at the outlet of the box at four different positions. This result obtained from the anemometer divided by two gave the actual velocity of the air through the box.

RESULTS OF EXPERIMENT.

From the results obtained from my experiment I find that the heat transmitted varies as the velocity of the air over the surface. With high velocities on the hot side, more heat was transmitted than with low velocities. My results were not uniform enough to determine a direct ratio with different velocities.

GENERAL CONCLUSION

From the results obtained in determining U (the heat transmitted per square foot, per degree difference in temperature between the two sides per hour) we find that as the opening into

the inlet decreaded U decreased om practically every test. From the curves we find that in counter flow the greatest difference in temperature is at the entrance of the cold air into the box. In parallel flow the greatest drop is at the entrance of the cold air but the curves slope in different directions to the curves in counter flow, that is, in counter flow the greatest drop is near the ordinate axis or at the beginning of the curve, while in parallel the greater drop is at the end of the curve.

In most cases of counter flow the slope of the curve increases as the velocity increases while in parallel flow the slope of the curves decrease as the velocity increases.

HEAT TRANSMISSIONS OF BUILDING MATERIAL.

PARALLEL FLOW A.

Cold air from opening	Hot air from opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Cold Air from opening	Hot air from opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side.
3	1	973.5	235.5	63	68	4	1	973.5	91.5	65	68
3	1	973.5	235.5	59	69	4	1	973.5	91.5	60	69
3	1	973.5	235.5	59	69	4	1	973.5	91.5	60	69
3	1	973.5	235.5	58	69.5	4	1	973.5	91.5	58	69
3	1	973,5	235.5	58	70	4	1	973.5	91.5	58	69
3	1	973.5	235.5	57	70	4	1	973.5	91.5	58	69
3	2	825.5	235.5	63	66	4	2	825.5	91.5	66	67
3	2	825,5	235.5	58	67	4	2	825.5	91.5	62	67.5
3	2	825.5	235.5	57	66	4	2	825.5	91.5	60	68
3	2	825.5	235.5	57	68	4	2	825.5	91.5	60	69
3	2	825.5	235.5	56	68	4	2	825.5	91.5	59	68
3	2	825.5	235.5	56	68	4	2	825.5	91.5	60	68
3	3	470.5	235.5	62	66	4	3	470.5	91.5	66	68
3	3	470.5	235.5	58	68	4	3	470.5	91.5	63	69
3	3	470.5	235.5	57	68.5	4	3	470.5	91.5	60	68
3	3	470.5	235.5	56	69	4	3	470.5	91.5	62	69
3	3	470.5	235.5	59	70	4	3	470.5	91.5	60	68
3	3	470.5	235.5	53	71	4	3	470.5	91.5	61	69
3	4	128	235.5	59	60	4	4	128	91.5	59	60
3	4	128	235.5	58	61	4	4	128	91.5	59	60
3	4	128	235.5	57	62	4	4	128	91.5	57.5	60.5
3	4	128	235.5	57.5	62.5	4	4	128	91.5	57	61
3	4	128	235.5	57	63	4	4	128	91.5	56	61.5
3	4	128	235.5	57	69	4	4	128	91.5	56	62

HEAT TRANSMISSION OF BUILDING MATERIAL

PARALLEL . FLOW A.

Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Cold Air for opening	Hot Air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	1	973.5	318	72°	72°	2	1	973.5	300	70	71
1	1	973.5	318	70	71.5	2	1	973.5	300	69.5	71
1	1	973.5	318	70	71	2	1	973.5	300	68	71
1	1	973.5	318	70	73	2	1	973.5	300	67.5	73
1	1	973.5	318	69	74	2	1	973.5	300	66	74
1	2	825.5	318	68.5	70	2	2	825.5	300	60	64
1	2	835.5	318	67.5	69.9	2	2	825.5	300	59	64
1	2	825.5	318	68	69.5	2	2	825.5	300	58	64
1	2	825.5	318	67	71	2	2	825.5	300	58	65
1	2	825.5	318	66	70	2	2	825.5	300	56	66
1	2	825.5	318	66	72	2	2	825.5	300	56	67.5
1	3	470.5	318	70	70	2	3	470.5	300	60	64
1	3	470.5	318	69	70	2	3	470.5	300	58	64
1	3	470.5	318	69.5	70	2	3	470.5	300	56	64
1	3	470.5	318	69	72	2	3	470.5	300	55.5	65
1	3	470.5	318	68	71	2	3	470.5	300	55.5	67
1	3	470.5	318	68	72	2	3	470.5	300	59	68
1	4	128	318	59	60	2	4	128	300	58	59
1	4	128	318	59	60	2	4	128	300	58	59.5
1	4	128	318	58.5	60	2	4	128	300	57	59.5
1	4	128	318	58	60	2	4	128	300	56.5	60.5
1	4	128	318	58	61	2	4	128	300	56.5	61.0
1	4	128	318	58	62.5	2	4	128	300	56.5	62

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW A

Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Hot Side	Temp. Cold Side
1	1	973.5	318	55	75	2	1	973.5	300	59	70
1	1	973.5	318	57	76	2	1	973.5	300	60	73
1	1	973.5	318	59	76	2	1	973.5	300	60	72
1	1	973.5	318	62	77	2	1	973.5	300	65	72
1	1	973.5	318	62	79	2	1	973.5	300	63	73
1	1	973.5	318	70	80	2	1	973.5	300	66	73
1	2	825.5	318	61	73	2	2	825.5	300	60	71
1	2	825.5	318	64	75	2	2	825.5	300	60	72.5
1	2	825.5	318	63	74	2	2	825.5	300	61	72
1	2	825.5	318	67	76	2	2	825.5	300	63	73
1	2	825.5	318	69	76	2	2	825.5	300	67	74
1	2	825.5	318	69	76	2	2	825.5	300	66	74
1	3	470.5	318	59	69	2	3	470.5	300	59	70
1	3	470.5	318	60	71	2	3	470.5	300	59	71.5
1	3	470.5	318	60	71	2	3	470.5	300	60	71
1	3	470.5	318	61	71.5	2	3	470.5	300	62	71
1	3	470.5	318	62	70	2	3	470.5	300	63	73
1	3	470.5	318	65	72	2	3	470.5	300	65	73
1	4	128	318	59	70	2	4	128	300	59	70
1	4	128	318	59	70	2	4	128	300	60	70
1	4	128	318	61.5	72.5	2	4	128	300	61	71
1	4	128	318	63	74	2	4	128	300	62	71
1	4	128	318	64	74.5	2	4	128	300	64	72
1	4	128	318	66	76	2	4	128	300	64	72

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW A

Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side.	Cold air for openings	Hot Air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side.
3	1	973.5	235.5	62	73	4	1	973.5	91.5	59	60
3	1	973.5	235.5	63	75	4	1	973.5	91.5	59	60
3	1	973.5	235.5	64	74	4	1	973.5	91.5	58.5	60
3	1	973.5	235.5	67	74	4	1	973.5	91.5	58	60
3	1	973.5	235.5	68	75.5	4	1	973.5	91.5	58	61
3	1	973.5	235.5	68	75	4	1	973.5	91.5	58	62.5
3	2	825.5	235.5	60	72	4	2	825.5	91.5	58	59
3	2	825.5	235.5	62	72	4	2	825.5	91.5	58	59.5
3	2	825.5	235.5	62	73	4	2	825.5	91.5	57	59.5
3	2	825.5	235.5	64	73	4	2	825.5	91.5	56.5	60.5
3	2	825.5	235.5	65	73	4	2	825.5	91.5	56.5	61
3	2	825.5	235.5	66	74	4	2	825.5	91.5	56.5	62
3	3	470.5	235.5	60	71	4	3	470.5	91.5	59	60
3	3	470.5	235.5	61	71	4	3	470.5	91.5	58	61
3	3	470.5	235.5	61	72	4	3	470.5	91.5	57	62
3	3	470.5	235.5	63	72	4	3	470.5	91.5	57.5	62.5
3	3	470.5	235.5	65	72	4	3	470.5	91.5	57	63
3	3	470.5	235.5	66	74	4	3	470.5	91.5	57	64
3	4	128	235.5	59	60	4	4	128	91.5	59	60
3	4	128	235.5	58	61	4	4	128	91.5	59	60
3	4	128	235.5	57	62	4	4	128	91.5	57.5	60.5
3	4	128	235.5	57.5	62.5	4	4	128	91.5	57	61
3	4	128	235.5	57	63	4	4	128	91.5	56	61.5
3	4	128	235.5	57	64	4	4	128	91.5	56	82

HEAT TRANSMISSION OF BUILDING MATERIAL

PARALLEL FLOW B.

Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Cold air for opening	Hot air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	1	1549	318	71	72	1	2	1549	300	68.5	70
1	1	1549	318	70	72	1	2	1549	300	67.5	70
1	1	1549	318	68	70	1	2	1549	300	66	69.5
1	1	1549	318	67	70	1	2	1549	300	64.5	70
1	1	1549	318	67	70	1	2	1549	300	64	71
1	1	1549	318	66	70	1	2	1549	300	63	71.5
2	1	1200	318	67	70	2	2	1200	300	71	74
2	1	1200	318	67	71	2	2	1200	300	71	74
2	1	1200	318	66.5	72	2	2	1200	300	69.5	73.5
2	1	1200	318	66	71	2	2	1200	300	69	74
2	1	1200	318	64	72	2	2	1200	300	68	73.5
2	1	1200	318	63	72	2	2	1200	300	67	72.5
3	1	705	318	67	69	3	2	705	300	79	74
3	1	705	318	66	69.5	3	2	705	300	70	74
3	1	705	318	65.5	70	3	2	705	300	69	73
3	1	705	318	65	71.5	3	2	705	300	69	73
3	1	705	318	65	70.5	3	2	705	300	68.5	74
3	1	705	318	64	71	3	2	705	300	68	75.5
4	1	247	318	69	71	4	2	247	300	72	74
4	1	247	318	68	71.5	4	2	247	300	72	74
4	1	247	318	66	72	4	2	247	300	70	73.5
4	1	247	318	65.5	72	4	2	247	300	70	75
4	1	247	318	65	73	4	2	247	300	70.5	72
4	1	247	318	62	74	4	2	247	300	70	71.5

HEAT TRANSMISSION OF BUILDING MATERIAL

PARELLEL FLOW B.

Hot air opening for	Cold air opening for	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air opening for	Cold air opening for	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	3	1549	235.5	71.5	72	1	4	1549	91.5	73.5	77
1	3	1549	235.5	71	72.5	1	4	1549	91.5	72.5	77.5
1	3	1549	235.5	69	72.5	1	4	1549	91.5	71	77.5
1	3	1549	235.5	68	73	1	4	1549	91.5	70.5	77.5
1	3	1549	235.5	66	73	1	4	1549	91.5	68	77.5
1	3	1549	235.5	66.5	73	1	4	1549	91.5	66	77.5
2	3	1200	235.5	72	75	1	4	1200	91.5	74	74
2	3	1200	235.5	72	75.5	2	4	1200	91.5	73	74
2	3	1200	235.5	71	75	2	4	1200	91.5	72	74
2	3	1200	235.5	70	75	2	4	1200	91.5	71	74.5
2	3	1200	235.5	68	75.5	2	4	1200	91.5	69.5	74.5
2	3	1200	235.5	67	76	2	4	1200	91.5	68	74.5
3	3	705	235.5	73	75	3	4	705	91.5	74	75
3	3	705	235.5	72.5	75	3	4	705	91.5	74	75
3	3	705	235.5	71	74	3	4	705	91.5	72.5	75
3	3	705	235.5	70	74	3	4	705	91.5	71	75.4
3	3	705	235.5	70	75	3	4	705	91.5	70.5	75.5
3	3	705	235.5	69	76.5	3	4	705	91.5	69	75.5
4	3	247	235.5	72	75	4	4	247	91.5	74	76
4	3	247	235.5	72	75	4	4	247	91.5	74	76
4	3	247	235.5	69	75.5	4	4	247	91.5	73	76
4	3	247	235.5	70	76	4	4	247	91.5	72.5	76
4	3	247	235.5	70	76.5	4	4	247	91.5	72	77
4	3	247	235.5	69	78	4	4	247	91.5	71	77

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW B

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	1	1549	318	81	86	1	2	1549	300	81	85
1	1	1549	318	81.5	86	1	2	1549	300	82	85.5
1	1	1549	318	80	85	1	2	1549	300	81	85
1	1	1549	318	81	85.5	1	2	1549	300	81	86
1	1	1549	318	83	86.5	1	2	1549	300	83	87.5
1	1	1549	318	84	87.5	1	2	1549	300	84.5	87.5
2	1	1200	318	81.5	86	2	2	1200	300	81	86
2	1	1200	318	82	86	2	2	1200	300	82	86
2	1	1200	318	81.5	85.5	2	2	1200	300	81	85
2	1	1200	318	81	85.5	2	2	1200	300	81.5	86
2	1	1200	318	84	87	2	2	1200	300	84	86.5
2	1	1200	318	83	86	2	2	1200	300	83	85.5
3	1	705	318	81	85	3	2	705	300	81	84
3	1	705	318	82	85	3	2	705	300	82	85
3	1	705	318	81	85	3	2	705	300	80	84
3	1	705	318	81	86	3	2	705	300	80.5	84.5
3	1	705	318	82	86.5	3	2	705	300	82	86
3	1	705	318	83	87	3	2	705	300	83	86.5
4	1	247	318	80	84	4	2	247	300	81.5	84.5
4	1	247	318	81	84	4	2	247	300	82	85
4	1	247	318	80	84	4	2	247	300	81	84
4	1	247	318	80	84.5	4	2	247	300	81	85
4	1	247	318	82	85	4	2	247	300	82	85.5
4	1	247	318	81	86	4	2	247	300	83	87

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW B.

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	3	1549	235.5	82	86	1	4	1549	91.5	81	84
1	3	1549	235.5	82.5	86	1	4	1549	91.5	82	84
1	3	1549	235.5	81	85	1	4	1549	91.5	80.5	83.5
1	3	1549	235.5	82	86	1	4	1549	91.5	81.5	84.5
1	3	1549	235.5	82.5	86.5	1	4	1549	91.5	83	86
1	3	1549	235.5	83.5	86.5	1	4	1549	91.5	83.5	86
2	3	1200	235.5	81.5	85	2	4	1200	91.5	81	85
2	3	1200	235.5	82.5	85	2	4	1200	91.5	82	85
2	3	1200	235.5	81	84	2	4	1200	91.5	81	84
2	3	1200	235.5	82	84.5	2	4	1200	91.5	81.5	85
2	3	1200	235.5	82.5	85.5	2	4	1200	91.5	82.5	86.5
2	3	1200	235.5	83	86	2	4	1200	91.5	84	87
3	3	705	235.5	80	84	3	4	705	91.5	81.5	85.5
3	3	705	235.5	81.5	85	3	4	705	91.5	82.5	86
3	3	705	235.5	80	84	3	4	705	91.5	81.5	85.5
3	3	705	235.5	80.5	85.5	3	4	705	91.5	82	86
3	3	705	235.5	82	86.5	3	4	705	91.5	84.5	87
3	3	705	235.5	83	86	3	4	705	91.5	84.5	87
4	3	247	235.5	80	84	4	4	247	91.5	81	84
4	3	247	235.5	81	84	4	4	247	91.5	82	84
4	3	247	235.5	80	84	4	4	247	91.5	80	83
4	3	247	235.5	80	84.5	4	4	247	91.5	81	84
4	3	247	235.5	81.5	85	4	4	247	91.5	82	85
4	3	247	235.5	82.5	86	4	4	247	91.5	83	86

HEAT TRANSMISSION OF BUILDING MATERIAL

PARALLEL FLOW C.

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	1	1261	318	78	80	1	2	1261	300	83	84
1	1	1261	318	78	80	1	2	1261	300	82.5	84
1	1	1261	318	76	79.5	1	2	1261	300	81	84
1	1	1261	318	74.5	79.5	1	2	1261	300	80	84.5
1	1	1261	318	73	81	1	2	1261	300	79	86
1	1	1261	318	73	82	1	2	1261	300	78	85.5
2	1	914.5	318	80	81	2	2	914.5	300	83	85
2	1	914.5	318	79	82	2	2	914.5	300	83	85
2	1	914.5	318	78	81	2	2	914.5	300	81	84
2	1	914.5	318	76.5	82	2	2	914.5	300	81	85
2	1	914.5	318	76	82.5	2	2	914.5	300	79	86
2	1	914.5	318	75.5	83	2	2	914.5	300,	78.5	87
3	1	554.5	318	80	81	3	2	554.5	300	83	84.5
3	1	554.5	318	80	81	3	2	554.5	300	83	84.5
3	1	554.5	318	78	81	3	2	554.5	300	81	84
3	1	554.5	318	78	82	3	2	554.5	300	80.5	85
3	1	554.5	318	78	82	3	2	554.5	300	81	85.5
3	1	554.5	318	78.5	84	3	2	554.5	300,	81	86
4	1	206	318	80.5	82	4	2	206	300	82	83.5
4	1	206	318	80.5	82.5	4	2	206	300	82.5	84
4	1	206	318	79	83	4	2	206	300	81	83
4	1	206	318	79	84	4	2	206	300	81	84
4	1	206	318	79	85	4	2	206	300	81.5	84.5
4	1	206	318	79	86	4	2	206	300	80.5	86

HEAT TRANSMISSION OF BUILDING MATERIAL

PARALLEL FLOW C

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side%	Temp. Cold Side	Temp. Hot Side
1	3	1261	235.5	83	84	1	4	1261	91.5	82.5	84.2
1	3	1261	235.5	83	84	1	4	1261	91.5	81	84
1	3	1261	235.5	81	84	1	4	1261	91.5	80	84.5
1	3	1261	235.5	80	85	1	4	1261	91.5	79.5	85
1	3	1261	235.5	79	85	1	4	1261	91.5	77	85
1	3	1261	235.5	78.5	85	1	4	1261	91.5	75	85
2	3	914.5	235.5	82.5	84.5	2	4	914.5	91.5	83	84
2	3	914.5	235.5	82.5	85	2	4	914.5	91.5	82	84.5
2	3	914.5	235.5	81	85	2	4	914.5	91.5	80	83
2	3	914.5	235.5	81	85	2	4	914.5	91.5	79.5	83.5
2	3	914.5	235.5	80	85.5	2	4	914.5	91.5	77.5	85
2	3	914.5	235.5	79	85.5	2	4	914.5	91.5	76	85
3	3	554.5	235.5	82.5	84	3	4	554.5	91.5	82.5	84
3	3	554.5	235.5	82.5	84	3	4	554.5	91.5	82	84
3	3	554.5	235.5	81	84	3	4	554.5	91.5	80.5	84
3	3	554.5	235.5	81	85	3	4	554.5	91.5	79.5	84
3	3	554.5	235.5	81	85.5	3	4	554.5	91.5	77	85
3	3	554.5	235.5	80	85.5	3	4	554.5	91.5	76.5	85
4	3	206	235.5	82	83.5	4	4	206	91.5	82	83.5
4	3	206	235.5	81.5	83.5	4	4	206	91.5	82	83.5
4	3	206	235.5	79.5	84	4	4	206	91.5	80	83
4	3	206	235.5	79	85	4	4	206	91.5	80	85
4	3	206	235.5	79	85.5	4	4	206	91.5	80	84
4	3	206	235.5	79	87	4	4	206	91.5	80	84.5

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW C

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	1	1261	318	75	77	1	2	1261	300	83	84
1	1	1261	318	75	76.5	1	2	1261	300	83	84
1	1	1261	318	74	76	1	2	1261	300	82	84
1	1	1261	318	74.5	77	1	2	1261	300	82	84
1	1	1261	318	76	78	1	2	1261	300	83.5	85.5
1	1	1261	318	76	78	1	2	1261	300	84	84.5
2	1	914.5	318	79	80	2	2	914.5	300	84	85
2	1	914.5	318	79	80	2	2	914.5	300	84	85
2	1	914.5	318	78	80	2	2	914.5	300	82.5	84.5
2	1	914.5	318	78	80	2	2	914.5	300	83	85.5
2	1	914.5	318	79	81.5	2	2	914.5	300	84	87
2	1	914.5	318	80	83	2	2	914.5	300	84	86
3	1	554.5	318	81	82	3	2	554.5	300	85	85.5
3	1	554.5	318	81	82	3	2	554.5	300	85	85.5
3	1	554.5	318	81	81.5	3	2	554.5	300	84	85
3	1	554.5	318n	81	82.5	3	2	554.5	300	84	86
3	1	554.5	318	81.5	83.5	3	2	554.5	300	85	87
3	1	554.5	318	81.5	84	3	2	554.5	300	85.5	87
4	1	206	318	81.5	81.5	4	2	206	300	78	82
4	1	206	318	81.5	82	4	2	206	300	79	82.5
4	1	206	318	80	81	4	2	206	300	78n	82
4	1	206	318	80	82	4	2	206	300	78	83
4	1	206	318	81	83	4	2	206	300	79	83
4	1	206	318	81	83	4	2	206	300	79;5	84

HEAT TRANSMISSION OF BUILDING MATERIAL

COUNTER FLOW C.

Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side	Hot air for opening	Cold air for opening	Reading of Anemo. Hot Side	Reading of Anemo. Cold Side	Temp. Cold Side	Temp. Hot Side
1	3	1261	235.5	79	83.5	1	4	1261	91.5	80	84
1	3	1261	235.5	80	83.5	1	4	1261	91.5	81	84
1	3	1261	235.5	79	83	1	4	1261	91.5	81	83
1	3	1261	235.5	80	83.5	1	4	1261	91.5	81.5	83.5
1	3	1261	235.5	81	84	1	4	1261	91.5	82	84
1	3	1261	235.5	81.5	84	1	4	1261	91.5	83	84.5
2	3	914.5	235.5	78.5	82	2	4	914.5	91.5	80.5	83.5
2	3	914.5	235.5	78.5	82.5	2	4	914.5	91.5	81	84
2	3	914.5	235.5	78.5	82	2	4	914.5	91.4	81	83
2	3	914.5	235.5	79	83	2	4	914.5	91.4	82	83
2	3	914.5	235.5	80	84	2	4	914.5	91.5	82.5	84.5
2	3	914.5	235.5	81	84	2	4	914.5	91.5	82.5	84
3	3	554.5	235.5	81	84	3	4	554.5	91.5	80	83
3	3	554.5	235.5	79	83	3	4	554.5	91.5	81	83
3	3	554.5	235.5	80	83	3	4	554.5	91.5	80	82
3	3	554.5	235.5	79	83	3	4	554.5	91.5	80	82.5
3	3	554.5	235.5	79	83	3	4	554.5	91.5	82	84
3	3	554.5	235.5	81.5	84	3	4	554.5	91.5	82	84
4	3	206	235.5	81	83.5	4	4	206	91.5	80.5	83
4	3	206	235.5	79	82	4	4	206	91.5	81.5	83.5
4	3	206	235.5	80	82	4	4	206	91.5	80	83
4	3	206	235.5	78.5	81.5	4	4	206	91.5	80	83.5
4	3	206	235.5	79	82.5	4	4	206	91.5	81	84
4	3	206	235.5	80	82.5	4	4	206	91.5	82.5	84.5

NOTATIONS USED IN CALCULATIONS.

C_b = specific heat for a cubic foot of air = .018

A = Area of tin

Q^1 = B.T.U.'S transmitted per hour

A^1 = Area of opening

O^1 = Intake opening in hot fan

O" = Intake opening in cold fan

V_1 = Velocity of air on hot side

V_2 = Velocity of air on cold side

$V_1 C_b (t_2 - t_1)$ = Heat in B.T.U. received by hot surface

$V_2 = C_b (t_2 - t_1)$= Heat in B. T. U. emitted by cold side

Q = B.T.U. transmitted per degree, per minute ?

U = B.T.U. transmitted per degree, per minute per sq. ft. per hour

A.B. & C. are designations of groups of experiments

V_a = Volume of hot air

V_b = Volume of cold air

t_2 & t_1 = temperatures at extreme ends of hot side

t_2 & t_1 = tmeperatures at extreme ends of cold side

CALCULATIONS

Calculation for Parallel Flow A with hot and cold fan openings wide open (hot 1, cold 1)

(a) Area of tin = $\frac{11.5"}{12}$ x 31.25' = 30 sq. ft. of heating surface.

(b) V_1 = 973.5'/min.

(c) V_2 = 318'/min.

(d) $V_a = A^1V_1 = (\frac{11.5 \times 6}{144})\ 973.5 = 467$ Cu. ft.

(e) $V_b = A^1\ V_2 = \frac{11.5 \times 6}{144} \times 318 = 152$ cu. ft.

(f) $V_a\ C_b = 467 \times .018 = 8.4$

(g) $V_b\ C_b = 152.5 \times .018 = 2.74$

(h) $V_a\ C_b\ (t_2 - t_1) = V_b\ C_b\ (t_2' - t_1') = Q^1$

$467 \times .018 \times 2 = 152.5 \times .018 \times 3 = Q^1$

$16.8 \quad = \quad 8.22 \quad = Q^1$

Use Q1 as 8.22 for the difference between the heat received and emitted is lost by radiation thru the openings of the box. Therefore $Q^1 = 8.22$ B.T.U.'S per hour

$$Q = \frac{8.22}{2.4} = 3.42$$

$$U = 60 \times \frac{Q}{4} = \frac{3.42 \times 60}{30} = 6.84 \text{ B.T.U.}$$

$$U = 6.84 \text{ B.T.U.}$$

PARALLEL FLOW

A

O'	O"	V_a	V_b	$V_aC_b(t''_2-t_1)$	$V_bC_p(t'_2-t'_1)$	Q	U
1	1	973.5	318	16.8	8.22	3.42	6.84
2	1	825.5	318	14.2	6.85	2.24	4.48
3	1	470.5	318	8.12	5.48	2.28	4.56
4	1	128	318	2.75	2.74	1.27	2.54
1	2	973.5	300	25.2	10.4	2.42	4.84
2	2	825.5	300	24.9	10.4	1.43	2.86
3	2	470.5	300	16.24	15.5	1.75	3.50
4	2	128.0	300	3.30	2.73	0.86	1.72
1	3	973.5	235.5	16.8	12.18	1.2	2.4
2	3	825.5	235.5	14.2	14.2	1.52	3.04
3	3	470.5	235.5	26.3	18.27	1.53	3.06
4	3	128.0	235.5	4.4	4.06	0.90	1.80
1	4	973.5	91.5	8.4	5.39	0.57	1.14
2	4	825.5	91.5	7.12	4.62	0.68	1.36
3	4	470.5	91.5	4.06	3.85	0.59	1.18
4	4	128.0	91.5	2.20	2.31	0.67	1.34

COUNTER FLOW

A

O'	O''	V_1	V_2	$V_aC_p(t_2-t_1)$	$V_bC_p(t_2'-t_1')$	Q	U
1	1	973.5	318	42.00	38.36	2.35	4.70
2	1	825.5	318	21.36	21.92	2.30	4.60
3	1	470.5	318	12.18	16.44	1.71	3.42
4	1	128.0	318	6.60	19.18	1.70	3.40
1	2	973.5	300	25.20	18.20	1.82	3.64
2	2	825.5	300	21.36	15.60	1.59	2.18
3	2	470.5	300	12.18	15.60	1.53	3.06
4	2	128.0	300	2.20	13.00	1.40	2.80
1	3	973.5	235.5	16.80	12.18	1.33	2.66
2	3	825.5	235.5	14.24	12.18	1.27	2.54
3	3	470.5	235.5	12.18	12.18	1.30	2.60
4	3	128.0	235.5	3.30	12.18	1.15	2.30
1	4	973.5	91.5	16.80	7.70	1.11	2.22
2	4	825.5	91.5	14.24	6.93	1.00	2.00
3	4	470.5	91.5	12.18	6.16	0.77	1.54
4	4	128.0	91.5	6.60	6.16	0.66	1.32

PARALLEL FLOW

B

O'	O''	V_1	V_2	$V_aC_p(t_2-t_1)$	$V_bC_p(t_2'-t_1')$	Q	U
1	1	1549	318	26.72	13.70	5.48	10.96
2	1	1200	318	20.72	10.96	1.90	3.80
3	1	705	318	12.16	8.22	1.70	3.40
4	1	247	318	6.39	5.48	0.86	1.76
1	2	1549	300	20.04	14.30	3.01	6.02
2	2	1200	300	15.54	10.40	2.40	4.80
3	2	705	300	9.12	7.80	1.60	3.20
4	2	247	300	5.32	5.20	2.01	4.02
1	3	1549	235.5	13.36	10.15	2.53	5.06
2	3	1200	235.5	10.36	10.15	1.90	3.80
3	3	705	235.5	9.1	8.12	2.03	4.06
4	3	247	235.5	6.39	6.09	1.07	2.14
1	4	1549	91.5	6.7	5.775	0.806	1.61
2	4	1200	91.5	5.18	4.52	1.506	3.01
3	4	705	91.5	3.10	3.80	1.140	2.28
4	4	247	91.5	2.13	2.21	0.610	1.22

COUNTER FLOW

B

O'	O"	V_1	V_2	$V_aC_b(t_2-t_1)$	$V_bC_p(t_2'-t_1')$	Q	U
1	1	1549	318	20.04	8.22	1.90	3.80
2	1	1200	318	10.36	4.11	1.05	2.10
3	1	705	318	12.16	5.48	1.34	2.68
4	1	247	318	4.26	2.74	0.76	1.52
1	2	1549	300	33.40	9.10	2.30	4.60
2	2	1200	300	5.18	5.20	1.38	2.76
3	2	705	300	15.20	5.20	1.45	2.90
4	2	247	300	5.33	3.90	1.40	2.80
1	3	1549	235.5	6.68	3.04	0.82	1.64
2	3	1200	235.5	10.36	3.04	1.04	2.08
3	3	705	235.5	12.16	6.09	1.52	3.04
4	3	247	235.5	4.26	5.07	1.35	2.70
1	4	1549	91.5	26.70	1.44	0.51	1.02
2	4	1200	91.5	20.72	2.31	0.67	1.34
3	4	705	91.5	9.12	2.31	0.67	1.34
4	4	247	91.5	4.26	1.54	0.54	1.08

PARALLEL FLOW

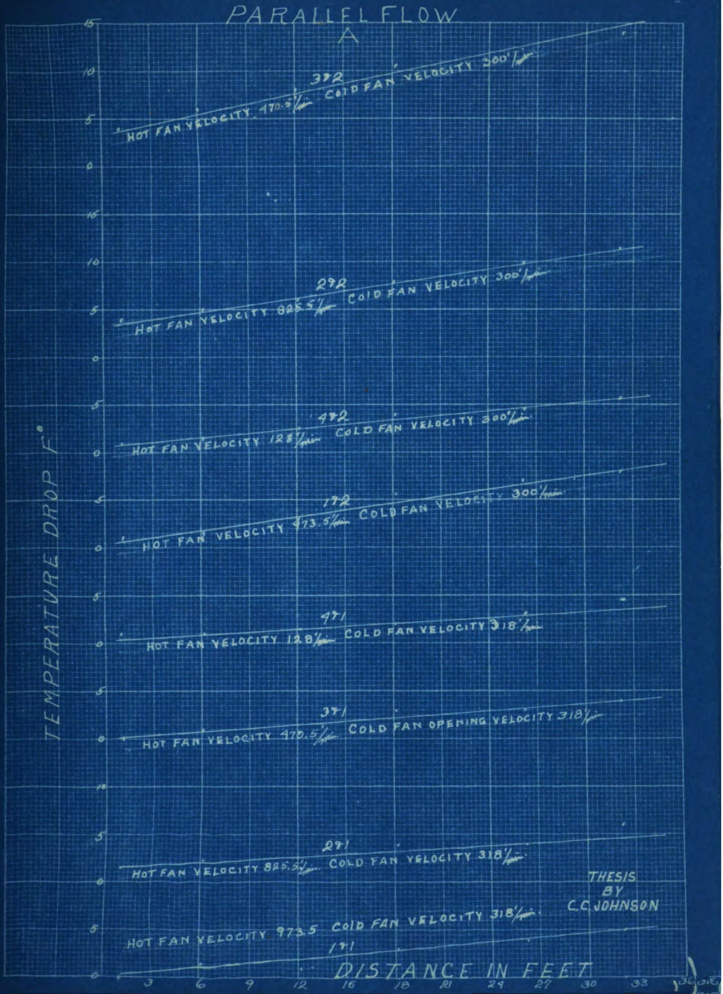
C

O'	O''	V_1	V_2	$V_aC_p(t_2-t_1)$	$V_bC_p(t_2'-t_1')$	Q	U
1	1	1261	318	21.76	13.70	2.700	5.40
2	1	914.5	318	15.76	11.33	2.570	5.14
3	1	554.5	318	11.90	9.96	3.200	6.40
4	1	206	318	5.98	4.11	0.967	1.93
1	2	1261	300	16.32	13.00	3.10	6.20
2	2	914.5	300	15.76	10.53	2.38	4.76
3	2	554.5	300	7.17	5.20	1.59	3.18
4	2	206	300	4.42	4.00	1.45	2.90
1	3	1261	235.5	10.88	9.14	2.43	4.86
2	3	914.5	235.5	7.88	7.10	1.73	3.46
3	3	554.5	235.5	7.17	5.07	1.52	3.04
4	3	206	235.5	6.19	6.09	1.28	2.56
1	4	1261	91.5	8.70	5.80	1.53	3.06
2	4	914.5	91.5	7.88	5.39	1.20	2.40
3	4	554.5	91.5	4.78	4.72	1.01	2.02
4	4	206	91.5	1.77	1.54	0.53	1.06

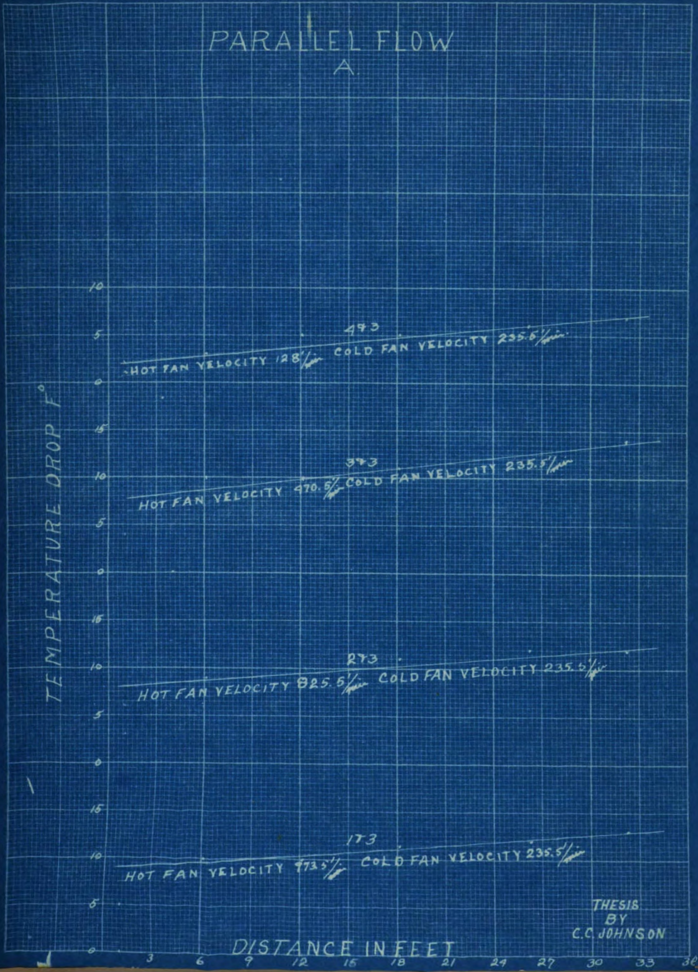
COUNTER FLOW

C

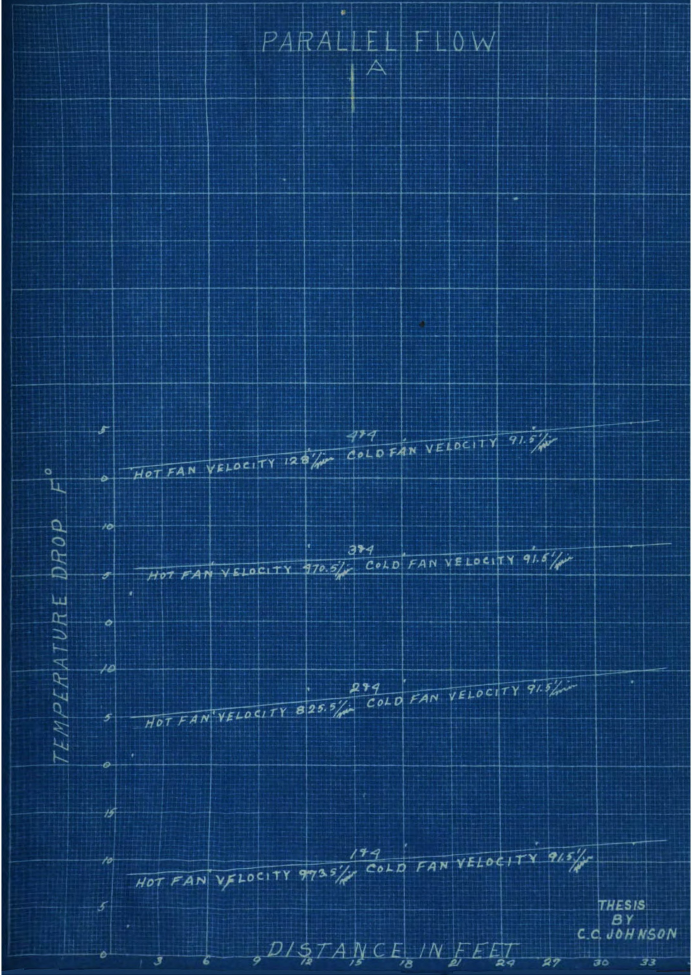
O'	O''	V_1	V_2	$V_aC_p(t_2-t_1)$	$V_bC_p(t'_2-t'_1)$	Q	U
1	1	1261	318	10.88	2.74	1.50	3.00
2	1	914.5	318	23.60	2.74	1.37	2.74
3	1	554.5	318	9.56	1.37	0.98	1.96
4	1	206	318	2.65	1.37	0.87	1.74
1	2	1261	300	5.44	2.60	1.90	3.80
2	2	914.5	300	7.88	2.60	1.36	2.72
3	2	554.5	300	7.17	1.30	1.04	2.08
4	2	206	300	3.54	3.90	0.907	1.814
1	3	1261	235.5	5.44	5.07	1.45	2.90
2	3	914.5	235.5	19.70	5.07	1.37	2.74
3	3	554.5	235.5	2.39	4.06	1.23	2.46
4	3	206	235.5	3.54	3.04	0.98	1.96
1	4	1261	91.5	10.88	2.30	0.96	1.92
2	4	914.5	91.5	3.94	1.54	0.73	1.46
3	4	554.5	91.5	4.78	1.54	0.64	1.28
4	4	206	91.5	2.65	1.59	0.55	1.10

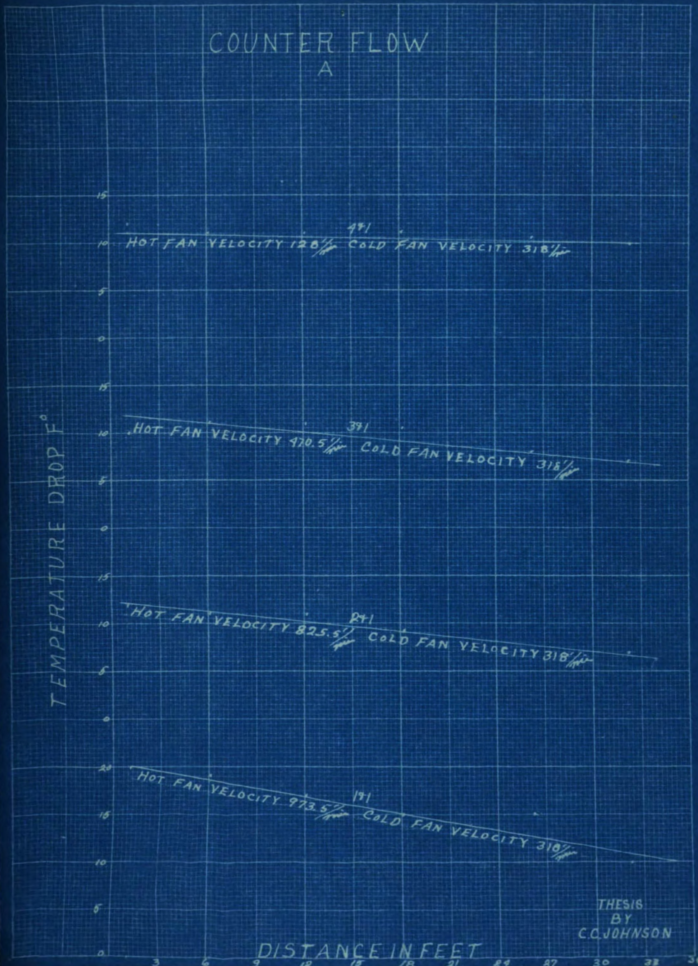


PARALLEL FLOW
A
3 & 2
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 300'/min
2 & 2
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 300'/min
4 & 2
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 300'/min
1 & 2
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 300'/min
4 & 1
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 318'/min
3 & 1
HOT FAN VELOCITY 470.5'/min COLD FAN OPENING VELOCITY 318'/min
2 & 1
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 318'/min
HOT FAN VELOCITY 973.5 COLD FAN VELOCITY 318'/min
1 & 1
TEMPERATURE DROP F°
DISTANCE IN FEET
3
6
9
12
15
18
21
24
27
30
33
36
THESIS
BY
C.C. JOHNSON

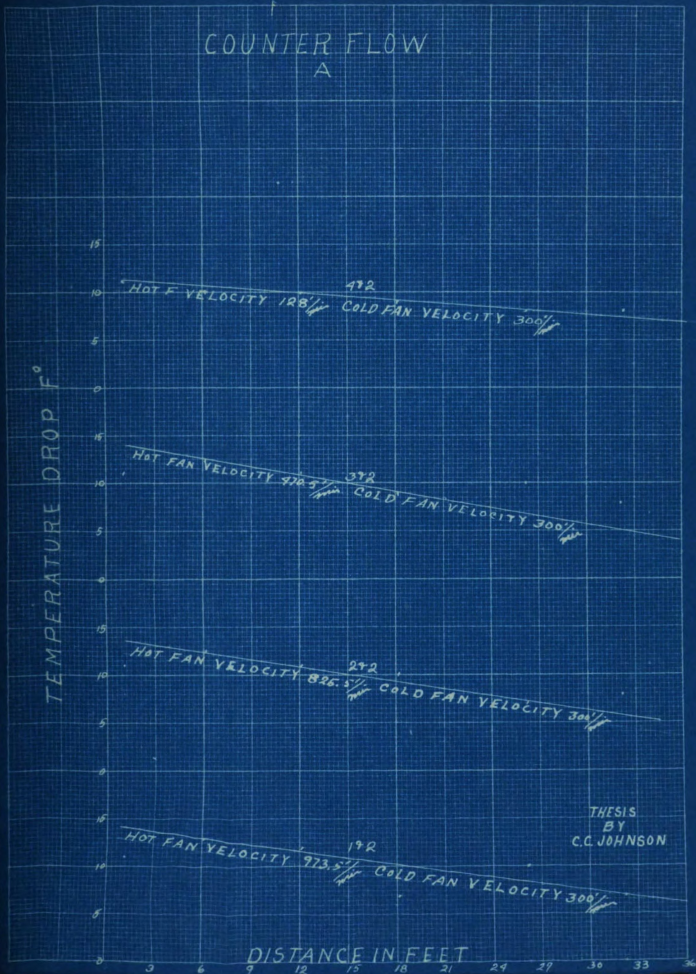


PARALLEL FLOW
A
473
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 235.5'/min
373
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 235.5'/min
273
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 235.5'/min
173
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 235.5'/min
TEMPERATURE DROP F°
10
5
0
15
10
5
0
15
10
5
0
15
10
5
0
DISTANCE IN FEET
3
6
9
12
15
18
21
24
27
30
33
36
THESIS
BY
C.C. JOHNSON

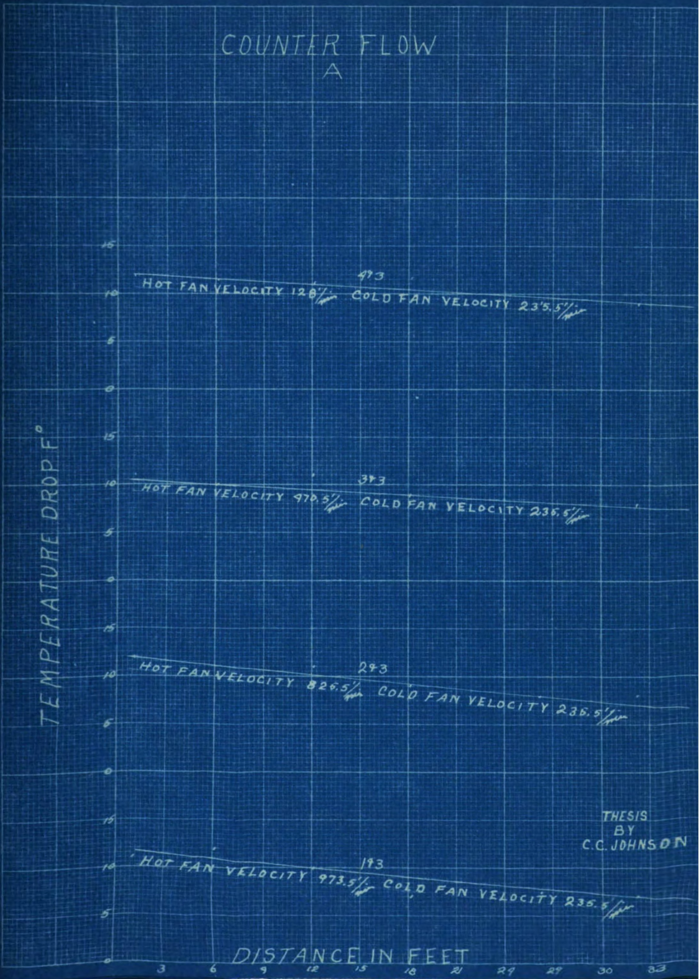

PARALLEL FLOW
A
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 970.5'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 91.5'/min
TEMPERATURE DROP F°
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33
THESIS
BY
C.C. JOHNSON

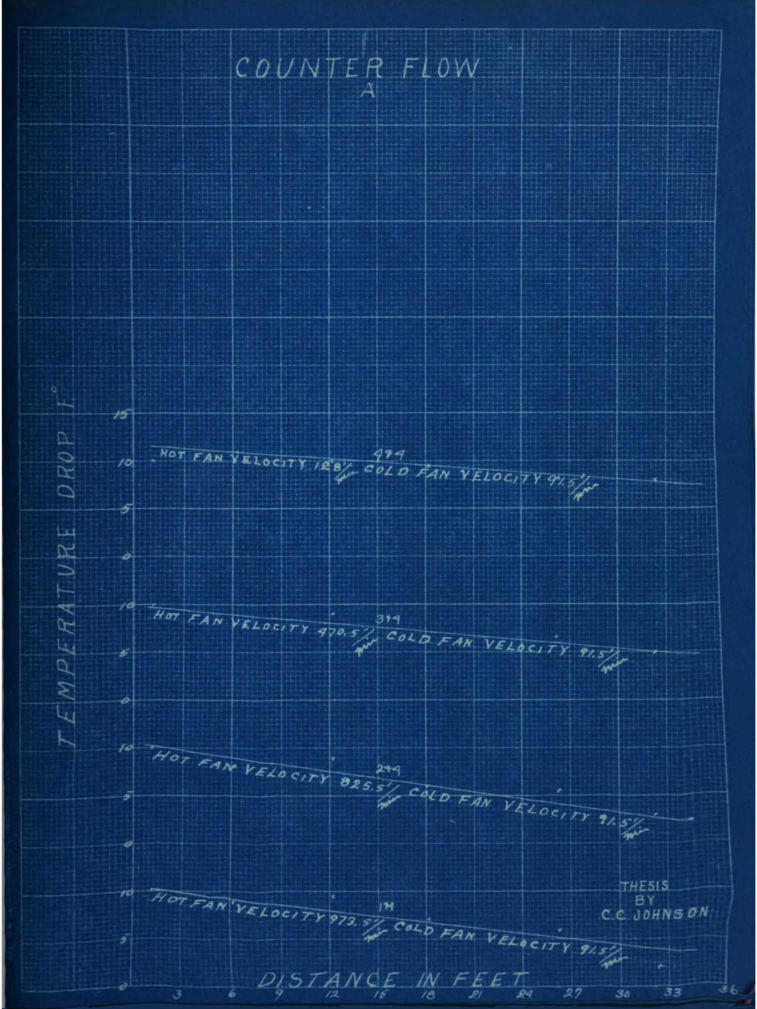


COUNTER FLOW
A
TEMPERATURE DROP F°
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 318'/min
4+1
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 318'/min
3+1
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 318'/min
2+1
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 318'/min
1+1
DISTANCE IN FEET
3
6
9
12
15
18
21
24
27
30
33
36
THESIS
BY
C.C. JOHNSON

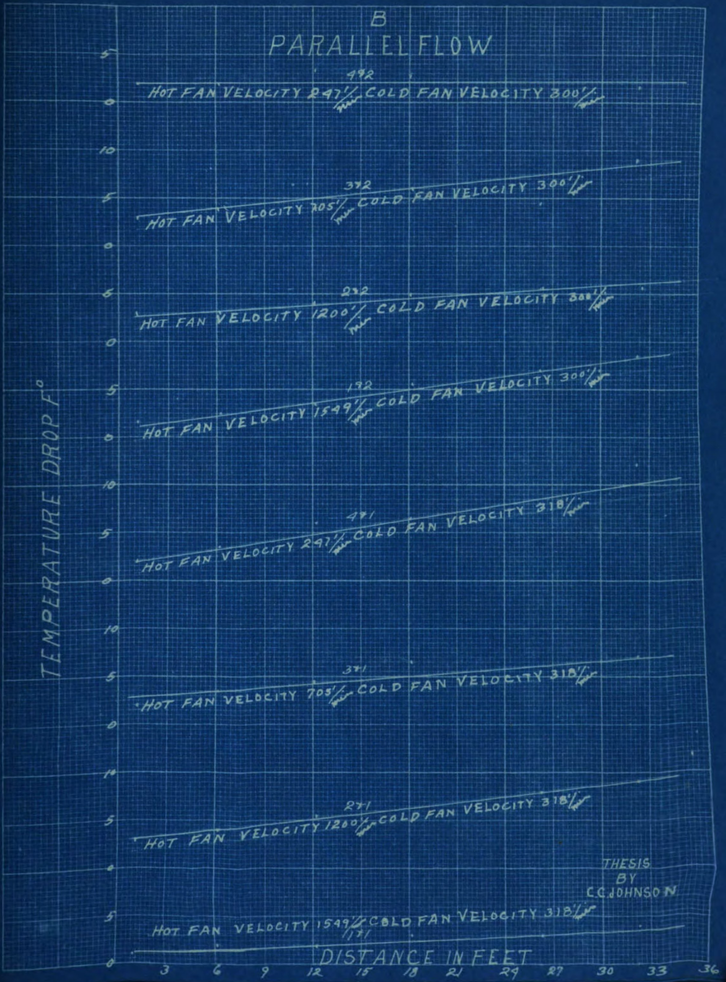


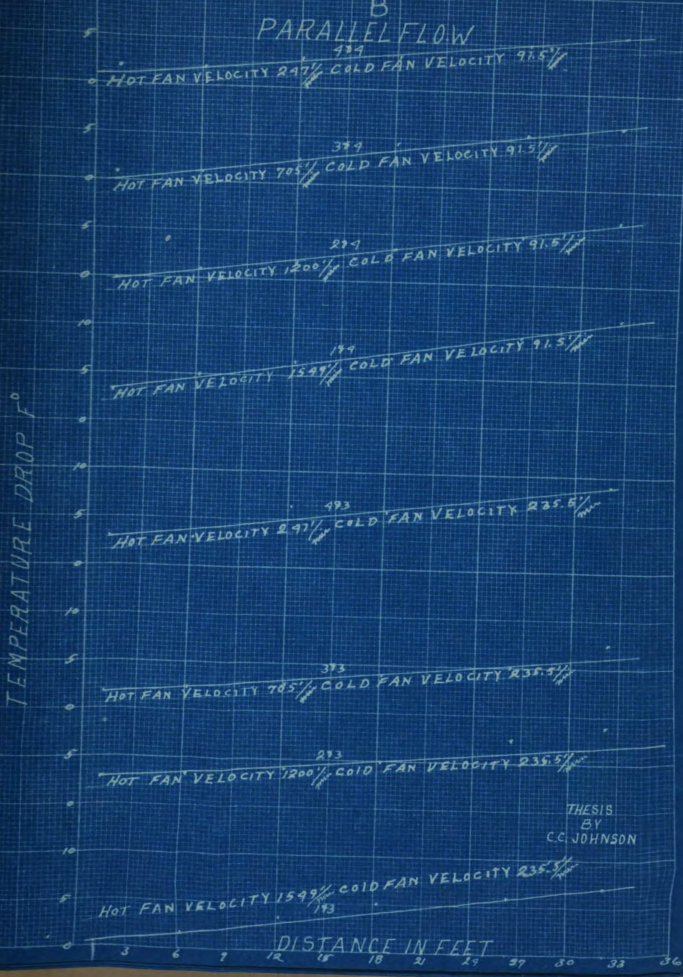
COUNTER FLOW
A
TEMPERATURE DROP F°
4&2
HOT F VELOCITY 128'/min COLD FAN VELOCITY 300'/min
3&2
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 300'/min
2&2
HOT FAN VELOCITY 826.5'/min COLD FAN VELOCITY 300'/min
1&2
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 300'/min
THESIS
BY
C.C. JOHNSON
DISTANCE IN FEET
0
3
6
9
12
15
18
21
24
27
30
33
36

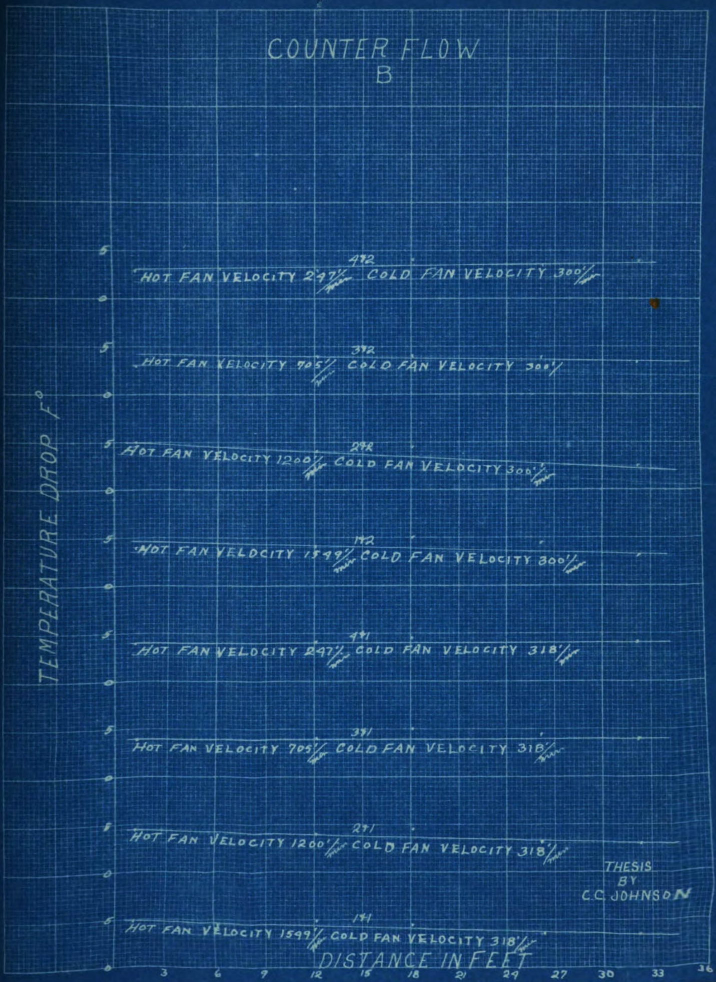

COUNTER FLOW
A
TEMPERATURE DROP F°
493
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 235.5'/min
393
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 235.5'/min
293
HOT FAN VELOCITY 826.5'/min COLD FAN VELOCITY 235.5'/min
193
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 235.5'/min
THESIS
BY
C.C. JOHNSON
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33



COUNTER FLOW
A
TEMPERATURE DROP F°
DISTANCE IN FEET
0
3
6
9
12
15
18
21
24
27
30
33
36
HOT FAN VELOCITY 128'/min COLD FAN VELOCITY 91.5'/min
4-9
HOT FAN VELOCITY 470.5'/min COLD FAN VELOCITY 91.5'/min
3-9
HOT FAN VELOCITY 825.5'/min COLD FAN VELOCITY 91.5'/min
2-9
HOT FAN VELOCITY 973.5'/min COLD FAN VELOCITY 91.5'/min
1-9
THESIS
BY
C.C. JOHNSON


B
PARALLEL FLOW
492
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 300'/min
372
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 300'/min
292
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 300'/min
192
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 300'/min
471
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 318'/min
371
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 318'/min
271
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 318'/min
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 318'/min
171
TEMPERATURE DROP F°
DISTANCE IN FEET
3
6
9
12
15
18
21
24
27
30
33
36
THESIS
BY
C.C.JOHNSON


B
PARALLEL FLOW
TEMPERATURE DROP F°
DISTANCE IN FEET
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 91.5'/min
4 9
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 91.5'/min
3 9
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 91.5'/min
2 9
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 91.5'/min
1 9
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 235.5'/min
4 3
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 235.5'/min
3 3
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 235.5'/min
2 3
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 235.5'/min
1 3
THESIS
BY
C.C. JOHNSON


COUNTER FLOW
B
TEMPERATURE DROP F°
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 300'/min
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 300'/min
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 300'/min
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 300'/min
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 318'/min
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 318'/min
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 318'/min
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 318'/min
DISTANCE IN FEET
3
6
9
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33
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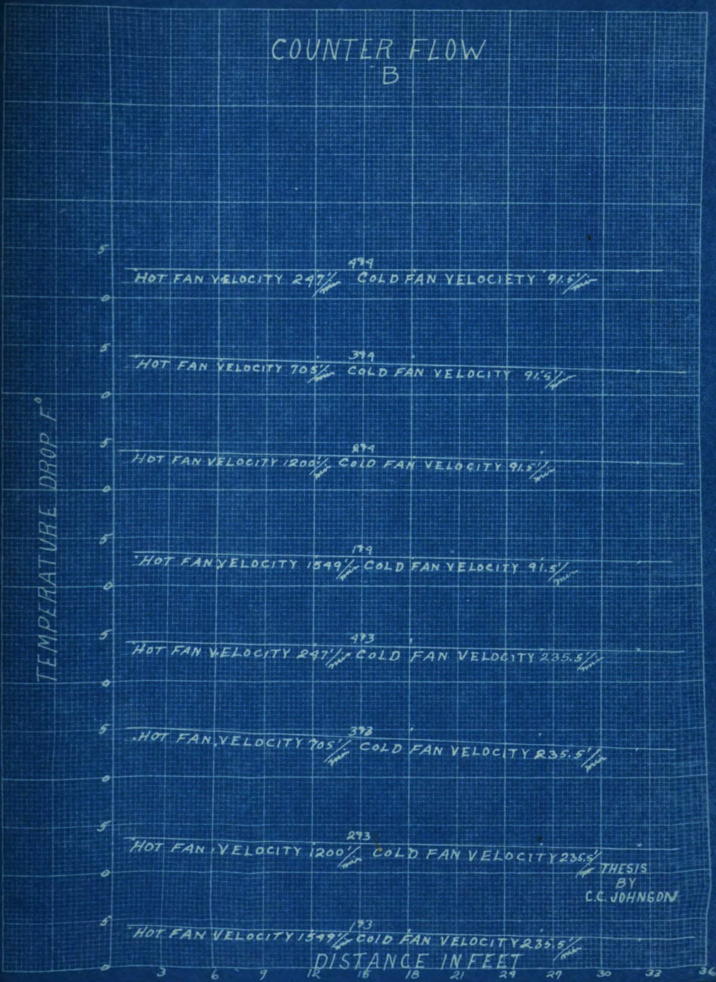
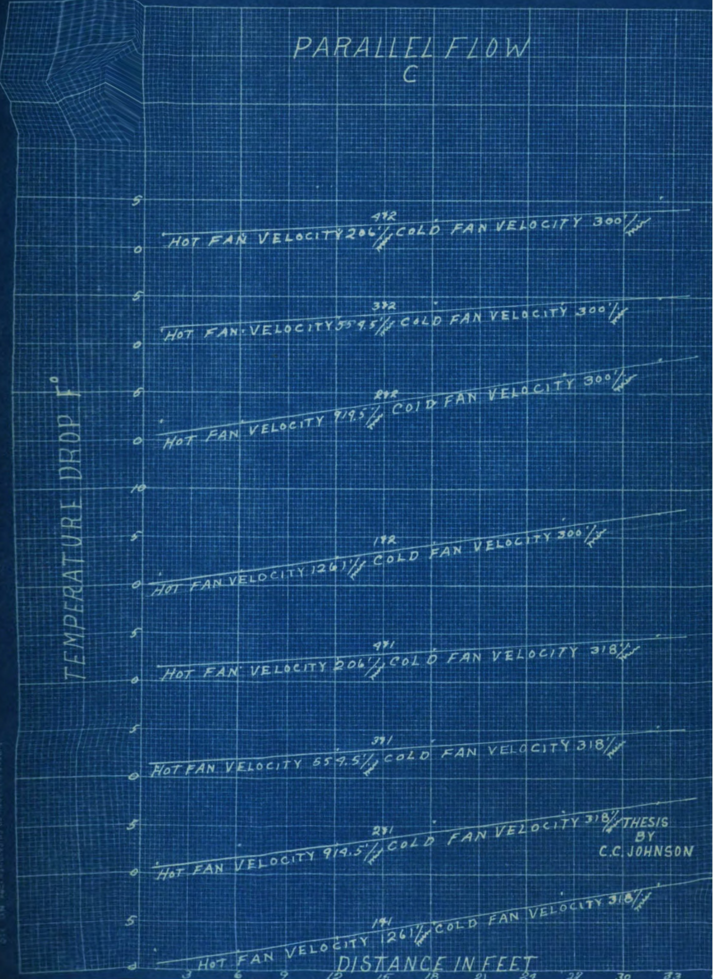
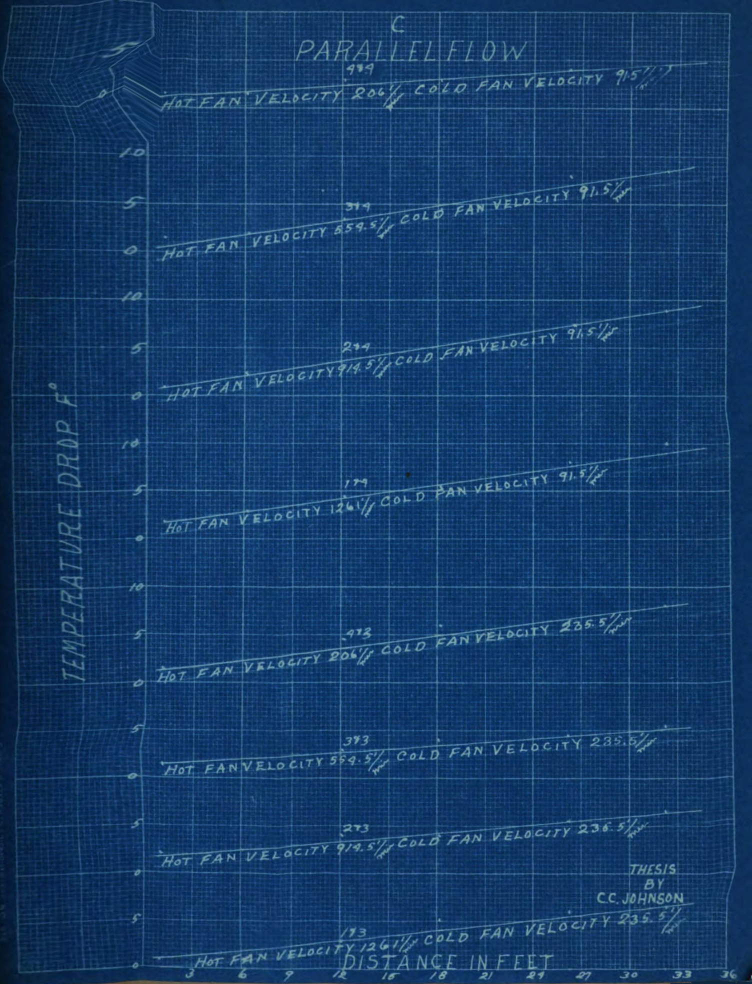
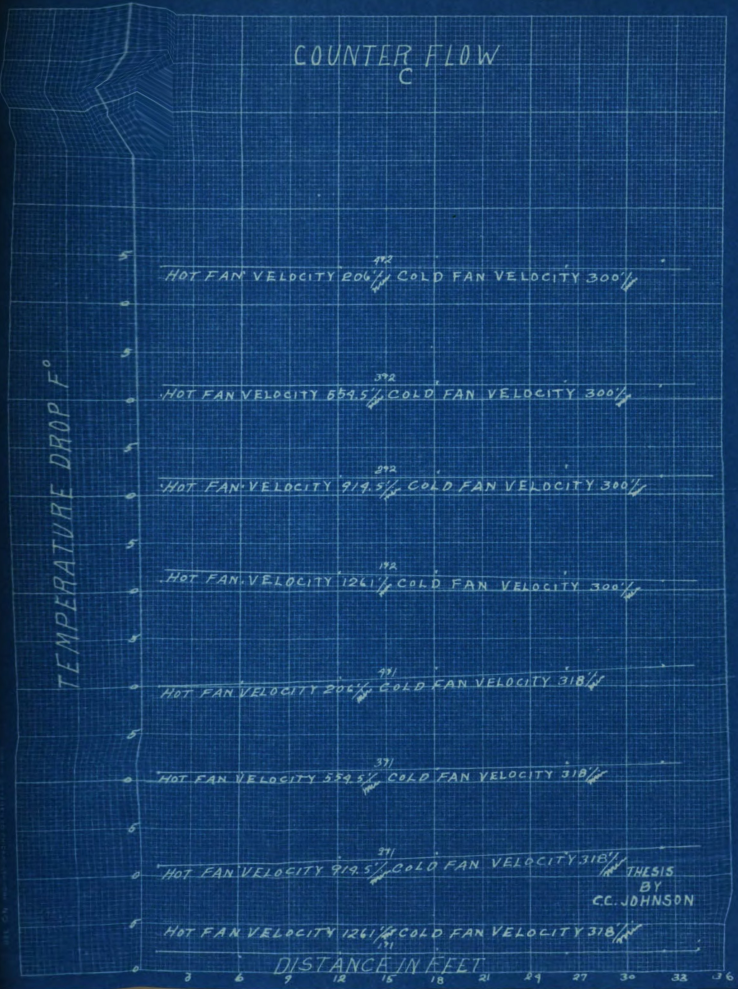
THESIS
BY
C.C. JOHNSON


COUNTER FLOW
B
HOT FAN VELOCITY 247'/min COLD FAN VELOCIETY 91.5'/min
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 247'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 705'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 1200'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 1549'/min COLD FAN VELOCITY 235.5'/min
TEMPERATURE DROP F°
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33 36
THESIS
BY
C.C. JOHNSON

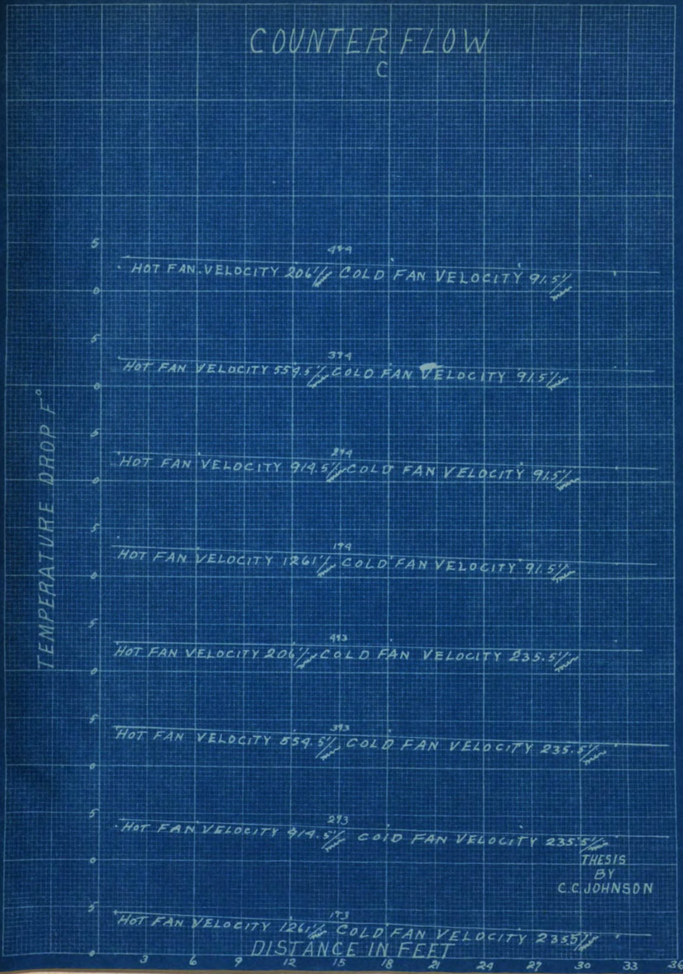


PARALLEL FLOW
C
TEMPERATURE DROP F°
4&2
HOT FAN VELOCITY 206'/min COLD FAN VELOCITY 300'/min
3&2
HOT FAN VELOCITY 559.5'/min COLD FAN VELOCITY 300'/min
2&2
HOT FAN VELOCITY 919.5'/min COLD FAN VELOCITY 300'/min
1&2
HOT FAN VELOCITY 1261'/min COLD FAN VELOCITY 300'/min
4&1
HOT FAN VELOCITY 206'/min COLD FAN VELOCITY 318'/min
3&1
HOT FAN VELOCITY 559.5'/min COLD FAN VELOCITY 318'/min
2&1
HOT FAN VELOCITY 914.5'/min COLD FAN VELOCITY 318'/min
1&1
HOT FAN VELOCITY 1261'/min COLD FAN VELOCITY 318'/min
THESIS
BY
C.C. JOHNSON
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33


C
PARALLEL FLOW
4+4
HOT FAN VELOCITY 206'/M COLD FAN VELOCITY 91.5'/M
3+4
HOT FAN VELOCITY 559.5'/M COLD FAN VELOCITY 91.5'/M
2+4
HOT FAN VELOCITY 914.5'/M COLD FAN VELOCITY 91.5'/M
1+4
HOT FAN VELOCITY 1261'/M COLD FAN VELOCITY 91.5'/M
4+3
HOT FAN VELOCITY 206'/M COLD FAN VELOCITY 235.5'/M
3+3
HOT FAN VELOCITY 559.5'/M COLD FAN VELOCITY 235.5'/M
2+3
HOT FAN VELOCITY 914.5'/M COLD FAN VELOCITY 235.5'/M
1+3
HOT FAN VELOCITY 1261'/M COLD FAN VELOCITY 235.5'/M
TEMPERATURE DROP F°
DISTANCE IN FEET
3
6
9
12
15
18
21
24
27
30
33
36
THESIS
BY
C.C. JOHNSON



COUNTER FLOW
C
TEMPERATURE DROP F°
HOT FAN VELOCITY 206'/ COLD FAN VELOCITY 300'/
HOT FAN VELOCITY 554.5'/ COLD FAN VELOCITY 300'/
HOT FAN VELOCITY 914.5'/ COLD FAN VELOCITY 300'/
HOT FAN VELOCITY 1261'/ COLD FAN VELOCITY 300'/
HOT FAN VELOCITY 206'/ COLD FAN VELOCITY 318'/
HOT FAN VELOCITY 554.5'/ COLD FAN VELOCITY 318'/
HOT FAN VELOCITY 914.5'/ COLD FAN VELOCITY 318'/
HOT FAN VELOCITY 1261'/ COLD FAN VELOCITY 318'/
THESIS
BY
C.C. JOHNSON
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33 36


COUNTER FLOW
C
TEMPERATURE DROP F°
HOT FAN VELOCITY 206'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 559.5'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 914.5'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 1261'/min COLD FAN VELOCITY 91.5'/min
HOT FAN VELOCITY 206'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 554.5'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 914.5'/min COLD FAN VELOCITY 235.5'/min
HOT FAN VELOCITY 1261'/min COLD FAN VELOCITY 2355'/min
THESIS
BY
C.C. JOHNSON
DISTANCE IN FEET
3 6 9 12 15 18 21 24 27 30 33 36

USE ONLY

22 '49