United States Patent

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[54] **PNEUMATIC SUCTION SYSTEM**

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[52] **U.S. Cl.** **128/276**

[51] **Int. Cl.** **A61m 1/00**

[58] **Field of Search** 128/276–278, 145.5–145.8

[56] **References Cited**

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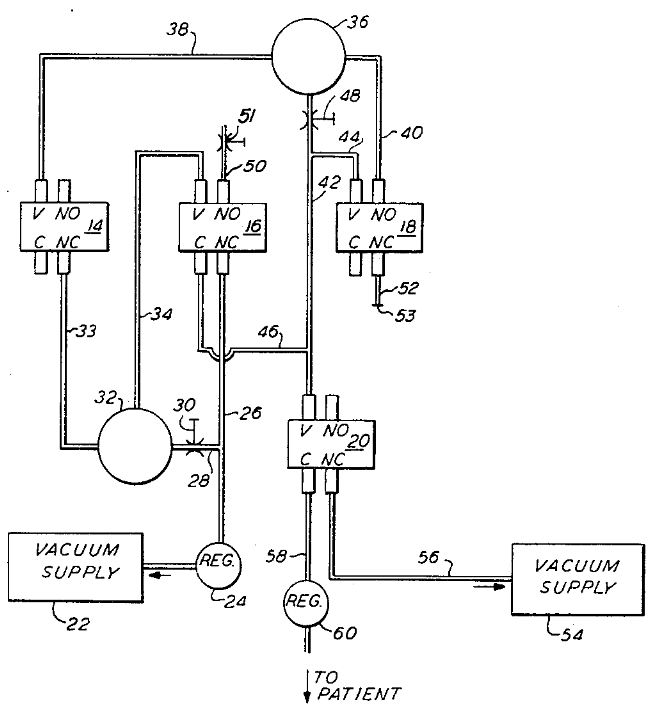
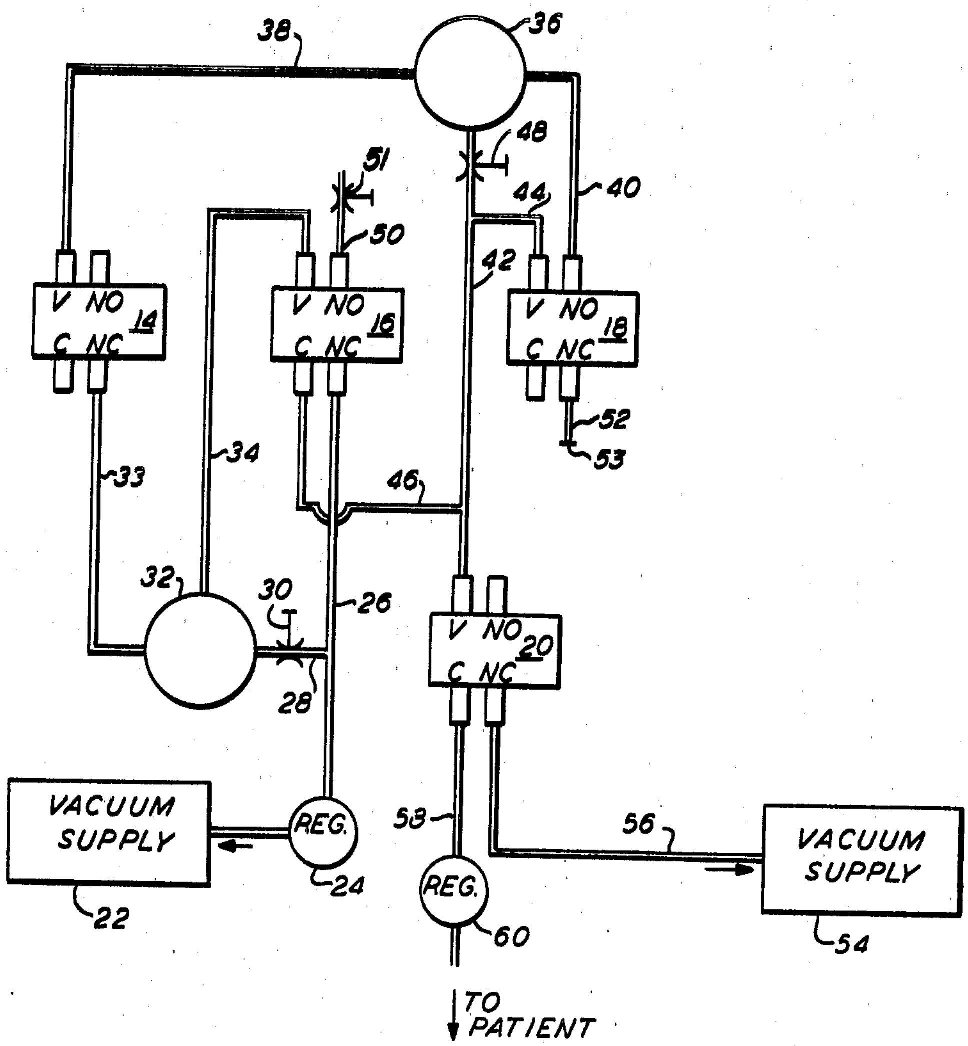
[57] **ABSTRACT**

A pneumatic suction system having extreme reliability comprising a plurality of interconnected, vacuum actuated modular switches adapted to be connected to a vacuum source to provide an intermittent vacuum source having controllable timed intervals for withdrawing fluids from a patient.

6 Claims, 1 Drawing Figure





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PNEUMATIC SUCTION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to pneumatic timing devices and, more particularly, to a pneumatic modular system for producing a pulsed suction having predetermined time intervals.

The use of intermittent suction devices is well known in the medical field, one of the more important uses being for the removal of drainage from the stomach or intestines of patients. The suction devices normally are connected to a tube which is internally inserted within the patient and which withdraws the fluid either continuously or intermittently.

In the intermittent type suction device, the suction cycle withdraws the fluid through the tubes for a predetermined period, at the end of which time the external end of the tubing is opened to atmospheric pressure, thereby allowing the draining liquid to reverse in direction and return toward the area being drained. As this atmospheric pressure cycle is terminated, the vacuum is again applied and the cycle repeated until the desired total draining time is attained.

Through the intermittency and timed alternating cycles, the back flow which occurs during the atmospheric pressure cycle assists in dislodging possible obstructions which might cause a stoppage in the internal tubing. The timing must, of course, be carefully set in order to insure that the total continual flow is outward from the patient and this is accomplished by providing relatively short intervals in which the tubing is allowed to be vented to atmospheric pressure as compared to the suction intervals.

It is advantageous in intermittent suction devices to adapt them for operation from a regulated source of vacuum since it is common in many hospitals to provide a vacuum outlet from a central system where outlets are accessible in a great number of locations, including the patient's room. Therefore, the intermittent suction device is preferably suitable for attachment to a regulated vacuum source which provides a relatively constant vacuum and thereafter the device produces an intermittent cycling function.

There are devices presently used which are adapted to communicate with a regulated vacuum source and thereafter introduce an intermittently cycled vacuum to a patient; however, the present devices rely on various mechanical functions to effect the cycling. As an example, various of the known devices rely on sliding friction in some manner to create a timed interval and thus, are subject to irregularities in friction as well as eventual inaccuracies through wear of the sliding parts. Similar problems are inherent in the use of mechanical rotating valves, hydraulic fluids, lever arms and the like.

Of particular importance in medical applications is the reliability of suction devices. It is extremely important that the devices be as free as possible of moving parts or any features where wear or misadjustment could lead to even a temporary failure of the vacuum cycling, and therefore medical devices preferably incorporate the least number of moving or other stressed parts as is functionally possible.

BRIEF SUMMARY OF THE INVENTION

The present pneumatic intermittent suction system overcomes present disadvantages by providing a modulized construction wherein standard pressure actuated logic switches are uniquely interconnected such than an extremely reliable intermittent suction system is produced which may easily be connected to a source of regulated vacuum. The logic switches themselves are compact and easily replaceable for servicing and are inherently reliable since the total movement of any single part is on the order of 0.010 inches. These switches do not rely upon any friction pistons or the like for their operation and, in addition, the intermittent devices of this invention operate entirely pneumatically from a vacuum service and require no additional source of energization for their functioning. All timed cycles are accurately adjustable and such adjustment or timing setting does not involve any change in moving parts, therefore, the timing is independent of sliding friction. The timed settings, once determined, are extremely stable and do not fluctuate or change through wear in any moving parts.

The improved intermittent suction system is illustrated in the accompanying drawing which shows the preferred embodiment of the invention, incorporating the features and advantages described.

FIG. 1 is a schematic diagram showing the assembled intermittent suction device.

Referring now to FIG. 1, there is shown a schematic circuit utilizing pneumatic logic switches, identified as **14**, **16**, **18** and **20**, all of which are of identical construction.

These logic switches are pneumatic, diaphragm switches of the type commercially available under the trademark UNILOGIC from the Robertshaw Controls Company and, therefore, only the basic function of one of these switches will be briefly described. Although this particular switch has been found preferable, the invention may easily be adaptable to be performed with other similar pneumatic switches.

As shown in FIG. 1, a logic switch **14** is provided having a plurality of ports, indicated as a V port, NO port, NC port and a C port. Basically the C port is the common port and, when the switch is in its non-actuated state, C port communicates with the NO port, therefore, being a normally opened fluid circuit. In the same, non-actuated position, therefore, the NC port is normally closed with respect to the common or C port. The V port serves as an actuating port for the logic switch, and is sensitive to a vacuum signal of a specific value, whereupon the switch becomes actuated and the C port is in open communication with NC port while the NO port is then closed with respect to the C port. The use of these operations will become apparent during the later description of the overall function of the invention.

Referring again to FIG. 1, the aforedescribed logic switches are shown schematically and are interconnected in such a manner as to provide an intermittent suction function.

A vacuum supply **22** is provided and, as explained, is normally supplied by a central supply system of a hospital; however, a suitable portable vacuum pump or other alternate means may be utilized.

The amount of vacuum from the supply **22** is controlled by vacuum regulator **24**. When the vacuum supply **22** is energized, a vacuum is continually drawn through regulator **24** from tubing **26**. Since the extreme end of tubing **26** terminates at the NC port of logic switch **16**, the switch **16** being in the non-actuated state, the vacuum of supply **22** is drawn from the interior of tank **32**, through bleed tubing **28** and restriction **30**. The restriction **30** in tubing **28** serves to increase or decrease the amount of resistance to fluid flow in the tubing **28**, and thereby controls the rate of evacuation of the tank **32**, which is of a predetermined volume.

A further tubing **33** communicates with the interior of tank **32**; however, it terminates at the NC port of unactuated logic switch **14** and, therefore, does not effect the evacuation of tank **32**.

As the volume in tank **32** continues to be evacuated, a vacuum signal is eventually reached of sufficient value to actuate logic switch **16** through tubing **34**, which communicates between the interior of tank **32** and the V port of switch **16**.

Actuation of logic switch **16** causes its NO port to close and its NC port to be opened with respect to the C port of switch **16**, and therefore the continuing vacuum supply **22** provides a vacuum signal to actuate both switch **18** and switch **20** through tubing **46, 42, 44**, and **46, 42** respectively. In addition, the vacuum begins to evacuate tank **36** through restriction **48** as will be later explained.

The actuation of logic switch **20**, as described, causes the NC port and C port of switch **20** to be in mutual communication. As shown, a continuous vacuum supply **54** is provided to port NC of switch **20** through tubing **56** and such vacuum is normally provided through the same source as vacuum supply **22**, preferably from a central hospital vacuum system and is at a regulated constant negative pressure. Since logic switch **20** is actuated, this vacuum supply **54** is for application to a patient through tubing **58** to a suitable device, not shown, for entering the patient for withdrawal of the fluid to be removed. A regulator **60** may be provided in tubing **58** in order to insure the proper amount of vacuum applied to the patient. The actuation of logic switch **20**, therefore, begins the cycle whereby vacuum is applied to the patient.

As explained, the tank **36** is being evacuated through tubing **42**. A restriction **48** is provided in tubing **42** in order to regulate the resistance to fluid flow through tubing **42**, and thereby control the rate at which tank **36** is evacuated.

A tubing **40** communicates with the interior of tank **36**; however, it terminates at the NO port of logic switch **18** since this switch has been actuated and the NO port is effectively closed.

As the predetermined volume in tank **36** continues to be evacuated, a vacuum signal is eventually reached of sufficient value to actuate logic switch **14** through tubing **38** which communicates between the interior of tank **36** and the V port of logic switch.

The actuation of logic switch **14** opens port NC to port C which is open to the atmosphere, and therefore the atmosphere enters evacuated tank **32** through tubing **33**.

As the atmosphere enters tank **32**, the vacuum within the tank is dissipated to the point where a vacuum signal is no longer provided from tank **32**, through tubing **34** to the V port of logic switch **16**. Logic switch **16**, therefore, becomes unactuated and the NC port is closed with respect to the C port, while the NO port opens to allow the C port of switch **16** to communicate with the atmosphere through now opened NO port. The atmospheric pressure enters the NO port of switch **16** through a restriction **51** and tubing **50**. The purpose of the restriction **51** is to provide more positive control to switch **16**. During the switching process of the pneumatic switches described, there is a certain amount of time when, due to the gradual application of vacuum to the V port, both the NC and NO ports may be in communication with each other. By therefore restricting the entrance of atmospheric pressure into the NO port, this effect is minimized.

As atmospheric pressure enters the tubings **46, 42** and **44**, both logic switches **20** and **18** lose the vacuum signal applied to their respective V ports, and both switches become unactuated.

The unactuation of logic switch **20** closes NC port with respect to C port and, therefore, the vacuum signal from vacuum supply **54** is no longer applied for the purpose of withdrawing fluids from the patient. Instead, atmospheric pressure is allowed to enter the tubing **58** to the patient from NO port of logic switch **20**, thereby allowing the fluids within internal tubing to drain backward to the patient to facilitate unclogging of the lines.

In turn, the unactuation of logic switch **18** allows communication between NO port and C port which is open to the atmosphere and, therefore, the atmosphere is allowed to enter the evacuated tank **36** through tubing **40**. Again, to avoid the introduction of atmospheric pressure into the NC port of switch **18** and thereafter possibly to the NO port during switching, a tubing **52** is connected to the NC port and is completely closed at its end **53**.

As the vacuum in tank **36** is dissipated, the vacuum signal applied from tank **36** to the V port of logic switch **14** through tubing **38** is removed and logic switch **14** becomes unactuated.

The unactuation of logic switch **14** closes communication between the NC port and C port, thereby closing tank **32** to the atmosphere.

At this point in the cycle, the entire system has been restored to its original disposition, all logic switches are unactuated and the described cycle begins anew by the gradual evacuation of tank **32**.

As may now be seen, each time the vacuum in tank **32** is sufficient to cause the actuation of switch **16**, a vacuum signal is transmitted to logic switch **20** allowing the vacuum supply **54** to be applied to the patient for the withdrawal of fluids. When the volumn within tank **36** is then withdrawn sufficiently to actuate logic switch **14**, atmospheric pressure is allowed to enter tank **32**, thereby removing the vacuum signal from switch **16** to deactuate the switch. There is then no vacuum signal at switch **20** and the patient line **58** is opened to the atmosphere.

By adjusting the restrictions **30** and **48**, the rates of evacuation of tanks **32** and **36**, respectively, may be independently controlled, thereby regulating the time required to evacuate each of the tanks.

Control of the evacuation times, as may be seen, also controls the time periods within which logic switch **20** alternately allows vacuum or atmospheric pressure to be applied to the patient tube **58**, thereby providing a system having independent control over the intermittent suction and atmosphere cycles.

There is thus provided a novel modular design system utilizing standard pneumatic logic components having negligible frictional resistance, extreme reliability, and which is capable of providing an intermittent suction function of predetermined variable cyclic periods for the removal of fluids from a patient.

I claim:

1. An intermittent suction system for alternately applying a vacuum and atmospheric pressure for removing fluids from a patient comprising a supply line adapted to communicate with a source of vacuum, a first container means communicating with said supply line and adapted to be evacuated, means responsive to a vacuum in said first container means for applying an independent supply vacuum to the patient, a second container means adapted to be evacuated, means responsive to a vacuum in said second container means for breaking the vacuum to the patient and applying atmospheric pressure to the patient.

2. An intermittent suction system for alternately applying a vacuum and atmospheric pressure to a patient line comprising a pneumatic switch having a first position where a vacuum is applied to the patient line and a second position where atmospheric pressure is applied to the patient line, and means for operating said neumatic switch comprising a first container adapted to be evacuated, means responsive to a vacuum in said first container to place said pneumatic switch in its first position, a second container adapted to be evacuated, means responsive to a vacuum in said second container for placing said pneumatic switch in its second position.

3. An intermittent suction system as in claim **2**, wherein said first and second containers are evacuated at a predetermined rate.

4. An intermittent suction system as in claim **3** wherein means are provided to vary the rate of evacuation of said first and second containers.

5. An intermittent suction system as in claim **3** wherein means are provided for de-evacuating said first and second containers.

6. A method of providing an intermittent suction system comprising the steps of evacuating a known volume from a first container at a predetermined rate, sensing a vacuum produced in the first container, applying a vacuum to a patient in response to the sensed vacuum in the first container evacuating a second known volume from a second container at a predetermined rate, sensing a vacuum produced in the second container, breaking the vacuum to the patient and applying atmospheric pressure thereto in response to the sensed vacuum in the second container and restoring the first and second containers to a non-evacuated state.

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