

Facility Dynamics

ENGINEERING

Variable Air Volume Systems

Terminal Unit Basics

Presented By:

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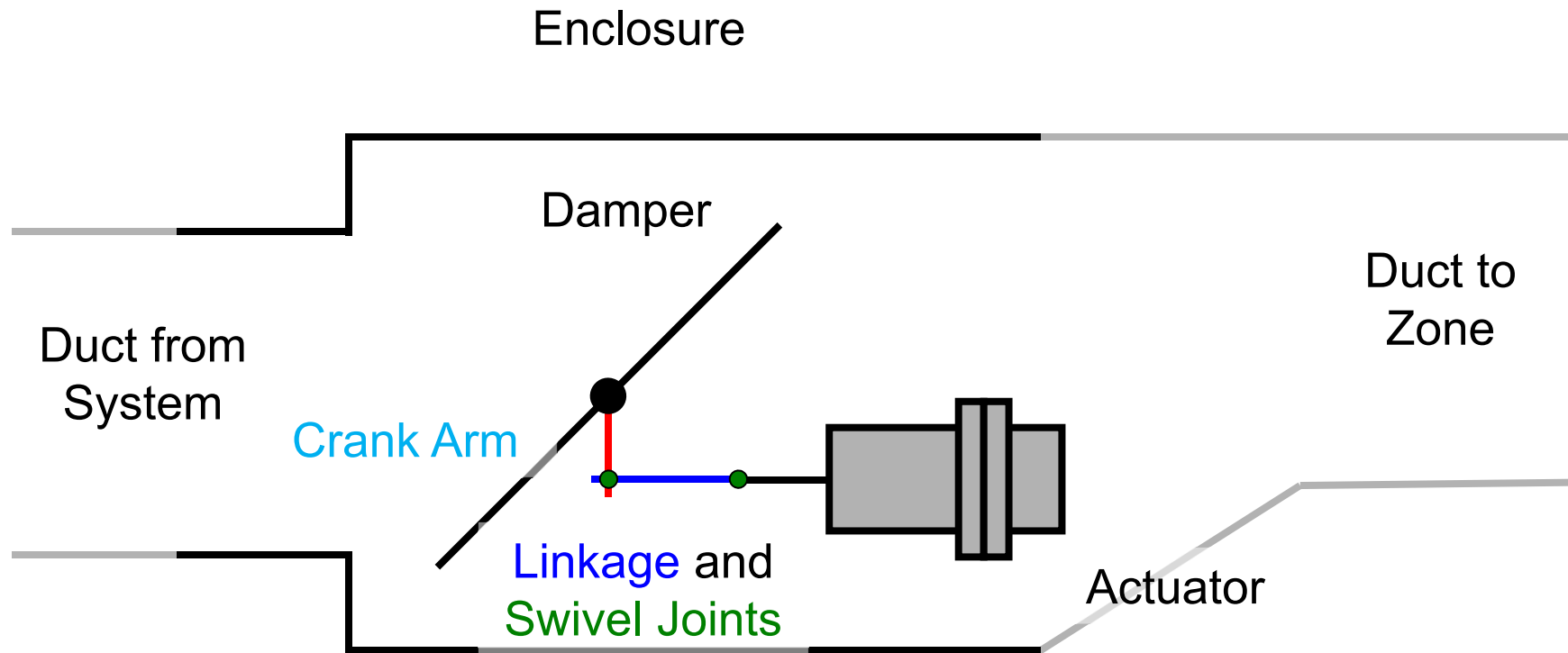
Senior Engineer

NAVFAC DDC Training

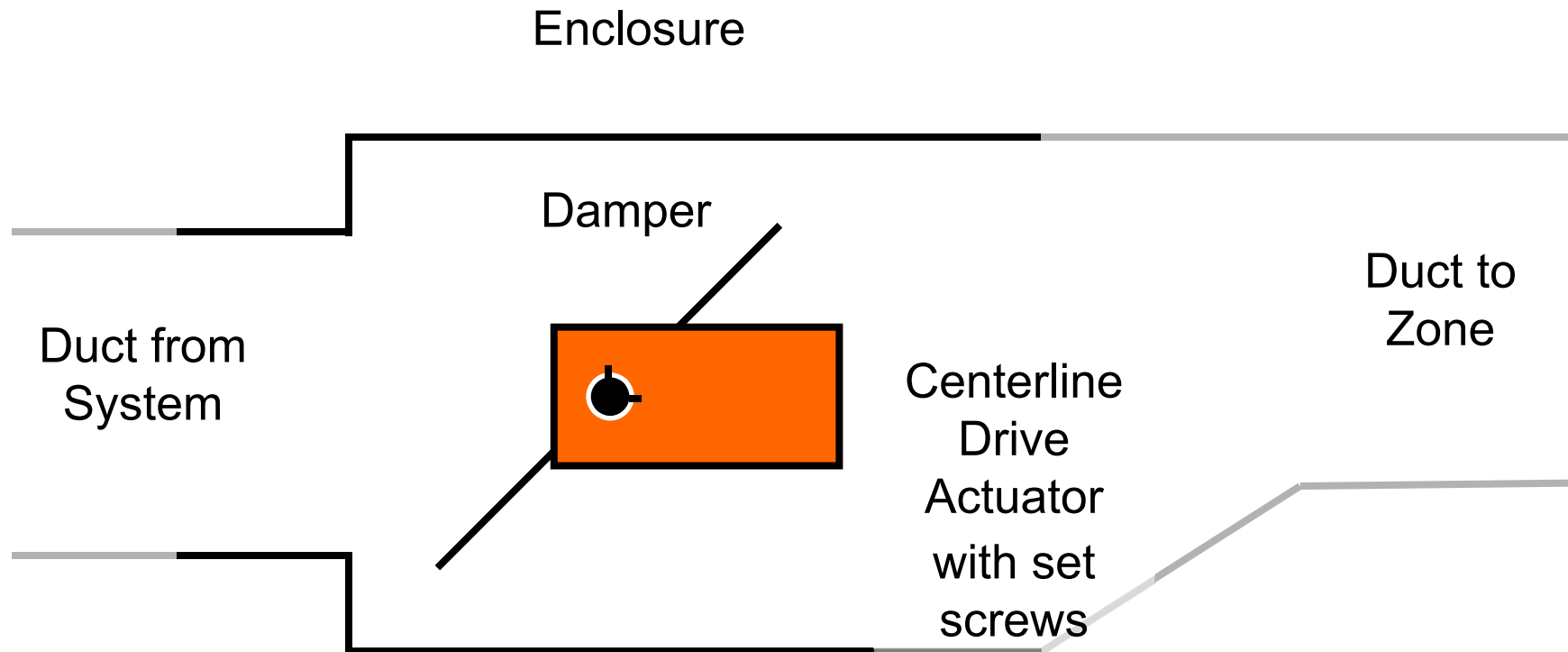
What's In This Module

- Your basic box:
 - Pressure dependent
 - Pressure independent
 - Fan powered boxes
 - Double duct boxes

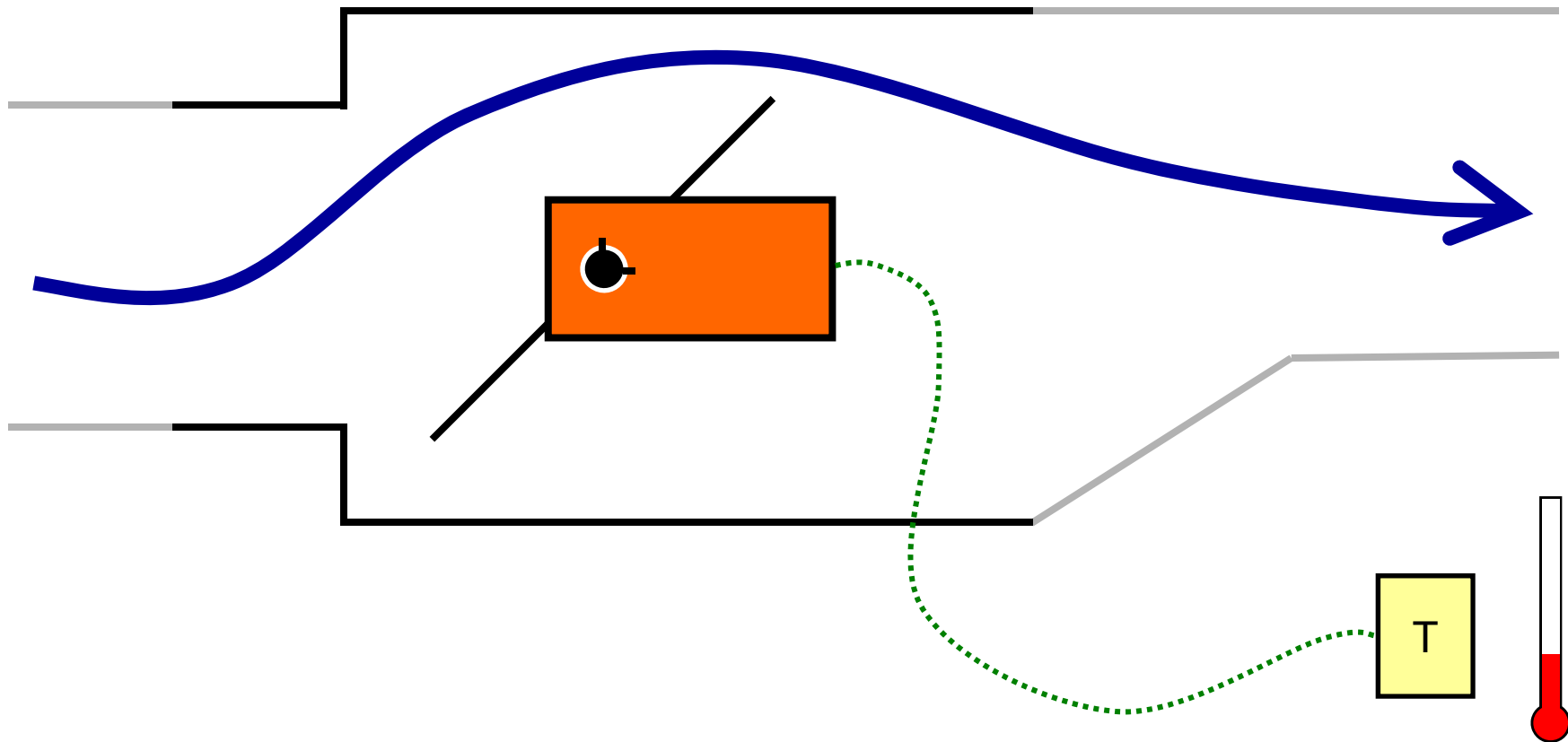
Your Basic Box



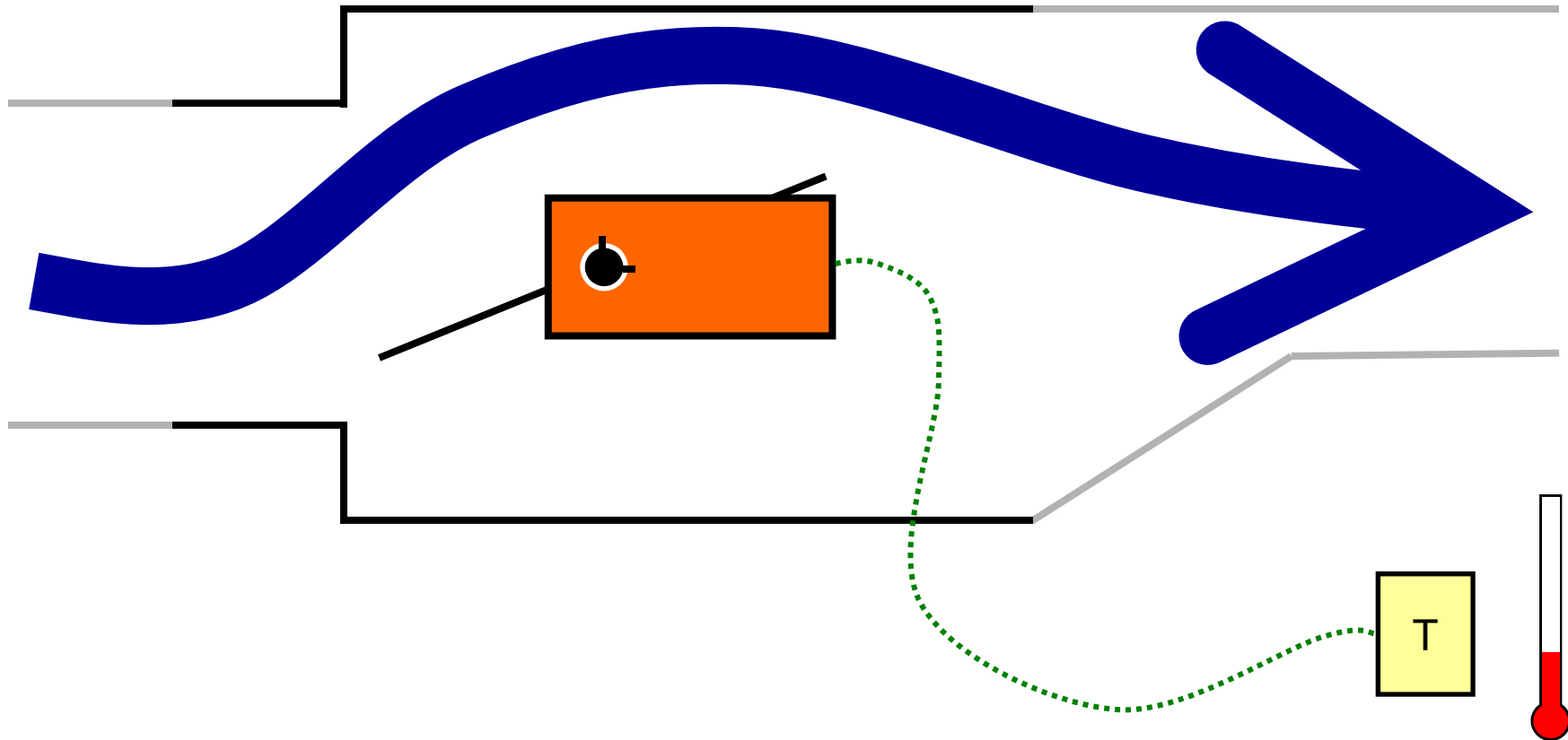
Your Basic Box



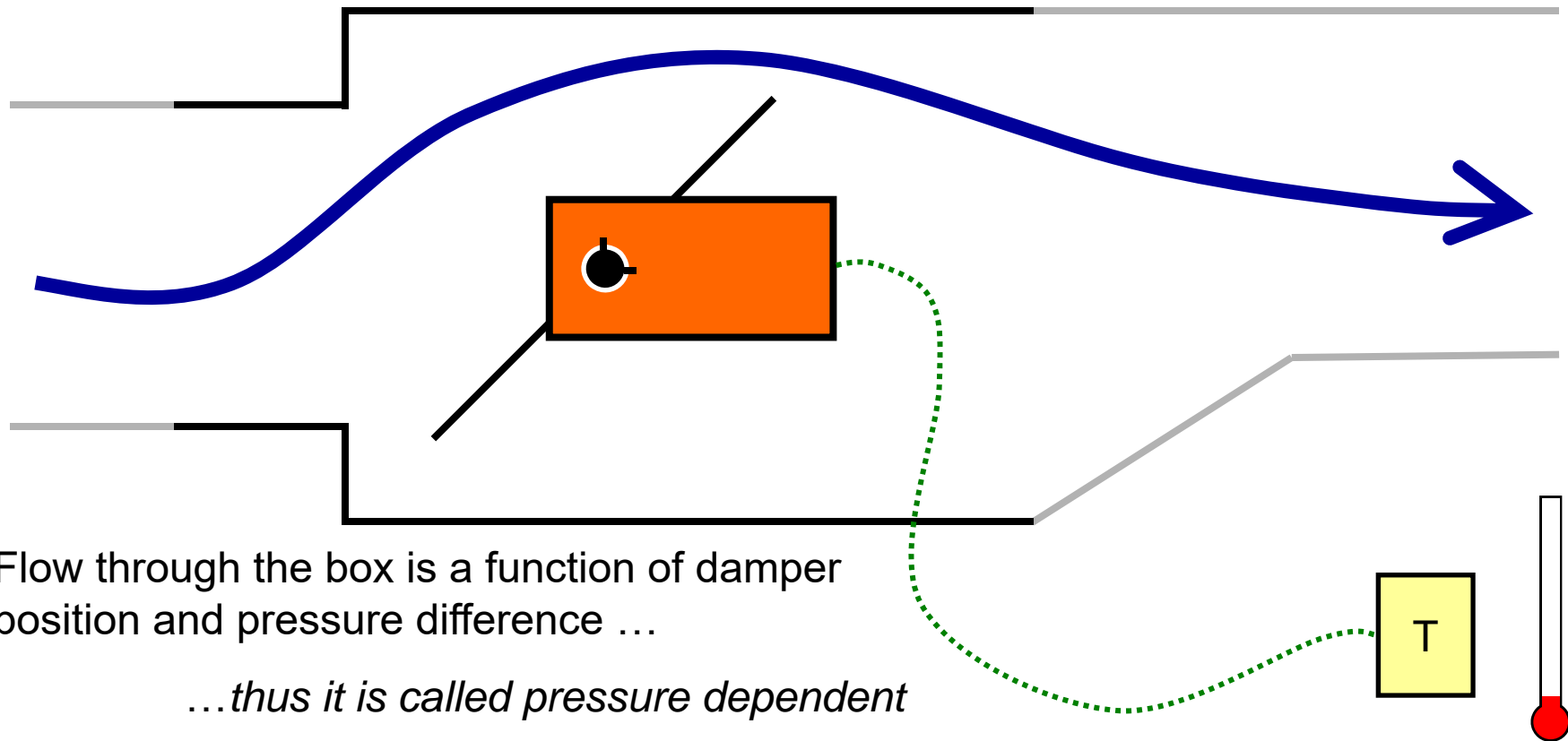
Your Basic Box



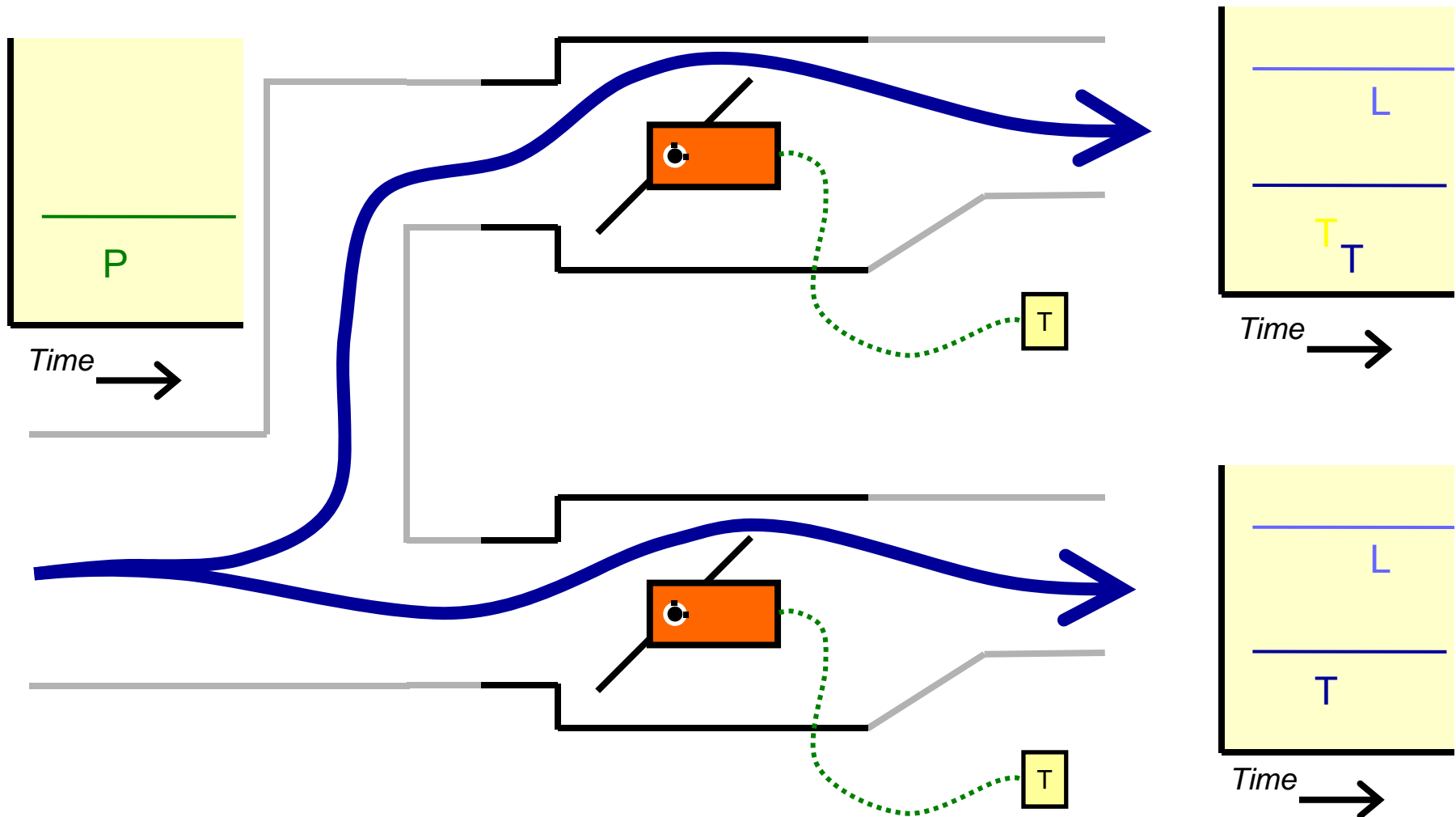
Your Basic Box



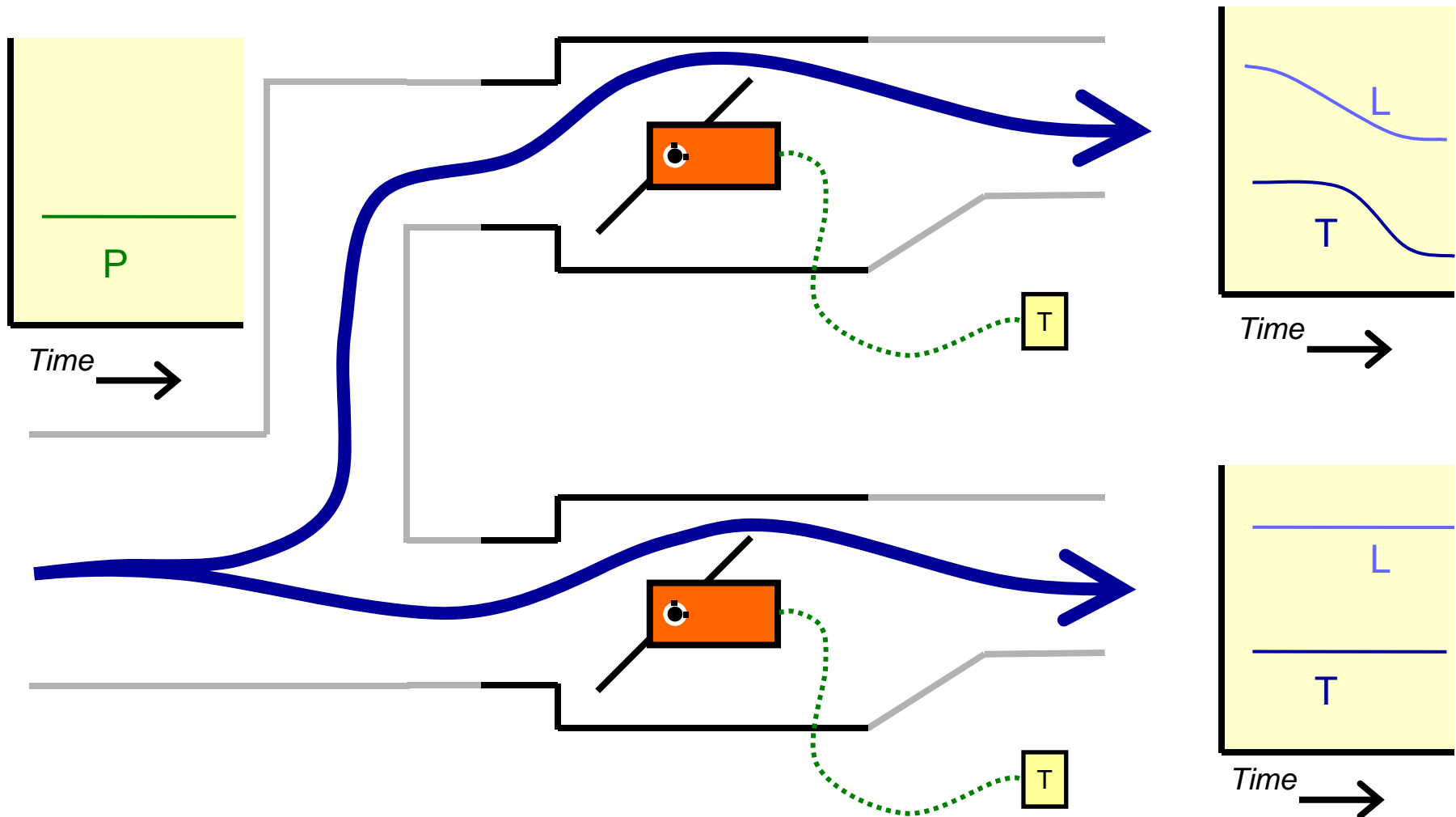
Your Basic Box



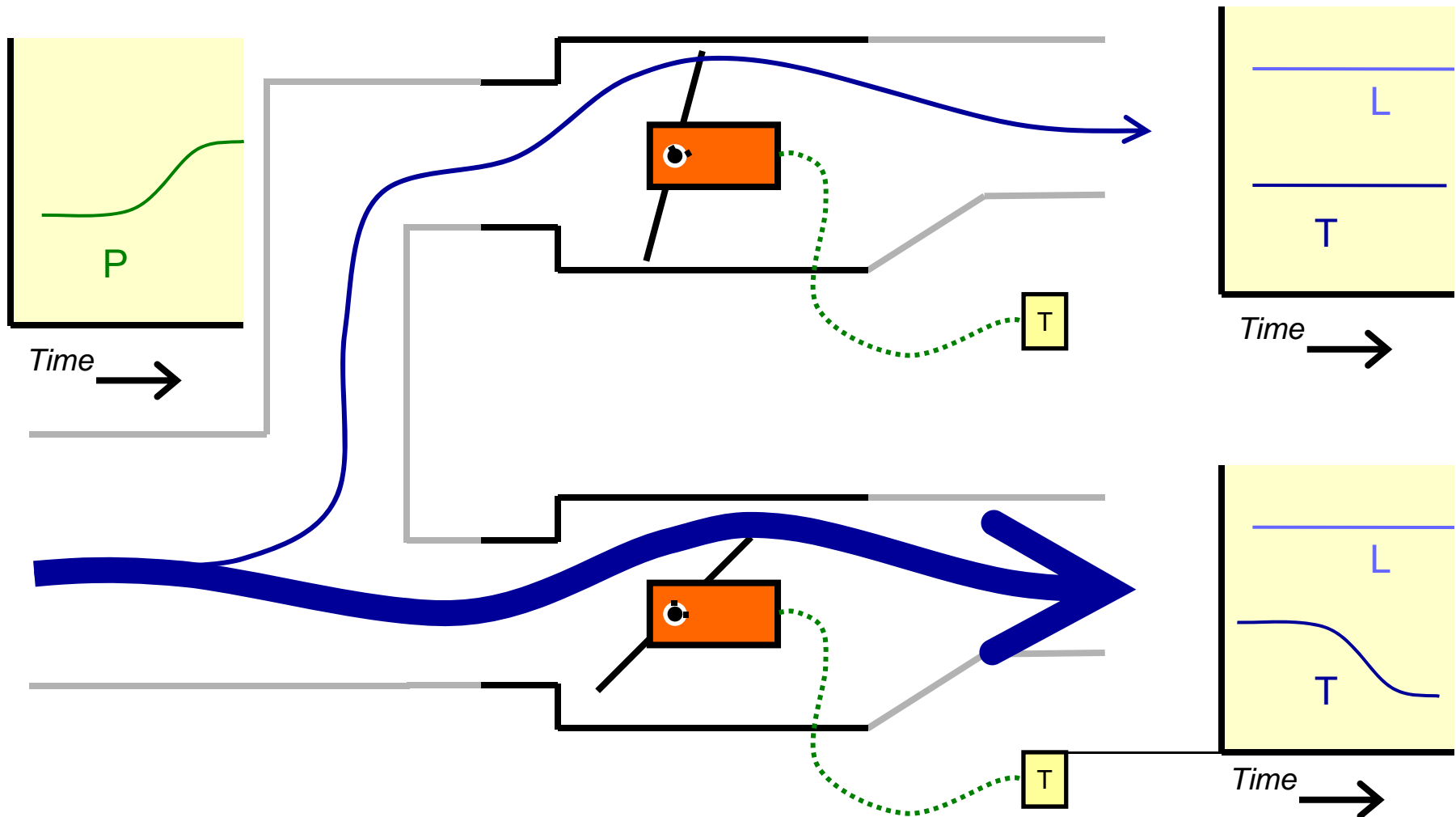
Your Basic Box



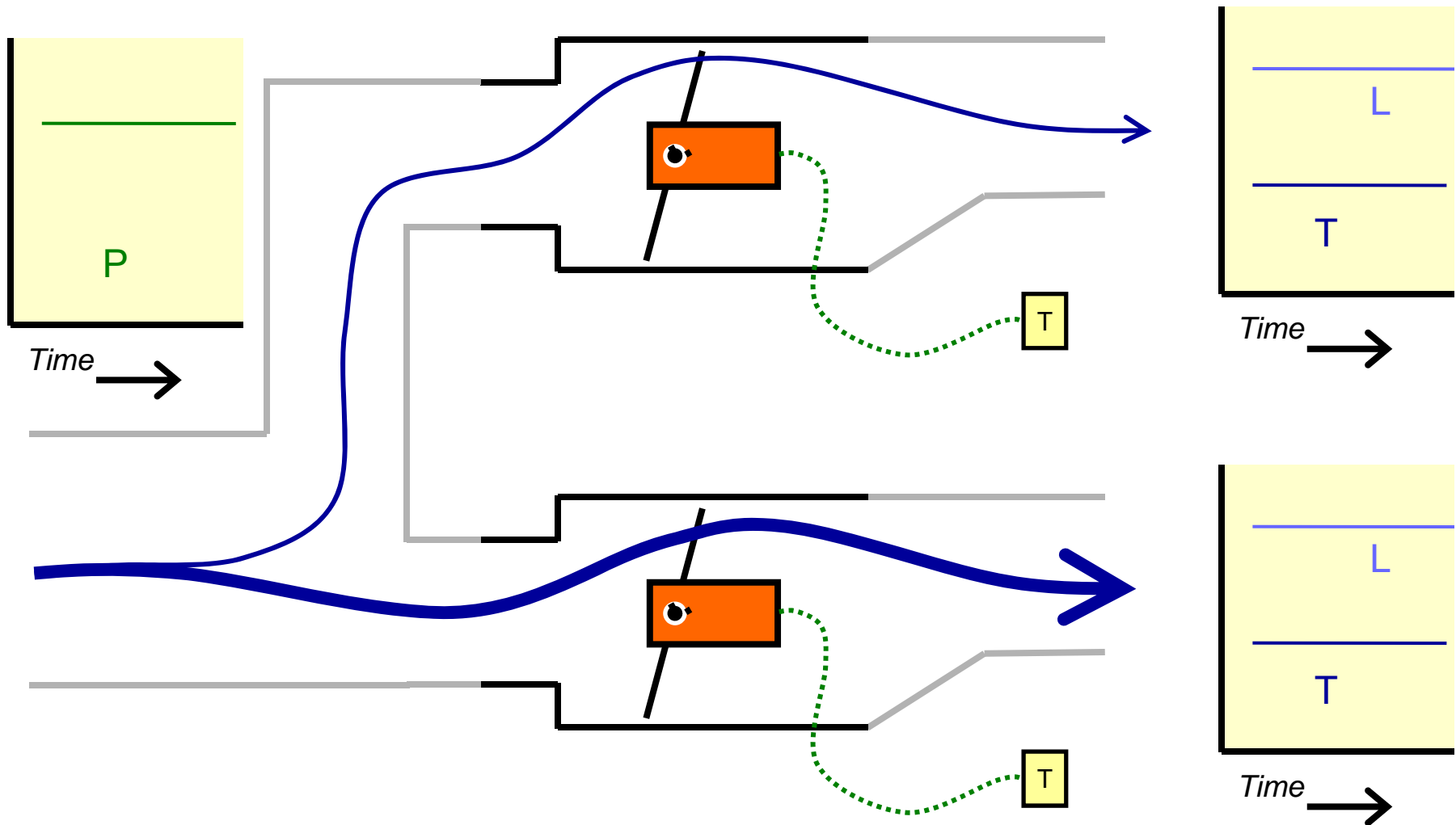
Your Basic Box



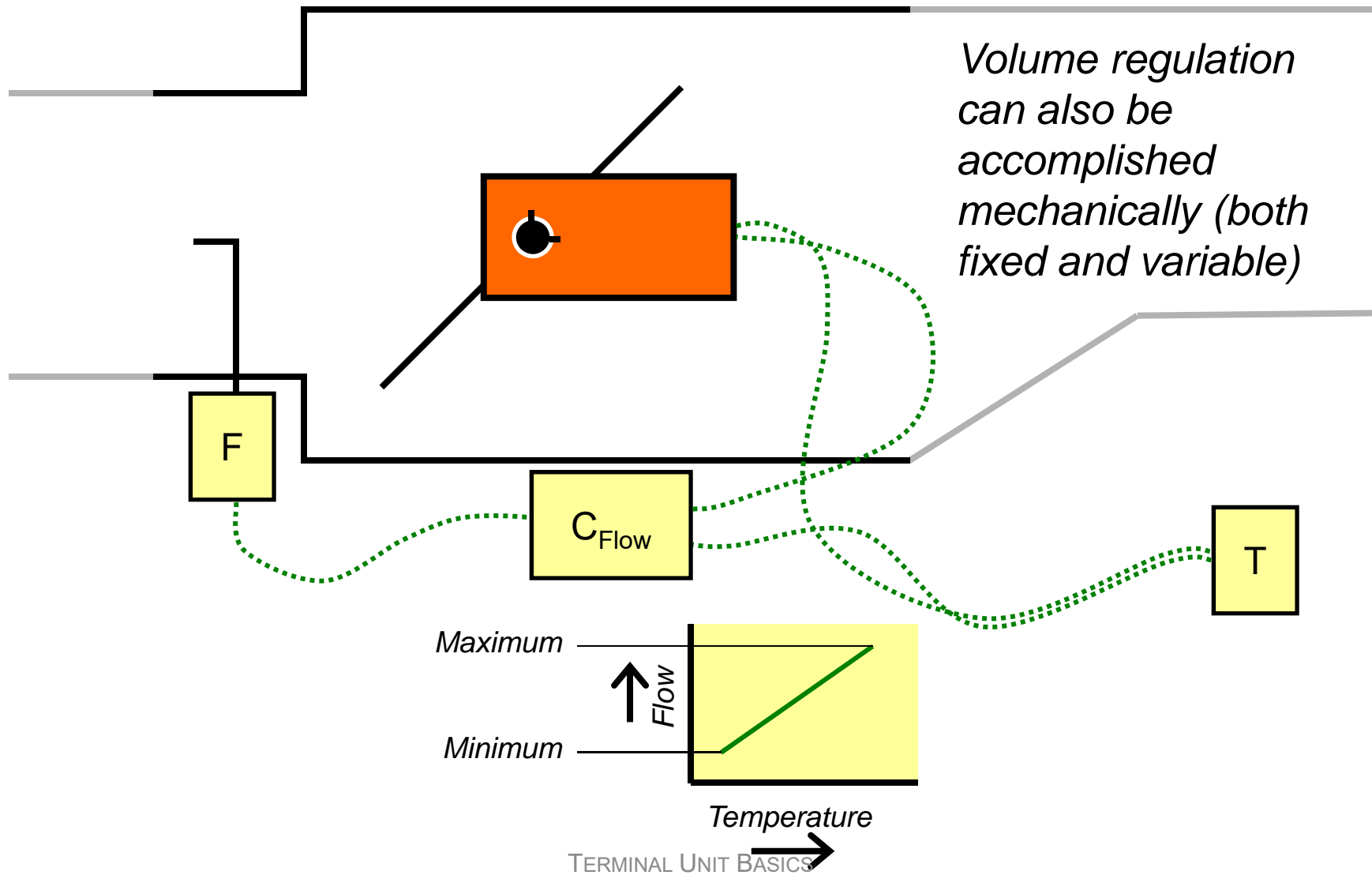
Your Basic Box



Your Basic Box



Becoming Pressure Independent



The Relationship Between Flow and Velocity

$$Q = VA$$

Where :

Q = Flow rate in cubic feet per minute

V = Velocity in feet per minute

A = Cross sectional area in square feet

The Relationship Between Velocity and Velocity Pressure

$$V = 4,005 \sqrt{VP}$$

Where :

V = Velocity in feet per minute

4,005 = A units conversion constant

VP = Velocity pressure in inches w.c.

Pneumatic vs. DDC Terminal Unit Controllers

DDC Terminal Units

- Newer technology
- No moving parts
- Maintenance on condition
- Can provide important diagnostics
 - Leaving air temperature
 - Current flow rate
- Can provide data useful for system optimization strategies
- Set points can be adjusted and verified from the OWS
- Performance can be verified from the OWS

Pneumatic Terminal Units

- Been around for a long time
- A lot of moving parts
- Don't know the condition
- They are low first cost
- They are low first cost
- They are low first cost
- They are low first cost

The Relationship Between Velocity and Velocity Pressure

12 inch VAV Box

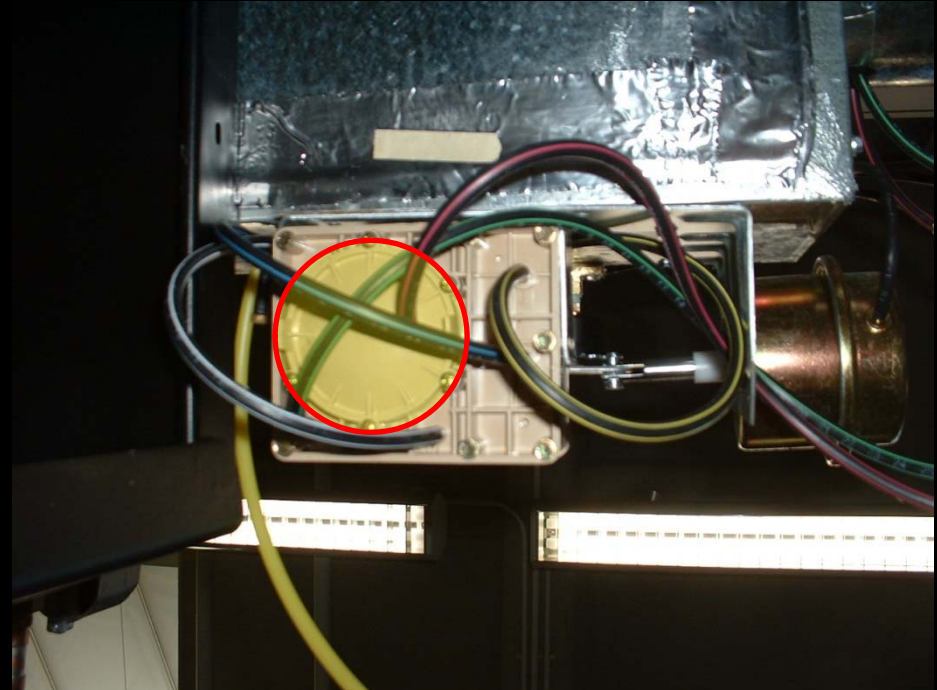
- Maximum flow
 - 2,000 cfm
 - $VP = .2494 \text{ in.w.c.}$
- Minimum flow
 - 325 cfm
 - $VP = .0066 \text{ in.w.c.}$



The Relationship Between Velocity and Velocity Pressure

12 inch VAV Box

- Maximum flow
 - 2,000 cfm
 - $VP = 0.2494 \text{ in.w.c.}$
 - Force = 0.0465 lb
 - Force = 0.74 oz
- Minimum flow
 - 325 cfm
 - $VP = 0.0066 \text{ in.w.c.}$
 - Force = 0.0017 lb
 - Force = 0.03 oz



Frame of reference; a letter in an envelop weighs about 1 oz.

Pneumatic Terminal Failure Modes

- Flow set points drift up
- Recent experience
 - Sample 10 of 45 pneumatic zones
 - Three years since last service effort
- Many of the controllers worked
- Many thermostats were out of calibration
- 0 (zero) zones were regulating at the required flow
- Many zones were wide open
- Some reheat valves were leaking through

Pneumatic Zones = Opportunity

Troubleshooting a Pneumatic Terminal



Troubleshooting a DDC Terminal

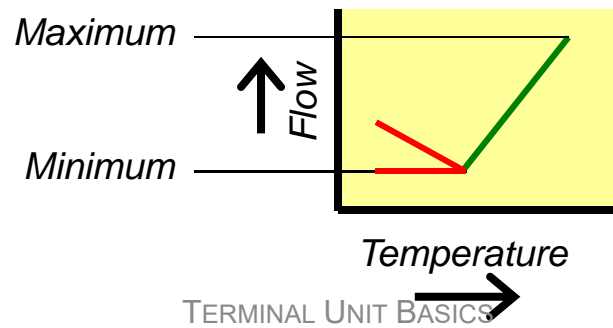
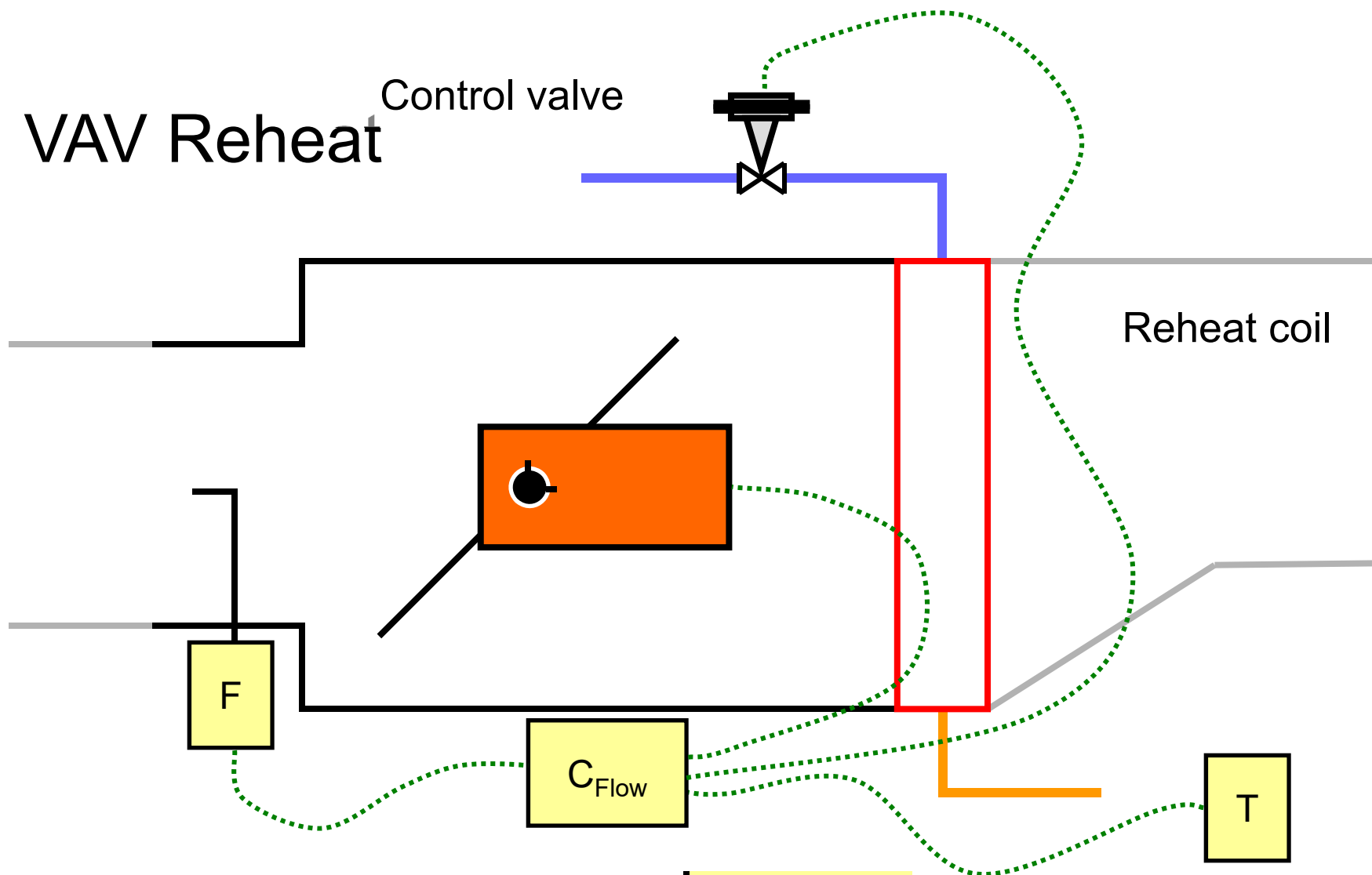


The Regulator

(PG13)

<http://tinyurl.com/3kebw3s>

VAV Reheat



A Typical VAV Reheat Box

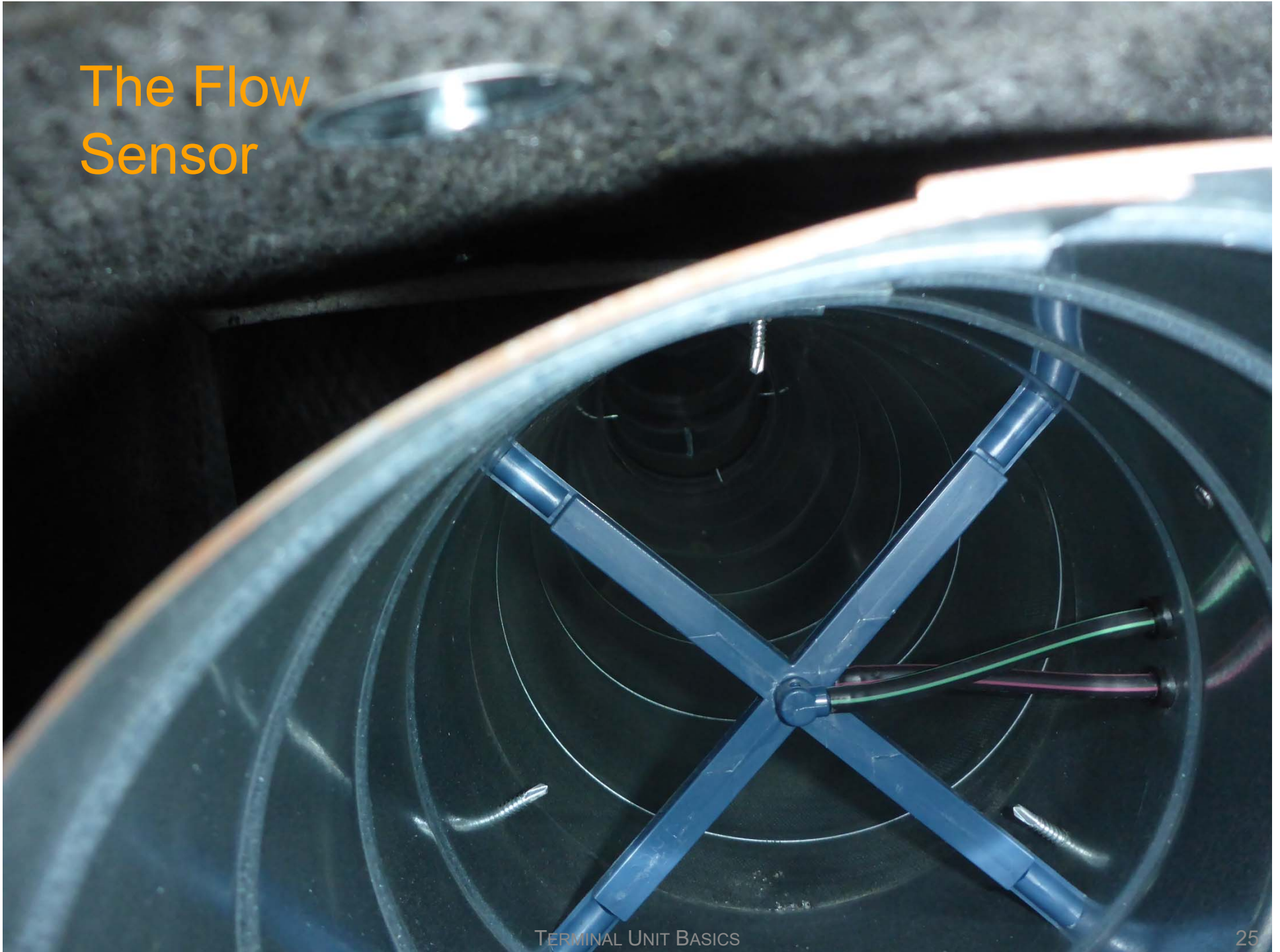




Overview

The Damper

The Flow Sensor

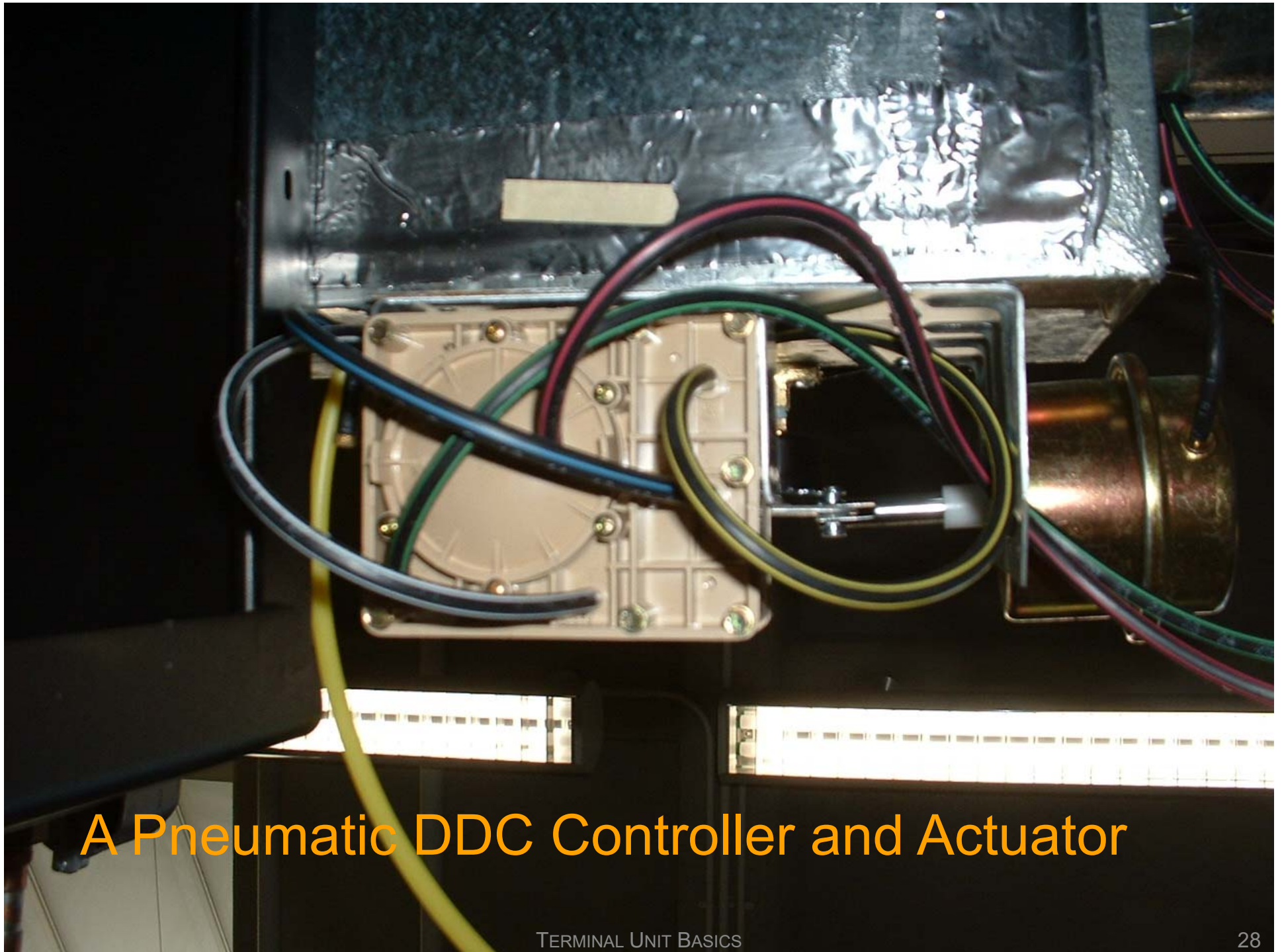




The Reheat Coil

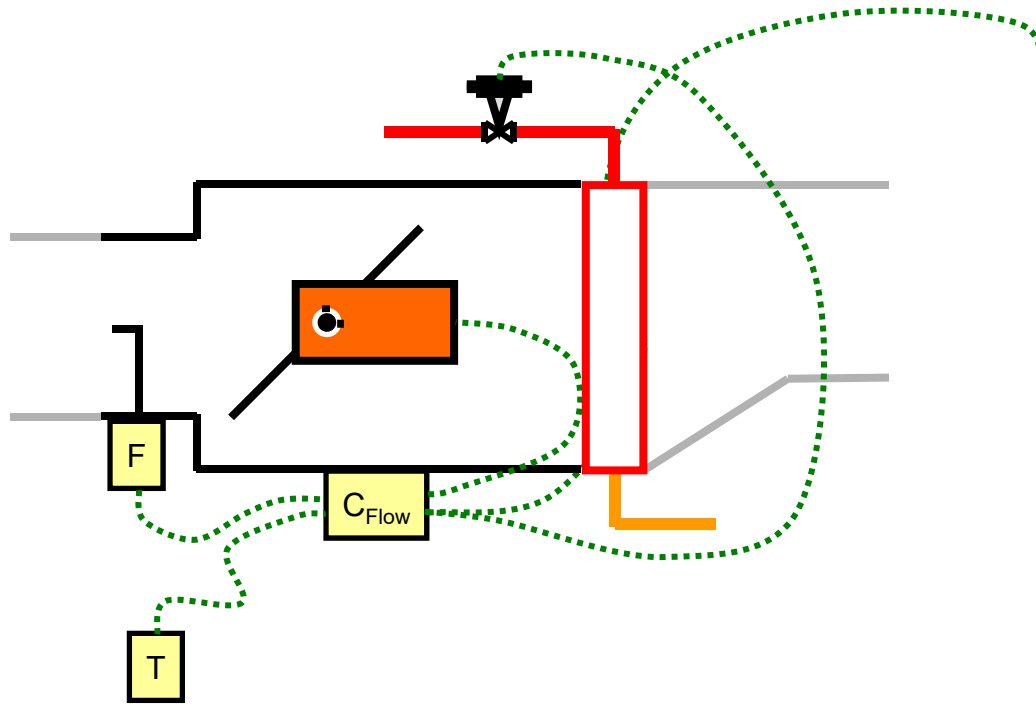


The DDC Controller with Built In Actuator

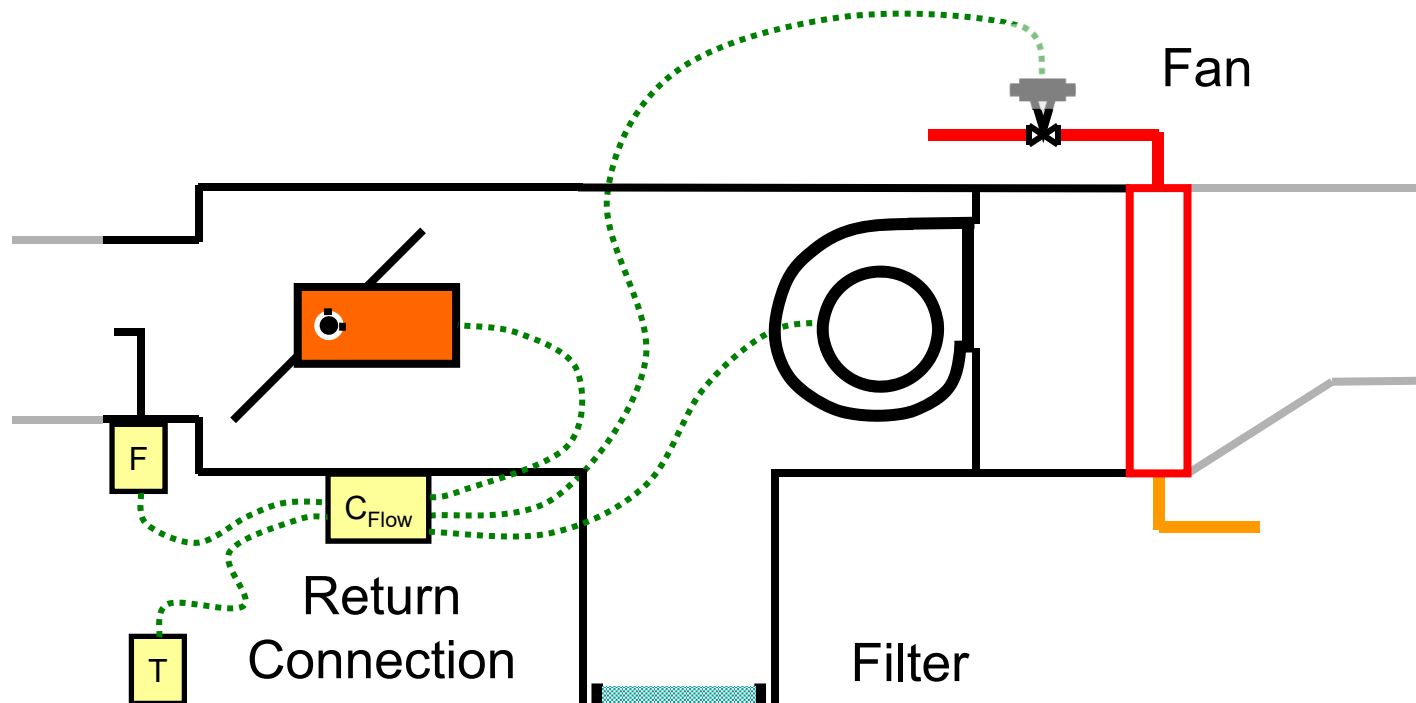


A Pneumatic DDC Controller and Actuator

Recovering Heat to Reheat Series Fan Powered Box



Recovering Heat to Reheat Series Fan Powered Box



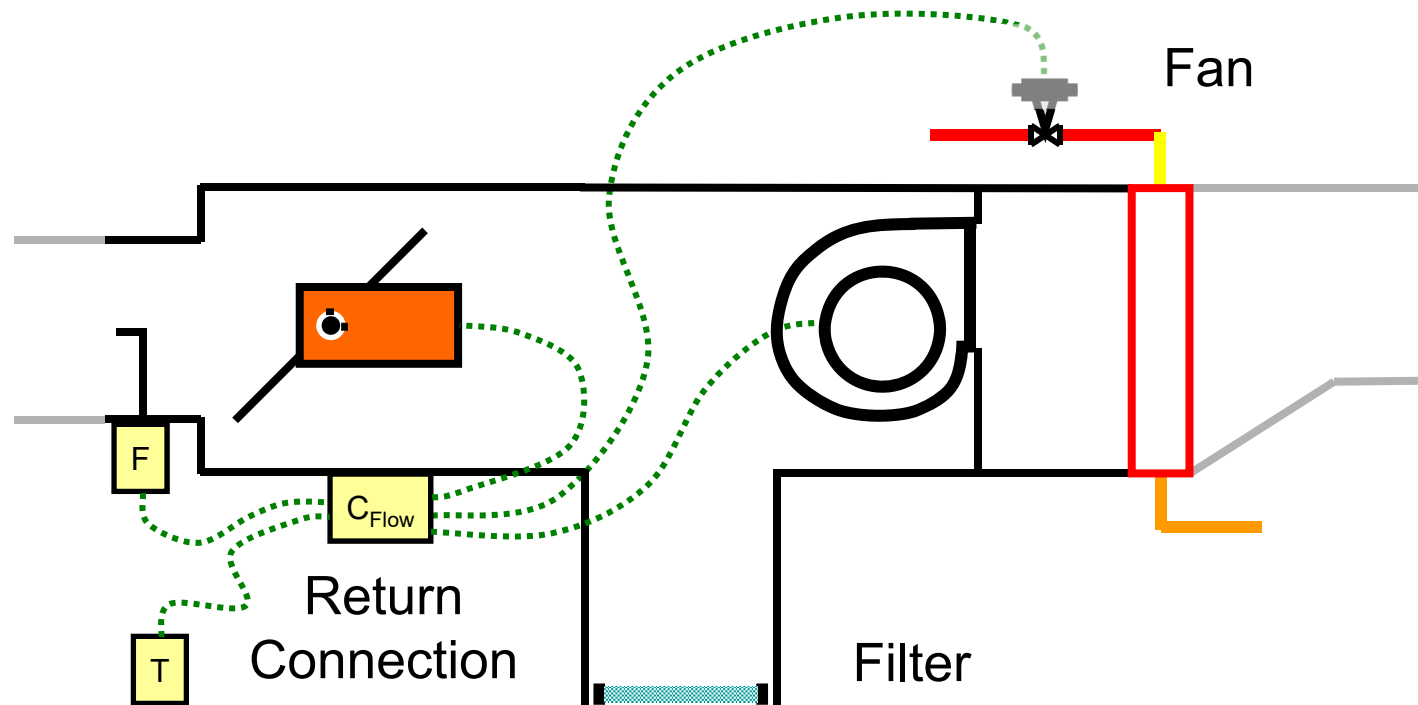
Fan runs continuously when the zone is occupied

- Tends to be constant volume

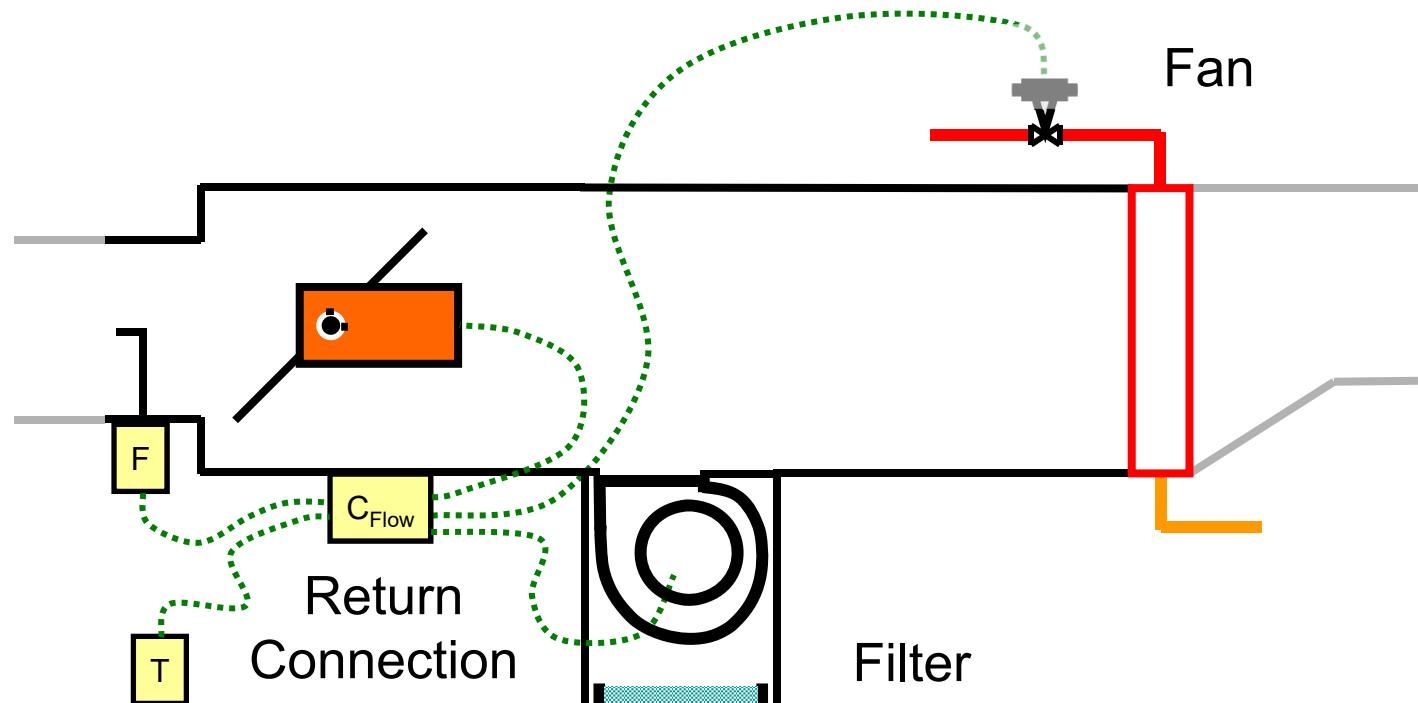
Reduction in primary flow (cooling air) is compensated for by increased return flow

- First stage of reheat
- Coil provides second stage

Recovering Heat to Reheat Series Fan Powered Box



Recovering Heat to Reheat Parallel Fan Powered Box



Fan runs intermittently when the zone is occupied

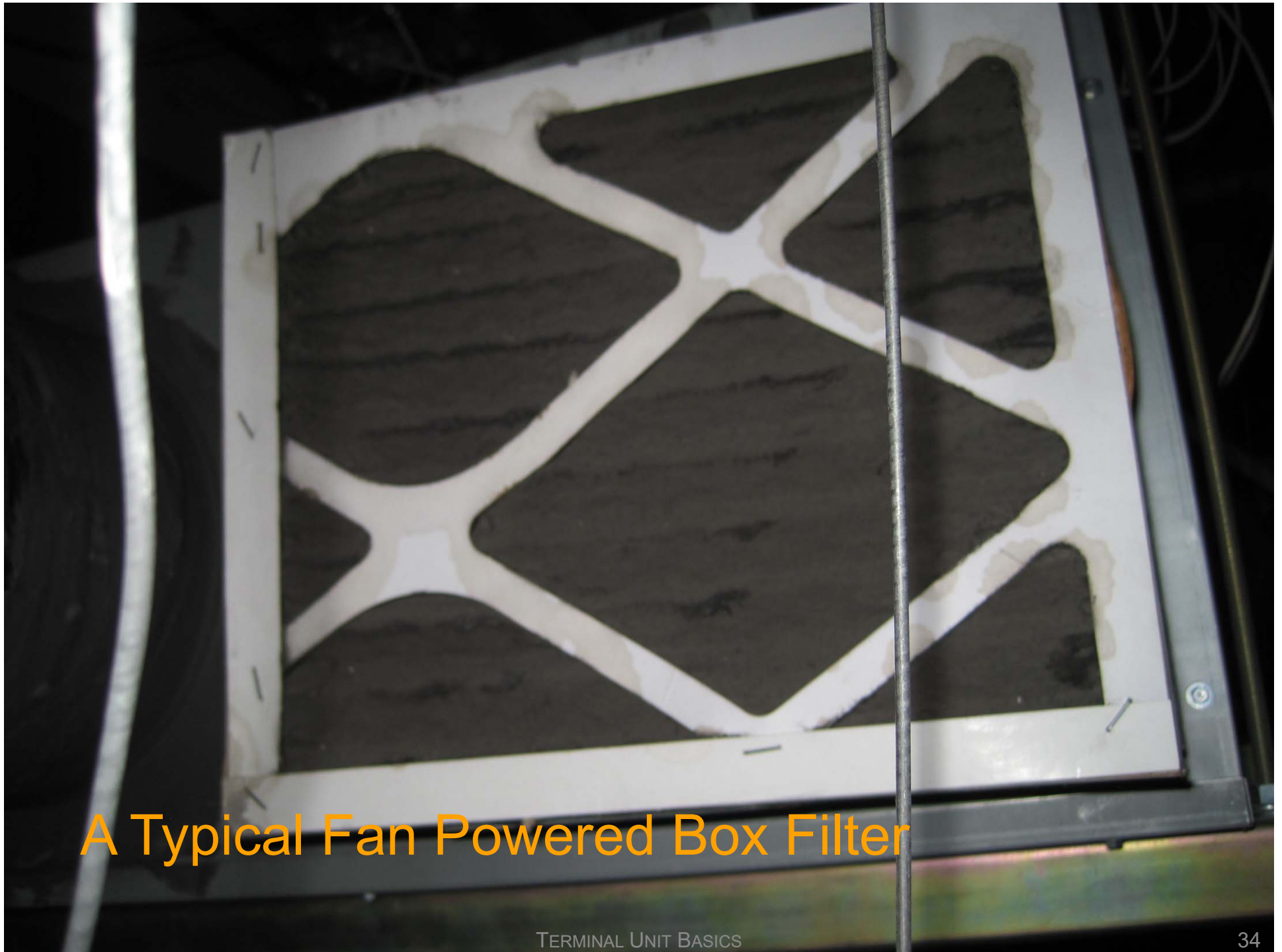
- Tends to be constant volume when the fan runs

Zone sees some reduction in flow until the fan starts

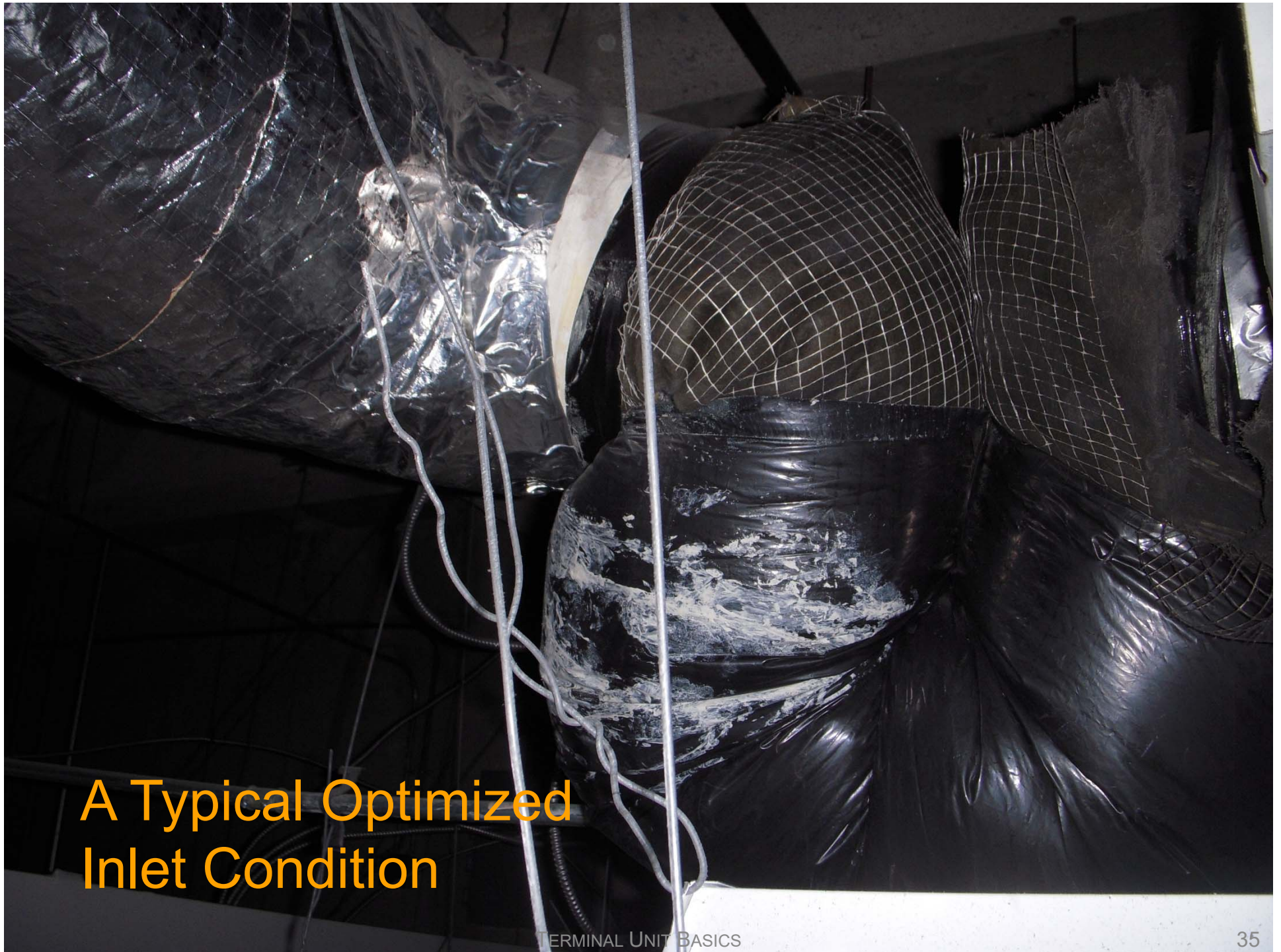
- First stage of reheat
- Coil provides second stage



A Typical Fan Powered Box

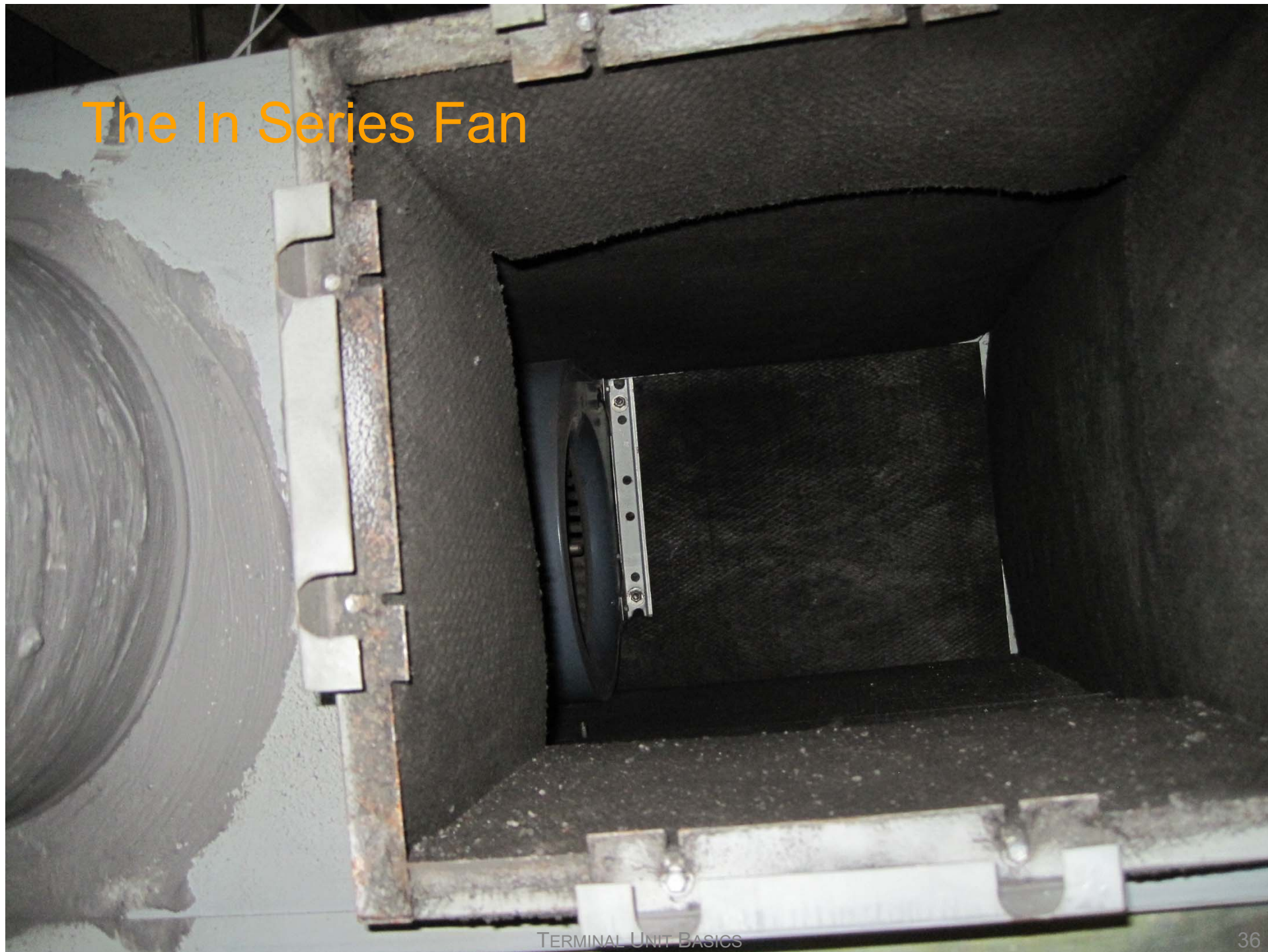


A Typical Fan Powered Box Filter



A Typical Optimized
Inlet Condition

The In Series Fan



The In Series Fan



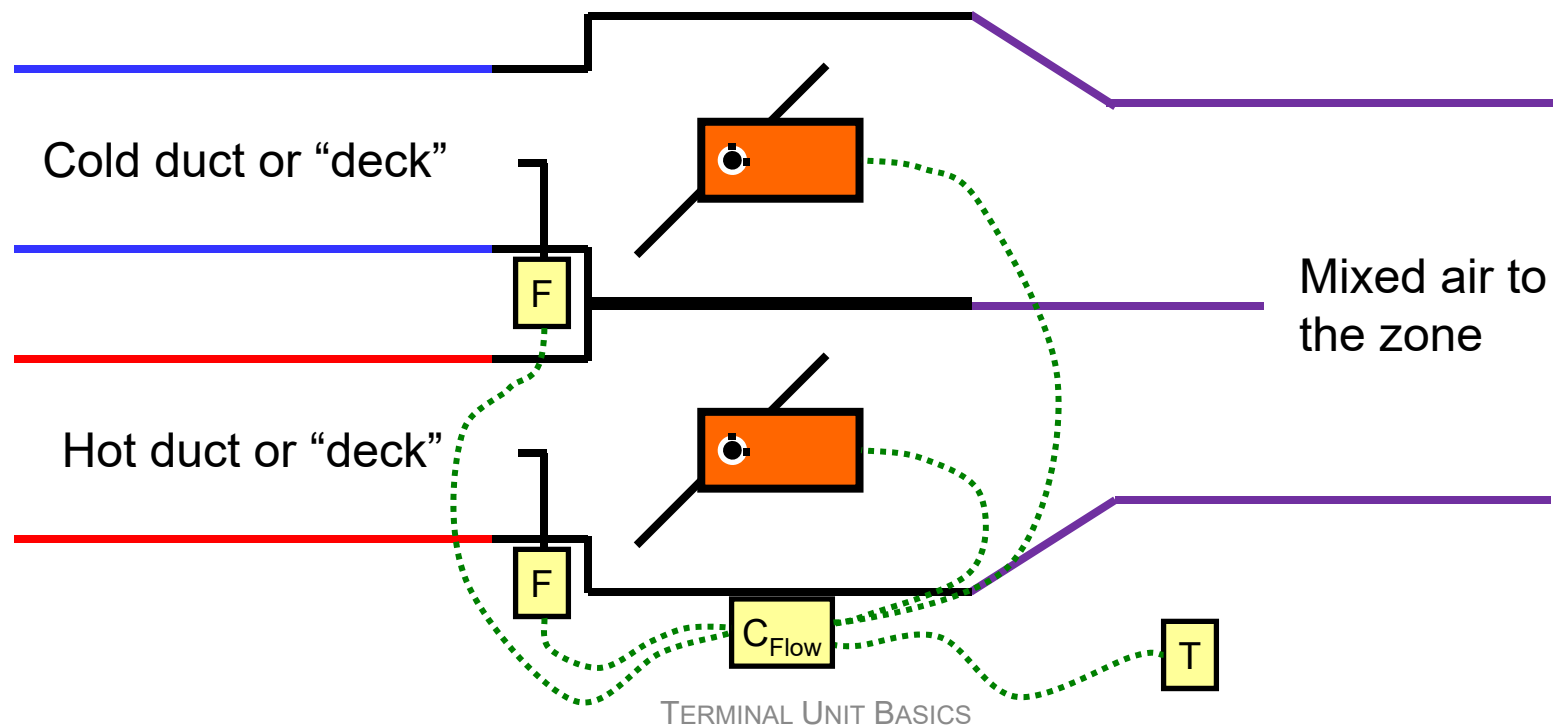
Double Duct Boxes = Reheat with Hot Air

Twice the components = twice the “fun”

Often separate fan systems for each deck

Ventilation air typically provided by the cold deck

- Always minimum cold deck flow
- Hot deck goes to 0 cfm



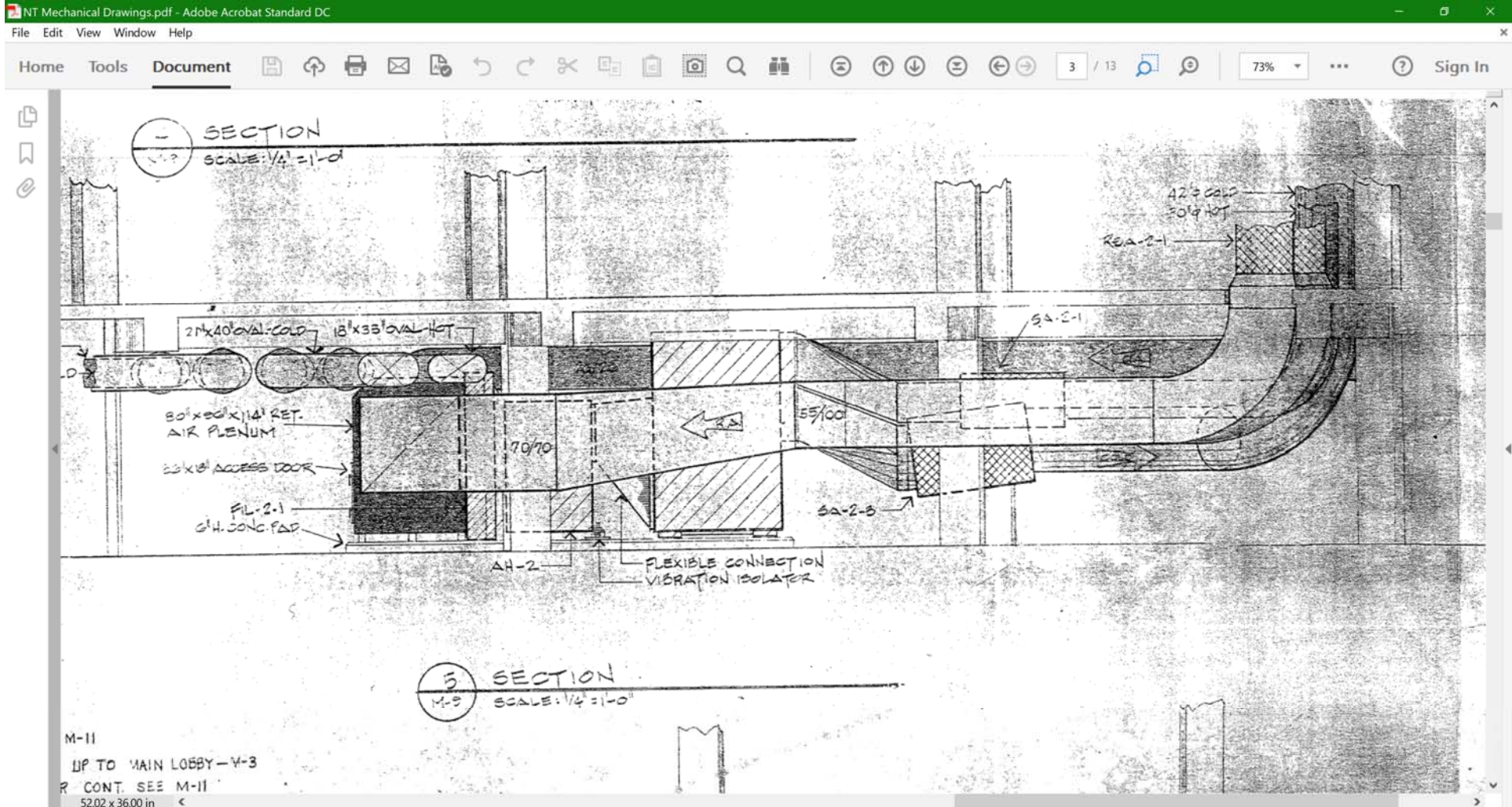
A Single Path Double Duct Unit

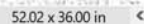


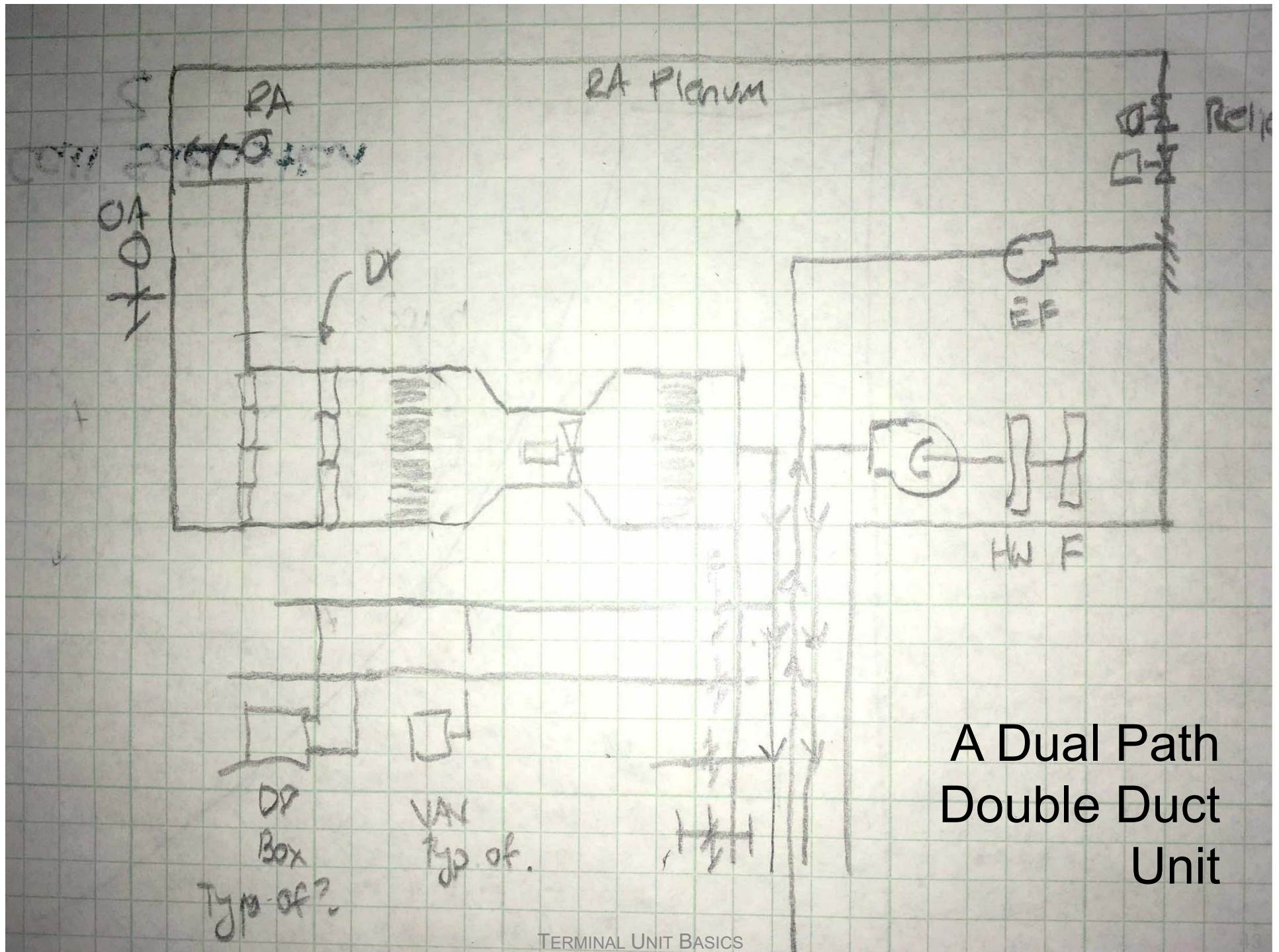
A Single Path Double Duct Unit



A Single Path Double Duct Unit









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A Constant Volume to VAV Conversion



A Double Duct Box



Bottom Lines

1. The basic box is pretty simple
2. Making it bullet proof makes it a bit more complex
3. Making it energy efficient makes it more complex
4. Making it cost effective makes persistent complexity challenging