

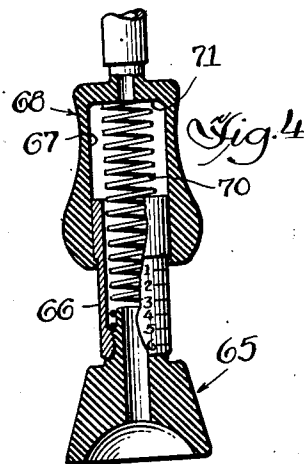
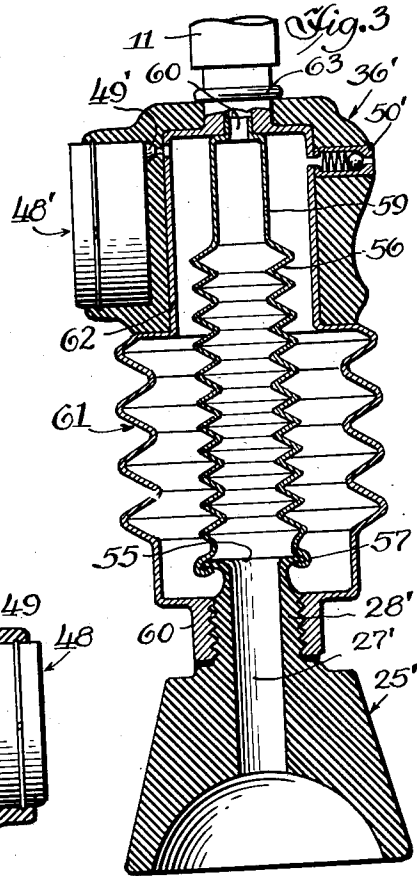
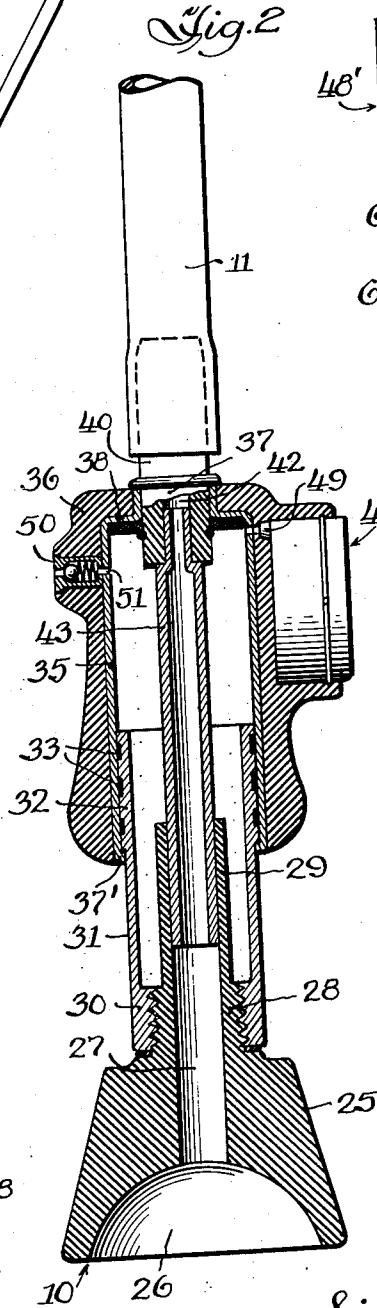
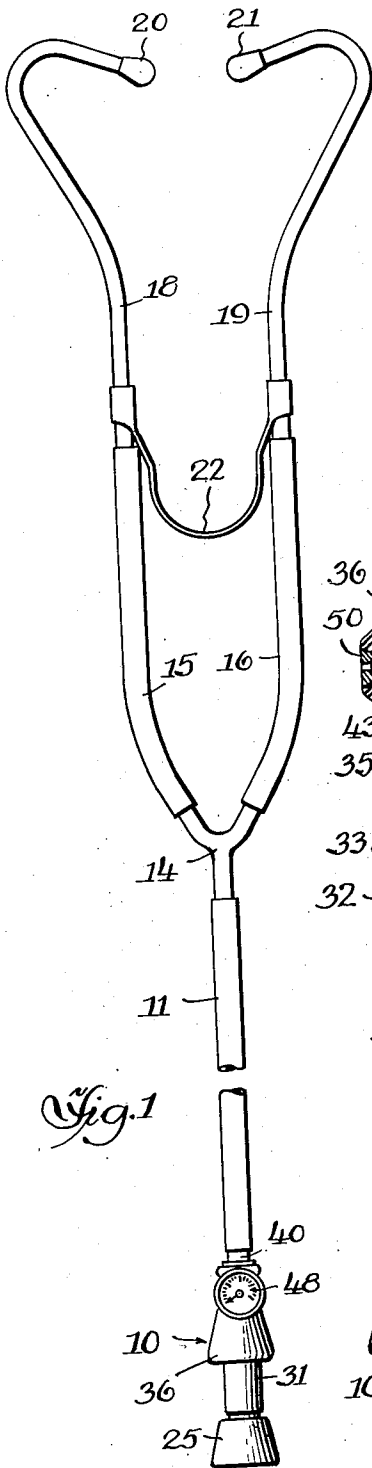
July 16, 1957

S. RODBARD
DIAGNOSTIC INSTRUMENT

2,799,270

Filed April 25, 1955

2 Sheets-Sheet 1



Inventor,
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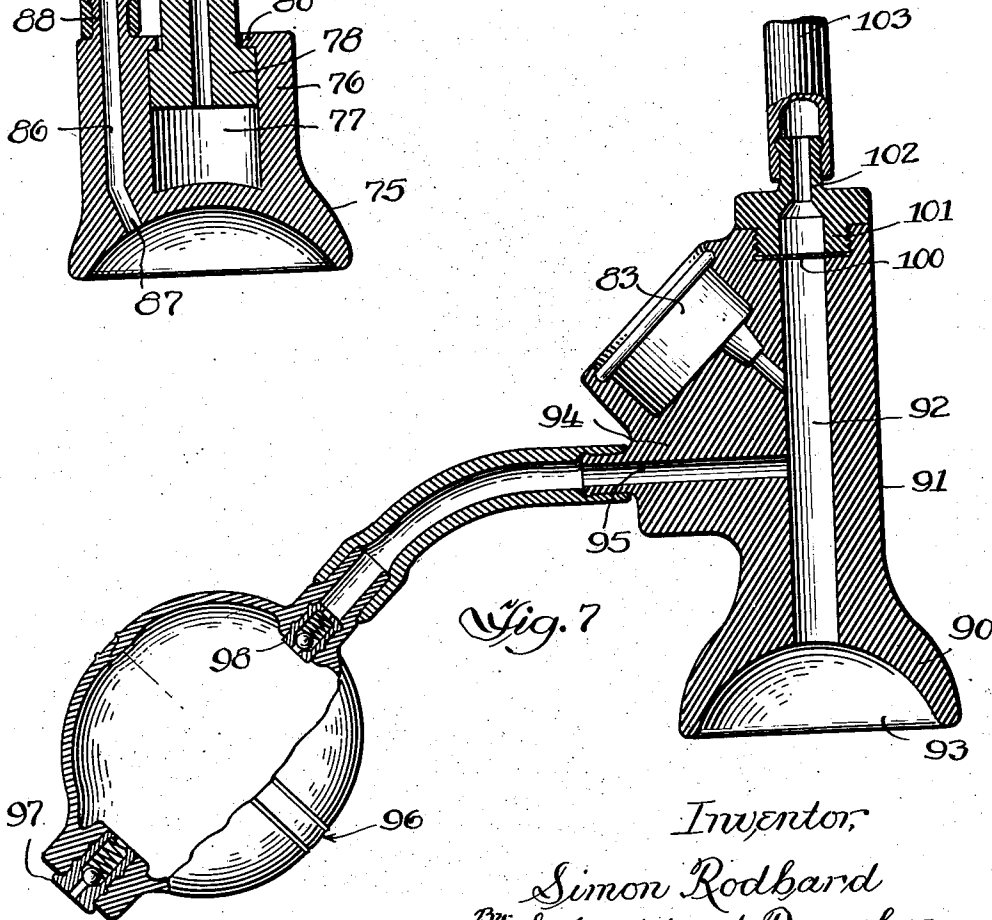
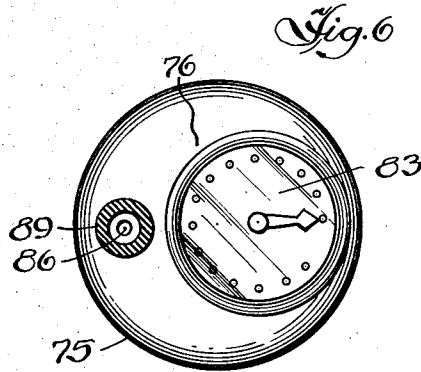
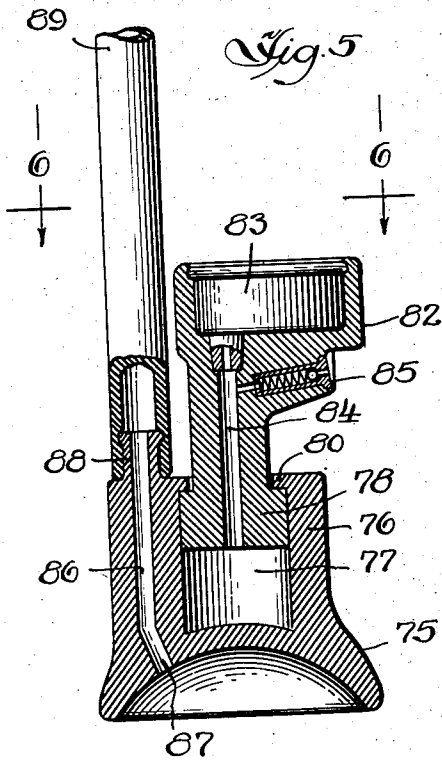
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DIAGNOSTIC INSTRUMENT

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This invention relates to a diagnostic instrument combining the functions of a stethoscope and sphygmomanometer, and for convenience will be hereinafter referred to as a "sphygmeter."

As is well known, a stethoscope is an instrument for auscultation and is widely used in medical work. A simple stethoscope consists of a small bell shaped member connected by flexible tubing to one or two ear pieces and adapted to transmit sounds generated at the bell. The technique of using a stethoscope varies among individual doctors and in some measure depends upon the pressure of the bell upon the skin.

A sphygmomanometer is used for the measurement of blood pressure and the common form thereof includes a flexible air-tight bag with means for obtaining suitable air pressure within the bag and having pressure-indicating means, such as a pressure gauge. Such an instrument is relatively heavy and large in comparison to a conventional stethoscope and in addition has several disadvantages. Thus the cuff or bag of the common sphygmomanometer directly contacts a large area of skin and should therefore be sterilized after each use. This is not done in actual practice. In addition, the common type of sphygmomanometer can be used to measure blood pressure and pulse pressure only at certain parts of the body, such as for example at the arms or legs.

An instrument embodying the present invention has the advantages of a stethoscope and none of the disadvantages of a sphygmomanometer while combining the functions of both the stethoscope and sphygmomanometer. An instrument embodying the present invention makes it possible to function either as a stethoscope or sphygmomanometer in a manner superior to the functioning of conventional stethoscopes and sphygmomanometers.

The new instrument, designated as a sphygmeter, generally comprises a stethoscope having means for applying a predetermined pressure to a skin area.

For a complete understanding of the invention, reference will now be made to the drawings wherein exemplary embodiments illustrative of the invention are shown. It is understood, however, that variations and modifications of the constructions illustrated may be made without departing from the scope of the invention except as defined by the appended claims.

Referring therefore to the drawings, Figure 1 shows a sphygmeter embodying the present invention;

Fig. 2 is an enlarged sectional view of the skin-contacting portion of the sphygmeter illustrated in Fig. 1;

Fig. 3 is an enlarged sectional view of the skin-contacting portion of a modified form of sphygmeter;

Fig. 4 is a sectional detail of the skin-contacting portion of a still further modified form of sphygmeter;

Fig. 5 is a sectional elevation of the skin-contacting portion of an additional modified form of sphygmeter;

Fig. 6 is a section on line 6—6 of Fig. 5, and

Fig. 7 is a sectional elevation of a still further modified form of skin-contacting portion of a sphygmeter.

Referring first to Figs. 1 and 2, the sphygmeter comprises skin-contacting and sound pick-up portion generally indicated by 10 connected to tubular member 11. Tubular member 11 is connected to a rigid Y 14, each branch of which is connected by flexible rubber tubes 15

2

and 16 to bent rigid tubular members 18 and 19. Tubular members 18 and 19 terminate in ear pieces 20 and 21. Tubular members 18 and 19 are adapted to be spring-pressed to the position illustrated in Fig. 1 by curved spring 22 attached to tubular members 18 and 19. With the exception of skin-contacting portion 10, the structure described is conventional and may assume a variety of forms.

Referring now to Fig. 2, skin-contacting portion 10 is shown in enlarged form. Skin-contacting portion 10 has bell 25 having hemispherical cavity 26 communicating with axial bore 27. Bell 25 may be of any suitable material, such as plastic or hard rubber, and is preferably of rigid material. Bell 25 has threaded portion 28 and sleeve portion 29 extending axially thereof, bore 27 being in part formed in the body of bell 25 and in threaded portion 28 and sleeve 29.

Engaging threaded portion 28 of the bell is end 30 of plunger sleeve 31. End 30 of the plunger sleeve is threaded so that the sleeve and bell may be tightly joined. Plunger sleeve 31 has end portion 32 enlarged to form a shoulder, the outer surface of the shoulder thus formed being provided with a series of annular slots 33 for accommodating packing rings.

Shouldered end 32 of the plunger sleeve works within cylinder 35 carried by fitting 36. Fitting 36 and cylinder 35 may be of one piece or cylinder 35 may be of metal having a smooth inside surface while fitting 36 may be of molded material. Cylinder 35 has outer edge 37 inwardly turned to provide a locking lip so that enlarged shoulder 32 of the sliding plunger will be locked within the cylinder chamber.

Fitting 36 has nipple 37 disposed within the top end thereof. Nipple 37 is tightly pressed into the fitting and engages apertured portion 38 of cylinder 35 to make an airtight fit which will withstand pressure. Nipple 37 has portion 40 over which the rubber tube 11 may be disposed.

Nipple 37 has axial bore 42 into which is snugly fitted tube 43. Tube 43 is of rigid material and may, for example, be of brass, copper or any other suitable material.

Tube 43 in effect forms an extension for nipple 37, tube 43 extending through fitting 36. Tube 43 has its outer surface finished smoothly and works inside of sleeve 29 of the bell. The fit between the tube 43 and sleeve 29 should be air-tight. If desired, one or two annular grooves in the outer surface of tube 43 or the inside surface of sleeve 29 or both may be provided for some small O-rings for the purpose of insuring an air-tight seal while permitting the two parts to slide relative to each other.

Fitting 36 carries pressure gauge 48 of any suitable type, the gauge having air inlet 49 disposed in a recess within the fitting. Air inlet 49 is connected to the interior of cylinder 35 by a channel so that gauge 48 may indicate the air pressure existing within cylinder 35.

Fitting 36 is recessed to accommodate ball type check valve 50. The check valve communicates with the interior of cylinder 35 by channel 51. Normally the spring pressed ball keeps the valve closed against any pressure build-up within the cylinder 35. However, in order to permit the air within cylinder 35 to be equalized with atmosphere for gauge calibration, the check valve may be opened by pressing a wire from the outside against the ball bearing.

To use the device illustrated in Figs. 1 and 2, fitting 36 may be grasped by the hand and positioned so that bell 25 rests upon the skin of a patient. Fitting 36 is then pressed down toward bell 25 to force the bell against the skin, the telescoping arrangement serving to increase the air pressure within cylinder 35. The air pressure will be indicated by the needle of gauge 48 while at the same time sounds present within chamber 26 of the bell

will be transmitted to the ear pieces. Thus auscultation is possible while impressing bell 25 upon the blood vessels or skin at a predetermined pressure.

Referring to Fig. 3, a modified form of the apparatus is shown wherein expansible bellows rather than sliding sleeves are utilized. Bell 25' has threaded portion 28' and flanged end 55. Inner expansible bellows 56 has one end 57 spun or coiled around flange 55 to form an air-tight seal. Expansible bellows 56 may be of spring brass or copper or may even be of molded flexible rubber or plastic. Expansible bellows 56 has end 59 provided with reduced nipple 60.

Threaded over portion 28' of the bell is end portion 60 of outer expansible bellows 61. Bellows 61 is preferably of spring copper or brass and is rigidly attached to fitting 36'. The inside of fitting 36' may be conveniently formed of bellows extension 62 having coupling fitting 63 at the end thereof. Coupling fitting 63 is apertured to accommodate nipple portion 60 of the inner bellows to provide an air-tight seal. Coupling fitting 63 is adapted to have rubber tube 11' slipped over the same.

Fitting 36' carries gauge 48', this gauge and the mounting thereof being generally similar to the construction illustrated in Fig. 2. Thus gauge 48' has air inlet aperture 49' connected to the interior of outer bellows 61 through a restricted channel passing through the wall of fitting 36' and the wall of extension 62 of the outer bellows.

In assembling the construction illustrated in Fig. 3, inner bellows 56 may be attached to bell 25' prior to the insertion of the bellows within outer bellows 61. Thereafter outer bellows 61 may be attached to bell 25' by turning the entire fitting 36' and outer bellows with respect to the bell. During the attachment of the outer bellows to bell 25', inner bellows 56 is retracted so that nipple 60 does not extend into the aperture in coupling fitting 63. When the two bellows are properly positioned with respect to bell 25', a tool may be inserted from the bell end of the device up channel 27' in the bell and inside the inner bellows to engage the annular shoulder formed between extension 59 and nipple 60. Nipple 60 may then be forced into the channel in coupling fitting 63.

It will thus be clear that the contraction of outer bellows 61 will result in increased air pressure being developed within the bellows, which increased air pressure will be indicated by gauge 48'. In order to eliminate any inaccuracy due to the spring in the two bellows, inner bellows 56 which has finer convolutions may be normally in a tensioned condition so that in the position illustrated in Fig. 3, inner bellows 56 has a tendency to contract. At the same time, outer bellows 61 may be contracted somewhat from a normal untensioned condition. Thus it is possible to rely upon the natural spring of inner bellows 56 to increase its length somewhat to overcome the resistance of outer bellows 61 to contract due to the spring of the metal. When fitting 36' is grasped by the hand and the bell is pressed upon the skin of the patient, the force of the bell upon the skin will be indicated by the pressure gauge and the reading thereof will be the true force exerted upon the bell by virtue of the air compressed within outer bellows 61.

The construction illustrated in Fig. 3 is provided with check valve 50' similar to the construction shown in Fig. 2.

Instead of having outer bellows 61 as illustrated in Fig. 3, a sliding sleeve arrangement as illustrated in Fig. 2 may be used. In such case, inner bellows 56 will take the place of the telescoping tube arrangement 29 and 43 of Fig. 2.

It is also possible to dispense with inner bellows 56 in the modification illustrated in Fig. 3 and instead use a pair of telescoping sleeves as illustrated in Fig. 2.

In the two modifications heretofore described, the pressure of the bell upon the skin has been due to compressed air within a sealed chamber, the pressure of the

air being indicated by a gauge. It is possible to provide a modification wherein the pressure of the bell upon the skin is due to a compressive force upon a spring and the amount of pressure will be indicated by the displacement of the spring from normal position. Referring to Fig. 4, bell 65 has barrel 66 threaded over the same. Barrel 66 has a number of graduations as indicated in the drawing. Barrel 66 operates in cylinder 67 of fitting 68. The shouldered arrangement illustrated in Fig. 2 may be used in Fig. 4 to maintain barrel 66 within 67 at the extreme retracted position of the barrel. Within cylinder 67 is coil spring 70 extending between top wall 71 of fitting 68 and the threaded end of bell 65. Coil spring 70 tends to bias barrel 66 downwardly as illustrated in Fig. 4. By holding fitting 68 and pressing bell 65 against the skin, compression of spring 70 will result in the barrel being moved upwardly into the fitting. The compression of the spring will be indicated by the graduations on the barrel, such graduations being suitably calibrated so that readings may be duplicated or may be referred to some standard air pressure.

The barrel and fitting may be made of metal or some rigid plastic. It is not necessary, and in fact undesirable, that an air-tight seal be established between the barrel and the fitting. As illustrated in Fig. 4, bell 65 has the usual axial channel providing an air path into the interior of bell 66 and fitting 67. Wall 71 of fitting 67 is suitably apertured to provide a through air path to the ear pieces of the device.

Referring now to Figs. 5 and 6, a further modification is illustrated wherein the air path for auscultation is distinct from the pressure-generating part of the device. In this modification, bell 75 has body 76 containing cylinder 77 in which piston 78 is adapted to operate. In order to prevent withdrawal of the piston from the cylinder, body 76 may have lip 80. In practice, this lip may be formed by a metal liner for body 76 with the edge of the metal spun over if the piston is disposed in position. However, other means such as a separate cover for containing the lip may be applied to body 76 after the piston is inserted.

Piston 78 is supported from handle portion 82 containing air pressure gauge 83 connected to the air chamber within cylinder 77 through bore 84. Suitable packing for the piston may be provided to provide a tight air seal. An air check valve 85 is connected to bore 84 for equalization purposes.

Body 76 has channel 86 extending through the same, channel 86 having mouth 87 at the bell chamber. Body 76 has nipple extensions 88 for channel 86 and over nipple extension 88 rubber tube 89 may be drawn. The remainder of the instrument including the metal Y and the ear pieces will follow along the lines illustrated in Fig. 1.

It is also possible to have a sphygmeter construction wherein the entire area of skin underneath the bell is subjected to a desired air pressure, a sound path being provided from the bell chamber to the ear pieces. Thus referring to Fig. 7, bell 90 has stem 91 provided with axial channel 92 extending into bell chamber 93.

Branching from stem 91 is part 94 having bore 95 in communication with axial channel 92. Attached to part 94 by a slip fit or other means is rubber bulb 96 having air intake and exhaust valves 97 and 98. Rubber bulb 96 may be squeezed and exhaust valve 98 will permit compressed air from bulb 96 to pass into the tube and into the valve chamber.

The air pressure region is sealed by flexible diaphragm 100 maintained in position by part 101 engaging the threaded end of 91 to clamp the diaphragm in position. Diaphragm 100 may be of thin steel or spring brass or phosphor-bronze or other resilient material strong enough to withstand the desired pressure upon the skin while responding to the sound vibrations generated within the bell chamber. Nipple 102 of part 101 may be en-

gaged by rubber tube 103, the rubber tube going to the Y connection as above.

It is also possible to modify Fig. 2, for example, by providing a diaphragm to seal the bottom end of the nipple 37. Thereafter, the telescoping sleeve arrangement may be dispensed with and the increased pressure within the cylinder will be communicated to the bell chamber.

Similarly, the modification illustrated in Fig. 3 may be changed by providing a diaphragm to seal nipple 60 and dispensing with the inner bellows arrangement completely. In such cases, it will be necessary to design the pressure-generating means so that sufficient pressure may be generated within the bell, this being accomplished by proper design of the piston stroke and piston displacement.

By virtue of the invention, auscultation technique may be greatly improved. The variations in pressure of a bell or diaphragm of a stethoscope on the chest or other body parts may markedly affect the intensity and quality of tones heard. The new sphygmeter makes it possible for auscultation to occur under known pressure conditions. Thus intensity and quality of sounds remain as the only parameters to be qualitatively assessed.

What is claimed is:

1. A sphygmeter comprising a bell for engaging a small skin area, means for exerting a measured pressure of the bell upon the skin engaged by the bell, and means for providing an acoustic path from the bell interior to the ears of an observer for auscultation.
2. A sphygmeter comprising a bell for engaging a small skin area, means including a piston and cylinder for creating a measured pressure of the bell upon the skin, and means for providing a direct air path from the bell interior to the ears of an operator.
3. A sphygmeter comprising a bell for engaging a small skin area, a handle portion for the bell, said handle portion including a sealed air chamber whose volume may be expanded or contracted to adjust the air pressure therein, means for indicating the air pressure so that said bell presses upon the skin with predetermined force, and means for providing an acoustic path from the bell interior to the ears of an operator.
4. A sphygmeter comprising a member having a bell body for engaging a small skin area, a handle portion for holding said bell body against the skin, said handle portion being relatively movable to said bell body, piston and cylinder means disposed between said handle portion and bell body so that said bell may be pressed upon the skin with desired force, means for indicating the pressure inside said cylinder and means for providing an acoustic path from the bell interior to the ear of an operator.
5. A sphygmeter comprising a bell for engaging a small skin area, a handle portion for said bell, relatively movable cylinder and piston means between said handle portion and bell so that said bell may be pressed down upon the skin through the operation of said piston and cylinder means, said cylinder being sealed, an air pressure gauge connected to the interior of said cylinder to indicate the pressure within said cylinder, a conduit extending from the interior of said bell through the piston and cylinder means and the handle and means for conducting sounds through said conduit to the ear of an operator.
6. A sphygmeter comprising a bell for engaging a small skin area, said bell including a body portion having an air passage from the bell interior to the exterior thereof, pressure-generating means connected to said passage for generating an air pressure within said bell interior, a diaphragm forming one of the walls of said air passage for confining the air under pressure while transmitting vibrations, and means for providing a direct acoustic path from said diaphragm to the ear of an operator whereby said bell may be held in position on the skin with a predetermined air pressure impressed on the skin while providing for auscultation.

7. A sphygmeter comprising a bell having a body portion, means in said body portion for creating a measured air pressure within said bell, a diaphragm forming part of the air enclosure for the region within which air is compressed, and means for providing a direct air path between the diaphragm and the ear of an operator.

8. A sphygmeter comprising a bell having an axial channel therethrough, a pair of concentric sleeves coaxial with said channel extending from said bell, a member having a pair of coaxial sleeve surfaces for cooperating with the bell sleeve surfaces, the inner sleeve on said member and inner sleeve on said bell providing a sliding conduit for sounds from the bell interior through said member, the outer sleeve of said member and outer sleeve of said bell cooperating to provide a sealed air chamber whose volume may be varied to control the air pressure within said chamber, a pressure gauge carried by said member and having a part communicating with the interior of said air chamber for indicating air pressure and means for conveying the sound in said inner sliding sleeve arrangement to the ears of an operator.

9. A sphygmeter comprising a bell having an axial channel therethrough, a pair of expandible bellows attached to said bell, said two bellows being concentric, the inner bellows providing an extension for said axial channel, means coupled to said outer bellows for providing a sealed air chamber around said inner bellows, pressure gauge means for indicating the pressure in the sealed air space and means for conducting the sound transmitted through said inner bellows to the ears of an operator.

10. The sphygmeter according to claim 9 wherein said two bellows are oppositely tensioned so that the tendency of one to contract is substantially neutralized by the tendency of the other one to expand.

11. A sphygmeter comprising a bell having an axial channel therethrough, a pair of telescoping sleeve members carried by said bell, the interior of said telescoping sleeve members communicating with said axial channel, a spring in said telescoping sleeve members, means for indicating the compression of said spring due to telescoping one member into said other member and means for conducting the sound from said telescoping members to the ears of an operator.

12. A sphygmeter comprising a member having a concave region forming a bell, a channel extending from the bell region through said member for conveying sound, means for transmitting the sound from said channel to the ear of an operator, a second member, said two members having cooperating portions providing a cylinder and piston arrangement, a pressure gauge carried by said second member, said second member having a channel extending from said pressure gauge into the cylinder of said cylinder and piston arrangement so that said pressure gauge may measure the air pressure within said cylinder.

13. The construction according to claim 12 wherein a check valve is provided, said check valve communicating with the interior of said cylinder whereby the air within said cylinder may be equalized with atmosphere.

14. A sphygmeter comprising a member having a bell-shaped region and an axial channel, a pressure gauge carried by said member and communicating with said axial channel, an air pump connected to said axial channel for providing air under pressure thereto, said air pump including a check valve and said axial channel including a diaphragm for maintaining the air pressure within said axial channel and bell at a desired value and means cooperating with said diaphragm for communicating sound to the ear of an operator.

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