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D. P. PENHALLOW.

STETHOSCOPE.

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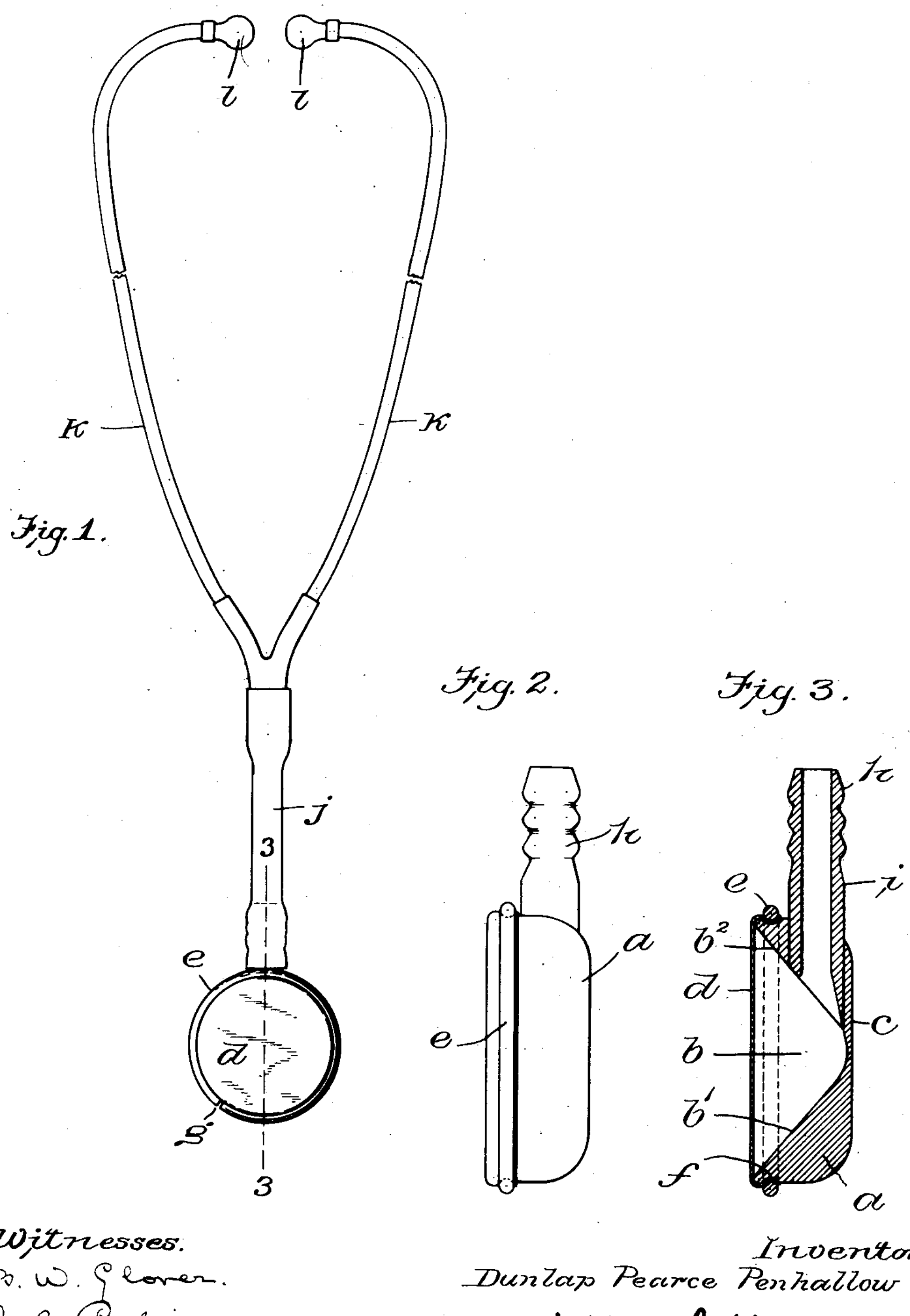

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STETHOSCOPE.

No. 872,448. Specification of Letters Patent. Patented Dec. 3, 1907.

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To all whom it may concern:

Be it known that I, DUNLAP PEARCE PENHALLOW, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Stethoscopes, of which the following is a specification.

This invention relates to stethoscopes, and its principal object is so to construct such an instrument that it can be used in examinations of bedridden patients without requiring either that the patient should be moved or raised or that the bed-clothing should be removed.

Other objects are to provide an improved means for detachably securing a diaphragm over the mouth of the cavity of the stethoscope, and in so constructing such cavity that improved results as to transmission of sounds are obtained, all as will more fully appear from the specification with reference to the accompanying drawings forming a part thereof in which,—

Figure 1 represents an elevation of a stethoscope embodying the principles of my invention. Fig. 2 represents a side elevation on an enlarged scale, of the cup or body portion of the stethoscope. Fig. 3 represents a longitudinal section through the center of the cup, the same being taken on line 3—3 of Fig. 1.

The same reference characters indicate the same parts in all the figures.

In the drawings,—*a* represents the body portion or cup of the stethoscope which is cylindrical or circular in front elevation, as shown by Fig. 1, and is of relatively slight depth or thickness. In the front face of the cup is formed a recess or cavity *b*, while the back *c* is imperforate and smooth throughout its whole extent without projections, indentations or other irregularities of any kind. As the cup is formed from a single block of metal, the back is rigid and not readily vibrated, and at its periphery it is beveled so that it merges into the cylindrical sides on a curve of large radius.

Across the opening of the cavity *b* is stretched a diaphragm *d*, the edges of which are drawn over the end of the body *a* and clamped to the sides thereof by a spring ring *e*, which presses the diaphragm into a groove *f* formed externally on the cylindrical portion of the cup adjacent the edges thereof. This ring is discontinuous, being divided or split at *g* (see Fig. 1), and can be expanded so as to be slipped on or off over the edge of the cup *a*, while its resiliency causes it to contract and clamp the edges of the diaphragm tightly in the groove *f*. The diaphragm preferably is made of a somewhat elastic material which will vibrate easily when stretched, such as sheep-skin, rubber or the like, and can very readily be secured in place or removed by simply slipping the ring *e* on or off. In first applying the diaphragm, when the latter is of sheep-skin, it is first wet, which causes it to expand and become soft, and is stretched across the opening of the cavity with its edges turned up over the sides of the cup. The ring is then slipped on to hold it in place. In drying, the diaphragm shrinks and becomes stiff and tightly stretched.

At one side of the cup *a* is formed a fixed tube *h* having a passage *i* which opens into the cavity *b* so as to form an outlet for conducting away the sound vibrations produced therein by the vibrations of the diaphragm *d* when the latter is pressed against the body of a person. This tube is preferably united to the cup by being pushed into a lateral passage cut through the side of the cup and opening into the cavity *b*. When in place the tube is soldered so that it cannot be withdrawn, and thus becomes a rigid, fixed, and to all intents and purposes, an integral part of the stethoscope body. It might be possible in some circumstances to form the tube integrally from the same piece of metal as the cup, but the method of construction above described is the preferable one. The end of the tube *h* is provided with corrugations adapted to retain the end of a flexible tube *j* which may be slipped over it. To the flexible tube is connected in the usual manner, two tubes *k* for conducting the sounds to the ears of the user of the stethoscope, which tubes are provided with the usual ear tips *l*.

From Fig. 3, which shows a section taken through the center of the cup, it will be seen that the elements b' b^2 of the walls of the recess or cavity are straight lines converging nearly at right angles at the point where the back *c* has the least thickness. Similarly, a section taken on any other diameter of the cup would show the walls as straight lines converging toward the same point. The walls or bounding surfaces of the cavity thus are seen to be conical.

The comparatively slight thickness of the stethoscope body, the outlet tube extending from the side instead of the back thereof, and the rigid smooth back having rounded edges, enable the instrument to be easily slipped under the bed-clothing or beneath the body of a patient who is in such a condition that changing of the position is impossible or highly undesirable. The ordinary stethoscope which has its sound-conducting tube extending directly from the back cannot be used in this manner, except with great difficulty and impairment of its efficiency. This is due to the fact that in order to apply such a stethoscope, the conducting tube must be bent at a sharp angle, which of course impedes the transmission of the sound waves, and so cuts off much of the sound, and renders very indistinct what sound does reach the ears of the observer. Furthermore, the pressure and movement of the bed-clothing on the thin, flexible tube or of the latter on the bed when it is slipped under the patient, produce friction sounds which greatly interfere with the sounds caused by the organ being examined. As the body of my instrument has a rigid, non-vibratory back, the friction sounds are minimized and so reduced as to be almost inaudible. Then again, the outlet tube coming from the side of the cup, and being perfectly rigid, is not susceptible to vibrations due to friction, and so does not transmit any friction sounds.

From Fig. 1, which shows the body of the stethoscope in its actual size, and Figs. 2 and 3, which show it enlarged to twice the actual size, it will be seen that all the dimensions are very small, and that therefore it can be slipped into small spaces without disturbing the patient. Furthermore, the small area of the diaphragm enables sounds produced by different organs to be exactly located, and permits aural examination to be made of the apices of the lungs, a result which is not possible with any instrument of this character of which I have knowledge. This feature also causes the sounds from any particular part to be transmitted with the maximum distinctness and without confusion by sounds emanating from another organ or parts of an organ than that immediately under examination. The small size also permits the instrument to be contained in a small space and easily carried by the possessor. The body also has a comparatively thick rim surrounding the cavity, as is evident from Fig. 3, and this gives not only rigidity, but also relatively great weight, so that when placed upon the body of a person being examined, the weight alone holds it firmly against the skin of the patient without requiring much pressure from the fingers of the user.

One of the principal causes of the increased efficiency of this instrument I attribute to the conical formation of the cavity above described, which condenses the sound waves and brings them to a sharper and clearer focus than is the case when the cavity is spherical or the walls are otherwise curved. It also permits of no angles or pockets being formed to impede the progress of the sound waves. The result of transmitting the sounds more clearly is in part caused by the fact that the passage *i* extends straight from one side of the cavity as near the focus thereof as it can be placed, with one of its sides in line with the bottom of the cavity, and without any bends or angles. As it makes a very large obtuse angle with the wall *b′* of the cavity opposite the opening into the passage (practically the same angle as that made with the same wall by the axis of the body *a*, for the conical walls lie approximately at angles of 45° (with the axis), the sounds are reflected by this wall directly into the passage without diminution. As a matter of fact, I have found by observation that the sounds received through this instrument are much sharper, clearer and much more distinct than is the case with other stethoscopes.

Another result from having the tube led off from the side of the cup is that thereby the latter may be made relatively thin from face to back, while at the same time, the cavity may be of greater depth and the walls thereof more steeply inclined (whereby a sharper focus of the sound waves is obtained) than is possible with those instruments wherein the passage extends from the back of the cavity and is then curved toward the side.

The manner of securing the diaphragm in place not only permits a ready removal and substitution of a new diaphragm, in case one becomes broken or injured, but also, the fact that the edges of the diaphragm are wrapped over the rim of the cup and secured by a ring at a distance from the edge of the latter instead of by an annular cap, prevents the metal part of the stethoscope coming into contact with the flesh of a patient, and so guards against causing a chill when the metal is cold. The presence of the diaphragm also causes the air in the cavity and tubes up to the ears of the user to be at a constant pressure, and prevents inflow or outflow of any of the air. Thereby any vibration, even the slightest, sets the air column in the tubes into vibration, and transmits the sounds clearly to the observer's ears.

Finally, the device is one of extreme simplicity, consisting only of three parts (exclusive of the tubes and ear pieces which are common to all stethoscopes), and being only the body *a* with the rigid tube, the diaphragm, and the clamping ring. This of course minimizes the chance of loss of parts of the device, since there are only a few parts which can be lost, and enables it to be put readily into condition for use.

I claim:—

1. A stethoscope consisting of a cup formed

from a solid block with a cavity in one face, the elements of the bounding walls of said cavity being straight from end to end and converging from the edges of the block to a sharp apex near the opposite face, and a straight tube extending into one side of the block and opening at the apex of the cavity.

2. A stethoscope consisting of a cup made from a solid block of metal with a cavity in one face, the bounding walls of which form a conical surface converging to a sharp apex, and are straight from the apex to the edges, and a straight tube extending into one side of the block and opening at the apex, the walls of the cavity making substantially equal angles with the axes of the tube and of the cavity, whereby the sound waves are gathered into a sharp and distinct focus and reflected directly through the tube.

In testimony whereof I have affixed my signature in presence of two witnesses.

DUNLAP PEARCE PENHALLOW.

Witnesses:
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