L. F. BISHOP & R. GRACE.

SPHYGMOMANOMETER.

APPLICATION FILED MAR. 18, 1908.

915,329. Patented Mar. 16, 1909.

Fig. 1.

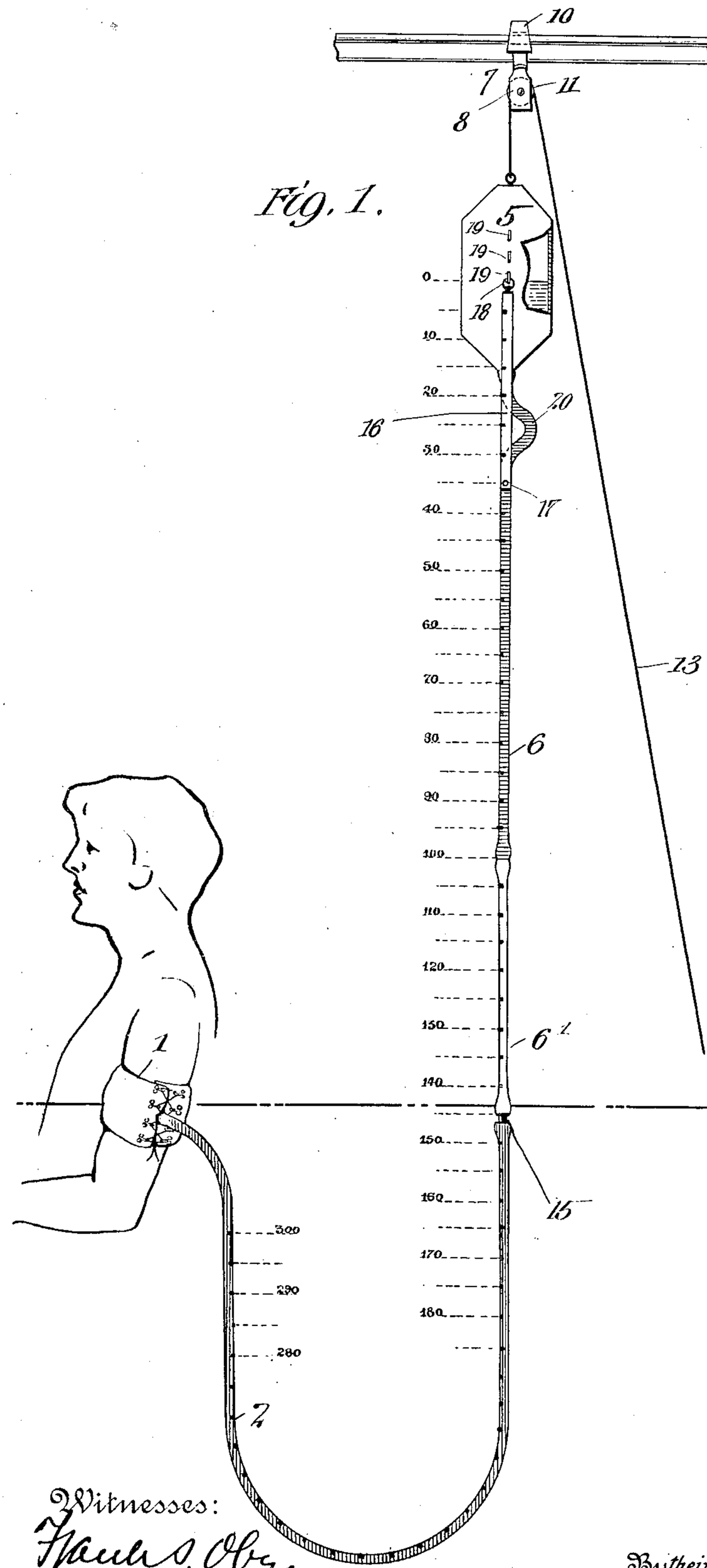


Fig. 2.

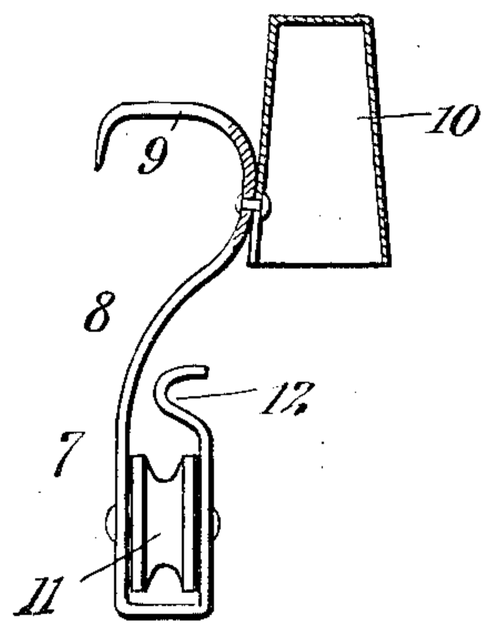
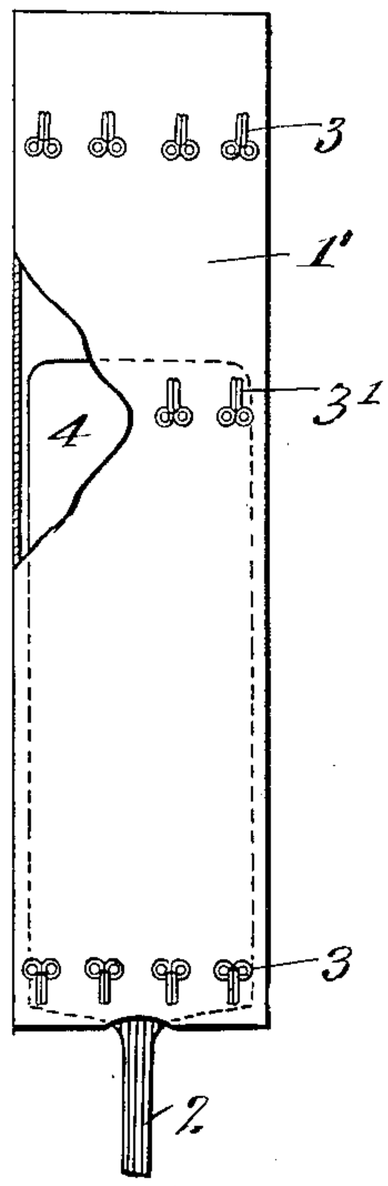


Fig. 3.



Witnesses:

Inventors
Louis F. Bishop and
Ralph Grace

By their Attorneys
Rosenbaum & Stockbridge

UNITED STATES PATENT OFFICE.

LOUIS F. BISHOP AND RALPH GRACE, OF NEW YORK, N. Y.

SPHYGMOMANOMETER.

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To all whom it may concern:

Be it known that we, LOUIS F. BISHOP and RALPH GRACE, citizens of the United States, residing at the city of New York, in the borough of Manhattan and State of New York, have invented certain new and useful Improvements in Sphygmomanometers, of which the following is a full, clear, and exact description.

Our invention relates to an instrument for determining the blood pressure of man and animals, and commonly known as the sphygmomanometer. The types of apparatus for this purpose which have been proposed and used heretofore, ordinarily make use of glass indicators containing mercury or a fluid which is displaced by air pressure. Ordinarily a small hand pump has been provided to secure an air pressure in the apparatus equivalent to the blood pressure to be measured, and this air pressure is then determined by the mercury or other manometer. With such an apparatus, the attention of the physician is distracted in two ways, first, by the necessity of manipulating the pump, and second, by the pulsations in the pressure caused by the pump strokes. The last-mentioned effect is particularly disturbing because the normal blood pulsations are made use of as the indicating means for the test, and it is important that they should not be confused with any mechanical pulsations of the apparatus. Besides this, it is evident that the glass apparatus is very fragile and cannot be packed away and carried in a small compass.

It is the purpose of our present invention to provide a simple apparatus in which the above objections are overcome.

With this object in view, we have devised an apparatus which does not rely upon air pressure or the manipulation of a hand pump and which is compact and portable, and made of soft rubber or flexible material throughout, so that it is not liable to breakage.

The invention consists in the features of construction and combinations particularly pointed out in the appended claims, reference being made to the accompanying drawing and specification which set forth a preferred embodiment of the invention.

In the drawing, Figure 1 is a general view showing a complete sphygmomanometer embodying the principles of our invention. Fig. 2 is a detail view partly in section, showing one of the parts. Fig. 3 is a detail view partly broken away, showing the cuff or bandage.

Referring to the drawing, in which like parts are designated by the same reference sign, 1 indicates a cuff or bandage designed to be applied to the arm or body of the patient, and comprising a vessel having a membranous wall which can be forced against the surface of the patient's body by fluid pressure. A convenient construction is that shown in Fig. 3 in which a fabric casing 1′ is shown of sufficient length to encircle an ordinary person's arm, and having a plurality of rows of hooks 3 between which lacings may be passed to bind the device in position. One or more extra rows of hooks 3′ may be located on the casing to accommodate arms of different sizes. The rubber bag 4 within the cuff or bandage is preferably considerably shorter than the surrounding fabric casing, being adapted to bear only against a portion of the circumference of the patient's arm corresponding to the location of the artery. We consider it advantageous to avoid encircling the patient's arm with the expansive vessel or membrane, since the application of the latter at points beyond the particular location of the artery is unnecessary and painful. The bag 4 has a rubber or similar flexible tube 2 extending therefrom and communicating with its interior.

In place of the pump and mercury tube apparatus hitherto generally used, we provide means for obtaining a water column, the height of which may be varied at will to any degree within the ranges ordinarily measured. In a healthy adult human being, the average normal blood pressure amounts to about 100 to 145 mm. of mercury. This pressure is equivalent to that of a water column between $4\frac{1}{2}$ and $6\frac{1}{2}$ feet in height. Abnormal blood pressures run considerably higher and lower than this value, and it is evident that means must be employed for securing a corresponding range in the variable water column.

We provide a vessel, preferably a fabric covered rubber or similar bag 5, the most particular characteristic of which is that it is very flexible or flaccid so as to exert substantially no pressure on its contents, except that transmitted from the atmosphere. To this bag, we connect a rubber or other tube 6, which is joined to the tube 2, the whole tube having a complete length equal to the height of a water column giving the greatest pres-

sures to be measured. For this purpose, a length of 13 or 14 feet is ordinarily amply sufficient. For ordinary cases, a lesser length would answer all requirements. The bag 5 constitutes a tank or reservoir for water, which fills the tubes 6 and 2 and the bandage 1, and creates a water column which transmits to said bandage a fluid pressure exactly proportionate to the height of the water level in the bag 5 vertically above said bandage 1. This result occurs by reason of the aforesaid flexible character of the bag 5, which transmits atmospheric pressure to the surface of the water column as freely as if the latter were open directly to the atmosphere. It is practically important in the use of the present invention that the pressure of the fluid column should only result from its own fluid height, without any additions or corrections on account of the air pressure above, and this can only be attained by insuring the application of atmospheric pressure to the top surface of the water column under all circumstances. The form of vessel 5 shown, having very thin flexible walls, secures this result. The effective pressure of the water column is varied by adjusting the height of the bag 5, and is determined by observing the vertical length of the tube 6, which depends from the bag 5 to a point on a level with the bandage 1 or with the heart of the patient.

7 designates a fixture comprising a metal frame 8 having a hooked portion 9 which may be engaged upon the picture molding of a room or any other object of sufficient altitude.

10 designates a socket fixed to the frame 8 and adapted to receive the extremity of a cane or umbrella by means of which the fixture is conveniently raised and attached to the desired point. The frame 8 is deflected upwardly over the top of the pulley wheel 11, terminating in a rounded curved extremity 12. The form of this extension or extremity permits the insertion of a cord 13 on to the pulley, but acts as a guide to prevent the cord accidentally leaving the pulley when in use. The cord 13 has one end attached to the bag 5, and at its other end depends within reach of the operator who may by this means raise and lower the bag 5 to any altitude limited only by the height of the fixture 7 or the length of the rubber tube.

The tube 6 is graduated in equally-spaced divisions corresponding to unit increments of pressure. A convenient unit standard is one millimeter of mercury, in which case each unit division on the tube 6 corresponds to the specific gravity of mercury in millimeters of lineal extent. The zero of the scale is located at or near the middle of the bag 5, and from this point, the graduations extend in a continuous sequence throughout the tubes 6 and 2 to the cuff or bandage 1. In addition to these graduations, we distinguish different sections of the tube by different colors, or otherwise; for example, the upper part 6 may be colored blue, and the extreme lower part 2 red. Between these two colored portions, there may be a section 6′ of white. It is obvious that the tube may be in one integral length throughout, but we prefer to have a detachable connection or joint 15 at some point therein, preferably between the differently colored portions.

We have referred to the fact that the zero of the scale divisions should always be opposite the level of the fluid in the bag 5. Inasmuch as this level is likely to vary somewhat, depending on the amount of fluid supplied, together with the shape and character of the patient's arm and the tightness of the bandage, it is desirable to provide means by which such variation can be compensated for. For this purpose we make use of a tape or similar flexible element 16 fastened to the tube 6 at the point 17 and on which the scale divisions below, say 35 mm., are continued upward to the zero point where we fasten a loop or eye 18. 19 designates a plurality of hooks at different levels on the bag 5 to any one of which the eye 18 may be attached, depending on the fluid level in the bag. The fluid level in the bag can be accurately noted by any medical practitioner by palpation, that is, by gently tapping on its surface with the fingers. It is possible to tell the location of the fluid level very accurately by the character of the impact or resistance when the finger strikes against a portion of the bag which is backed by fluid pressure and when backed by air pressure. The flexible tube 6 loops itself automatically at 20 to accommodate this adjustment. In this way the height of the fluid column is made to accurately correspond with the scale divisions.

The use and operation is as follows: The sections of the tube are separated at the point 15, and the air sucked out of the respective sections and bags. Water is then allowed to siphon into each section, and, when a sufficient quantity, determined by the capacity of the bags, has been admitted, the tube sections are joined under water. The bandage 1 is then applied to the arm or other portion of the body where convenient and the practitioner with one hand on the pulse of the patient gradually raises the bag 5 by pulling on the cord 13. As the elevation increases the fluid pressure in the vessel 4 becomes greater and eventually preponderates over the pressure of the blood. When such preponderance occurs the artery will be collapsed and restricted, and the practitioner is able to note this result by the patient's pulse which grows weaker until finally it is imperceptible, at which point the scale will indicate at the level of the arm or heart the pressure of the blood. The practitioner can

see at a glance whether the patient's blood pressure is above or below normal by the color of the flexible tube at the reading point on the scale. If any portion of the blue section 6 is opposite the line of the heart or bandage, the patient's blood is below normal pressure. If the red section is opposite, the patient's blood pressure is above normal. If the white is opposite, the patient's blood pressure is within normal limits. The numerical values are obtained by observing the scale divisions. In unusually high pressure cases, it is, of course, necessary to attach the pulley to a staircase or some point where a sufficient altitude is available. By this means, it is possible to read with the greatest possible accuracy, the highest as well as the lowest pressure cases, which has not hitherto been possible in air mercury machines. In the use of the apparatus, it is important to see that the air is absolutely excluded from the tubes before a test is made, since the presence of bubbles vitiates the accuracy of the readings. With this simple precaution, the method is susceptible of as great accuracy as the nature of this character of a test will permit.

What we claim, is:

1. A sphygmomanometer comprising a bandage adapted to be applied to the arm or body of a patient, a rubber bag contained therein and having a rubber tube extension, a vessel at the terminal end of said rubber tube extension, means adapted to be attached to an elevated support for raising said vessel to any required height above the rubber bag corresponding to a water column balancing the blood pressure of the patient, and measuring means associated with said rubber tube for determining the length of the portion thereof which depends from said vessel to a point horizontally opposite the location of said bandage.

2. A sphygmomanometer comprising a bandage adapted to be applied to the arm or body of a patient, a rubber bag contained in said bandage and having a flexible tube extension, means for lacing said bandage on the patient, a second bag at the terminal end of said flexible tube, means adapted to be attached to an elevated support for raising said second bag to a height above the first bag corresponding to a water column balancing the blood pressure of the patient, a connection or joint in said tube whereby it may be separated to fill the apparatus with water, means including an element 16 and hooks 19 for varying the relation of said second bag to said divisions, whereby the level of water in said second bag may be compensated for, and measuring means associated with said tube for determining the length of the portion thereof which depends from said second bag to a point horizontally opposite the location of said bandage.

In witness whereof, we subscribe our signatures, in the presence of two witnesses.

LOUIS F. BISHOP.
RALPH GRACE.

Witnesses:
A. W. MEAD,
IDA RUTHERFORD.