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BLOOD PRESSURE RECORDING INSTRUMENT

Original Filed March 18, 1924 4 Sheets-Sheet 1

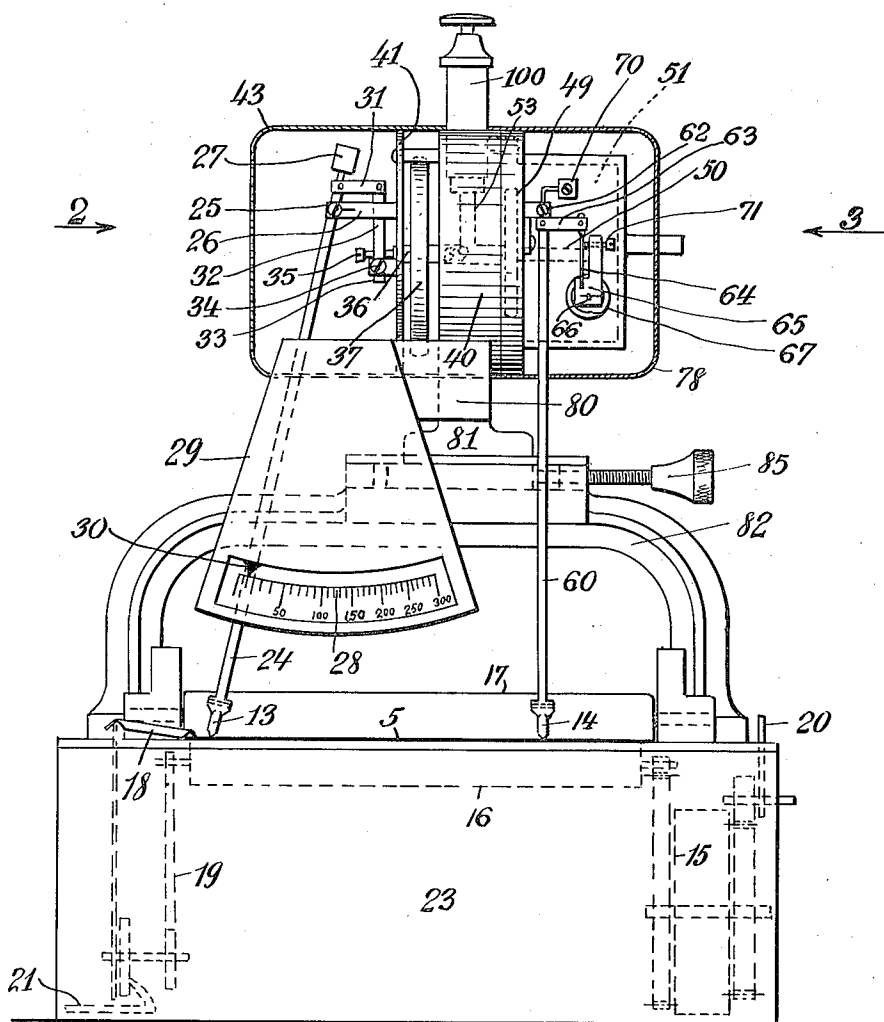


Fig. 1

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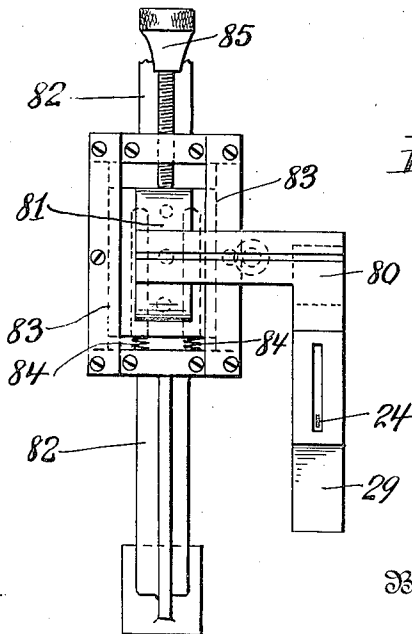
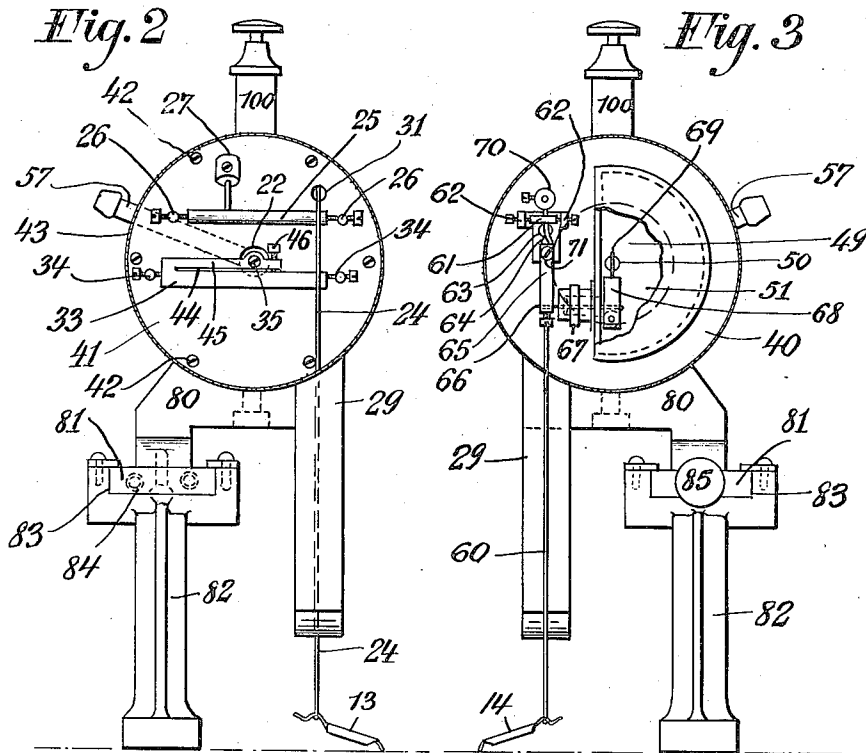


Fig. 4

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Fig. 5

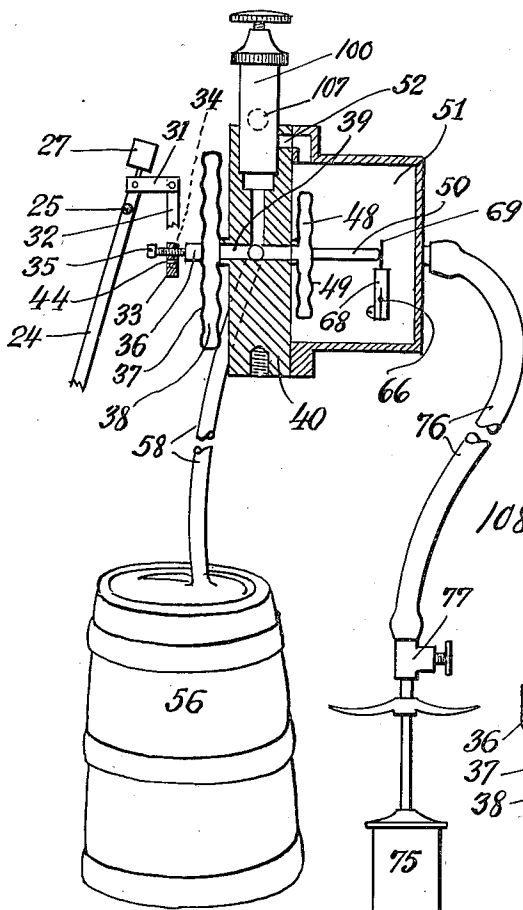
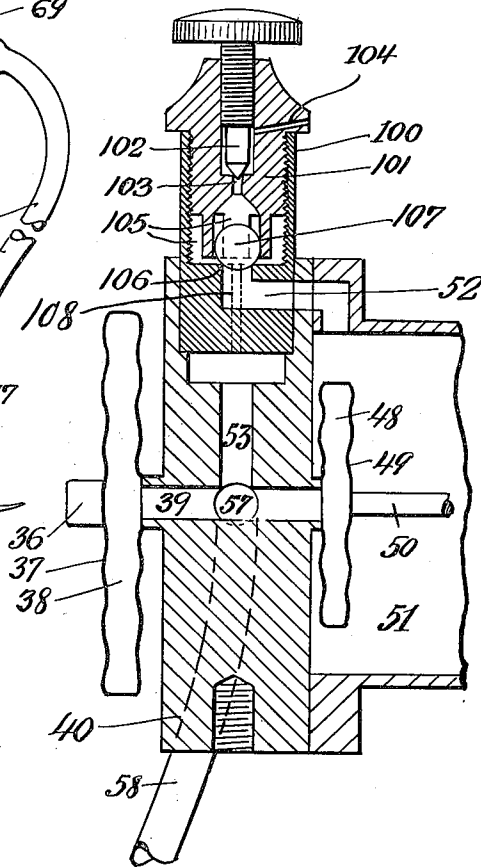


Fig. 6



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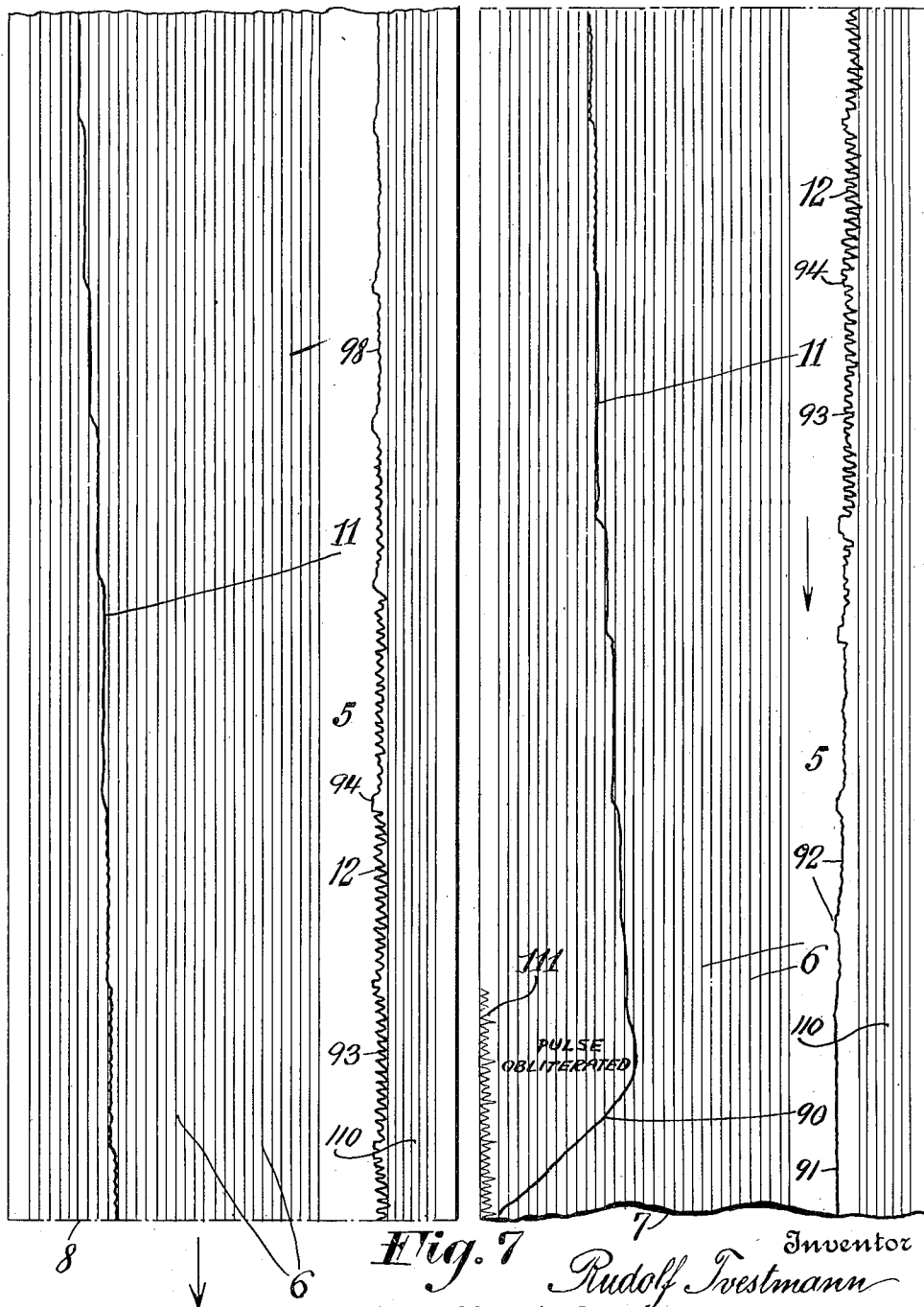
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BLOOD PRESSURE RECORDING INSTRUMENT

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UNITED STATES PATENT OFFICE.

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BLOOD-PRESSURE-RECORDING INSTRUMENT.

Application filed March 18, 1924, Serial No. 699,991. Renewed June 17, 1927.

This application is a continuation in part of application No. 632,268.

This invention relates to improvements in blood pressure recording instruments. The object of the invention is to provide a generally improved instrument for this purpose. Another object of the invention is to improve the construction of the instrument with a view of greater simplicity in operating the same.

It is further a particular object of the invention to provide means by way of a so called telltale device for assisting the physician in determining the exact time when the systolic and diastolic blood pressure of a patient is being recorded during the operation and use of the device.

In the accompanying drawings illustrating the preferred embodiment of my invention

Figure 1 is a front elevation of an apparatus embodying my invention with parts omitted.

Figure 2 is a view of the upper parts of the apparatus looking in the direction of arrow 2 in Figure 1.

Figure 3 is a similar view looking in the direction of arrow 3 in Figure 1.

Figure 4 is a detail plan view of the adjustable supporting means.

Figure 5 is a sectional somewhat diagrammatic view of the pressure chambers of the apparatus and adjacent parts. This figure also shows the arm cuff inflator. Parts are omitted and parts broken away.

Figure 6 is an enlarged detail sectional view of the automatic air valve and adjacent parts of the apparatus.

Figure 7 is a view in two sections of a printed record of a blood pressure produced by the instrument.

Referring first to Figure 7, the instrument is designed to make two records on a strip or web of paper marked 5 and ruled in any convenient manner for reading the records. For instance, the lines 6 may represent a blood pressure gage in gradations of 50 mm. The paper moves under the recording pens in the direction of the arrows, the end 7 of the paper being the beginning of the record. The record is shown in two sections for the sake of clearness and should be read from the numeral 7 and upwards on the drawing to the breach and then continuing from the

breach at 8 upwards to the end of the record as will be understood.

One record or curve 11 is that of the pulse. The other record or curve 12 is the telltale curve which records and shows the times when the pulse reappears and disappears during the operation. By comparing the two records the physician is able to tell exactly the blood pressure of the patient. Without the curve 12 this would be impossible, because the curve 11 merely shows the gradations or pulsations of the pulse, but does not show when the pulse is fully operating or reappearing after having been obliterated first, such as is necessary in using the apparatus. This, however, will be more fully set forth later on.

Referring now to the other figures the numeral 13 denotes a scribe or pulse recording pen and the numeral 14 a scribe or telltale recording pen. Both are adapted to trace their respective records on the paper 5. The latter is fed, by suitable means such as a spring motor 15, between two feed rollers 16 and 17. A third or time pen 18 is operated from the motor by suitable gearing such as is indicated at 19. 20 denotes a lever for starting and stopping the motor and 21 is a lever for starting and stopping the time pen. It is not necessary to describe these parts in detail as they are known to the art. The operating mechanism, paper supply and associated parts may conveniently be enclosed in a box 23 which also forms a support for the other parts of the apparatus.

The pulse pen 13 is carried by the stem 24 which is secured to a rock shaft 25 pivoted in bearings 26, 26. A weight 27 tends to keep the pulse pen in zero position with respect to a dial arranged with a scale 28 graduated or calibrated in comparison with a standard scale of blood pressure from zero to 300 m. m. Hg.

The pulse pen is protected in its movement by a casing 29 surrounding the pen and provided with a window through which the scale appears. The stem 24 carries a pointer 30 co-acting with the scale on the dial in an obvious manner.

The rock shaft 25 is actuated by a link 31 pivotally secured to an upright arm 32 fixed in a diaphragm rocker 33 pivoted at 34, 34. The diaphragm rocker carries an adjustable abutment in the form of a screw

35, see Figure 5, which is adapted to contact with a button 36 secured centrally to a diaphragmatic wall of a casing having an air chamber therein the opposite wall of said chamber also comprising a diaphragmatic wall having a central opening whereby it is mounted upon a valve body 40 in communication with a passage 39 in the valve body the chamber wall 37 constituting the pulse pen actuating diaphragm.

The aforesaid bearings 26 and 34 are adjustable pivot screw bearings as shown. They are carried by a bearing plate 41 secured to the valve body 40 by screws 42. The diaphragm button 36 projects through a hole 22 in the plate 41. A hollow casing 43 protects the parts.

The diaphragm rocker 33 is split as at 44 to provide an adjustable portion 45. By turning the screw 46, the adjustable portion is moved towards or away from the axis through the pivots 34, hence the centre of the screw abutment 35 is raised or lowered for fine adjustment with respect to the diaphragm button 36. In other words, the abutment 35 which rocks on the centers 34 may be adjusted to swing on said centers through a longer or shorter arc. This adjustment may be required for locating the abutment in exact coaxial relationship with the pulse pen diaphragm 37, or for correcting possible errors in making and assembling the instrument. Again, the effective length of the swinging arm, that is the vertical distance 34—35, see Figure 5, in turn affects the throw of the upright arm 32 and associated parts connecting to the pulse pen. Very fine and very accurate adjustment of these parts are thus provided for.

Returning now to the valve body 40, the said central passage 39 passes through said body and communicates with an air chamber 48 formed within a second casing having opposite diaphragmatic walls, the one wall having a central opening whereby it is mounted upon the valve body 40 in communication with the passage 39 therein, the opposite wall 49 constituting an actuating diaphragm for the telltale pen 14, said latter diaphragm having a stem 50 connected thereto centrally for a purpose to be hereinafter described. A casing 51 is mounted on the side of and cooperates with the valve body to form an air chamber enclosing the casing 48 which communicates with the passage 39 by passages 52 and 53, by way of an automatic check valve mechanism comprising a valve housing 100 inserted in the main valve body 40 aforesaid. The housing carries a valve plug 101 provided with a needle valve 102 which controls a port 103. 104 is a bore leading from the needle valve to the atmosphere.

The port 103 leads to an air chamber 105 formed between the plug 101 and the hous-

ing 100. The passage 52 has a port 106 which leads to said air chamber and which port is closed by a gravity operated ball 107.

From the chamber 105 two passages 108 (only one is seen) lead to the passage 53.

In operation, when air is pumped into the chamber 51 it passes through passage 52, lifts the ball 107 and then passes into the chamber 105 and down through passages 108 to passage 53. When the pumping ceases the ball will fall and close the port 106.

The passage 53 communicates with the arm cuff 56, Figure 5, through a passage 57 and rubber tube 58.

The telltale pen 14 is carried by a stem 60 which swings on a rock shaft 61 mounted in bearings 62, 62. A link 63 is pivoted to the stem 60 and to the yielding portion 64 of a rocker 65 which is secured to and rocks with a needle shaft 66 which extends from without the valve body 40 through a stuffing box 67 to within the air chamber 51 aforesaid. Inside this chamber the needle shaft carries an upright arm 68 having a pin 69 which is adapted to contact with the end of the diaphragm stem 50.

A weight 70 secured to the aforesaid rock shaft 61 acts to keep the pin 69 in contact with the diaphragm stem 50 through the instrumentalities aforesaid.

The said yielding portion 64 of the rocker 65 may be adjusted by a screw 71 whereby to change the relations of the said rocker, the line 63 and the pen stem 60 for fine adjustment purposes. This of course also affects the pressure of the pin 69 against the end of the diaphragm stem 50. The needle shaft 66 and stuffing box 67 are important elements in this mechanism, because only by means of the stuffing box surrounding the fine needle shaft can airtightness be obtained with respect to the chamber 51 so that the diaphragm 49 therein is subject only to the air pressure produced within the valve body.

The chamber 51 communicates with the inflator 75 by means of the rubber tube 76. 77 is an air release valve between the inflator and the chamber 51. A casing or shell 78 protects the parts as shown.

The casing 29 and valve body 40 are secured to a bracket 80 having a foot 81 slidably mounted in the bridge bracket 82 which forms a general support for the device on the box 23. As shown in Figure 4 the foot 81 is slidably and adjustably mounted in ways 83 by springs 84 which urge said foot against the adjusting screw 85. By turning the latter the bracket 80 with all the parts carried thereby including the pens are adjustable with respect to the record or paper 5.

The operation is as follows: The arm cuff is attached to the arm of the patient in the usual manner and the pulse obliterated by inflation of the arm cuff by means of the pump or inflator 75. As the arm cuff be-

comes inflated, the chambers 38, 48 and 51, also their communicating passages, are filled with air under pressure. The air pressure within the diaphragm 37 causes this diaphragm at this stage to vibrate in response to the inflation produced by the inflator 75 and consequently the recording pen 13 traces a record such as is marked 90 on the ruled paper 10 in Figure 6, it being understood that when a record is to be taken, the motor is started to feed the paper, while the time pen operates to record the time factor.

The air pressure does not affect the diaphragm 49 but balances it as is obvious.

As is well known, it is a practical impossibility for the physician to know the exact point at which the pulse is obliterated and he therefore continues the inflation of the arm cuff a moment or so after the pulse has disappeared, which the physician of course is able to feel with his finger on the artery. While the aforesaid operation takes place, the telltale pen has traced a straight line record indicated at 91 in Figure 7.

When the pulse has been completely obliterated as indicated on the drawing, the physician opens the needle valve 102 slightly to release some of the air in the chambers aforesaid.

The opening of the needle valve establishes communication between air chamber 105 and the atmosphere by way of the bore 104, and the greater air pressure below the ball 107 causes the latter to lift momentarily to release some of the air as will be understood.

Having thus reduced the air pressure slightly, the physician closes the needle valve 102. This equalizes the air pressure around the ball 107 which drops by gravity to automatically close the port 106.

If the reduction of the air pressure within the apparatus is insufficient to cause any movement of the pens, the physician repeats the operation and reduces the air pressure still further.

When, however, the reduction in air pressure has been sufficient to permit the pulse to act, that is, the pulse reappears, then the pulsations in the air column (very faint at first) from the arm cuff will cause both diaphragms to vibrate, but the vibrations of the diaphragm 37 will be greater or more marked than those of the diaphragm 49, because the latter operates against a balanced air pressure, while the diaphragm 37 operates against atmospheric pressure.

Consequently, the moment the pulse reappears, however faintly, the telltale diaphragm 49 commences to operate at once, the telltale pen 14 through the button 50, pin 61, arm 68, needle shaft 66, rocker 65, link 63 to stem 60 carrying the pen 14, which then traces a record such as is marked 92 in Figure 6, where it will be noted, the curve of the pulse has also dropped.

Up to the point 92 of the telltale record, the latter has been practically a straight line, but at 92 the telltale pen moves with a slight jerk due to the sudden reduction in the air pressure and from then on the telltale pen vibrates more and more as the air pressure is reduced.

The point 92 indicates that the pulse has reappeared and gives the systolic blood pressure in the blood pressure record 11 as being about 125 m. m. in this particular instance.

The physician now continues the operation of gradually reducing the air pressure within the diaphragms, and the pens will trace the records as shown on the drawing in Figure 7 which is a reproduction of an actual test made with the instrument. It will be seen that the telltale pen vibrates with greater amplitude as the pressure curve drops because of the lessened pressure against which diaphragm 49 operates; so that for a while the telltale record will appear as at 93 indicating, together with the pressure curve, the pressures at which the operation takes place. The marked portions 94 of the telltale record are caused by the jumps or jerky movements of the telltale pen each time the pressure is reduced.

Finally the vibrations will die out as at 98 when the record indicates the diastolic pressure.

The physician may now draw a line across the paper at the point where the first full stroke of the telltale pen occurs and ascertain the blood pressure by reading the printed scale at the point where the line meets the pulse curve. Or he may after some experience simply read the pulse from the scale which is calibrated in comparison with a standard scale of blood pressure from zero to 300 m. m. Hg.

The ruled lines at 110 assist the observation of the lengths of the telltale pen strokes.

It will be noted that a reading of the pulse curve alone will not indicate definitely the reappearance of the pulse, hence is insufficient, but that the telltale pen curve definitely indicates the reappearance of the pulse, because only at that time does the telltale diaphragm vibrate in response to the pulsations of the pulse or the movements in the air column acting against the air pressure on the diaphragm.

The time factor has of course been recorded at the same time at 111 so that the physician during his observations has all the means at hand for determining the blood pressure of the patient. The time record is shown for a short distance only.

It will further be noted in the foregoing description that ample means have been provided for adjusting the several elements to insure precise operation thereof.

The foregoing is thought to fully disclose the principle of operation, and the construc-

tion of the apparatus. All the finer elements are protected, yet the parts are easily accessible for inspection, repair or adjustment. While I have shown and described the preferred embodiment of my invention, nevertheless changes in the detailed construction may be made without departing from the principle of the invention.

I claim:—

10 1. In apparatus for making simultaneous records of blood pressure and pulse conditions, a pair of diaphragms, a carrier for said diaphragms having a passage open to one side of each of said diaphragms, the
15 other side of one diaphragm being open to the atmosphere, and said carrier arranged with a chamber enclosing the other side of the other diaphragm, a check valve controlled connection between said chamber and the passage, and means connected with
20 the passage operative from blood pressure pulsations for the purpose specified.

2. Apparatus for making records of blood pressure and pulse conditions as described
25 in claim 1, wherein the chamber and the passage in communication therewith and with one side of each diaphragm are adapted to have a predetermined intercommunicating fluid pressure stored therein, and
30 said chamber being arranged whereby the pressure therein acts as an opposing force on the one diaphragm against the force of the blood pressure pulsations thereon to vibrate said diaphragm.

35 3. Apparatus for making records of blood pressure and pulse conditions as claimed in claim 1, wherein the chamber and the passage in communication therewith and with one side of each diaphragm are adapted to
40 have a predetermined intercommunicating fluid pressure stored therein, and said chamber being arranged whereby the pressure therein acts as an opposing force on the one diaphragm against the force of the blood
45 pressure pulsations thereon to vibrate said diaphragm, and scribes having operative connection with and actuated from the diaphragms in consonance with the vibrations thereof to make graph records of blood
50 pressure and pulse conditions.

4. In apparatus for making simultaneous records of blood pressure and pulse conditions as claimed in claim 1, means for creating and storing a predetermined intercommunicating fluid pressure in the chamber and the passage in communication with the one side of each diaphragm to act as an opposing force on the one diaphragm against the force of the blood pressure pulsations
55 thereon to vibrate said diaphragm, scribes having operative connection with and actuated from the diaphragms in consonance with the vibrations thereof to make graph
60

records of the blood pressure and pulse conditions, a passage to the atmosphere leading from the valve controlled connection of the chamber with the passage, and a manually operative valve to control said passage.

5. Apparatus for making records of blood pressure and pulse conditions as claimed in claim 1, wherein the chamber and the passage in communication therewith and with one side of each diaphragm are adapted to have a predetermined intercommunication fluid pressure stored therein, and said chamber being arranged whereby the pressure therein acts as an opposing force on the one diaphragm against the force of the blood pressure pulsations thereon to vibrate the same, and the valve in the connection of the chamber with the passage comprises a check valve normally urged to closing position, a passage opening to the atmosphere leading from said connection between the chamber and the passage, and manually operative means to control the opening of said passage to the atmosphere.

6. In apparatus for making simultaneous records of blood pressure and pulse conditions as claimed in claim 1, means for creating and storing a predetermined intercommunicating fluid pressure in the chamber, and the passage in communication with the one side of each diaphragm, and acting as an opposing force on the diaphragm against the force of the blood pressure pulsations thereon to vibrate said diaphragm, scribes operative from the diaphragms in consonance with the vibrations thereof to make a graph record of the blood pressure and pulse conditions, a dial, and a pointer associated with the blood pressure recording scriber to co-operate with said dial for the purpose specified.

7. In apparatus for making simultaneous records of blood pressure and pulse conditions as claimed in claim 1, means for creating and storing a predetermined intercommunicating fluid pressure in the chamber and the passage in communication with one side of each diaphragm, and acting as an opposing force on the diaphragm against the force of the blood pressure pulsations thereon to vibrate the diaphragms, a record graph receiving medium, a scriber operatively connected to the side of the diaphragm open to the chamber and movable in consonance with the vibrations of said diaphragm to make a graph record of the pulse condition on the graph receiving medium, and a scriber operatively connected with the side of the other diaphragm open to the atmosphere and movable in consonance with the vibrations of said diaphragm to make a graph record of the blood pressure.

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