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P. N. RANDALL

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GRID SUPPORT AND SEAL FOR FLUIDIZED SOLIDS SYSTEMS

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Fig. 1

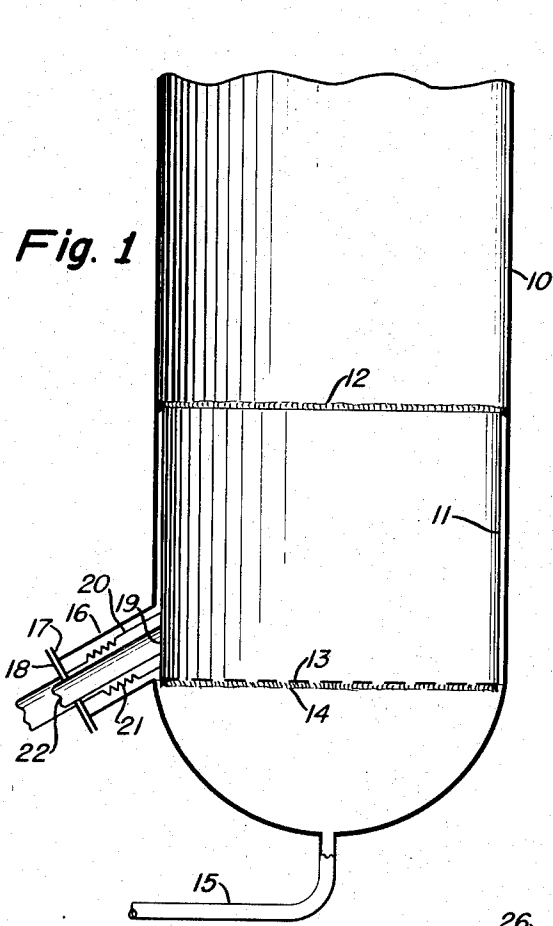


Fig. 3

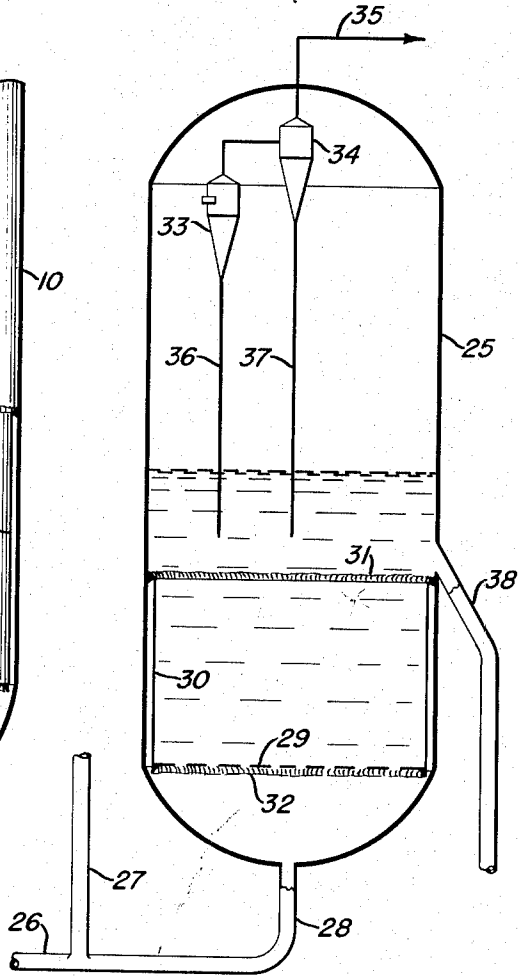
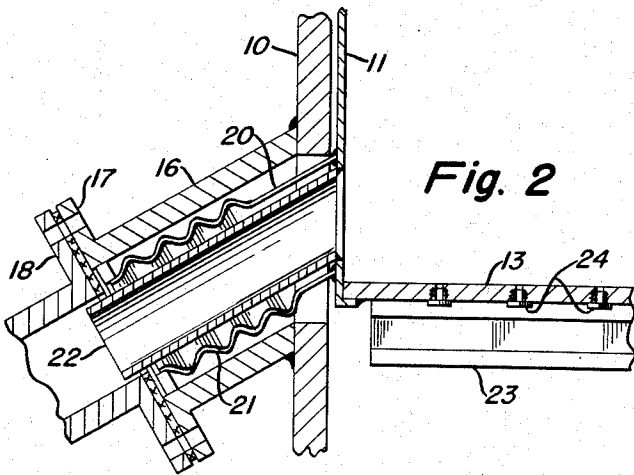


Fig. 2



INVENTOR.
Pryor N. Randall
BY *Ronald Payne*
ATTORNEY

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GRID SUPPORT AND SEAL FOR FLUIDIZED SOLIDS SYSTEMS

Pryor N. Randall, Homewood, Ill., assignor to Standard Oil Company, Chicago, Ill., a corporation of Indiana

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2 Claims. (Cl. 23—288)

This invention relates to an improved grid support and seal for fluidized solids systems and it pertains more particularly to a distributor-grid seal structure for use in catalytic conversion systems which operate at elevated temperatures and pressures and which employ catalyst in the form of small, abrasive solid particles.

In most fluidized solids systems a grid is mounted at the base of a contacting vessel for uniformly distributing gas introduced below the grid across the cross sectional area of the fluidized solids immediately above the grid. Heretofore such grids have been supported by structural elements secured to the base of the contacting vessel (note U.S. 2,595,384) and/or by lugs or rings mounted around the periphery of the vessel below the grid structure. These grid supports have been a consistent source of trouble because of differential thermal expansion which takes place during startup operations and because of leaks which inevitably develop between the periphery of the grid and the walls of the vessel. In processes for effecting hydrocarbon synthesis with fluidized iron catalyst which are effected at elevated temperatures and pressures, these problems are most serious; in this case it is desirable to have the space below the grid substantially free from catalyst and none of the structures heretofore proposed will maintain a tight grid seal during the startups and fluctuations encountered in a long period of use. The object of my invention is to provide an improved grid support which serves the dual function of effecting a positive grid seal and which will withstand maximum temperature changes, differences in loading, and other stresses and strains without failure or leakage. Other objects will be apparent as the detailed description of the invention proceeds.

In practicing my invention, I employ a skirt whose outside diameter is slightly smaller than the inside diameter of the contacting vessel, I secure the upper end of the skirt to the inner walls of the contacting vessel, preferably by welding around the entire periphery, and I secure the lower part of the skirt to the periphery of the grid, also preferably by welding around the entire periphery. The space between the skirt and the vessel walls is sufficient to take care of any relative movement caused by temperature differentials, changes in loading or other external or internal forces. The thickness of the skirt is sufficient to carry the required load of the grid structure and the catalyst and other elements which are carried thereby, and of sufficient length to provide the required flexibility. Usually the skirt must be of the order of about 1 to 6 feet in length depending on the size of the vessel and on the temperature differential which may exist between the grid and the walls of the vessel. Although the skirt is preferably cylindrical, it may be slightly tapered and it may extend sufficiently below the grid so that it may be also secured to the I-beams or other structural supporting elements which must be mounted underneath grids of large diameter.

When it is desired to remove solids from the vessel

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through an opening in the vessel wall immediately above the grid, a suitable outlet conduit is welded to the vessel at this point, an aligned opening is made in the skirt at this point and an expansible and contractible tubular member such as a bellows tube is welded to the skirt and secured to the outlet conduit. This tubular member may be readily replaced if it becomes unduly worn by the abrasive nature of solids flowing therethrough but preferably I employ an inner replaceable wear tube of smaller outside diameter than the inside diameter of the tubular member, the wear tube being removably secured to the skirt around the opening therein so that it may be readily replaced instead of replacing the bellows tube.

The invention will be more clearly understood from the following detailed description of particular examples thereof read in conjunction with the accompanying drawings which form a part of this specification and in which:

Figure 1 is a schematic section through a portion of a hydrocarbon synthesis reactor employing my combined grid support and grid seal,

Figure 2 is a schematic section showing in greater detail the structure of the outlet conduit of Figure 1, and

Figure 3 is a schematic section through a catalytic cracking vessel employing my improved grid support and seal.

While my grid support and seal was expressly designed to solve the problems presented in the design of a hydrocarbon synthesis reactor, it may be utilized in any fluidized solids contacting system, its greatest utility being in systems which operate at elevated temperatures and pressures and wherein it is important to maintain an effective seal between the periphery of the distributor grid and the vessel walls. The hydrocarbon synthesis reactor herein described is a steel pressure vessel 10 about 16 feet in diameter and about 40 feet or more in height designed to operate at about 250 to 500, e.g. about 400, p.s.i.g. at a temperature of about 600 to 700° F., e.g. about 650° F. (note U.S. 2,620,262). Only the lower part of the pressure vessel is shown in the drawing but it should be understood that the vessel has an upper gas outlet, heat exchange tubes for dissipating the heat of reaction and separators for removing catalyst from discharged gases. The catalyst bed depth in such a vessel may be of the order of 15 feet and the iron catalyst is maintained in fluidized condition by upflowing gases moving at a superficial velocity of about .4 to 1.4, e.g. about .7 feet per second. The catalyst inventory in the vessel may be of the order of 150 to 200 tons or more.

A tubular steel skirt 11 about 2 feet in length about 1/4 inch in thickness and having an outside diameter about 1/2 to 1 inch less than the inside diameter of the vessel is secured to the vessel walls by weld 12 which extends around the entire periphery of the vessel. A steel grid 13 is secured by weld 14 to the bottom of skirt 11, weld 14 extending around the whole periphery of the skirt and grid. In this example the grid is of carbon-molybdenum steel about 1 inch in thickness superimposed by a cast iron filler, the steel grid being tapped at space points for receiving removable aeration jets which extend upwardly through openings in the cast iron filling, the openings in the jets being about 1/8 to 3/16 inch in diameter, the space jets thus providing a uniform distribution of gas across the cross sectional area of the vessel with a pressure drop across the grid of about 10 p.s.i. A carbon monoxide-hydrogen gas mixture is introduced at the base of the vessel through line 15 at a pressure of about 410 p.s.i. in order to maintain a contacting pressure immediately above the grid of about 400 p.s.i. Since the grid is heavy and of large diameter it should be suitably reinforced, for example, by I-beams or other structural elements which may be secured to the grid at the base

thereof. From the foregoing description it will be observed that the relatively flexible skirt 11 (which is only 1/4 inch thick as compared to a vessel wall thickness of 1 3/8 inches) fully accommodates any and all stresses caused by differential thermal expansion or changes in loading, it will withstand the 10 p.s.i.g. pressure on its lower side even if no catalyst solids are present in the vessel and it will support the weight of the catalyst in the chamber should it become defluidized on account of compressor failure. At the same time, it is impossible for even the smallest of the iron particles to pass between the periphery of the grid and the lower part of the vessel and should any catalyst drop through an aeration jet, there is no danger of this catalyst getting between skirt 11 and the walls of vessel 10. The improved grid support is thus not only less expensive, easier to install and more effective than grid supports heretofore known to the art but it serves the dual function of effectively sealing the space between the periphery of the grid and the vessel walls.

It is usually desirable to be able to add or remove catalyst at a level immediately above the grid. I therefore may provide an outlet conduit 16 provided with a flange 17 which is removably connected to flange 18 of a further conduit section. An opening 19 is provided in skirt 11 in alignment with conduit 16 and a tubular member 20 is welded to skirt 11 around opening 19 and also secured in this example to conduit 16 adjacent flange 17. Tubular member 20 is provided with a bellows 21 to provide for expansion and contraction of the tubular member and to allow for relative motion between skirt 11 and the walls of vessel 10. While bellows element 21 is an illustration of a structure which will provide for the required relative motion, it should be understood, of course, that other structures may be designed to serve this function. Tubular member 20 may become eroded by flow of catalyst solids therethrough and hence may require periodic replacement. I prefer to employ an inner wear tube 22 of smaller diameter than tubular member 20 and to secure this wear tube in a readily removable manner, e.g. by tack welding either to tubular member 20 or skirt 11. The replacement of the wear tube can be effected with greater facility than the replacement of the expandible and contractible tubular member 20. Figure 2 shows in greater detail the supporting I-beam structure 23 (not shown in Figure 1) and it also shows the jet orifices 24 which are preferably removably inserted in the grid at space points.

In Figure 3 I have shown a catalytic cracking vessel 25 into which an inlet oil vapor stream from line 26 carries catalyst from standpipe 27 through transfer line 28 to that portion of vessel 25 below grid 29. Grid 29 in this case is supported by steel skirt 30 which is welded around its top periphery by weld 31 to the walls of vessel 25 and which is welded around its bottom periphery by weld 32 to grid 29. In this case the catalyst passes through openings in grid 29 to the fluidized catalyst bed above the grid. Gases are removed from vessel 25 via

cyclone separators 33 and 34 and thence through line 35, the separated catalyst being returned by diplegs 36 and 37. Spent catalyst may be removed from the reactor through standpipe 38. It should be understood, of course, that the catalyst may be withdrawn through an opening in skirt 30 as described in connection with Figure 1 or, alternatively, standpipe 38 may extend upwardly through grid 29 since in this case slight leakage between the grid and the standpipe may be tolerated. Considerable advantages may be obtained by introducing the catalyst above the grid at one side of vessel 25 and removing catalyst above the grid on the other side of vessel 25 and thereby avoiding the presence of catalyst below grid 29. Here again grid 29 should be supported by structural elements mounted below the grid.

While specific examples of the invention have been described in considerable detail, it should be understood that modifications and alternative arrangements will be apparent from the above description to those skilled in the art. The skirt member may be conical rather than cylindrical and while it is preferably made of steel and secured by welds, it may in some cases be made of other material and secured to the vessel walls and to the grid respectively by other known means.

I claim:

1. In a fluidized solids contacting system which comprises a contacting vessel, a distributor grid near the base of said vessel, a gas inlet below the grid and a gas outlet in the upper part of the vessel, the improvement which comprises a skirt of smaller outside diameter than the inside diameter of the vessel and extending from the periphery of the grid to a higher level in the vessel, said skirt being secured to the vessel walls at its upper end and being secured to the periphery of the grid at its lower end to serve the combined functions of supporting the grid and sealing the space between the grid and the vessel walls, a solids outlet conduit leading from said vessel immediately above the grid, an opening in said skirt aligned with said outlet, and an expandible and contractible tubular member secured to the skirt around said opening and movably mounted with respect to said conduit.

2. The system of claim 1 which includes a replaceable wear tube of smaller outside diameter than the inside diameter of the tubular member, said wear tube being inside said tubular member.

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