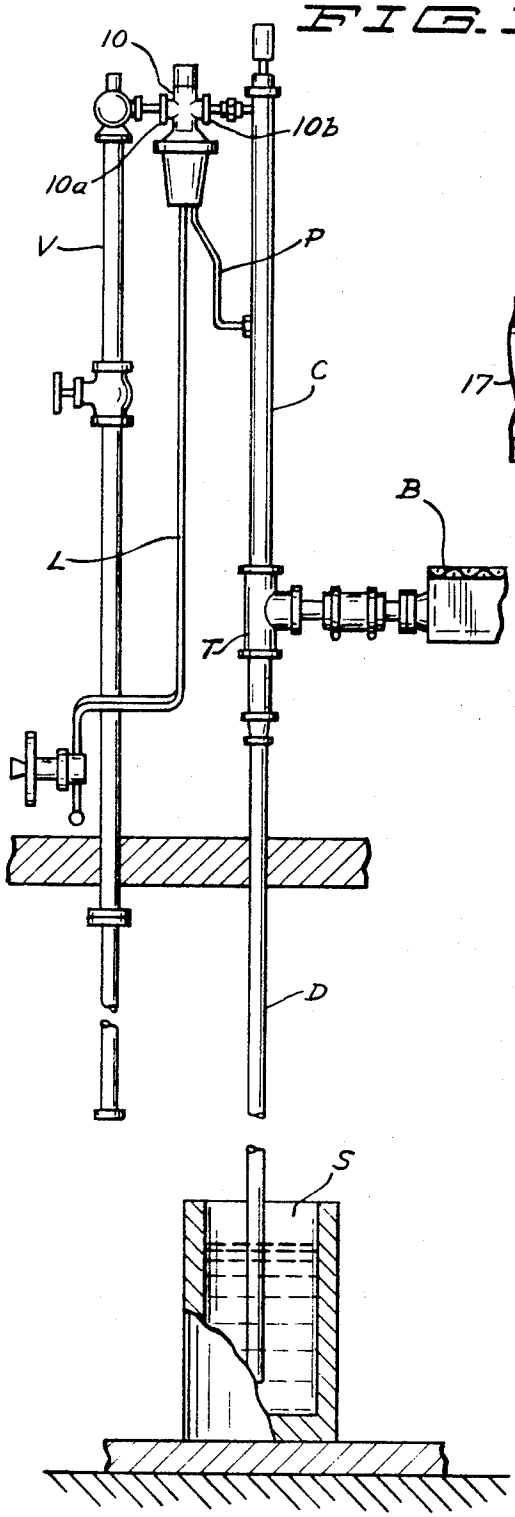
Sept. 23, 1969 D. H. NEWCOMB ET AL 3,468,341

PRECISION VACUUM CONTROLLER

Filed Nov. 19, 1964 2 Sheets-Sheet 1

FIG. 1



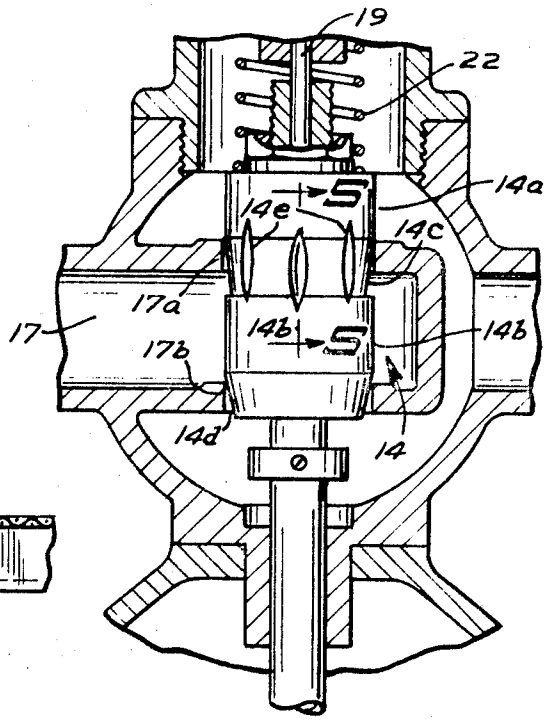


FIG. 4

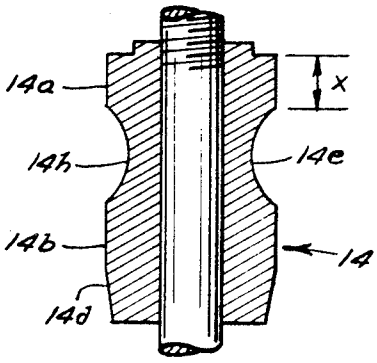


FIG. 5

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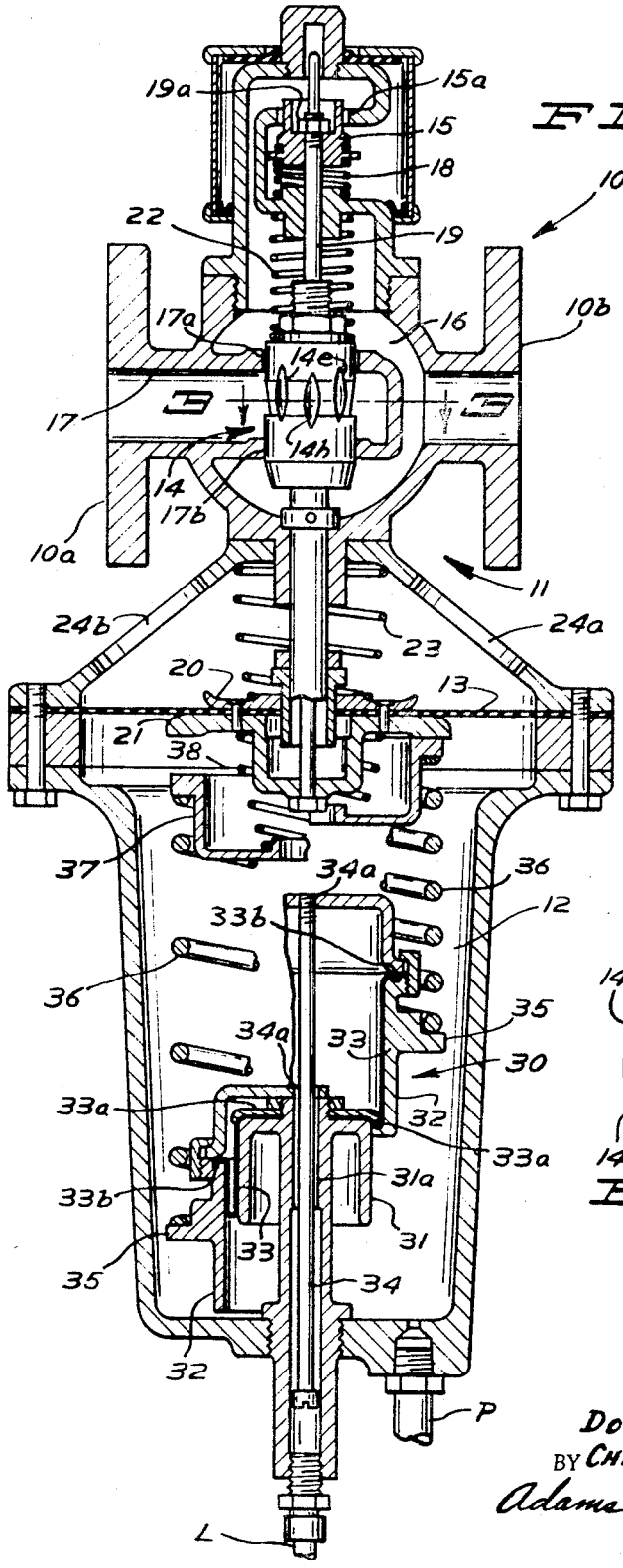
FIG. 2



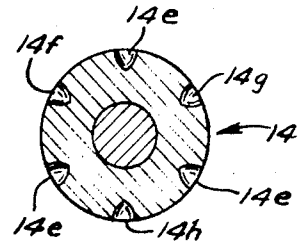


FIG. 3

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PRECISION VACUUM CONTROLLER

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Int. Cl. F16k *31/145, 31/365*
U.S. Cl. 137—625.3 1 Claim

This invention relates generally to pressure control equipment and more specifically to a precision vacuum control mechanism particularly constructed for use in controlling the vacuum supplied to a suction head for a paper making machine.

In paper making operations the paper pulp is deosited in a layer on the upper run of a Fourdrinier wire and the water in the pulp drains therefrom through the wire and is sucked out of the pulp by means of a plurality of suction heads or flat boxes. When making particular types of paper such as a thin carbonized paper the vacuum on the first flat boxes must be particularly low and precisely controlled. The vacuum in the next succeeding boxes may be increased since the paper has progressively more strength as the water is removed therefrom. It is and has been difficult in the past to provide a concise control at the low vacuum boxes and for this reason applicant has provided a new and unique valve member for a vacuum controller which enables him to precisely control this vacuum.

A general arrangement of these flat box systems is to provide a vacuum header with a control valve between the header and the suction box. The control valve modified in this invention is adjusted through a pressure diaphragm arrangement and a second constant vacuum control likewise communicates with the diaphragm arrangement such that the vacuum in the suction head is maintained at a constant. The major modification to this valve provides precise control at low vacuums and thus insures a more constant pressure at the suction boxes at these low pressures.

Although this valve is illustrated in a vacuum control operation, it should be obvious that it would be useable with many pressure systems where it is necessary to slowly introduce the pressure into a system.

It is therefore an object of applicant's invention to provide a precision vacuum controller for controlling the pressure of the flat boxes in a paper making machine.

It is a further object of applicant's invention to provide a vacuum control mechanism arranged to precisely control the pressure in flat boxes of paper making machine which depends on a unique valve aperture arrangement wherein the valve opening may be progressively enlarged through a series of progressively opening valve apertures.

It is a further object of applicant's invention to provide a precise vacuum control mechanism for paper making machines and the like wherein a precise spring balance arrangement permits accuracy of control at low vacuums and which balance arrangement is deleted from operation when the valve is operating under high vacuum.

These and other objects and advantages of my invention will more fully appear from the following description made in connection with the accompanying drawing,

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wherein like reference characters refer to the same or similar parts throughout the several views, and in which:

FIG. 1 is a diagrammatic illustration of the control mechanism as it would be arranged in a paper making machine;

FIG. 2 is a vertical section taken centrally of the vacuum controller and illustrating a portion of the adjustment mechanism in two positions;

FIG. 3 is a horizontal section taken substantially along line 3—3 of FIG. 2 illustrating the valve aperture construction;

FIG. 4 is a portion of FIG. 2 drawn to an enlarged scale;

FIG. 5 is a vertical section taken substantially along line 5—5 of FIG. 4.

As shown in FIG. 1 of the accompanying drawings the vacuum controller **10** of this invention is illustrated in operative position wherein the suction side **10***a* thereof is attached to a vacuum manifold V and the other side **10***b* termed the inlet side is attached to a flat box B of a paper making system through an upright conduit C. A tee member T divides conduit C to permit vacuum to be applied to the flat box B and provide discharge conduit D extending downwardly therefrom through which water drawn from flat box B may be discharged into sealing tank S. A control pressure line L is provided to control valve **10** and likewise an equalizing pressure line P is provided to the control **10**, the purposes of which will be described hereinafter.

Valve member **10** is best illustrated in the cross section of FIG. 2 and in the form shown comprises a valving portion **11** and a control portion **12** separated by an actuating diaphragm **13**. The valving portion **11** is maintained in a housing and includes a pair of connected valve members comprising a balanced vacuum supply valve **14** and a balanced air relief valve **15**, both of which control supply to a vacuum chamber **16** communicating with the inlet or flat box B end **10***b* of the valve **10**. A vacuum supply conduit **17** extends inward to the cavity **16** and in the form shown is provided with a pair of aligned valve seats **17***a*–**17***b* on the walls thereof such that the vacuum supply valve **14** may operate therein and afford communication to vacuum chamber **16**. Air relief valve **15** operates within valve seat **15***a* arranged on the valve housing and is open to the atmosphere and to vacuum chamber **16**. Relief valve **15** is normally biased upward into closed position by a balancing spring **18**. Relief valve **15** and vacuum supply valve **14** are arranged on a common shaft **19** which in turn is operatively associated with diaphragm **13** through an upper **20** and lower **21** diaphragm confining arrangement for actuation thereby such that as diaphragm **13** moves upwardly valve **14** is opened upwardly and valve **15** is biased upwardly into closed position. Depression of diaphragm **13** of course reverses the procedure and a stop nut **19***a* opens valve **15** downwardly while a balancing spring **22** operates against valve **14** to insure downward closure thereof. An additional balance spring member **23** operates between the upper diaphragm plate **20** and a portion of the valve housing to insure proper positioning of the diaphragm. It should be noted that the upper portion of diaphragm **13** is open to the atmosphere by at least a pair of openings **24***a*–**24***b* provided in the

housing. Through this valving arrangement it should be obvious that when the vacuum control valve **14** is opened the air relief valve **15** will be biased into closed position and when vacuum control valve **14** is closed the air relief valve **15** is forced downwardly into open position, thus increasing or decreasing the vacuum in flat box B.

The structure of the vacuum supply valve **14** to provide precision control at low vacuum is illustrated in FIGS. 3, 4 and 5 wherein valve **14** is provided with a pair of longitudinally spaced cylindrical seats **14***a*–**14***b* for seating respectively in valve seats **17***a*–**17***b* of conduit **17**. Directly adjacent each of the seats **14***a*–**14***b* is provided a tapered opening portion **14***c*–**14***d* which taper allows the valve **14** to open progressively larger as valve **14** is urged upwardly.

To provide the desired precision control at low vacuum a plurality of longitudinally extending slots, three of which are designated **14***e*, the remaining being designated **14***f*, **14***g*, and **14***h*, are provided in the outer surface of valve **14** such that one end of each slot will be arranged on the cylindrical surface **14***a* and will extend longitudinally along valve **14** across the first tapered portion **14***c* with the other end thereof located on the second cylindrical portion **14***b*. The cross sectional shape of the slots is shown in FIGS. 3 and 5 and the purpose of the slots is to provide a series of openings which will provide progressively increasing cross sections to provide gradually increasing communication of vacuum to the flat box B. As shown in FIG. 5 this progressive opening is provided by changing the dimension X such that as the valve **14** is moved upwardly the introduction ends of the slots will come into staggered communication with the flat box conduit C. For example and in the form applicant has found most successful the slots **14***e* are spaced at a particular dimension, X and slots **14***f*, **14***g* and **14***h* are each spaced respectively X+1/16 inch, X+1/8 inch and X+3/16 inch. This dimension naturally is arbitrary and would vary upon the size and application for the valve.

As seen in FIG. 4 the slots are generally elliptical in shape with sides converging to a smoothly radiused bottom as seen in FIG. 5. This configuration provides a cross sectional opening increasing in dimension as the valve **14** is moved upwardly. Movement of the valve **14** upwardly then allows communication between the vacuum and the flat box initially through the ends of the slots **14***e* arranged on cylindrical surface **14***a*. Progression of the valve upwardly progressively discloses slots **14***f*, **14***g* and **14***h* in communicating position. As the tapered portions **14***c*–**14***d* of the valve **14** passes through the valve seats **17***a*–**17***b* the cross sectional dimension of the disposed slots increase the total communication area and thus on the last portion of valve travel a much larger opening is presented.

The control portion of the valve **12** is arranged below the diaphragm **13** and as shown in FIG. 2 a longitudinal adjustable diaphragm tensioning member **30** is arranged for longitudinal reciprocation about a center guide **31**. For clarity of operation the adjustable member **30** is shown in two positions. Positioning member **30** comprises a generally arcuate cylinder **32** receivable about the upstanding center guide member **31** with a boot **33** arranged sealingly therebetween; one end **33***a* of the boot **33** being sealed to guide member **31** and the other end **33***b* of the boot **33** being sealed to cylinder **32**. A central guide rod **34** is arranged in sliding relation within guide **31** and has one end thereof **34***a* attached to a top closure plate of cylinder **32**.

Pressure is introduced through a passage **31***a* in guide member **31** from control line L and will cause the cylinder **32** to project upwardly as shown in FIG. 2 whereby the diaphragm **13** position and hence the valve **14** position may be controlled. An arcuate shoulder **35** is arranged around cylinder **32** and a first tensioning adjustment spring **36** is seated thereon. The upper end of the adjustment spring **36** is received against and surrounds a spring retainer **37** which is in operating alignment with the bottom diaphragm plate **21**. A second adjustment member such as resilient spring **38** is disposed between the spring retainer **37** and the bottom diaphragm plate **21** such that initial movement of the first tensioning spring **36** by the adjustment cylinder **32** will be transmitted to adjustment spring **38** providing a particularly delicate spring tensioning system to diaphragm **13**. This delicate adjustment is particularly important when operating at the desired low vacuums.

It is possible to cancel out the effect of the second tensioning spring **38** which cancellation is also shown in FIG. 2 wherein the spring retaining member **37** operates directly against the lower diaphragm capturing plate **21**. This arrangement will be used at high vacuum requirements.

Sensing conduit P connects the control chamber **12** with conduit C and flat box B whereby the vacuum in the box B will be communicated to the control chamber **12**. This sensing conduit P provides automatic means to actuate the diaphragm **13** in response to changes in the vacuum within the flat box B and thus will control the vacuum in the flat box B. Sensing conduit P provides automatic adjustment to the valves **14**–**15** such that pressure in the flat box B will be kept at a constant.

At extremely low vacuums the combination of the progressively opening slots on valve **14** with the second tensioning spring member **38** provides particularly delicate adjustment such that the vacuum in the flat box B may be maintained within critical levels. At high vacuum the cancellation of the second tensioning device **38** and the cooperation of the slots on the tapered portion **14***c* of valve **13** allows greater communication area to the flat box B.

It should be obvious that applicant has provided a unique progressively opening valve member in order to break the vacuum to a flat box very gently and to delicately and precisely control the vacuum at these low vacuums.

It should be obvious that although applicant has illustrated the use of this valve for controlling vacuum introduction to flat boxes of a paper making machine the principle of progressive openings on the valve member would be easily adaptable and may be useable in this specific form on many other pressure applications.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportion of parts without departing from the scope of my invention, which generally stated consists in the matter set forth in the appended claim.

What is claimed is:

1. A vacuum control valve including:

(a) a housing defining a chamber therein;

(b) a suction conduit having a sealed end communicating with said chamber and having a generally arcuate diametrically aligned passage through the walls thereof to provide valve seats and to provide communication between the interior thereof and said chamber;

(c) an inlet communicating with said chamber;

(d) a valve member arranged for sealing with said seats including:

(1) a pair of longitudinally spaced generally arcuate sealing portions receivably into said seats for sealing therewith against the outer periphery thereof;

(2) an opening portion adjacent each of said sealing portions being tapered to provide progressively increasing communication between the inlet and said chamber;

(3) a plurality of slots extending longitudinally of said valve member arranged on one of said arcuate sealing portions and extending therefrom onto the adjacent tapered portion, the ends of at least certain of the slots on the arcuate portion being spaced longitudinally of the valve to provide a plurality of progressively increasing and successively opening communication passages as the valve is moved through said seats

such that the ends of the slots may be arranged respectively on either side of the wall of the suction conduit affording the only communication between the suction conduit and the chamber;

(e) a control chamber defined by said housing and having a pressure responsive diaphragm member therein, said diaphragm being connected to said valve member for actuation thereby; and

(f) means for applying valve positioning pressure to said diaphragm for initially opening the same.

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HOWARD W. WEAKLEY, Primary Examiner

U.S. Cl. X.R.

137—116.3, 505.13; 251—282