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Nicholson, Jr.

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[54] **ROLLING DIAPHRAGM VACUUM CONTROL**

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[73] Assignee: **Broughton Corporation**, Glens Falls, N.Y.

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[21] Appl. No.: **58,283**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 835,709, June 23, 1969, abandoned.

[52] **U.S. Cl.**..... **137/116.3**, 137/596.18, 137/DIG. 8, 251/DIG. 2

[51] **Int. Cl.**..... **F16k 31/365**

[58] **Field of Search**..... 137/116, 116.3, 596, 137/596.18, 625.3, 625.33, 625.34, 625.37, 625.66, 625.67, DIG. 8; 251/61.1, 331, 334, 358, DIG. 2

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[57] **ABSTRACT**

A vacuum control device for controlling the vacuum delivered to certain elements of paper making machines including a housing wherein passages are provided to permit selective control from a vacuum header or atmosphere to a flat box of a paper making machine and wherein a flexible member is provided to control communication through the vacuum and atmospheric introduction passages which member is normally held in closing position to said passages through the utilization of the introduced vacuum, but will upon proper sensing of the element to be controlled, be rolled past certain of the passages to either open or close the same to thereby control the admission of vacuum or atmospheric pressure or pressure above atmospheric pressure.

9 Claims, 5 Drawing Figures

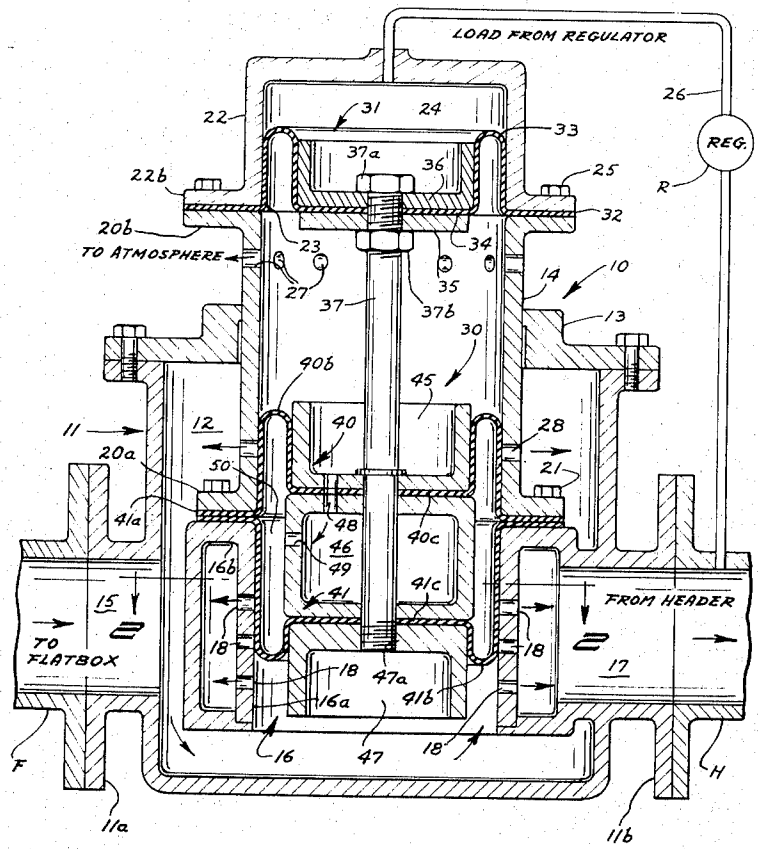

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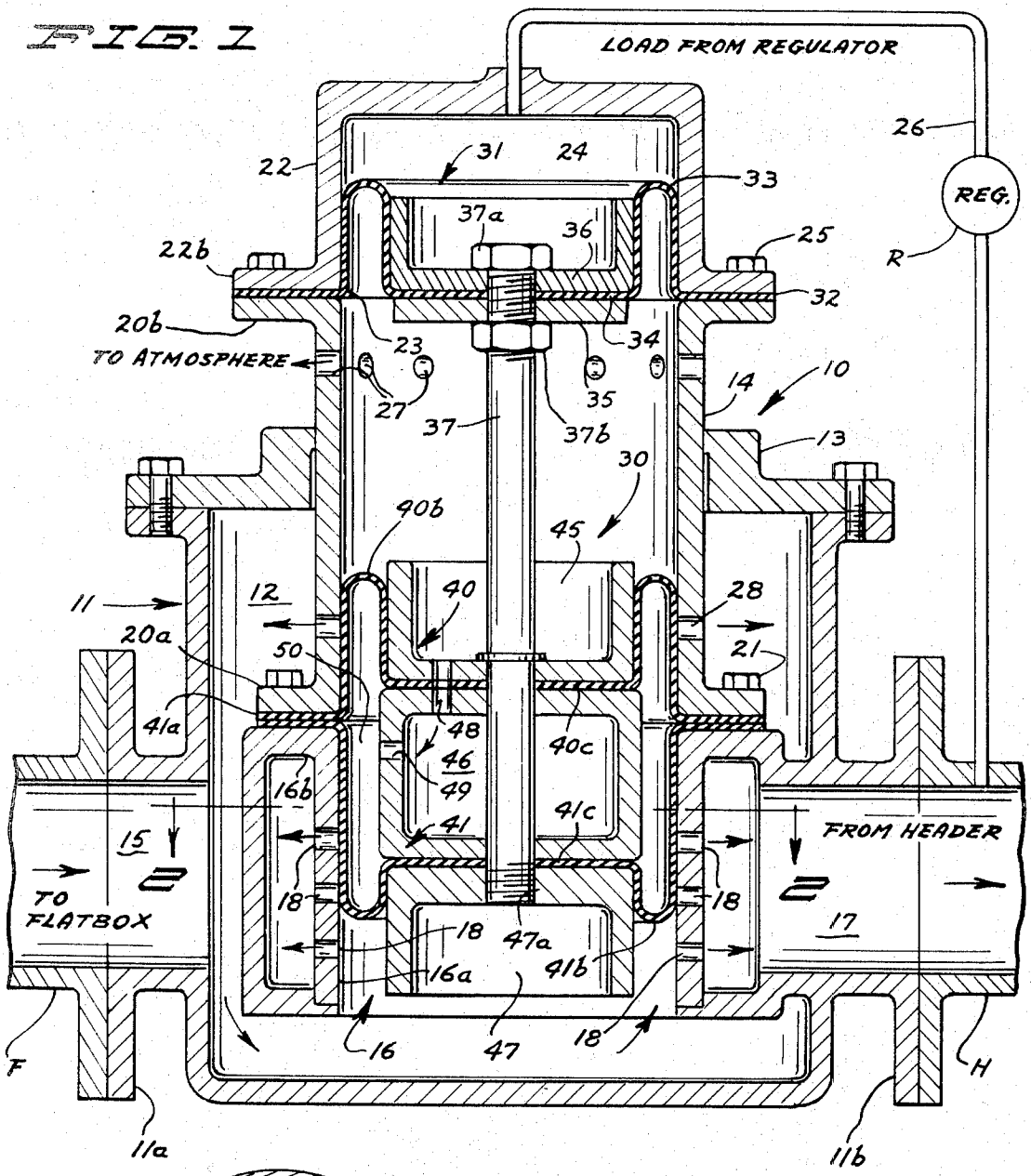
FIG. 1



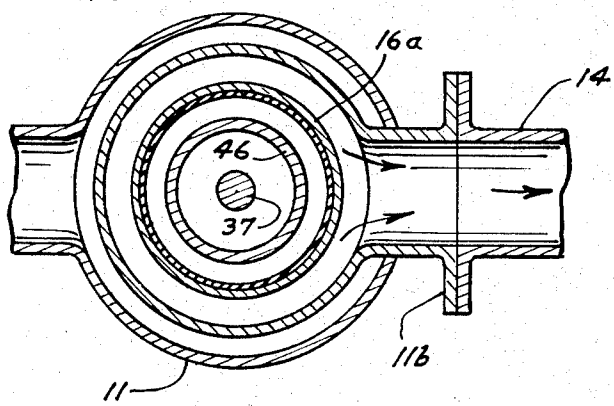


FIG. 2

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FIG. 3

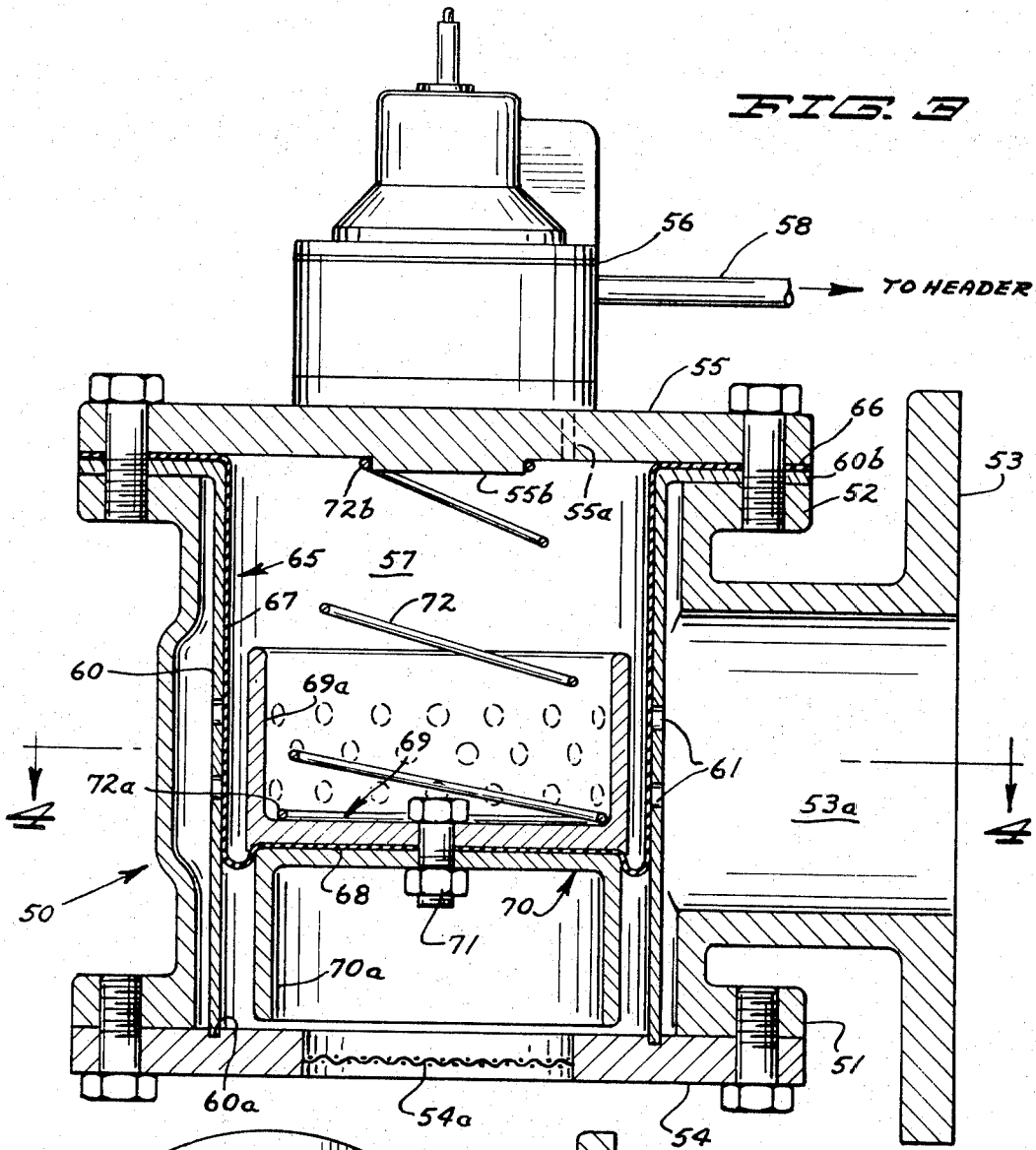
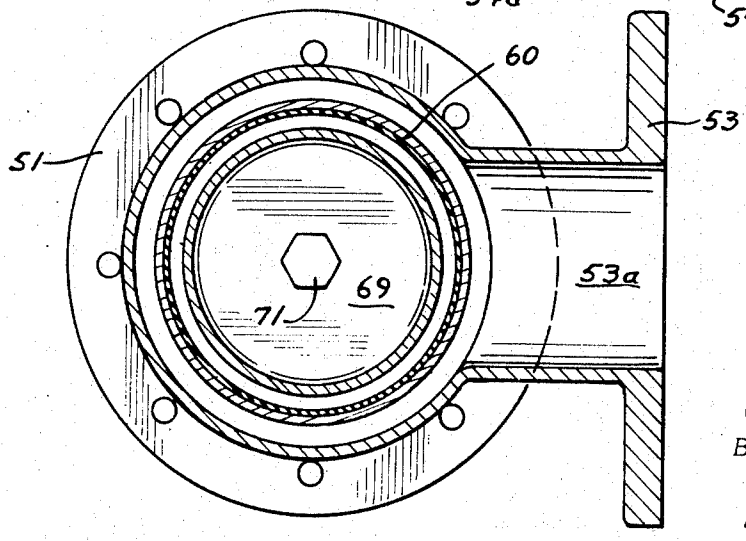


FIG. 4



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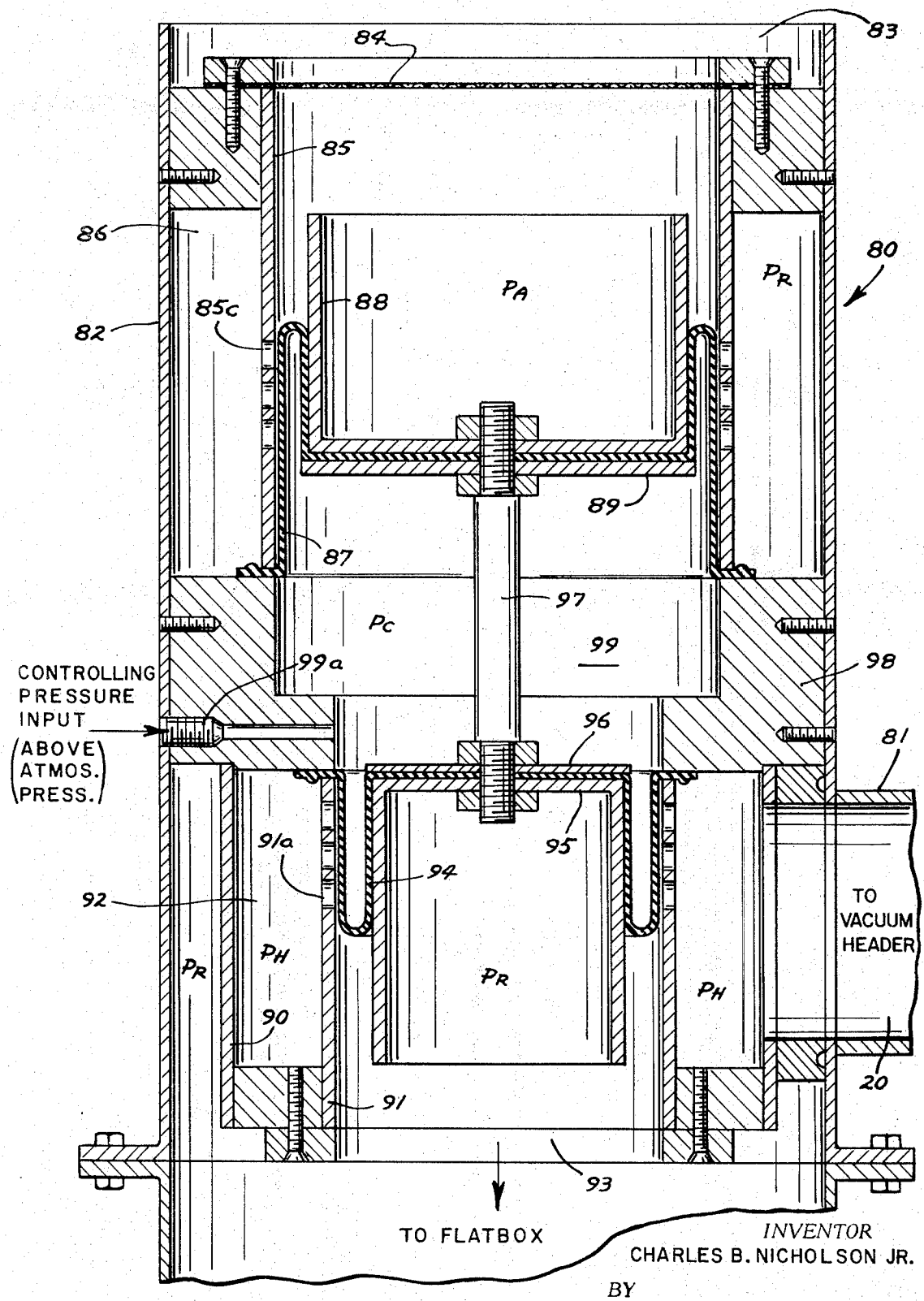

FIG. 5

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ROLLING DIAPHRAGM VACUUM CONTROL

This application is a continuation in part application of an application filed June 23, 1969, Ser. No. 835,709 filed by Charles B. Nicholson, Jr. entitled Rolling Diaphragm Vacuum Control, now abandoned.

In the past, various vacuum control devices for controlling specific operations of paper making machines have been provided which control mechanisms primarily assume the normally assumed shape of a valve wherein a passage is provided between a vacuum header or source of vacuum and the element to be controlled which passage is surrounded by a seat member with a valving device being placed in shiftable relation to said valving seat such that a normal valving function will be performed. Applicant has through this concept, provided a new and unique valving arrangement wherein the normal valving member and seating arrangement is completely eliminated and rather a rolling flexible member is utilized to selectively and controllably open certain selected passages to control the vacuum supply to for example, a flat box. In addition to this particular concept, a sensing arrangement may be provided wherein the rolling operation is controlled in accordance with a predetermined vacuum pressure to be delivered to the element to be controlled with an automatic movement of the rolling member taking place upon any variations from the set condition for the element.

Applicant's device includes variations of the prime concept which will incorporate either a vacuum breaking device such that a vacuum system may be opened to atmosphere upon the system reaching a predetermined vacuum pressure level or that may be utilized to maintain vacuum at a predetermined level by the introduction of either vacuum or atmospheric pressure to the particular sensed area. Primarily, each of the concepts includes the concept of pressure introductions through a selective valving system wherein the valving member provides a flexible member to roll upon itself when opened or closed such that a unique valve member is utilized rather than the now readily available valve and seat structure.

It is therefore an object of applicant's invention to provide a vacuum control member incorporating a flexible valving member designed to selectively open or maintain control through communicating passages by being selectively moved thereacross.

It is a further object of applicant's invention to provide a rolling diaphragm valving member to control vacuum systems wherein the diaphragm is designed to roll upon itself and thereby open and control communication between certain passages in the valving device.

It is still a further object of applicant's invention to provide a rolling diaphragm or bellows valving system to control vacuum pressures which includes a sensing arrangement operatively connected to the operative section, which operative section requires control such that pressure will be automatically maintained at this particular operative section either through the introduction of vacuum or atmospheric pressures thereto.

It is still a further object of applicant's invention to provide a valving member consisting and including a pair of rolling diaphragm members having a control chamber therebetween for introduction of pressures thereto which chamber depends for its actuation upon differentiation in areas of the two rolling diaphragm members.

It is still a further object of applicant's invention to provide a rolling diaphragm valving device including a controlling pressure chamber arranged between a pair of rolling diaphragm members which will provide an automatic actuation device for the introduction of either relief atmospheric pressure, or controlled vacuum pressure into an area in which the pressure is to be controlled.

These and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views, and in which:

FIG. 1 is a vertical section taken substantially centrally through a valving member which incorporates the concepts of applicant's invention and illustrated in connective position between a vacuum header and a flat box of a paper making machine;

FIG. 2 is a transverse section taken substantially along Line 2—2 of FIG. 1;

FIG. 3 is a vertical section taken substantially centrally longitudinally through a modified form of the invention; and

FIG. 4 is a transverse section taken substantially along Line 4—4 of FIG. 3.

FIG. 5 is a vertical section taken substantially centrally longitudinally through a modified form of the invention which basically includes the variations and the improvements over the original invention.

In accordance with the accompanying drawings the utilization of applicant's concept to control the vacuum pressure at flat boxes of paper making machines is illustrated in FIGS. 1 and 2 while the utilization of the concept to control or relieve excessive pressure in vacuum headers is illustrated in FIGS. 3 and 4.

In controlling the flat box pressure the unit **10** is positioned between the vacuum header H and flat box Line F and includes a housing body **11** provided with attachment flanges **11***a*, **11***b*, with the entire control portion of the unit **10** carried by and in the housing **11**. The housing **11** provides a control cavity **12** having a cover plate **13** by which the control cylinder **14** is placed into cavity **12**.

Communication between the cavity **12** and the flat box line F is provided through passage **15** in flange **11***a*. Communication between the cavity **12** and the vacuum header H is provided through the hollow toroidal insert **16** arranged generally centrally in the cavity **12** communicating through passage **17** in flange **11***b* and the plurality of radially extending passages **18** formed in the inner wall **16***a* of the toroidal section **16**. As illustrated the toroidal section **16** provides inner wall **16***a* opening in an axial direction to permit insertion of the control cylinder **14**.

Control cylinder **14** includes a first hollow, generally arcuate member **20** having a flange **20***a* on the bottom thereof, and a flange **20***b* at the upper end thereof. Lower flange **20***a* is secured as through cap screws **21** to the upper wall **16***b* of the toroidal section **16** and provides a clamping arrangement therewith for certain bellows sections as will be described hereinafter. The upper flange **20***b* provides a second clamping surface for a domed closure member **22** having a flexible resilient member **23** is provided such that a loading chamber **24** is provided thereabove. Cap screws **25** provide

the closure effect for the closure member **22** to the control cylinder **14.**

A vacuum introduction Line **26** is provided between the loading chamber **24** and the header H. This Line **26** permits, through the utilization of a regulator R, loading of the chamber **24** such that predetermined vacuum pressures will be maintained at the flat box.

Cover plate **13** is pressure sealed to the control cylinder **14** in such a manner to permit the assembly of the control cylinder H to the toroidal vacuum section **16** as access must obviously be afforded to attachment screws **21** interiorly of the cavity **12.**

Sets of apertures designated **27, 28** are provided respectively above and below the cover plate **14** to permit atmospheric pressures to be selectively to the interior of cavity **12.**

Within the control cylinder **14** a floating piston member **30** is provided. Piston **30** includes a connective control end **31** arranged in controlled relation to the loading chamber **24.** This connective control end **31** includes the afore-mentioned flexible, resilient, diaphragm bellows member which in its common form would comprise a cup-shaped member having a radially extending flange at its upper end. When related to the drawing the flange is designated **32,** the sides of such cup **33** and the bottom **34.** The flange **32** is captured between the afore-mentioned flanges **20*b*, 22*b*** and the bottom **34** is captured through the use of a generally arcuate flat plate member **35** and an inverted cup-shaped member **36** on opposite sides of the bottom **34.** These two capturing elements are clamped by a connecting rod **37** extending therethrough with capturing elements **37*a*, 37*b*** cooperatively associated therewith.

The concept of the bellows member is to permit a relatively large stroke of the connective rod **37** by permitting the bellows to roll upon itself. Obviously, to control such rolling the sizing of the upstanding inverted cup-shaped clamp element **36** in relation to the interior wall of the dome shaped closure **22** is important and in this drawing this relationship is distorted to permit full explanation of the coaction of the elements. It should also be obvious that this sensing bellows could be provided as a flat diaphragm member if the same were large enough to permit the desired stroke.

The connective rod **37** extends to the vacuum and atmospheric introduction area of the cavity **12** and at such area a pair of rolling diaphragm bellows members designated respectively as an atmospheric bellows **40** and a vacuum bellows **41** are provided. The flange portions **40*a*, 41*a*** thereof are clamped between the afore-mentioned flange **20*a*** and the upper wall **16*b*** of the toroidal section **16** while the side wall portions **40*b*, 41*b*** thereof are held respectively upwardly into sealing relation to the interior surface of control cylinder **14** and downwardly into sealing relation to the interior wall **16*a*** of the toroidal section **16** which upward and downward relation is maintained through the means for clamping the respective bottom **40*c*, 41*c*** of the members in spaced relation along the connective rod **37.**

The connective rod **37** and the means for clamping the bellows members **40, 41** are designed to provide a rolling, opening and closing action over the vacuum introducing apertures **28** such that a balancing or floating motion will occur in accordance with the loading chamber **24** pressure and the pressure in the flat box.

A plurality of clamp means including a first cup-shaped member **45,** a spacing member **46** and a second cup shaped member **47** are provided on rod **37** between a shoulder **37c** and a member device such as the threaded aperture **47a** in cup member **47.** The diaphragm bellows members **40, 41,** are respectively provided between first cup member **45** and spacer **46** and the second cup clamp member **47.** Again the cup members control the rolling effect of the diaphragm bellows members to place the sealing side thereof against a solid surface with the low pressure always acting to hold the same against such surface. To further insure the existence of this relative pressure differential a passage system **48, 49** is utilized to introduce atmospheric pressure into the area **50** defined by the diaphragm. To further expound on this relative pressure concept the vacuum control diaphragm **41** has the relatively low pressure of the header H acting to pull the same against wall **16*a*** of the toroidal section **16** and the atmospheric control diaphragm H as the relatively lower pressure within cavity **12** acting to pull the same against the inner wall of control cylinder **14.**

In operation of this unit vacuum pressure is introduced into loading chamber **24** to thereby draw the connective control end **31** and rod **37** upwardly thus drawing up or rolling diaphragms **40, 41** upwardly to roll over to close atmospheric apertures **28** and to roll over to open at least certain of the vacuum introducing apertures **18.** When the proper vacuum pressure exists at the flat box the regulator acts to maintain this attained pressure in the loading chamber **24.**

As the formed sheet of paper passes over the flat box the vacuum pressure in the flat box will vary and as these variations occur the pressure existing in the flat box is transmitted to the cavity **12** and the unit will operate to maintain the predetermined pressure by either introducing more vacuum or by the introduction of atmospheric pressure into the cavity **12.** For example, should the pressure in the flat box decrease, i.e. higher vacuum than proper, the control unit will move downwardly to open the cavity to atmosphere while closing or tending to close vacuum communication. As the pressure in cavity **12** and thus the flat box pressure increases to its proper level this motion will reverse to the point where it should be obvious that if the vacuum pressure is less than desirable the control unit will move upwardly to open the passages **18** between the header H and the cavity **12.** In this manner then a continuously operating unit is provided which will maintain proper flat box pressure.

In the modification of the device as illustrated in FIGS. **3** and **4,** the unit will primarily perform a relieving function which will open the header H to atmospheric pressure should the vacuum in the header H exceed a predetermined limit to prevent what is termed dead ending in which the vacuum pumps are forced to operate against a closed system.

In the form shown, this modified form designated generally **50,** includes a generally T-shaped housing having a pair of opposed attachment flanges **51, 52,** and a third attachment flange **53** arranged to attach the unit **50** to the vacuum header H. A screening attachment **54** is provided on flange **51** having a screen **54*a*** therein and a regulator mounting attachment **55** is provided on the opposed flange **52** with a control member **56** mounted thereon controlling the introduction of vacuum to a control portion **57** within the housing. Regulator **56** receives vacuum from a header connect-

ing line 58 and delivers the same through passage 55a into the control portion 57.

A control cylinder 60 is provided interiorly of the housing 50 having one end 60a thereof sealed to screening flange 54 with the other end provided with a radially extending flange 60*b* which is sealingly clamped between flange 52 and the regulator attachment plate 55. A plurality of apertures 61 are provided in spaced relation generally longitudinally centrally of the cylinder 60 to be in communicating alignment with the header communicating passage 53*a*. Interiorly of control cylinder 60 a movable, flexible, valving diaphragm bellows 65 is provided to selectively open and close the apertures 61 by rolling upon itself as the pressure in the control section 57 varies.

The diaphragm 65 includes on it the first described device an inverted cup shaped unit having a radially extending flange 66 for clamping between flange 52 and regulator mount 55, side members 67 and a closure bottom 68. Clamp members 69,70 are provided on opposite sides of the closure bottom 68 with a clamping element 71 exerting the clamping force thereon. In the form shown the clamp member 69,70 are cup shaped and are provided with longitudinally extending side elements 69*a*, 70*a* of a diameter to permit free movement thereof within the interior of control cylinder 60. A biasing member 71 is provided with the control section 57 with one end 71*a* thereof located against clamp element 69 and the other end 72*a* thereof arranged about a locating shoulder 55*b* on regulator mounting plate 55. This member 72 normally biases the diaphragm 65 downwardly against vacuum introduced into control section 57 to close the aperture 61. The diaphragm member 65 provides, as the pressure in chamber 57 varies in combination with spring 72, an opening and closing effect over the aperture 61 by rolling upon the inner wall of the control cylinder 60 and is held there against by the relatively low vacuum pressure existing in the vacuum header H which communicates with all of the area around the control cylinder 60 and thus through the apertures 61.

The sizing of the aperture as applicant has determined is important to prevent tearing of bellows member 65 and also to control the introduction of atmospheric pressure into header H. Utilizing a staggered aperture arrangement will permit a varied vacuum pressure within chamber 57 which may be lower than the header vacuum to lift the bellows member and permit the introduction of atmospheric pressure while always providing that the relatively higher vacuum pressure in the header H will hold the sides of the bellows against the interior of the control cylinder 67.

In operation of the unit for example, if it is desired to maintain the header pressure at 20 inches, a pressure of 10 inches may be introduced into chamber 57 which will in combination with spring member 72, place the unit in the position of FIG. 3. Increase to 20.5 inches in the header will result in an increase in chamber 57 and will immediately start lifting of the bellows against the spring 72. Here again the area of the bottom of the bellows 68 and the clamp members becomes important as the sensitivity of the unit will be a function of this area as compared to the respective areas of the aperture 61. As apertures 61 are opened the admission of atmospheric pressure will cause lowering of the header pressure and pressure in chamber 57. Obviously, as the pressure in chamber 57 again returns to its present condition the bellows system will return to close apertures 61. Conversely to these conditions if the header pressure should vary to 19.5 inches the spring 72 will prevent movement of the bellows 57. In this manner then it should be obvious that this modified form of the invention may be termed a vacuum header controller or vacuum header relief mechanism.

The modified form of the invention and the portion of the invention that includes the new subject matter herein is particularly illustrated in FIG. 5.

In the form shown the controller 80 would be mounted on the standpipe for the individual flat box with a connection 81 being made to the vacuum header for the introduction of vacuum to the unit. In the form shown the unit includes a body member 82, having an opening 83, to atmosphere which would normally be covered with a screening device 84, or the like, to prevent particles from flowing therein.

A first cylindrical sleeve member 85, is positioned within the body 82 and defines a pressure regulated chamber 86, between itself and the body member 82. This chamber 85 communicates with the flat box and is at flat box pressure. A plurality of apertures 85a, are formed through sleeve 85 to permit controlled communication between this pressure regulating chamber and the atmospheric pressure which obviously exists internally of the sleeve number 85. This particular sleeve 85 is of a first diameter, and a rolling diaphragm member 87, is arranged therein for vertical movement therewithin to open the apertures 85a and permit communication between the atmospheric pressure and the pressure regulated chamber 86. This particular diaphragm member 87 is, in the form shown, captured between a cup member 88, and a plate member 89.

Additional chambers are formed below this atmospheric entrance 84, and in the form shown a first cylindrical sleeve member 90 is positioned within the body member 82, and a second cylindrical sleeve member 91 is spaced radially inwardly therefrom, and said second sleeve has a plurality of apertures 91*a* therein to permit communication between the chamber 92 formed therebetween, which chamber, as illustrated FIG. 5, communicates with the vacuum header such that vacuum header pressure may be introducted through apertures 91*a* into the area which is directly connected to the flat box.

In order to control communication between the vacuum header chamber 92, and the flat box area which is designated as 93, a second rolling diaphragm member 94 is provided, again held by a cup member 95, and a plate member 96 on opposite sides thereof. The two diaphragm members 87, 94, are connected in sealed relationship through a control shaft 97, such that they will move in unison vertically within the body member 82. It should be noted that the diameter of the aforementioned cylindrical member 91 is less than the diameter of the upper atmospheric cylinder 85 for purposes which will be explained hereinafter.

As stated, the upper chamber 86 is a continuous chamber and is at the same pressure as the flat box area 93. This is obviously accomplished through communicating passages through the high pressure introduction member 98 located intermediate the afore-mentioned cylindrical members 85, 90 and 91. This atmospheric introduction member basically provides an isolation arrangement and a mounting means for attachment of the rolling diaphragms 87, 94, thereto such that a cavity 99

is provided therebetween with an inlet passage **99***a*, affording the means for introducing pressure above atmospheric pressure into the chamber **99.**

Basically, the concept of this device is to provide a means for controlling the pressure in the flat box by the introduction of vacuum pressure into the flat box area, or the introduction of atmospheric pressure into the flat box area. Obviously, this is obtained through the upward or downward movement of the combined structure consisting of the upper diaphragm **87,** and the lower diaphragm **94** as joined by shaft **97.** When the movement of this structure is downward, the apertures **91***a* will be covered to prevent vacuum introduction into the flat box area and the apertures **85***a* will be open to permit the introduction of atmospheric pressure to the flat box area. Upon vertical rising of the control element the reverse will occur and higher vacuums will be introduced into the flat box area while the introduction of atmospheric pressure is controlled to sealing of the apertures **85***a*.

The manner in which this control is obtained is the differentiation in areas between the two diaphragm members. The introduction of pressures above atmosphere into the cavity **99** through the inlet **99***a* will result in a normal upward movement of the control structure thereby introducing or permitting the introduction of higher vacuums into the flat box area. Obviously, this above atmospheric controlling pressure must also overcome the weight of the combined control structure before such vertical movement will result. Once this weight is overcome, however, the unit will perform its own control function without further adjustment.

In operation of the unit an initial control pressure will be introduced into the cavity **99,** and this control pressure will be determined by the amount of vacuum which is desired to be held on the flatbox. The differentials in various sizes when introducing the pressure above atmospheric into the control chamber **99** will result in a net upward vertical movement of the structure opening the communication apertures **91***a* to vacuum header pressure until the vacuum header pressure and the resultant flatbox pressure is enough to draw the control unit downwardly to cover the apertures **91***a*. Should the vacuum exceed a desired limit the net effect will be to draw the control structure of the diaphragms **87,94** downwardly to uncover the atmospheric apertures **85***a* and permit the introduction of atmospheric pressure into the regulated area. This opening will decrease the vacuum pressures and will cause the control element and associated diaphragms **87, 94** to rise, thereby cutting off the atmospheric introduction. Obviously, this entire system could not be utilized unless the diaphragms were of different areas.

From the comparison of the two units it should be obvious that in the first form of the invention as particularly illustrated in FIGS. **1** and **2** atmospheric pressure is introduced in the area between the diaphragms, but this does not necessarily serve a control function and the regulator member at the upper portion thereof is necessary for proper control of the unit. With the particular device shown in the improvement of FIG. **5** this additional controlling factor is not necessary and rather the whole unit is controlled by combining the control area into the area between the diaphragms and using only above atmospheric pressure therein.

It should be obvious that application has provided a unique valving member to control vacuum systems which eliminates common valve seating arrangements by providing a flexible valving member which will selectively seal communicating passages and which will because of the flexibility of the material utilized seal over impurities which may enter the system.

I claim:

1. A pressure controller to define a maintained vacuum pressure to a remote location including:

a. a housing defining a cavity;

b. means permitting connection of said cavity to the remote location;

c. means for introducing vacuum pressure to said cavity including a generally arcuately disposed conduit arranged in said cavity having a connection means for the introduction of vacuum pressure thereto and at least one passage through the inner radial wall thereof for the introduction of such vacuum to said cavity;

d. means for introducing atmospheric pressure to said cavity including a generally arcuately disposed tubular member having the inner wall generally aligned with the inner wall of said vacuum introduction means to provide therewith a common valving surface with means for introducing atmospheric pressure to the interior of said member and having at least one passage through said wall for the introduction of atmospheric pressure to said cavity;

e. shiftable valving means arranged in controlling arrangement to said vacuum and atmospheric pressure introduction means;

f. a control chamber having a movable portion having a controlling connection to said valving means and communicating with said cavity; and

g. means for introducing control pressure to said control chamber whereby said shiftable valving means will be moved in response to pressure existing in said cavity and said control chamber.

2. The structure set forth in claim **1** and a plurality of passages through the wall of said tubular member.

3. The structure set forth in claim **1** and said shiftable valving means including:

a. a flexible diaphragm member arranged to seal against the inner walls of said tubular member and said conduit member and being shiftable therealong by said movable portion of said control chamber whereby the vacuum and atmospheric passages therethrough are respectively opened and closed.

4. The structure set forth in claim **3** and passage means permitting communication of pressure within said cavity against said valving means.

5. The structure set forth in claim **4** and said valving means including:

a. a pair of flexible diaphragm means extending respectively in both directions from a common location intermediate the vacuum and atmospheric pressure introduction passages on the inner wall of said tubular member and conduit member;

b. connecting shaft means extending from said movable portion of said control chamber to said diaphragm means; and

c. the inner portions of said diaphragm means being attached to said shaft means at spaced locations therealong.

6. The structure set forth in claim 5 and the movable portion of said control chamber including a resilient diaphragm member.

7. The structure set forth in claim 5 and said pair of flexible diaphragm means including:

a. cup shaped members having the sides thereof arranged and constructed to sealingly engage said inner walls; and

b. strengthening means on the spaced bottom portions thereof to prevent collapsing thereof from said walls and to hold the same thereagainst for rolling upon themselves.

8. The structure set forth in claim 1 and said tubular member extending exteriorally of said housing with said atmospheric pressure introduction means including a passage through the wall portion thereof exteriorally of said housing.

9. The structure set forth in claim 8 and said control chamber arranged on said tubular member to position said movable portion thereof in operative alignment with said valving means.

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