July 23, 1940. W. J. KERR 2,209,164

STETHOSCOPE

Filed April 25, 1939

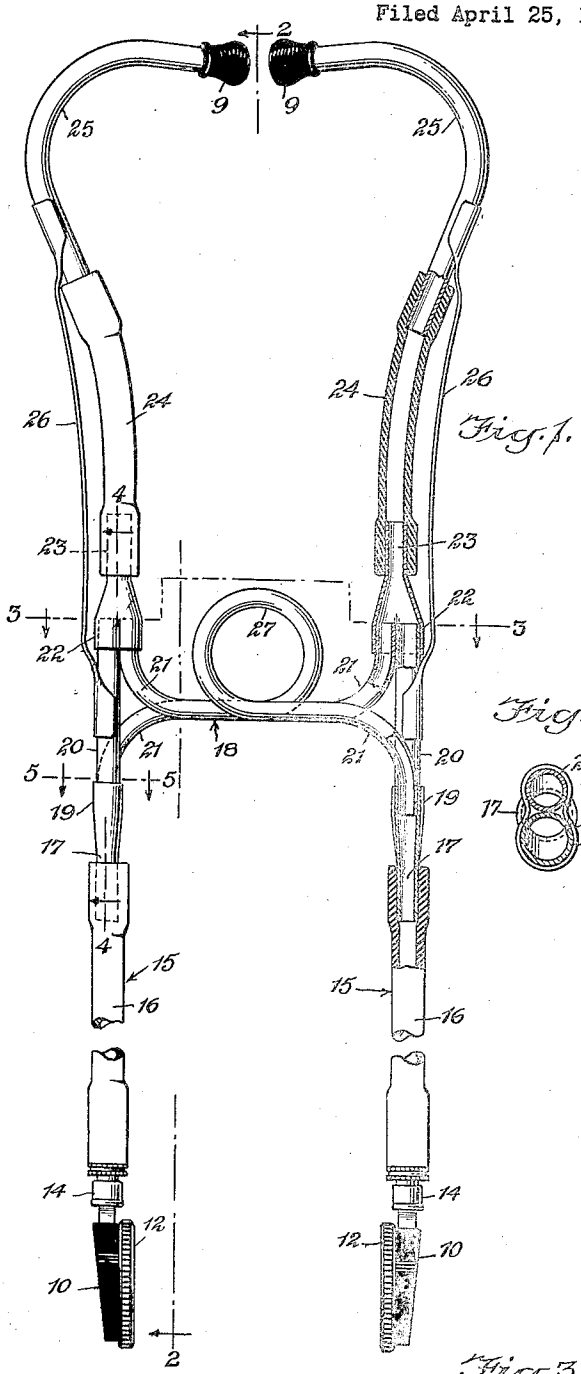


Fig. 1.

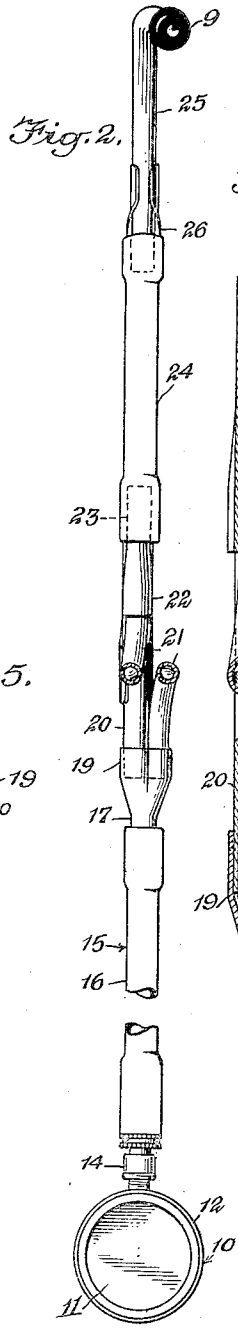


Fig. 2.

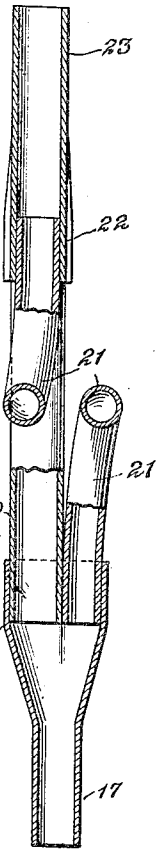


Fig. 4.

Fig. 5.

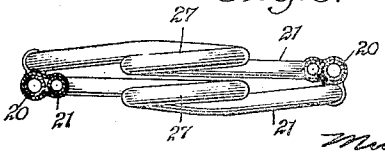


Fig. 3.

WITNESSES

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STETHOSCOPE

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1 Claim. (Cl. 181—24)

This invention relates to an improved stethoscope, particularly to a stethoscope operating upon the principles of binaural or two-ear hearing.

The conventional type of stethoscope now in use employs a single sound receiver or chest piece and sound transmitting means of equal length and caliber connected to the sound piece and adapted to transmit the sound to the two ears of the operator. It will thus be seen that sound waves of equal intensity are transmitted to both ears at the same time. Attempts have been made to provide stethoscopes operating upon the principles of binaural hearing so as to give the illusion of perspective or direction to the sound. However, such attempts have been more or less unsatisfactory for the reason that they have failed to properly utilize the factors upon which the principles of binaural hearing are based.

It is a prime object of the present invention to overcome the difficulties and disadvantages heretofore encountered in this respect and to provide an improved stethoscope operating upon the principles involved in binaural hearing which will give the illusion of direction to sound and will enable the operator to readily ascertain the situs or point of origin of the sound.

It is a further object of this invention to provide an improved stethoscope of the above character which is of relatively simple and inexpensive construction and which operates in accordance with the principles of natural binaural hearing so that without special training or technique the operator can readily locate the situs or point of origin of a given sound or disturbance.

It has been found that the direction of sound and the situs or point of origin thereof is determined in ordinary binaural hearing by two factors. The most important of these factors is the time lag or difference in time at which the sound waves reach the respective ear drums of the listener. It will be appreciated that if sound arises on one side of the mid-line outside of the head of the listener the sound waves will reach the nearer ear sooner than the farther ear. Where the difference in time is greater than 32-millionths of a second there will be a sufficient difference in phase to enable the listener to localize the sound as to the side of origin. The second factor which enables the listener to determine the situs or point of origin of sound is the difference in intensity of the sound reaching the respective ears. Thus sound arising on one side of the mid-line outside of the head of the listener is more intense when received at the nearer ear than at the farther ear. In carrying out my invention I utilize both of these factors and my improved stethoscope is so constructed that the illusion of direction is imparted to the sound transmitted thereby both by the difference in time at which the sound reaches the respective ears of the operator and by the difference in intensity of the sound.

For a more complete understanding of my invention reference should be had to the accompanying drawing in which:

Fig. 1 is a view partially fragmentary and partially in section of a stethoscope embodying my invention;

Fig. 2 is a partially sectional view in the direction of the arrows on the line 2—2 of Fig. 1;

Fig. 3 is a partially sectional view in the direction of the arrows on the line 3—3 of Fig. 1;

Fig. 4 is a partially sectional view in the direction of the arrows on the line 4—4 of Fig. 1; and

Fig. 5 is a sectional view in the direction of the arrows on the line 5—5 of Fig. 1.

My invention comprises generally a pair of sound receivers or chest pieces having connected thereto a pair of sound transmitting means for transmitting the sound to the respective ears of the operator and a pair of auxiliary interconnected sound transmitting means whereby sound from each of the sound receivers is transmitted at a lesser intensity and at a slight time lag to the opposite ear of the operator. Thus in the accompanying drawing, in which I have illustrated a preferred embodiment of my invention, I show a pair of similar sound receivers or chest pieces 10 which are of conventional construction. In the sound receivers illustrated in the drawing, a diaphragm 11 is provided which is held in position by means of a knurled rim 12 which is threaded to the body of the receiver 10. In back of the diaphragm 11 a space is provided and the duct of a tubular nipple 14 communicates with this space. The sound receivers illustrated and described are of conventional construction and it should be understood that any desired type of sound receivers or chest pieces may be employed. However, for the satisfactory operation of my device the two chest pieces should have substantially identical acoustical characteristics. For example, in chest pieces of the type illustrated and described the diaphragms 11 should have the same acoustical property.

Each of the sound receivers is connected by means of a primary conduit 15 to an ear piece 9, the ear pieces being adapted to engage the two ears of the operator. The conduits 15 are of equal length and the bores or ducts are of equal caliber

or diameter. In addition, as will be more fully described, the ducts 15 are interconnected by a pair of interconnecting auxiliary conduits whereby the sound from each of the sound receivers will be transmitted at reduced intensity and with a slight time lag to the opposite ear of the operator. To obtain these results each of the conduits 15 may be formed of a section of flexible tubing made of rubber or similar material as indicated at 16 which is connected at its one end to the nipple 14 and at its opposite end to a nipple 17 formed on a fitting 18. The fitting 18 is of balanced construction having a fitting 17 on the two sides thereof so as to engage the ends of each of the respective flexible tubes 16. The fitting is preferably made of a rigid material such as metal, plastic material or the like and as shown is of tubular construction so as to transmit sound waves through the respective portions thereof. The upper end of each of the nipples 17 is in the form of an adapter 19 which receives the ends of the tube 20 forming part of the primary conduit and of the tube 21 forming part of the auxiliary conduit. The upper end of each tube 20 fits into another adapter 22 formed at the end of nipple 23. Nipples 23, in turn, are connected by flexible tubes 24 which may be made of rubber or the like, to tubes 25 preferably made of some rigid material such as metal or plastic material, and which are curved as shown so that the ear pieces 16 which are attached to the ends thereof may conveniently be inserted into the ears of the operator. So as normally to hold the ear pieces in the positions illustrated and so as to retain the ear pieces in the ears of the operator I preferably provide the resilient members 26 which may be made of spring metal and which are connected between the tubes 25 and the fitting 18.

The two sides of the stethoscope, that is, the two sound receivers, the two conduits 15, and the two ear pieces 16 are of identical construction. In this way sound will be transmitted from each sound receiver to each ear piece through the primary conduit at the same rate of speed.

Referring now more particularly to the auxiliary sound transmitting means, in the form of my invention shown in the drawing this mechanism comprises the tubes 21 of the fitting 18. The fitting is provided with two tubes 21, one adapted to receive a portion of the sound from the first conduit and transmit it to the second conduit and the other being adapted to receive a portion of the sound from the second conduit and transmit it to the first conduit. Thus it will be seen that each of the conduits 21 is connected at one end to the adapter 19 of one of the conduits and at its opposite end to the adapter 22 of the other conduit. I have found that more satisfactory results are obtained by making the conduits 21 of somewhat smaller caliber or capacity than the primary conduits 15 because in this way the sound transmitted through the auxiliary conduits will be of lesser intensity. The path from the sound receiver through the auxiliary conduit to the opposite ear piece should also be somewhat longer than the path from the sound receiver through the primary conduit to the adjacent ear piece in order to provide for the necessary time lag. I have found that the difference in length should be at least one centimeter and that the maximum effect is obtained by a difference of 17 centimeters. So as to provide for the necessary difference in length, each of the auxiliary conduits may be formed with a coil in the manner shown at 27.

It will thus be seen from the structure described that sound will be transmitted from each of the sound receivers 10 through the primary conduits 15 to the respective ear pieces 16. Some of the sound from each ear piece will also be transmitted through the rubber tube 16, the auxiliary conduit 21 and rubber tube 24 to the opposite ear piece. The sound thus transmitted will be of lesser intensity and at a slight time lag thereby creating the illusion of direction and enabling the operator to determine the approximate situs or point of origin of the sound.

In using the stethoscope in medical practice the two sound receivers or chest pieces are applied simultaneously to homologous points on the two sides of the body or to any two points where it is desirable to compare sounds and the two ear pieces are inserted in the ears of the operator. Differences in intensity, pitch and timing are automatically noted and qualities of timbre or other qualities which may differ are readily detected. In studying respiratory sounds where diseased parts may emit a variety of abnormal sounds, it is possible to perceive a number of different qualities simultaneously. A difference in timing of sounds is readily detected. Sounds such as "murmurs" associated with faults in streamlining in the circulatory system appear to be moving in the direction of the blood stream which carries or accompanies them along the heart or blood vessel. The point of origin of the murmur and its course can be readily detected by applying the two chest-pieces to two points along its course.

Practical application of my invention is found in any situation where comparison of sounds is desirable. In medical practice the sounds produced by the two lungs and their adjacent structures in motion may be compared with great advantage in diagnosis and treatment. In the circulatory system the basal second sounds of the heart may be compared. The point of origin, direction and timing of murmurs may be correctly determined and be of great aid in diagnosis and treatment. On the two sides of the body similar joints may be studied for changes in sounds; the vibrations produced in the two sinuses (antra of Highmore) and in the two vocal cords may be compared and accurate diagnoses of disease established; in the stomach and large bowels the direction of peristaltic sounds may aid in the diagnosis of diseases; in pregnancy the detection of fetal heart sounds beating synchronously may establish the diagnosis of twins; and in a study of the tempero-mandibulary joints comparison may aid in the diagnosis and treatment of local disease. I have found my invention to be of practical value in all the clinical conditions noted as well as the study and demonstration to students of the normal sound relations.

In the mechanical field I have found that abnormal sounds, such as "knocks" in moving machinery or engines may be readily located at a great saving in expense of dismantling and reassembling.

It should be understood that, while in the accompanying drawing I have illustrated a preferred embodiment of my invention, modifications may be made without departing from the invention as set forth in the accompanying claim.

I claim:

A stethoscope comprising a pair of independent sound receivers, a pair of independent ear pieces adapted to be applied to the respective ears of the operator, a pair of independent primary tubu-

lar means for transmitting sound from the sound receivers to the ear pieces, each of said primary tubular means being connected between one of the sound receivers and one of the ear pieces, and a pair of independent auxiliary sound transmitting tubular means connected between the pair of primary tubular means, each auxiliary tubular means adapted to transmit a portion of the sound at reduced intensity and at a slight time lag from one of the receivers to the ear piece which is connected to the primary tubular means of the other sound receiver, the bore of said auxiliary tubular means being smaller than the bore of the primary tubular means, and the combined length of each auxiliary tubular means and the interconnected portions of the primary tubular means between each sound receiver and the opposite ear piece being greater than the length of each primary tubular means.

WILLIAM J. KERR.