

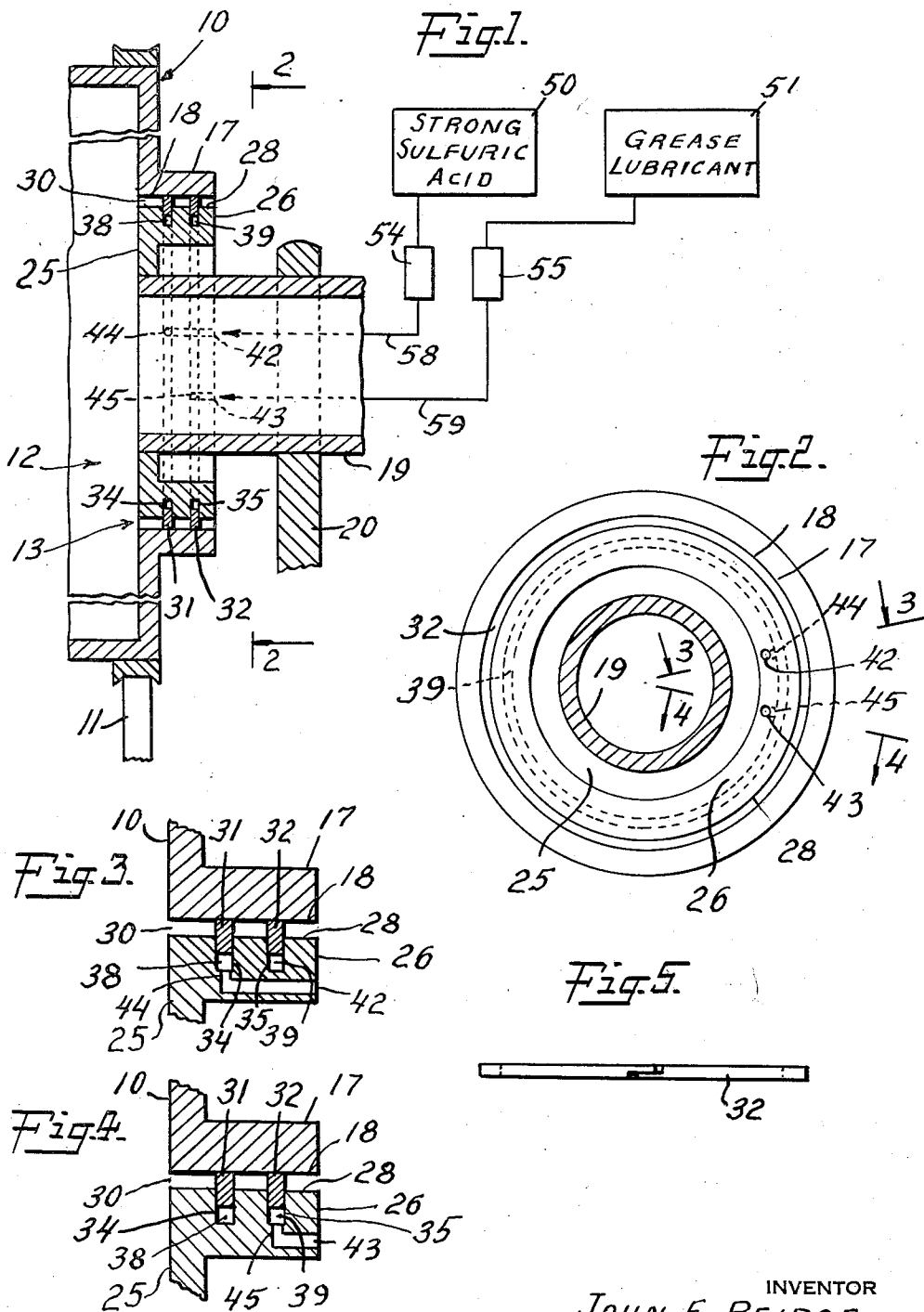
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PRESSURE SEAL FOR ROTARY DRUM REACTORS

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PRESSURE SEAL FOR ROTARY DRUM
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This invention relates to furnaces adaptable for use in the manufacture of hydrogen fluoride gas, and is more particularly directed to construction of gas tight joints particularly suitable for use in connection with communicating gas conduits.

In the practice of chemical processes involving the manufacture of gases and the handling of the same in conduits usually of relatively large cross-section, it is often desirable to provide a gas tight joint in a gas line one section of which is movable with respect to another. As one practical example, in the production of hydrogen fluoride gas, fluorspar and sulfuric acid are reacted in a horizontal rotary furnace to form an HF gas which is discharged from one end of the furnace thru a short exit pipe which is axially aligned with the horizontal axis of the furnace and which is fixed to and rotates with the furnace shell. This exit pipe is connected by some kind of a joint to a stationary flue serving to conduct the gas stream to the subsequent gas purification and HF recovery stages of the process. While the pipe or outlet connection attached to and rotating with the furnace and the stationary gas main are designed so as to be at least theoretically coaxial, it is well known that in actual operation these pipe sections are almost always out of alignment to some greater or lesser extent. In the past, this circumstance has caused considerable difficulty in connection with the construction of leakproof joints between the fixed and rotating pipe sections. The usual packed gland type of joint has proved inadequate, particularly after the apparatus has been in use for some period of time. Tendency for gas leakage at the joint has been so pronounced that, particularly in the manufacture of noxious gases, it has been the practice almost universally to operate at least the gas generating portion of the system under negative pressure in order to prevent escape of harmful gases to the atmosphere and avoid injury to workmen. Since commercially available joint constructions of previous design have not been gasproof, the result of negative pressure operation has been infiltration of air thru the connecting point to such an extent as to dilute the gas stream as much as 50% by volume. This difficulty requires the use of gas purification and recovery apparatus substantially

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larger than would be needed if infiltration of air from the atmosphere could be avoided.

This invention aims to provide a construction which affords a gasproof seal between two apparatus elements, at least one of which is movable with respect to the other, even if such elements are substantially out of alignment during operation.

This invention, its objects and advantages will appear from the following description taken in connection with the accompanying drawing in which Fig. 1 shows partly in section and partly diagrammatically a preferred embodiment; Fig. 2 is a vertical section on the line 2—2 of Fig. 1; Figs. 3 and 4 are enlarged sections taken on the lines 3—3 and 4—4 of Fig. 2; and Fig. 5 is an elevation of an expansible sealing barrier.

The improvements of the invention are adapted for use in situations in which one pipe section rotates and the other is stationary; both sections rotate but one rotates at a higher velocity than the other; and both sections rotate but in opposite directions.

To exemplify utility of one embodiment of the invention, Fig. 1 illustrates application thereof in connection with manufacture of hydrogen fluoride gas. In Fig. 1, 10 indicates in section the gas outlet end of a horizontal cylindrical retort rotatably mounted on roller supports 11 and providing reaction chamber denoted generally by 12. A circular opening 13 in the vertical end wall of the furnace affords means for supplying reactants to the furnace or for discharging gas therefrom. Welded or otherwise attached to the end wall of the furnace is an outwardly projecting annular flange 17 which rotates with the furnace, the inner periphery of this flange providing a sealing face 18 which may be machine finished. The end of the main gas conduit 19 is stationary and is held in position by a support 20. While opening 13 and pipe 19 appear coaxial on the drawing, it will be understood that, because of irregularities arising largely from wear and tear and warping caused by heat, the axis of rotation of the furnace 10 is variable, and in operation the axes of opening 13 and pipe 19 are almost always out of alignment which results in substantially continuous eccentric rotation of opening 13. Further, wear and tear of roller 11 and the associated track causes the furnace to

have a small but appreciable axial movement relative to fixed pipe 19. Both of these movements contribute to gas leakage at the connection between the furnace and the pipe. In accordance with this invention the foregoing difficulties are overcome by provision of a joint constructed so as to permit relative eccentric and/or axial movement between the furnace and outlet pipe, and at the same time prevent escape of gas if the furnace is operated under positive pressure or prevent ingress of air if the system is operated under negative pressure.

Fixed in gas-tight relation on the end of pipe 19, as by welding, is a circular disc 25 having at its circumference remote from pipe 19 an outwardly projecting flange 26 of substantial thickness in a direction radial of pipe 19. The outermost cylindrical periphery of flange 26 forms a surface 28 which, thru disc 25, is fixed to stationary conduit 19.

It will be noted from Fig. 1 that sealing face 18 carried by the retort and surface 23 fixed to conduit 19 are substantially spaced apart radially. This construction permits appreciable eccentric and/or axial movement of the furnace without causing a metal-to-metal contact between rotating flange 17 and the fixed flange 26. Thus, the annular space between sealing surface 18 and the surface 23 of flange 26 form an annular port 30 of substantial dimension thru which gas tends to egress from or ingress to the furnace.

To aid in prevention of passage of gas thru annular port 30, the latter is provided with barriers 31 and 32. In the embodiment illustrated, each barrier comprises a split expansible ring one of which is shown in elevation in Fig. 5. Cut into surface 28 of flange 26 are circumferential grooves 34 and 35 which are respectively formed to movably receive and guide barriers 31 and 32. Taking into consideration the radial dimension of annular port 30 and the radial width of rings 31 and 32, the radial depth of grooves 34 and 35 and the expansibility of rings 31 and 32 are chosen so that on substantially complete compression rings 31 and 32 totally fill grooves 34 and 35 and lie within the circumference of surface 28, and so that on expansion to operative position (i. e. as shown in Fig. 1) the outer machined peripheries of rings 31 and 32 wedge tightly against sealing face 18 while the inner edges of the rings seat about half way within grooves 34 and 35, thereby providing within flange 26 two annular lubricant receiving channels 38 and 39.

In accordance with the present invention, completion of sealing of port 30 is effected by continuously or intermittently supplying certain lubricants to sealing surface 18, surface 23 and rings 31 and 32. Such supply of lubricant is effected by provision of means to furnish lubricant under pressure to the annular channels 38 and 39. As more clearly shown in Figs. 3 and 4, the foregoing is accomplished by conduits 42 and 43 in flange 26, the inner ends of conduits 42 and 43 communicating with channels 38 and 39 by short radial ducts 44 and 45 respectively. Shown diagrammatically in Fig. 1 are lubricant supply tanks 50 and 51. Numerals 54 and 55 indicate pumps or other injectors operative to force lubricants thru pipes 58 and 59 and into conduits 42 and 43 in flange 26, the liquid-tight connections between the ends of pipes 58 and 59 and conduits 42 and 43 not being shown.

When the rotary furnace 10, stationary conduit 19, and rings 31 and 32 are assembled as

illustrated in Fig. 1 and the furnace is put into operation, by means of pumps 54 and 55, the annular channels 38 and 39 are kept filled with lubricant under such pressure that there is a constant circumferential outflow of lubricant over the vertical faces of grooves 34 and 35, over those portions of the vertical faces of rings 31 and 32 lying within port 30, and to the surfaces of contact between rings 31 and 32 and sealing surface 18. Because of their expansibility, rings 31 and 32 wedge tightly against sealing face 18 although, if necessary, axial movement between these members is permissible. This arrangement and the lubricant which works in between the sealing face 18 and the outer peripheries of rings 31 and 32 seal off escape of gas between the sealing face 18 and the rings. As the rings normally rotate with the furnace, it will be seen that the relative movement between rings 31 and 32 and grooves 34 and 35 affords an effectively constant outflow of lubricant from channels 38 and 39 and distribution of the same to the vertical faces of rings 31 and 32 and also to the surfaces at which the latter engage sealing face 18.

This invention is especially directed to improvements in the manufacture of hydrogen fluoride gas which is formed by reaction of fluor-spar and sulfuric acid in furnace 10. In such process, it is highly desirable to eliminate or minimize formation of SO_2 in the reaction chamber because the presence of SO_2 is objectionable in the subsequent processing of the HF gas to recover liquid hydrofluoric acid or liquid anhydrous hydrogen fluoride. It has been proposed to use ordinary hydrocarbon lubricants to facilitate sealing of the joint between the rotary furnace and the fixed gas outlet. In such situations, appreciable quantities of hydrocarbon lubricant works thru the joint and into the reaction chamber with the result that troublesome quantities of SO_2 gas are contained in the HF off-gas of the furnace.

In accordance with the preferred embodiment of this invention as applied to the manufacture of hydrogen fluoride gas, it has been found that efficient sealing of the joint between the rotary furnace and the fixed gas outlet may be effected in such a way as to adequately lubricate the joint and at the same time prevent introduction of hydrocarbon lubricant into the fluor-spar-sulfuric acid reaction. This objective may be accomplished by supplying sulfuric acid to channel 38. Thus, the lubricant maintained in tank 50 and supplied to the inner annular channel 38 is sulfuric acid, the H_2SO_4 strength of which may be chosen in accordance with the nature of the materials of which furnace flange 17, conduit flange 26 and the rings 31 and 32 are made. If, as is usually the case, flanges 17 and 26 are of ordinary steel or cast iron, the sulfuric acid employed should be preferably of 96% H_2SO_4 strength or more in order to avoid undue corrosion of the furnace and conduit parts with which such acid comes in contact. Should flanges 17 and 26 and rings 31 and 32 be made of acid resistant alloys, any suitable strength of sulfuric acid may be employed, although the use of weaker acid is not favored because of the introduction of contained water into the furnace with the resultant dilution of the HF off-gas.

Since a heavy semi-pasty hydrocarbon lubricant generally affords a better gas seal between moving surfaces than does a more fluid material such as sulfuric acid, this invention provides for

taking advantage of this feature by the use of the second ring 32 and its associated lubricant channel 39. Thus, by means of injector 55, annular channel 39 is kept filled with a heavy hydrocarbon lubricant, such as Starfak #3, under sufficient pressure to cause an appreciable circumferential outflow of heavy lubricant over the vertical faces of ring 32 and to the sealing surface 18 of flange 17.

It will be noted that sulfuric acid channel 38 is adjacent the reaction chamber 12 and that heavy lubricant channel 39 is remote from the reaction chamber. Because of this arrangement, the sulfuric acid seal formed at ring 31 prevents admission to the reaction chamber 12 of any appreciable quantities of hydrocarbon lubricant, while on the other hand any excess sulfuric acid which may be used in conjunction with the sealing afforded by ring 31 runs into the reaction chamber where such sulfuric acid is utilized in the fluorspar-sulfuric acid reaction taking place in the furnace. Similarly, the heavy hydrocarbon seal effected by the outer ring 32 prevents outward flow of the sulfuric acid associated with inner ring 31, while any excess hydrocarbon lubricant which may be extruded at the open end of port 30 causes no particular operating disadvantage. Thus, the invention affords a means for maintaining a sulfuric acid seal in port 30 at a position immediately adjacent reaction chamber 12, and a means for maintaining a heavy lubricant seal in port 30 at a position remote from the reaction chamber.

Commercial use of the structure described shows that it is possible to obtain and maintain furnace off-gases of 95% HF strength, and that it is also possible to operate the furnace at a plus pressure of $\frac{1}{2}$ " of water and successfully retain the gas in the furnace.

Structurally, the invention is subject to several modifications. The relationship of the operative parts as shown in the drawing may be reversed, that is, the apparatus represented by furnace 10 and its flange 17 may be fixed, while the conduit 19 and its flange 26 may be rotary, in which instance suitable connections may be used to supply acid and heavy lubricant to conduits 42 and 43 as the latter move thru their respective orbits. Further while as shown in Fig. 1, furnace flange 17 envelops conduit flange 26 and rings 31 and 32, the arrangement may be reversed so that a generally corresponding but inwardly projecting flange such as 26 circumferentially envelops furnace flange 17, in which situation grooves corresponding with illustrated grooves 34 and 35 would be cut in the outer circumference of flange 17. The construction shown might well be utilized in apparatus other than a furnace. Thus, furnace 10 might be replaced by a rotating gas conduit in which situation there would be provided communicating conduit sections having adjacent ends positioned and arranged so as to facilitate passage of a gas stream from one section into the other and so as to permit eccentric movement between such sections. The invention may be adapted to prevent gas leakage at the connection between a reaction chamber and an associated rotary element. For example, furnace 10 of the drawing may be a fixed reaction chamber and the pipe 19 of Fig. 1 may be replaced by a solid shaft such as the rotary shaft of an agitator. In this situation, a flange corresponding with flange 26 would rotate with the shaft, and a flange attached to the fixed reaction chamber and corresponding with flange

17 of the drawing, together with rings corresponding with rings 31 and 32 of the drawing would seal off any tendency for gas to escape from the inside of the fixed reaction chamber.

I claim:

1. Apparatus comprising a pair of adjacent members, at least one of said members being rotatable with respect to the other, a sealing face of substantially cylindrical shape fixed to one of said members, a surface of substantially cylindrical shape fixed to the other member in spaced relation to said sealing face, said sealing face and said surface forming an annular non-gas-tight port between said members and being so arranged as to permit upon rotation, eccentric movement between said members, an annular groove cut into said surface and formed to movably receive and guide an annular barrier, an annular metallic barrier in said groove maintained constantly in sliding contact with the sides of said groove, said barrier being sufficiently self-extensible, in a direction toward said face and substantially at a right angle to the axis of said cylindrical surface and sealing face to normally effect contact with said sealing face, and pressure means to supply liquid sealing medium under pressure to said groove, barrier and sealing face thereby to prevent substantial flow of gas through said port.

2. Apparatus comprising a rotary retort providing a reaction chamber, a stationary conduit communicating with said chamber, said conduit being associated with said retort so as to form between the retort and conduit a non-gas-tight port, an outer sealing face fixed to said retort and forming the outer side of said port and annularly surrounding said conduit, a surface lying inside the confines of said face and forming an annular side of said port and fixed to said conduit in substantially spaced relation from said sealing face whereby said port permits substantial eccentric movement between said retort and said conduit, an annular groove cut into said surface and formed to movably receive and guide an annular barrier, an annular metallic barrier in said groove maintained constantly in sliding contact with the sides of said groove and forming in said groove an annular channel, said barrier being sufficiently outwardly self-expansible in a direction at a right angle to the longitudinal axis of said conduit to normally effect contact with said sealing face, compression means to introduce liquid sealing medium under pressure directly into said channel, to said barrier and to the adjacent portion of said sealing face thereby to prevent substantial flow of gas through said port.

3. Apparatus comprising a rotary retort providing a reaction chamber, a stationary conduit communicating with said chamber, said conduit being associated with said retort so as to form between the retort and conduit a non-gas-tight port, an outer sealing face fixed to said retort and forming the outer side of said port and annularly surrounding said conduit, a surface lying inside the confines of said face and forming an annular side of said port and fixed to said conduit in substantially spaced relation from said sealing face whereby said port permits substantial eccentric movement between said retort and said conduit, a pair of annular grooves cut into said surface and each formed to movably receive and guide an annular barrier, an annular metallic barrier in each of said grooves, each barrier maintained constantly in sliding contact with the sides of its respective groove and forming an annular

channel in each groove, said barriers being sufficiently outwardly self-expansible in a direction at a right angle to the longitudinal axis of said conduit to normally effect contact with said sealing face, compression means to introduce a different liquid sealing medium under pressure directly into each of said channels, to their corresponding barriers and to the adjacent portion of said sealing face, thereby to prevent substantial flow of gas through said port.

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