FOX Equipment

ies

- LOUVERS
- GUILLOTINES/SLIDE GATES
- WAFER/BUTTERFLY DAMPERS
- RADIAL VANES
- STACK ISOLATION DAMPERS
- DIVERTERS
- POPPETS
- METALLIC EXPANSION JOINTS
- NON-METALLIC EXPANSION JOINTS
- ELASTOMER EXPANSION JOINTS FOR PIPING AND DUCTING
- SILENCERS/NOISE CONTROL
- STACKS
- PERFORMANCE DUCTWORK
- SERVICE
- ENGINEERING & CONSULTING

LOUVER DAMPERS

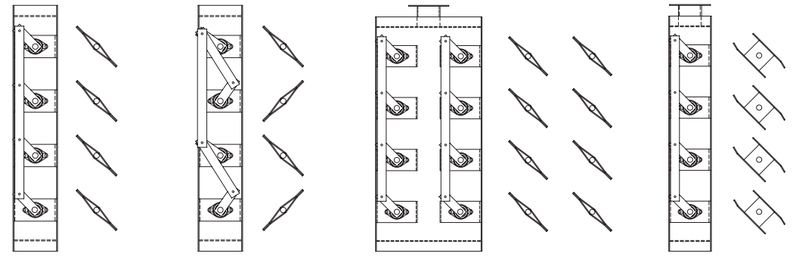
Louver dampers are used for process gas control and/or isolation, there are four standard types of louver dampers: Parallel, Opposed, Double and Tandem Louvers. Each louver has a row of blades that are used to control or isolate the gas flow of any process system.

Parallel Blade Louvers - Designed primarily for isolation applications, all blades rotate in the same direction when opening and closing. With the addition of blade seals this damper can achieve better than 99% shut off. Parallel blade louvers are also used on inlet boxes of large industrial fans to promote pre-spin to the in-rushing air, thus enhancing fan performance.

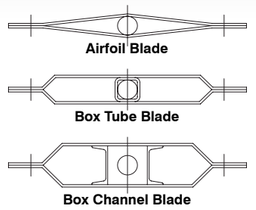
Opposed Blade Louvers - Designed for process gas control applications, the damper functions by rotating adjacent blades in opposite directions (one clockwise; the next blade counterclockwise). Operating the blades in this manner gradually decreases or increases the cross-sectional area between the blades during operation. This gradual change capability allows this louver to have good air control features as well.

Double Louvers - Designed to achieve zero leak isolation, double louvers function by pressurizing the space between the two louver dampers with "seal air". Seal air is supplied at a pressure higher than the pressure in the flue duct, creating a safe, positive pressure environment.

Tandem Louvers - Designed to achieve zero leak isolation in clean gas streams, tandem louvers function by pressurizing the space between the two louver blade skins with "seal air". Seal air is supplied at a pressure higher than the pressure in the flue duct, creating a safe, positive pressure environment. Tandem louvers are typically used when space is not available for a double louver.



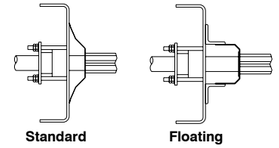
BLADES & AXLES



Fox Equipment's standard blade utilizes a dual skin airfoil shape to reduce pressure drop. Blade skins are bolted together and utilize slots so that each individual skin can grow at different rates when heated unevenly.

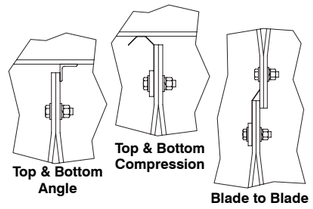
Fox Equipment uses many different styles of axles that span the full length of the blade. Blade and axles are engineered for each application and can be as simple as a pipe or as complex as fabricated trusses. Blade and axle selection is essential to your damper sealing capabilities.

JAMB SEALS



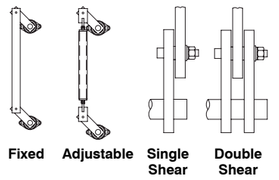
Fox Equipment has two different style jamb seals that are used on a regular basis. Jamb seals compress between the damper housing/frame and the end of the blade(s). The compression capabilities of this seal allows for thermal growth of the blade(s). Jamb seals are streamlined to minimize the accumulation of fly ash.

BLADE SEALS



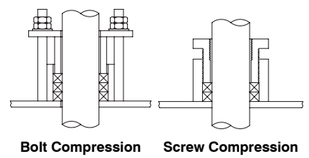
Fox Equipment compression seals are made from high quality Austenitic Stainless Steels and Nickel Alloys. Blade to frame seals are a sweeping compression allowing for the damper to seal in dirty environments. Blade to blade seals overlap the adjacent blade and have approximately 1-½" of flexibility.

LINKAGE



Fox Equipment linkage is designed to transmit at least 150% of the full rated stall torque of the actuator. Fox Equipment standard linkage is a heavy duty fixed style. Double shear, adjustable and thermal compensating linkage is also available.

PACKING GLANDS



Fox Equipment utilizes two different styles of packing glands to seal the shaft penetrations in the frame. We have a screw compression style and a bolted compression style. Both styles can be packed with different types of materials to meet each dampers specific application requirements.

GUILLOTINE/SLIDE GATE DAMPERS

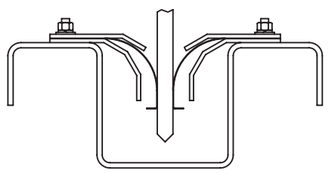
Guillotine / Slide Gate dampers are most commonly specified when isolation is the primary function of the damper. Guillotines / Slide Gates are classified in two styles: Low Leak and Zero Leak. Both styles are ideal for achieving a high degree of isolation while providing low pressure drop when the dampers are in the open position. Fox Equipment provides these dampers with five types of drives: Chain & Sprocket, Rack & Pinion, Pneumatic Cylinder, Electric Jackscrews or Manual Jackscrews. The design and mechanics of this style damper allow for ease of operation even in the most adverse duct build up conditions.

Low Leak - Primarily supplied for isolation purposes where low levels of leakage and pressure drop are required. Low leak applications include isolation for systems that function under negative pressure or require a tight shut-off to aid in the system's process, ie: shaking the bags in a large bag house.

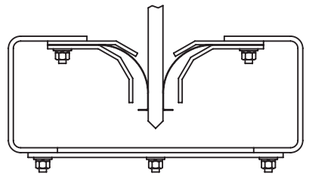
Zero Leak - Supplied when zero leak isolation is required. This is accomplished by pressurizing the seal air chamber that surrounds the blade edges. When compared to a double louver, a zero leak gate requires less seal air and flange to flange space, allowing it to be used in tight runs of duct work.

SEALS

Internally / Externally Replaceable Seals
Seals can be provided so that they can be replaced from inside the ductwork or from the outside of the ductwork. Smaller duct sizes require the use of externally replaceable seals, however, any ductwork with man doors can technically have internal replaceable seals. Seal location needs to be considered for ease of service and/or replacement.



Internally Replaceable Seal



Externally Replaceable Seal

SEALS *continued*

Structural Seals
Low leak guillotines / slide gates can be supplied with a structural seal made from the same material as the guillotine housing.

Compression Seals
Fox Equipment compression seals are made from high quality Austenitic Stainless Steels or Nickel Alloy materials. This seal has proven to provide long term sealing efficiency in the harshest environments. It also has the capability to conform to the shape of the blade. Seals can be supplied around the complete perimeter of the blade and with a seal air fan can achieve zero leakage. Fox Equipment has multiple standardized seal sizes so the same spares can be used on multiple guillotines.

DRIVE TYPE

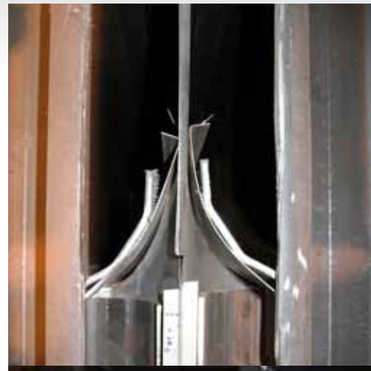
Fox Equipment guillotine / slide gate dampers are designed with drives that will move them in both the open and closed direction. Gravity is not used to drive the units open or closed. Therefore Fox Equipment can design these dampers to be installed in any position including Horizontal, Vertical, Side Draw, or Angled.

Chain & Sprocket
Fox Equipment uses long wall mining chain and heavy duty sprockets to drive our guillotines / slide gates. Long wall mining chain requires no grease and does not utilize pins. This is essential in providing a maintenance friendly heavy duty guillotine / slide gate. Chain systems are supplied with easy length adjustment mechanisms.

Rack & Pinion
Fox Equipment provides two (2) different styles of rack & pinion drive systems. The first style has an integral rack built into the blade which is a good option for smaller guillotines / slide gates below 8ft in size. The second style is a traveling pin rack which extends past the ambient frame and requires a significant clearance above the damper. A pin rack can be designed for any size guillotine / slide gate damper.

Cylinder
Pneumatic or hydraulic cylinders are also used on guillotine / slide gate dampers. This is the fastest actuation option for this type of damper.

Jackscrew
Fox Equipment can provide either Manual or Electric Jackscrew for operation. Both a Rising Stem or a Traveling Nut Style Jackscrew can be designed into this style damper.








Diverter Dampers
Used typically in gas turbine applications with heat recovery steam generators (HRSG), a diverter damper is primarily used for isolation purposes. Diverters are designed with one inlet and two outlets. The outlets are normally at right angles from one another and can never be closed at the same time. This system always allows for an escape route for the flue gas, therefore protecting any upstream equipment from bottlenecking. Diverters are supplied mainly in three different styles: Flap Diverter, Louver Diverter and Tee Diverter. All diverters can be supplied in low leak or zero leak applications.

Flap Diverter
Flap diverters pivot a large door 90 degrees to close off one of the two outlets. Since there is only one blade it is mechanically impossible to close off both outlets at the same time. Flap diverters main function is isolation, however, they are occasionally used for control. Typically flap diverters are internally insulated with a floating steel liner.

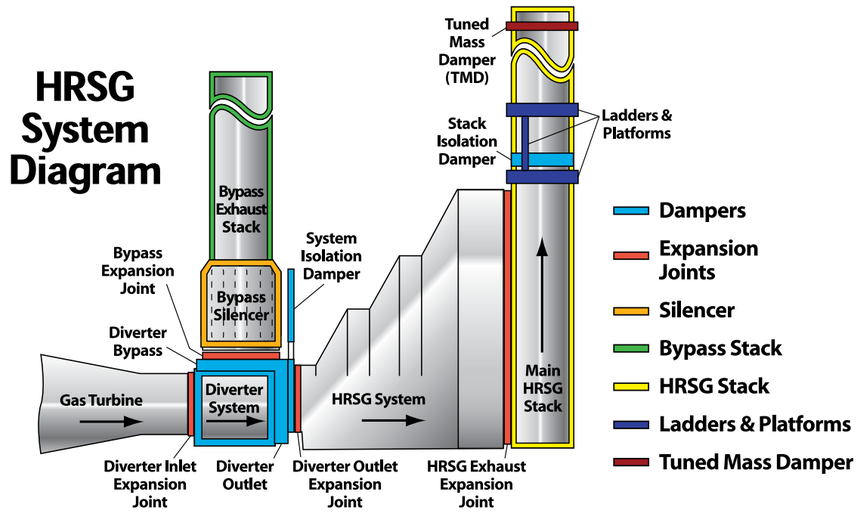
Louver Diverter
Louver diverters are fitted with a louver on both outlets. These louvers will be connected with linkage that will make it impossible for them both to close at the same time. The advantages of a louver diverter are significant improvement in control capability, and better thermal growth characteristics. (See the Louver section of this brochure for more details.) Typically louver diverters are internally insulated with a floating steel liner.

Tee Diverter
Tee diverters are typically supplied on WHRU systems. Tee diverters are supplied in round ducts with wafer dampers at both outlets. Tee dampers can also utilize multi-blade wafer dampers for better control. These wafers will be connected with linkage that will make it impossible for them both to close at the same time. Typically Tee diverters are externally insulated in the field by others.

Stack Isolation Damper
Stack isolation dampers provide accurate airflow and isolation at elevated temperatures. These dampers function to reduce the stack effect of a system when it is offline, and to protect ductwork from the elements, such as rain water. A stack closure damper is provided to slow HRSG component temperature decay rate by limiting convective heat loss through the HRSG and stack following gas turbine shutdowns.

Frame/Casing
Damper frame/casings are integral to the stack section and are capable of transmiting all dead loads and wind moment loads as calculated at location.

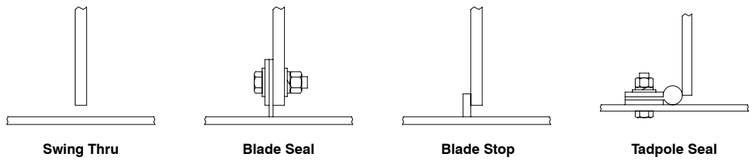
Blades
An HRSG stack damper has a blade assembly with self-relieving counter-weighted linkage design using opposed blade rotation. Actuator and linkage is configured to drive the blades open during normal operation.



Wafer / Butterfly Damper
Wafer / Butterfly dampers are used in round duct applications, with the typical function of simple isolation or system balancing. The advantages of this damper are the simplicity of design, quick closing capability, versatility and low cost.

Multi-Blade Wafer / Butterfly Damper - Often, better control is required than what can be achieve with a single blade wafer. Therefore, additional blades can be added to increase the control capabilities of the damper. These blades will function like an opposed blade louver.

Seals - Fox Equipment offers primarily four different seal variations.
Swing Thru – No Seal – The damper typically never closes and is used for system balancing.
Blade Seal – Seal is located on the blade and compresses against the frame to form the seal.
Blade Stop – A metallic seat/stop is located on the frame. The blade will rest against this stop in the close position.
Tadpole Seal – The tadpole is a flexible seal mounted to the frame that will form to the surface of the blade when it is closed.



Radial Vane Damper (VIV)
Radial Vane dampers provide additional flow control for fan inlets, and also provide pre-spin of the air into the fan. Starting the fan while the damper is in the closed position allows for a low horsepower startup. Fox Equipment supplies all radial vane dampers with a cantilevered blade design complete with two external bearings, eliminating the need for blade support and bearings in the gas stream. Fox Equipment also has a cantilevered conical design for FD fan applications.

Poppet Damper
Ideal for applications that require quick cycling time and tight shut-off, poppet dampers provide isolation capabilities for bag house applications and incineration systems. Poppet dampers are used for multi-directional airflow control. They are engineered to control the reverse gas flow, outlet flow, and bypass flow of gases, in turn enhancing filtration, eliminating gas starving and reducing bag wear.

EXPANSION JOINTS

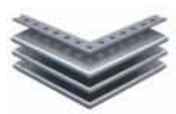
Expansion joints are flexible connectors in ducting and pipe systems, designed to provide stress relief by absorbing movement caused by thermal changes, vibrations and minor misalignment of adjoining ductwork or equipment.

Metal Expansion Joints - Designed with relatively thin gauge bellows (see photos) than compress or expand when the pressure is applied. They are designed to absorb the specific mechanical and thermal movements expected in the application.

The advantages and benefits of using metal expansion joints:

- Many designs available for the specific fit-up needs
- Extreme High temperatures
- High pressure capabilities
- Available in many corrosion resistant materials
- Can handle abrasive media

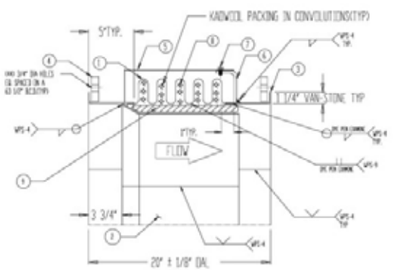
The performance of metal expansion joints is determined by the system design conditions, and by the selection of material. Material selection is made based on the pressure requirements, temperature and chemical capabilities. The proper selection of material can provide long-term performance for the expansion joints. Fox Equipment has the engineering expertise and experience to assist with this selection.


Single Miter Type


Camera Corners Type


Double Miter Type


Rounded Corners Type



Non-Metalic Expansion Joints

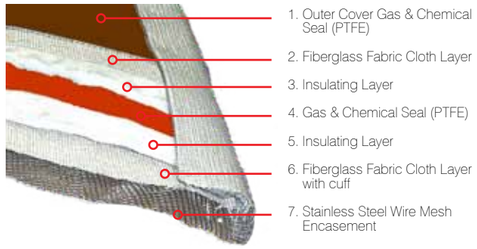
Since the early 1960's, the use of non-metallic expansion joints has continuously developed material technology for the design of expansion joints. Important factors must be considered when designing non-metallic expansion joints including: system design, operating temperatures, chemical resistance, pressure for belt reinforcement requirements, and thermal movements. Proper material selection and design are essential to provide long term performance of non-metallic expansion joints.

The advantages and benefits of using non-metallic expansion joints:

- High flexibility for concurrent movements
- Minimal overall face-to-face length
- Isolates vibration
- Lower cost to ship, install, and replace
- Corrosion resistant
- Insignificant spring forces

BELT MATERIAL/SERIES	TYPE	FLUE GAS TEMP (CONTINUOUS)		TYPICAL SERVICE CONDITIONS
		F°	C°	
EPDM	ELASTOMER	300	150	WET/DRY
VITON®	FLUOROELASTOMER (FKM)	400	205	WET/DRY
FOXFLEX 600	FLUOROPLASTIC (PTFE LAMINATE)	600	315	WET/DRY
FOXFLEX 850	FLUOROPLASTIC (PTFE LAMINATED COMPOSITE)	850	454	DRY
FOXFLEX 1100	FLUOROPLASTIC (PTFE LAMINATED COMPOSITE)	1,100	593	DRY
FOXFLEX EXTR	FLUOROPLASTIC (PTFE LAMINATED COMPOSITE)	1,200	650	DRY

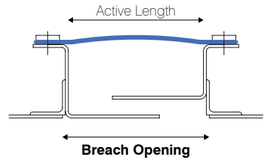
The performance of non-metallic expansion joints is determined by the flue duct system design conditions, and by the selection of material. Material selection is made based on the functional requirements, temperature and chemical capabilities. The engineering of materials can provide long-term performance for the expansion joints. Fox Equipment provides reinforced elastomers and PTFE laminated composites as the expansion joint "gas seal membrane".



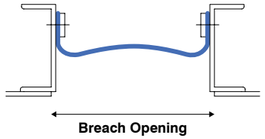
TECHNICAL DATA & TYPES

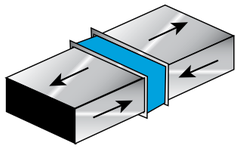
Type	Active Length	6"	9"	12"	16"
Flat Belt	Axial Compression	2"	3"	4"	6"
	Axial Extension	½"	½"	½"	½"
	Lateral	1 ¼"	2"	2 ¾"	3 ½"
	Breach Opening	6"	9"	12"	16"
Integrally Flanged U-Belt	Axial Compression	1 ½"	2 ¾"	3 ½"	5"
	Axial Extension	½"	½"	½"	½"
	Lateral	1"	1 ½"	2"	3"
	Breach Opening	5 ½"	8 ½"	11"	15"

"Flat Belt Design"
Expansion Joints

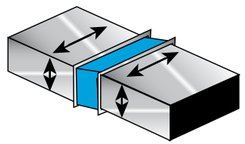


"U-Belt Design"
Expansion Joints

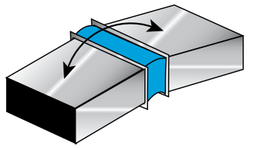




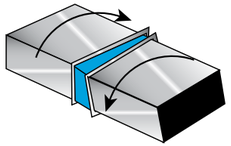
Axial Movement
(Compression & Extension)



Lateral Movement
(Alignment)

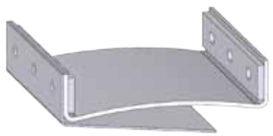


Angular Deflection
(Bending)



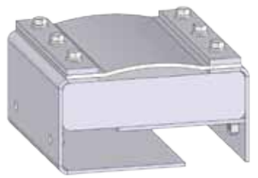
Torsional Deflection
(Twisting)

BASIC CONFIGURATIONS

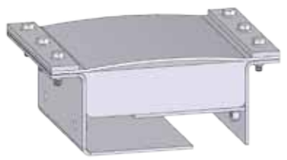


U-Belt w/Liner

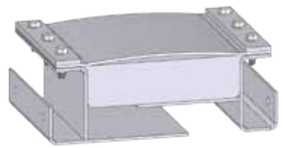
L Frame w/Liner



Inverted Z Frame w/Double Liner



Z Frame w/Double Liner



J Frame w/Double Baffle w/Double Liner

NON-METALIC EXPANSION JOINTS

STACKS & DUCT SYSTEMS

Fox Equipment's registered, professional engineers custom design stack and duct systems to the latest codes and standards for industry and commerce. Our engineers are active leaders in industry technical organizations and stay abreast of the latest building and construction codes. We use popular commercial design software as well as custom, proprietary software to optimize fluid flow, heat transfer, and structural design parameters.

The most common industrial stack is constructed of single wall steel. Common materials used for steel stacks include structural carbon steel, weathering carbon steel, and many alloy steels such as austenitic and duplex stainless steels. When acid loads exceed the corrosion resisting ability of stainless steels, high nickel alloys and fiber reinforced plastics (FRP) deserve consideration. These material selections are made considering lifetime maintenance, operating temperature, structural stability, and corrosion resistance. Corrosion and fatigue are the are the most common conditions contributing to steel stack failure.

The most effective way to combat corrosion in steel stacks is to choose alloy materials of construction that sufficiently resist the expected chemical attack. Alternately, heat retention can be an effective means to resist corrosion. Acid attack occurs when acid vapors condense on surfaces below the applicable acid dew point. Externally insulating such stack surfaces so that they remain safely above that dew point prevents corrosion. Cold spots occur inside an externally insulated single wall stack in locations where stiffeners, insulation supports, manways, test ports, and the like act as heat sinks through the insulation. These cold spots may experience more corrosion than the rest of the stack. These conditions give rise to the internally insulated dual wall stack consisting of an outer windscreen and an independent, insulated inner shell. The windscreen concept used in the dual wall stack can also be used to support one or more internal flues that would not be structurally stable on their own.

The effects of fatigue can appear in bolts, flanges, openings, and stiffeners. The most common cause of fatigue in steel stacks is vortex-induced motion. Wind flow around a bluff body develops a boundary layer such that the flow is zero near the surface of the body. When the flow separates from the body, a vortex is generated and a localized negative pressure results. The alternate shedding of these vortices is known as von Karman vortices named after the Hungarian-American mathematician who first described them. Today we combat fatigue in steel stacks by either eliminating the vortex shedding or by controlling the stack's response to the vortex generated forces.

STACKS & DUCT SYSTEMS

STACKS & DUCT SYSTEMS

In 1957 Englishmen Scruton and Walshe patented a method for avoiding wind-excited oscillations of structures with a circular cross-section. Their method is what we today refer to as helical strakes or spoilers. They work by redistributing the vortex forces over larger areas that are not diametrically opposed.

A stack's response to vibration can be controlled by manipulating its mass or its damping. By nature, steel stacks are very lightweight structures with very low inherent damping. The stiffness of a stack is measured by its natural frequency and may be increased by increasing its moment of inertia or by bracing. Damping is a measure of a structure's ability to absorb vibrational energy. Naturally, this absorption could occur in the flexibility of the foundation or in flanged connections. Today, Fox Equipment uses secondary vibrating systems called Tuned Mass Dampers (TMD) or Tuned Liquid Dampers (TLD) to add damping to a steel stack. Tuned damper systems consist of a mass added near the top of a stack and either coiled wire rope springs or liquid passing through a screen to absorb energy.

Duct systems require application of many of the same concepts as stacks except that their configuration, operating conditions, and support-expansion scenarios are more complicated. Ducts may operate at elevated pressure and may contain substantial dust loads. Support reactions are dependent upon the location and spans of fixed and sliding supports. The use of metal bellows as opposed to non-metal bellows expansion joints have a major impact on the magnitude of duct support reactions.

Noise Control

Noise control has become an integral part of the design process for industrial plant design. The need for noise abatement in the industrial market continues to increase due to governmental regulations and residential encroachment on previously secluded industrial sites. OEMs and engineering groups are increasingly dependent on suppliers for noise control solutions. Noise emissions from turbines and industrial fans are reduced using silencers custom designed for each application to meet the noise control requirements. For these applications Fox Equipment evaluates projects for customers and designs and fabricates custom industrial noise control solutions. Silencer internals are aerodynamically designed to minimize flow backpressure, and constructed of heavy gauge materials from carbon steel to stainless steel and designed to solve your unique noise control challenges.

By-pass silencers for turbine exhausts

In Bypass mode, silencers are used to reduce sound emissions through the bypass stack. With diverter damper, expansion joints and silencers included in the Fox Equipment offering, this completes the major portion of back end turbine exhaust diverter packages. Heat recovery packagers can look to Fox Equipment for coordination of the diverter system from flange to flange including Diverter, Silencer, Expansion Joints, Stack and accessories.

Silencer Design Options

Insert Baffle Silencers - An economical solution to many stack noise control applications, particularly when there is a need to improve existing installations or where stack dimensions are too large for a fully assembled silencer.

Tuned Dissipative Absorbers - A unique baffle design for applications where there are high levels of particulate in the gas path, or where there is a high tonal noise component and low pressure drop requirement.

Reactive "Packless" Silencers - Where applications do not permit absorptive media in the air stream, tuned chambered noise sections attenuate duct noise to acceptable levels.

At Forefront of Design

Baffle design has evolved over the past two decades to improve longevity and durability of silencers often exposed to high temperatures and turbulent environments. Fox Equipment uses the latest design, materials and fabrication techniques to withstand these environments.

- Acoustic medias from fiberglass for low temperature applications, to mineral wool, ceramic and basalt media carefully selected and protected for optimal performance in high temperature applications.
- For high temperature systems, acoustically transparent high thread count stainless steel mesh is used for erosion protection. Stainless steel mesh provides more durability and protection than fiberglass cloth materials commonly used for this purpose.
- Materials of construction include carbon steels, 400 and 300 series stainless steels with appropriate weld procedures.
- Our proprietary acoustical prediction programs for hot gas applications and years of application experience are used on every project. We can supply parallel baffle or annular concentric ring designs to meet your acoustic performance requirements.

With our relentless commitment to the consistent manufacturing of quality products, Fox Equipment provides damper, expansion joint and silencer solutions that exceed our customers' expectations. From design and engineering, to the materials and processes that create the products, our commitment to quality is steady. Our worldwide manufacturing partners are familiar with the Fox name and the reputation of quality and service that precedes it. With over 500,000 square feet of manufacturing space, and over 200 employees at our disposal, we can react quickly and efficiently to your requirements while providing unparalleled quality. Total Commitment, Total quality, Total Service... Fox Equipment is Quality Through Engineering.

Fox Equipment provides a wide range of dampers, expansion joints and silencers throughout the global market for on and offshore applications such as:

- Conventional Power Plants - Coal, Oil, Gas
- Gas Turbine & Heat Recovery
- Cement & Lime Plants
- Pulp & Paper Industry
- Petrochemical Industry
- Steel Mills
- Industrial HVAC & Wind Tunnels
- Smeltering Plants (zinc, copper, aluminum)
- Desulphurization (wet & dry)
- Refuse Incinerators
- Chimney & Stacks
- Dust Removal Equipment
- Industrial Furnaces
- Fan & Ventilation
- RTO (Regenerative Thermal Oxidizers)
- Waste Water

PRODUCTS

- **» Louver Dampers**
- **» Guillotine / Slide Gate Dampers**
- **» Wafer / Butterfly Dampers**
- **» Radial Vane Dampers**
- **» Stack Isolation Dampers**
- **» Diverters**
- **» Poppet Dampers**
- **» Metalic Expansion Joints**
- **» Non-Metalic Expansion Joints**
- **» Elastomer Expansion Joints for Piping and Ducting**
- **» Silencers / Noise Control**
- **» Stacks**
- **» Performance Ductwork**
- **» Service**
- **» Engineering & Consulting**

Benefits

- Advance Engineering & Design
- Financially Stable
- Worldwide Capability
- CWI (Certified Welding Inspector) on Staff

Service

- ISO9001 Compliant
- Field Service - Survey, Repair, Replacement
- Equipment Testing

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