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ALTERNATING TOURNIQUET SYSTEM

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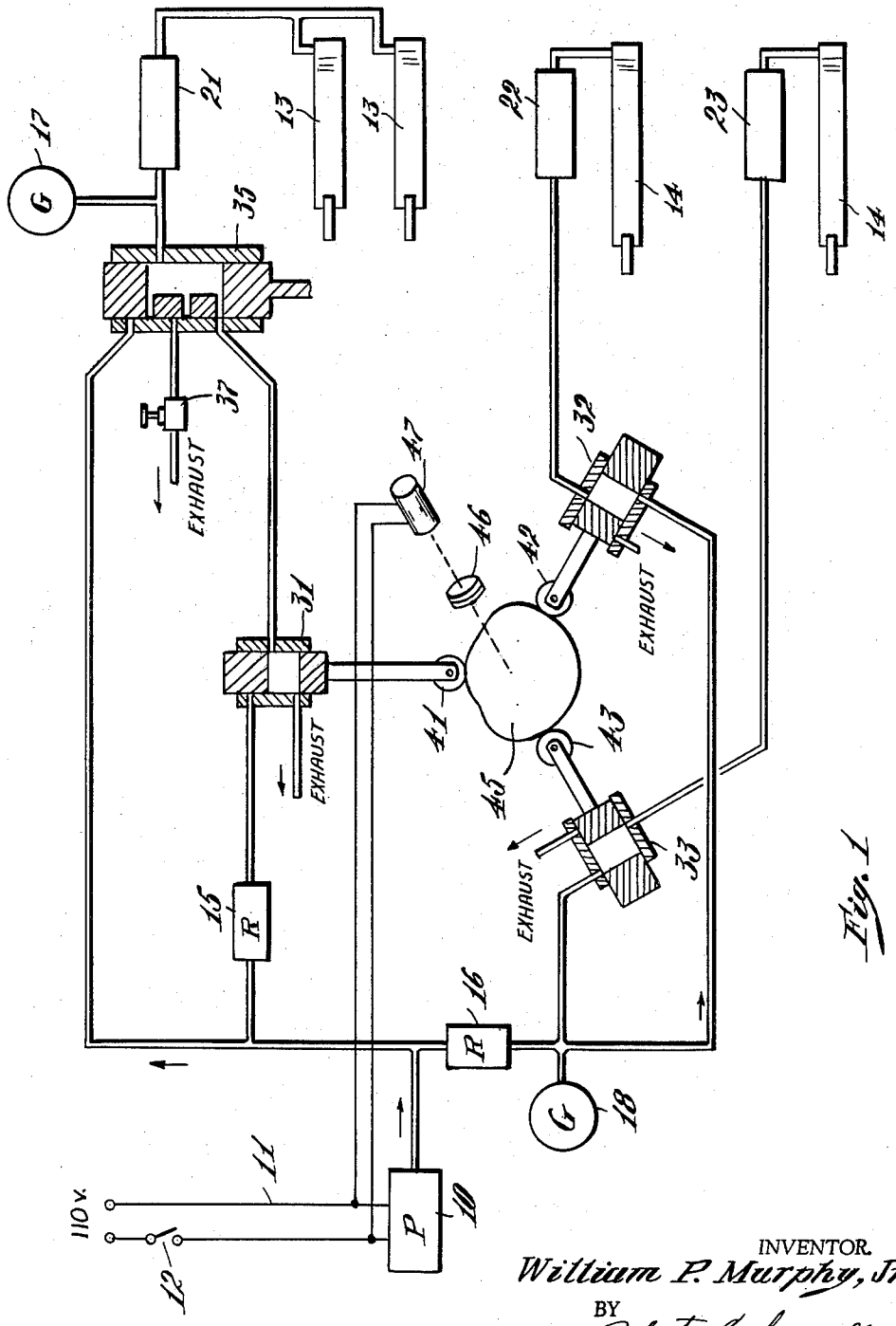


Fig. 1

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ALTERNATING TOURNIQUET SYSTEM

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This invention relates to blood flow limiting apparatus and more particularly to an alternating tourniquet system.

Certain types of heart ailments can cause a condition known as pulmonary congestion in which an excess of blood backs up in the patient's lungs due to the inability of the left side of the heart to pump the entire volume of blood getting to it. This condition is immediately dangerous to the patient because the excess of blood or fluid in the lungs prevents the normal exchange of air and therefore oxygenation of the blood.

One simple way of treating this condition is to remove a portion of the patient's blood. Another relatively simple and more useful technique is to trap and retain a portion of the patient's blood in his extremities by means of tourniquets applied to the various limbs.

Another application of this technique is following heart surgery or other direct injury to the heart. Removal of part of the blood load from the heart can speed its recovery and improve the patient's overall chances of recovery.

Preferably the tourniquets used in this technique are applied at the pressure which is above venous pressure but below arterial pressure. In this way, not only is the blood which was already in the limbs trapped there, but also additional blood from the body proper is allowed to enter the limb through the arteries causing a further dilation and pooling of blood, the venous return thereof being effectively blocked. However, pressure both above and below this range will also trap a portion of the blood circulating and so should be understood to lie within the scope of the present invention. Another factor which must be reckoned with in selecting the proper pressures to be applied to the tourniquets is that the relative structure of the arm or leg will influence the value of pressure at which maximum pooling is achieved. Thus typically a different pressure will be applied to a patient's arms than to his legs.

In the application of tourniquets, it is recognized that if a tourniquet is left on any given limb for many hours that stasis may cause gangrene. It is therefore necessary that each tourniquet be released periodically so as to permit a normal flow of blood completely through the limb. On the other hand, in the treatment of pulmonary congestion it is desirable that the volume of blood circulating, or conversely the amount of blood trapped, be kept substantially constant and that the heart not be subjected to any abrupt overloads. Accordingly, the tourniquets on the various limbs are released in rotation at periodic intervals. In that the volume of blood held by each arm is substantially less than that held by a leg, the two arms are typically treated as a single unit to be released together, there then being three units to be rotated.

The type of tourniquet typically used is pneumatic, the structure being substantially similar to the type of inflatable tourniquet used in measuring blood pressure. Previously, the inflation and deflation of the several tourniquets required was accomplished by a nurse who had to be in frequent or practically constant attendance and had to exercise great care in order to perform each operation at the proper moment and in proper sequence.

Accordingly, objects of the present invention are to provide an alternating tourniquet system which will automatically inflate a plurality of pneumatic tourniquets in proper sequence and at proper intervals for the treatment of pulmonary congestion.

Further objects are to provide such an automatic alternating tourniquet system which includes means for overriding and resetting the predetermined program of tourniquet inflations, which provide air at a different pressure for the arm tourniquets than for the leg tourniquets, which includes means for adjusting and measuring the various pressures applied to the tourniquets, simple and highly dependable in operation, and which is of relatively inexpensive construction.

For purposes of illustration a preferred embodiment of the invention is shown in the accompanying drawing in which:

FIGURE 1 is a diagrammatic illustration of an automatic alternating tourniquet system.

Referring now to the drawing there is provided a pump **10** for supplying air under pressure for inflating the various pneumatic tourniquets. This pump is preferably electrically powered and is provided with leads **11** for connection to the standard alternating current mains. One of these leads contains a switch **12** so that the apparatus may be turned on or off. For connection to the arm tourniquets **13** and the leg tourniquets **14** there are provided outlets **21**, **22** and **23** respectively which may be of any standard type. Each of these outlets has associated with it a two-position valve **31**, **32** and **33**, respectively, by which each outlet may be connected to either the appropriate source of air pressure or vented to the atmosphere. Each of these valves **31**, **32** and **33** are arranged to be operated by an associated cam follower **41**, **42** and **43**, respectively, and the cam followers in turn are driven by a single timing cam **45**. The cam **45** is turned at a steady rate as for example two revolutions per hour by a geared-down synchronous electric motor **47** which is, like the pump **10**, arranged for connection to standard alternating current mains. The contour of the cam **45** is such that each valve **31–33** is, for two-thirds of the cam's cycle, thrown so as to connect the corresponding tourniquet to its respective pressure source and for the remaining portion of the cycle, is thrown so as to permit the tourniquet to exhaust to the atmosphere. The cam followers **41–43** are equidistantly spaced around the cam **45** so that as one valve is thrown from pressure to exhaust, an adjacent valve is thrown from exhaust to pressure. The cam **45** is driven by the motor **47** through a friction clutch **46** so that the timing cycle may be reset by manually rotating the cam **45** and thereby overriding the clutch **46**. For this purpose there is preferably provided a knob (not shown) connected directly to the cam **45** and projecting exteriorly of the apparatus.

Because of the difference in structure between arms and legs there are provided separate regulators **15** and **16** for regulating the flow of air to the respective tourniquets. These regulators are preferably adjustable and there are provided gauges **17** and **18** respectively by which the regulators may be adjusted to appropriate pressures. As explained above, these regulators are preferably adjusted to pressures above venous and below arterial blood pressure but may also be set for pressures outside of this range.

Since in the treatment of pulmonary congestion it is necessary to take blood pressure measurements frequently, there is provided in the preferred embodiment shown means for utilizing the gauge **17** for this purpose. A three-way valve **35** is arranged so that at least one of the arm tourniquets may be connected either to the full pump pressure or permitted to exhaust to the atmosphere through a needle valve **37** as well as being connected to its associated programmed source of air pressure. By means of this valve **35** a physician may first inflate the corresponding arm tourniquet to a pressure above arterial and then slowly release that pressure through the adjustable needle valve **37**. By listening for arterial sounds at the anticubital

space the physician may then determine at what pressure arterial blood again begins to flow. By this means blood pressure may be taken and the arm returned to its blood storing function without disturbing the existing tourniquet arrangement.

It should be understood that this disclosure is for the purpose of illustration only and that the present invention includes all modifications and equivalents falling within the scope of the appended claims.

I claim:

1. An alternating tourniquet system comprising: a source of air pressure; a pair of pneumatic arm tourniquets; a first pneumatic leg tourniquet; a second pneumatic leg tourniquet; valve means having a first state in which the arm tourniquets and the first of the leg tourniquets are connected to said source and said second leg tourniquet is vented to the atmosphere, a second state in which both leg tourniquets are connected to said source and the arm tourniquets are vented, and a third state in which the arm tourniquets and said second leg tourniquet are connected to said source and said first leg tourniquet is vented; and motor means for driving said valve means successively from one state to another in rotation at a predetermined rate.

2. An alternating tourniquet system according to claim 1 further comprising means for regulating the air pressure available from said source to a pressure which is above venous but below arterial pressure.

3. An alternating tourniquet pressure controller comprising a source of air pressure, first regulating means for adjusting air pressure to a level suitable for application to pneumatic arm tourniquets, a second regulating means for adjusting air pressure to a level suitable for application to pneumatic leg tourniquets, a first outlet, a second outlet, a third outlet, said first outlet being connectable only to said first regulating means and said second and third outlets being connectable only to said second regulating means, valve means for selectively connecting any

two of said outlets to their respectively associated regulating means and venting the remaining outlet to the atmosphere, and motor means for continuously driving said valve means at a predetermined rate so that pressure is removed from each of said outlets in succession.

4. An alternating tourniquet system comprising: a pair of pneumatic arm tourniquets; a first pneumatic leg tourniquet; a second pneumatic leg tourniquet; an air pump; a first pressure regulating means connected to the pump for providing air pressure suitable for application to said arm tourniquets; a second pressure regulating means connected to the pump for providing air pressure suitable for application to said leg tourniquets; valve means having a first state in which the arm tourniquets and the first of the leg tourniquets are subjected to respectively appropriate pressures, a second state in which both leg tourniquets are subjected to an appropriate pressure and a third state in which the arm tourniquets and said second leg tourniquet are subjected to respectively appropriate pressures; and motor means for driving said valve means successively from one state to the next in rotation at a predetermined rate.

5. An alternating tourniquet system according to claim 4 including a pressure gauge associated with each of said pressure regulating means.

6. An alternating tourniquet system according to claim 5 including manually controllable means for selectively applying pressure directly from the pump to the arm tourniquets and then gradually venting the arm tourniquets to the atmosphere independently of the state of said valve means thereby facilitating the measurement of blood pressure.

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