

Oct. 21, 1952

J. K. PACKER
AUTOMATIC TOURNIQUET

2,614,565

Filed March 17, 1951

2 SHEETS—SHEET 1

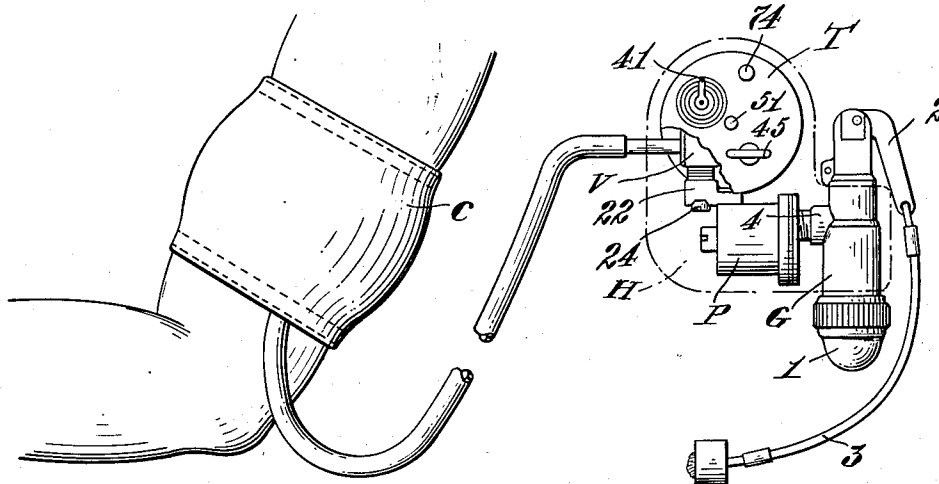


Fig. 1

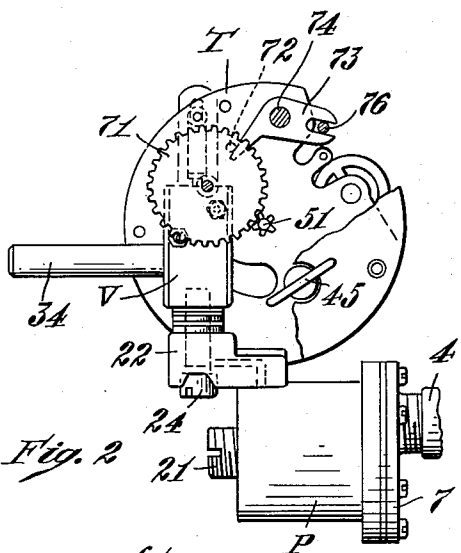


Fig. 2

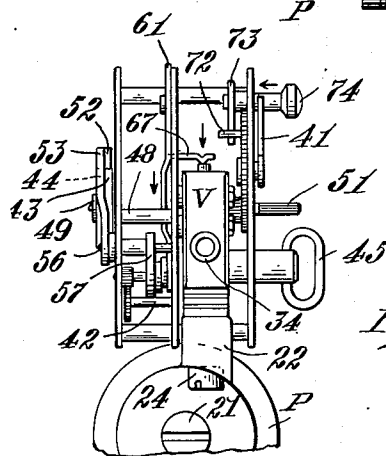


Fig. 3

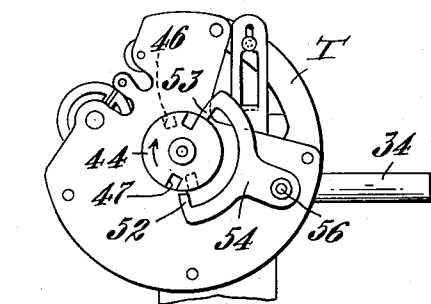


Fig. 4

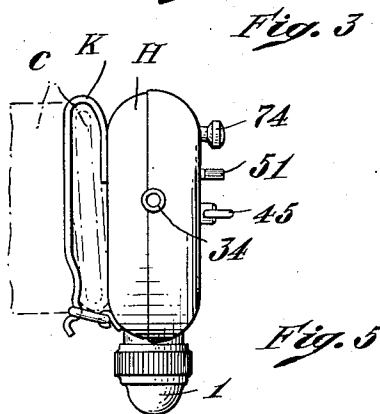


Fig. 5

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2 SHEETS—SHEET 2

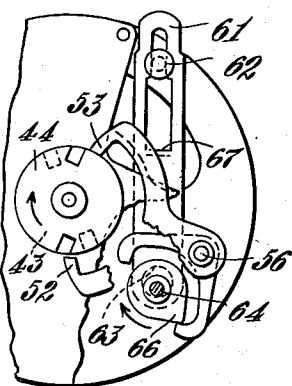


Fig. 6

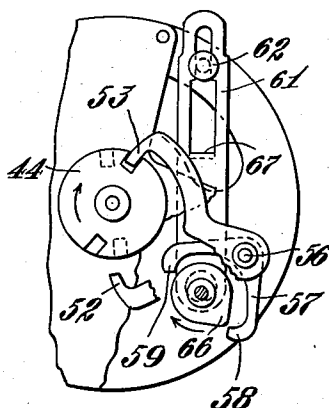


Fig. 7

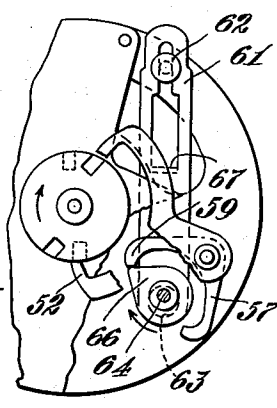


Fig. 8

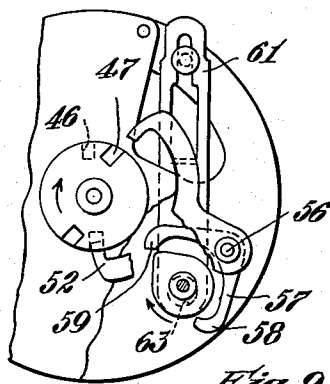


Fig. 9

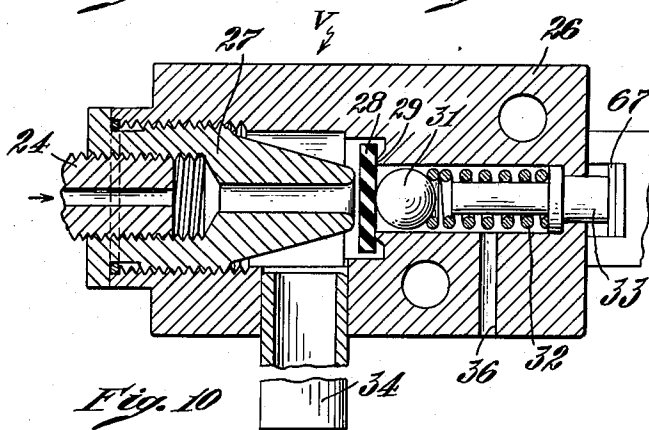


Fig. 10

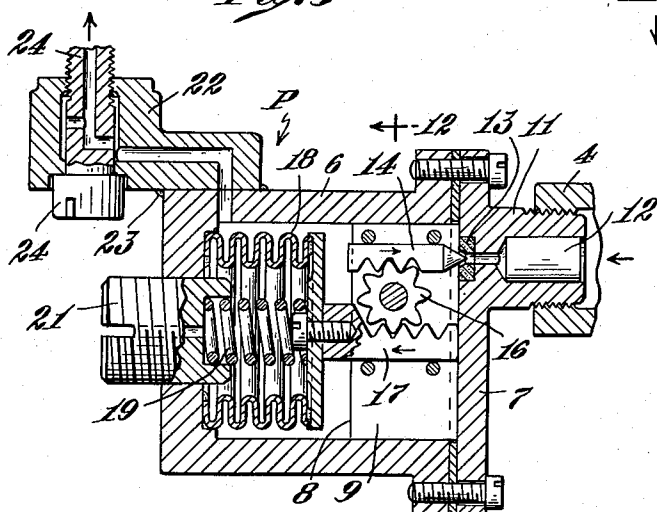


Fig. 11

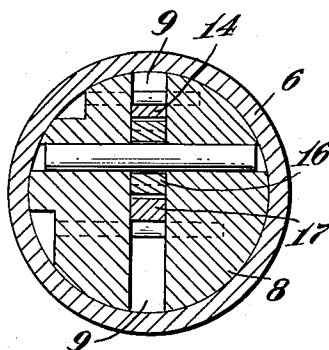


Fig. 12

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UNITED STATES PATENT OFFICE

2,614,565

AUTOMATIC TOURNIQUET

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Application May 17, 1951, Serial No. 226,811

6 Claims. (Cl. 128—327)

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In many situations it is necessary to apply a tourniquet to stop blood flow and to leave the tourniquet in use for a considerable period of time. One example is in warfare where it takes considerable time to get injured men to a hospital. Similar situations develop in many other places as for example in the case of accidents on ships, aircraft, etc. However if the blood flow is stopped very long at a time the consequences to the patient may be serious. Consequently, if there is a doctor or nurse available, it is customary to relieve the pressure of the tourniquet periodically to let the blood flow for brief intervals. For example the blood flow may be obstructed for twenty-five minutes, then permitted to flow for forty-five seconds, then obstructed again for twenty-five minutes, and so on over a period of several hours without danger from the obstruction and without much bleeding.

Objects of the present invention are to produce an automatic tourniquet which will alternately impede the flow of blood and then permit it to flow, which can readily be set for any desired periods of flow and non-flow, which will maintain the pressure on the patient constant during each period of non-flow, which will automatically stop the cycles of flow and non-flow at the end of a predetermined number of cycles, which will leave the pressure applied to the patient at the end of the series of cycles, which is simple and economical in construction, which is light and portable, and which is durable and reliable in use.

According to the present invention the blood circulation is preferably controlled with an inflatable cuff, that is any device adapted to apply pressure on a part of the body by being inflated, as for example a rubber bag or tube enclosed in a fabric sleeve such as commonly used by physicians in taking blood pressure. According to this invention the device comprises a pressure regulator to control the pressure in the cuff, in combination with a valve to relieve the pressure in the cuff and a timer for actuating the valve periodically, whereby the flow of blood is normally impeded but periodically permitted to flow. While any source of gas pressure may be employed, such as an air compressor, the source preferably comprises a small tube of carbon dioxide gas under high pressure with a tight casing to house the tube and means to puncture the tube after the casing is closed. The aforesaid valve preferably comprises a three-way valve in the conduit connecting the pressure regulator with the cuff, the valve being movable between two positions, an "on" position in which the cuff is connected with the regulator and an "off" position in which this connection is closed and the cuff is connected to an exhaust to permit the gas in the cuff to flow out into the atmosphere. The aforesaid timer preferably comprises

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a rotary controller having "on" and "off" positions, corresponding to the aforesaid position respectively, means for urging the controller to turn, time-controlled stop means for blocking rotation of the controller for predetermined times in the aforesaid positions, and means for adjusting each of the predetermined times independently of the other.

For the purpose of illustration a typical embodiment of the invention is shown in the accompanying drawing in which

Fig. 1 is a side view of the apparatus applied to a patient;

Fig. 2 is a full-size view of a portion of the apparatus with parts broken away;

Fig. 3 is a side elevation of the timer viewed from the side opposite to that shown in Fig. 2;

Fig. 4 is a side view, viewed from the left of Fig. 2;

Fig. 5 is a side view of the apparatus in use, viewed from the same side as in Fig. 4;

Fig. 6 is a view like Fig. 3 showing the parts in "on" position;

Fig. 7 is a similar view at the instant the parts start to shift from "on" to "off" position;

Fig. 8 is a similar view with the parts in "off" position;

Fig. 9 is a similar view at the instant the parts start to shift from "off" to "on" position;

Fig. 10 is an axial section of the three-way valve;

Fig. 11 is an axial section of the pressure regulator; and

Fig. 12 is a section on line 12—12 of Fig. 11.

The particular embodiment chosen for the purpose of illustration comprises a cuff C of the type referred to, a gas container G, a pressure regulator assembly P, a three-way valve V, a timer T and a housing H for the parts, the housing having a clip K adapted to hook over the cuff when the cuff is applied to a patient to support the apparatus (Fig. 5).

The gas container G has a removable cap 1 at one end closing an opening through which a cylinder of carbon dioxide gas may be inserted. At the other end of the container is a pivot arm 2 having a pointed end projecting inside the housing to puncture the end of the cylinder when the arm 2 is pulled away from the housing by means of the pull cord 3. The container G communicates with the pressure regulator through the connection 4 shown in Figs. 1, 2 and 11.

The pressure regulator assembly, which is shown in detail in Figs. 11 and 12, comprises a cylindrical housing 5 having an open end which is closed by a cap 7 comprising an integral portion 8 which projects into the housing, the part 8 having a slot 9 milled therein. The cap 7 has a nipple 11 for connection with the outlet 4 of the gas container G. Mounted in the nipple

11 is a filter 12 and a valve seat 13 of soft metal. Seating on 13 is a valve 14 actuated by a pinion 16 which in turn is actuated by a rack 17 connected to bellows 18, the parts 14, 16 and 17 being movably mounted in the slot 9 by means of pins bridging the slot as shown in Figs. 11 and 12. Bearing against the inner end of the bellows is a spring 19 the pressure of which may be adjusted to any predetermined value by screw 21 extending outside the casing, the screw having an axial opening to vent the interior of the bellows. Thus the regulator assembly comprises a casing 6 and internal regulating means including the aforesaid parts 13 to 21. When the pressure inside the casing 6 falls below that for which the screw 21 is set the bellows expand, moving the rack 17 to the right and the valve 14 to the left, thereby admitting gas to the cuff from the container G. When the pressure is restored to the predetermined value the valve 14 is again closed by the pressure of the gas on the bellows.

The valve assembly V is mounted on the pressure regulator by means of a connection 22 which is soldered or welded to the pressure regulator as indicated at 23 (Fig. 11). Extending through the projecting end of the connection 22 is a screw 24 which threads into the lower end of the valve to hold the parts together, the connection and screw having passageways connecting the valve with the regulator. As shown in Fig. 10 the valve is located in a casing 26 interconnected with the screw 24 by means of a nipple 27, a disk valve 28 movable back and forth between the end of the nipple 27 and a valve seat 29, a ball 31 bearing on the valve, a spring 32 having one end bearing on the ball, a plunger 33 having a shoulder bearing on the other end of the spring and projecting outside the casing so that it may be pressed inwardly against the action of the spring to move the valve from the seat 29 to the nipple 27, an outlet 34 for connection to the cuff, and an exhaust port 36. With the valve in the "on" position shown in Fig. 10 gas may flow from the regulator through the nipple 27 and thence through the outlet 34 to the cuff. When the valve 28 is shifted from the seat 29 to the nipple 27 the gas supply is shut off and the outlet 34 communicates with the exhaust port 36 so that the gas in the cuff may flow out into the atmosphere.

The timer T comprises clockwork similar to an ordinary alarm clock including an indicator 41 visible through an opening in the housing H. However instead of being calibrated in terms of hours and minutes it is preferably calibrated in terms of cycles, each cycle comprising an "on" period and an "off" period. The timer comprises the usual main spring (not shown) for driving the shaft 42 (Fig. 4) which, through suitable gearing, drives inner and outer timing disks 43 and 44 having in their peripheries recesses 46 and 47, and a projecting key 45 for winding the main spring. The disks are held in adjusted position on shaft 48 by means of a collar 49 pressed on one end of the shaft, the other end of the shaft having a projecting handle 51 with which the disks may be manually turned to any desired position. Engageable with the recesses 46 and 47 are fingers 52 and 53 on arm 54 fast to the outer end of shaft 56. Fast to the inner end of shaft 56 is another arm 57 having similar intumed ends 58 and 59 (Figs. 6 to 9). Adjacent the arm 57 is a bar 61 having a slot for a screw 62 which permits the bar to slide lengthwise. The lower end of the bar has

a circular opening to receive an eccentric 63 which is eccentrically mounted on a shaft 64. The bar 61 has a struck-up tongue 67 projecting at right angles from the bar over the end of the plunger 33 of the three-way valve (Figs. 4 and 10). Fast to the shaft 64 is a controller 66 engageable with the ends 58 and 59 or arm 57. When the controller 66 is in the position shown in Fig. 6 the bar 61 is moved up by the eccentric to the position shown in Figs. 6 and 10 to open the passageway from the source of gas to the cuff, and when the controller 66 is in the position shown in Fig. 8 the eccentric has moved the bar 61 down to shift the valve 28 from the seat 29 to the end of the nipple 27 (Fig. 10) thereby to close the passageway from the source to the cuff and open the passageway from the cuff to the atmosphere.

The controller 66 is continuously urged in the direction indicated by the arrow in Figs. 6 to 9 but is held from turning by the ends 58 and 59 in the two positions shown in Figs. 6 and 8. When the parts are in the "on" position shown in Fig. 6 they remain in this position until the finger 53 snaps into one of the recesses 47 in the outer timing disk 44, the finger being caused to snap into the recess by the pressure of the controller 66 on the end 58 of arm 57. When finger 53 snaps into the recess the arms 54 and 57 move to the position shown in Fig. 7 permitting the controller 66 to turn to the position shown in Fig. 8. When the controller reaches this position it presses against the end 59 of arm 57, thereby yieldingly pressing the finger 52 against the periphery of the inner timing disk 43. Then when the timing disks have turned to the position shown in Fig. 9 the finger 52 snaps into a recess 46 of the inner disk, thereby permitting the controller 66 to advance to the position shown in Fig. 6 to inflate the cuff.

The controller 66 is driven independently of the timing disks 43 and 44 so that the timing disks may continue to turn while rotation of the controller is blocked by arm 57. While this may be accomplished with a separate spring, it is preferably accomplished by connecting one end of the main spring to the gearing which drives the timing disks and the other end to the gearing which drives the controller, as in an alarm clock where one end drives the clock and the other end the alarm.

The length of each cycle may be predetermined in various ways as for example by choice of ratio of the gears which drive the timing disks or variation of the number of recesses in the peripheries of the timing disks; and the relative lengths of the "on" and "off" periods may be varied by angularly shifting one timing disk relative to the other.

In a portable device where the source of gas is not inexhaustible it is desirable to discontinue the aforesaid cycle of operation before the gas is exhausted. For this purpose the timer is provided with a gear 71 which makes one revolution during the period of time the apparatus is to continue to cycle (Fig. 2). Projecting from one side of the gear is a pin 72 engageable with one end of a bell-crank 73 fast to a plunger 74 which projects through an opening in the housing H. The other end of the bell-crank has a slot receiving a pin 76 fast to the clock frame. When the pin 72 reaches the bell-crank the gear 71 is stopped and, inasmuch as it is interconnected with the timing disks 43 and 44 by gearing, the timing disks 43 and 44 also stop. The

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pin 72 is so located on the gear 71 that when the parts are stopped the valve V will be in the "on" position so that the cuff will remain inflated until all of the gas in the container G is exhausted. To start the apparatus to cycle again the shaft 74 is pushed inwardly (in the direction of the arrow in Fig. 4) until the pin 72 can pass the bell-crank 73.

From the foregoing it will be evident that the passageway through the regulator assembly P and the valve assembly V constitutes a conduit having an inlet 12 (Fig. 11) for connection to the gas source G and an outlet 34 (Fig. 10) for connection to the cuff C. It will also be understood that the stops 52 and 53 and associated parts (Figs. 6 to 9) constitute time-controlled stop means and the length of the "on" and "off" periods may be adjusted by shifting the timing disks 43 and 44 relatively to each other as described above.

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

I claim:

1. A device for regulating blood circulation with an inflatable cuff applied to a patient comprising a conduit having an inlet for connection to a suitable source of gas and an outlet for connection to the cuff, pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value, a valve communicating with the cuff to relieve the pressure in the cuff, and a timer associated with the valve for actuating the valve periodically, whereby the flow of blood is normally impeded but periodically permitted to flow.

2. A device for regulating blood circulation with an inflatable cuff applied to a patient comprising a conduit having an inlet for connection to a suitable source of gas and an outlet for connection to the cuff, pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value, between the regulating means and outlet a three-way valve movable between two positions in one of which the outlet is connected to the regulating means and in the other of which the passage from the regulating means is closed and the outlet is connected to an exhaust, and a timer associated with the valve for moving the valve to said positions alternately, whereby the blood is alternately impeded and permitted to flow.

3. A device for regulating blood circulation comprising an inflatable cuff for application to a patient, a source of gas under pressure, a conduit having an inlet connected to the source and an outlet connected to the cuff, pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value, between the regulator and outlet a three-way valve movable between two positions in one of which the outlet is connected to the regulating means and in the other of which the passage from the regulating means is closed and the outlet is connected to an exhaust, and a timer associated with the valve for moving the valve to said positions alternately, whereby the blood is alternately impeded and permitted to flow.

4. A device for regulating blood circulation

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with an inflatable cuff applied to a patient comprising a conduit having an inlet for connection to a suitable source of gas and an outlet for connection to the cuff; pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value; between the regulating means and outlet a three-way valve movable between an "on" position in which the outlet is connected to the regulating means and an off position in which the passage from the regulating means is closed and the outlet is connected to an exhaust; and a timer associated with the valve for moving the valve to said positions alternately, the timer comprising a rotary controller having "on" and "off" positions corresponding to said positions respectively and time-controlled stop means for blocking rotation of the controller for predetermined times in said positions, whereby the blood is alternately impeded and permitted to flow.

5. A device for regulating blood circulation with an inflatable cuff applied to a patient comprising a conduit having an inlet for connection to a suitable source of gas and an outlet for connection to the cuff; pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value; between the regulating means and outlet a three-way valve movable between an "on" position in which the outlet is connected to the regulating means and an "off" position in which the passage from the regulating means is closed and the outlet is connected to an exhaust; and a timer associated with the valve for moving the valve to said positions alternately, the timer comprising a rotary controller having "on" and "off" positions corresponding to said positions respectively and time-controlled stop means for blocking rotation of the controller for predetermined times in said positions, parts of the timer being adjustable to vary each of said predetermined times independently of the other, whereby the blood is alternately impeded and permitted to flow.

6. A device for regulating blood circulation with an inflatable cuff applied to a patient comprising a conduit having an inlet for connection to a suitable source of gas and an outlet for connection to the cuff, pressure regulating means in said conduit which opens to admit gas to the cuff when the pressure in the cuff falls below a predetermined value, a valve communicating with the cuff to relieve the pressure in the cuff, and timing means associated with the valve for moving the valve into position to restore the pressure at a predetermined time after the pressure has been relieved.

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