Dampers – Selection & Application

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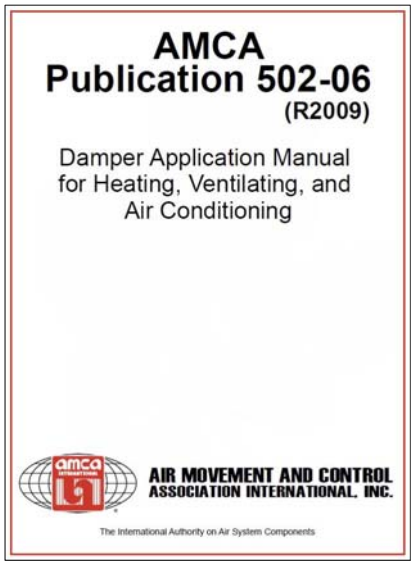
Learning Objectives

- Define the purpose of a damper
- Understand damper design and damper components
- Know how a damper interacts with the system
- Understand damper performance parameters
- Know how to specify a damper
- Damper types of installations



HVAC Dampers

Damper Applications





- Air Shutoff
- Pressure Control
- Backdraft
- Mixed Air (Economizer)
- Face & By Pass
- Insulated Dampers
- Temperature Control
- Industrial vs Commercial Dampers

What are the types of dampers?

1. Control Dampers
2. Manual Dampers
3. Backdraft (relief) dampers

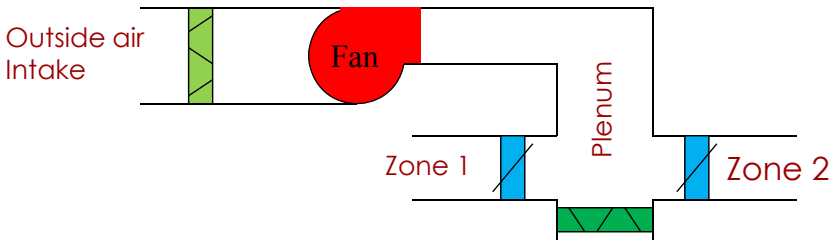






Basic Uses

- Air Shut-off: used to allow and restrict air from entering a space.
- Air Control: used to control the rate of airflow into a building or to zones within the building.
- System Balancing: used to balance the occupied air system zones of a building.



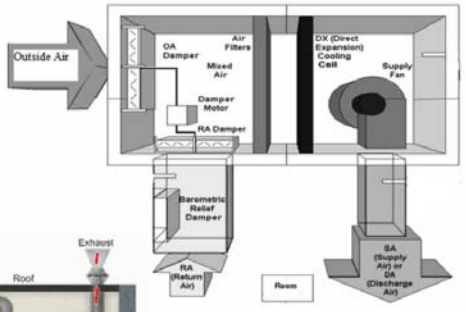
What is a control damper/ How does it operate

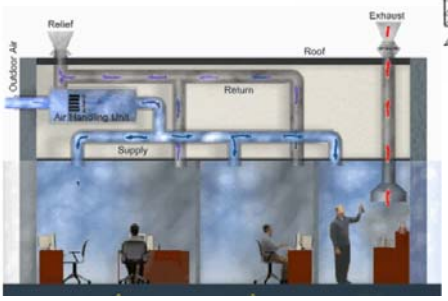
- Device that controls (or regulates) the flow of air
- Operates manually or is actuated
- Actuators are available as two-position or modulating
- Actuator voltages: 24VAC/ 24VDC, 120V, 240V



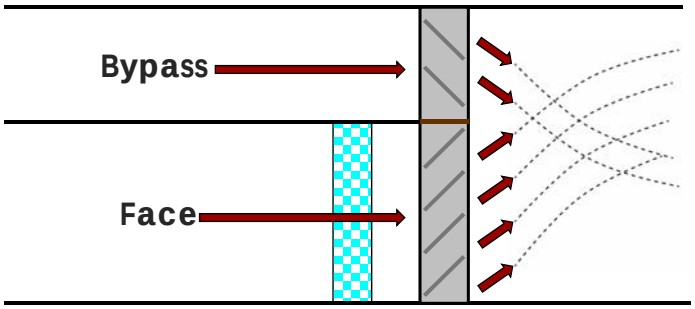
Where are dampers used?

- Air Handling Units (AHU)
- Mixing Boxes (MB)
- Outside Air (OA)
- Supply Air (SA)
- Return Air (RA)
- Exhaust Air (EA)
- Zones





Face and Bypass Damper Application



- Coil dampers often installed same size as face area of the coil.
- Coil is low velocity, around 500 fpm (2.54 m/s).
- Face damper has a low pressure drop and low authority.
- Bypass damper used to achieve full flow resistance of coil and face damper.

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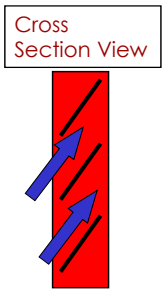
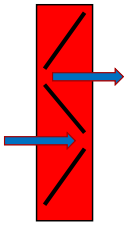
Blade Operation

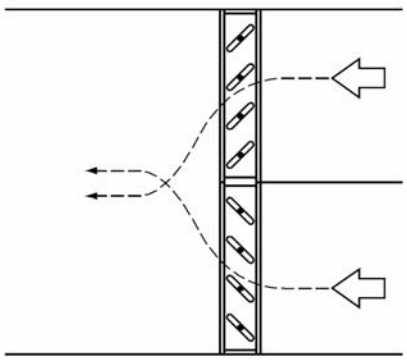


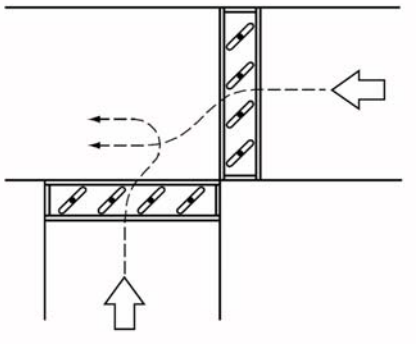
- Parallel - all blades will rotate in the same direction and in unison when actuated
- Used in two position applications
- Used in mixing applications
- Used to direct airflow as with elbows



- Opposed - blades will operate with an alternating pattern of opposing rotation
- Used in modulating applications

Fresh Air Mixing Dampers





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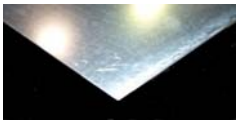
Materials

Dampers can be made from



- Galvanized steel

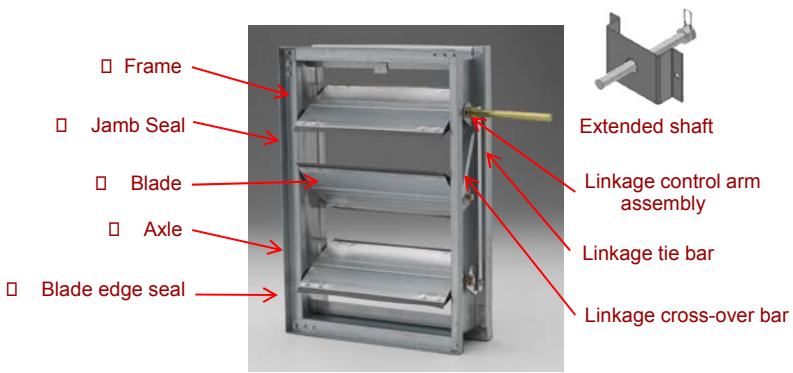


- Aluminum (Extruded or Formed)

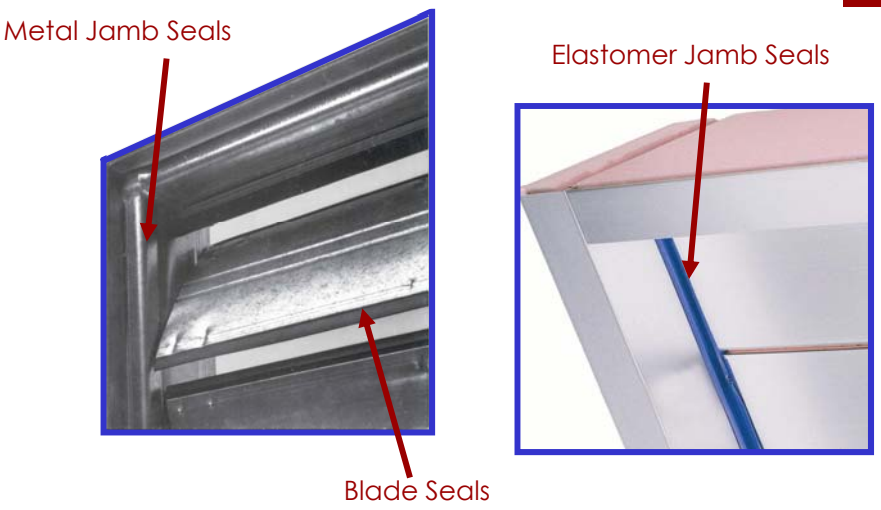


- Stainless steel

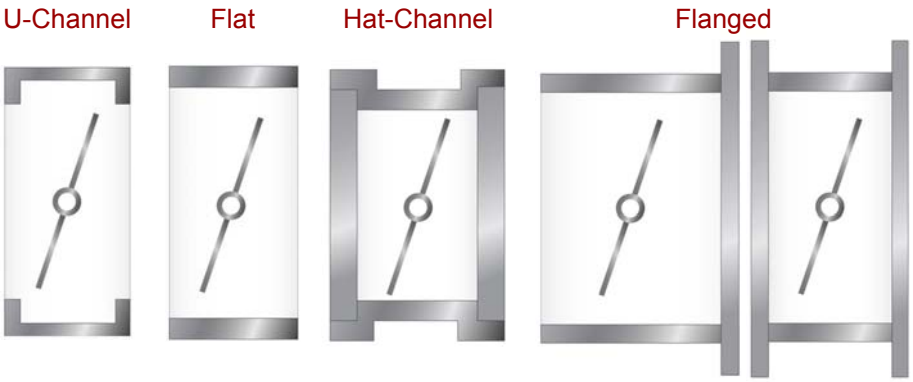
Control Damper Anatomy



Side/Jamb Seals & Blade Seals



Damper Frames



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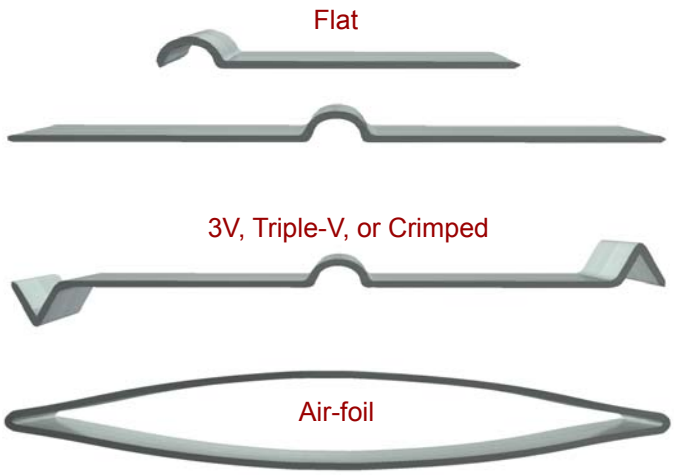
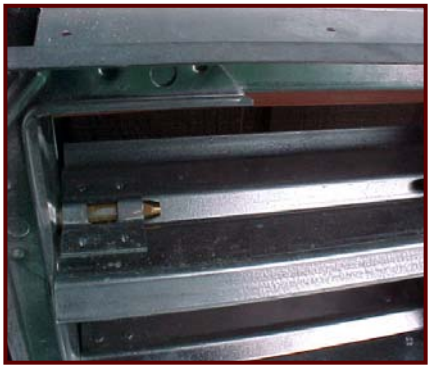
Damper Blades



3V or Triple V Blades



- Velocity . . . . < 2000 fpm (10.2 m/s)
- Static pressure . . . 4" w.g. (1,000pa)
- Economy / Balancing dampers
- Maximum blade length 48" (1,219mm)
- Leakage with seals 10-20 cfm/ft ²
  @ 4"w.g. (50.8-102 L/s/m² @1,000pa)

Airfoil Shaped Blades
Lower pressure drop vs. 3V

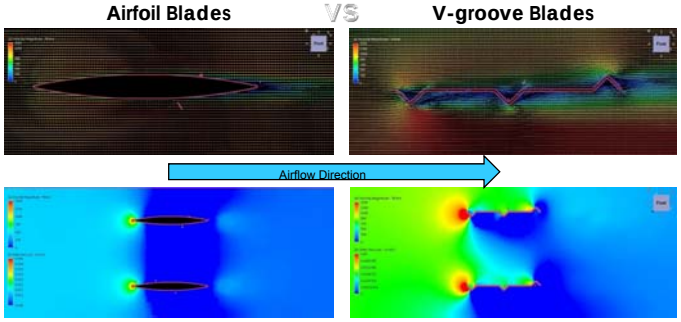


- Higher Velocity .. 2500 – 6000 fpm (12.7 – 30.5 m/s)
- Higher Static Pressure . . 4"–10"w.g (1000 – 2500pa)
- "High End" Applications
- Aluminum or Galvanized
- Maximum blade length 48" – 60" (1219 – 1524mm)
- Leakage 3 – 8 cfm/ft ² @ 4" w.g. with seals (15.2 – 40.6 L/s/m²@1,000pa)

Airfoil vs V-groove Performance

Conserve Energy and reduce noise with reduced pressure drop

Airfoil Blades VS **V-groove Blades**



~ 3V has 2.5 Times More Pressure Drop

Linkage Types



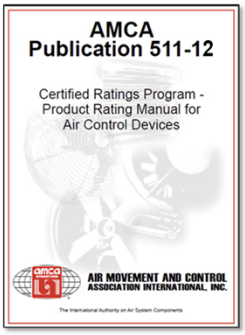
- **In-Jamb** or **Concealed** linkage controlling blade operation is located out of the air stream. The jamb or side of the damper frame houses the linkage.

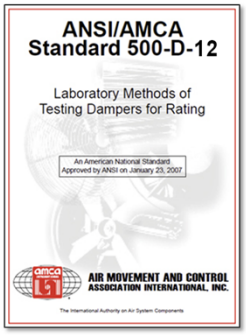


- **On-Blade** or **Exposed** linkage controlling the blade operation is located in the air steam. The linkage is directly affixed to the blades.

Test Standards and Certification Programs

- AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating
- AMCA Publication 511, Certified Ratings Program for Air Control Devices





Certified Performance Rating Seals





Certified Performance Rating Seals

"Tested in accordance with AMCA" or "AMCA tested"

IS NOT

AMCA Certified.

It means it HAS NOT BEEN approved as

Tested in an AMCA Certified Laboratory

and **CANNOT**

bear the AMCA certification seal.

*Read AMCA's White Paper at www.amca.org
"Certified Ratings Program - A Closer Look"

Pressure Drop

- Resistance to airflow across an open damper.
- Usually expressed in inches of water (in. W.G.) or Pascal (Pa) at a specified velocity.
- AMCA has 5 different configurations in which they test and certify damper performance (pressure drop).

Leakage

Defined as "The relationship between the airflow leakage rate and static pressure at a given seating torque".

Leakage can have a dramatic effects on:

- System Balance
- Noise Generation
- Building Energy Usage
- Fan Sizing

Typical Air Leakage Chart

	Leakage Class		
Max Damper Width	1 in. wg	4 in. wg	8 in. wg
12 in.	1	1	1
48 in.	1	1	2
60 in.	1	2	N/A

Data are based on a torque of 7.5 in-lb/ft² applied to close and seat the damper during the test. Air leakage is based on operation between 32° F and 120° F. Data is converted to Standard air density of 0.075 lb/ft³.

Test Sample Sizes:
12"w x 48"h
48"w x 36"h
60"w x 36"h

Maximum Leakage per Class

Maximum Leakage Per Class			
Class	1 in. wg	4 in. wg	X in. wg
1A	3	n/a	n/a
1	4	8	$\sqrt{x}$ x 4
2	10	20	$\sqrt{x}$ x 10
3	40	80	$\sqrt{x}$ x 40

Damper Ratings & Performance … example

- Velocity & Pressure
- Leakage
- AMCA certified



VELOCITY AND PRESSURE DATA		
DAMPER WIDTH INCHES	MAXIMUM SYSTEM PRESSURE In. wg (kPa)	MAXIMUM SYSTEM VELOCITY FPM (m/s)
60" (1524)	3.5" (0.9)	3000 (15.2)
48" (1219)	6.2" (1.5)	4000 (20.3)
36" (914)	8.5" (2.1)	4000 (20.3)
24" (610)	10.8" (2.7)	5000 (25.4)
12" (305)	13.0" (3.25)	6000 (30.5)

	LEAKAGE CLASS*			
Maximum Damper Width	1" w.g. (0.25 kPa)	4" w.g. (1 kPa)	8" w.g. (2 kPa)	10" w.g. (2.5 kPa)
60" (1524)	1A	1	NA	NA

Damper sizes

- Most models are unlimited with multi-section



LINE ITEM	QTY.	A OR DIA	B			ACTUATOR				SLEEVE		BLADE	SHIP SECT.	TAG
						MODEL	QTY.	FAIL	SIDE	LENGTH	GA.	ACT		
1	7	432	180			XL2215R80	10	CL	IN	NONE		OB	12	

NOTES:
1. ACTUATOR TO BE PROVIDED WITH SPEED CONTROLS, AND PROXIMITY QV210101 LIMIT SWITCH W/ VISUAL INDICATO ACCESSORIES WILL BE FACTORY MOUNTED ON ACTUATOR.
2. ACTUATOR TO ROTATE CCW TO CLOSE DAMPER UPON INCREASE OF AIR SUPPLY & FAIL CW TO OPEN DAMPER UP AIR SUPPY AS VIEWED LOOKING INTO AUX. SHAFT SIDE OF ACTUATOR.
3. PLANT SHOULD TAG EACH SHIP SECTION AS NOTED TO ASSIST WITH FIELD INSTALLATION.
4. EACH ASSEMBLY TO BE GIVEN A SET OF UNIQUE SECTION TAG NUMBERS. FOR EXAMPLE: DAMPER ASSEMBLY β3 1 A-1, A-2, A-3, A-4, B-1, B-2, B-3, B-4, C-1, C-2, C-3, AND C-4. EACH OF THESE DAMPER ASSEMBLIES PACKAGED TOGETHER.

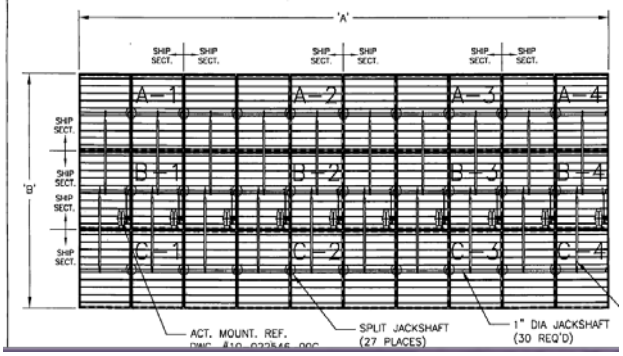


FIG. 5.1 DAMPER TEST SETUP (AMCA Standard 500-D)

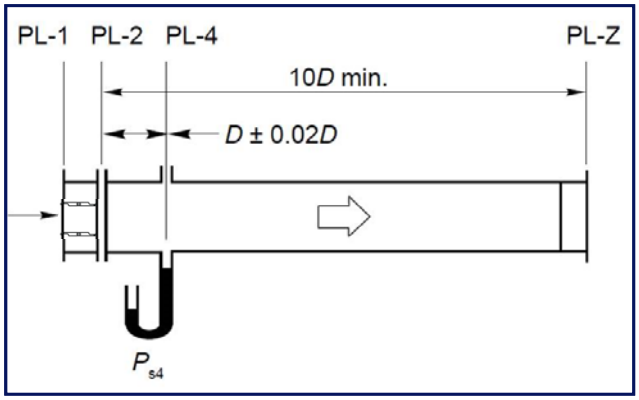


FIG. 5.2 DAMPER TEST SETUP (AMCA Standard 500-D)

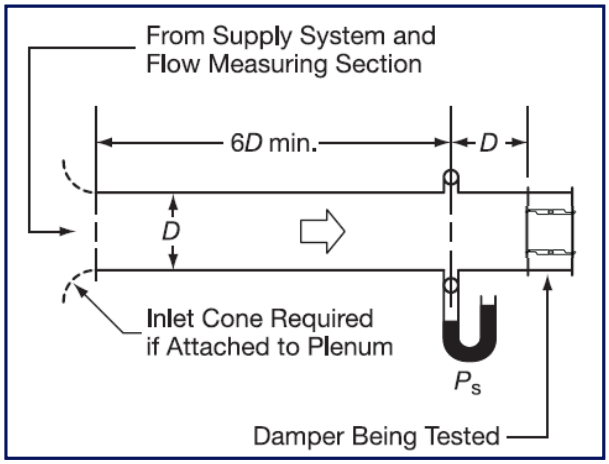
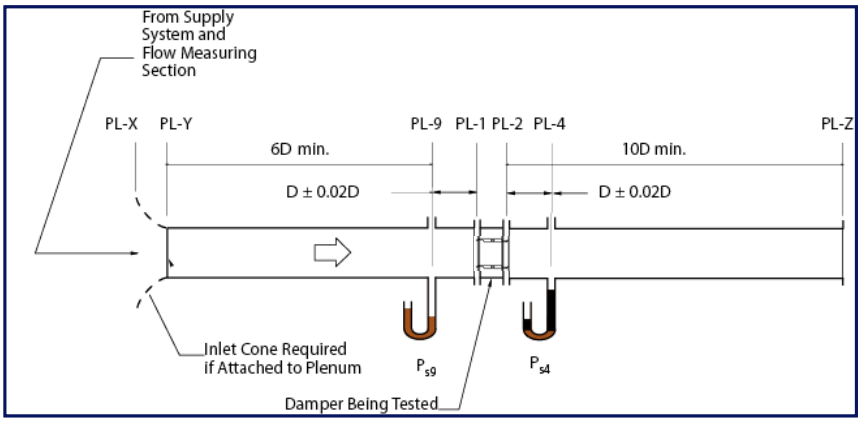


FIG. 5.3 DAMPER TEST SETUP (AMCA Standard 500-D)



Typical Size Comparison for Test per Fig. 5.3 (AMCA 500-D)

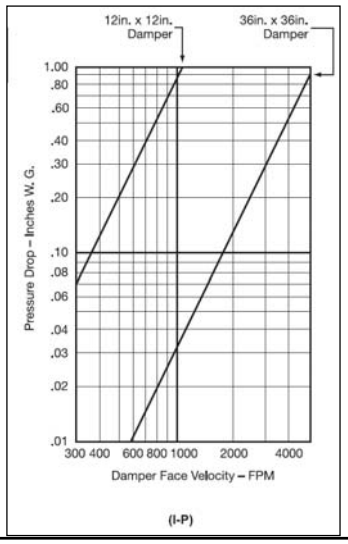


FIG. 5.4 DAMPER TEST SETUP (AMCA Standard 500-D)

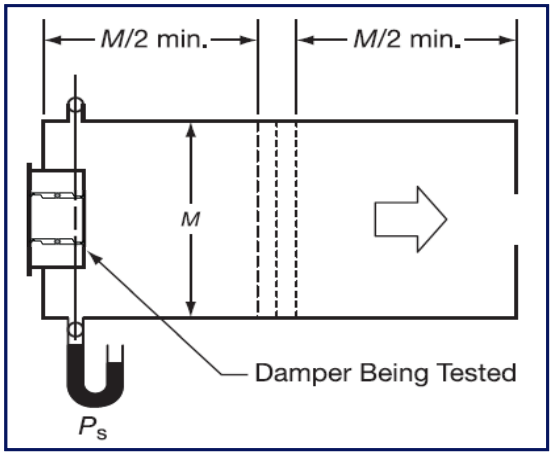
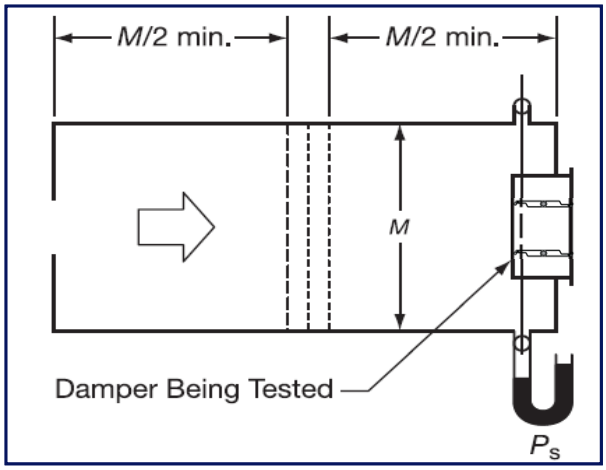
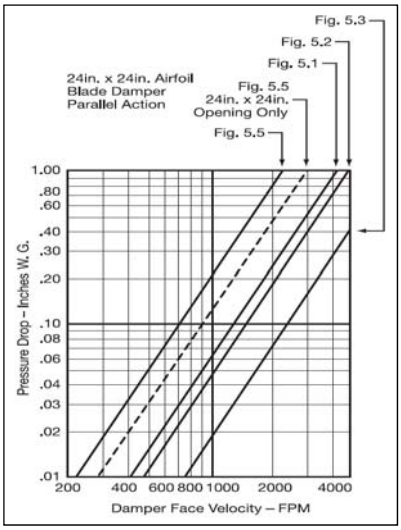


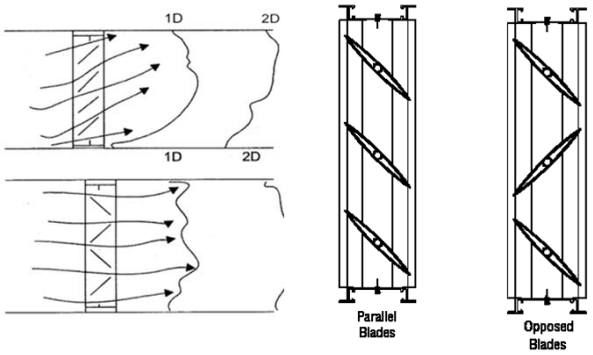
FIG. 5.5 DAMPER TEST SETUP (AMCA Standard 500-D)



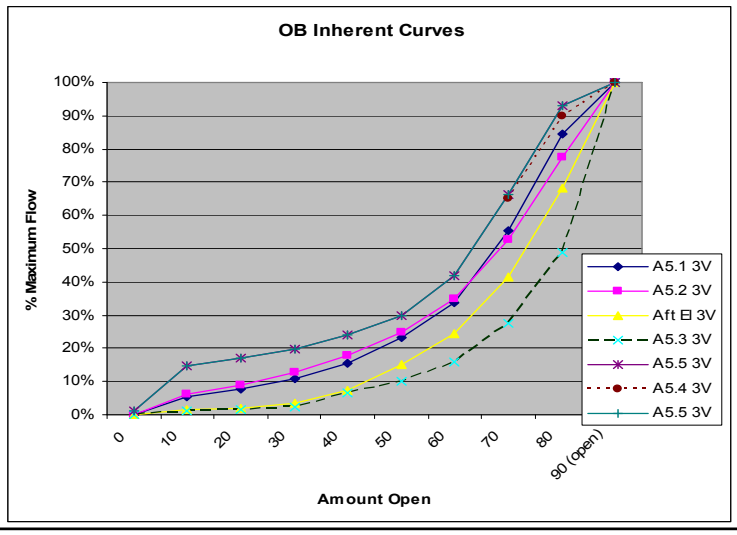
Sample Size Comparison for Test per Several Figures (AMCA 500-D)



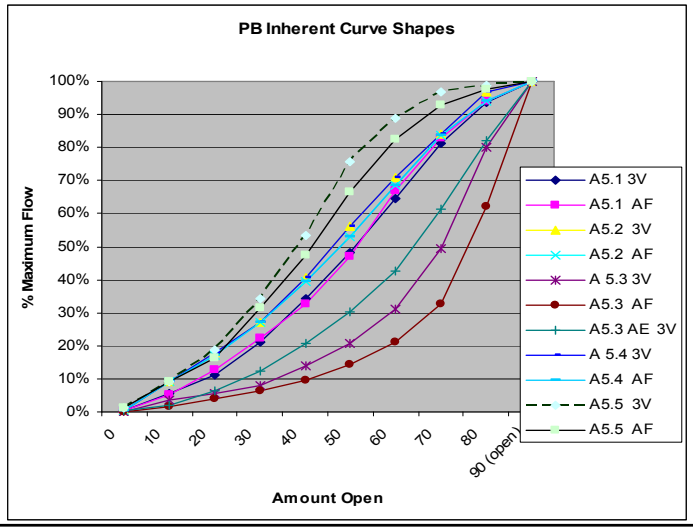
Blade Action



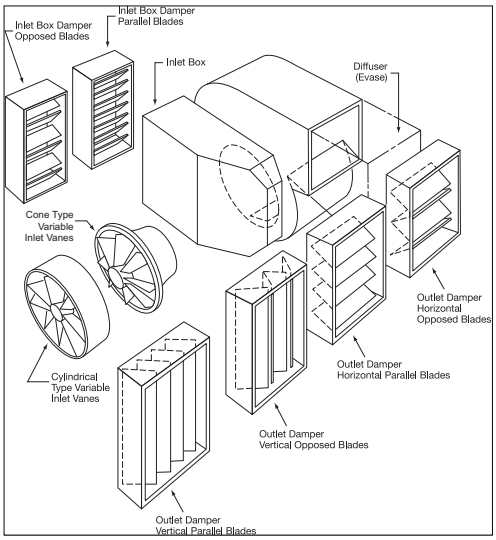
Damper Flow Characteristics
Opposed Blade Damper



Damper Flow Characteristics
Parallel Blade Damper



Common Terminology for Cent. Fan Control

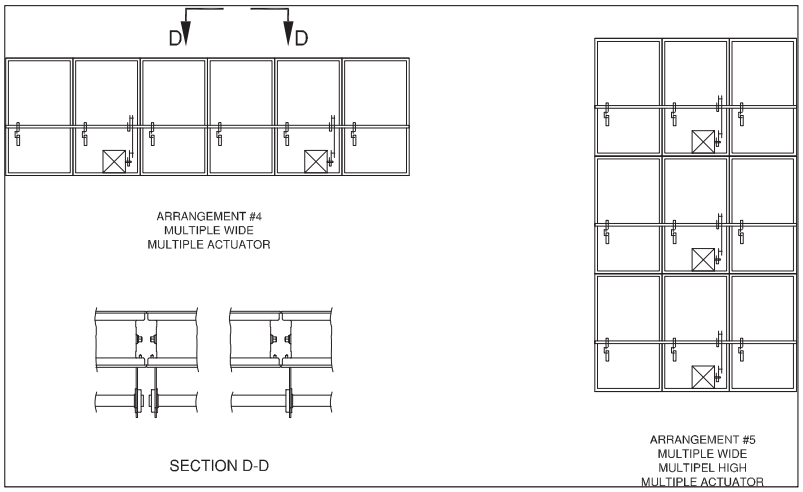


Blade Configurations

- Horizontal Blades
- Vertical Blades
- Size limitations for vertical blades
- Vertical blade modulating dampers should require thrust bearings
- Parallel Blade Dampers good for mixing



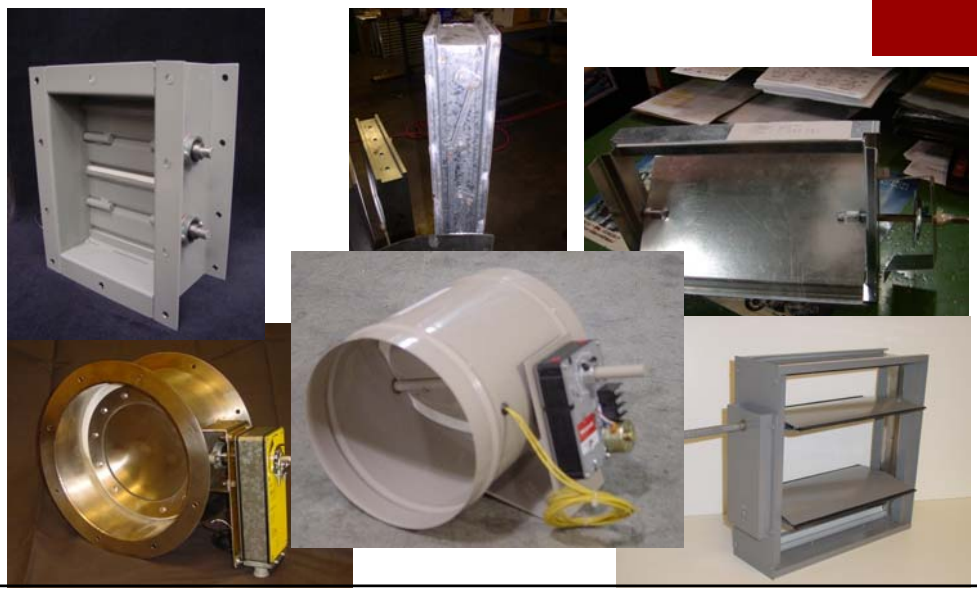
Jackshaft Arrangement



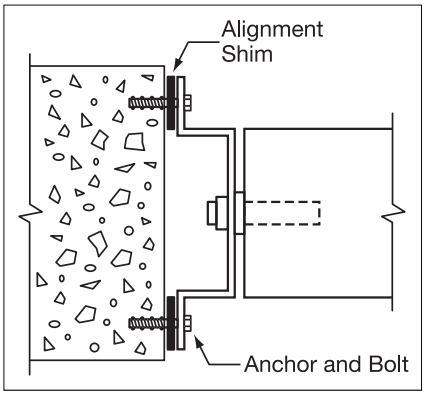
Different Type of Jack Shafts



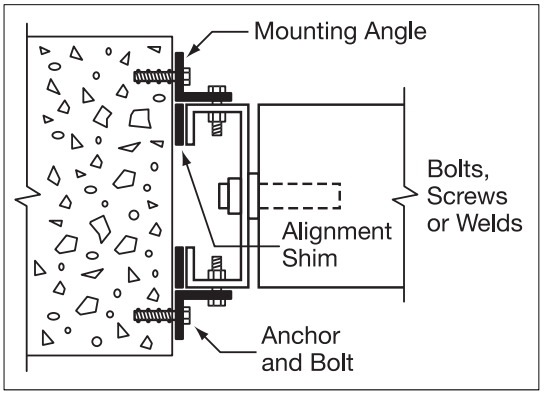
Different Damper Frames for Installations



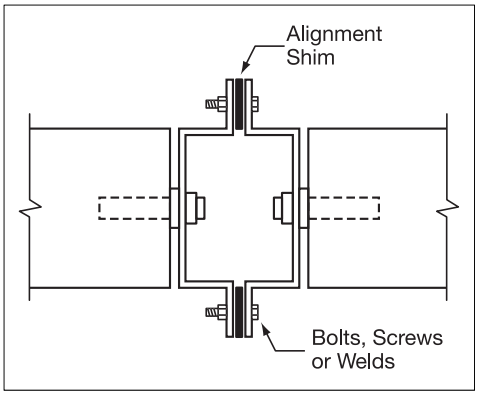
Installation - Hat Channel Frame



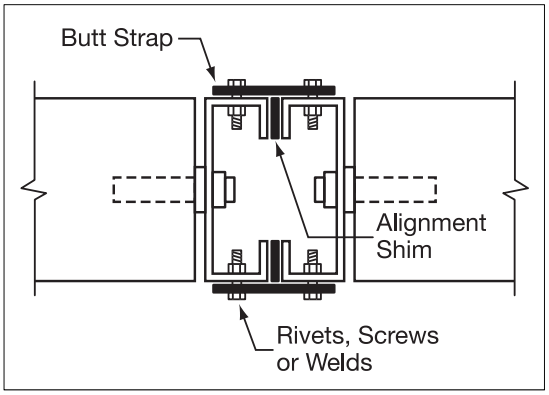
Installation – Channel Frame



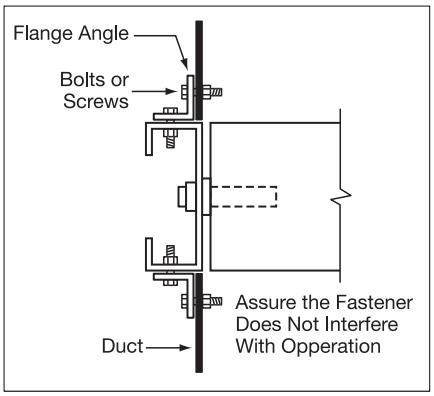
Multiple Damper Sections



Multiple Damper Sections – Field Assembly



Installation – Flange Type



What Makes it Industrial?

- Application
  - Process Control
  - System Isolation
  - Fan Isolation
  - Laboratories
  - Clean Rooms
  - Generator Rooms
  - Blast Protection
  - Tunnel Ventilation



What Makes it Industrial?

- System Conditions
  - Elevated or Frigid **Temperatures**
  - High **Pressures** or **Velocities**
  - Low Leakage Requirements (**Containment** of the Airstream)
  - **Corrosive** Airstream





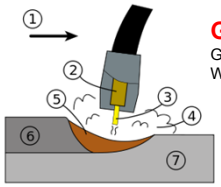
What Makes it Industrial?

- Construction
  - Thicker frames
  - Thicker blades
  - Larger axles
  - Materials of Construction
  - Stout linkage
  - Heavy Duty Bearings





And **WELDED** Connections



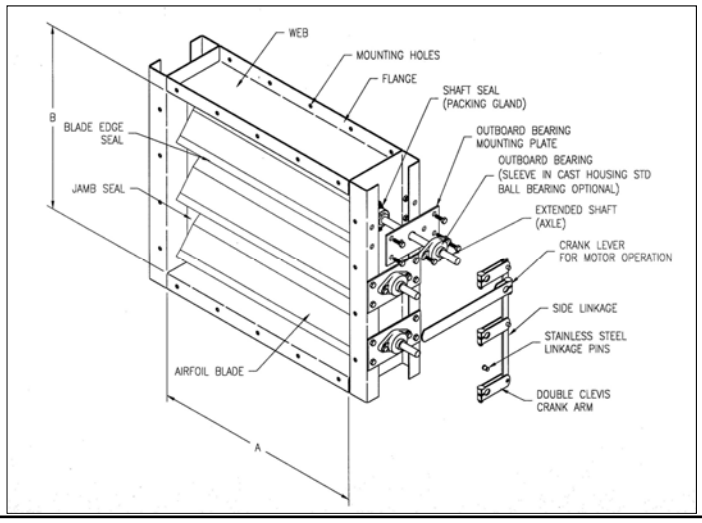
GMAW – Gas Metal Arc Welding

- **Fan Isolation**
  - Control Damper
  - Backdraft Damper
- **Data Centers**
  - Generator Intake/Exhaust
  - Cooling Towers
- **Laboratory Systems**
  - Bubble Tight Containment/Exhaust
- **Paint Systems**
  - Higher Velocities
  - Higher Temperatures
- **Pollution Control Systems**
  - High Temp
  - Low Leakage
  - FRP
- **Transit Tunnels!!!**
  - NFPA-130/502

What is the
Desired Damper Function?
Selection by Application



Identifying multiblade industrial damper "parts & pieces"



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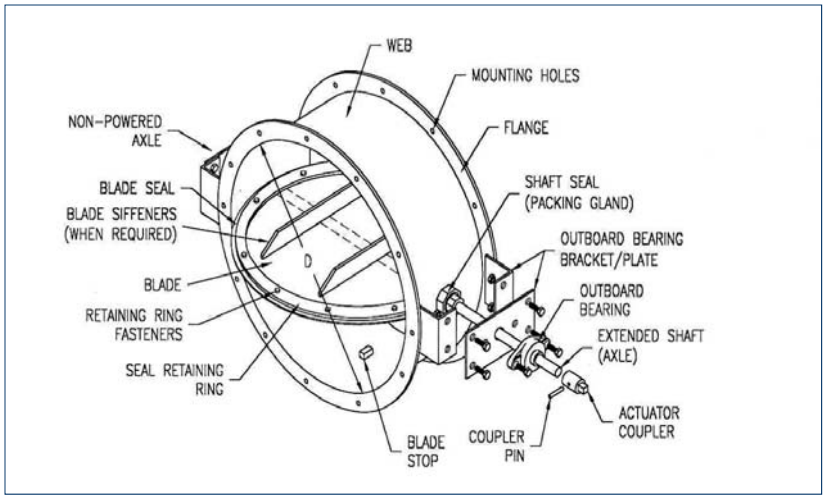

Identifying the "nuts & bolts" of Round industrial dampers

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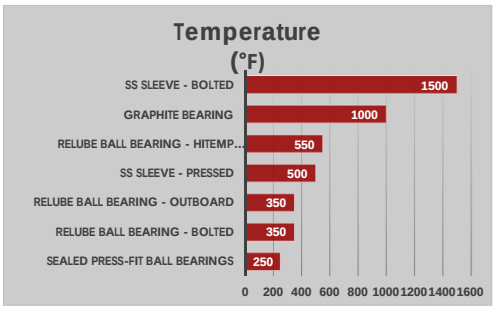


Industrial Bearing **Types**

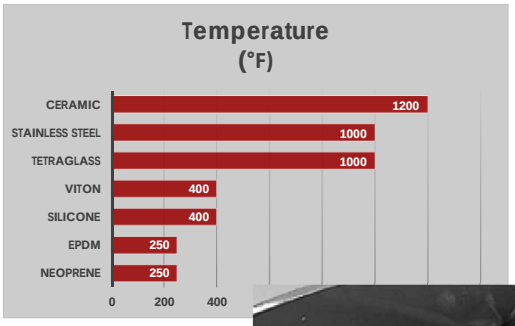


Graphite Insert



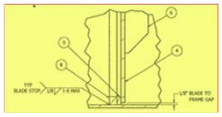
Sealed, Press-Fit Ball Bearing



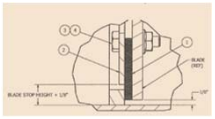


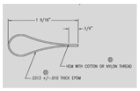
Blade Seal **Types**

CDR 82



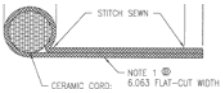
CDR 92







Stainless Steel



Industrial/Process Dampers Key Take-Aways

- Ask Your Customer..
  - What is the intended function of the damper in your system?
    - This will direct you to the proper damper "family"
  - Describe your intended Installation.
    - This will direct you to any design variations which may be needed and raise flags where space constraints are to be taken into consideration.
  - How will this damper be operated?
    - Sell dampers with factory-mounted actuation whenever possible!
    - Torque requirements not based on square footage like commercial products.
    - What is the Sequence of Operation?
  - Are you set up to "receive" this damper(s)?
    - Off-loading & Materials Handling to be addressed.
  - What is your expectation for the delivery date?
    - Manual process vs. automated, roll-formed process for commercial products.

Damper Actuators & Accessories

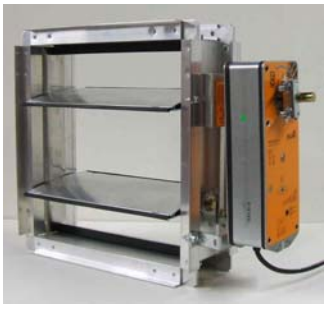
- Two-position, spring return (open or closed)
- Modulating (input control signal)
- NEMA 4 or Hazardous duty type
- Pneumatic
- Blade position indicator switches



Factory supplied actuator



Actuator Mounting (IN or OUT of airstream)



Actuator OUT of airstream



Actuator IN the airstream

Accessories

- Blade switch package
- Actuator with built-in switch



Switches indicate blade position OPEN/CLOSED







Installation Tips



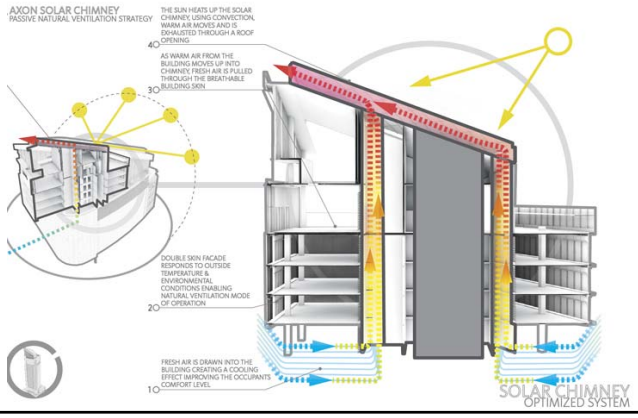
Outside wall louvers installed to prevent rain penetration.

Hi- Rise Roof Exhaust Shaft









Troubleshooting



Incorrect



Correct

Troubleshooting



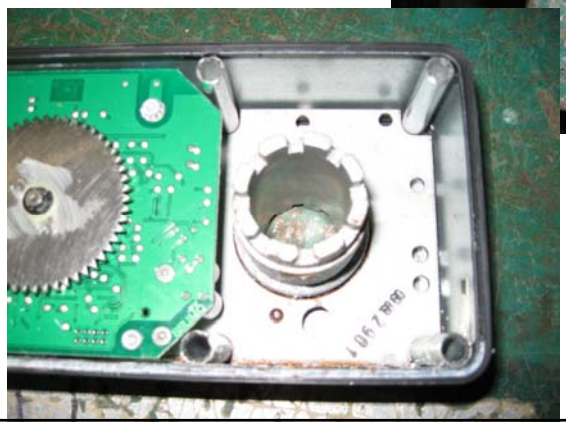
Troubleshooting



- Installed out of square
- Damper in good condition
- Compression seal popped out

Water damage





Do not store exposed outside

Troubleshooting



Poor structural support on outside air damper

Summary

- Control Damper selection starts with the application
- Parallel blades are better for mixing applications, OB better for maintaining directional flow
- Airfoil blades have lower pressure drop at higher velocities
- Exposed Linkage vs Concealed linkage
- Multisection dampers use jackshafting for larger openings
- Pressure drop and leakage are key to application performance – AMCA certifies this
- Look for AMCA certification on the manufacturer's website by product – or go to amca.org
- Commercial vs. Industrial Control dampers depend on T,P,V and environment