

June 5, 1962

H. W. FAEBER ET AL
ROTARY VACUUM CYLINDER

3,037,557

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3 Sheets-Sheet 1

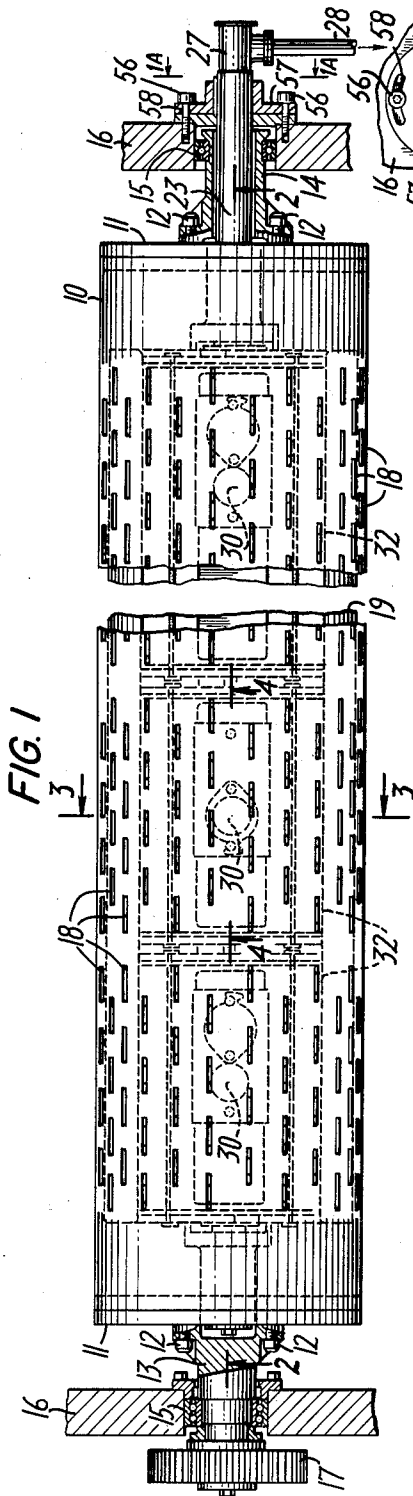
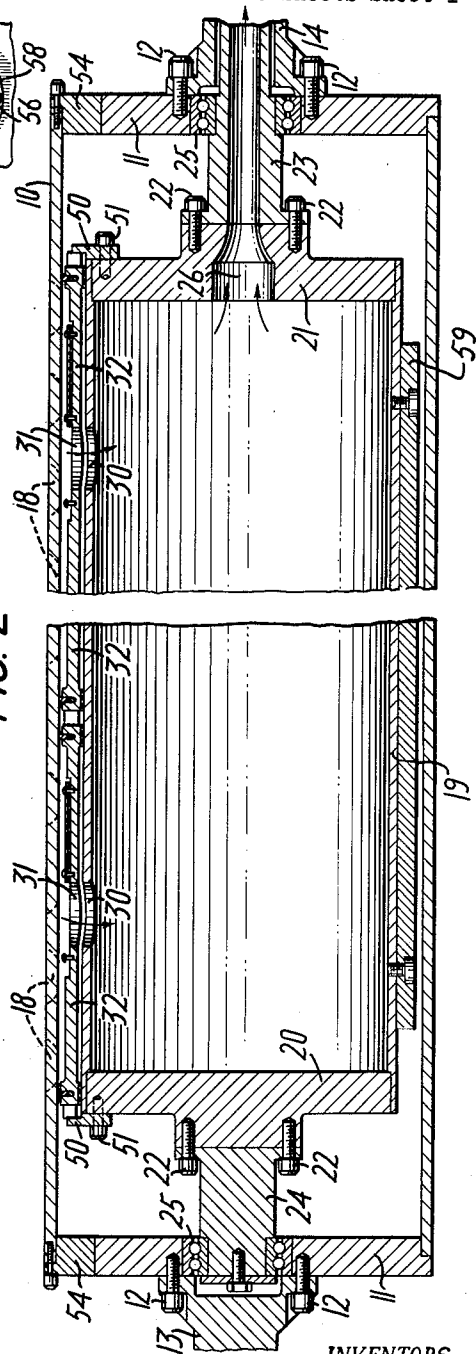


FIG. 2



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3 Sheets-Sheet 2

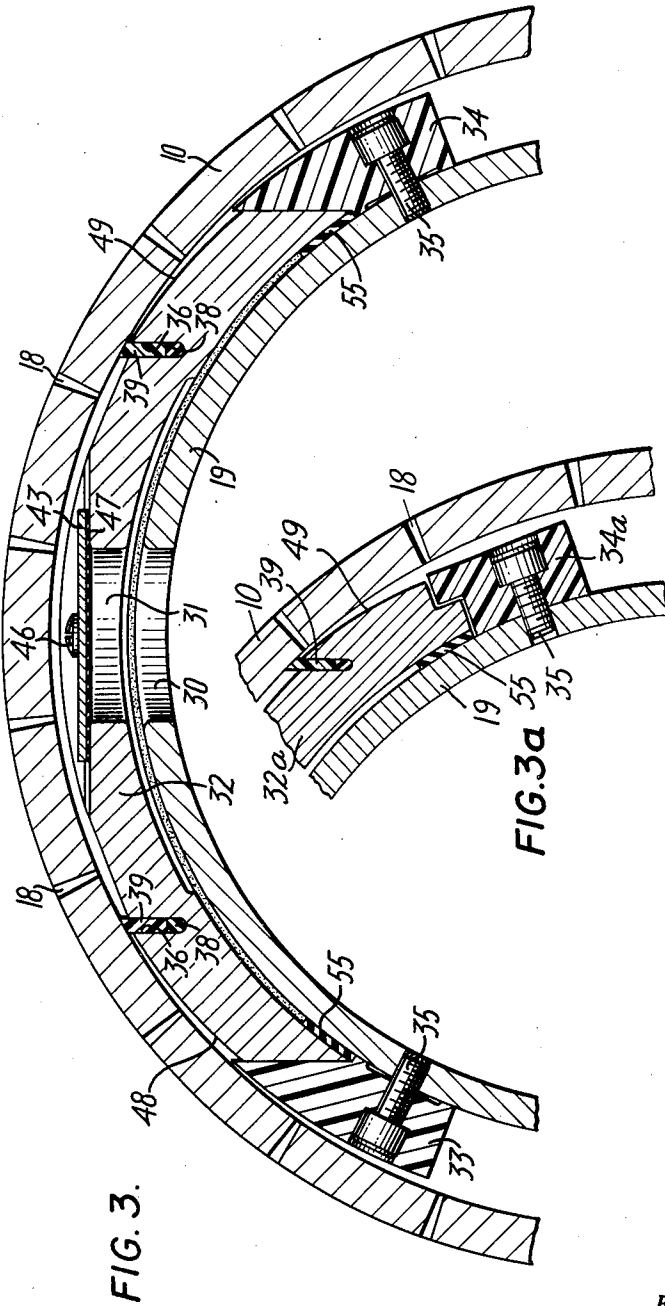
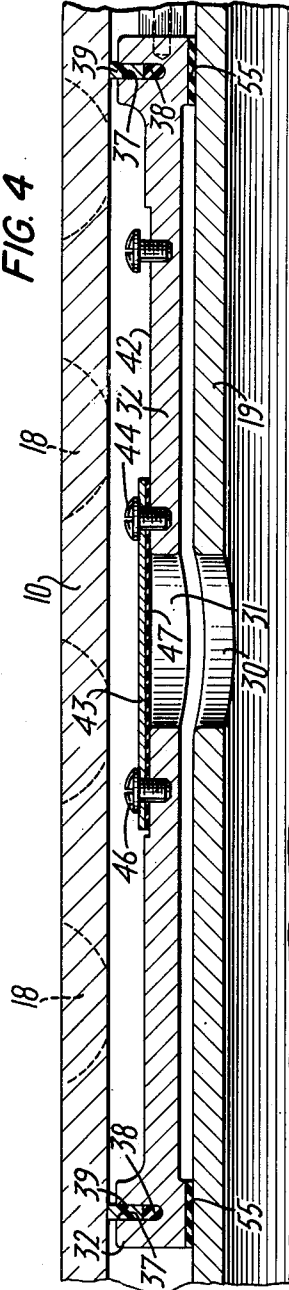


FIG. 4



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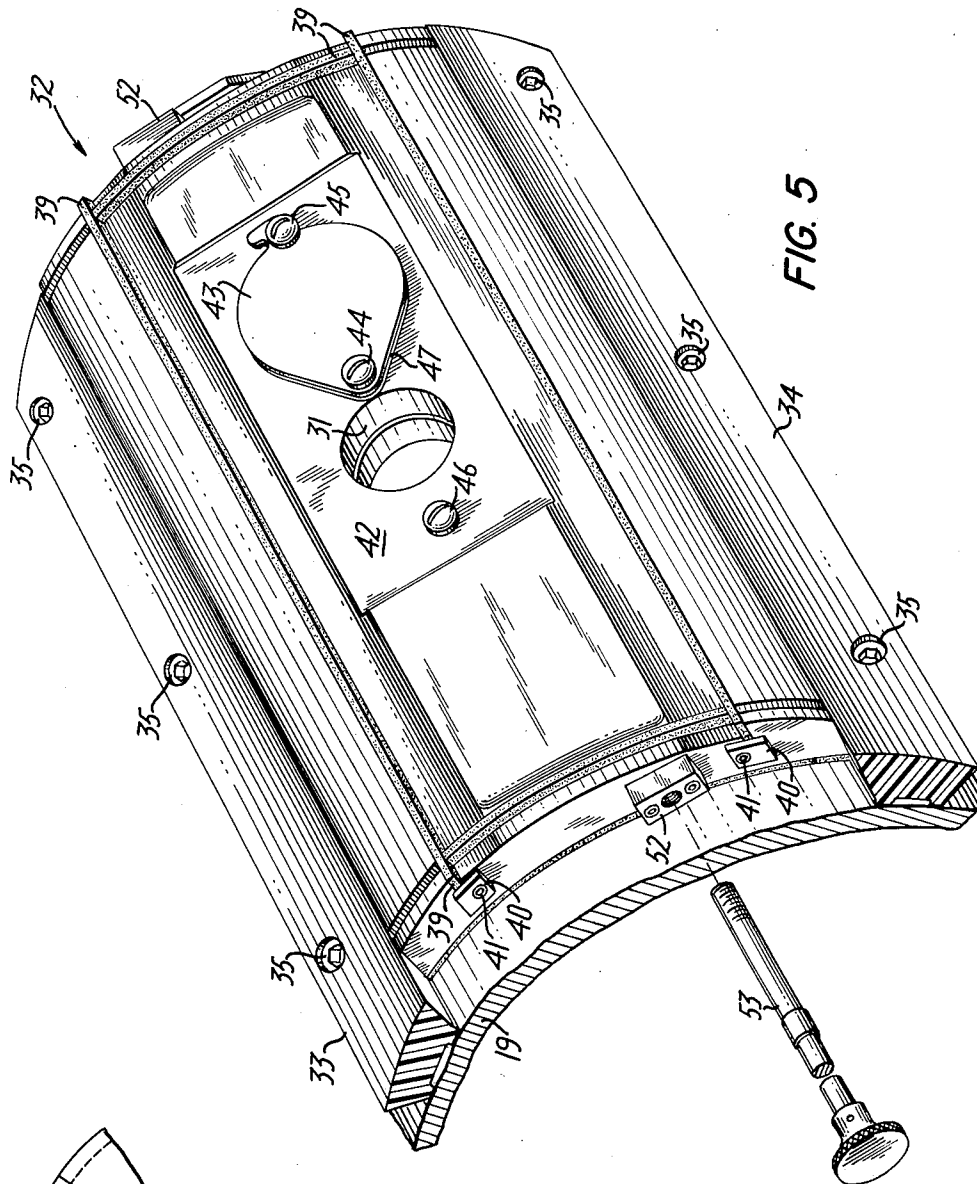
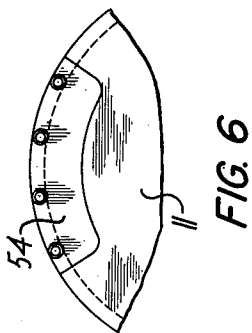
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3 Sheets-Sheet 3



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3,037,557

ROTARY VACUUM CYLINDER

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This invention relates to a novel low-friction rotary vacuum cylinder.

The rotary vacuum cylinder of the present invention has various applications. For example, it can be used in printing presses and coating apparatus to apply tension to a paper web, in paper-making machines to draw off excessive moisture from the paper web, and in apparatus for laminating sheets, particularly in the lamination of thin, difficult to handle plastic film to a paper web.

Conventional rotary vacuum cylinders generate a substantial amount of heat due to friction between the outer rotating cylinder and the non-rotary internal parts. In some applications, therefore, provision is made for cooling the vacuum cylinder. In paper mill practice, for example, the vacuum rolls or cylinders receive water cooling by virtue of the water extracted from the paper stock. However, in other applications, such as in a printing press or laminating apparatus, there is no opportunity for water cooling, and internal spray cooling and spray lubrication are objectionable because they might spot or stain the webs being processed.

It is an object of this invention to provide a rotary vacuum cylinder which, in operation, generates a very small amount of heat caused by friction so that in many applications, even applications requiring high-speed operation for long periods of time, cooling systems will not be required.

The rotary vacuum cylinder of the present invention includes an inner stationary housing having a vacuum chamber therein in communication with a pressure below atmospheric pressure, an outer rotatable perforated cylinder, and sealing strips intermediate the inner housing and outer cylinder held in stationary frames and defining one or more vacuum frames which are in communication with the vacuum chamber. As the perforated cylinder rotates relative to the vacuum frames a web or sheet in contact with the outside of the cylinder is gripped by suction in the areas defined by the vacuum frames.

An important feature of the rotary vacuum cylinder of the present invention lies in the structure which minimizes the generation of heat due to friction. Toward this end, the apparatus is constructed so as to provide a stationary seal frame between the outer rotary cylinder and the internal vacuum housing. This seal frame carries sealing strips which define an outer vacuum area between the outer side of the seal frame and the inner surface of the outer rotary cylinder, as well as a gasket which defines a larger vacuum area between the internal vacuum housing and the inner side of the seal frame. Since both vacuum areas are in communication with the same vacuum chamber by way of an opening through the seal frame, the different sizes of the vacuum areas on opposite sides of the seal frame establish a differential pressure which holds the seal frame firmly against the inner cylinder. This limits the dynamic frictional contact pressure to that between the seal strips and the outer rotary cylinder exerted by the resilience of the underlay urging the seal strips against the inside of the outer cylinder. This is in sharp contrast with the conventional vacuum chambers of the sector shaped design which have a tendency to be drawn by the vacuum against the inner surface of the rotary cylinder, causing the seals to exert substantial pressure on the cylinder which generates a considerable amount of heat by friction.

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Other features of the present invention include means for adjusting the vacuum frames relative to the rotatable perforated cylinder, means for reducing the noise generated by rotation in either direction, and means for opening or closing off the passageways connecting the vacuum chamber and certain of the vacuum frames so that the vacuum effect can be produced at the desired areas on the outer cylinder.

This invention can be more completely understood by reference to the following detailed description of a representative embodiment of the invention taken in conjunction with the accompanying figures of the drawings, in which:

FIGURE 1 is a view of a rotary vacuum cylinder constructed in accordance with the invention;

FIGURE 1a is a section view taken along the line 1a—1a of FIGURE 1;

FIGURE 2 is a view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a view taken along the line 3—3 of FIGURE 1;

FIGURE 3a is a fragmentary view similar to FIGURE 3, but showing an alternative embodiment;

FIGURE 4 is a view taken along the line 4—4 of FIGURE 1;

FIGURE 5 is a view of a seal frame constructed in accordance with the invention; and

FIGURE 6 is an end view of part of the cylinder.

With reference to FIGURES 1 and 2, there is illustrated a vacuum cylinder which includes a hollow outer cylinder 10 having a fitted end plate 11 at both ends. One end plate is fastened by a plurality of bolts 12 to a shaft 13. The other end plate is similarly fastened to a shaft 14. These shafts are rotatably mounted by means of bearings 15 in a frame 16. The cylinder 10 is driven through a gear transmission system which includes a gear 17 affixed to the shaft 13. The cylinder 10 is provided with a plurality of slots 18 which pass through the cylinder wall.

A stationary cylindrical housing 19 having a vacuum chamber therein is accommodated within the interior of the rotary cylinder 10. The cylindrical housing 19 includes press-fitted end plates 20 and 21. These end plates are fastened by a plurality of bolts 22 to the stub shafts 23 and 24 which are supported by the end plates 11 of the cylinder 10 within the bearings 25. The bearings 25 permit relative rotation of the cylinder 10 with respect to the stationary cylinder 19.

The chamber within the closed housing cylinder 19 communicates with a vacuum through a passage 26, a coupling 27 and a suction line 28. The rotatable shaft 14 is hollow, permitting the shaft 23 to extend through it. Sufficient clearance is provided to permit the shaft 14 to rotate relative to the stationary shaft 23.

The inner housing or cylinder 19 contains a plurality of ports 30 therein which are more or less in alignment with ports 31 formed in a series of seal frames 32 positioned between the outer and inner cylinders 10 and 19. Each seal frame 32 is in sealing relationship with the outer surface of the cylinder 19 by means of gasket 55 and with the inner surface of the cylinder 10 by means of seal strips 39. The plurality of sealing strips 39 surrounds a port 31 and defines a vacuum or suction area between the outer surface 42 of each frame and the inner surface of the perforated cylinder. These suction areas cause the outer surface of the cylinder 10 to grip a web or sheet in contact therewith as the slots 18 come into registry with these suction areas underlying the inner wall of the cylinder. In one application of the vacuum cylinder, this gripping action enables the cylinder to apply tension to the web. In other applications, the suction draws air, fumes, vapors or the like through or from a porous web.

The seal frames 32, illustrated in detail in FIGURES 3, 4 and 5, are mounted on the outer circumference of the inner cylinder between two longitudinal guide members 33 and 34 which are fastened to the inner cylinder by a plurality of bolts 35. As shown in FIGURE 3, the opposite edges of the seal frame are beveled and lie beneath complementary surfaces of the members 33 and 34. An alternative construction in which the opposite edges of the end plate 32a are stepped and locked in place by a stepped clamp 34a is shown in FIGURE 3a. The outer surface of each seal frame has two longitudinal slots 36 and two circumferential slots 37 which receive the sealing strips 39. In order to help maintain the outer edges of the seal strips 39 in sealing engagement with the inner surface of the cylinder 19, a resilient insert 38 consisting of material such as sponge rubber or Curon (a plastic material produced by the plastics division of Curtiss-Wright Corp. and identified as formula 508) is inserted on the bottom of each of the slots 36 and 37 beneath the sealing strips 39. Although the sealing strips 39 can be made of various materials, Lamitex, a molded material made by impregnating layers of cloth with a phenolic resin and treating them to produce a molded material similar to Bakelite, has been found particularly suitable. The two longitudinal sealing strips are fixed in place at each end of the frame by stops 40 which are fastened to the seal frame by screws 41. The circumferential sealing strips are fixed in place between the longitudinal seal strips.

The suction area enclosed by the four sealing strips and between the outer surface 42 of the seal frame and the inner surface of the cylinder 10 is in communication with the vacuum chamber within the cylindrical housing 19 through the ports 30 and 31. Each of the suction areas can be closed off by a shutter 43. The shutter 43 is pivotally mounted on a screw 44 adjacent the opening 31 and can be locked in an open position (shown in FIGURE 5) by a screw 45, or in a closed position over the opening 31 by a screw 46. A gasket 47 on the underside of the shutter 43 assures a substantially air-tight seal when the shutter is in the closed position. To prevent air from leaking between the inner cylinder 19 and the frame 32, a gasket 55 is interposed therebetween at the outer edge of the frame 32.

The surfaces 48 and 49 of the seal frames are designed to act as silencers. The surface 48 lies between the guide member 33 and the corresponding longitudinal sealing strip 39, and the surface 49 lies between the guide member 34 and the corresponding longitudinal sealing strip. A very small clearance is provided between the portions of the surfaces 48 and 49 immediately adjacent the longitudinal sealing strips and the outer cylinder 10. However, between the longitudinal sealing strips 39 and the guide members 33 and 34, the surfaces 48 and 49 gradually slope away from the outer cylinder, or, that is to say, the clearances between the surfaces 48 and 49 and the inner surface of the cylinder 10 increase.

As shown in FIGURE 3, the outer surfaces of the guide members 33 and 34 are designed in a similar manner for the same purpose. Their inner edges are spaced closely to the inner surface of the outer cylinder 10 and the clearances between the outer surfaces of the guide members 33 and 34 and the inner surface of the cylinder 10 progressively increases toward the opposite edges of the guide members.

The seal frames 32 can be moved longitudinally of the cylindrical housing 19 between the guide members 33 and 34. A stop 50 is fastened to each of the end plates 20 and 21 by bolts 51 to keep the seal frames 32 in place on the inner cylinder.

Each seal frame has at least one block 52 fastened to it. The block 52 has an internally threaded hole formed therein which is adapted to receive the threaded end of a pull-out rod 53 (FIGURE 5). When the rotary cylinder 10 is not in operation and one of the stops 50 is re-

moved, the frames 32 can be inserted or removed from between the guide members 33 and 34 with the help of the rods 53. Crescent-shaped removable segments 54 in the end plates 11 of larger size than the frames 32, secured by screws (see FIGURE 6), provide the necessary access to the stops 50 and the cylinder 19 when the cylinder 10 is properly oriented.

The areas on the outer cylinder 10 over which a vacuum effect will be produced is determined prior to the insertion of the seal frames 32 by fixing the shutters 43 in either the open or the closed position. When the shutter of a frame is in the closed position, the area defined by the sealing strips 39 of this frame will be cut off from the vacuum chamber within the cylindrical housing 19. On the other hand, the corresponding area of a frame having an open shutter will be in communication with the vacuum chamber. Thus, partial webs (or ribbons) can be run without loss of vacuum.

A very important feature of the invention lies in the means for minimizing the generated heat due to friction. In this connection, it will be noted that the projected area defined by the gasket 55 is greater than the projected area defined by the sealing strips 39. This causes the seal frame 32 to be held against the stationary outer cylindrical surface of the housing 19 by the balance of pressure due to the difference of the above-mentioned projected areas. Thus, the only pressure prevailing between the stationary seal strips 39 and the inner surface of the rotating cylinder 10 is that which is exerted by the resilience of the sponge rubber or Curon inserts 38.

A web-tensioning apparatus constructed in accordance with the invention has the advantage that it can be run without coolant at high speeds on a printing press without danger that the surface of the cylinder will become overheated. This is important because whenever a coolant is used there is a danger that it will reach and ruin the web being printed. This, however, is not intended to suggest that the invention is limited to a web-tensioning device or other applications in which no coolant is used.

The apparatus has another very important advantage in that it can be driven in both directions because the seal frames and silencing features are symmetrically designed. Still another advantage is that the apparatus can be used with a relatively narrow web by closing some of the shutters.

In the preferred construction, the slots 18 do not extend axially beyond the area between roundwise sealing strips 39, as shown in FIGURES 1 and 2 to avoid vacuum leakage and reduce the wear of these seal strips.

The vacuum sector defined by the seal frames 32 is positioned peripherally by rotating the inner cylinder 19 and locking it in position. This is accomplished by loosening the flange screws 56 securing the flange 57 to frame 16. Flange 57 is keyed and clamped to stub-shaft 23 and serves to secure that shaft and thus chamber 19 against rotation. When the flange screws are loose, the assembly can be rotated by virtue of the circular slotted holes 58 in the flange. A counterweight 59 secured to the periphery of inner cylinder 19 diametrically opposite to the frames 32 serves to balance the assembly and thus facilitates turning it to any desired position.

While a representative embodiment of the present invention has been shown and described for purposes of illustration, it is apparent that various modifications can be made therein without departing from the invention in its broader aspects. For example, the housing 19 can take other shapes. Therefore, the invention described herein is not to be construed as limited to the specific embodiment described, but is intended to encompass all modifications thereof coming within the scope of the following claims.

We claim:

1. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder

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rotatably mounted around said inner enclosure, a plurality of removable frame members supported on said enclosure and positioned between said inner enclosure and said outer rotary cylinder, said frame members having sealing means thereon defining with said rotary cylinder a plurality of selected vacuum areas along the inner surface of said cylinder and means by which suction is communicated from said enclosure to said selected areas.

2. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, a plurality of aligned openings formed in said enclosure and extending across the width thereof, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of aligned individually removable plate-like frame members secured to said enclosure over said openings and positioned annularly between said inner enclosure and said outer rotary cylinder, said frame members having sealing means thereon defining with said rotary cylinder a multiple number of selected vacuum areas against the inner surface of said cylinder, and means by which suction is communicated from said enclosure to said selected areas.

3. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, a plurality of openings formed in said enclosure and extending across the width thereof, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of individually removable plate-like frame members secured to said enclosure in sealing engagement therewith and over said openings and positioned annularly between said inner enclosure and said outer rotary cylinder, said frame members defining with said rotary cylinder a multiple number of selected vacuum areas against the inner surface of said cylinder, means by which suction is communicated from said enclosure to said selected areas, and sealing strips mounted on each of said frame members in contact with the inner surface of said cylinder for sealing said vacuum areas.

4. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder rotatably mounted around said inner enclosure, at least one removable plate-like curved frame means supported on said enclosure and positioned annularly across the width thereof intermediate said inner enclosure and said outer rotary cylinder, a first sealing means disposed on the side of said frame means adjacent to said rotary cylinder defining with said rotary cylinder a first vacuum area between said frame means and said rotary cylinder, and a second sealing means disposed on the side of said frame means removed from said rotary cylinder defining a second vacuum area between said frame means and said stationary enclosure, means establishing a vacuum communication between said first and second vacuum areas and said stationary enclosure, said first vacuum area having a smaller projected surface area than said second vacuum area thereby producing a differential pressure on said frame means by which said frame means is urged towards said stationary enclosure and away from the inner surface of said rotary cylinder.

5. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder rotatably mounted around said inner enclosure, at least one removable plate-like and curved frame means supported on said enclosure and positioned intermediate said inner enclosure and said outer rotary cylinder, recesses formed on the side of said frame means adjacent said outer cylinder, sealing strips disposed in said recesses and arranged to define with said rotary cylinder a first vacuum area between said frame means and said rotary cylinder, resilient means within said recesses and acting against the ends of said sealing strips removed from said

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rotary cylinder to urge said sealing strips into engagement with the inner surface of said rotary cylinder, a second sealing means disposed on the side of said frame means removed from said rotary cylinder to define a second vacuum area between said frame means and said stationary enclosure, means establishing a vacuum communication between said first and second vacuum areas and said stationary enclosure, said first vacuum area having a smaller projected surface area than said second vacuum area thereby producing a differential pressure on said frame means by which said frame means is urged towards said stationary enclosure and away from the inner surface of said rotary cylinder.

6. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of removable plate-like and curved frame members supported on said enclosure and positioned intermediate said inner enclosure and said outer rotary cylinder, recesses formed on the sides of said frame members adjacent said outer cylinder, sealing strips disposed in said recesses and arranged to define with said rotary cylinder a first vacuum area between said frame members and said rotary cylinder, resilient means within said recesses and acting against the ends of said sealing strips removed from said rotary cylinder to urge said sealing strips into engagement with the inner surface of said rotary cylinder a second sealing means disposed on the sides of said frame members removed from said rotary cylinder to define a second vacuum area between said frame members and said stationary enclosure, means establishing vacuum communication between said first and second vacuum areas and said stationary enclosure, said first vacuum area having a smaller projected surface area than said second vacuum area thereby producing a differential pressure on said frame members by which said frame members are urged towards said stationary enclosure and away from the inner surface of said rotary cylinder, and closure means mounted on said frame members arranged to close off desired ones of said selected areas from said stationary enclosure.

7. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of individually removable plate-like frame members supported on said enclosure and disposed annularly across the width thereof between said inner enclosure and said outer rotary cylinder, said frame members defining with said rotary cylinder a multiple number of selected vacuum areas against the inner surface of said cylinder, means by which a vacuum effect is directed from said inner enclosure to said selected areas, and closure means mounted on said frame members arranged to close off desired ones of said selected areas from said vacuum effect.

8. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for producing a partial vacuum, a plurality of openings in said enclosure extending across the width thereof, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of individually removable plate-like members supported on said enclosure and disposed annularly across the width thereof between said enclosure and said outer rotary cylinder and over said openings, said frame members defining with said rotary cylinder a multiple number of selected vacuum areas against the inner surface of said cylinder, means by which a vacuum effect is directed from said inner enclosure to said selected areas, and closure means mounted on said frame members arranged to close off desired ones of said selected areas from said vacuum effect.

9. A rotary vacuum cylinder comprising an inner stationary enclosure adapted to be connected to means for

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producing a partial vacuum, a plurality of openings in said enclosure extending across the width thereof, an outer perforated cylinder rotatably mounted around said inner enclosure, a plurality of individually removable plate-like members supported on said enclosure and disposed annularly across the width thereof between said enclosure and said outer rotary cylinder and over said openings, said frame members defining with said rotary cylinder a multiple number of selected vacuum areas against the inner surface of said cylinder, means including said plurality of openings by which a vacuum effect is directed from said inner enclosure to said selected areas, closure means mounted on said frame members arranged to close off desired ones of said selected areas from said vacuum effect, and sealing strips mounted on said frame members in contact with the inner surface of said rotary cylinder for sealing said vacuum areas.

10. A rotary vacuum cylinder comprising an inner stationary vacuum cylinder adapted to be connected to means for producing a partial vacuum, an outer perforated cylinder rotatably mounted around said inner cylinder and coaxial therewith, a plurality of openings formed substantially in a row parallel to the longitudinal axis of the cylinder and across the width thereof, a plurality of removable curved plate-like frame members mounted on said inner cylinder intermediate and sub-

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stantially concentric with said inner and outer cylinders and over said openings, each of said frame members having an opening formed therein aligned with said first mentioned openings, a plurality of sealing strips mounted on the sides of said frame members adjacent to said rotary cylinder and defining with said rotary cylinder a first vacuum area between said frame members and said rotary cylinder about said openings, and second sealing means mounted on the sides of said frame members removed from said rotary cylinder defining a second vacuum area between said frame members and said inner stationary cylinder, said first and second vacuum areas having means for establishing a differential pressure on said frame members by which said frame member is urged towards said stationary cylinder and away from the inner surface of said rotary cylinder.

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