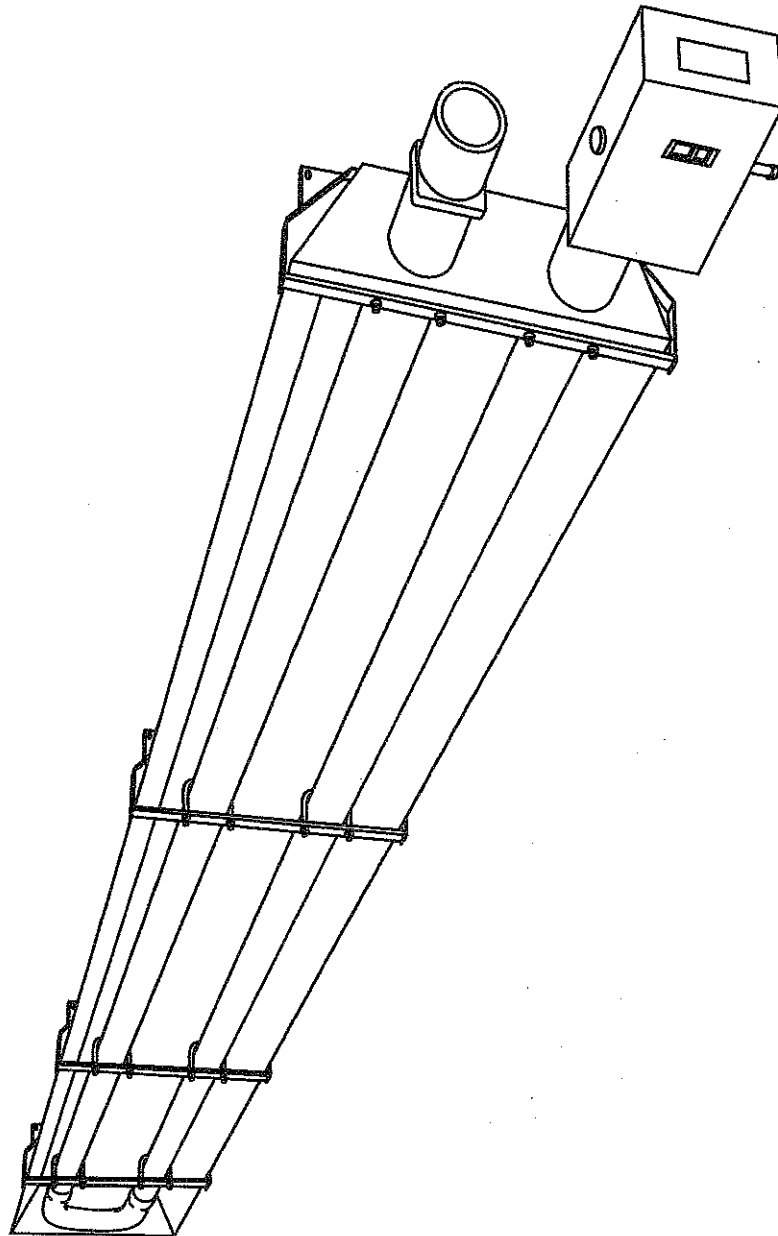


# HERRINGBONE DESIGN MANUAL

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FOR THE HERRINGBONE COMBINED FLUE HEATING SYSTEM



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**AMBI-RAD®**  
Energy Efficient Heating Systems

# USER INSTRUCTIONS FOR AMBI-RAD HERRINGBONE HEATERS

FIG. 1. TYPICAL HERRINGBONE HEATING ARRANGEMENT USING AR22HB & HB22AR HEATERS.

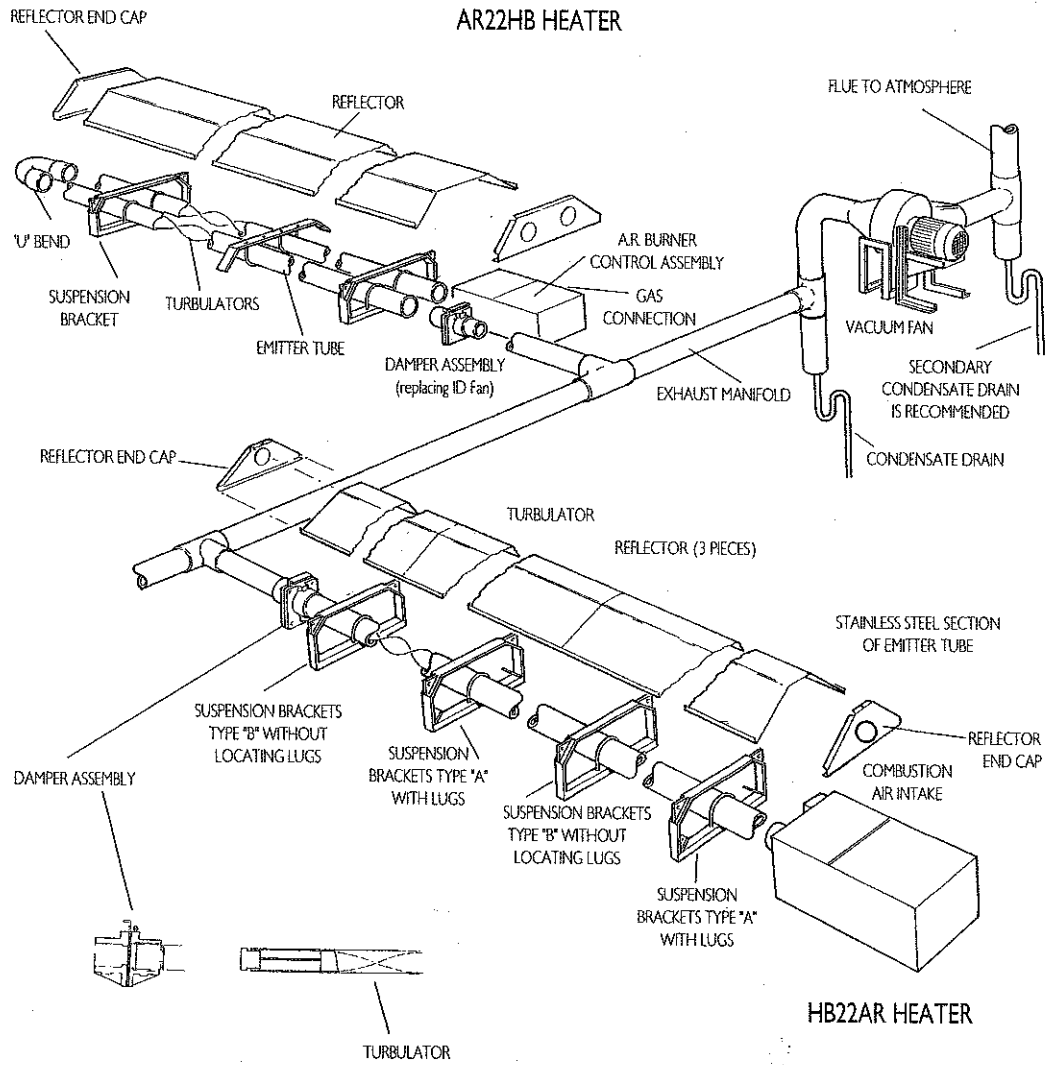
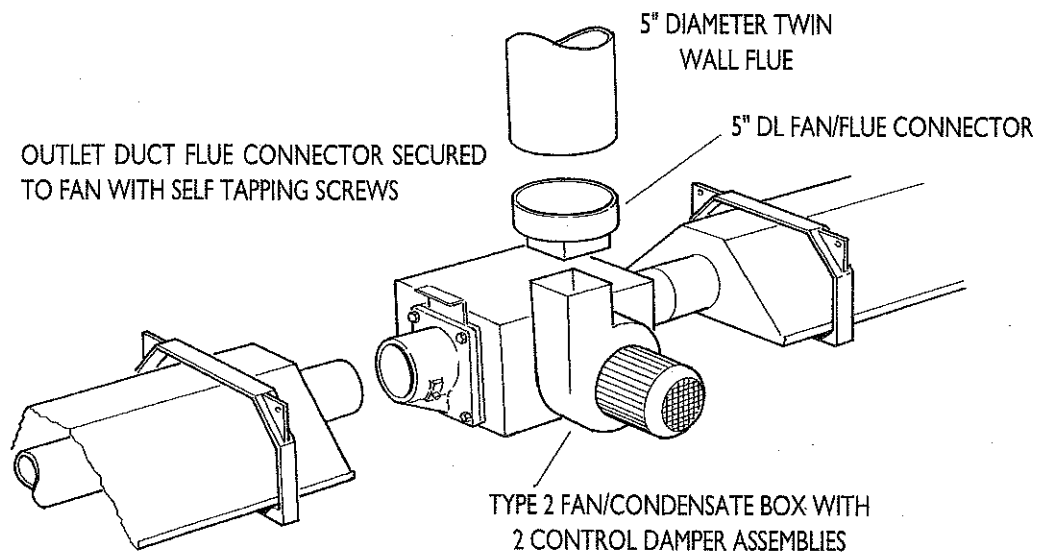


FIG. 2 DL HEATER ARRANGEMENT



FOR HEATER ASSEMBLY INSTRUCTIONS  
REFER TO:

COMBINED HERRINGBONE	-	Doc ref 134
ER U TUBE	-	Doc ref 74
ER LINEAR	-	Doc ref 76
AR U TUBE	-	Doc ref 75
AR LINEAR	-	Doc ref 77
RB U TUBE	-	Doc ref 78
RB LINEAR	-	Doc ref 79
AR DL	-	Doc ref 80

A combined flue system is required to alleviate the necessity of cutting holes in the roof to accommodate individual flues or where there are concrete roofs.

## THE HERRINGBONE COMBINED SYSTEM

The Ambi-Rad Herringbone combined flue heating system incorporates the Ambi-Rad linear or 'U' tube heaters. Up to ten 10 heaters can be connected together via the exhaust manifold system, utilising only one hot gas vacuum fan. Ambi-Rad supplies all the necessary components and exhaust manifold. The Herringbone heating system can be designed for use with all ER, AR or RB 'U' tube or linear heaters. The mounting heights of all heaters are given in the individual Assembly Instructions.

## DESIGN OF SYSTEM

When designing a Herringbone Combined Flue System, the manifold layout should be designed to be as compact as possible with the final exit connection to the vacuum fan approximately central to the manifold system. Providing the manifold length between successive connections in the manifold from the heater units does not exceed 10m (33ft. 0in.). The following pipe sizes are recommended when designing a compact system. All bends, tees and reducers are equal to 5m length of tube.

**Rule of thumb** design criteria for maximum number of heaters (**note: all design pressure drops should be checked before installation**).

No. Heaters	Size	Manifold Size	Fan Type
1-2	13	75/100mm (3/4in. Dia.)	Type 2
3	13	100mm (4in. Dia.)	Type 2
4-10	13	100/150mm (4/6in. Dia.)	Type 1
1-2	22/18	75/100mm (3/4in. Dia.)	Type 2
3	22/18	100mm (4in. Dia.)	Type 2
4	22/18	100mm (4in. Dia.)	Type 1
5-10	22/18	150mm (6in. Dia.)	Type 1
1-2	38/35/30	100mm (4in. Dia.)	Type 2
3	38/35/30	100mm (4in. Dia.)	Type 1
4-6	38/35/30	150mm (6in. Dia.)	Type 1
7-8	38/35/30	150mm (6in. Dia.)	Type 0

Ambi-Rad will, upon receipt of a proposed Herringbone combined flue system, check the pressure drop of the manifold system to ensure it does not exceed vacuum fan design criteria.

## INSTALLATION OF SYSTEM

The manifold should be arranged to fall slightly in the direction of the fan with care being taken to ensure that any condensate formed in the pipe on cold start up will flow towards the fan and will not be trapped or drain back into the heater unit. The manifold should be supported at the following centres by chains or other semi-flexible means from the roof structure.

Manifold Pipe Size	Max. dist. Between
75mm	2.4m (8ft)
100mm	2.4m (8ft)
150mm	3.0m (10ft)
200mm	3.0m (10ft)

At the exit from the manifold, before entering the fan, provision should be made for the collection of condensate and for the drainage of condensate to a drain via a deep 'U' shaped trap (minimum depth 450mm or 18in.). A suitable arrangement of this is shown in (Fig.3) together with alternative arrangements for connecting the manifold to the hot gas vacuum fan. Two recommended methods of discharging the products of combustion to atmosphere are also indicated in Fig.3a and 3d. The square to round transformation piece or the stainless steel telescopic flue can be supplied by Ambi-Rad but preference of flue arrangement must be advised. Where a conventional flue is to be installed, Ambi-Rad only supply the vacuum fan square to round transformation piece.

## CORROSION PROTECTION

It is important to properly drain the condensate formed during start up and stopping of the heating system. Otherwise leaks may develop after extended use of the heating system.

Aluminium and stainless steel are attacked by sugar dust and starch, or chloride and fluoride based cleaning compounds which are used in some industrial processes. Effective protection can be obtained by fitting ducted air from outside the building. Should there be any doubts Ambi-Rad will be pleased to advise.

FIG. 3a. HIGH FAN ARRANGEMENT

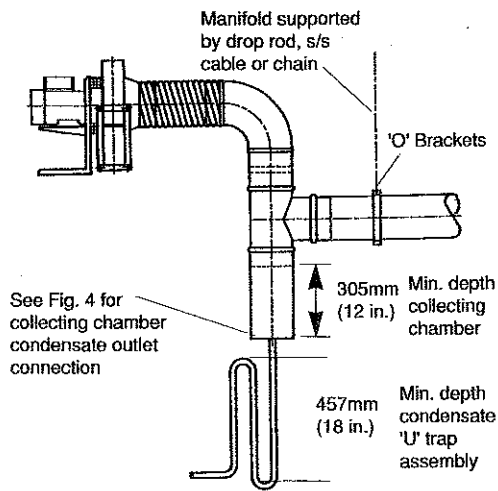


FIG. 3d.

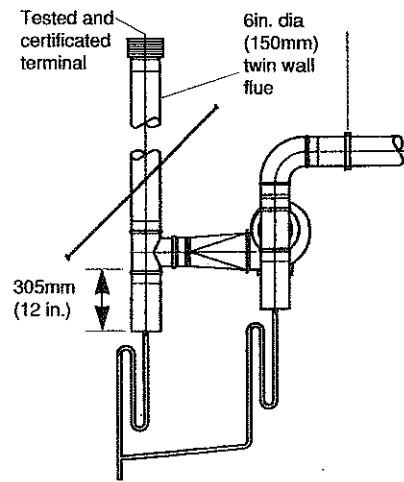


FIG. 3b. LOW FAN ARRANGEMENT

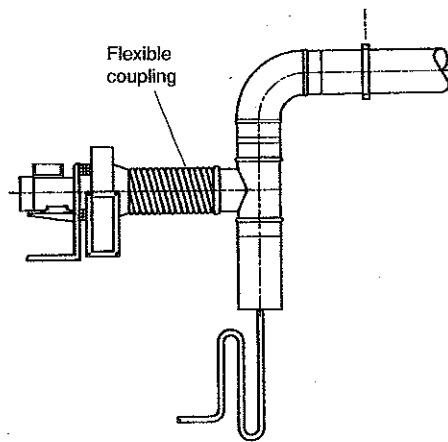


FIG. 3e.

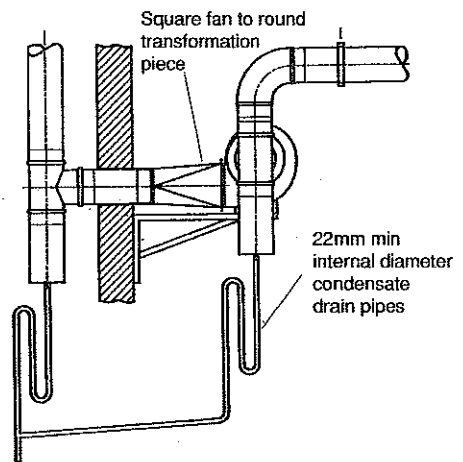


FIG. 3c

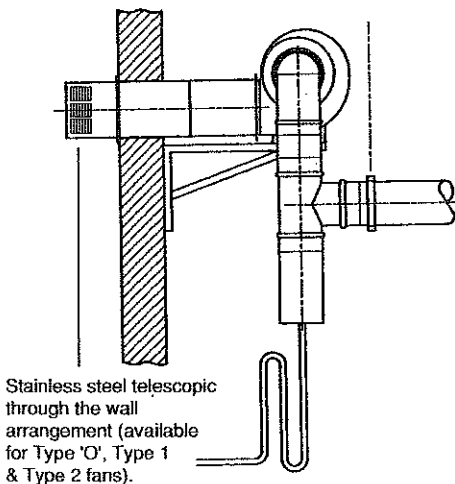
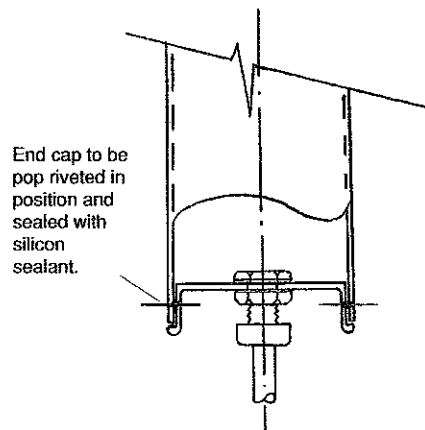


FIG. 4. COLLECTING CHAMBER ARRANGEMENT



## DO's

1. Do check design pressure drop.
2. Do check for corrosive industrial processes in proposed building - e.g., cleaning, electroplating, printers using sugar powder etc.
3. Do drain all flue ducts and seal all joints.
4. Do secure joints with pop rivets as well as sealing compound.
5. Do fit drain traps before and after fans (see Fig.3).
6. Do fit expansion joints before fan and at intermediate points on the Herringbone system.
7. Do run drains in galvanised steel or plastic pipe.
8. Do follow guide to Combined Flue Heating System.

## DON'Ts

1. Do not install system with extra 90° bends without asking Ambi-Rad if the system will operate correctly.
2. Do not run drains in copper pipe as it will corrode.
3. Do not install flue going upwards without fitting a drain point at lowest level.
4. Do not fit fan with outlet pointing vertically upwards or with top horizontal discharge
5. Do not fit damper assembly upside down or on its side. See Fig.(1).

FIG.5. VACCUM FAN MOUNTING DETAILS.

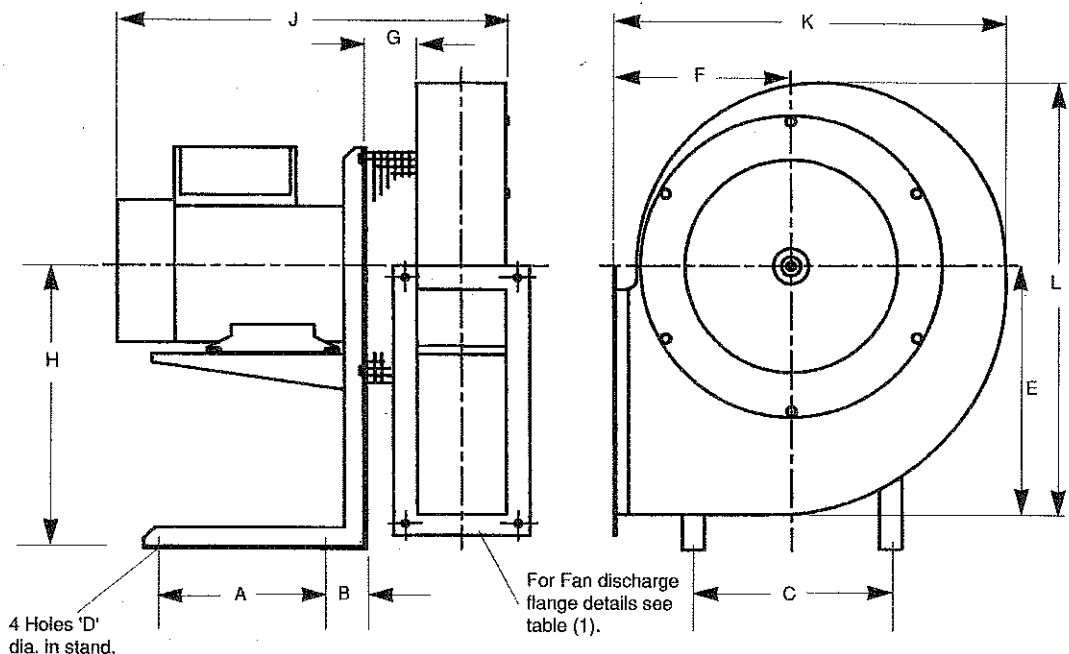


TABLE I

FAN TYPE	DIMENSIONS IN mm.										
	A	B	C	D	E	F	G	H	J	K	L
0	124	38	175	7.1	209	153	42	239	340	332	363
1	124	38	175	7.1	209	153	42	239	296	332	363
2	80	35	174	7	125	100	25	120	210	205	215

For a typical design example see Appendix 2 (1-5)

**STEP BY STEP PROCEDURE**

1. Draw a sketch of the proposed heating layout on form A (see page 13) or draw directly on to architects scaling drawings.
2. Position heaters and keep to a maximum manifold length of 10m (33ft) between each heater. Use rule of thumb method to initially size manifold diameters.
3. Either estimate or scale measure the lengths of manifold or fresh air inlet ducts. Split the system into sections. Each section to be numbered and split at the junction of each manifold branch or change in manifold diameter.

**USING FORM B (see pages 15 & 16)**

4. Enter the exhaust manifold diameters in Row 2.
5. Calculate the total heat input in kilowatts upstream of each section and enter these values in Row 3.
6. Estimate manifold lengths of each section and fitting allowances as obtained from p. 14 & enter in Row 4.
7. Add together all values of the group in Rows 4 and enter in Row 5.
8. Read off the specific resistance for each section of exhaust duct from Table 1 and enter these values in Row 6.
9. Multiply the values in Row 5 by those in Row 6 and enter the pressure drop in Row 7 under the section number column.

**USING FORM C (see page 17)**

10. For each heater enter the kilowatt rating in Row 2.
11. For each heater read off the damper setting vacuum from Table 2 (see page 9) and enter these values under the appropriate heater numbers in Row 9.
12. Note any heaters, if any, on the system which are supplied with ducted fresh air.
13. Enter the true air duct lengths for these heaters in Row 3.
14. For each heater having ducted air, enter the bends allowance from Row 4 on page 17 (see text and notes at the bottom of form C).
15. Enter an allowance for an air duct terminal for each heater supplied with fresh air in Row 5.
16. Add together the values in Rows 3, 4 and 5 for each heater and enter these sums in Row 6.

17. For each size of heater supplied with fresh air, read off the specific air duct pressure drop from Table 3 and enter these figures in Row 7.

18. Multiply the values in Row 8 and Row 9 and enter these sums in Row 10.

**USING FORM D (see page 18)**

20. For each heater number, transfer the values in Row 10 of form C to column 2 of form D.
21. Log each manifold section from each heater to the fan and enter into column 2 the pressure drop of each section against the heater number.
22. From form B enter the section pressure drop value, Row 7 into Column 3.
23. Add together the section value for each heater, column 2 and 3 (if applicable) and enter the sum on column 4.
24. Add together all values in column 4 and enter total system pressure drop.
25. Calculate the total kW heat input of the system (e.g. 10 model 22kW input heaters = 220kW).
26. Using the Herringbone Fan Curve (Fig. 7, 8 and 9) and depending upon type of fan or motor to be specified, plot the total system pressure drop against the total kW heat input of the system.

**NOTE**

All the values should fall just below the appropriate curve.

If any value(s) falls above the curve, check Row 7 of form B to determine where the highest pressure drop(s) occurs along that particular flue gas route(s) and increase the duct diameter for that particular section(s). Where heaters have fresh air intake ducts, refer to column 2 of form D to ascertain if a high pressure drop occurs in the fresh air duct.

If any value(s) falls well below the curve check Row 7 of form B to identify the lowest pressure drop(s) along the particular route(s) and decide whether or not reducing the duct diameter corresponding to that pressure drop(s) would be possible or economical.

FIG. 6.

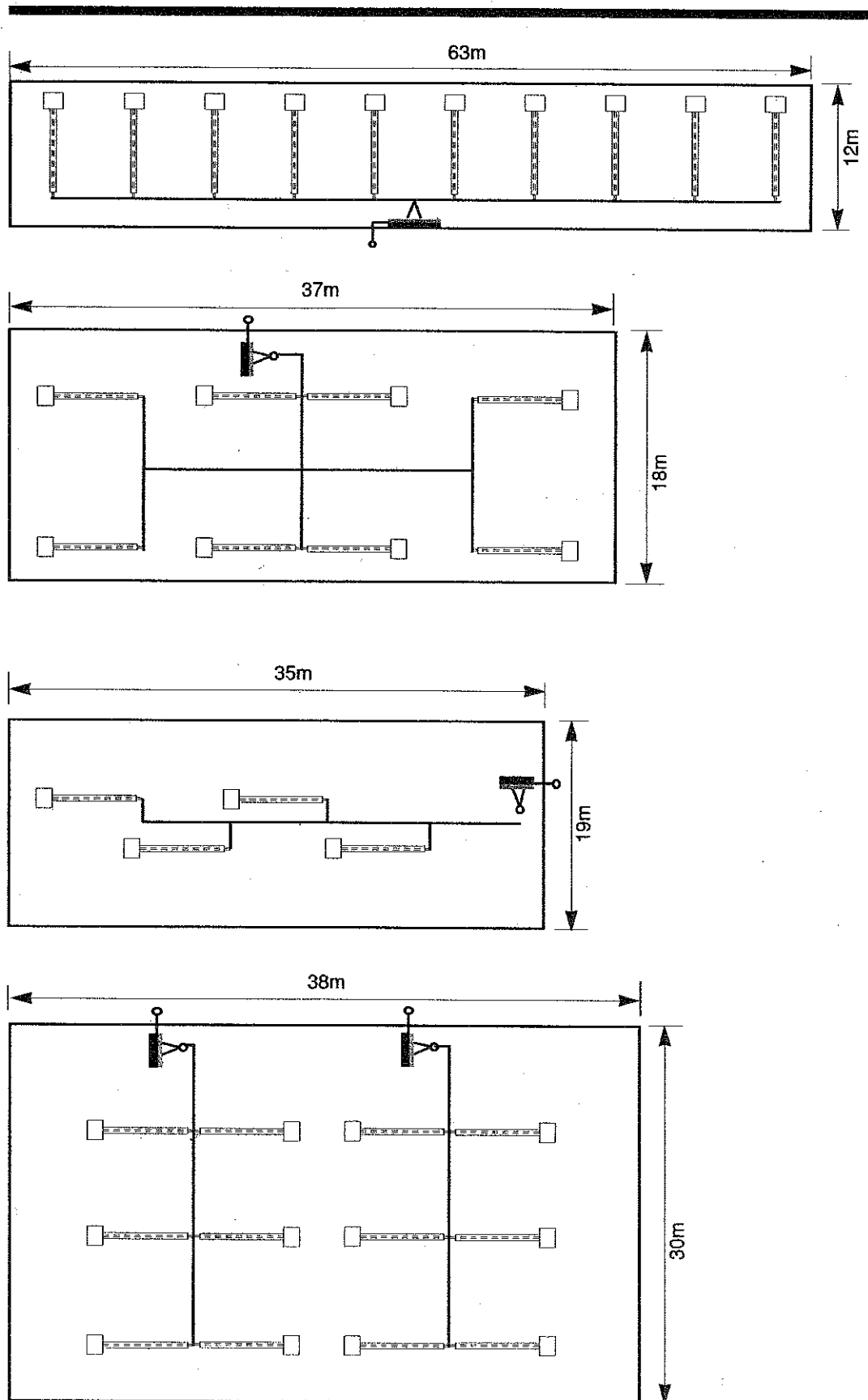
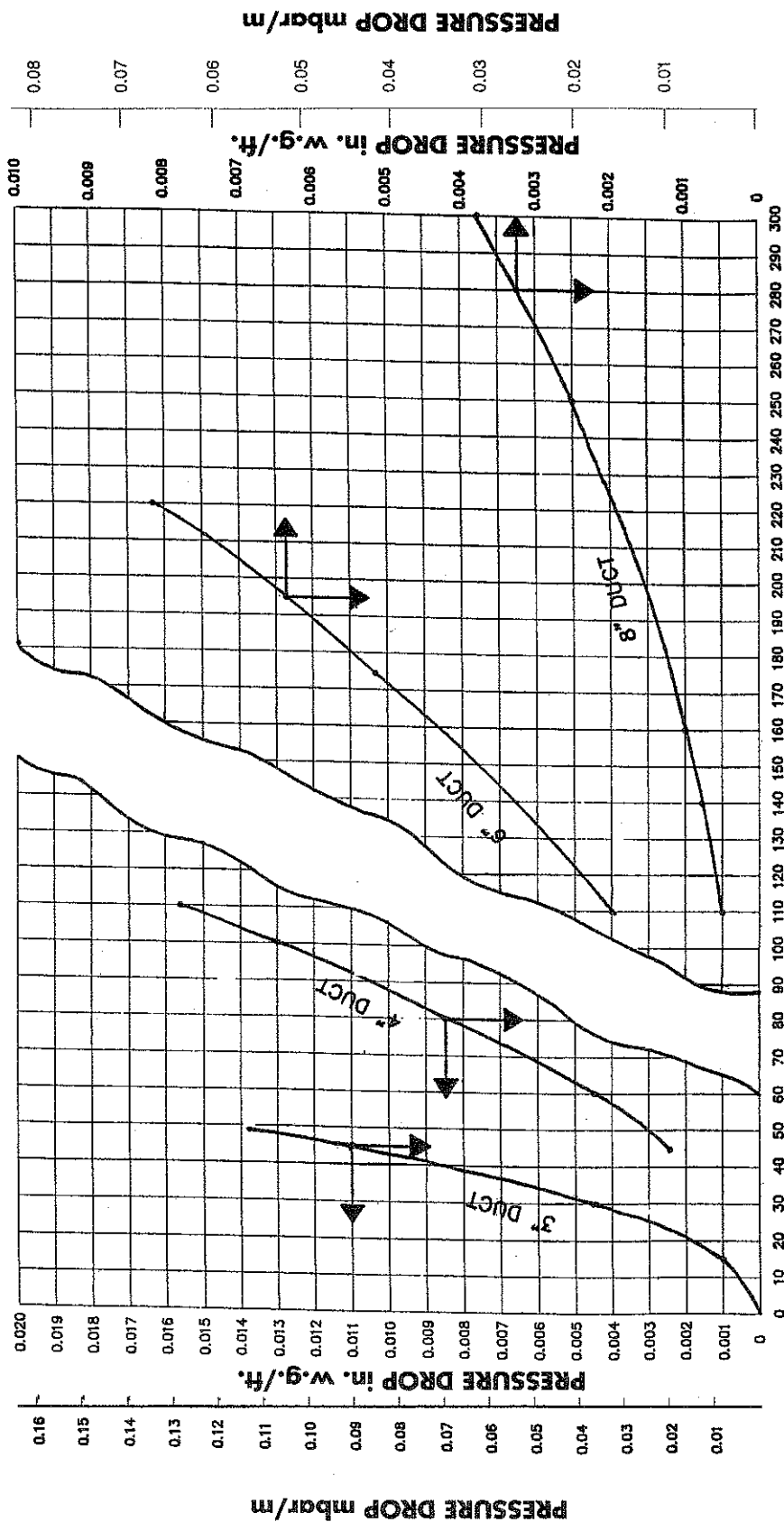


TABLE 2



HEAT INPUT UPSTREAM OF TUBE SECTION (kW)

TABLE 3.

HEATER TYPE	DAMPER SETTING HOT CONDITIONS	
	in. w.g.	mbar
ER13HB	0.67	1.67
HB13	0.61	1.52
ER22HB	0.49	1.22
HB22	0.40	1.00
ER38HB	0.45	1.12
HB38	0.40	1.00
AR13HB	0.67	1.67
HB13AR and A13/DL	0.61	1.52
AR22HB	0.60	1.49
HB22AR and AR22DL	0.50	1.25
AR35HB	0.41	1.02
HB35AR and AR35/DL	0.40	1.00
RB18HB	0.55	1.40
HB18RB and RB18DL	0.40	1.00
RB30HB	0.55	1.40
HB30RB and RB30/DL	0.37	0.92

After initial setting of damper re-check when system is at equilibrium.

TABLE 4.

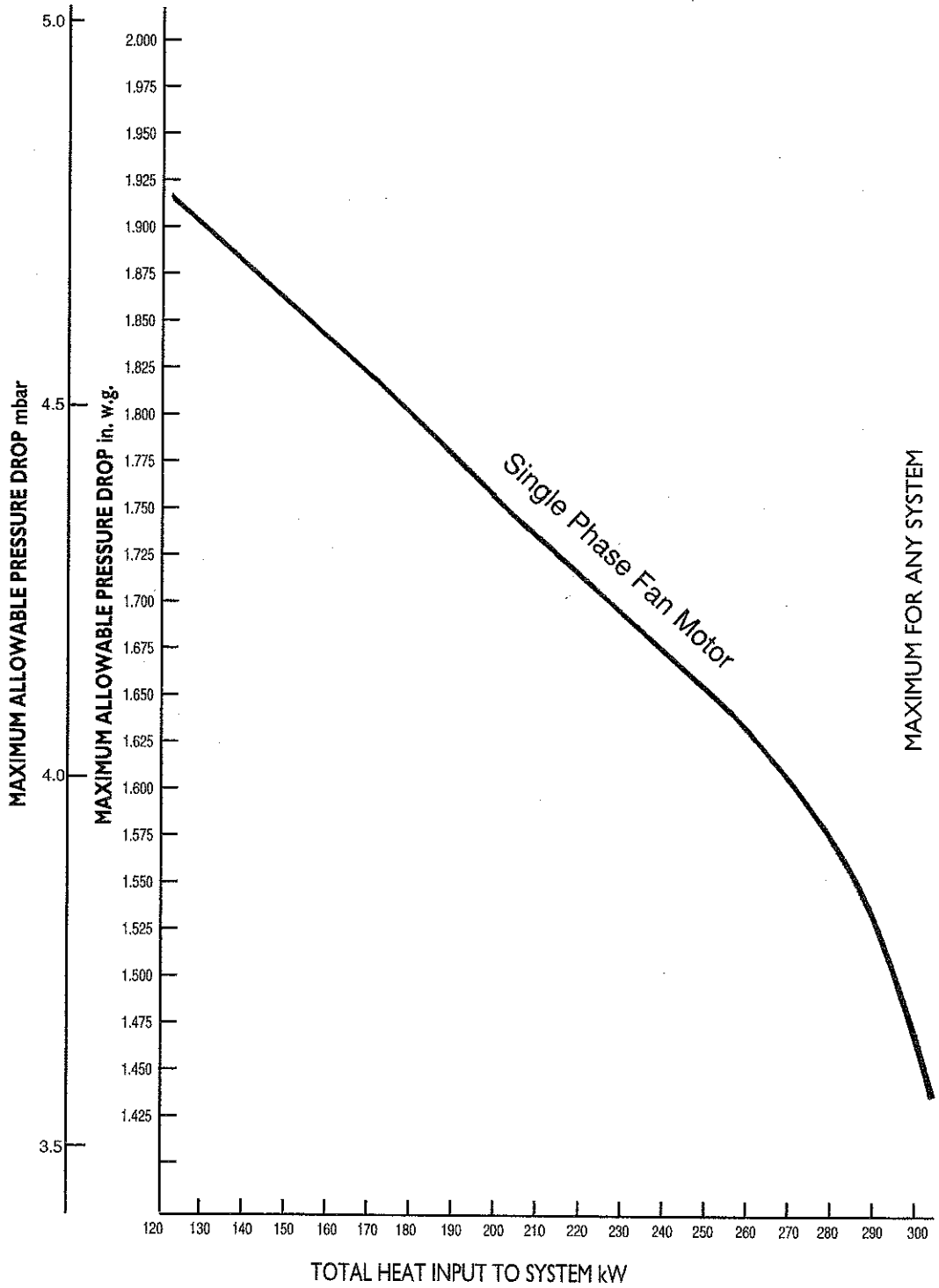
Heater Input	Pressure Drop/Unit Length For 4in. (100m) dia. duct	
	in. w.g./ft.	mbar/m
13kW	0.0001	0.0008
22kW	0.0004	0.0033
35kW	0.0010	0.0082
38kW	0.0012	0.0098

MAXIMUM ALLOWABLE DUCT RESISTANCE FOR ROUTE BETWEEN ANY PARTICULAR HEATER AND EXHAUST FAN FOR HERRINGBONE SYSTEMS.

FOR AN EXHAUST GAS TEMPERATURE OF 188°C (I.E., TEMP CORRECTION FACTOR 1.6) AND A SAFETY FACTOR OF 1 1/3.

**TYPE 0 FAN**

FIGURE 7

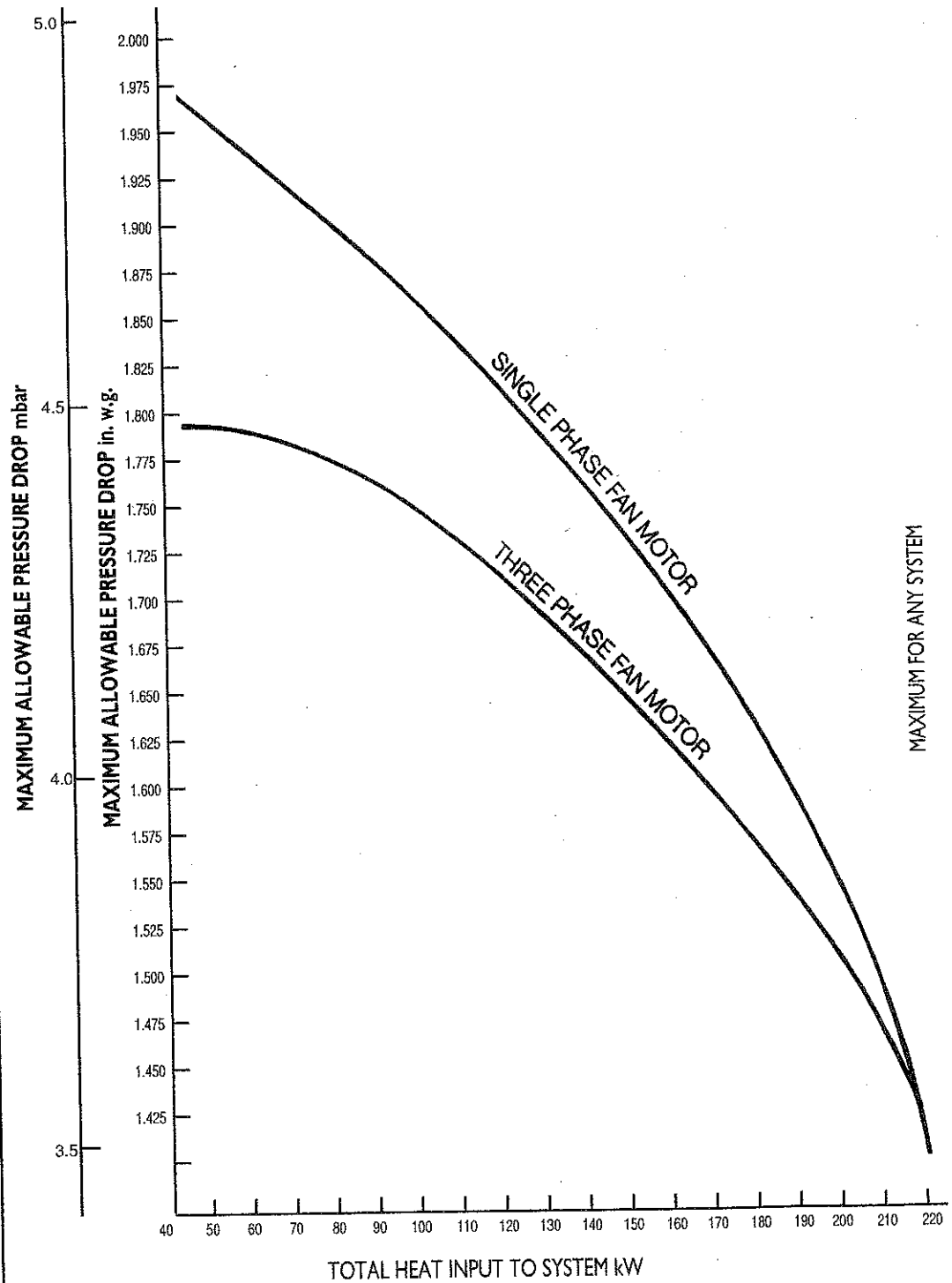


MAXIMUM ALLOWABLE DUCT RESISTANCE FOR ROUTE BETWEEN ANY PARTICULAR HEATER AND EXHAUST FAN FOR HERRINGBONE SYSTEMS.

FOR AN EXHAUST GAS TEMPERATURE OF 188°C (I.E., TEMP CORRECTION FACTOR 1.6) AND A SAFETY FACTOR OF 1 1/3.

**TYPE I FAN**

FIGURE 8

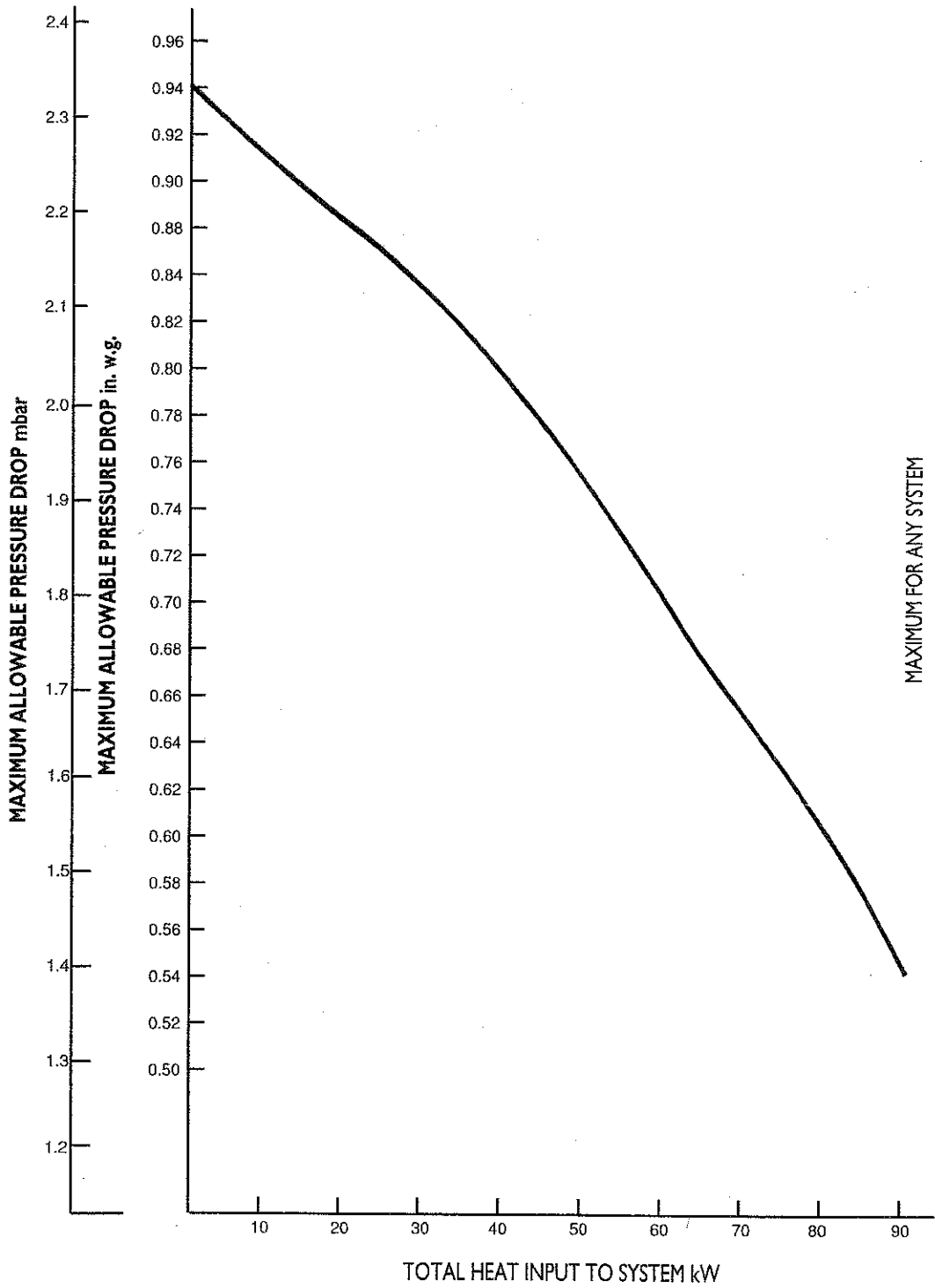


MAXIMUM ALLOWABLE DUCT RESISTANCE FOR ROUTE BETWEEN ANY PARTICULAR HEATER AND EXHAUST FAN FOR HERRINGBONE SYSTEMS.

FOR AN EXHAUST GAS TEMPERATURE OF 188°C (I.E., TEMP CORRECTION FACTOR 1.6) AND A SAFETY FACTOR OF 1 1/2.

**TYPE 2 FAN**

FIGURE 9



MAXIMUM FOR ANY SYSTEM

**APPENDIX 2 (I)**

Proposed herringbone HEATER AND EXHAUST  
MANIFOLD LAYOUT.

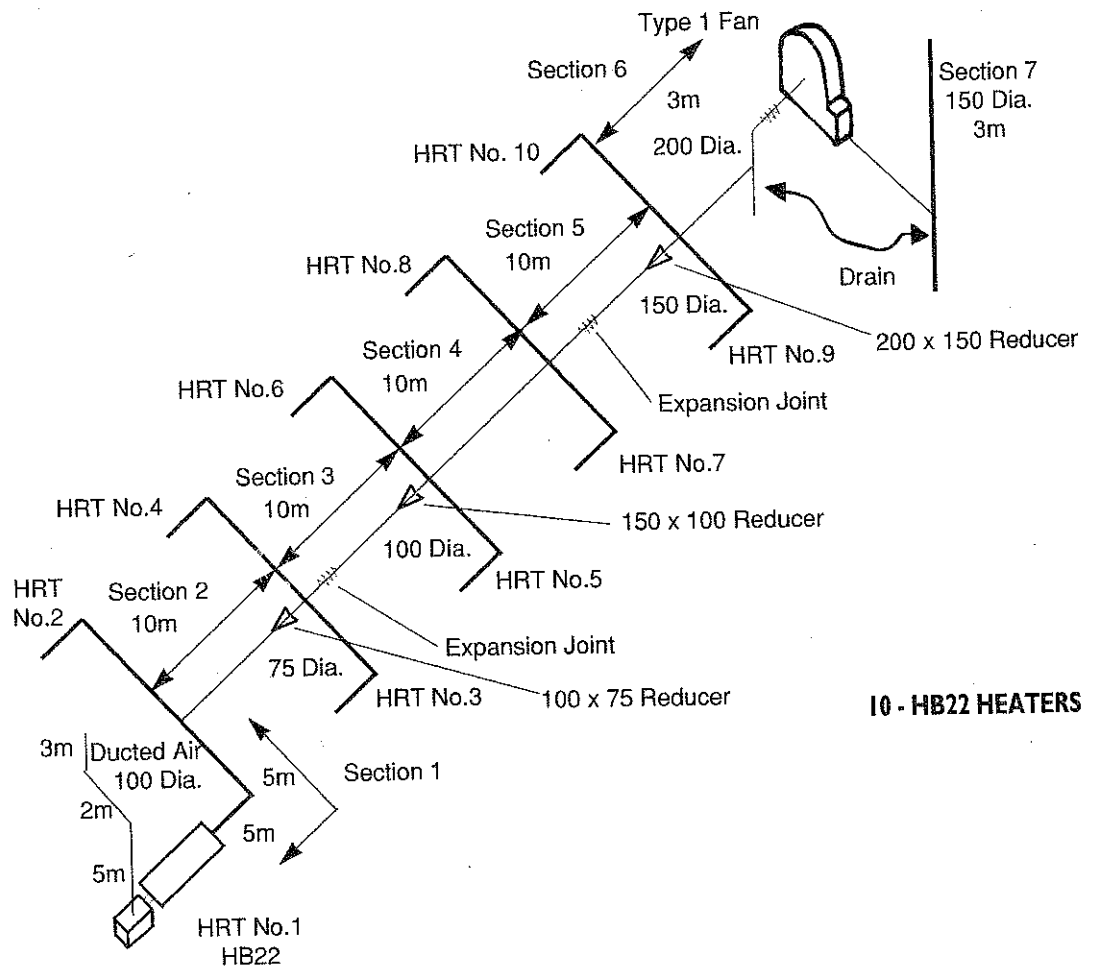
**FORM A**

JOB NAME OR IDENTIFICATION

DATE

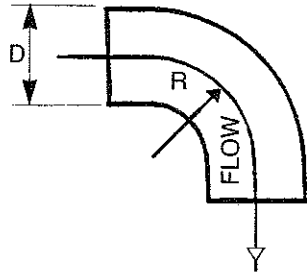
EXHAUST MANIFOLD SYSTEM (NOT TO SCALE): INDICATE MANIFOLD TUBE SIZES, TRUE LENGTHS AND "SECTIONS"

- Note:
- Manifold joints must be sealed and pop riveted.
  - Manifold to have slight slope towards fan.
  - Manifold to be in one plane.
  - Expansion joints must be fitted.



TYPICAL DESIGN

FIG.10

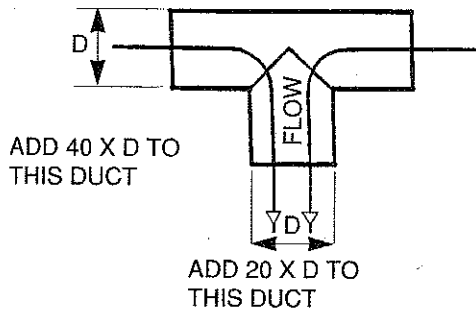


R/D approx. = 1

BENDS

D = diameter of duct in feet or metres

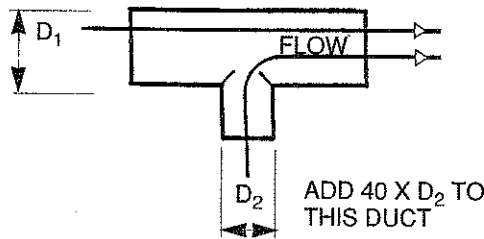
ADD 24 X D TO DUCT LENGTH



TEES

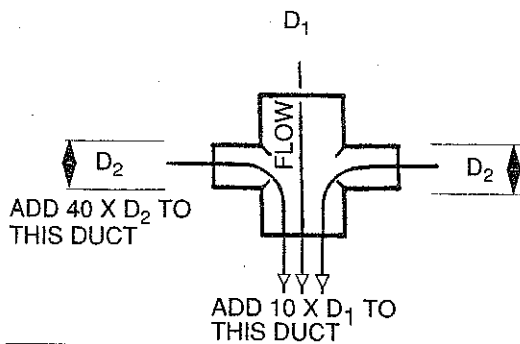
ADD 40 X D TO THIS DUCT

D = diameter of duct in feet or metres  
(FLOWS NOT NECESSARILY EQUAL)



ADD 10 X D<sub>1</sub> TO THIS DUCT

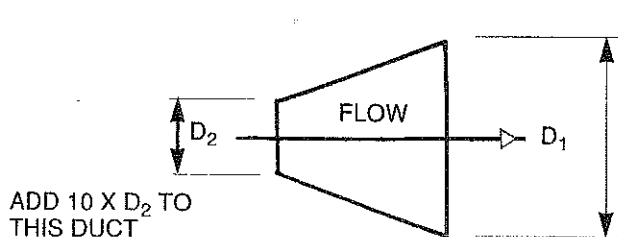
ADD 40 X D<sub>2</sub> TO THIS DUCT



CROSSES

ADD 40 X D<sub>2</sub> TO THIS DUCT

D = diameter of duct in feet or metres



ENLARGEMENTS

ADD 10 X D<sub>2</sub> TO THIS DUCT

D = diameter of duct in feet or metres

THESE ALLOWANCES HAVE BEEN SIMPLIFIED IN ORDER TO APPLY TO ALL HERRINGBONE HEATING SYSTEM ARRANGEMENTS LIKELY TO BE MET.

FORM B PART I — Example

PRESSURE LOSSES THROUGH EXHAUST DUCT MANIFOLD

1	SECTION NO:	UNITS*	1	2	3	4	5	6	7	
2	Manifold Tube Diameter	<del>in.</del> / mm	75	75	100	150	150	200	150	
3	Total Heat Input Upstream	kw	22	44	88	132	176	220	220	
4	Tube Lengths and Fittings	Measured Length	6	10	10	10	10	3	3	
			1.8	-	-	-	-	4.8	-	
	Allowances (Fig.2)	Tees (No. x allowances)	3	1.5	-	-	-	-	8.0	6.0
			-	-	-	1.5	1.5	-	-	-
5	Effective Length (Sum of Rows 4)	feet / m	10.8	12.25	11	11.5	11.5	19.3	9.0	
			0.0213	0.0082	0.0775	0.0229	0.4075	0.015	0.0636	
6	Pressure Drop /Unit Length (Table 1 or 2)	<del>in. w.g.</del> / ft. / mbar m	0.230	0.101	0.853	0.264	0.469	0.290	0.572	
7	Total Pressure Drop for Section (Row 5 x 6)	<del>in. w.g.</del> / mbar								

REFER VALUES IN ROW 7 TO FORM D, PAGE 18.

\*Delete where applicable

FORM B PART 2 — SPARE FORM

PRESSURE LOSSES THROUGH EXHAUST DUCT MANIFOLD

SECTION NO:	UNITS*	1	2	3	4	5	6	7
1	in. / mm							
2	Manifold Tube Diameter							
3	Total Heat Input Upstream							
4	Tube Lengths and Fittings	Measured Length						
		Bend (No. x allowances)						
		Tees (No. x allowances)						
		Crosses (No. x allowances)						
5	Allowances (Fig.2)	Enlargements (No. x allowances)						
		Effective Length (Sum of Rows 4)						
6	Pressure Drop /Unit Length (Table 1 or 2)							
7	Total Pressure Drop for Section (Row 5 x 6)							

Delete where applicable

FORM C

PRESSURE LOSSES THROUGH FRESH AIR INTAKE DUCTS AND HEATER UNITS

		I	II	III	IV	V	VI	VII	VIII	IX	X
1	Heater No.										
2	Heat Input	22									
3	Fresh Air Duct Length	10									
4	No Fresh Air Bends x Allowances**	2 x 2.5									
5	Fresh Air Inlet Terminal Allowance (3ft or 1m for all systems)	1									
6	Effective Length (Row 3 + Row 4 + Row 5)	16									
7	Pressure Drop per Unit Length (Table 3)	0.0033									
8	Fresh Air Duct Pressure Drop per Heater (Row 6 x Row 7)	0.053									
9	Suction at Heater Damper	0.40									
10	Total Pressure Drop/Heater (Row 8 + Row 9)	0.453									

\* Delete where applicable  
 \*\* For each (45 degree) bend allow 2.5 ft. (0.75m). For each (90 degree) bend allow 8 ft. (2.5m)

REFER VALUES IN ROW 10 TO FORM D PAGE 18

## FORM D

1	2	3	4
Section/Route Fan to Fan to Heater No.	Pressure Drop Through Heater + Fresh Air Duct in. w.g./mbar*	Exhaust Manifold Pressure Drop in. w.g./mbar*	Total Pressure Drop in. w.g./mbar*
1 No. 1	0.453	0.230	0.683
2	—	0.101	0.101
3	—	0.853	0.853
4	—	0.264	0.264
5	—	0.469	0.469
6	—	0.290	0.290
7	—	0.572	0.572
8	—	—	—
9	—	—	—
10	—	—	—
Total System Pressure Drop in. w.g./mbar*			3.232

\* Delete units where not applicable

Refer total system pressure drop (i.e. 3.232 mbar example) to fan resistance curve (For type 1 fan, see page 11).

Special Comments: System is designed within fan capacity for a properly jointed and sealed manifold.

# **AMBI-RAD<sup>®</sup>**

Energy Efficient Heating Systems



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Because of our policy of continuous development Ambi-Rad limited reserves the right to vary the equipment specification without notice.