

Sept. 16, 1969

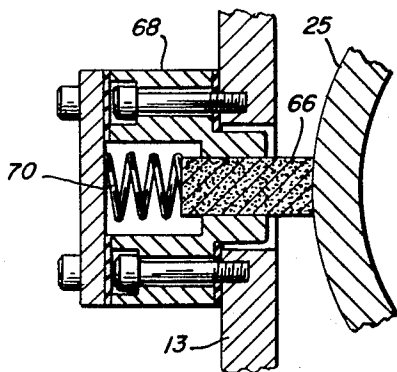
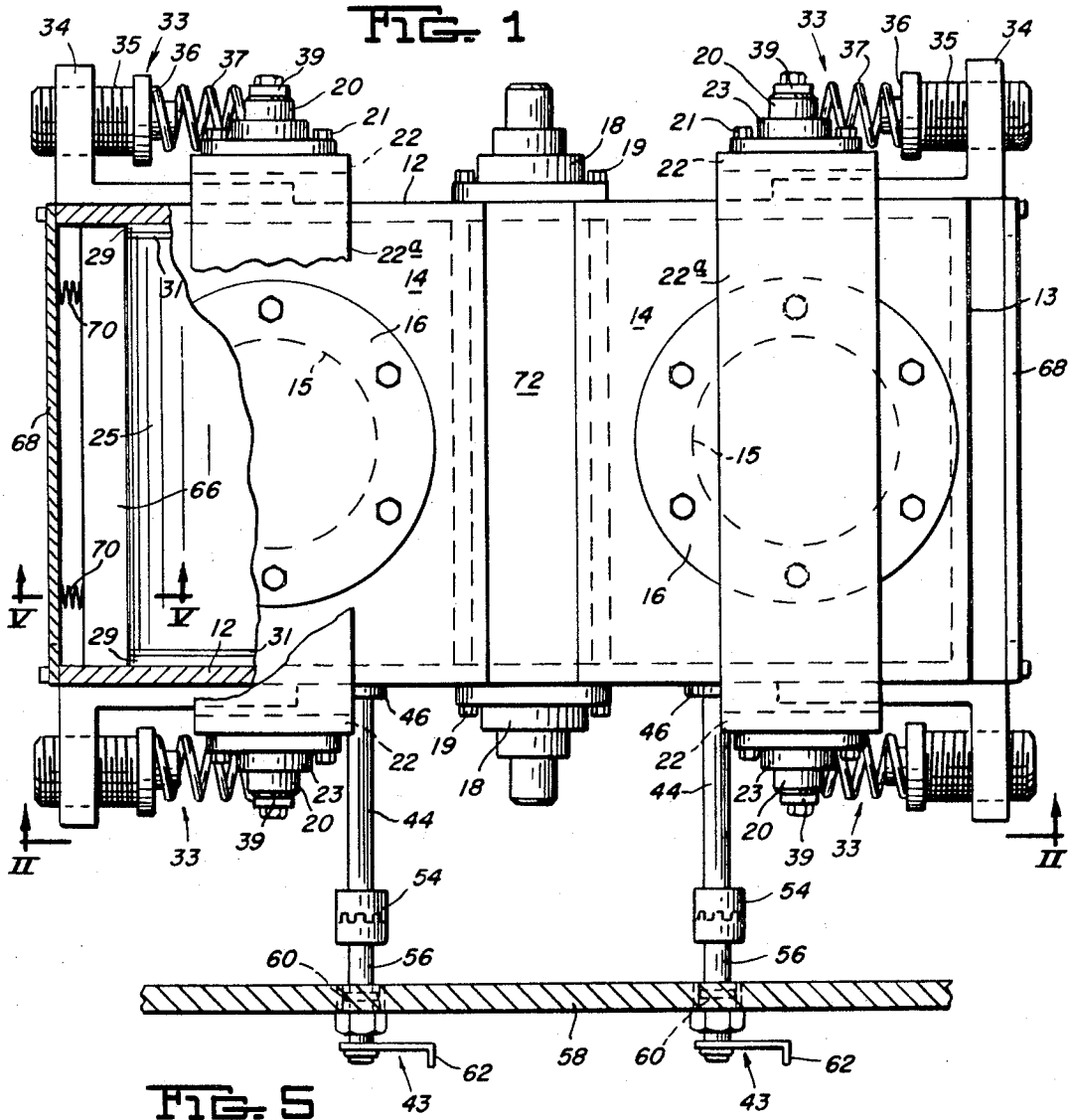
C. E. KELLY ETAL

3,467,399

ROLL SEAL FOR VACUUM STRIP-TREATING CHAMBER

Filed July 17, 1967

4 Sheets-Sheet 1



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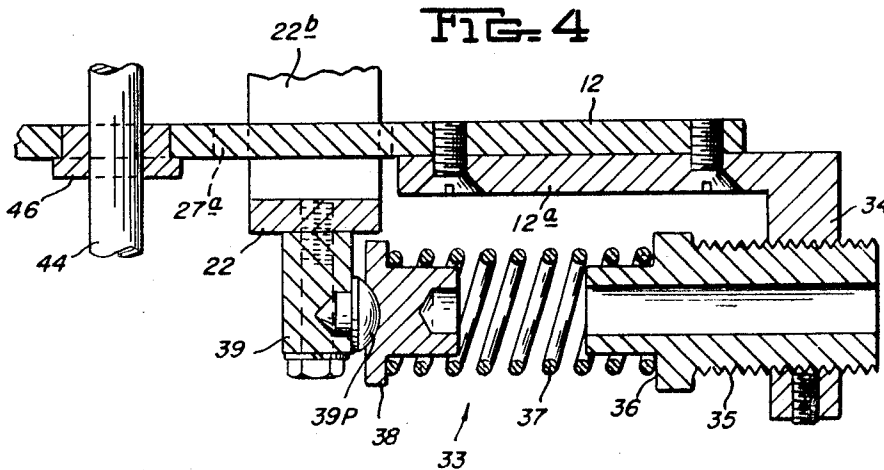
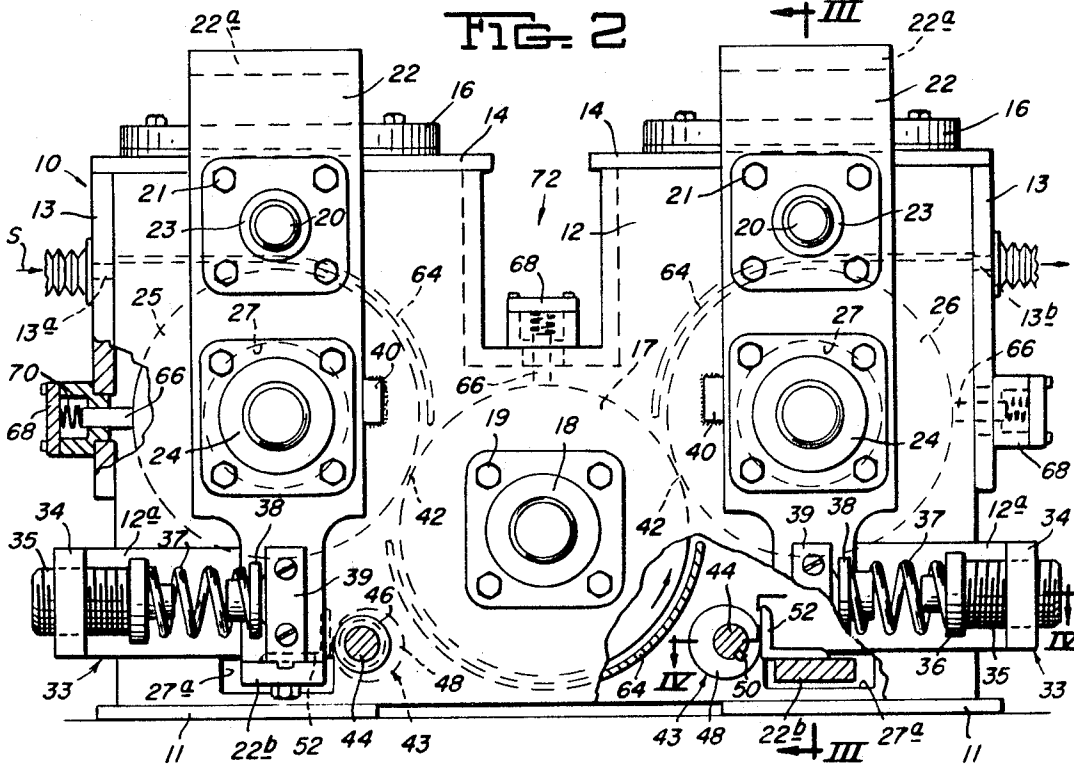
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ROLL SEAL FOR VACUUM STRIP-TREATING CHAMBER

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4 Sheets-Sheet 2



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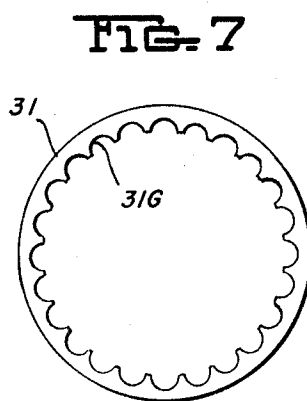
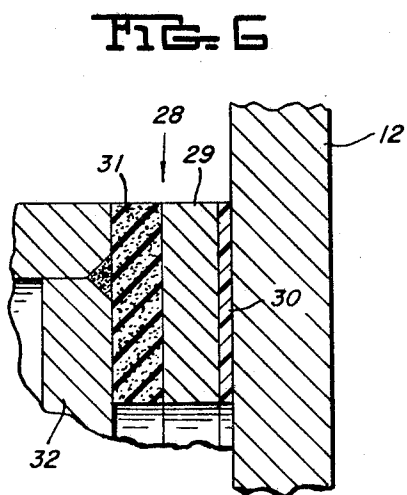
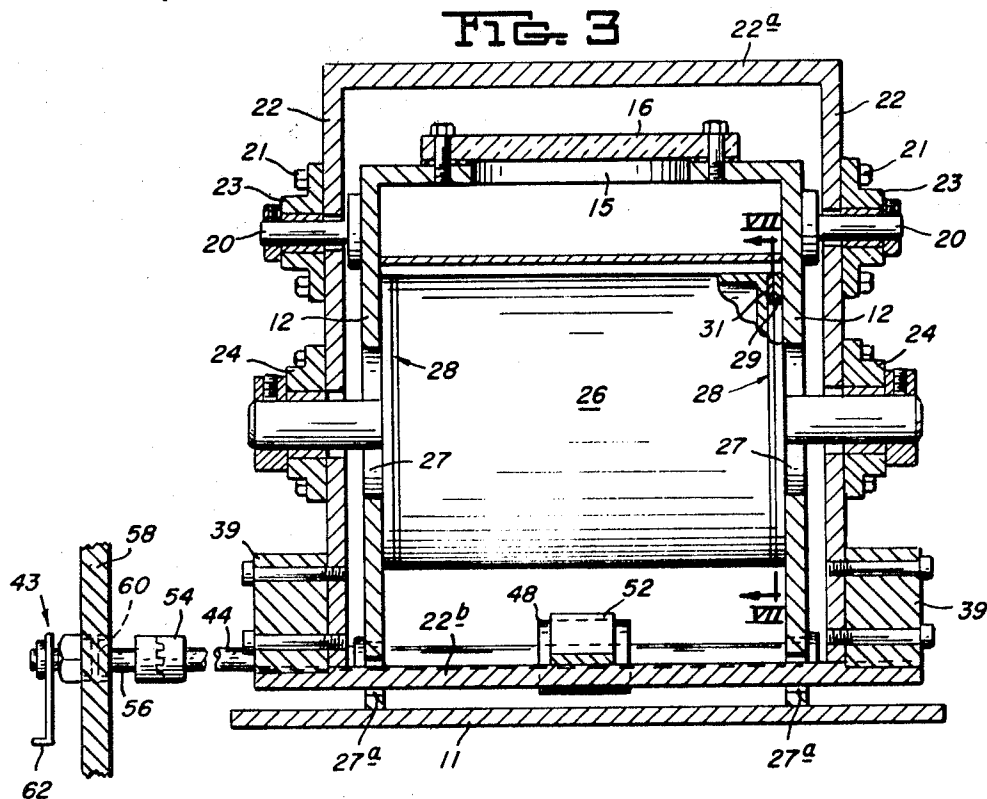
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4 Sheets-Sheet 3



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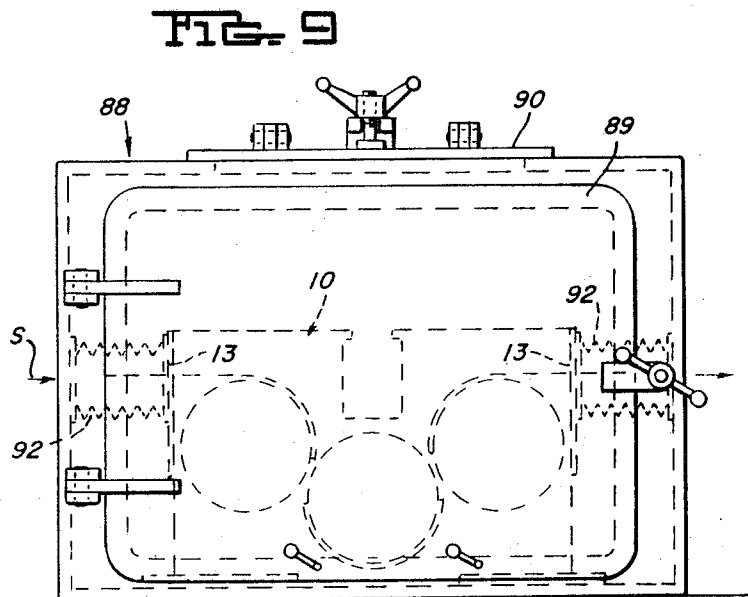
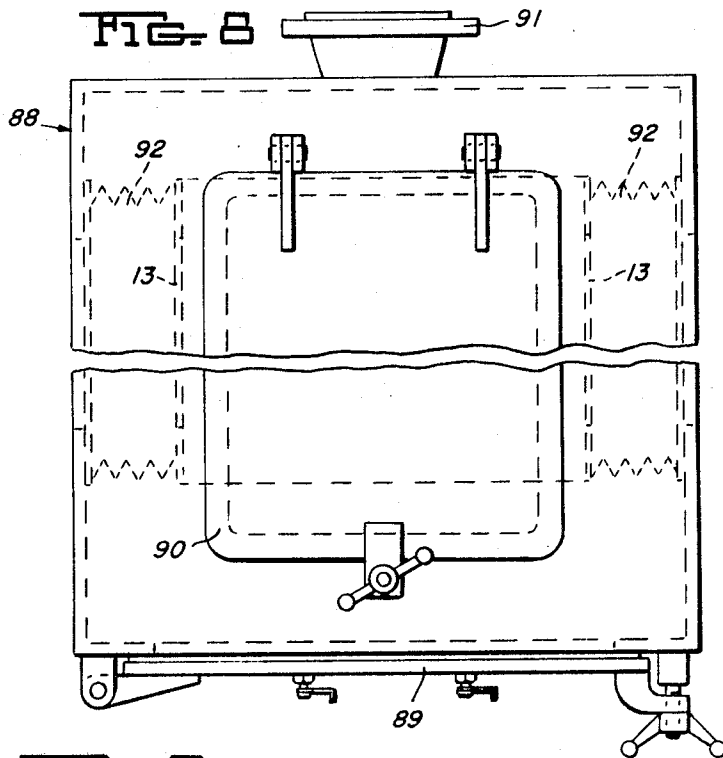
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ROLL SEAL FOR VACUUM STRIP-TREATING CHAMBER

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4 Sheets-Sheet 4



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3,467,399

ROLL SEAL FOR VACUUM STRIP-TREATING CHAMBER

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Continuation-in-part of application Ser. No. 424,405, Jan. 8, 1965. This application July 17, 1967, Ser. No. 653,687

Int. Cl. F16j 15/16, 15/00

U.S. Cl. 277—237

10 Claims

ABSTRACT OF THE DISCLOSURE

A seal for strip entering a vacuum chamber including at least two rolls between and about which the strip passes. One of the rolls is fixed and the other is bodily movable toward and from the fixed roll under adjustable spring pressure. Stops limit the movement of the movable roll toward the fixed roll so that a gap is provided which is wider than strip thickness. The movable roll is journaled in bearings carried by hanger bars pivoted externally on the side walls of the box. Low friction sealing bars parallel to the rolls engage them peripherally. The rolls include a sponge rubber ring of special shape secured to each end of the roll body, an end ring secured to each sponge rubber ring, and a low friction washer secured to the end ring and bearing against the side wall of the box to provide a dry vacuum seal.

This application which is a continuation-in-part of our co-pending application Ser. No. 424,405, filed Jan. 8, 1965 and now abandoned, relates to seals for the entrance and exit of a vacuum strip-treating chamber and, in particular, to a seal embodying a cluster of rolls which afford a circuitous path for the strip and dry seal means slidably engaging the peripheries and ends of the rolls.

It is desirable, in certain instances, to subject a traveling strip to treatment in a vacuum chamber. One example is the coating of steel strip with aluminum, copper, or other metal by vapor deposition in a vacuum. Since the strip must be fed continuously into and withdrawn from the vacuum chamber, seals are required for the chamber entry and exit to maintain the vacuum within the chamber while the strip enters and leaves it.

Seals for this general purpose have been previously provided such as shown in Minton Patent No. 1,595,240, Russell Patent No. 1,924,883 and Nakaguchi Patent No. 3,048,992, but those seals of which we have knowledge have various disadvantages. When a wet seal is used there is the probability that the seal material will be sucked into the vacuum chamber, thus destroying the seal unless additional liquid is added. The seal material can also cause damage to the strip, especially when it is freshly coated. The seals generally depend upon both rolls bearing against the strip which will damage a fresh coating. It is advantageous to use undriven rolls to prevent damage to the coating on the strip. However, this requires that the rolls rotate with little friction. Former seals produced considerable friction, either because of metal to metal contact and/or because of axial forces produced on contact surfaces as the rolls expand due to heat.

It is therefore an object of our invention to provide a vacuum seal for traveling strip which eliminates damage to the strip.

Another object is to provide such a seal which has a controlled gap between adjacent rolls forming the seal.

Still another object is to provide such a seal which does not utilize a liquid sealing material.

A still further object is to provide such a seal which produces little friction between sealing surfaces.

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These and other objects will be more apparent after referring to the following specification and attached drawings in which:

FIGURE 1 is a plan view, partly broken away and in horizontal section, of one multi-roll seal unit of our invention;

FIGURE 2 is a view taken on line II—II of FIGURE 1, partly broken away and shown in section;

FIGURE 3 is a transverse section taken along the plane of line III—III of FIGURE 2;

FIGURE 4 is a partial section taken along the plane of line IV—IV of FIGURE 2;

FIGURE 5 is a view taken on the line V—V of FIGURE 1;

FIGURE 6 is a portion of FIGURE 3 enlarged;

FIGURE 7 is a view taken on line VII—VII of FIGURE 3;

FIGURE 8 is a plan view of an outer vacuum chamber; and

FIGURE 9 is an elevation thereof.

Referring now in detail to the drawings, a preferred seal unit of our invention includes a roll-enclosing housing or box 10 comprising base plates 11, side walls 12, end walls 13 and top plates 14. Access openings 15 in top plates 14 are closed by removable transparent cover plates 16. A fixed center roll 17 is journaled transversely of box 10, in bearings 18 secured to side walls 12 by screws 19.

Adjacent its upper corners, box 10 has bearing pins 20, normal to side walls 12, secured thereto by screws 21. Rollhanger bars 22 are journaled on pins 20 by bearings 23. Bars 22 have bearings 24 at their lower ends in which are journaled the necks of rolls 25 and 26 which coast with roll 17 to form a sealing cluster within box 10. By virtue of hanger bars 22, rolls 25 and 26 may move toward and from roll 17. Side walls 12 of box 10 have roll-neck ports 27 permitting such movement. The hanger bars of each roll 25 and 26 are connected top and bottom by tie bars 22a and 22b, respectively. Ports 27a in the side walls permit movement of the latter.

As shown in FIGURE 3, the rolls 17, 25, and 26 extend the full width of box 10 and have seals 28 at their ends engaging the planed inner surfaces of side walls 12, which are highly polished to reduce friction and give good sealing contact. FIGURE 6 shows a portion of one of the seals 28, which includes a steel ring 29 having a low friction washer 30 of a high temperature synthetic resin such as Dixon Corporation's "Rulon" resin chemically bonded thereto which is in wiping engagement with the inner surface of one of the side walls 12. A gasket ring 31 of high temperature non-absorbing closed cell resilient material, such as COHRLASTIC R-10470 closed cell silicone sponge rubber which has a flexible temperature range of -100° F. to 500° F. and which is manufactured by the Connecticut Hard Rubber Company of New Haven, Conn., is disposed between end ring 29 and the end of roll body 32 and is secured to both by means of high temperature cement. Thus, it is impossible for atmosphere to leak through or around the ring 31 from the outside. The inner periphery of the gasket ring 31 is provided with equally spaced grooves 31G so as to reduce the area of the sidewall of the ring and provide a particular calculated pressure on the adjacent walls 12. This special design permits longitudinal thermal expansion of the seal rolls without any substantial increase in pressure on the sidewalls and maintains a positive seal without increase in drag.

Rolls 25 and 26 are urged toward roll 17 by adjustable spring assembly 33 which is best shown in FIGURE 4. Lugs 34 extend laterally from plates 12a attached to side walls 12 and are drilled and tapped to receive adjusting screws 35 having a spring seat 36 at one end. A compres-

sion spring 37 has one end on the seat of each bushing and a head 38 at the other. Heads 38 engage lugs 39 extending laterally from the lower ends of bars 22. Pin 39P, having a conical surface in contact with head 38 maintains the force of spring 37 normal to bars 22. Stops 40, which maintain a pre-set minimum roll gap 42, limit angular movement of the bars thus effected by the spring 37. The gap between the rolls may be adjusted from outside the vacuum assembly by gap-adjusting assembly 43 which includes a control shaft 44 supported by bushings 46 mounted in sidewall 12 and extending laterally some distance from said sidewall. An eccentric ring 48 secured to shaft 44 by key 50 is mounted in contact with angle 52 welded to crossbar 22b. Shaft 44 is connected by means of a flexible coupling 54 to shaft 56 which is mounted in the outer wall of outer housing 58 by means of vacuum seal 60. Crank 62 affixed to the outer end of shaft 56 is used to control the gap. Suitable drive motors and control units (not shown) may be substituted for the crank 62.

Steel strip S is introduced into box 10 through a slot 13a in the left hand end wall 13, is trained around rolls 25, 17, and 26 as shown in FIGURE 2, and is then brought out through a slot 13b in the right-hand end wall 13. Guide troughs 64 are positioned partially around rolls 17, 25 and 26 to facilitate passage of the leading end of the strip around the rolls. Also to facilitate threading, eccentrics 48 are turned sufficiently to open up spaces between rolls 25 and 26 and roll 17. These eccentrics 48 are thereafter backed off to permit rolls 25 and 26 to provide any selected small gaps between them and roll 17, under the pressure applied by spring back-ups 33. The adjustment must be such that the strip is not squeezed between the rolls.

Rolls 17, 25 and 26 have longitudinal sealing bars 66 which are made of a temperature resistant material having a uniform texture substantially softer than, but not transferable to, the peripheral surface of the roll. Graphite is a suitable material. The inner surfaces of the bars 66 do not need to precisely fit the roll contour initially since it wears under continued use until it does, and thus improves sealing efficiency. The sealing bars for rolls 25 and 26 are slidable in guide frames 68 secured to end walls 13, and are provided with back-up springs 70 which urge the bars 66 against the rolls. The guide frame for the sealing bar engaging roll 17 is located in a central transverse wall 72 in the box 10. This permits replacing or inspection of the bar seal from outside of box 10.

It will be evident that the combination of any two adjacent rolls of the three, 17, 25 and 26, together with their sealing bars 66 and end seals 28 and the roll-surface contact with the strip between the rolls, effectively closes off the flow of gas through the box 10 along the length of the strip, except for the spaces between rolls, between their ends, and the edges of the strip. Thus, the strip passing between two adjacent rolls is used to effect this seal. These spaces are quite small, however, and despite the leakage flow therethrough, the two sealing barriers afforded by the three-roll assembly maintains a very high pressure differential between the entrance and exit slots in opposite end walls. The roll-cluster sealing unit of the drawings may be duplicated in whole or in part (i.e., using only two rolls), to divide the total desired pressure differential among several units in series. One or the other type of unit is fitted tightly against the inlet or outlet of a vacuum chamber (not shown).

It will be seen that the spring back-ups 33 always urge the rolls 25 and 26 toward roll 17, but with a minimum gap greater than the thickness of strip S being established by stops 40 so that the fresh coating material will not be damaged. The gaps are completely closed to effect minimum pump down time when seal modules are cold and not in operation. When sufficient high vacuum is obtained and the coating process started, the components within the seal module become hot and expand. The roll gaps are gradually opened until the equilibrium temperature is

attained within the module. Thus, minimum leakage is maintained permitting a minimum amount of pumping capacity. The gap can also be increased during operation by turning cranks 62. If irregular strip enters the space between rolls, it will force the rolls apart against spring pressure, thus preventing damage to the strip. The gap will be closed instantaneously as the irregular strip leaves the rolls. It will also be noted that the sealing bars always maintain intimate contact with the rolls regardless of their positions.

Since the rolls 17, 25 and 26 are not driven, but are rotated solely by movement of strip S, it is a necessity that very little friction be provided by the seals 28. It is also imperative that there be no relative movement between rolls and strip. This is accomplished by eliminating all metal-to-metal contact during rotation of the rolls and by providing as little axial force by resilient ring 31 as the dimensions of the rolls vary due to heat. This particular design of seal unit is particularly well adapted for staging in series to effect an exit seal system for any degree of vacuum.

In ordinary use, it is desirable to enclose the rollcluster sealing means (one or more) in outer containment boxes 88 (FIGURES 8 and 9), having hinged doors 89 and 90, an exhaust outlet 91 and bellow-like boots 92 adapted to mate with side walls 13, permitting ease of installation without precision machining. Operation of a suitable vacuum pump connected to outlet 91 will serve to bring the pressure within box 88 and outside box 10 to about 10^{-3} torrs and the pressure within box 10 to 10^{-7} torrs. A gas-tight strip-treating chamber (not shown) to which the rollcluster seals of our invention are secured, may therefore be operated at this or even lower pressure since the limited amount of gas leakage through these seals may easily be removed by a pump of reasonable capacity.

Although we have discovered herein the preferred embodiment of our invention, we intend to cover as well any change or modification therein which may be made without departing from the spirit and scope of the invention.

We claim:

1. A multiple-roll seal for traveling strip comprising a box having a top, a bottom and side and end walls; a pair of bearings fixed on said side walls on a common axis;
 - a first rotatable roll journaled in said bearings and extending substantially the full width of the box, said strip passing only partially around said roll;
 - a second pair of aligned bearings fixed in said side walls on a common axis spaced from but parallel to said first-mentioned axis;
 - hanger bars disposed externally of said box and journaled in the bearings of said second pair, respectively;
 - a third pair of aligned bearings carried, respectively, by said bars;
 - a second rotatable roll extending substantially the full width of said box and having journals projecting through said side walls with clearance relative thereto, into the bearings of said third pair, said strip passing only partially around said second roll;
 - means urging said hanger bars and second roll toward said first roll;
 - the inner surfaces of said side walls adjacent the ends of said rolls being flat, the ends of said rolls having a low friction surface bearing against said inner surfaces;
 - said rolls including a main body portion, at least one end section, and a closed cell resilient ring member between said end section and said body portion;
 - first dry sealing means including a low friction sealing bar extending parallel to said first roll for the full length thereof between the adjacent wall and the outer surface of the first roll where not contacted by the strip, and resilient means urging the sealing bar against the first roll; and

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second dry sealing means including a second low friction sealing bar extending parallel to said second roll for the full length thereof between the adjacent wall and the outer surface of the second roll where not contacted by the strip, and resilient means urging the second sealing bar against the second roll; said box having slits therein for the entrance and exit of the strip.

2. Apparatus according to claim 1 in which the low friction surface of said roll includes a high temperature resin bonded to said end section.

3. Apparatus according to claim 1 in which said closed cell resilient ring member is bonded to the end of said roll body and to said end section, said resilient ring member being made of silicone sponge rubber, the inner periphery of said resilient ring member having transverse grooves therein.

4. Apparatus according to claim 1 in which each of said sealing bars is made of a temperature resistant material having a uniform texture substantially softer than, but not transferable to, the peripheral roll surface, the inner surface of each bar being shaped to closely fit the associated roll surface.

5. Apparatus according to claim 1 in which said means urging each of said hanger bars is a spring, said apparatus including means outside said box adjustably positioning said second roll closely adjacent the first roll, but with a minimum space between the rolls greater than the thickness of said strip, said last named means permitting movement of said second roll away from said first roll.

6. Apparatus according to claim 2 in which said closed cell resilient ring member is bonded to the end of said roll body and to said end section, said resilient ring member being made of silicone sponge rubber, the inner periphery of said resilient ring member having transverse grooves therein.

7. Apparatus according to claim 6 in which each of said sealing bars is made of a temperature resistant material having a uniform texture substantially softer than the peripheral roll surface, the inner surface of each bar being shaped to closely fit the associated roll surface.

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8. Apparatus according to claim 7 in which said means urging each of said hanger bars is a spring, said apparatus including means outside said box adjustably positioning said second roll closely adjacent the first roll, but with a minimum space between the rolls greater than the thickness of said strip, said last named means permitting movement of said second roll away from said first roll.

9. Apparatus according to claim 3 in which each of said sealing bars is made of a temperature resistant material having a uniform texture substantially softer than, but not transferable to, the peripheral roll surface, the inner surface of said bar being shaped to closely fit the associated roll surface.

10. Apparatus according to claim 9 in which said means urging each of said hanger bars is a spring, said apparatus including means outside said box adjustably positioning said second roll closely adjacent the first roll, but with a minimum space between the rolls greater than the thickness of said strip, said last named means permitting movement of said second roll away from said first roll.

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U.S. Cl. X.R.

34—92, 242; 118—50