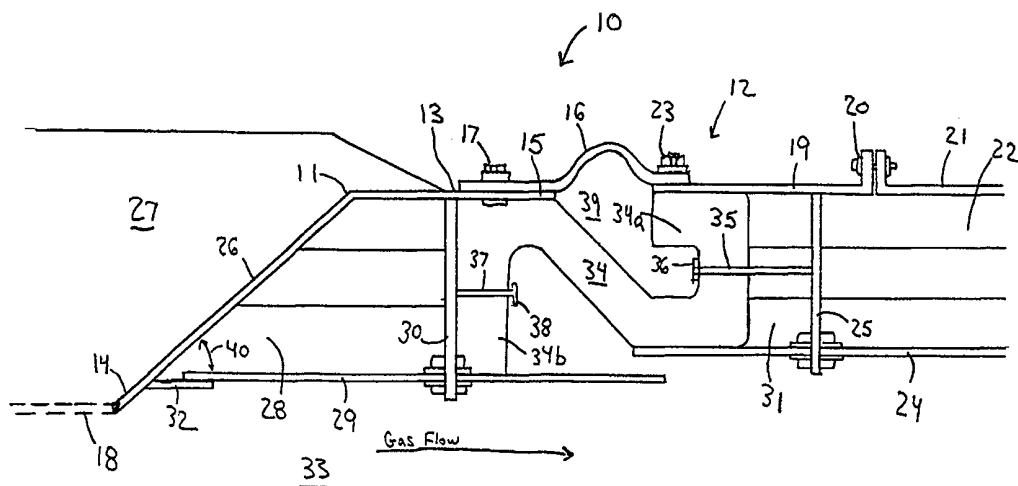




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(54) Title: EXPANSION JOINT WITH THERMAL TRANSITION CONNECTOR



(57) Abstract

A modified expansion joint to provide a transition from one conduit to an adjacent conduit. The expansion joint includes a flexible coupling member and an angled transition leg having insulation on both sides thereof. The flexible coupling member takes up any variations in dimensional differences between the adjacent conduits. The transition leg provides a gradual thermal transition from a hot upstream conduit to a downstream conduit at a lower exterior surface temperature.

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EXPANSION JOINT WITH THERMAL TRANSITION CONNECTOR

Cross-Reference To Related Application

This application claims the benefit of the priority of provisional U.S.
5 application serial no. 60/095,971, filed 08/10/98, entitled "EXPANSION JOINT
WITH THERMAL TRANSITION CONNECTOR" and assigned to a common
assignee.

Background Of The Invention

10 1. Field of the Invention.

The present invention relates to systems for transporting fluids from one
location to another. More particularly, the present invention relates to an
apparatus to accommodate variations in component dimensions associated with
temperature changes. Still more particularly, the present invention relates to
15 expansion joints that connect fluid transport devices having fluids therein at
significantly different temperatures. The present invention is an expansion joint
that accommodates dimensional changes between adjacent fluid transport
devices.

20 2. Description of the Prior Art.

Expansion joints are used in many industries, including, but not limited to,
the power generating industry. Expansion joints allow the relative movement of
conduits (ducting, piping, etc.) used to control the flow of gases from one location
to another. In the power generating industry in particular, the gases that are
25 generated and that are to be diverted are very hot as they exit a turbine
associated with a primary power generator. The hot turbine gases may either be
exhausted directly via an exhaust stack or they may be directed to a secondary
power generator. The secondary power generator may be used to recover a
substantial portion of the thermal energy of the turbine exhaust gases. The gases
30 generated by the turbine rise rapidly and place significant thermal stress on all
components of a system in contact with those very hot gases. The expansion

joint is designed to absorb thermal expansion in the exhaust ducting due to temperature changes. It is also designed to alleviate that thermal stress that comes from the transition from a "hot" fluid temperature zone to a "cold" fluid temperature zone. The expansion joint must therefore be designed specifically to
5 accommodate a combination of all the above-noted duties.

U.S. Patent No. 5,658,024 issued to **Bachmann et al.** describes the importance of the proper design of an expansion joint. The background section of the **Bachmann** patent is incorporated herein by reference. The **Bachmann** patent describes a new expansion joint design that eases the stress of any of the
10 transitions associated with the connection between hot conduits having external insulation (a hot frame) and cold conduits having internal insulation (a cold frame). Of course, this can mean any transition wherein the temperature at the interior surface of one conduit is substantially different from the temperature at the exterior surface of an adjacent conduit.

15 In the power generating industry for example, it may be of importance to ensure that the exterior surface of a downstream conduit does not exceed a predetermined temperature. In some circumstances that temperature may be 65°C or less. At the same time, the interior surface of an adjacent upstream conduit in direct contact with the hot fluid being transported may be at 600°C or
20 more. The prior **Bachmann** expansion joint provides one way of maintaining structural integrity in the coupling of the two adjacent conduits while also accounting for differentials in axial and lateral movement of those conduits as a function of temperature differentials. In particular, the prior **Bachmann** expansion joint includes a flexible material as an intermediary link between one end of the
25 joint itself and the downstream conduit. The other end of the expansion joint is rigidly connected to the upstream conduit. A channel formed of one or more metal parts links the two ends of the expansion joint together. That channel includes a mouth within which fluid dwells.

The channeled **Bachmann** joint is designed with angled walls to form the
30 mouth for capturing flowing fluid. Those angled walls are also intended to provide a geometry that is more tolerant of thermal stresses. Under most conditions, the

angled-walls channel design is suitable to reduce sufficiently to acceptable levels the thermal stresses experienced in fluid flow conduits. However, the ability of the expansion joint element to perform at elevated temperatures is limited and, under some conditions, particularly those in which fluid temperatures are very high (600°C or more), it is advantageous for the exterior of an adjacent conduit to be at ambient temperature.

As noted, the prior **Bachmann** expansion joint includes a channeled section. That channeled section includes a metal-to-metal connection at its exterior surface, proximate to the exterior surface of the downstream conduit. The fluid within the mouth of the channeled section remains very hot. At the same time, the temperature at the exterior of the adjacent downstream internally-insulated conduit will be approximately at ambient. The flexible coupling that connects the exterior of the channeled section to the exterior of the downstream conduit is therefore subject to significant thermal stress due to the significant thermal gradient between its two contact points. Specifically, since the fluid within the mouth of the channeled section remains very hot, that end of the flexible coupling is also very hot. In fact, the temperature may exceed the temperature limitations of the flexible coupling material. Further, at transition areas of the channel, such as at the leg-to-base interfaces, there remains substantial thermal stress. That stress may cause weakening or failure of the expansion joint and, together with the flexible coupling's temperature limitation may cause potentially significant development of hazardous conditions caused by escaping fluid. Repair and maintenance costs may also be significant.

Therefore, what is needed is an expansion joint that accommodates differences in dimensional changes in adjacent fluid conduits. What is also needed is an expansion joint that is formed so that it is subject to minimal thermal distortion of the type that would cause its failure. Further, what is needed is an expansion joint design in which both ends of the expansion coupling are essentially at ambient temperature so as to ensure longevity of that coupling.

Summary Of The Invention

It is an object of the present invention to provide an expansion joint that accommodates differences in dimensional changes in adjacent fluid conduits. It is also an object of the present invention to provide an expansion joint that is
5 formed so that it is subject to minimal thermal distortion of the type that would otherwise cause its failure. Further, it is an object of the present invention to provide an expansion joint design in which both ends of the expansion coupling are essentially at ambient temperature so as to ensure longevity of that coupling.

These and other objects of the present invention are achieved by providing
10 a modified expansion joint design that includes a single angled transition leg. The single angled transition leg is coupled between an upstream conduit and an outlet frame. The outlet frame is connected to a downstream conduit by way of the same sort of flexible coupling described in the prior **Bachmann** patent. The length and specific angle of the transition leg may be varied as a function of
15 operating conditions and dimensional constraints associated with the particular fluid transfer system. Insulative material is applied to both sides of the transition leg. The insulative material acts to isolate the transition leg from contact with the hot fluid passing through the upstream and downstream conduits. This isolation allows a gradual cooling of the transition leg from a temperature that is
20 substantially the same as the temperature at the interior of the hot conduit to a temperature that is substantially the same as the exterior surface of the downstream conduit. The insulative material accommodates expansion of the transition leg, which expansion tends to be radial into the insulative material and which varies with the change in temperature of the transition leg. Although
25 thermal transition legs have been applied in other limited situations, none has been coupled to a flexible material in the way noted so as to provide for a thermally effective expansion joint. The prior **Bachmann** design teaches away from that type of arrangement by permitting the temperature variations of the flexible coupling noted, which variations may exceed the temperature limitations
30 of that coupling, particularly when the channel is subjected to increasingly higher fluid temperatures.

There are several apparent benefits from the use of a thermal transition leg in conjunction with the flexible coupling to create the expansion joint of the present invention. First, the elimination of the channel of the prior expansion joint reduces fluid turbulence caused by the mouth transition. Second, thermal stresses associated with the channel legs and base of the prior design are eliminated. Finally, the new expansion joint of the present invention may be used to replace bellows joints that have been used in certain systems. Bellows joints are designed to establish a transition between adjacent conduits that may be subject to differing thermal stresses. Unfortunately, the prior metal bellows are subject to the same thermal distortions developed in any expansion joint. As operating temperatures continue to increase, failure of those metal bellows becomes increasingly likely due to fatigue. The modified expansion joint of the present invention is designed to perform the same task of transitioning from one conduit to another. It does so structurally as well as thermally and is therefore a suitable replacement for a metal bellows in many instances.

These and other advantages of the present invention will become more apparent upon review of the following detailed description and the accompanying drawing.

Brief Description Of The Drawing

FIG. 1 is a simplified cross-sectional elevation view of a modified expansion joint of the present invention.

Detailed Description Of The Preferred Embodiment Of The Invention

A modified expansion joint **10** of the present invention is illustrated in Fig. 1. The expansion joint includes a transition leg **11** and a downstream connector **12**. The transition leg **11** includes a first end **13** and a second end **14**. The first end **13** includes a connector leg **15** that is connected to a flexible expansion material **16** of connector **12**, preferably by first bolting means **17**. The second end **14** of leg **11** is coupled to an upstream conduit **18**, preferably by welding. The upstream conduit **18** may be, for example, a turbine conduit.

The downstream connector **12** includes the flexible expansion material **16**, and a coupling plate **19**. A second bolting means **20** connects the coupling plate **19** to a downstream conduit **21** having interior conduit insulation **22**. A third bolting means **23** couples the flexible material **16** to the plate **19**. Interior liner **24** is preferably a bridge panel that captures insulation **22** therein by means of one or more studs such as stud **25**.

The only direct connection between the transition leg **11** and the downstream connector **12** is the flexible material **16**. The flexible material **16** is preferably refractory, ceramic, or high-temperature insulation material. It is the flexible material **16** that is free to move in order to accommodate any change in dimensional characteristics of the transition leg **11**. However, the transition leg **11** is insulated in a manner to be described herein such that the temperature of the flexible coupling material **16** is substantially the same at the contact points associated with bolting means **17** and **23**.

The transition leg **11** includes an angled portion **26** that is surrounded by an exterior insulative transition material **27** and an interior insulative transition material **28**. It is the combination of transition materials **27** and **28** that ensures the temperature of the angled portion **26** of the transition leg **11** will cool in a gradual and uniform way from the second end **14** to the connector leg **15**. Exterior insulative material **27** may be minimally coupled to the transition leg **11** while interior insulative material **28** is preferably captured by means of a transition liner **29** that is connected to the transition leg **11** by one or more of a transition liner support stud **30**. Shelf **32** is tacked to end **14** and it provides a support for liner **29** to expand on to as the temperature of the fluid within space **33** increases.

Angled portion **26** may be of any suitable length. Its length is a function of the temperatures involved as well as the insulation K value required to ensure that the temperature of leg **11** at end **13** is substantially equivalent to the temperature of plate **19**. Preferably, angle **40** of angled section **26** is about 15° to about 25° from the base of liner **29**. However, it is to be understood that that may be modified as a function of specific design parameters.

A connector insulative material **31** operates as a transition insulator between the downstream connector **12** and insulative material **22** of conduit **21**. A first end **34a** of insulative material **34** is coupled to connector insulative material **31** by way of one or more studs such as stud **35** that is connected to stud **25**.

- 5 Stud **35** is preferably used to capture material **34** using speed clips **36**. Similarly, stud **37** and speed clips **38** connect a second end **34b** of material **34** to stud **30**. Material **34** acts as a dome seal for thermal and acoustic insulation purposes in regard to space **39**. Insulative materials **22**, **28**, and **31** may be formed of a suitable block or blanket insulative composition of fairly high quality and K value.
- 10 Material **34** is preferably a blanket insulative material also with high K value. Exterior insulative material **27** may be of lower quality and lower K value than that employed for the other insulative components. However, it is to be understood that particular insulative qualities and values will be dependent upon the particular operating conditions within space **33** and the desired temperatures at the exterior
- 15 of flexible material **16**.

It can be seen that the liners **24** and **29**, and leg **11** are all arranged and coupled such that thermal expansion is accommodated by way of the particular insulative material adjacent thereto. Additionally, the flexible material **16** permits movement of the entire hotter upstream side of the joint **10** upward without effect

20 on the positioning of the downstream section of the joint **10**. This design permits the user to choose from a wide array of materials to create flexible material **16** without concern of thermal degradation in that the application is a benign one.

Although the present invention has been described and illustrated with specific reference to certain detailed designs, it will be apparent to those skilled in

25 this field that alternative embodiments will achieve the same results without deviating from the basic concept of the invention. All such embodiments and their equivalents are deemed to be within the scope of the invention as set out in the description.

We Claim:

1. An expansion joint to provide a coupling between: i) a first conduit capable of transporting a fluid and having external insulation of a certain thickness thereon; and ii) a second conduit capable of transporting the fluid, the expansion joint comprising:
- 5
- a. a transition leg couplable to the first conduit, said transition leg having an angled portion with a first end for coupling to the first conduit and a second end fixed to a connector leg thereof;
 - b. a connector frame couplable to the second conduit; and
 - 10 c. a flexible connector connected to said connector leg and for connecting said transition leg to said connector frame,
- wherein said angled portion of said transition leg extends at an angle away from said connector leg toward the first conduit.
- 15 2. The expansion joint as claimed in **Claim 1** wherein said angled portion of said transition leg has an exterior face and an interior face, wherein said exterior face is designed to be in contact with the exterior insulation of the first conduit.
3. The expansion joint as claimed in **Claim 2** further comprising an interior transition insulation material designed to be in contact with said interior face of said angled portion.
- 20
4. The expansion joint as claimed in **Claim 3** further comprising a liner for retaining said interior transition insulation material adjacent to said interior face of said angled portion.
- 25
5. The expansion joint as claimed in **Claim 4** wherein said liner includes a first end and a second end, said transition leg further comprising a liner shelf coupled to said first end of said angled portion for slidably retaining said first end of said liner thereon as the expansion joint expands and contracts.
- 30

6. The expansion joint as claimed in **Claim 5** wherein said connector frame includes a first end coupled to said flexible connector, a second end couplable to the second conduit, and a connector plate therebetween having an interior face and an exterior face, said expansion joint further comprising a connector
5 insulative material adjacent to said interior face of said connector plate.
7. The expansion joint as claimed in **Claim 6** further comprising a transition insulative material retained within a space between said transition leg and said connector frame.
10
8. The expansion joint as claimed in **Claim 7** wherein said flexible connector is a high-temperature insulation material selected from the group consisting of refractory or ceramic insulation materials.
- 15 9. The expansion joint as claimed in **Claim 1** wherein said angled portion of said transition leg is sized and angled such that its temperature at said first end thereof is substantially the same as the first temperature in the first conduit and near ambient temperature at said second end thereof.
- 20 10. The expansion joint as claimed in **Claim 9** wherein said angled portion is angled at an angle of about 15° to about 25° from a plane defined by said connector leg of said transition leg.

