July 3, 1962 D. H. GIESKIENG 3,042,389

AIR SEAL FOR ROTATING CYLINDERS SUCH AS KILNS AND THE LIKE

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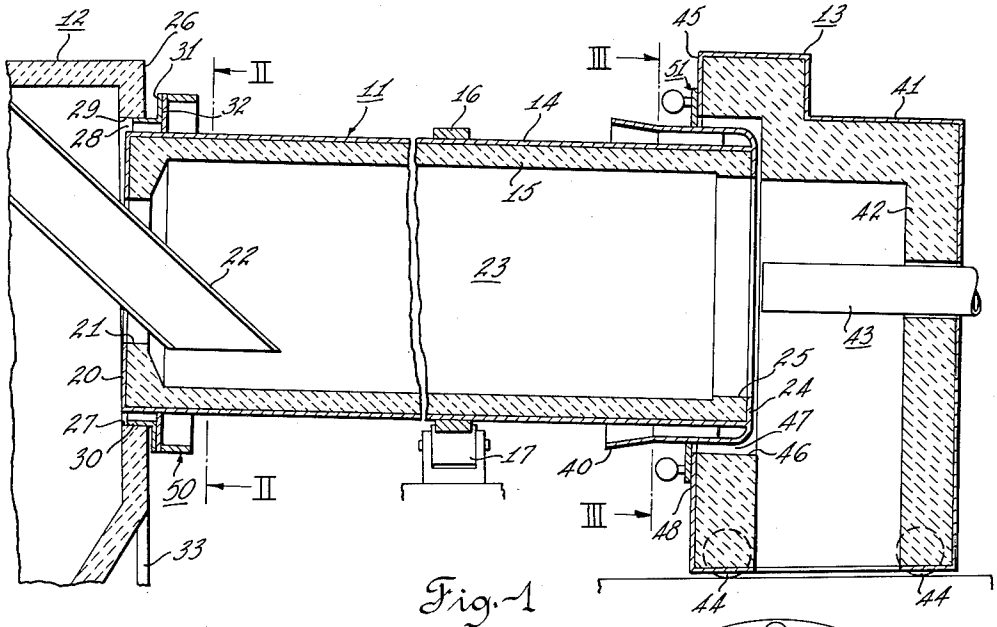


Fig. 1

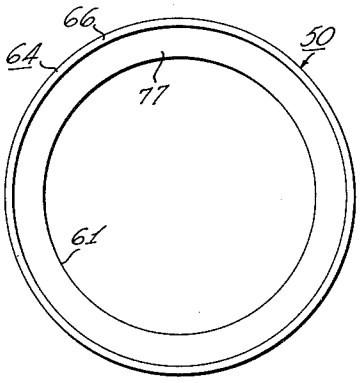


Fig. 2

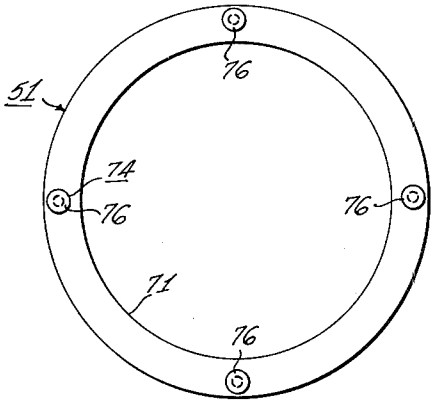


Fig. 3

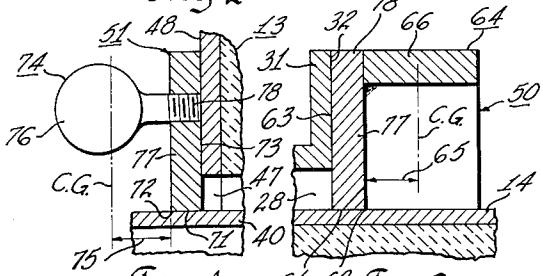


Fig. 4

Fig. 5

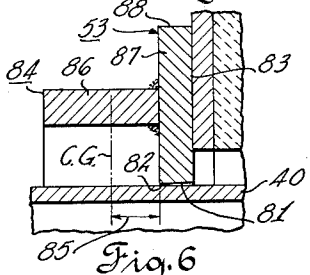


Fig. 6

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AIR SEAL FOR ROTATING CYLINDERS SUCH AS KILNS AND THE LIKE

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The present invention relates generally to sealing rings and more particularly to novel air seals for rotating cylinders, sulh as kilns and the like, which are used in combination with auxiliary equipment at the ends thereof whereby the ingress and egress of substantial amounts of diluent and contaminating fluids therebetween are significantly reduced to a controllable and tolerable minimum.

In the description of the present invention, rotary kilns have been chosen to exemplify rotary cylinders of the type herein contemplated although the present invention is not intended to be so limited.

Essentially, the problem encountered and solved by the present invention arises in connection with the processing of material in a rotating shell-like mechanism having a material feeder at one end thereof and a firing hood or burner at the other end. When kilns and the like are used with these or similar auxiliary apparatus, e.g., coolers and the like, it is the normal practice to attach the apparatus relative to the kiln in telescopic fashion, i.e., the apparatus will surround and overlap the end of the cylinder or vice versa. Such telescopic arrangements must be loose, that is, an annular opening must be provided between the surrounding equipment and the surrounded equipment to permit, particularly at the burner end, the continual free rotational movement of the equipment relative to each other which otherwise would become bound because of the thermal distortion normally attendant such a setup and would not rotate. Further, the annular opening is essential because the equipment settles on its foundation which, even though slight, is sufficient to further bind the pieces if the opening were not provided.

With such an annulus present, however, processing problems arise both of a social and an economic nature. Thus the ingress of air from the surrounding atmosphere through the annulus dilutes the burner gases and greatly impairs the fuel economies so essential to mineral processing. Further, the egress of exhaust gases (irrespective of whether countercurrent or parallel gas flow is employed) spreads dust and, depending on the material treated, foul odors to the nearby community. Certain materials treated in this manner are also found to be highly corrosive upon dispersion into the normally moist air characteristic of a major portion of the North American industrial area.

A further problem arising from an unattended annulus is in the control of the draft. Thus, where a burner is used to create a reducing atmosphere in a kiln by flooding with fuel and controlling the oxident (as in the production of sponge iron and the like from its oxide salts), it is essential that the additional oxygen from the air be precluded from the kiln to avoid upsetting the desired fuel-oxygen ratio and which could radically change the operating conditions in the kiln.

Various means have heretofore been proposed to maintain an annular sealing ring in sealing engagement over the annulus to overcome the aforementioned problems.

One prior art proposal includes a plurality of independent crank arms with pendulum type counterweights hung therefrom whereby the counterweights cause the crank arm to pivot into engagement with the ring and bias the ring into engagement over the annulus. While substantially effective in providing the seal for which they

were designed, these extra pieces of equipment mounted around the kiln are frequently damaged, require additional cost both to install and to maintain, and are not satisfactory at all for prolonged installation at the heated end of the kiln, because the great heat there encountered distorts both the kiln, the ring and the biasing means thereby impairing the essential interrelationship therebetween.

Another prior art device comprises compression spring clamps mounted between the kiln and a bearing ring disposed adjacent thereto whereby the compression springs bias the kiln seal into engagement with the hood wall to achieve the desired object. These again, however, require extra parts, frequent maintenance and, additionally, involve extra costs both to install and maintain.

A third prior art approach comprises camming of the seal ring with juxtaposed channel irons secured to the surrounding equipment whereby the relative rotational movement of the ring is maintained in a substantially uniform plane, preset to the annulus, during the rotation of the kiln. These rings prove satisfactory with new kilns, but again when a kiln becomes out of round, these rings bind and have to be replaced with larger rings long before their otherwise useful wear life has been exhausted.

A fourth prior art device comprises an angular annular ring mounted at one end in a channel defined on the surrounding equipment and at another end in a similar channel defined on the surrounded equipment. This ring, similarly to the third device above, again proves undesirable after the kiln has been run on heat for a while because it binds the kiln and greatly interferes with its operation. Another disadvantage arises from its number of parts which require considerable material and labor for fabrication.

The present invention is based upon my unexpected discovery that all of the aforementioned special attachments, levers, pendulum weights, cams, springs, channels and the like, can be completely eliminated and a ring provided which achieves excellent results by an assymetrical ring design in which the plane of the center of gravity of the ring (normal to the axis of cylinder rotation) is axially displaced relative to a corresponding parallel plane including the engagement between the ring and the kiln to create a force moment which opposes the natural response of the ring to the rotation of the kiln by continuously tilting the ring into sealing engagement with its corresponding sealing surface.

Accordingly, one of the primary objects of the present invention is to provide a suitable kiln air seal which obviates the aforementioned disadvantages and has a simple structure completely devoid of extra pendulum weights, special cranks, angle irons, channels, grooves, cams, springs, and other biasing or camming means auxiliary to the ring, to maintain it in sealing engagement over the annulus intermediate the auxiliary equipment and the kiln.

Another object of the present invention is to provide an improved sealing ring of the type described which offsets the helix angle encountered by normal rotation of the kiln relative to the ring to walk itself into and maintain sealing engagement throughout its operation over an annular opening circumscribing the kiln.

Another object of the present invention is to provide for rotating cylinders an improved sealing ring characterized by having the plane of its center of gravity (normal to the axis of cylinder rotation) axially displaced relative to a corresponding parallel plane including the engagement between the ring and the kiln whereby a force moment is created about the engagement which continuously urges the sealing ring into sealing engagement over an annular opening circumscribing the kiln.

Another object of the present invention is to provide

an improved air seal ring which is self-counterweighted and continuously tends to tilt itself into sealing engagement with associated equipment.

These and still further objects as shall hereinafter appear are fulfilled by the present invention in a manner easily discerned from the following detailed description when read in conjunction with the accompanying drawing.

In the drawing,

FIG. 1 is a side elevation partially in section of a rotary kiln embodying the present invention;

FIG. 2 is a sectional view taken along line II—II of FIG. 1 with details of the kiln being omitted for clarity;

FIG. 3 is a sectional view taken along line III—III of FIG. 1 with details of the kiln being omitted for clarity;

FIG. 4 is an enlarged fragmentary cross sectional showing of a portion of a seal embodying the present invention;

FIG. 5 is a fragmentary section of another seal embodying the present invention; and

FIG. 6 is an enlarged section of another seal embodying the present invention.

Referring to the drawing, the present invention is exemplified in connection with an inclined rotary kiln having a countercurrent flow of gas therethrough although it is understood that the concept of this invention is equally applicable to rotating cylinders utilizing parallel gas flow.

In FIG. 1, a conventional rotary kiln **11** inclines slightly downwardly from a feeder housing **12** to a burner hood **13** to assist in the translation of material therethrough. Kiln **11** comprises a tubular shell **14** having an internal lining **15** formed of a suitable refractory material such, for example, as refractory bricks. A plurality of riding rings **16** (only one ring is shown in the drawing) is disposed circumferentially about shell **14** and is supported on suitable carrying rollers **17**. Suitable drive means (not shown) are provided such, for example, as motor driven ring gears and the like.

At one end of the tubular shell **14**, an annular end plate **20** is secured and defines a substantially circular opening **21** (hereafter called "feed opening") through which a feed material, either dry or as a slurry, is fed from a chute **22** interconnecting kiln chamber **23** and a suitable storage facility (not shown).

Another annular end plate **24** is secured at the other end of shell **14** and defines a substantially circular opening **25** (hereafter called "discharge opening") through which the material, after treatment in the kiln, is discharged to conveyors, coolers and the like according to the exigencies of the material being treated.

At the feeder end of the kiln, chute **22** is supported within housing **12** which has a front wall **26** in which is defined an opening **27**. Opening **27** preferably corresponds generally to the shape of cylindrical shell **14** but is intentionally larger to provide for the telescopic arrangement of the kiln **11** within the housing **12** as shown. The dimensional difference between opening **27** and shell **11** defines an annulus **28** which permits slight distortion of kiln shell, attendant operation to occur without binding the housing and the kiln.

The opening defining surface **29** of the front wall **26** of the feeding housing is provided with a collar member **30** extending outwardly from the housing toward the kiln having a radially extending flange **31** circumferentially disposed thereupon presenting a bearing surface **32** toward kiln **11**, the significance of which shall hereinafter be more fully explained. Housing **12** is provided with suitable support such, for example, as legs **33** which maintain housing **12** substantially stationary after installation.

At the discharge end of the kiln **11**, a cooling jacket **40** may be provided in circumscribing relationship to shell **14**. Such a jacket is found particularly desirable when the material being processed requires high temperatures. When exceedingly high temperatures are used, the discharge end encounters severe thermal conditions. The use of a cooling jacket, therefore, helps to dissipate some of the heat from the end of the shell to overcome to a certain extent the serious distortion otherwise resulting from the action of the heat on the metal shell.

Adjacent the discharge end of kiln **11**, burner hood **13** comprises a housing **41** having a lining **42** formed of a suitable refractory material. Hood **13** contains a conventional burner **43** through which is fed the mixture of fuel and oxygen desired for the specific process to be employed in the kiln. The firing hood is provided with a suitable means such, for example, as rollers **44** to permit the axial expansion and contraction of the kiln simply in response to the application of the heat.

Hood housing **41** includes a front wall **45** having defined therein an annular opening **46** (similar to opening **29** in the feeder wall **26**) which circumscribes the cooling jacket **40** to define an annulus **47** therebetween. Where the particular kiln application does not require a cooling jacket **40**, annular opening **46** is adjusted in dimension to define annulus **47** with the shell **14**. The portion of hood front wall **45**, extending radially away from opening **46** but contiguous thereto, corresponds to bearing surface **32** hereinbefore described in connection with flange **31** and will be hereinafter identified as the hood bearing surface **48**.

As shown in FIG. 1, annular sealing rings **50**, **51** are respectively provided in circumscribing relationship to shell **14** for respectively closing annuluses **28**, **47** to the passage of gases therethrough.

Ring **50** (see FIGS. 1, 2 and 5) illustrates one embodiment of the present invention and comprises an axially extending annular inner surface **61** having a cylinder engaging portion **62**, an annular sealing surface **63** extending radially from inner surface **61** and engaging bearing surface **32** of the feeder **12** to close annulus **28** and a weighting portion **64** extending generally axially away from sealing surface **63** and coacting with cylinder engaging portion **62** to define a moment arm **65** therewith.

Ring **51** (see FIGS. 1, 3 and 4) illustrates another embodiment of the present invention in circumscribing relationship to jacket **40**. Of course, where jacket **40** is omitted, ring **51** can be made smaller and will ride directly upon shell **14**.

Ring **51** likewise exemplifies the salient characteristics of the present invention and comprises an axially extending annular inner surface **71** having a cylinder engaging portion **72**, an annular sealing surface **73** extending radially from inner surface **71** and engaging bearing surface **48** of hood **13** to close annulus **47** and a weighting portion **74** extending generally axially away from sealing surface **73** and coacting with cylinder engaging portion **72** to define a moment arm **75** therewith.

As particularly shown in FIGS. 3 and 4, weighting portion **74** of ring **51** comprises a plurality of independent weight means **76** which are symmetrically secured to an annular portion **77** to form effectively an integral structure therewith in which the center of mass is axially offset from the natural center of ring **51**, the significance of which shall be developed more fully in subsequent paragraphs.

The weight means **76** may be formed in ring **51** in any suitable manner such as with threads **78** (see FIG. 4) and welding (see FIG. 3).

Similarly, in ring **50**, weighting portion **64** comprises a continuous annular flange **66** secured to the outer end **78** of an annular portion **77** to form effectively an integral structure therewith in which the center of mass is axially offset from the natural center of ring **50**.

Another alternative embodiment is ring **53** (see FIG. 6) comprising an axially extending annular inner surface **81** having a cylinder engaging portion **82**, an annular sealing surface **83** extending radially from inner surface **81** for engaging a bearing surface such as surfaces **32**

and 48 to close an annulus such as annuluses **28**, **47** and a weighting portion **84** extending away from sealing surface **83** in a generally axial direction and coacting with cylinder engaging portion **82** to define a moment arm **85** therewith.

As shown in FIG. 6, weighting portion **84** comprises a continuous annular flange **86**, which in the manner of ring **51** may be segmented if desired, secured to annular portion **87** intermediate the outer end **88** and the inner surface **81** thereof.

As previously explained, an important characteristic of the present invention is the definition of a moment arm by the coaction of the weighting portion and the kiln engaging portion of the interior surface to bear the sealing surface of the ring into engagement with its corresponding bearing surface.

In the operation of the rotary kiln inclined as shown in FIG. 1, the weighting portion of the rings over compensates the normal helix angle engendered by the rotation of the kiln within the rings and through the moment arms so created, turns the ring into a sealing engagement with the corresponding bearing surface whereby the ingress and egress of gases through the respective annular openings are substantially precluded. It has been found that less counterweighting mass is required on the downhill seal, as at the burner hood, than at the uphill seal, as at the feeder as shown. However, the essential concepts involved remain the same. That is, the kiln seal rings embodying the present invention provide an axial displacement of the plane normal to the axis of rotation of the kiln containing the center of gravity of the ring and the corresponding plane through the engagement between the slightly larger ring and the kiln with the gravity plane being displaced away from the annulus being sealed; whereby a force moment is created and a new helix angle is created which causes the ring to walk into its sealing position.

Further, it has been found desirable to position the feeder housing **12** and the burner hood **13** slightly askew so that front walls **26** and **45** converge in a horizontal direction on the downwardly moving side of the kiln. While the exact phenomenon resulting from this slight misalignment is not fully understood, it is observed that the seal rings counterweighted in accordance with the present invention (that is, provided with a weighting portion which causes the center of mass of the resulting structure to be axially offset from the natural center of the ring) conform more nicely to their bearing surfaces which may more nearly simulate the new helix angle.

Weighting as used herein means that amount of weight required to provide a force moment equal to that required to over compensate the normal helix angle of the free ring during kiln rotation (irrespective of location) added to that required to create a new helix angle which walks the rings into their desired sealing positions. These calculations are rudimentary in view of the present disclosure identifying their pertinence and can be readily accomplished by a technician.

Three embodiments have been shown which illustrate the concept of the present invention. However, it is

readily understood that such modifications as may occur to one skilled in the art which entail the spirit of the present invention and the actual displacement of the plane following normal to the axis of rotation of a kiln of the center of gravity relative to that of the contact between the rings and the kiln are intended within the scope of the present invention.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. Apparatus comprising in combination a stationary member and a rotating cylinder telescopically arranged therein, said cylinder coacting with said stationary member to define an annular opening therebetween disposed in circumscribing relationship to said cylinder, and closing means circumscribing said cylinder adjacent said stationary member and closing said annular opening, said closing means comprising an annular ring member circumscribing said cylinder, said member having a narrow inner circular edge portion adapted to rest on and make loose contact with the outer periphery of said cylinder and having a flat annular surface adapted to engage said stationary member and to close said annular opening and weighted means extending axially away from a back side of said ring opposite said annular surface, said weighted means extending from a location on said back side that is radially outward of said inner edge portion and providing together with the weight of the ring a center of mass axially backward of said edge portion for tilting said surface whereupon said tilting and rotation of said cylinder moves said ring member into engagement with said stationary member.

2. A structure according to claim 1 in which said weighted means comprises a continuous annular flange projecting axially from the outer periphery of said annular surface and in the axial direction extending away from the back side of said annular surface.

3. A structure according to claim 1 in which said weighted means comprises a continuous annular flange projecting axially from said annular surface intermediate the outer and inner peripheries of said annular surface and in the axial direction extending away from the back side of said annular surface.

4. A structure according to claim 1 in which said weighted means comprises a plurality of discrete symmetrically disposed weights.

5. A structure according to claim 4 in which each of said discrete weights comprises a shank portion attached to said closing means and a knob portion attached to said shank portion in axially spaced relation to said closing means.

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