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2,784,932

BLOOD OR STERILE FLUID EQUIPMENT

Filed Jan. 20, 1955

2 Sheets-Sheet 1

Fig. 1.

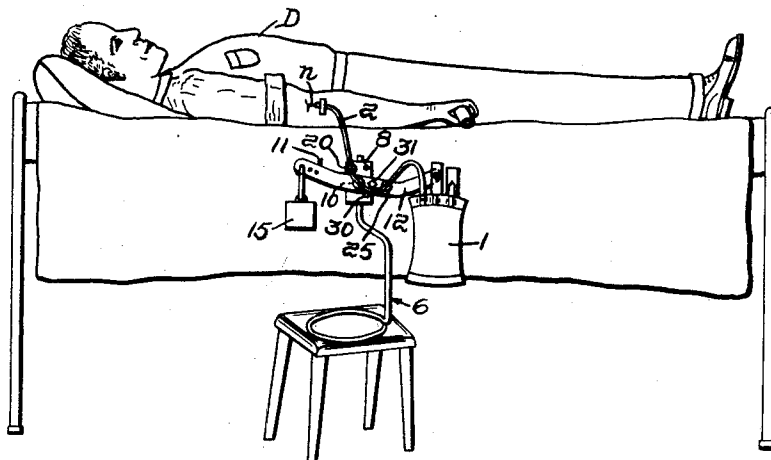
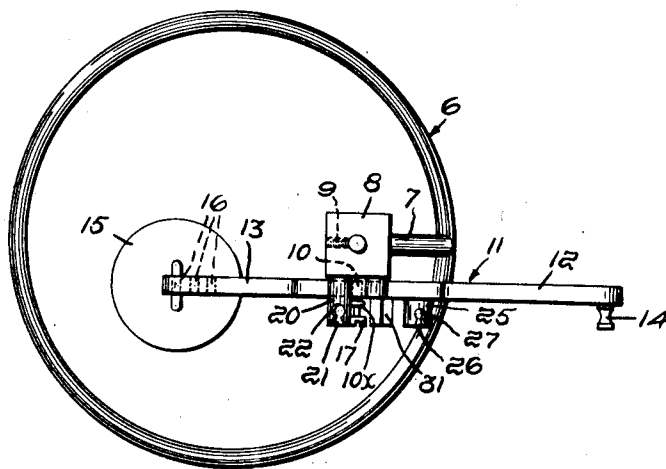


Fig. 4.



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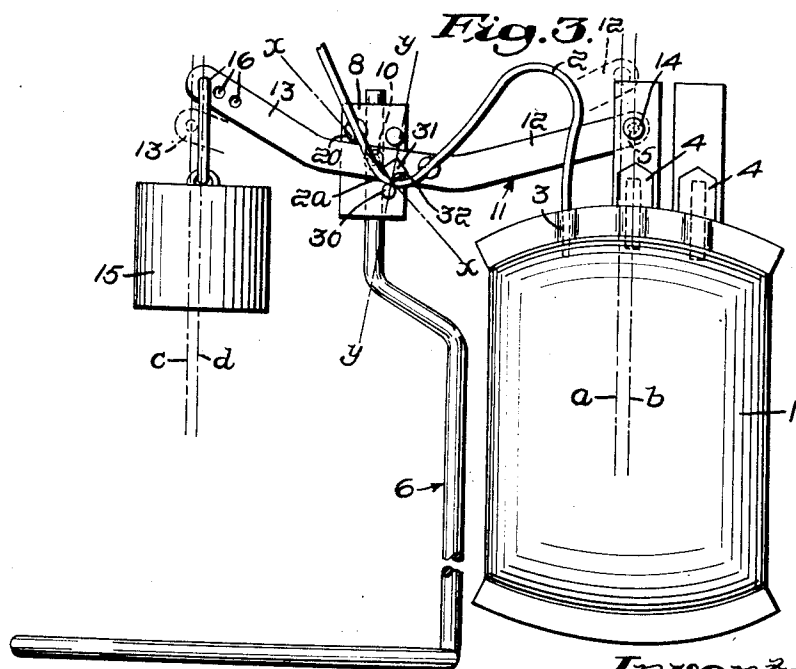
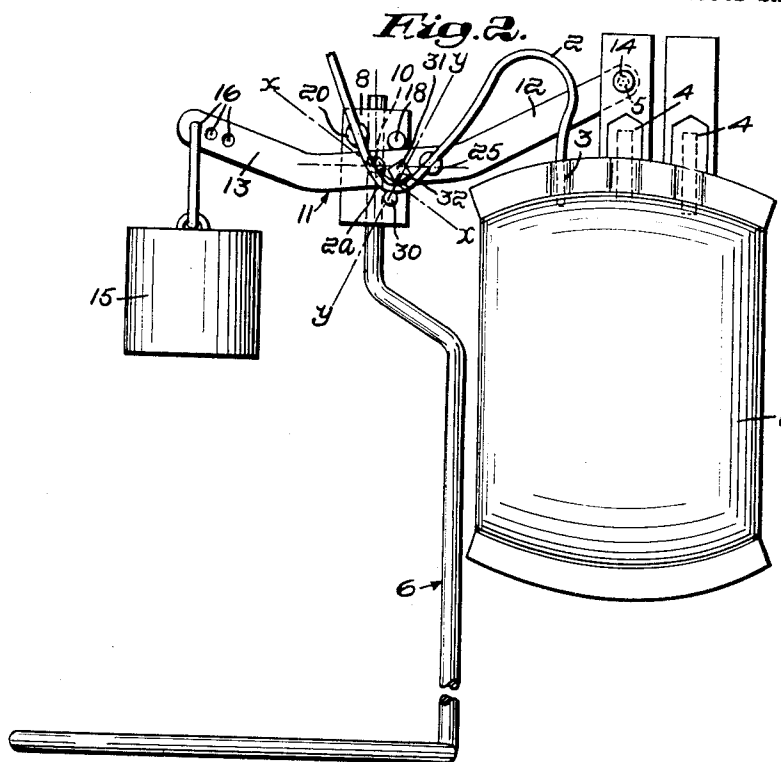
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2 Sheets-Sheet 2



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BLOOD OR STERILE FLUID EQUIPMENT

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4 Claims. (Cl. 249—3)

This invention relates to medical and surgical apparatus. More particularly it aims to provide blood and other sterile fluid collecting equipment whereby the flow of blood from a donor or of intravenous and the like sterile fluids from a supply is automatically controlled and shut off when a determined amount has been obtained.

In the drawings illustrating by way of example one embodiment of apparatus of the invention:

Fig. 1 is a relatively small-scale elevational view of the same in use with a blood donor;

Fig. 2 shows the equipment of Fig. 1 on a larger scale, in the initial open or starting position;

Fig. 3 is a view like Fig. 2 but with the flow tube automatically shut off with the desired quantity of blood in the collecting vessel; and

Fig. 4 is a top plan of the apparatus of the preceding figures.

An important use for the therapeutic apparatus of the invention is in blood donation, represented in Fig. 1 as one example of medical, surgical and hospital fluid handling to which the invention is pertinent. Fluid as herein referred to includes intravenous and other sterile fluids in the therapeutic field as well as blood and blood preparations and other fluids.

The illustrated equipment includes a suitable fluid-receiving container adapted for suspension or vertically movable support. While other forms of collecting container may be employed in the practice of the invention, the novel means thereof is especially adapted for handling a flexible-walled collapsible container or bag 1 such as that of the Fenwal system.

The bag 1 has closed communication with a tube or length of flexible tubing 2 one end of which is integrally or otherwise sealed into the closed and collapsed bag 1 as at the port 3. The other end is connected to the fluid supply source, as by a hypodermic needle *n* for insertion in the arm of a donor D, in the case of blood collection. For subsequent sterile access to and use of the content fluid the bag 1 has one or more sealed and sterile-sheathed outlets 4 including projecting tab-like portions affording convenient hanger connection as at an eye 5. In the practice of this invention the container or bag 1 and the donor-connectible tube 2 are operatively positioned upon and by automatic flow control and limiting means as exemplified in the several views.

Such comprises a fixture or stationary support shown as a stand designated generally at 6 presenting at a suitable height a mounting post 7 for a head or bearing block 8 adjustably held thereon as by a set screw 9, Fig. 4. A lateral boss or stud 10 on the head 8 provides horizontal pivotal support for a two-arm tiltable lever designated as a whole at 11 and comprising at opposite sides of said pivot 10 a container-supporting or bag arm 12 and a counterbalance or weight arm 13.

The fluid-collecting bag 1 is adapted to be hung at the outer portion of the bag arm 12 as by a button 14 on the latter receivable in the mentioned hanger eye 5

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provided for the purpose on the bag. Such button or other suspending member 14 may be adjustable along the arm for regulating purposes. The other lever arm 13 carries at the outer end an adjustable counterbalance or weight 15 hung thereon as at one of a series of selectable holes or other attaching formations 16. Such weight is selected and adjusted, as by interchange of weight members, by adding or subtracting small masses, or by changing the weight-attaching position along the arm 13, as appropriate for the given therapeutic fluid collecting operation.

It will be understood that the weight of the bag 1 and of the supported portion of the tubing 2 for a given operation and size of bag, is uniform. The correct weight setting for the apparatus accordingly may be predetermined for the amount of blood or other fluid to be collected, taking into consideration any initial content of the bag such as certain anti-coagulant material sometimes placed in it in the case of blood collection. Hence a standard setting of the apparatus is available for repeat operations of the given character, such as the usual taking of 500 cc. of blood from a human donor. The apparatus may be calibrated and readably marked, on the lever arm or elsewhere, as appropriate for a given fluid collection, such as that mentioned.

The automatic fluid content control and limiting apparatus of the invention further comprises means for disposing the inlet tube 2 to present an intermediate portion thereof for pinch closure and yet to afford free flow therein during the collecting procedure, while also avoiding introduction of any factor tending to bias the reading of the apparatus. Accordingly an intermediate portion of the tube 2 is arranged to present a bight 2a thereof, Figs. 2 and 3, at and around the lever pivot 10 and such that the tubing will enter the control arm 11 at the pivot 10 and be able to flex thereat with the arm and thus be free from pull attendant on arm movement.

For this purpose suitable tubing guide means is provided at opposite sides of the lever pivot 10. Such means includes a first and fixed guide and holder member 20 on the stationary head 8, herein somewhat above and behind said pivot 10. This guide 20 shown as a boss or stud on the head 8 has a tube holding guide slot formation including a laterally open mouth 21 admitting to a tubing-conformant guide portion 22 of interrupted circular cross-section. The guide mouth 21 is adapted to retain the tubing 2 upon lateral entrance into the guide portion 22, being shown as narrowed to less than the outer diameter of the resilient-walled tubing, but permits the latter easily to be set into and later removed from this slotted guide means 20—22. As seen in Figs. 2 and 3 the opposite end portions of this guide formation, in the direction paralleling the tubing, may be flared or rounded to facilitate mounting and guidance of the tubing.

The tubing guide means further includes at the opposite side of the lever pivot 10 a similar tubing guide member 25 having a mouth 26 and retainer slot 27 but in this instance positioned on and moving with the bag arm 12 of the lever 11. The plurality of tube holding guides 20—22 and 25—27 is positioned relative to each other and to the arm pivot 10 as appropriate to define and present a bight 2a of the tubing passing to and around said pivot point 10. Hence the respective guide slots 22 and 27 are disposed in general line with the path desired for the corresponding leg of such tubing bight 2a. As shown they stand at opposite sides of a generally vertical line through the arm pivot 10, and, at least in the starting of the apparatus, Fig. 2, upon the same side of a generally horizontal line through said arm pivot. Accordingly the plural guide means holds and presents the tube 2 in an open loop or bight such as 2a. The tube

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guides 20, 25 and the arm pivot 10 also are so correlated in position that the end of the tubing is non-constrictive of flow in the tubing yet the bight 2a is presented closely around the arm pivot 10 and in such manner that the tubing in effect enters the lever arm at the pivot point with the latter adapted to serve as a fulcrum for the flexing of the tube, or the outgoing leg of the bight thereof, attendant on pivotal tilting movement of the lever 11. Thus the tube 2 is directed in its approach to and departure from the pivot 10 along a bend or curved path consistent with unobstructed flow of fluid through the tube. As further facilitating this arrangement the pivot-defining boss or stud 10 preferably has a tube-guiding concentric circumferential groove or guide channel 10x, Fig. 4, similar to that of a rope pulley, integrally or otherwise formed on the pivot boss or stud 10 as by threading a headed stud member 17 into it at the pivot axis. An inner flange on such member may serve as a retaining collar for the lever arm 11.

In the foregoing description of the tubing guide means and the forming and location of the tubing bight 2a the latter merely for purposes of disclosure is treated as generally upright and open at the top and the reference lines for the guides are for identification called "vertical" and "horizontal." The tubing bight may be otherwise positioned about the pivot axis 10, inversely to that shown or in some intermediate position around the pivot, said reference lines then being correspondingly disposed radially of the pivot and generally perpendicular to each other. Also, while the position length of tubing 2a entering the lever arm at the pivot thereof is referred to as a "bight" it should be understood that the degree of curvature or bend may be less or more than that shown and may range widely between substantially a zero curvature and 360° of arc. Some degree of bend is generally found desirable, to slack the tubing at the arm pivot region and prevent undue tension or other effect thereon apt to bias the apparatus reading.

The invention further comprises automatic shut-off means associated with the tubing bight and the parts already described. Such means is illustrated as a pinch valve or clamp device and includes a fixed member or anvil 30 shown as a pin projecting from the stationary head 8 herein below the tubing bight 2a, together with a cooperative movable constrictor or nip member 31 on the bag arm 12 of the lever 11, within the tubing bight and at the opposite wall of the tubing. These clamp members 30, 31 are disposed in opposed paired relation adjacent the lever pivot 10. In the initial or starting position of Fig. 2 the tube 2 passes uninterruptedly between said clamp members. In the predetermined loaded position of Fig. 3 said valving clamp members have closed upon the tubing with a positive and forceful nipping action such that the inner wall of the tube is collapsed upon itself across a full diameter and fluid flow is completely cut off. For this purpose one or both of the pinch valve members 30, 31, herein the movable arm-carried member 31, is formed with an angular nose or corner portion 32 adapted to define a cross-sectional zone or line of pinch-off engagement across the tubing 2.

The relative proportioning and positioning of the described parts including the supporting lever 11, its pivot point 10 and the pinch valve elements 30, 31 are so calculated that the desired automatic shut-off action, which is had without introduction of any external force beyond that of gravity, takes place in a definite and positive fashion, with rapidly increasing force application and with a force multiplying and toggle-like action at the region of the cut-off. As apparent in Figs. 2 and 3 the bag arm 12 has an upward rake. The point of suspension of the bag 1 thereon is such that in the descent of the bag arm 12 under predetermined loading of the bag there is an increase in the effective length of the lever arm to an extent as indicated by the dotted lines a and b on Fig. 3. These represent respectively, in vertical pro-

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jection, the horizontal distances of the bag suspension point from the lever pivot point 10 in the initial and the loaded or shut-off positions of the bag.

In similar but opposite fashion the weight arm 13, also formed with an upward rake, undergoes a decrease in effective lever length as the weight 15 rises. Such upward leverage decrease is indicated on Fig. 3 by the dotted lines c and d vertically projecting respectively the initial and the final positions of the weight-attaching point of the weight arm 13 relative to a horizontal line through the lever pivot 10.

Hence the closing-off down-travel of the bag 1 and fluid content as the pre-set load point arrives is adapted to exert increasing and quickly and positively effective activation of the pinch valve with respect to the in-flow tube 2.

Positive cut-off is still further assured by the force multiplication and toggle-like action at the valve. First, the force-applying arm 12 from the pivot 10 to the bag suspension point 14 is of a length greatly exceeding and herein many times that of the work arm from the same pivot point to the pinch nose 32. Further, the toggle action is seen by regarding the nose 32 as the central or intermediate point of the toggle. Then the toggle arms are represented by the dotted line x—x joining the arm pivot center 10 and said nose 32, and the line y—y at an angle to line x—x and joining said nose 32 and the proximate point upon the fixed or anvil member 30 of the clamp valve.

Now comparing Figs. 2 and 3 it is seen that the toggle-angle between the lines x—x and y—y flattens in the course of the shut-off action. The nose member 32 is thus in effect forcibly thrust in between the two relatively fixed points or abutment members 10 and 30. Under this toggle effect combined with the augmented leverage of the bag arm 12 itself a substantial pinching force is exerted upon the engaged cross-sectional zone of the tube 2 insuring the desired positive closure thereof at the predetermined set point for the bag load. With the leverage system of the illustrative example an amplification of the shut-off force of the order of 10 to 1 and higher may be had.

The initial position or up limit for the bag arm 12 is determined by a preferably adjustable stop 18 on the mounting head 8, above said arm. The described anvil or pin 30 provides an opposite or down limit for said arm.

From the foregoing description in connection with the exemplary apparatus of the drawings, and in view of the toggle action for the pinch-off valve and the torque multiplication obtained by the relative radii or lever arms 10—14 for the bag and 10—32 for the movable pinch valve element, together giving more than ample force for securely and promptly pinching off the donor tube 2, it is apparent that the invention provides for certain and automatic cut-off of the flow of the blood or other fluid by pinch-closing the flexible tubing 2 at the correct predetermined fluid quantity. This flow cut-off is self-energized in the sense that it is accomplished without resort to external power in aid of gravity. Under the geometry of the illustrated leverage system an augmented and substantial torque is developed when the proper weight of fluid has been taken. Further, the construction and arrangement is such that the container-supporting arm 12 is caused to tilt through a considerable angle, making the loaded or cut-off position quickly recognizable and thus giving an easily noted indication to the phlebotomist or other fluid-collecting operator that the procedure has been completed.

It will be understood that my invention, either as to means or method, is not limited to the exemplary embodiment or steps herein illustrated or described, and I set forth its scope in my following claims.

I claim:

1. Therapeutic fluid collecting apparatus comprising,

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in combination with a closed container and flexible tubing leading thereto from a fluid source, a fixture, a horizontally pivoted arm on the fixture having means to attach such container at a point remote from the arm pivot, means to counterbalance the arm and container up to a predetermined fluid load for the latter, and opposed constrictor means on the fixture and the arm having the tubing passed between them, said constrictor means and arm constructed and arranged for nip closure of the tubing by sudden gravitational down-swinging of the arm with increasing mechanical advantage and torque at arrival of the predetermined fluid load in the container.

2. Therapeutic fluid collecting apparatus comprising a stationary support, a two-arm lever movable thereon about a horizontal pivot, one arm of the lever having means for suspending a fluid-collecting closed container having a length of flexible tubing delivering thereto, a counterbalance on the other lever arm, laterally open slip-in tubing holders at spaced points adjacent and at opposite sides of the lever pivot to present between them and around the lever pivot a bight of the tubing for pinch closure, a fixed anvil member, and a cooperable pinch member moving with the lever, said members disposed at opposite walls of the tubing of said bight so as to there pinch close the tubing under down-swinging of the lever upon predetermined fluid collection into the container, and said lever arm at the container side having an angular outer portion upwardly directed in the filling position and serving automatically to increase the mechanical advantage by effectively lengthening said arm

as it swings down and thereby producing positive closure of the tubing.

3. In the collection and handling of therapeutic fluids in containers, the method which comprises predetermining gross weight for the container and desired fluid quantity, vertically movably suspending a container to be loaded, flowing therapeutic fluid through flexible tubing from a supply into the container and continuing the flow until occurrence of self-energizing descent of the container and fluid content, mechanically multiplying the descent force increasingly during the descent, and availing of such force at a section of the tubing between the container and the fluid supply positively to pinch-shut the tubing and thereby automatically to segregate the desired quantity of therapeutic fluid in the container.

4. The therapeutic fluid collecting apparatus according to claim 2 wherein the lever arm at the counterbalance side also has an angularly upwardly directed outer portion and further increases the mechanical advantage for positive tubing closure by effectively shortening said counterbalance arm as it rises under down-swinging of the container arm.

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