American Society of Gas Engineers
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FIELD CONTROLS
Improving Indoor Environments

James Aycock – *Product Engineer*

“CAS & VPS”

(or Two Devices to Improve the Safety & Performance of Gas-Fired Appliances)

Do You Have Enough Combustion Air?

Gas Appliance Safety & Performance

Indicators of Inadequate Combustion Air/Combustion Air Zone (CAZ) Depressurization:

- Off/On Blocked Vent Switch
- Off/On Flame Rollout Switch
- CO Alarm
- Hot Mechanical Room
- Pilot Outages
- Premature Thermocouple Failures
- Burnt Wiring in Vestibule
- Scorched, Discolored Burner Tubes
- Scorched Burner Shield

Note: When servicing or troubleshooting a problem, run the appliance with all doors to the equipment room closed, under maximum depressurization conditions.

Basics

Combustion

The chemical process of burning a fossil fuel or hydrocarbon for the purpose of obtaining heat or energy.

$$C_xH_y + 0_2 \rightarrow C0_2 + H_20 + \text{heat}$$

hydrocarbon + oxygen (combustion air) → carbon dioxide (gas) + water vapor + heat

Combustion Air

The air required by the heating appliance for the combustion process (stoichiometric + excess air).

Note: Carbon Monoxide (C0) can form when insufficient oxygen (from combustion air) is supplied.

Dilution (Secondary) Air

CAZ air drawn into the vent system through the draft control, draft hood or diverter etc., diluting the flue gas (combustion) products.

It's Code

Indoor Combustion Air (Standard Method)

The minimum required volume of indoor air for natural draft appliances shall be 50 ft^3/1000 Btu/hr of total input.

(NFPA 54 – National Fuel Gas Code)

Example: Boiler room (CAZ) is 20' x 30' x 7' or 4200 ft^3

$$4200\ ft^3 \times \frac{1000\ Btu/hr}{50\ ft^3} = 84{,}000\ Btu/hr$$

Result: If the total appliance input firing rate is greater than 84,000 Btu/hr, then Outdoor Combustion Air **must** be provided.

Note: A typical residential installation consists of a 105,000 Btu boiler and a 40,000 Btu water heater or 145,000 Btu/hr of total input.

It's Code (Cont.)

Outdoor Combustion Air

When the requirements for Indoor Combustion Air are not met, Outdoor Combustion Air shall be provided in accordance with methods prescribed in NFPA 54. One of these is use of a Mechanical Combustion Air Supply such as the **Field Controls Combustion Air System (CAS-3,4,6, or 7)**.

Mechanical Combustion Air Supply

Where all the air is provided by a mechanical air supply system, the combustion air shall be supplied from the outdoors at the minimum rate of 0.35 ft^3/ min/ 1000 Btu/hr for all appliances in the space.

Note: Where exhaust fans are installed, additional air shall be provided to replace the exhausted air.

It's Code (Cont.)

Sources of Exhaust & Typical Air Flow Rates

• Radon Mitigation	40 - 60 CFM
• Central Vacuum	60 - 80 CFM
• Fan Assisted W/H	60 - 80 CFM
• Bath Fan	50 - 100 CFM
• Clothes Dryer	100 - 200 CFM
• Microwave (Vented)	100 - 200 CFM
• Attic Fan	300 - 600 CFM
• Fireplaces	300 - 600 CFM
• Kitchen Exhaust	100 - 1400 CFM
• Whole-House Fan:	1000 – 5000 CFM

Note: Make-Up Air must be provided to offset each source of exhaust. **Field Controls Make-Up Air Systems (MAS)** are designed to do this.

It's Code (Cont.)

Mechanical Combustion Air Supply

Example: A gas-fired boiler with a 105,000 Btu/hr. input rate and a 40,000 Btu/hr. gas-fired natural draft water heater are installed in a boiler room for a total input of 145,000 BTU/hr. (or 145 MBH).

$$\frac{0.35\ ft^3}{min} \times \frac{145000\ Btu/hr}{1000\ Btu/\ hr} = 50.8\ CFM$$

Result: The Mechanical Combustion Air Supply must supply at least 51 CFM to the room where the boiler and water heater are installed during their operation. A **Field Controls CAS-4 Combustion Air System** is just what is needed.

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CAS-4 “Fan-in-a-Can”

CAS-4 (Gas)

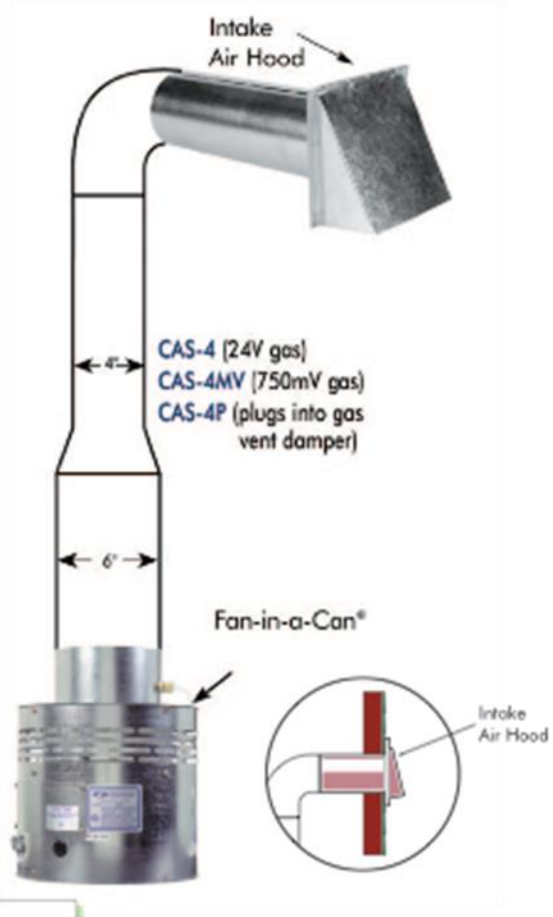
These models are designed to provide combustion air for appliances when direct connection to the burner is not possible (when the appliance is located in a confined space). According to NFPA 54 and NFPA 31, an engineered system such as a CAS-4, 6 or 7 may be used to overcome the lack of air in a confined space. The CAS-4 is for use with gas appliances with 24 VAC gas valve controls. The CAS-4MV is for use with 750mV power pile gas appliances. Each is designed for optimum safety and includes a proving device that won't allow the burner to engage without the Fan-in-a-Can® operating. Multiple units or additional controls are required for multiple appliance installations. Each is equipped with a two speed control for enhanced versatility.

How the CAS-4 work

When the thermostat calls for heat, the Fan-in-a-Can® engages and begins drawing air into the structure. When air flow is established, the pressure switch closes. The CAS sends a signal to the appliance, allowing the burner to fire. The Fan-in-a-Can® diffuses the outside air into the room near the burner to ensure adequate air for efficient combustion.

CAS-4Jr.™

The Fan-in-a-Can, Jr. is designed for gas appliances up to 110,000 BTU/hr input. A 4" intake Air Hood (IAH) is included along with mounting brackets to secure the Fan-in-a-Can, Jr. to a wall. It may be used with a residential water heater with the addition of control kit CK-20 FV/FG.



Model	Fuel	Application	Appliance Input	Components
CAS-4	Gas	24V Gas Appliance	See Specifications	4" Intake Air Hood Fan-in-a-Can® 6" to 4" Reducer Restrictor Plate
CAS-4MV	Gas	750mV Power Pile Gas Appliance		
CAS-4P	Gas	Boiler with automatic vent damper	See Specifications	4" Intake Air Hood Fan-in-a-Can® 6" to 4" Reducer Restrictor Plate ADA-1
CAS-4Jr.	Gas	24V Gas Appliance	See Specifications	4" Intake Air Hood Fan-in-a-Can®

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CAS-4 “Fan-in-a-Can”

Installation Specifications						
Total Input of Appliance(s)		Max. Equivalent Feet of Installation				
CAS-4, 4mV, 4P GAS			4" duct & 4" hood		6" duct & 6" hood	
(BTU/hr)	HI	LOW	HI	LOW	HI	LOW
50,000	300	300	300	300	300	300
75,000	300	300	300	300	300	300
100,000	300	300	300	300	300	300
125,000	300	220	300	220	300	300
150,000	174	108	232	118	300	300
175,000	99	48	152	63	300	300
200,000	52	14	102	32	300	300
225,000	20	NA	68	13	300	239
250,000	NA	NA	45	NA	300	150
300,000	NA	NA	16	NA	300	53
350,000	NA	NA	NA	NA	193	8
400,000	NA	NA	NA	NA	109	NA
450,000	NA	NA	NA	NA	56	NA

CAS-4Jr “Fan-in-a-Can”

- Designed for gas applications
- Up to 110,000 BTU
- Compact design
- Quiet operation

Max. Equivalent Feet of Vent Pipe		
BTU/hr.	4" pipe	6" pipe
50,000	230	300
60,000	160	300
70,000	105	300
80,000	70	300
90,000	40	300
100,000	25	180
110,000	15	80

CAS-4TMR “Fan-in-a-Can”

The **CAS-4TMR** is the latest model in Field Controls’ family of indirect combustion air systems with a number of enhancements such as an anti-freeze shut-off timer and plug-in harness.

NEW!

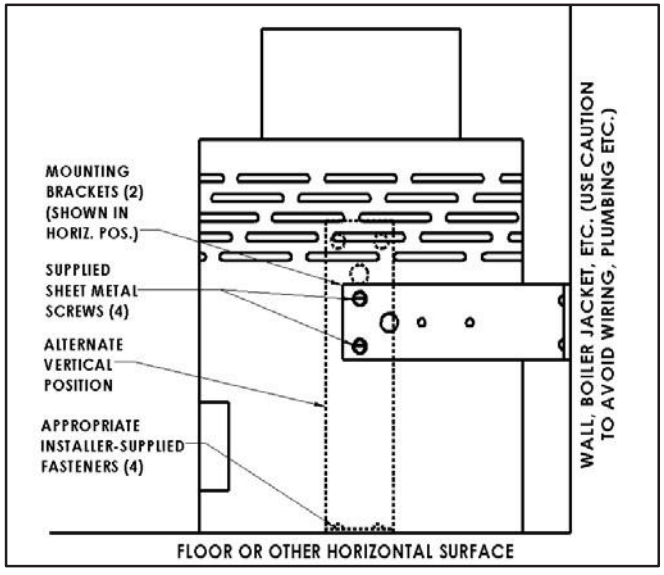
Field Controls innovative and popular Fan-in-a-Can was designed to make appliance combustion more reliable, efficient, and safe.

Combustion Air Systems – CAS-4TMR

Features

Motorized Blower Assembly

- Differential air proving safety switch
- Safety interlock with appliance control circuit
- 2-Speed Fan w/ Hi-Lo switch
- 40-minute Anti-Freeze Shutoff Timer
- Multi-position mounting brackets
- Terminal strip for 120V power
- Polarized connector for 24V control harness



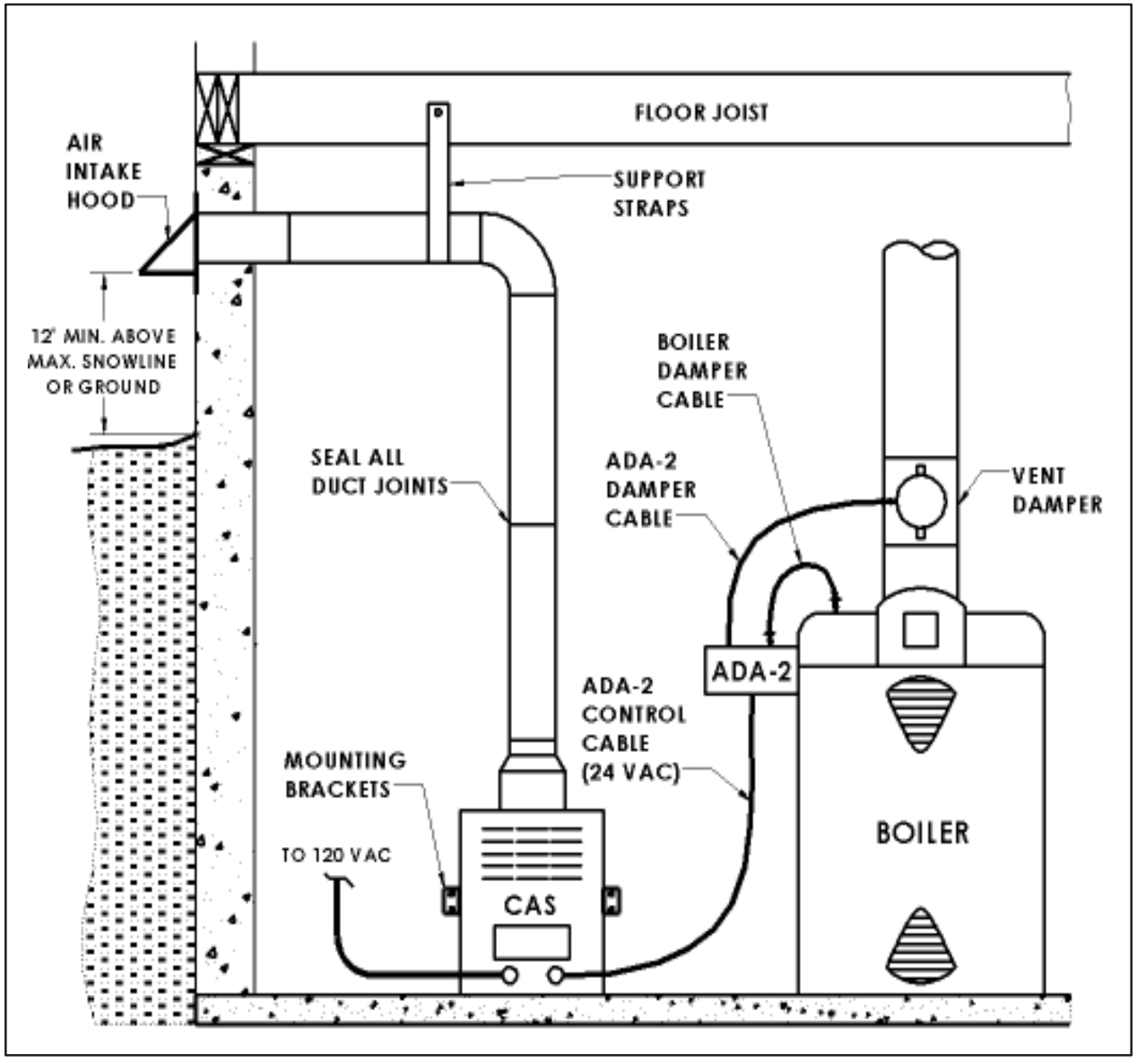
ADA-2 Harness Assembly

- Simplifies connections between CAS, vent damper and appliance
- Dedicated connectors to prevent miswiring

Vent Hood & Duct Adapter

Combustion Air Systems – CAS-4TMR

Typical Installation



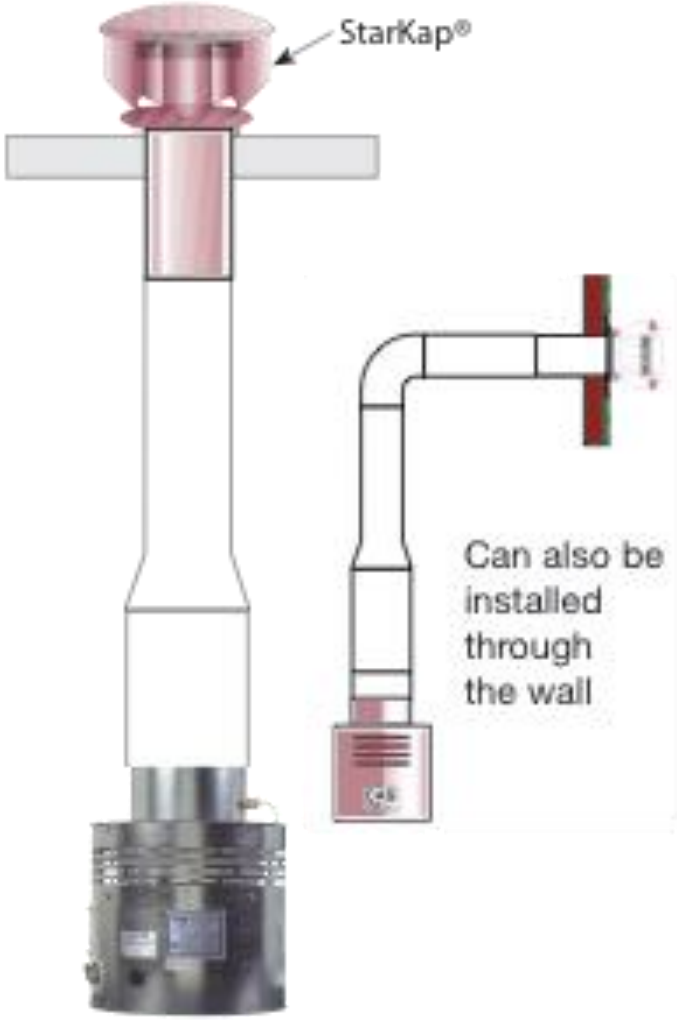
CAS “Fan-in-a-Drum”

CAS-6 and CAS-7

The Fan-in-a-Drum® is a commercial product designed to deliver combustion air into the mechanical room, boiler room or furnace location to overcome a confined space or inadequate air supply. CAS 6 & 7 are dual voltage units for gas applications.

Fan-in-a-Drum®

StarKap®



Fan-in-a-Drum® Assembly

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CAS "Fan-in-a-Drum"

Max. Equivalent Length of Pipe, Including StarKap®			
CAS-6 GAS (BTU/hr)	8" duct	10" duct	12" duct
420,000	410	1253	3119
455,000	344	1051	2616
490,000	291	890	2217
525,000	249	760	1893
560,000	214	653	1627
595,000	185	584	1405
630,000	160	489	1217
665,000	139	424	1057
700,000	121	369	919
735,000	105	321	800
805,000	79	241	601
840,000	58	176	519
910,000	49	151	377

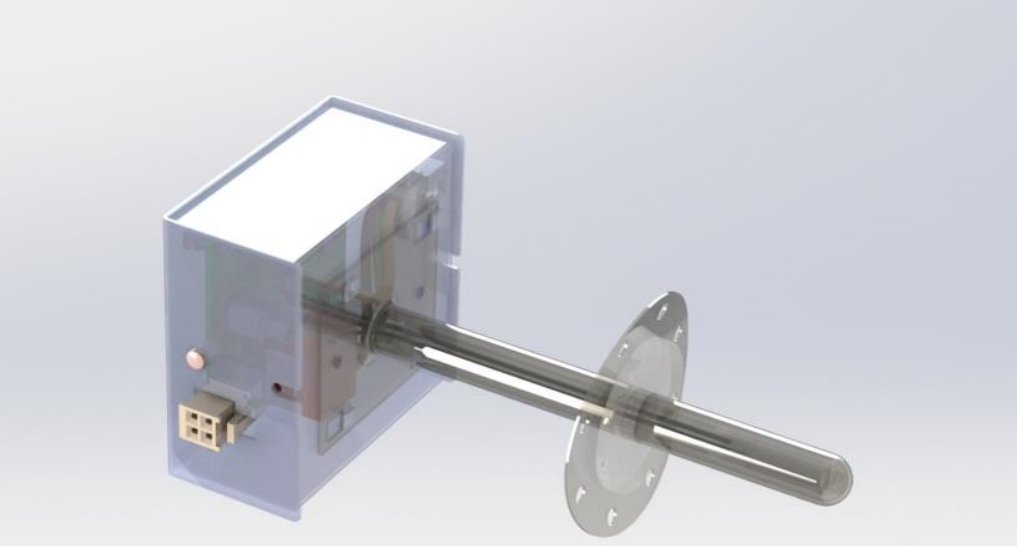
Max. Equivalent Length of Pipe, Including StarKap®			
CAS-7 GAS (BTU/hr)	10" duct	12" duct	14" duct
840,000	469	1167	2523
910,000	381	948	2050
980,000	311	776	1678
1,050,000	256	637	1378
1,155,000	191	476	1029
1,260,000	142	354	766
1,365,000	104	260	563
1,470,000	74	186	403
1,575,000	51	127	274
1,680,000	31	78	207
1,785,000	15	39	114
1,803,000	13	33	72

Vent Proving Sensor - VPS

AND NOW FOR SOMETHING COMPLETELY DIFFERENT…

Vent Proving Sensor - VPS

Field Controls Vent Proving Sensor (VPS) was developed to address venting issues caused by back drafting. It has a temperature sensing probe to sense vent gas temperature and shut down the appliance if it is not venting properly. Optional time-delay relay that monitors the temperature sensor is wired in-series with the vent damper safety circuit and features a soft lockout.



VPS

Vent Proving Sensor - VPS

Test Parameters

- **A natural draft boiler rated at 60MBH for natural gas with a 4” vent and VPS installed downstream of the vent damper.**
- **A natural draft water heater rated for 30MBH for natural gas with a 3” vent.**
- **The boiler and water heater were installed in a room and connected to a 6" common vent.**

Depressurization Test Room

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Vent Proving Sensor - VPS

Test #1

The room was depressurized to 0.07” w.c. (17.4 Pa). As shown in Table 1, the boiler and water heater were fired and after 5 minutes the VPS shut the boiler off. The VPS temperature did not reach set point within the time delay period.

Table 1

Time	Outdoor Air Temp.*	Room Pressure (in. w.c.)	6” Vent Temp.	BOILER						WATER HEATER	
				Status	VPS Temp.	BVS Temp.	Flue Outlet Temp.	Inlet H2O Temp.	Outlet H2O Temp.	Status	Draft Hood Temp.
10:06:59	72.4	-0.07"	76.6	OFF	79.8	117.0	148.5	155.7	160.1	OFF	85.0
10:07:29	72.3	-0.07"	76.5	OFF	79.6	115.2	148.4	153.0	160.2	ON	101.1
10:07:59	72.5	-0.07"	76.2	ON	77.1	99.0	187.7	117.2	145.5	ON	139.1
10:08:29	72.7	-0.07"	76.0	ON	76.8	97.2	247.6	121.6	127.8	ON	149.6
10:08:59	72.7	-0.07"	76.1	ON	76.8	96.5	264.7	121.0	128.5	ON	155.9
10:09:29	72.7	-0.07"	76.0	ON	76.7	96.6	276.0	115.8	124.6	ON	160.4
10:09:59	72.7	-0.07"	76.0	ON	76.9	96.2	283.7	117.6	123.6	ON	166.3
10:10:29	72.6	-0.07"	75.8	ON	76.7	96.9	290.2	116.0	123.7	ON	166.5
10:10:59	72.7	-0.07"	75.7	ON	76.6	97.3	294.6	115.8	122.9	ON	170.0
10:11:29	72.9	-0.07"	75.9	ON	76.8	98.1	298.3	115.9	123.2	ON	171.9
10:11:59	73.0	-0.07"	75.8	ON	76.9	98.2	301.3	115.6	123.0	ON	171.8
10:12:29	72.8	-0.07"	75.9	OFF	76.9	98.1	270.8	115.8	123.0	ON	170.2

***All temperatures in Degrees Fahrenheit**

Vent Proving Sensor - VPS

Test #2

The room was depressurized to 0.02” w.c. (5.0 Pa). As shown in Table 2, the boiler and water heater were fired and after 5 minutes the VPS shut the boiler off. The VPS temperature did not reach set point within the time delay period.

Table 2

Time	Outdoor Air Temp.*	Room Pressure (in. w.c.)	6” Vent Temp.	BOILER						WATER HEATER	
				Status	VPS Temp.	BVS Temp.	Flue Outlet Temp.	Inlet H2O Temp.	Outlet H2O Temp.	Status	Draft Hood Temp.
10:33:00	68.9	-0.02"	76.4	OFF	81.1	98.4	107.0	106.7	106.7	OFF	87.6
10:33:30	68.6	-0.02"	92.0	OFF	87.4	97.5	106.7	106.5	106.4	ON	152.7
10:34:00	68.5	-0.02"	79.3	OFF	83.1	97.4	106.2	106.6	106.2	ON	183.9
10:34:30	68.4	-0.02"	77.9	OFF	79.5	94.9	105.8	106.3	106.2	ON	215.9
10:35:00	68.2	-0.02"	77.0	ON	83.6	94.1	180.1	105.0	105.5	ON	239.6
10:35:30	69.2	-0.02"	77.1	ON	103.0	104.5	226.2	105.2	106.1	ON	256.1
10:36:00	69.6	-0.02"	77.3	ON	106.9	111.5	245.5	104.9	107.7	ON	280.8
10:36:30	69.9	-0.02"	96.0	ON	109.4	124.8	260.0	105.7	109.1	ON	282.1
10:37:00	70.1	-0.02"	85.4	ON	109.1	128.2	270.7	107.2	111.1	ON	278.9
10:37:30	69.6	-0.02"	79.9	ON	110.1	126.1	279.4	108.7	113.2	ON	284.9
10:38:00	69.3	-0.02"	79.0	ON	110.8	125.4	286.3	110.6	114.8	ON	288.3
10:38:30	69.6	-0.02"	78.4	ON	104.3	128.0	291.9	112.6	117.1	ON	292.8
10:39:00	70.2	-0.02"	78.0	ON	106.8	129.8	296.2	114.6	119.1	ON	292.4
10:39:30	70.6	-0.02"	77.8	OFF	91.6	130.8	235.0	116.5	121.2	ON	272.0

***All temperatures in Degrees Fahrenheit**

Vent Proving Sensor - VPS

Test #3

The boiler and water heater were fired and allowed to come to steady state. The room was then depressurized to 0.10” w.c. (25 Pa). As shown in Table 3, the VPS and flue outlet temperatures decreased once the room was depressurized due to reverse flow in the vent and the boiler. After the room was depressurized for 1 minute, the VPS shut the boiler off.

Table 3

Time	Outdoor Air Temp.*	Room Pressure (in. w.c.)	6” Vent Temp.	BOILER						WATER HEATER	
				Status	VPS Temp.	BVS Temp.	Flue Outlet Temp.	Inlet H2O Temp.	Outlet H2O Temp.	Status	Draft Hood Temp.
10:57:00	73.2	neutral	200.4	ON	194.4	84.3	339.7	146.3	151.3	ON	83.7
10:57:30	73.6	-.10"	112.4	ON	111.4	107.3	335.0	147.8	153.1	ON	172.2
10:58:00	73.9	-.10"	97.0	ON	99.2	110.9	335.3	149.3	154.5	ON	173.7
10:58:30	74.1	-.10"	91.4	OFF	96.6	111.8	280.0	150.9	156.4	ON	162.4

***All temperatures in Degrees Fahrenheit**

Conclusion

The VPS shut the boiler off when it was unable to establish proper draft at startup and when vent flow was reversed during steady state operation, indicating that it is feasible to prevent continuous back drafting using this device even when installed with commonly vented appliances.

Vent Proving Sensor - VPS

Features:

Time Delay to Make: 5 minutes

Temperature Set Point: 150°F

Soft Lockout: 1 hour

Probe: 304 Stainless Steel or Aluminum

Electrical Rating: 24VAC, 5 Amp

Indicator Light: LED

Electrical Connectors: 4-pin Molex Mini-Fit Jr
4-pin Molex .062

Installation: Plug & Play via appliance damper cable, mounts on vent pipe

Agency: UL 353 pending, CSA TBD

Patents:

- **United States US9958184B2**
- **Canada CA2757724C**

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Questions?

Contact: James Aycock
jaycock@fieldcontrols.com

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