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INSULATED SLIP-JOINT DEVICE

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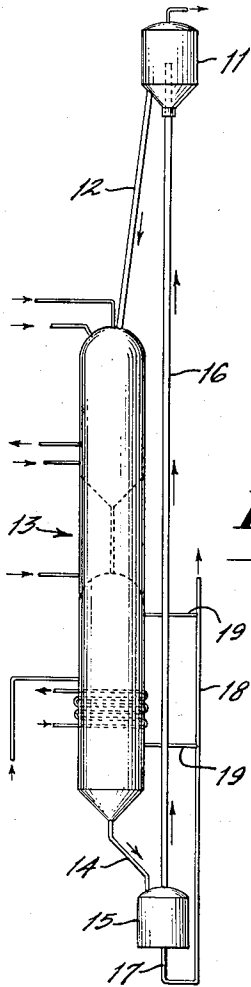


Fig. 1

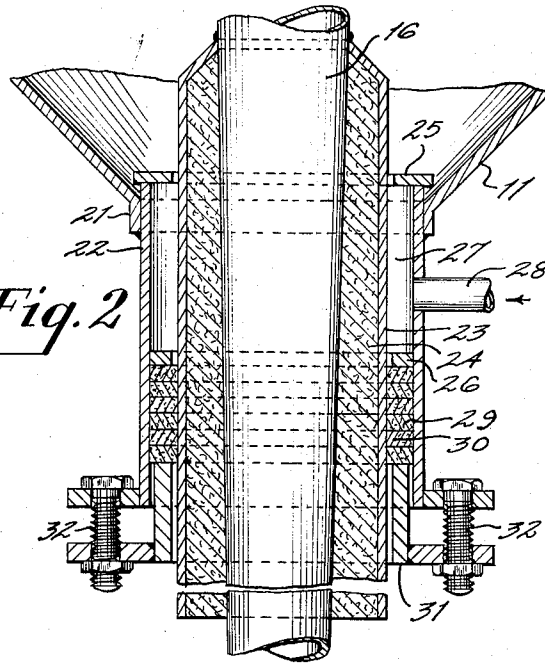


Fig. 2

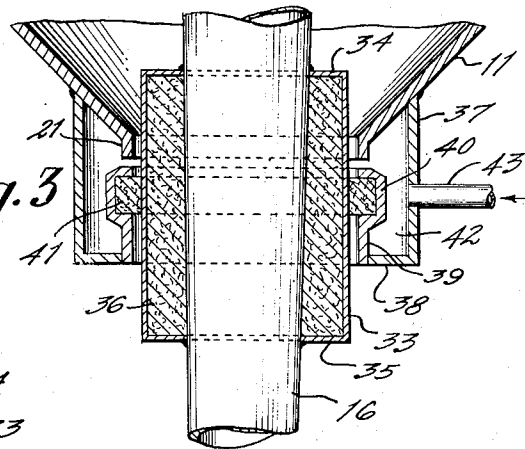


Fig. 3

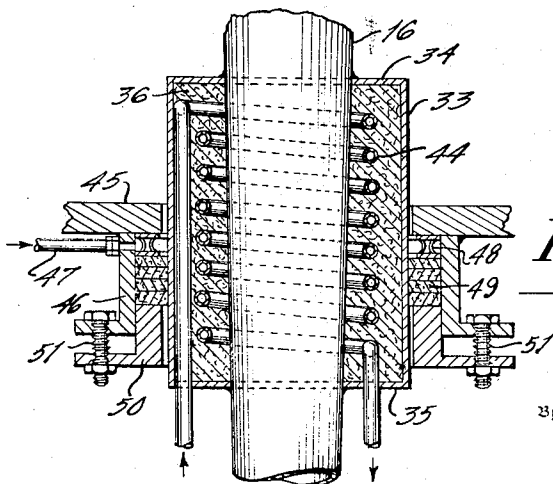


Fig. 4

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INSULATED SLIP-JOINT DEVICE

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This invention relates to an insulated slip-joint device for use in connecting a pipe line to a vessel, and particularly to such use in systems requiring a long distance transfer of particulate solid material at relatively high temperatures. More particularly, the invention relates to an insulated slip-joint device adapted to connect a tapered portion of an elongated pipe line to a vessel wall in such manner as to permit free longitudinal expansion or contraction of the pipe as a result of severe temperature changes, while maintaining the joint surfaces substantially free of particles of transferred solid material and at lower temperatures, in order to avoid serious abrasion of the slipping surfaces.

The invention, in general, is applicable to various points of connection between vessels and conduits employed in the chemical processing and petroleum refining arts. It is of particular advantage, for example, in connecting the gas-lift pipe extending between the upper and the lower lift hoppers of a system such as that described in the article entitled "Houdri-flow: New Design in Catalytic Cracking" appearing at page 78 of the January 13, 1949, issue of the "Oil and Gas Journal," or in connecting the catalyst transfer lines and vessels of fluid catalytic cracking systems. In such systems it is often necessary to pass particulate solid material, such as catalyst in granular or powdered form, in admixture with gases or vapors between vessels which may be separated by as much as several hundred feet. Since the vessels are usually rigidly supported on an extensive structural frame-work, provision is required in the way of expansion-joints, slip-joints, etc. for accommodating the longitudinal expansion and contraction of the connecting conduits during temperature changes. Although the invention is of general application, it will hereinafter for the purpose of illustration be particularly described in connection with a gas lift pipe of the type referred to in the aforementioned article. In the gas lift of that design, granular catalyst, after passing downwardly as a moving bed from an upper lift hopper through the treating or gas-solids contact section of the system, is discharged into a lower lift hopper surrounding the lower end of the lift pipe, from which point it is transported by means of a stream of lift gas, which may be flue gas from the kiln of the treating section, through the vertical lift pipe back into the upper lift hopper to complete a cycle of catalyst flow. In present commercial practice in large scale units the lift pipe may be 150 to 250 feet in length and may be maintained at temperatures in the range of 850 to 1200° F.

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In such ranges of pipe length and temperature the problem of accommodating differential expansion between the rigidly supported vessels and their connecting conduits is obviously acute, and provision must be made for a possible expansion of 20-25 inches. While various slip-joint devices are available in the art, none have been considered suitable for use under severe conditions of temperature change and elongation, especially in an atmosphere of abrasive material, such as the catalyst fines that may be found in the region surrounding the lift pipe in the upper lift hopper. The problem is accentuated when the lift pipe is adapted to provide a gradual decrease in lift gas velocity, as by gradually increasing its diameter for all or a portion of its length. In such case, the opposed surfaces of a slip-joint having a cylindrical zone of contact would separate during a period of expansion and tend to bind during a period of contraction. The present invention is especially effective in overcoming the difficulties arising in the latter case.

In accordance with the invention, the longitudinal expansion and contraction of the lift pipe is accommodated by a packed joint, such as a stuffing-box, or any other suitable packing arrangement that will provide a fluid-tight seal between the lift pipe and the vessel wall. A safeguard against deterioration of the joint packing by reason of the high temperatures to which the lift pipe and the vessel are subjected is obtained by the provision of means for insulating the joint packing from the lift pipe and, if necessary, dissipating a portion of the heat by indirect heat exchange with a fluid medium circulating through the critical heat zone. Injury to the contacting surfaces of the slip-joint, and the consequent destruction of the fluid seal, from the abrasive action of catalyst fines or other foreign solid particles infiltrating into the joint from the interior of the vessel is avoided by introducing gas, such as steam, between the opposed slipping surfaces to form a continuous bleed into the vessel chamber sufficient to clear the joint of such foreign matter. If the lift pipe is to be tapered instead of cylindrical, the aforementioned disadvantage of having opposed non-parallel joint surfaces is obviated by constructing the insulated covering surrounding the lift pipe in the region of the joint so that its outer surface is parallel to the axis of movement. The bleed gas may be injected directly into the joint from an external source, or it may be introduced therein by discharge from a chamber surrounding the joint through which a fluid heat exchange medium is circulated, in which case the latter

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serves the double purpose of exercising a temperature control and of flushing or cleaning the joint.

For a fuller understanding of the invention reference may be had to the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is a schematic view, in elevation, of a catalytic cracking system employing a gas lift in which the present invention may be employed.

Fig. 2 is an enlarged sectional view of the slip-joint at the upper end of the lift pipe connecting it to the upper lift hopper.

Fig. 3 is a modification of the slip-joint showing the use of a fluid heat exchange medium on the vessel side of the joint; and

Fig. 4 is another modification of the slip-joint showing the use of a fluid heat exchange medium on the lift pipe side of the joint.

Referring to Fig. 1 of the drawing, there is shown a schematic arrangement of a catalytic cracking system involving the cyclic flow of granular catalytic material between vertically spaced hoppers. The catalyst flows downwardly by gravity flow from the upper hopper through a treating section of the system to the lower hopper, and is returned to the upper hopper by conveyance in a gas stream through a lift-pipe section of the system.

Summarizing, briefly, the description given in the cited article, catalyst is withdrawn from the bottom of the upper lift hopper 11 through a seal leg 12 which passes the catalyst downwardly into a combined reactor-regenerator, generally indicated by the numeral 13. The catalyst passes by gravity flow in a moving bed downwardly through the vessel 13, and is withdrawn in regenerated condition from the bottom thereof through a seal leg 14 which passes the catalyst downwardly into the lower lift hopper 15. A vertical lift pipe 16, preferably tapered to provide increased flow area at its upper end, connects the upper and lower lift hoppers 11 and 15, respectively. A continuous stream of lift gas is introduced into an engagement zone within the lower lift hopper 15, as through inlet 17, wherein the catalyst is engaged by the lift gas and conveyed upwardly through the lift pipe 16 into the upper lift hopper 11, the catalyst being separated from the lift gas in the upper hopper and subsequently recycled through the system. For the purposes of illustration, the lift gas is shown as being supplied to the inlet line 17 from the flue line 18 which receives flue gas from the regenerator section of the vessel 13 through outlets 19. It is to be understood, however, that other means for introducing lift gas into the lower lift hopper, and other lift gases, such as air, steam, hydrocarbons etc. may be employed as the lift medium.

In view of the length of lift pipe required in large-scale commercial operations, and of the high temperatures commonly employed, allowance must be made in the system for longitudinal expansion and contraction of the catalyst transfer lines. The lift pipe extends between hoppers which are fixedly supported on a rigid framework, and is therefore subject to a considerable amount of elongation and contraction. While accommodation for the variations in lift pipe length may be made at either end of the lift pipe or at some intermediate point, a preferred arrangement is to provide for such expansion and contraction at the point where the upper end of the lift pipe enters the upper lift hopper. Because of the

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scale to which the schematic illustration is drawn, it has not been possible to show any details of the slip-joint in the lower conical head of hopper 11 in Fig. 1. A detailed illustration of the slip-joint and its association with the hopper 11 and the lift pipe 16 is clearly shown in the sectional view of Fig. 2.

Referring to Fig. 2, the fragmentary lower conical portion of hopper 11 is shown as terminating in a short cylindrical neck portion 21, providing an opening in the lower end of the hopper of substantially greater diameter than the diameter of the upper end of the lift pipe 16. A flanged stuffing-box housing 22 extends within the opening in the lower end of hopper 11 and is secured, as by welding, to the neck portion 21. The lift pipe 16 passes centrally through the housing 22 and terminates well within the upper lift hopper. The portion of lift pipe 16 adjacent to and passing through the hopper opening is provided with a skirt-like sleeve member 23 turned inwardly at its upper end and rigidly secured to the outer surface of the lift pipe. The sleeve 23 is cylindrical in shape and is arranged so that its axis is coincident with the axes of lift pipe 16 and the stuffing-box housing 22.

The annular space between the cylindrical sleeve 23 and the tapered lift pipe 16 is filled with a suitable insulating material 24, so that, despite the high temperature of the lift pipe, the outer surfaces of sleeve 23 may be maintained at a temperature that will not be injurious to the packing material used in providing a fluid-tight seal in the slip-joint. A flat ring member 25 is secured to the upper end of housing 22, surrounding the sleeve 23 and substantially closing one end of the annular space formed between the housing and the sleeve. The opening in ring 25 is slightly larger than the sleeve 23, so that the latter may move freely through the opening. A ring member 26 is secured to the inner wall of housing 22 to divide the annular space between the housing and the sleeve into an upper chamber 27, into which steam may be introduced through inlet 28, and a lower chamber 29 for receiving the joint packing 30. Ring member 26 is slightly larger than the sleeve 23, so that the latter may move freely through the ring. A packing gland 31 fits within the open lower end of housing 22, both members being provided with the usual flanges and flange bolts 32 for compressing the joint packing 30 sufficiently to obtain the necessary seal.

Because of the accumulation of granular catalyst in the lower portion of hopper 11, and especially an accumulation of minute particles or fines which are unavoidably produced by attrition as a result of continuously circulating the catalyst through the system, there is a tendency for the fine catalyst particles to infiltrate into the joint. The fine solid particles are injurious, to the opposed joint surfaces, eventually destroying the fluid-tight seal. By introducing a gas, such as steam, which is compatible with the gas or vapor within the hopper 11, into the chamber 27 at a rate sufficient to provide a constant bleed into the hopper through the space between the sleeve 23 and the ring 25, catalyst may be prevented from entering the joint. Thus, the outer surface of sleeve 23 in the region immediately adjacent the joint packing is maintained in relatively clean condition, so that catalyst particles are prevented from clinging to the surface of the sleeve and being carried during periods of contraction between the sealing surfaces of the sleeve

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23 and the packing 30. In addition to its function of preventing catalyst infiltration into the joint, the gas chamber 27 may serve the additional useful function of carrying off heat from the sleeve 23 by direct heat exchange with the fluid heat exchange medium passing through the chamber 27.

Referring to Fig. 3 of the drawing, a modified form of sleeve joint is illustrated. The portion of lift pipe 16 passing through the opening in neck 21 of hopper 11 is covered by a cylindrical sleeve member 33 of substantially larger diameter than the diameter of the lift pipe. The cylindrical member 33 is turned inwardly at its upper and lower ends 34 and 35, respectively, to form a confined space between the lift pipe and the sleeve for the reception of suitable insulating material 36 having sufficient insulating properties to maintain the outer surface of the sleeve 33 within a safe temperature range. An annular member of irregular shape is attached to the underside of hopper 11 surrounding the sleeve member 33. The irregularly-shaped member comprises a cylindrical wall section 37 attached at its upper end to the sloping bottom of the upper lift hopper and depending therefrom concentrically to the neck portion 21. The lower end of cylindrical member 37 is turned radially inwardly at 38 and then upwardly at 39 to form a short cylindrical portion terminating at its upper end in a concave annular portion 40 adapted to receive a packing ring 41. The annular member formed by the portions 37, 38, 39 and 40 provides a chamber 42 surrounding the slip-joint. An inlet 43 in the cylindrical wall 37 of the chamber 42 is provided for the introduction of gas, such as steam, into the annular chamber. The upper end of the concave portion 40 is spaced slightly from the lower end of neck 21, so as to provide a circumferential gas outlet from the chamber 42 into the space between the neck portion 21 and the cylindrical sleeve portion 33. The gas introduced through inlet 43 functions in the same manner as gas introduced through inlet 28 of Fig. 2.

Referring to Fig. 4 of the drawing, the sleeve member of Fig. 3 is shown in modified form. In order to provide increased capacity for heat transfer away from the region of the slip-joint, a cooling coil 44 is embedded in the insulation material 36 surrounding the lift pipe 16, through which a fluid coolant is continuously circulated. In Fig. 4, the shielded portion of the lift pipe is shown as passing through a flat horizontal wall member 45 of a vessel, in order to show its application to vessel walls of different configuration. The opening in wall member 45 is large enough to permit free longitudinal movement of the cylindrical portion 33 of the sleeve. A flanged neck 46 is attached to the undersurface of wall 45 concentric to the opening therein, the diameter of the neck 46 being substantially greater than the diameter of sleeve member 33 in order to provide a suitable space therebetween to form a stuffing-box. An inlet 47, for steam or other gas, is provided in the side of neck 46 near its upper end to permit the introduction of a stream of gas into the annular space between the neck 46 and the cylindrical sleeve member 33, so that a constant bleed may be maintained through the space between the sleeve member and the vessel wall 45. Within the stuffing-box formed by the member 46 there is first placed a lantern ring 48 followed by layers of packing 49. Packing gland 50 compresses the

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packing material 49 by means of bolts 51 in a conventional manner so as to provide a fluid-tight slip-joint for the sleeve member 33. The lantern ring 48 spaces the packing material 49 from the base of the stuffing-box sufficiently to permit uninterrupted introduction of gas through inlet 47.

It is obvious that the invention is susceptible to various other modifications without departing from the spirit or essential attributes of the invention.

What is claimed is:

1. A slip-joint between a vessel wall and a tapered portion adjacent to the free end of an elongated conduit extending through an opening in said wall, and adapted to maintain a sealed connection therebetween while permitting substantial relative displacement longitudinally of the axis of said conduit as a result of extreme changes in temperature, comprising a spaced sleeve member concentrically encircling said tapered portion and extending therewith through said opening, said sleeve member having a cylindrical outer surface, heat-resistant means between said sleeve member and said conduit, a housing member secured at one end along the edge of said opening and extending outwardly from said wall, said housing member being radially spaced from and encircling an intermediate portion of said sleeve member, a packing between said housing member and said sleeve member adapted to provide a fluid-tight slip-joint therebetween, means for retaining said packing inwardly from the supported end of said housing member, and means for introducing a fluid medium into the annular space formed between the inner portion of said housing member and said sleeve member for passage into said vessel through said opening.

2. A slip-joint as defined in claim 1 in which said sleeve member comprises a cylindrical member of substantially greater diameter than the maximum diameter of the encircled portion of said conduit, and an insulating material filling the annular space between said cylindrical sleeve member and said conduit.

3. A slip-joint as defined in claim 2 including a pipe coil concentrically embedded within said insulating material for continuously circulating therethrough a fluid heat exchange medium.

4. A slip-joint as defined in claim 1 in which the inner end of said annular chamber formed between said housing member and said sleeve member is substantially closed, so as to provide a free sliding fit with said cylindrical outer surface of said sleeve member.

5. A slip-joint as defined in claim 4 in which said cylindrical sleeve is of greater diameter than the maximum diameter of the encircled portion of said tapered conduit, and including an insulating material filling the annular space between said cylindrical sleeve member and said tapered conduit, and means for compressing said packing to maintain said fluid-tight slip-joint.

6. A slip-joint between a vessel wall and a tapered portion adjacent to the free end of an elongated conduit extending through an opening in said wall, and adapted to maintain a sealed connection therebetween while permitting substantial relative displacement longitudinally of the axis of said conduit as a result of extreme changes in temperature, comprising a spaced sleeve member concentrically encircling said tapered portion and extending therewith through said opening, said sleeve member having a cy-

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lindrical outer surface, heat-resistant means between said sleeve member and said conduit, a stuffing box member surrounding said sleeve member and extending partially within said opening, said stuffing-box member being secured to said vessel wall around said opening, and having inwardly-extending radial members both at the inner end and at a point intermediate the ends thereof forming, respectively, an end closure and an internal partition, said partition dividing said stuffing-box into inner and outer chambers, said closure member and said partition member forming a free-sliding fit with the outer surface of said sleeve member, a packing in the outer chamber of said stuffing-box member, a packing gland in the outer end of said stuffing-box adapted with said partition member to compress said packing and form a fluid-tight slip-joint around said sleeve member, and means for introducing a fluid medium into the inner chamber of said stuffing-box for passage into said vessel through said opening.

7. A slip-joint between a vessel wall and a tapered portion adjacent to the free end of an elongated conduit extending through an opening in said wall, and adapted to maintain a sealed connection therebetween while permitting substantial relative displacement longitudinally of the axis of said conduit as a result of extreme changes in temperature, comprising a spaced sleeve member concentrically encircling said tapered portion and extending therewith through said opening, said sleeve member having a cylindrical outer surface, heat-resistant means between said sleeve member and said conduit, an annular housing member of substantially U-shaped cross section secured along its upper outside edge to the outer surface of said vessel about and spaced from said opening, the inner side wall of said annular housing member being circumferentially indented to form a packing-ring groove, the upper edge of said inner side wall of said annular housing member being spaced from the vessel wall about the edge of said opening to form a circumferential passage between the annular chamber formed within said annular housing member, a packing-ring in said packing-ring groove forming a fluid-tight slip-joint between said housing member and said sleeve mem-

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ber, and means for introducing a fluid medium into said annular chamber, said fluid medium passing through said circumferential passage and through the annular space between the edge of said opening and the surface of said sleeve member into said vessel.

8. A slip-joint between a vessel wall and a tapered portion adjacent to the free end of an elongated conduit extending through said wall, and adapted to maintain a sealed connection therebetween while permitting substantial relative displacement longitudinally of the axis of said conduit as a result of extreme changes in temperature, comprising a spaced sleeve member concentrically encircling said tapered portion and extending therewith through said opening, said sleeve member having a cylindrical outer surface, insulating material in the space between said sleeve member and said conduit, a stuffing-box member surrounding said sleeve member and secured at one end to the outer wall surface of said vessel inwardly from the edge of said opening, a lantern-ring in the base of said stuffing-box adjacent to said vessel wall, a packing outwardly adjacent said lantern-ring, a packing-gland for compressing said packing against said lantern-ring to form a fluid-tight slip-joint around said sleeve member, and means for introducing a fluid medium into the base of said stuffing-box adjacent said lantern-ring for passage into said vessel through the annular space formed between the edge of said opening and the outer surface of said sleeve member.

9. A slip-joint as defined in claim 8 including means for circulating a fluid heat-exchange medium wholly within said insulating material and in indirect heat-exchange therewith.

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