

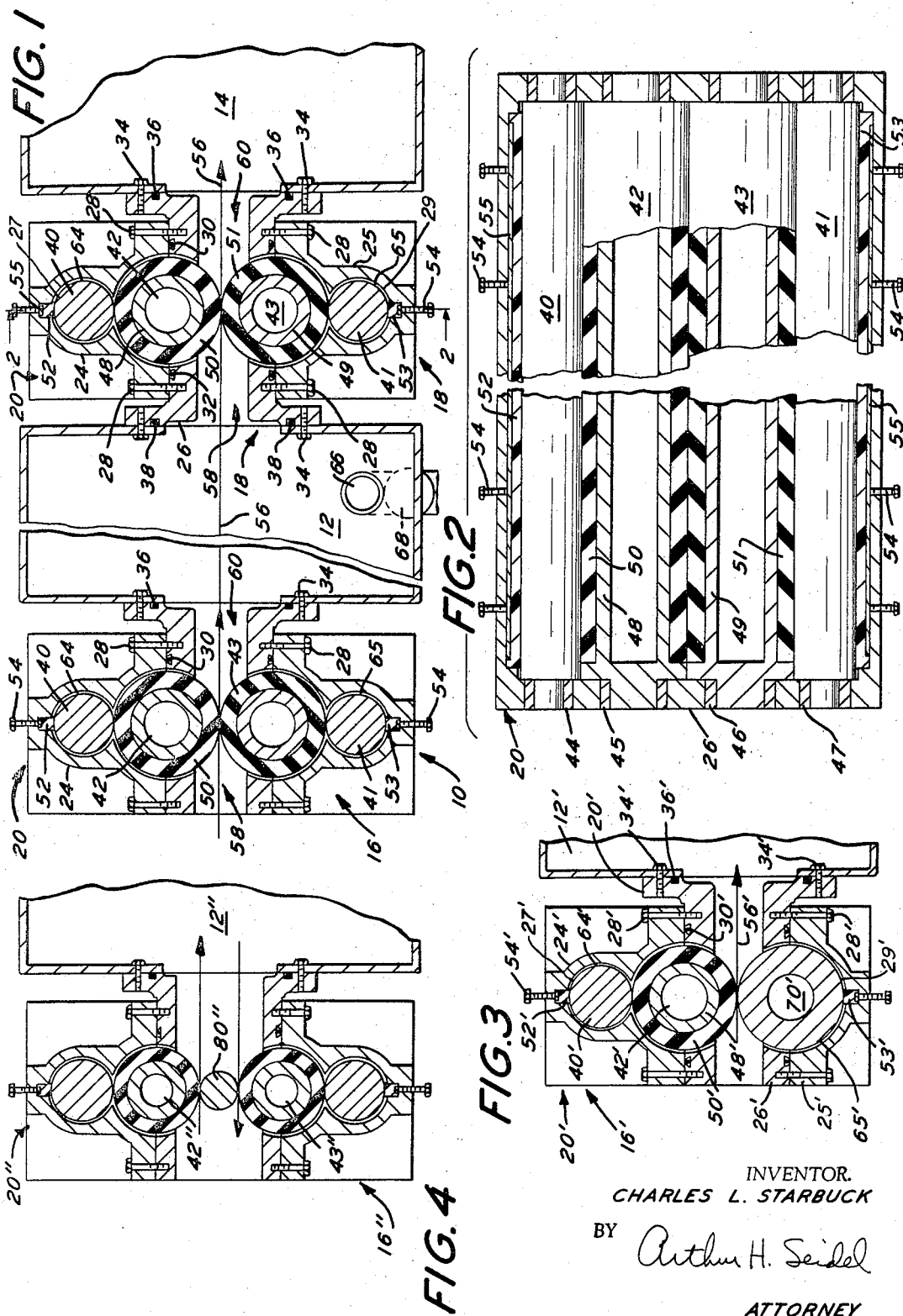
Aug. 8, 1967

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3,334,908

ROTARY SEAL

Filed April 13, 1964



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3,334,908

ROTARY SEAL

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Filed Apr. 13, 1964, Ser. No. 359,082

4 Claims. (Cl. 277-237)

This invention relates to a rotary seal means. More particularly, the present invention relates to an apparatus for providing a continuous rotary seal between chambers at different pressures.

In vacuum coating apparatus, it is necessary to feed the material to be coated through a heated chamber, the interior pressure of which is extremely low. The efficient operation of such coating apparatus requires that the material be fed continuously through said chamber. The problem presented, therefore, is to provide a means by which said chamber may be maintained at low pressures and raised temperatures while the material to be coated is fed through it. It has been found that rotating mating rollers may be used to provide continuous feeding of the material through said chamber while at the same time sealing said chamber against changes in its interior pressure.

It has been found that rotary sealing means may successfully be used for vacuum coating at extremely low pressures if a series of chambers are provided, each of which is at a successively lower pressure than the next preceding chamber. The rotary sealing means are spaced between said chambers and feed material to be coated from chamber to chamber.

The design and construction of such rotary sealing means is of extreme importance to insure that the vacuum within each chamber will be maintained at the correct pressure. In this regard, it has been found that a proper seal may be better maintained by providing the mating rollers, between which the material to be coated must pass, with an elastomeric sleeve. Additionally, it has been found that sealing is improved if the clearance between the housing enclosing the wiper roller and the wiper roller itself is dimensioned to be less than the mean free path of the molecules in the chamber at the higher pressure. To further increase the ability of the rotary seal means to prevent leakage, a wiper seal means is provided between said wiper roller and said housing.

In order to save much time and expense, the roller housings are constructed in such a manner that they may be disassembled to permit removal of one of the rollers without disturbing the other. Thus, the close tolerances between the rollers and their housings are not disturbed.

It is an object of the present invention to provide a novel rotary sealing means.

It is another object of the present invention to provide a rotary sealing means for use in vacuum coating apparatus.

It is another object of the present invention to provide a rotary sealing means wherein the clearances are designed to be less than the mean free path of molecules at that pressure.

It is still another object of this invention to provide a novel rotary sealing apparatus wherein the housing is constructed so as to permit removal of one of the rollers without disturbing the other rollers.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there are shown in the drawings forms which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

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FIGURE 1 is a longitudinal sectional view of the rotary sealing apparatus of the present invention illustrated in one of its environments.

FIGURE 2 is a cross sectional view taken along the line 2-2 in FIGURE 1.

FIGURE 3 is a sectional view similar to FIGURE 1 but illustrating a second embodiment.

FIGURE 4 is a sectional view similar to FIGURE 1 but illustrating a third embodiment.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown in FIGURE 1 a portion of a vacuum coating system 10.

The portion of vacuum coating system 10 as shown comprises a first vacuum chamber 12 and a second vacuum chamber 14. At either end of a vacuum chamber 12, rotary sealing apparatus 16 and 18 are attached thereto. The sealing apparatus 18 is also attached to vacuum chamber 14 and seals said vacuum chambers from one another. The material to be coated 56 enters vacuum chamber 12, traverses the same, and exits through sealing apparatus 18 into vacuum chamber 14. The pressure in vacuum chamber 12 is reduced from atmospheric pressure but is at a higher or lower pressure than that in vacuum chamber 14. Rotary sealing apparatus 16 and 18 seal vacuum chambers 12 and 14 from one another and the atmosphere, thereby enabling said chambers to be maintained at the correct reduced pressures.

Since, for purposes of description of this invention, rotary sealing apparatus 16 and 18 are substantially alike, only rotary sealing apparatus 18 will be described in detail.

The rotary sealing apparatus 18 is contained within a housing 20 which is comprised of roller housings 24, 25 and frame 26. Roller housings 24 and 25 include transversely disposed cavities 27 and 29, and are bolted onto frame 26 by means of bolts 28. A hermetic seal between roller housings 24, 25 and frame 26 is insured by providing seals 30 and 32. Frame 26 is hermetically coupled to vacuum chambers 12 and 14 by means of bolts 34. Seals 36 and 38 hermetically seal frame 26 to vacuum chambers 12 and 14.

Rotatably mounted within the cavities 27 and 29 of the roller housings 24 and 25 are wiper rollers 40, 41. Sealing rollers 42, 43 are rotatably coupled to the frame 26. As shown in FIGURE 2, said wiper rollers and sealing rollers 40-43 stand four high and are journaled within bearings 44-47. The outside diameter of each of wiper rollers 40 and sealing rollers 42 is such that each is in sealing contact along a line parallel to its longitudinal axis with the next adjacent roller.

Wiper rollers 40 and 41 are made of a metal such as steel. On the other hand, sealing rollers 42 and 43 are comprised of inner metal cylindrical cores 48, 49 and outer sleeves 50, 51 of elastomeric material molded or otherwise applied. Said elastomeric material may be any one of Viton, butyl rubber, silicone rubber, neoprene rubber, etc.

Mounted in the roller housings 24 and 25 are wiper seals 52 and 53. Wiper seals 52 and 53 are in continuous contact with wiper rollers 40 and 41, and provide a means to seal off any leakage that may occur because of the necessary clearance between the rollers and their housings. To make certain that complete continuous contact is made between the wiper seals 52 and 53 and wiper rollers 40 and 41, adjustable screws 54 are threaded into housing 20 and engage a flat spring 55 molded into wiper seals 52, 53. By tightening screws 54, wiper seals 52, 53 are forced into contact with wiper rollers 40, 41. Wiper seals 52, 53 may be made of a tough self-lubricating material such as Teflon or its equivalent to thereby provide a tough, substantially frictionless contact between them and wiper rollers 40, 41.

As may be seen in FIGURES 1 and 2, a continuous unbroken seal is provided between vacuum chambers 12 and 14. Wiper seal 52 is attached to roller housing 24 and makes contact with wiper roller 40; said wiper roller 40 is in contact with sealing roller 42 which in turn is in contact with sealing roller 43; said sealing roller 43 makes continuous sealing contact with wiper roller 41, which in turn is in continuous sealing contact with wiper seal 53.

The material to be coated 56 entered housing 20 through inlet means 58, passes between sealing rollers 42, 43, and exits into vacuum chamber 14 through outlet means 60 in frame 26. As the material to be coated 56 passes between sealing rollers 42 and 43, the elastomeric material of sleeves 50, 51 is forced apart by an amount only sufficient to permit passage of said material. The elastomeric sleeves deform around material 56 and thereby maintain the seal between chambers. Sheets of material 56 such as steel strips of a thickness from .010 to .120 have successfully been moved through the sealing means. Other materials and other thicknesses, of course, can be processed depending on the coating process.

To further insure a good seal between vacuum chambers 12 and 14, it has been found that if the clearance spacings 64 and 65 between wiper rollers 40, 41 and roller housings 24, 25 are dimensioned to be less than the mean free path of molecules at the pressure in vacuum chamber 12, leakage will be substantially eliminated. This feature of the invention necessitates that extremely close tolerances be maintained between said wiper rollers 40, 41 and roller housings 24, 25. As rubber rollers would be prone to grab the housings, rollers 40, 41 are made of metal such as steel.

Vacuum chambers 12 and 14 are evacuated in a conventional manner. For example, chamber 12 is evacuated by means of outlet 66 and pump 68.

Because of the close tolerances described above, whenever it is necessary to replace one of the wiper rollers 40, 41 or sealing rollers 42, 43, much time and expense can be saved by specially constructing housing 20. In this regard, roller housings 24, 25 are bolted directly to frame 26 and may be removed therefrom without disturbing the other wiper rollers and sealing rollers. After roller housing 24 has been removed, for example, sealing roller 42 is exposed and may be replaced. Since wiper roller 40, in removed roller housing 24, remains fixed in its bearings, the close tolerances between it and roller housing 24 are not disturbed. If wiper roller 40 is to be replaced, the other rollers are not disturbed.

In FIGURE 3, there is shown another embodiment of the present invention wherein the rollers are stacked three high. The embodiment described in FIGURE 3 is identical to that described in FIGURE 1 except as will be made clear hereinafter. Accordingly, corresponding elements have been provided with primed numerals.

In the embodiment illustrated in FIGURE 3, vacuum chamber 12' is sealed by means of rotary sealing apparatus 16'. Housing 20' is comprised of roller housings 24', 25' and frame 26'. Said roller housings 24' and 25' include transversely disposed cavities 27' and 29', and are bolted to frame 26' by means of bolts 28'. Frame 26' is secured to vacuum chamber 12' by means of bolts 34'. Seals 30' and 36' provide a hermetic seal between frame 26' and vacuum chamber 12'.

Wiper roller 40', sealing roller 42', and enlarged wiper roller 70' are rotatably mounted within housing 20' by means of journal bearings. Wiper roller 40' and enlarged wiper roller 70' are made of metal. Sealing roller 42' is constructed of an inner cylindrical metal core 48' and an outer sleeve of elastomeric material 50'. The sleeve is molded or otherwise applied.

Wiper seals 52' and 53', made from the same material as seals 52, 53, are rotatably mounted within the cavities 27' and 29' of the roller housings 24', 25', and make complete continuous contact with wiper roller 40. Threaded adjustable screws 54' insure that contact between wiper

roller 40' and wiper seal 52' is complete and continuous.

Spacings 64' and 65' between wiper rollers 40' and 70' and roller housings 24', 25' respectively, are dimensioned to be less than the mean free path of molecules at the pressure on the inlet side of rotary seal 16'. This provides the same sealing effect described above with regard to the embodiment shown in FIGURES 1 and 2.

As is obvious from the drawing, the embodiment shown in FIGURE 3 operates substantially as does the embodiment shown in FIGURES 1 and 2. Any one of wiper roller 40', enlarged wiper roller 70' or sealing roller 42' may be removed without disturbing the clearances 64' and 65' between said wiper rollers and roller housings 24' and 25'. As with the embodiment shown in FIGURES 1 and 2, rotary sealing apparatus 16' is completely effective in permitting material to be coated 56' to pass between two chambers at different reduced pressures on opposite sides of said rotary seal apparatus.

For most effective use, I have found that the elastomeric material used for sleeve 50' should be one of the following: Viton, butyl rubber, silicone or neoprene rubber.

In operation, a system using the sealing apparatus of the present invention would include a series of vacuum chambers like chambers 12 and 14 serially arranged at successive differential pressures. The pressure in each chamber would be progressively reduced as the sheet material moves toward the middle chamber. Then, pressure in each chamber would be progressively increased as the material moves toward the end of the series of chambers. A sealing apparatus according to the invention would be placed between each chamber in the series and on the end of the final chambers. The spacing between the wiper rollers and housings of each sealing apparatus is adjusted to be less than the mean free path of molecules in the chamber at the higher pressure.

Another embodiment of the invention, shown in FIGURE 4, may be used to reduce the number of vacuum chambers required by one-half.

The structure of the embodiment shown in FIGURE 4 is identical with that of FIGURE 1, except a fifth roller 80'' has been placed between sealing rollers 42'' and 43''. Because of the similarity between the embodiments of FIGURE 1 and FIGURE 4, only the operation of roller 80'' in the apparatus will be described.

Roller 80'' is journaled in roller housing 20'', and rotated between sealing rollers 42'' and 43''. Roller 80'' may be made entirely of metal or may be covered with an elastomeric surface. Thus, sheet material can pass into the vacuum chamber 12'' as indicated by the arrow, and exit from chamber 12'' on the other side of roller 80'' as indicated by the second arrow. The sealing action between roller 80'' and sealing rollers 42'' and 43'' will be the same as that described with regard to sealing roller 42' and enlarged wiper roller 70. A mechanism (not shown) will be provided in the last vacuum chamber to reverse the direction of the sheet material.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

It is claimed:

1. A rotary seal means comprising a frame having an opposed inlet and outlet, a pair of mating rollers rotatably coupled to said frame and extending transversely thereacross, at least one of said rollers having an elastomeric surface, a housing coupled to said frame overlying and enclosing a portion of said one roller, said housing including a transversely disposed cavity, a wiper roller in said cavity and normally in rolling contact with said one roller, said wiper roller and said housing defining therebetween a clearance space less than the mean free path of gas molecules at the inlet of said frame, wiper seal means between said wiper roller and said housing means for securing said housing to said frame so that said

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wiper roller may be removed from said rotary seal without displacing said mating rollers, and sealing means between said housing and said frame.

2. A rotary seal means in accordance with claim 1 including means for securing the other of said mating rollers to said frame so that it may be removed without displacing the other of said rollers.

3. A rotary seal means comprising a frame having an opposed inlet and outlet, sealing rollers rotatably coupled to said frame and extending transversely thereacross, at least one of said rollers having an elastomeric surface, housings coupled to said frame overlying and enclosing portions of said sealing rollers, said housings including transversely disposed cavities, wiper rollers in said cavities and normally in rolling contact with said sealing rollers, said wiper rollers and said housings defining therebetween clearance spaces less than the mean free path of gas molecules at the inlet of said frame, wiper seal means in said housings in contact with said wiper rollers, means for securing said housings to said frame so that said wiper rollers may be removed from said rotary seal without dis-

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placing said sealing rollers, and sealing means between said housings and said frame.

4. A rotary seal means in accordance with claim 3 including a roller intermediate said sealing rollers and in sealing contact therewith.

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