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(54) KOROTKOV SOUND SENSOR

(71) We, OMRON TATEISI ELECTRONICS Co., a Japanese Company incorporated under the laws of Japan, of 10 Tsuchido-cho, Hanazono, Ukyo-ku, Kyoto, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a Korotkov sound sensor for use with an electronic sphygmomanometer for electrically discriminating Korotkov sounds.

The typical recently developed electronic sphygmomanometer has a microphone incorporated in a cuff which occludes blood flow. The blood pressure of an individual is measured when the cuff is wrapped around the arm of an individual to position the microphone over or adjacent an artery below the blood-occluding portion of a cuff.

Since the microphone for such a sphygmomanometer is disc-shaped and is positioned over the artery, positioning the microphone on the arm of an individual affects the accuracy of detecting Korotkov sounds and is a major reason for introduction of errors and difficulty in the measurement of blood pressure by inexpert persons.

Various types of Korotkov sound sensors have been developed to measure blood pressure with high sensitivity and high accuracy independent of the skill of the individual. For example, an inflatable cuff for detecting Korotkov sounds is jointly used with an inflatable cuff for occluding blood flow and a small-sized microphone is applied to the end of the pressure guide tube which is connected between the cuffs. The sound pick up area in that structure is so wide, since the microphone receives Korotkov sounds transmitted through the air in the inflatable cuff for detecting Korotkov sounds, that positioning of the microphone is not a problem.

However, such structure shows a tendency to generate or pick up various noises, especially when the individual touches the cuffs or the pressure guide tube connected between the cuffs. As a result, easy and accurate measurement of blood pressure is not achieved.

The purpose of the present invention is to obviate the above described problems in the prior art. The present invention provides a Korotkov sound sensor for an electronic sphygmomanometer comprising: a housing body having a hollow therein; a film, substantially thinner than the housing body, to be placed adjacent an artery of an individual, being attached to the housing body and, with the body, forming an air space or "room" in the hollow between the film and the body; and a microphone in the housing body in direct communication with the air in said air room for detecting Korotkov sounds transmitted through the film and the air room.

In the preferred embodiment, the housing body is shaped like a rectangular board and is curved to make it fit around the arm of an individual, and the hollow made in a main surface of the housing body is long and narrow so that, in use, the air room is in a direction to cross an artery in the arm of the individual. The sensor hardly generates or picks up external noise since the housing body is thick and elastic enough, being preferably made of rubber or plastics material, to transmit hardly any noises to the microphone, and only the film being thin and flexible enough to permit sounds to pass, including Korotkov sounds from the arm of the individual to the microphone.

By this system, easy and accurate measurement of blood pressure is achieved by even inexpert persons.

Specific embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which

Fig. 1 is a perspective view of an embodiment of a sensor according to the present invention;

Fig. 2 is a sectional view taken along line II—II in Fig. 1;

Fig. 3 is a sectional view taken along line III—III in Fig. 1;

Fig. 4 is an elevational view of a modification of the sensor of Figs. 1 to 3; and

Fig. 5 is a sectional view taken along line V—V in Fig. 4.

In the drawings numeral 1 shows the housing body made of material such as rubber or plastics, being in nearly rectangular board shape, having an approximate length of 10cm, approximate width of 2.5cm, approximate height of 6mm, and being curved for fitting around the arm. A hollow 2 for air room, having an approximate depth of 3 mm, is formed on the concave side of the housing body, only the peripheral portions of which are retained. A number of projections 3 are located in a line along the length of the interior of the hollow 2. Sound pick up film 4, having an approximate thickness of 0.5—1 mm, made of material such as rubber or plastics is adhered to the periphery of the concave surface of the housing body 1 to form the air room or space 5 between the sound pick up film 4 and the surface of hollow 2. A thick portion 6, having approximate height of 1cm, is formed at the end of the convex portion of the housing body 1, being integral with the housing body 1.

A hole 7 passing through the thick portion 6 to the air room 5 is formed to hold a microphone therein. A disc-shaped miniaturized condenser microphone 8, which is ordinarily used in audio-equipment, is inserted into the hole 7, with its sound pick up side facing the air space 5, and is fixed in the hole by a stopper 9 made of rubber etc. This system is thus just as if the microphone 8 was molded into the thick portion 6 of the housing body 1. Conductive leads 10 of the microphone are led to the outside of the housing body through a hole 11 formed in the thick portion of the housing body. The microphone 8 may be built into another portion of the housing body 1, such as the middle of the housing body 1, which may then be the thick portion 6. A hole 12 passing through the side wall of the housing body 1 is formed at the other end of the housing body 1 to make the air room open to the outside, and a tube 13 with proper inside diameter is inserted into the hole so that the sectional area of the path between the air room 5 and the outside depends on the inside diameter of the tube 13. The tube 13 is useful to pass pulse sounds transmitted to the air room through the film 4 to the outside of the housing body and to reduce the pressure in the air room when the sensor is attached to the arm of the individual.

In measuring blood pressure by using the thus constructed Korotkov sound sensor, the sensor is attached to the pocket on the interior side of the cuff for occluding blood flow (not shown in the drawings) and the cuff is wrapped around the arm in order to touch, directly or indirectly, the sound pick up film 4 to the arm of the individual, then the cuff is inflated to occlude the blood flow. The Korotkov sounds gene-

rated during exhausting air from the cuff are transmitted to the air room 5 through the film 4 and further transmitted to the microphone 8 by the air in the air room 5. The housing body 1 has a reasonable thickness, shape, and rigidity to maintain the air room 5 even if high pressure is applied to the sensor during the inflation of the cuff. Namely, the housing body 1 is made of material having reasonable hardness and thickness maintaining the shape of the air room 5 while it curves and the shape of the air room 5 is changed depending on the size of the arm. As shown in Fig. 2, the projections 3 operate as spacers maintaining a gap between the inner surface of the hollow 2 and the sound pick up film 4 when the sensor is attached to the arm of the individual, the projections 3 not being in contact with the film 4 when the sensor is not in use. As is shown in Fig. 3, the sectional feature of the housing body 1 is an isosceles trapezoid with long base A corresponding to the width of the concave side and short base B corresponding to the width of the convex side. Also, the sectional feature of the air room 5 is an isosceles trapezoid. Other sectional shapes of the housing body 1 and the air room 5, such as a half circle or triangle may be also used. When pressure is applied to the above-described construction in the direction of the arrow X, the housing body 1 is deformed while it generates force in the direction of the arrow Y tensioning the sound pick up film 4 so that no folds, wrinkles or creases occur in the film. Preferably, the hollow of the housing body 1 is longitudinally grooved thereon.

In consideration of the anti-noise characteristics, noises such as pulse sounds from the cuff are hardly transmitted to the air room since the air room 5 is enclosed by the rather thick wall of housing body 1 except at the sound pick up film 4. Further, no noise is generated or collected in the sound transmitting path between the air room 5 and the microphone 8 since the microphone 8 is molded into the thick wall of the housing body 1 and directly faces the air room 5, so that a very high signal to noise ratio is obtained. The sensitivity and frequency characteristics of the sensor are adjusted by adjustment of the inner diameter of the tube 13 since the sound characteristics of the air room 5 depend on the inner diameter of the tube 13 which connects the air room 5 with the exterior of the housing body.

Fig. 4 and Fig. 5 show another embodiment of this invention including structure for attaching the sensor to the cuff. A long and narrow attachment piece 14 of T-shaped cross section is attached to the convex exterior side of the housing body 1. A long and narrow acceptor, partially shown in dotted lines in Fig. 5, complementary to the

attachment piece 14 is attached to the inside cover of the cuff (not shown). The sensor is thus attached to the cuff, not using the pocket of the cuff as mentioned above, but by inserting the T-shaped attachment piece 14 into the complementary acceptor. In this embodiment, the housing body 1 is deformed to apply tension to the sound pick up film 4 since the attachment piece 14 also operates as a rib when pressure from the cuff is applied to the attachment piece 14.

As shown above, the Korotkov sound sensor for an electronic sphygmomanometer of the present invention enables highly sensitive and high anti-noise characteristic detection of Korotkov sounds independent of the accuracy of the positioning the sensor, providing a system for easy and accurate measurement of blood pressure even by inexperienced individuals.

WHAT WE CLAIM IS:—

1. A Korotkov sound sensor for an electronic sphygmomanometer comprising:

25 a housing body having a hollow therein; a film, substantially thinner than the housing body, to be placed adjacent an artery of an individual, being attached to the housing body and, with the body, forming an air space or "room" in the hollow between the film and the body; and

30 a microphone in the housing body in direct communication with the air in said air room for detecting Korotkov sounds transmitted through the film and the air room.

2. The Korotkov sound sensor of claim 1, wherein the housing body has a nearly rectangular shape in its major dimensions.

40 3. The Korotkov sound sensor of claim 1 or claim 2, wherein the housing body is curved for fitting the film around an arm of an individual.

45 4. The Korotkov sound sensor of any one of claims 1 to 3, wherein the hollow of the housing body is longitudinally grooved thereon.

5. The Korotkov sound sensor of any one of claims 1 to 4, wherein the housing

body has one or more projections thereon in the hollow for preventing the film from contacting the bottom of the hollow.

6. The Korotkov sound sensor of claim 5, wherein the housing body comprises a plurality of said projections aligned in the longitudinal direction of the body.

7. The Korotkov sound of claim 5 or claim 6, wherein the projections do not contact the film when the sensor is not in use.

8. The Korotkov sound sensor of any one of claims 1 to 7, wherein the housing body includes a through-hole communicating between the air room and the exterior of the body.

9. The Korotkov sound sensor of any one of claims 1 to 8, wherein the housing body includes a portion having a through-hole therein in which the microphone is located.

10. The Korotkov sound sensor of any one of claims 1 to 9, wherein the width of the hollow increases when external pressure is applied to the housing body on the side thereof opposite said hollow, thereby tensioning said film.

11. The Korotkov sound sensor of any one of claims 1 to 10, wherein the housing body further comprises attachment means for attaching the body to a cuff.

12. The Korotkov sound sensor of any one of claims 1 to 11, wherein the thin film is adhered to the periphery of the hollow to form the air room in the hollow between the thin film and the body.

13. The Korotkov sound sensor of any one of claims 5 to 7, wherein the projections protrude from the bottom of the hollow.

14. The Korotkov sound sensor of claim 1, substantially as hereinbefore described with reference to, and as illustrated in, Figures 1 to 3 or as modified in Figures 4 and 5 of the accompanying drawings.

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FIG.1

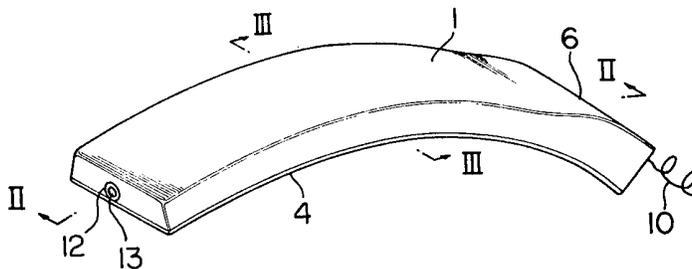


FIG.2

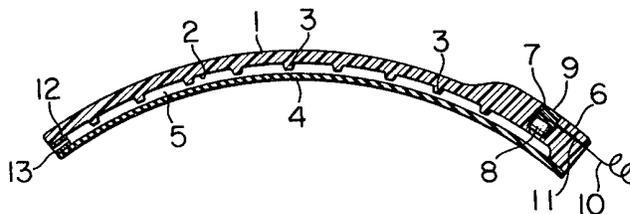


FIG.4

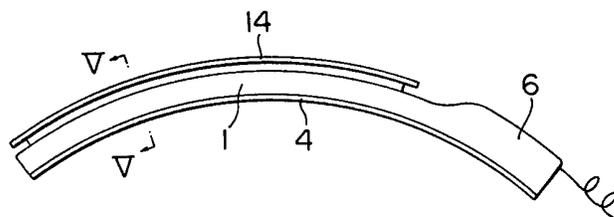


FIG.3

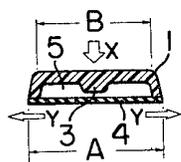


FIG.5

