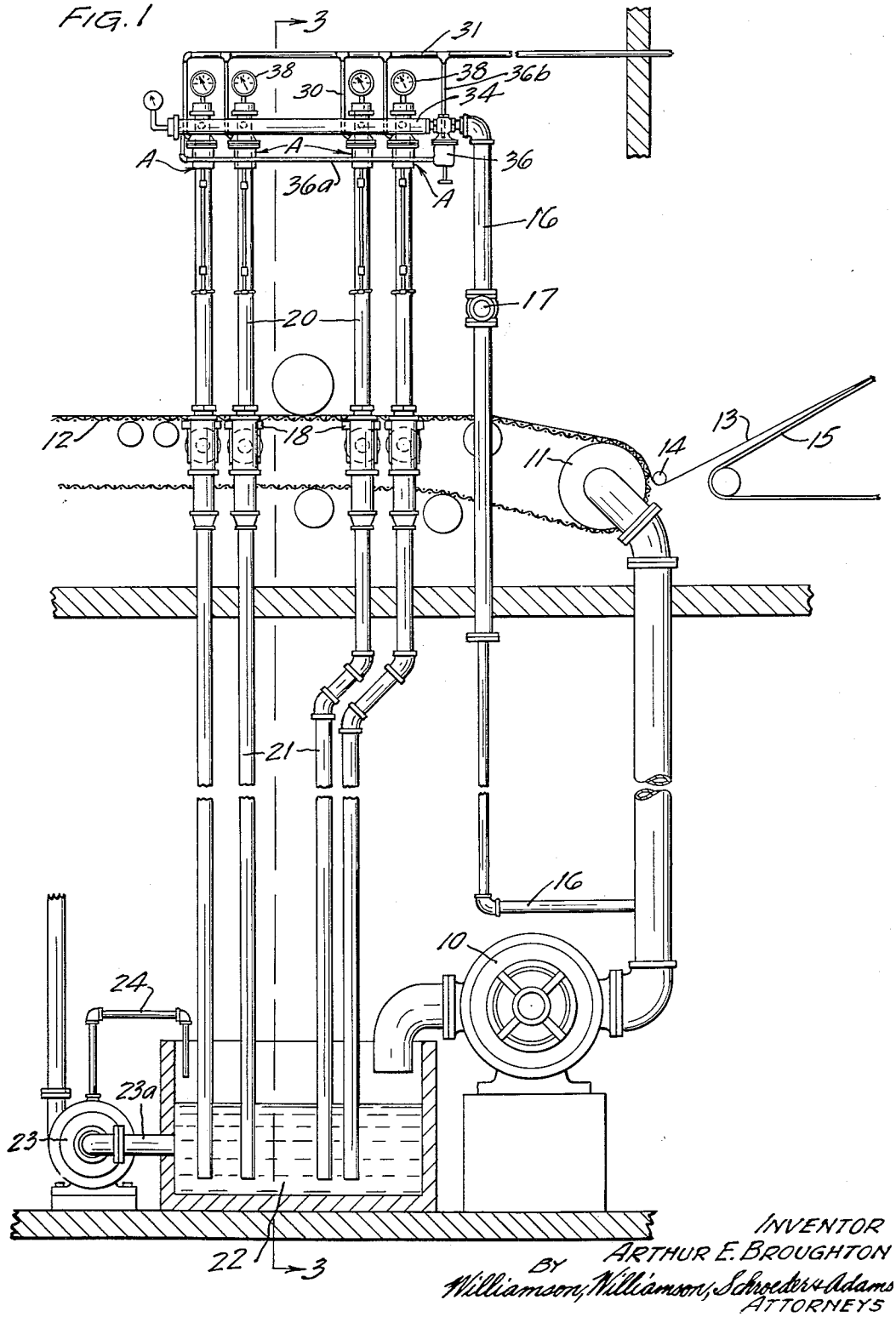
May 15, 1956 A. E. BROUGHTON 2,745,322

DIAPHRAGM OPERATED VACUUM CONTROL SYSTEM

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FIG. 1



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FIG. 4

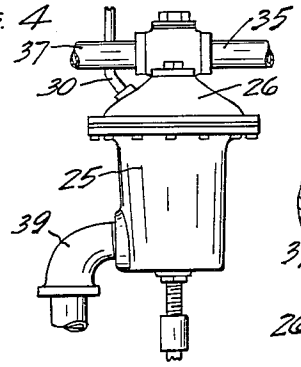


FIG. 5

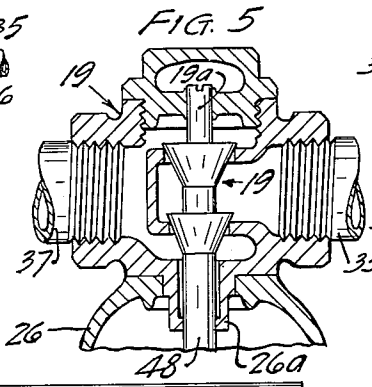


FIG. 3

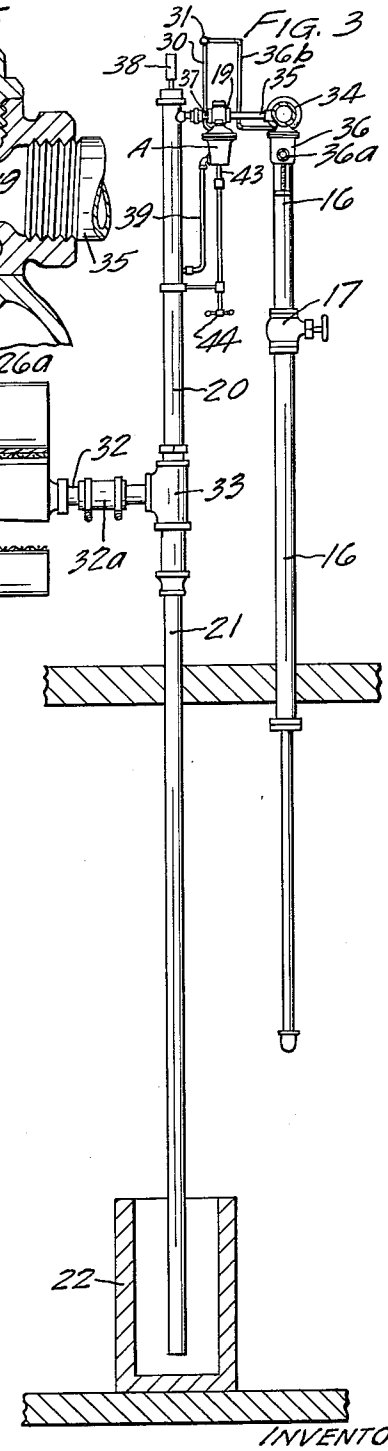
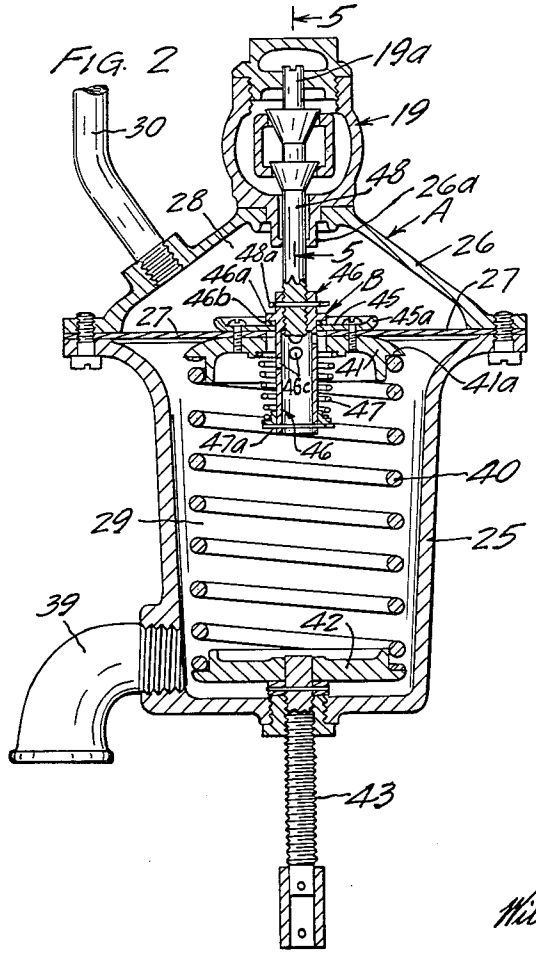


FIG. 2



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DIAPHRAGM OPERATED VACUUM CONTROL SYSTEM

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Application January 14, 1954, Serial No. 404,079

7 Claims. (Cl. 92—51)

This invention relates to a vacuum control system in combination with the suction head of a paper making machine.

The system disclosed and claimed herein is an improvement on the combination disclosed in my prior patents, No. 1,962,477 granted June 12, 1934, and No. 2,147,877 granted February 21, 1939, and is a continuation in part of my co-pending application, Serial No. 66,007, filed December 18, 1948, now abandoned and entitled "Vacuum Control," as well as being a division thereof with respect to the subject matter disclosed and claimed therein relating to the combination of the suction head and the diaphragm actuated suction control valve.

While my prior systems worked reasonably well and were a great improvement over any apparatus previously known, I found that the corrosive action of the paper making solutions produced considerable corrosion between the piston and surrounding cylinder wall which frequently caused sticking of the controller piston and rendered the same inoperative. Also chattering of control valves for such systems has always been a serious problem.

It is an object of my present invention to provide a system for accurately and constantly controlling and maintaining a predetermined vacuum in a suction head of a paper making machine and particularly constructed to prevent corrosive action of the paper making solutions on the actuating elements thereof and also designed to substantially eliminate chattering of the control valve mechanism.

It is another object to provide a highly efficient and extremely accurate control system including in the combination thereof a diaphragm actuated vacuum control valve which entirely eliminates any sliding action between the actuator elements of the controller and thereby preventing any harmful effect of the corrosive solutions and vapors on the efficient operation of the vacuum controller system.

It is still another object to provide a new and highly efficient combination including a suction head for a paper making machine, a source of negative air pressure communicating with said head to draw air and water through said suction head with means for separating said air and water, and including a control valve controlling the degree of suction produced in said head and having a highly sensitive non-corrosive valve actuator of the diaphragm type connected with said control valve and responsive to the suction in said head to vary the valve opening.

It is still a further object to provide a vacuum control system wherein the suction responsive valve actuator element is particularly designed to be unaffected by the corrosive action of the paper making solutions and constructed for producing highly accurate and sensitive control of a suction head used in a paper making machine and provided with a fresh air vent communicating with the high pressure side of the valve actuator to materially reduce the concentration of corrosive vapors in the air drawn therein from the suction head.

These and other objects and advantages of this 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 front elevational view showing my new combination including portions of a fourdrinier paper making machine;

Fig. 2 is a vertical sectional view showing the control valve and actuator therefor which are used in my new combination;

Fig. 3 is a central vertical sectional view taken longitudinally through a flat box of a paper making machine and showing certain elements of my new combination in side elevation;

Fig. 4 is a side elevational view of the controller and valve housing used in my new combination; and

Fig. 5 is a fragmentary vertical sectional view taken centrally through the valve housing substantially along the line 5—5 of Fig. 2.

As best shown in Fig. 1 of the accompanying drawing, I provide a vacuum system for removing the moisture from a layer of paper pulp in the process of manufacturing paper. A conventional couch pump **10** provides a source of suction for the paper making machine and communicates directly with an otherwise closed couch roll **11** around which the Fourdrinier wire **12** passes at the delivery end thereof. The layer of paper pulp from which a large percentage of the moisture has been removed through the wire **12** forms a paper web **13** and leaves the wire **12** above the couch roll **11** and passes around a guiding roll **14** and extends to a supporting felt **15** and is carried therefrom to the dryers in the usual manner.

A branch suction line **16** is connected with the main suction conduit extending from the couch pump **10** to the couch roll **11**, and a hand operated valve **17** controls the degree of vacuum supplied through suction line **16** to the flat boxes **18** which constitute the suction heads to be controlled. The suction line **16** forms a header **34** from which individual conduits afford communication to the respective flat boxes **18**. A controller actuated valve **19** is provided for each flat box **18** and controls the suction thereto through the upper portion of an upstanding receiving conduit which forms air leg **20**. A withdrawal conduit **32** is connected at one end to the discharge end of each flat box **18** and is connected at its other end to a connector T **33** through a flexible connector element **32***a*. A water leg **21** is connected at its upper end with the T **33** and is formed by the lower portion of the upstanding receiving conduit to which the air and water from each flat box **18** is delivered. The lower end of the water leg **21** is sealed as by being submerged in the reservoir tank **22**, the level in said tank being maintained by a pump **23** which is rendered inoperative unless the vent line **24** is submerged below the level of the liquid in tank **22**. The pump, when operative, removes liquid from said tank through inlet **23***a* and delivers the white water received therethrough for subsequent use in the manufacturing process. Since the white water contains a small percentage of paper pulp, it is desirable to avoid disposal thereof if possible.

A controller A is connected with each of the valves **19** for actuating the same, and each controller has a lower casing section **25** and an upper casing section **26**, which sections are cooperatively flanged and sealingly interconnected with an actuator diaphragm **27** securely clamped therebetween. The diaphragm **27** has a relief valve, designated as an entirety by the letter B, mounted through the central portion thereof. The relief valve B is normally closed so that the diaphragm **27** divides the cham-

ber formed within the two interconnected casing sections **25** and **26** into a relief chamber **28** and an actuating chamber **29**. Both chambers **28** and **29** are sealed except for a single outlet, the relief chamber **28** communicates with the atmosphere through said outlet, a conduit **30**, and a relief header **31** to which the conduit is connected and which extends through the building wall to the outside atmosphere, as best shown in Fig. 1. This permits fresh outside air to be drawn into the upper chamber **28** when the valve B is opened to produce negative pressure in said chamber and thus materially reducing the concentration of paper solution moisture in the air within chambers **28** and **29**.

A branch pipe **35** interconnects valve **19** with the suction header **34**, and a pressure regulating valve **36** is provided in said pipe **35**. In the form shown, this pressure regulating valve **36** consists in one of my diaphragm operated controller units A, such as the units previously provided herein, and a pressure-sensitive conduit **46** affords communication between the control chamber of the controller unit **36***a* for communication between the control chamber of controller A and the header **34** at the desired point of control. Also, a communication conduit **36***b* affords affords communication between the relief supply header **31** and the relief chamber disposed above the diaphragm and maintained at atmospheric pressure by said conduits **36***a* and **31**. This control unit **36** maintains a predetermined maximum limit on the vacuum supplied to said valve **19** and is of course adjustable to limit the pressure differential between the maximum vacuum supplied and the desired vacuum to be maintained by my control system. The valve **19** controls the flow to the upper portion of air leg **20** through a pipe **37** and a gauge **38** may be provided at the top of each of the air legs **20** to indicate the vacuum therein. A pressure sensing communication conduit **39** is connected at one end to the outlet from control chamber **29** and at the other end to the air leg **20** in spaced relation above the T **33**. The distance between the connection of the conduit **39** and the T **33** is sufficient to prevent foam produced in the water leg **21** from rising into the controller A to thus further reduce contact between the corrosive moisture and the controller parts.

An adjustable balancing spring **40** is, in the form shown, provided in chamber **29** to overcome the force exerted on diaphragm **27** by a predetermined adjustable suction which is controlled by valve **19** and communicated to chamber **29** by conduit **39**. The adjustable compression spring **40** is seated at its upper end on the outer marginal portion **41***a* of a spring seat member **41** which is secured to the underside of diaphragm **27** in a manner to be described. The lower end of spring **40** is seated on an adjustable spring seat **42** which is mounted on a screw stem **43** with an operating handle **44** connected therewith to adjustably vary the compression in spring **40** and thereby vary the counterbalancing force exerted by said spring on diaphragm **27** which overcomes a predetermined suction on said diaphragm produced by the suction in air leg **20**. An aperture is provided in the central portion of upper spring seat **41** and the valve B controls the flow of air between chambers **28** and **29** as has been previously stated. The valve B consists in a valve seat **45** which is securely fixed to the top of diaphragm **27** as by being positively connected with the upper spring seat **41** to form a central annular reinforcement for diaphragm **27** on both the top and bottom thereof. The two seat members **41** and **45** are constructed of any suitable corrosive-resistant material such as brass and of course said two seat elements securely clamp the portion of the diaphragm interposed therebetween in sealed relation. It should be noted that the outer marginal portions of the two seat elements **41** and **45** on the sides thereof adjacent the diaphragm **27** diverge from the diaphragm to provide smoothly contoured engagement portions for the adjacent diaphragm surfaces to minimize the wear thereon during flexing of the diaphragm. An elongated valve sleeve **46** is shiftably mounted through the opening in the two seat members **45** and **41** and diaphragm **27**, and has a sealing flange **46***a* around the upper portion thereof for sealed engagement with the portion of the valve seat **45** surrounding the opening therethrough, a sealing gasket **46***b* being provided between said flange and said seat. A lightly tensioned relief valve closure spring **47** is interposed between the seat member **41** and a top collar **47***a* connected to the lower portion of the elongated sleeve **46** and resiliently resists separation of flange **46***a* and valve seat **45**. The construction of valve **19** is generally similar to that disclosed in my prior patent, No. 2,147,877, and is a double poppet valve with an upstanding guiding stem **19***a* and a depending actuating stem **48** slidably mounted in a suitable guideway **26***a* formed in the upper casing member **26**. The lower end of stem **48** is securely anchored to the upper portion of valve sleeve **46** as by being threadably connected therewith and having a locking pin **48***a* extending through said sleeve and said stem. A plurality of peripherally spaced relief apertures **46***c* are provided through the side wall of valve sleeve **46** in progressively downwardly spaced relation below the valve flange **46***a*. As the diaphragm **27** is flexed by variations in the relative pressures between chambers **28** and **29**, the valve stem **48** is actuated upwardly or the valve seat **45** is shifted downwardly away from relief valve flange **46***a* when control valve **19** is in seated position.

The following is a description of the operation of my new system as disclosed herein. The resilient compression is initially adjusted in control spring **40** by turning operating handle **44** to resist and counterbalance a predetermined suction in air leg **20**. Unless at least this predetermined suction is produced in air leg **20** and the flat box **18** connected therewith, the spring **40** will of course push diaphragm **27** upwardly to open control valve **19**. As soon as the control valve **19** is opened, the suction in supply conduit **16** and header **34** will be impressed upon the upper portion of air leg **20** and flat box **18** connected therewith. If this suction is sufficient to produce a downwardly directed force on diaphragm **27** of sufficient magnitude to overcome the force exerted by spring **40**, said diaphragm will immediately pull the valve **19** downwardly into closed position. Obviously, during operation, variations in the degree of opening of valve **19** will be only momentary to maintain a precisely predetermined suction in the controlled flat box **18**. The pressure in chamber **29** will, of course, always be the same as that in air leg **20** which communicates therewith through conduit **39**, and the pressure in chamber **28** disposed above diaphragm **27** is constantly maintained at atmospheric by relief supply conduit **30** which is connected in direct communication with the outside air through header **31**. If the suction in air leg **20** exceeds a predetermined limit, the diaphragm **29** is pulled downwardly to further compress spring **40** if the control valve **19** has been shifted into closed seated position and relief air at atmospheric pressure is drawn into chamber **29** and air leg **20** through conduit **30** and relief valve B. The relief valve B, by the progressively downwardly positioned apertures **46***c*, initially provides a relatively small area of communication between chambers **28** and **29**, but progressively increases this area as diaphragm **27** is pulled to progressively increase the shifting movement of valve seat **45** downwardly along sleeve **46**. I have found that the maximum differential between the vacuum supplied through conduit **16** and the ultimate desired vacuum to be maintained in highest vacuum carried in the flat boxes **18** must not be more than 4 inches of mercury in excess of the highest vacuum being drawn in the flat boxes to prevent chattering of the valve **19**. In other words, a greater differential than this critical maximum limit will cause suddent increases in the suction in flat box **18** which will immediately snap control valve **19**

closed rather than merely gradually or partially closing the same. Obviously as soon as said valve is snapped shut the controller will again call for increased suction and open the same to cause the disagreeable and destructive chattering. However, if by adjustment of regulation valve **36** this pressure differential is maintained at less than 4 lbs. per sq. inch between the desired pressure on the flat box **18** and the maximum vacuum being supplied to valve **19** by conduit **16**, the opening valve **19** will not cause a sudden increase in the suction in flat box **18** but will cause only a gradual increase in said suction which will not result in said valve being immediately snapped shut and thereafter immediately snapped open and thus prevent the chattering described above. This chattering as has been previously described can also be caused if the relief valve initially affords a relatively large area of communication between chamber **28** and chamber **29** when the same is initially opened to cause said relief valve to be snapped shut and the control valve to be opened, but this is substantially eliminated in my present combination by the relief valve B affording only a limiting area of communication when initially opened.

It will be seen that I have provided a highly efficient combination of elements designed to produce an extremely durable and highly accurate system for precisely controlling a desired vacuum in a suction head such as the flat box **18** by eliminating the deleterious effect of the corrosive solution used in paper making processes and which will substantially eliminate all chattering of the controller by eliminating sudden changes in the suction being produced in the flat box **18**. All of the advantages present in my previously identified patented inventions are, of course, also present in the instant invention as well as the specific advantages set forth herein.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of this invention which, generally stated, consists in the matter shown and described herein and set forth in the appended claims.

What I claim is:

1. In a paper making machine, a system for controlling the vacuum in a suction head comprising a suction head positioned to remove water from an overlying layer of diluted paper pulp, a withdrawal conduit communicating with said suction head to permit the air and water drawn into said suction head to be removed therefrom, a hollow upstanding receiving member communicating with said withdrawal conduit and having a downwardly extended drainage leg with the lower end thereof vacuum sealed and through which water removed from said suction head is adapted to flow and having an upwardly extending air withdrawal leg, a vacuum control valve controlling the vacuum supplied to said air leg, a diaphragm controller operatively associated with said control valve including a chamber communicating with said suction head, a diaphragm working in said chamber, and a relief valve affording communication between said chamber and air under at least atmospheric pressure and operatively connected with said diaphragm for increasing the pressure in said chamber when the vacuum therein reaches a predetermined maximum limit.

2. In a paper making machine, a system for controlling the vacuum in a suction head comprising a suction head to remove water from an overlying layer of diluted paper pulp, a withdrawal conduit communicating with said suction head to permit the air and water drawn into said head to be removed therefrom, a hollow upstanding receiving member communicating with said withdrawal conduit and having a downwardly extending drainage leg with the lower end thereof water-sealed and through which water removed from said suction head is adapted to flow and having an upwardly extending air withdrawal leg, a vacuum control valve controlling the vacuum supplied to said leg, pressure sensitive means communicating with said suction head and operatively associated with said valve for opening and closing the same in response to variations in the suction in said head, and a regulating valve limiting the maximum vacuum supplied to said vacuum control valve to positively limit the differential between the vacuum maintained in said suction head and the vacuum supplied to said control valve.

3. The combination set forth in claim 2, and said control means including a relief valve operatively associated with said control means and affording communication between said suction head and at least atmospheric pressure when opened by a predetermined maximum suction produced in said head, said relief valve being constructed to permit only restricted pressure release upon initial opening thereof.

4. In a paper making machine, a system for controlling the vacuum in a suction head comprising a suction head positioned to remove water from an overlying layer of diluted paper pulp, a withdrawal conduit communicating with said suction head to permit the air and water drawn into said suction head to be removed therefrom, means connected with said suction head withdrawal conduit for supplying suction thereto, a control valve mounted in said suction supply means for controlling the suction supplied therethrough, means defining a control chamber communicating with said suction head, a control diaphragm working in said chamber and operatively associated with said valve for opening and closing the same in response to variations in the suction produced in said suction head, and a relief valve operatively associated with said diaphragm for supplying air under at least atmospheric pressure to said suction head whenever the suction therein reaches a predetermined maximum limit.

5. The structure set forth in claim 4, and a regulating valve limiting the maximum vacuum supplied to said control valve to maintain the pressure differential between the supply vacuum and the controlled vacuum below a predetermined maximum limit to prevent sudden fluctuations in the vacuum in said suction head.

6. In a paper making machine, a system for controlling the vacuum in a suction head comprising a suction head positioned to remove water from an overlying layer of diluted paper pulp, means for supplying vacuum to said suction head, a vacuum control valve connected in said vacuum supply means for controlling the degree of suction supplied to said head, a controller casing with a flexible, pressure-responsive diaphragm interposed therein to divide the interior thereof into a control chamber and a relief chamber, means affording communication between said control chamber and the suction head, relief means affording communication between the other chamber and a source of fresh air remote from the suction head, under at least atmospheric pressure free from the corrosive vapors produced by the paper making solutions, said diaphragm having a communication opening formed therethrough, a relief valve mounted in said opening to control the air flow therethrough, and connection means interconnecting said vacuum control valve and said diaphragm to open and close said valve in response to variations in pressure in said control chamber, said diaphragm being operatively associated with the opening and closing of said relief valve to afford communication between the relief chamber and the control chamber when the vacuum in said relief chamber and said suction head reaches a predetermined maximum limit.

7. In a paper making machine, a system for controlling the vacuum in a suction head comprising a suction head for removing water from an overlying layer of diluted paper pulp, a withdrawal conduit communicating with said suction head to permit the air and water drawn into said head to be removed therefrom, a hollow upstanding receiving member communicating with said withdrawal conduit and having a downwardly extending drainage leg with the lower end thereof water sealed and through which

water removed from said suction leg is adapted to flow, said drainage leg including an upwardly extending air withdrawal leg, a suction supply conduit connected with the upper portion of said air withdrawal leg, a pair of vacuum control valves respectively controlling the vacuum supplied to said air leg and through said suction supply conduit, a pair of pressure-sensitive controllers, one communicating with said suction head and the other communicating with said supply conduit and respectively operatively associated with said valves for respectively opening and closing the same in response to variations in the vacuum in said head and said conduit, and the controller associated with the valve in said conduit being constructed and set to constantly maintain a vacuum in excess of the vacuum to be maintained by the controller communicating with said suction head but positively limiting

the differential between the vacuum maintained by said two controllers.

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