

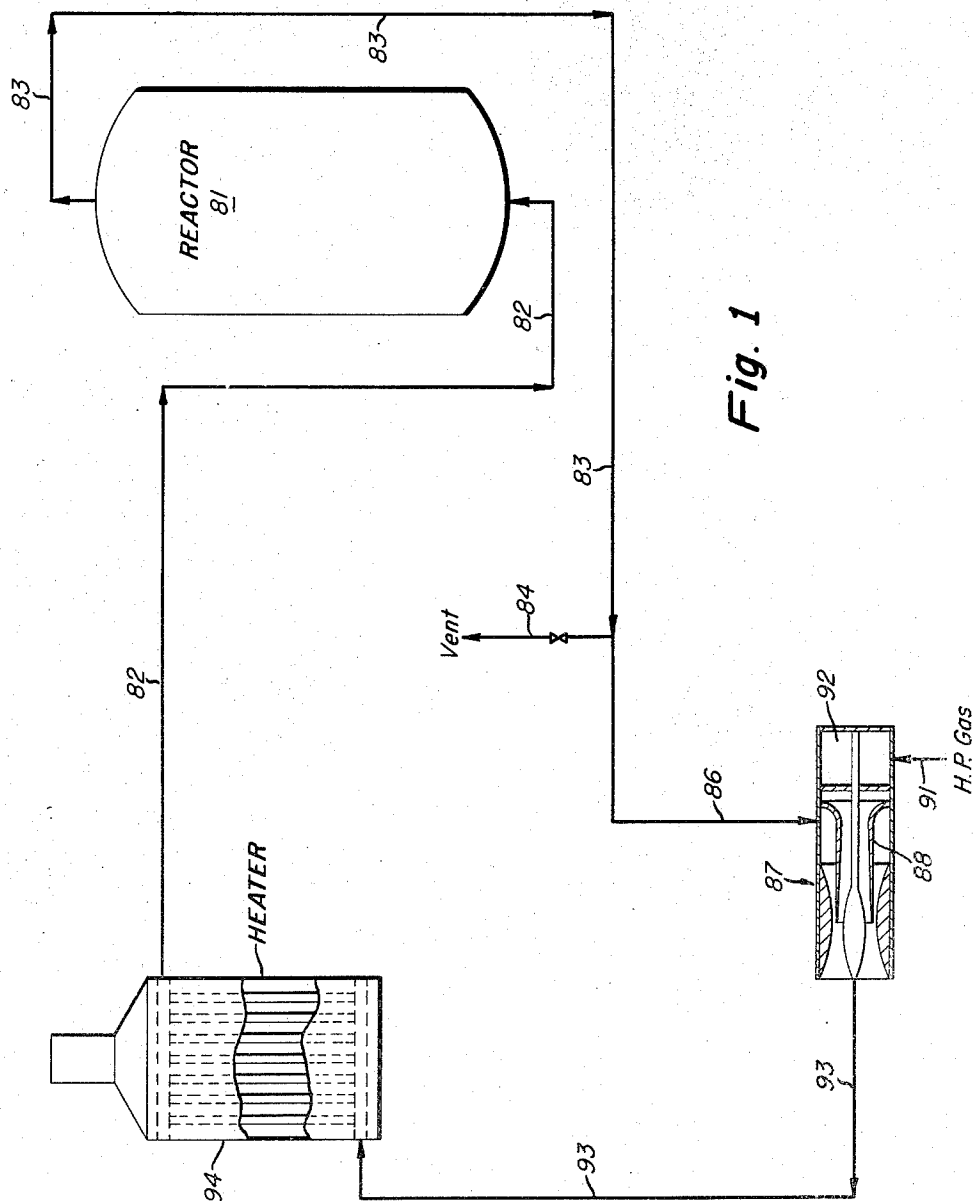
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ANNULAR VENTURI INJECTOR

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2 Sheets-Sheet 1



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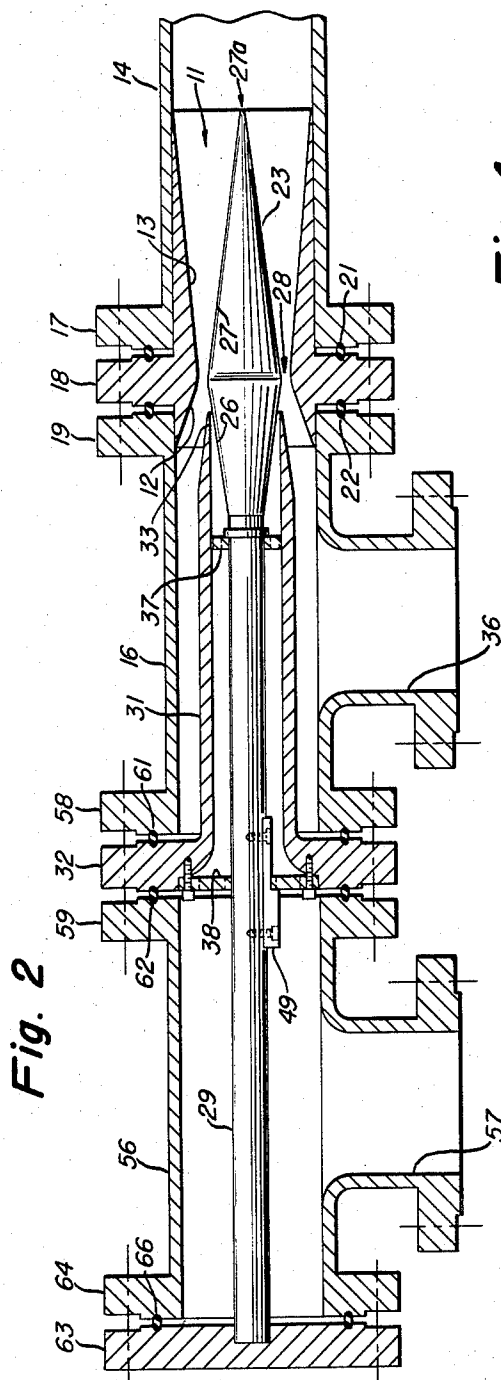


Fig. 4

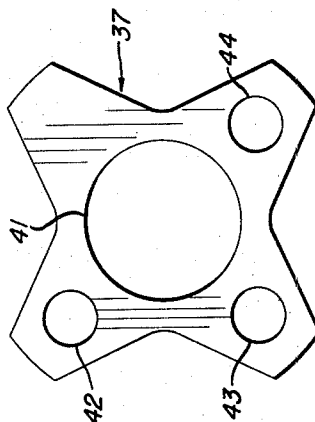
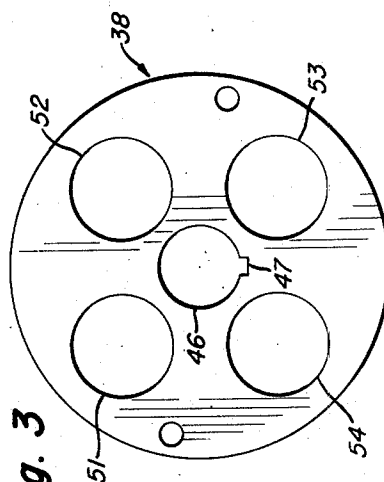


Fig. 3



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ANNULAR VENTURI INJECTOR

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This invention relates to injectors. More particularly, an injector adapted for moving fluids at high temperatures.

In the petroleum industry, there are many operations which require moving fluids at high temperatures. For example, in reforming operations using a catalyst, it is customary to operate with a circulating gas stream at a temperature on the order of 700°–1000° F. Large quantities of gas or liquid must be moved; this requires large compressors which are subject to breakdown due to the wear and tear of continuous operation at high temperature, pressure, and corrosive elements in the fluid stream.

Injectors are well known for movement of fluids. However, injectors are, on the whole, inefficient and useful only for small scale operations.

An object of the invention is an injector of improved efficiency. Another object is an injector capable of delivering large quantities of fluids at high temperatures. Other objects will become apparent in the course of the detailed description.

Figure 1 sets out a process illustrating one use of the injector of the invention.

Figure 2 shows a detailed cross sectional view of the construction of one embodiment of the injector of the invention.

Figure 3 shows the detail of a guide plate used in the embodiment of Figure 2.

Figure 4 shows another guide plate use in the embodiment of Figure 2.

Referring to Figure 2, the injector consists of a diffuser conduit 11. Diffuser conduit 11 comprises an inwardly converging portion 12, which meets an outwardly diverging portion 13; portions 11 and 12 afford a Venturi nozzle-shaped aperture. In this particular embodiment, portions 11 and 12 are conical in configuration; they may also be described as portions of a funnel-shaped passage. Diffuser conduit 11 is supported by conduit member 14 and by conduit member 16. Conduits 11, 14, and 16 are bolted together by way of flanges 17, 18, and 19, respectively, which flanged joints are provided with gaskets 21 and 22, respectively.

Positioned within diffuser conduit 11 is a throat forming member 23. Throat forming member 23 comprises an outwardly diverging portion 26, which meets an inwardly converging portion 27. In the specific embodiment of Figure 2, portion 26 may be considered as a frustum of a cone, and portion 27 a cone with the point 27a of the cone extending toward the discharge end of diffuser conduit 11. Thus, outwardly diverging portion 13 and outwardly converging portion 23 describe an annular opening corresponding to the calming section of a Venturi nozzle. The point of convergence of the portions 26 and 27 is positioned essentially in the same plane as the point of convergence of portions 12 and 13, i.e., the cross section of the Venturi nozzle throat 28 is in the plane of the meeting points of the diffuser conduit 11 and the throat former 23. In this embodiment, throat former 23 is positioned at the desired point by means

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of stem 29 affixed to portion 26. Stem 29 is positioned within diffuser conduit 11 coaxially therewith to provide a predetermined distance or gap affording a Venturi throat opening 28 of essentially constant rise over the 360° throat opening.

A divider shroud 31 provided with a flange 32 surrounds said outwardly diverging portion 26; shroud 31 terminates substantially at the annular Venturi throat 28. The terminus 33 (throat-end) of shroud 31 is spaced from the surface of portion 26 so as to afford an annular sheet-like passage. The purpose of the sheet-like passage is to cause the fluid emerging from within shroud 31 to move close to the surface of throat forming member 23, thereby providing maximum induction with respect to the fluid to be driven, which enters the interior of conduit 16 by way of driven-fluid conduit 36. In this embodiment, shroud 31 is a cylindrical tube positioned coaxially with stem 29.

Stem 29 and throat former 23 are maintained in coaxial relation with shroud 31 and conduit 11 by means of front guide plate 37 and rear guide plate 38. Front guide plate 37 is shown in more detail in Figure 4. Rear guide plate 38 is shown in more detail in Figure 3. Front guide plate 37 is provided with a central aperture 41 for entry of stem 29. Apertures 42, 43, and 44 are provided to permit flow of fluid as well as cutout portions provided by the cross-shaped configuration of plate 37. Plate 37 may be affixed to stem 38 by means of a set screw, not shown, or by other suitable means.

Rear guide plate 38 is provided with an opening 46 for passage of stem 29. Opening 46 has a keyway 47. Stem 29 is provided with a bar-key 49 fastened by screws, which permits adjustment of the position of throat former 23 with respect to diffuser conduit 11. Plate 38 is provided with openings, here, 51, 52, 53, and 54, for passage of fluid into shroud 31. Plate 38 is fastened to flange portion 32 of shroud 31 by means of bolts.

Conduit 56 is positioned coaxially with respect to shroud 31, conduit 16, and diffuser conduit 11. Conduit 56 is provided with a fluid inlet conduit 57. Conduit 16, shroud 31, and conduit 56 are bolted by means of flanges 58, 32, and 59, respectively. These flanges are provided with gaskets 61 and 62 respectively. Conduit 56 is closed by means of plate 63, which is bolted to flange 64; this joint is provided with gasket 66. Plate 63 is provided with a recess for positioning and holding the end of stem 29.

To illustrate the invention, a commercial scale annular Venturi injector of the invention is described in detail, in connection with Figures 2–4. In the commercial embodiment, throat forming member 23 has a diameter of 2.990 in. at the point of convergence. Portion 26 is 6.5 in. long; the slope of the conical side is 9°. Portion 27 is 12.5 in. long with a slope of the conical side of 7.5°. Stem 29 is 1.4 in. in diameter. Stem 29 is 32.5 in. in length.

Diffuser conduit 11 has an internal diameter at the convergence point of 3.75 in. The angle from the horizontal of converging portion 12 is 20° and the angle from the horizontal of diverging portion 13 is 5°. Diffuser conduit 11 has a discharge opening 6 in. in diameter. Shroud 31 is made of 0.5 in. thickness tubing and has an internal diameter of 3.000 in. From the throat-end 33, the wall of shroud 31 is beveled back at an angle of 7.5°. Throat-end 33 of shroud 31 terminates essentially 1 in. from the throat 28. It is to be understood that the terminal distance will be slightly different dependent upon the fluid being driven and the operating conditions, such as temperature.

Shroud 31 is positioned within conduit 16, which is 6 in. in internal diameter. Conduit 16 is made up of a right angle T, with the leg of the T also 6 in. in

diameter. Conduit 56 and conduit 57 are constructed in identical fashion to conduits 16 and 36. The overall length of conduits 16 and 56 is 25 in., respectively.

Guide plate 37 is provided with aperture 41, which is a sliding fit for stem 29. Openings 42-44 are 0.62 in. in diameter. The base of the legs of the cross are 0.5 in. wide. Plate 38 is 6 in. in diameter. Openings 51-54 are 1.62 in. in diameter.

The operation of the annular Venturi of the invention is described in connection with Figure 1. Figure 1 is an extremely simplified set-up of a catalytic reforming operation wherein reactor 81 contains a catalyst such as platinum on alumina or chromium on alumina. The catalyst in reactor 81 becomes inactivated by deposition of carbon thereon. This carbon is removed by controlled burning. A stream of gas comprising flue-gas admixed with air is introduced into reactor 81 by way of line 82. This stream of gas normally enters the reactor at about 700° F. and is on the order of 300 p.s.i.g. The gases exit from reactor 81 by way of line 83 and a portion thereof is vented to the atmosphere by way of valved line 84. The remaining gases are passed by way of line 86 to annular Venturi injector 87. Gases from line 86 pass into the space surrounding conduit 88. The driving gas is delivered by a compressor, not shown, at about 375 p.s.i.g. and about 100° F. by way of line 91 into conduit 92. The combined stream passes out of injector 87 by way of line 93 and is passed into heater 94. In heater 94, the temperature of the gas is raised to that desired for entry by way of line 82 into reactor 81.

Utilizing recirculating gas at a temperature of 900° F. and 305 p.s.i.g. and driving gas at 375 p.s.i.g. at 100° F., the commercial jet built as described in Figures 2-4 was able to circulate between 1700 and 2600 standard cubic feet per minute of gas, depending on the spacing of the Venturi throat 28. The new injector was able to circulate 3 to 5 s.c.f.m. of gas per s.c.f.m. of gas from the compressor.

Thus having described the invention, what is claimed is:

1. An injector consisting essentially of a diffuser conduit comprising an inwardly converging portion meeting an outwardly diverging portion, affording a Venturi nozzle shape; a throat forming member, comprising an outwardly diverging portion meeting an inwardly converging portion, positioned coaxially within said diffuser conduit so that the meeting of said portions of said

throat forming member and the meeting of said portions of said diffuser conduit are essentially in the same plane and so spaced that an annular Venturi throat is formed within said diffuser conduit where inwardly and outwardly are relative to the longitudinal axis of said diffuser conduit; a divider shroud surrounding said outwardly diverging portion of said throat forming member and terminating substantially at said annular Venturi throat, the throat-end of said shroud being spaced from the surface of said throat forming member affording an annular sheet-like passage for pumping-fluid into said annular Venturi throat; and a conduit surrounding said divider shroud joined to said diffuser conduit affording an annular passage for pumped-fluid into said annular Venturi throat.

2. An injector consisting essentially of a diffuser conduit comprising an inwardly converging conical portion meeting an outwardly diverging conical portion, affording a Venturi nozzle, a throat forming member, comprising an outwardly diverging conical portion meeting an inwardly converging conical portion, positioned coaxially within said diffuser conduit so that the meeting of the conical portions of said throat forming member and the meeting of the conical portions of said diffuser conduit are essentially in the same plane and so spaced therefrom a predetermined distance whereby an annular Venturi throat is formed within said diffuser conduit where inwardly and outwardly are relative to the longitudinal axis of said diffuser conduit, a divider shroud surrounding said outwardly diverging conical portion of said throat forming member and terminating substantially at said annular Venturi throat, the throat-end of said shroud being spaced from the surface of said throat forming member affording an annular sheet-like passage for pumping-fluid into said annular Venturi throat and a conduit surrounding said divider shroud joined to said diffuser conduit affording an annular passage for pumped-fluid into said annular Venturi throat.

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