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L. C. HOGLE

2,058,796

ELECTRIC STETHOSCOPE

Filed Jan. 11, 1933

Fig. 1.

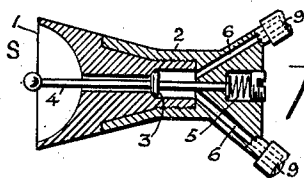
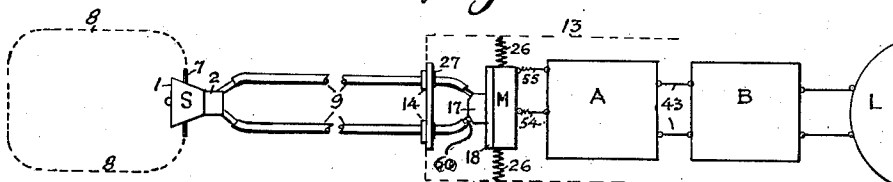


Fig. 2.

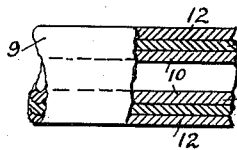


Fig. 3.

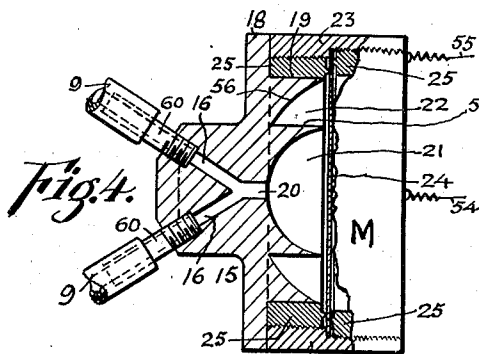


Fig. 4.

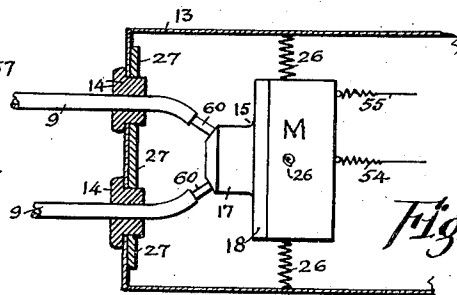


Fig. 5.

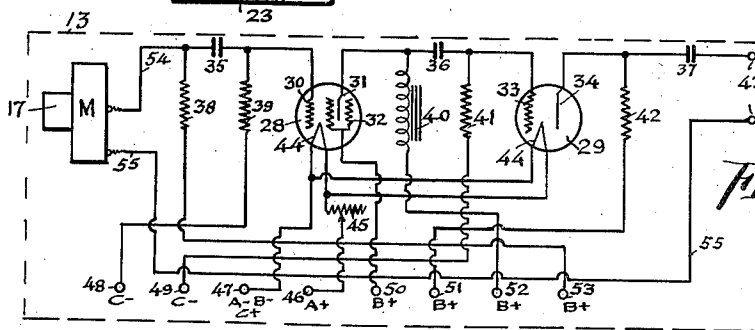


Fig. 7.

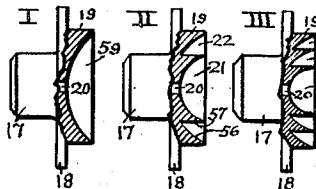


Fig. 6.

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ELECTRIC STETHOSCOPE

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10 Claims. (Cl. 181—24)

This invention relates to improvements in electric stethoscope and it more especially consists of the features pointed out in the annexed claims.

The purpose of the invention is to provide co-
 5 operating acoustic and electrical means for detecting the minutest changes in the functioning of the vital organs of the human body; that isolates various disturbances in the body and picks up the faintest histological defects; that elimi-
 10 nates all extraneous distorting influence; that enables a diagnostician to determine definitely the cardinal symptoms of various diseases to the highest degree of perfection; that so balances the entire system that the slightest frictions, murmurs and other symptomatic sounds in the respiratory,
 15 cardiac, pleural, arterial, venous, uterine and fetal areas, are so definitely detected as to secure a dependability in diagnosis which hitherto has been unattainable; that secures these results in a natural tone on either ear-phones or on a loud
 20 speaker; and that by reason of the flexibility of the system a subject under diagnosis can with separate ear-phones listen to the symptomatic impulses at the same time that the diagnostician does, thus making it possible to explain normal or
 25 abnormal conditions in an intelligent manner.

With these and other ends in view there is illustrated on the accompanying drawing such instances of adaptation as will disclose the broad
 30 underlying features of the invention without limiting it to the specific details shown thereon and described herein.

Fig. 1 is a diagrammatic view of the related features of the invention.

35 Fig. 2 is a cross-sectional view of an improved form of a stethoscope.

Fig. 3 is a lengthwise cross-sectional view of a conducting tube used between the stethoscope and the microphone.

40 Fig. 4 is a cross-sectional view of a receiver for the microphone.

Fig. 5 is a plan view of the microphone the enclosing casing being in section.

Fig. 6 is a diagrammatic view of several forms
 45 of microphone receivers.

Fig. 7 is a diagram of the circuit relations of the pre-amplifier.

In practicing this invention advantage may be taken of any alternative or equivalent elements of
 50 construction or steps of method without departing from the broad spirit of the invention.

The invention may be skeletonized as follows:—
 A pick-up device S similar to an ordinary stetho-
 55 scope used in medical practice is connected by a pair of twin equalizing tubes 9 to the receiving

member 15 of an ultra sensitive microphone M. The pick-up S is in two parts, a bowl 1 and an extension 2. It includes a valve 3 on a stem 4 and a spring 5 which normally holds the bi-lateral outlets 6 leading to the twin tubes inactive until
 5 the pick-up S is pressed against the surface under examination which automatically opens the central passage at the valve 3 to the outlets 6. This prevents the entrance of external sounds to the microphone.

The twin tubes 9 are composite in cross section comprising an inside rubber tube 10, an inner metal ribbon 11 and an outside rubber tube 12 which serve to avoid frictional disturbances and the ingress of voice vibrations of the physician or
 15 attendants without an armored tube extraneous voice vibrations, due to the high amplification, become disturbingly audible, even though the tubes are enclosed, because they would pass through the walls of ordinary tubes unenclosed.
 20 The impulses coming over the air column in the tubes 9 are directed into a receiver 15 forming a part of a microphone M that is suspended by springs 26 against external vibrations in a casing of the direct current pre-amplifier A to which
 25 the springs are attached. The output from here goes to an A. C. or D. C. conventional type of amplifier B and its output may actuate one or more conventional head phones or a loud speaker L as desired.

To attain the results which are necessary in precision diagnoses the microphone M whether of the condenser, carbon, dynamic or magnetic type must have a supersensitive response to the delicate and minute impulses which are directed
 35 against its diaphragm 24. The pre-amplifier A may consist of a two stage resistance coupled audio frequency direct current unit or any cooperative modification thereof. It and the microphone M is enclosed in a shielded casing 13. The
 40 D. C. output 43 of this pre or "A" amplifier becomes the input of the "B" amplifier. A suitable power pack from an A. C. source may supply D. C. current to the pre-amplifier. Any other source of current may be used.

In order that the physician's hands may be clear for manipulative work and be relieved from holding the stethoscope S against the patient's body, side projections 7 are formed on the stetho-
 50 scope and a belt 8 secured around the body of the physician has its ends attached to the projections 7.

As stated it is of the utmost importance that all frictional noises which would be caused if the tubes 9 simply passed through openings in the
 55

metal casing 13 be eliminated. This is accomplished by placing a solid piece 27 of ebonite, bakelite, etc. on the inside of the casing 13 (Fig. 5) to dampen any disturbances arising from any movement of the end wall of the casing. An opening for each tube 9 is made through the casing and the ebonite piece 27, sufficiently large to admit the soft rubber bushings 14.

The microphone M is provided with a receiving member 15 which comprises a large diameter part 19 on the inside and a small diameter part 17 on the outside of a flange 18. The inner face of the part 19 has a central concave shaped air chamber 21, concentric with this an annular equalizing chamber 22 is formed with a curved outer wall 56 and a straight inner wall 57. The concave central area 21 may be enlarged to include the chamber 22 as at 59 on I of Fig. 6. If desired a second annular equalizing chamber 58 with walls similar to chamber 22 may be formed as shown at III of Fig. 6. The numeral 58 is specific to the outer annular chamber of III, Fig. 6 while 59, I, Fig. 6 identifies the single cupped recess.

There are two entrances into the receiver 15, by means of passage ways 16 which join to form an opening 20 leading into the air chamber 21 or 59. Tubes 60 are threaded into the diverging openings 16 and the composite rubber-metal tubes 9 are attached to the short tubes 60. The microphone M has an extension 23 in which tension rings 25 are placed. These rings, in a conventional manner place the diaphragm 24 under the desired tension. The microphone M, instanced in Fig. 4 is of the condenser type which, as stated may be substituted by any other form of microphone having sufficient sensitiveness and freedom from external disturbances to pick up the most delicate changes within the area under observation, beneath the stethoscope.

The microphone M is connected by the lead 54 to the grid 30 of the first stage audion 28 and to the output of the pre-amplifier at 43 over the lead 55. There are two stages of amplification by tubes 28 and 29 in the pre-amplifier contained in the shielded casing 13 and the second amplifier B may have any desired arrangement of tubes, resistances, impedances etc. for amplifying the output of the pre-amplifier to one or more sets of headphones and simultaneously or separately to a loud speaker L, or any well known current meter, tape recorder or a visualizing oscilloscope not shown, may be used as desired.

Direct current is supplied to the pre-amplifier over connection 46 to 53 inclusive as instanced in Fig. 7. The circuit relation exemplified in Fig. 7 may be modified as desired to adapt it to different types of microphones provided that a supersensitiveness is retained and all interior disturbances are eliminated.

As instanced in Fig. 7, the terminal 48 carries C current at approximately three volts to the resistance 39. Terminal 49 connects a source of current at approximately four and a half volts to a resistance 41. The filaments 44 of tubes 28 and 29 are supplied with current over terminals 46 and 47. Terminal 46 is connected on the positive sides to the filaments 44 under control of the resistance 45. The terminal 47 also serves for minus A, minus B and positive C currents.

Terminal 50 is a positive B connection at approximately sixty-seven volts to the plate grid 32 of the tube 28. Terminal 51 is connected to the resistance 42 in advance of the condenser 37 at approximately ninety volts. It serves for a positive B current.

Terminal 52 at approximately one hundred and thirty-five volts B positive current includes the impedance 40, and positive B current at one hundred and eighty volts is connected to the resistance 38.

The plate 31 of tube 28 is connected to the grid 33 of tube 29 through a condenser 36 and the plate 34 of tube 29 is connected to one of the output terminals 43 through a condenser 37. A condenser 35 is placed between the grid 30 of the tube 28 and the lead 54 connected to the microphone, M.

The cut-out device in the stethoscope which may include a small knob at the outer end of the valve stem 4 is necessary in order to prevent picking up vibrations from the room or the speaker which would cause feed back of an annoying kind. The precautions associated with the stethoscope are also taken in respect of the tubes leading to the microphone. Each one of these tubes, as already stated, is composite. They are made as near sound proof as possible by first using an inner rubber tube, covering this with a thin spiral wound metal armor and lastly covering this with an outside rubber tube. An ordinary single rubber or even a metal tube will pick up the vibrations of the operator which, associated with the desired impulses coming from the stethoscope will result in a feed back interference.

By using two tubes 9 connected to a single passage of each end the pulses of dead air in them are carried more true than if only a single tube is used. Whatever external disturbances may arise they will strike the two tubes differentially so that the delivered pulses coming from each separate tube will be equalized. This equalizing or compensating feature is also present in the dead air chambers 21, 22, 58 and 59. The receiver 15 of the microphone has its inner face very close to the diaphragm 24, approximately 1/1000 inch away. The flange 18 is secured to the microphone projection 23 by screw or otherwise. The diaphragm 24 is stretched tightly between the tension rings 25. It is exceedingly thin and may be made of duralumin, steel, phosphor bronze or other cooperating materials.

Reverting to the pre-amplifier "A". Its resistances, condensers and chokes are of the highest quality obtainable. The tubes are ultra sensitive, non-microphonic. This condition is important because the slightest bit of stage rush or noise in the two stages of amplification will seriously impair the operation of the entire unit.

To secure adequate results it was found necessary to incorporate the pre-amplifier in the system because the impulses picked by the microphone were found to be so weak that they could not be heard with the most sensitive ear phones. When these impulses were fed into an ordinary A. C. or D. C. amplifier the hum and stage rush completely drowned out everything the microphone picked up. This is entirely obviated by using the pre-amplifier ahead of any good class "B" amplifiers of three or four stages, the faintest impulses are brought up to extraordinary speaker volume.

The electric stethoscope will pick up isolated impulses from any section of the body even when the areas under inspection are near each other, such as one valve of the heart without interference from any near-by related member of the heart. This delicate selection of normal or abnormal actions enables the diagnostician to come to definite decisions with great confidence.

It is further pointed out that the equalizing

or compensating chambers in the receiver of the microphone overcomes any tendency for the diaphragm to be subjected to excessive pressure, should the impulses coming through the sound

5 proof tubes 9 be so great as to blast the diaphragm. The varying impulses move the diaphragm to and fro which sets up very weak electrical impulses that are increased in strength by the pre-amplifier and still further increased
10 by the next amplification to whatever degree that the output is to be used.

The received result may be made visible on a ground glass, not shown, by sending the impulses through any well known oscillograph, or they
15 may be recorded on a conventional moving picture film. Phonograph records may ordinarily be made and, as stated above, if desired a tape recording machine may be employed.

What I claim is:

20 1. In an electric stethoscope, a valve controlled sound pick-up, a microphone, a source of direct current for the microphone, a shielded pre-amplifier connected to the microphone, an additional amplifier adapted to receive the output of
25 the pre-amplifier, means for conveying sounds from the pick-up to the microphone, and means for utilizing the amplified output as desired.

2. In an electric stethoscope, a valve controlled sound pick-up having a limited contacting area,
30 a pair of sound proof tubes leading from the pickup to a microphone at the other end of the tubes, a source of direct current for the microphone and subsequent amplifying means, a shielded pre-amplifier between the microphone
35 and a final amplification, and means for utilizing the amplified output as desired.

3. A microphone comprising an electrical microphone, a diaphragm for actuating the microphone, a receiving member terminating adjacent to the diaphragm, said member having a compensating chamber in front of the diaphragm and having an opening leading to the chamber, a valve controlled stethoscope, sound proof means connecting the stethoscope to the
40 opening leading to the chamber, a source of direct current for the microphone, and means for amplifying the output of the microphone as modified by the stethoscope.

4. A stethoscope, comprising a cup-shaped end
50 to be placed in contact with the surface that is under investigation, an extension therefrom having a passage leading to the interior of the cup-shaped end, a valve in the passage, a stem on the valve, a spring for keeping the valve closed, an extension of the stem projecting forward of the cup-shaped end whereby as the stethoscope is pressed against a surface the valve is moved to open the passage, and when the stethoscope is removed from the surface the
55 spring closes the valve, and sound proof means connected to the extension for conveying sounds

produced within the cup-shaped end to a microphone and an amplifying system, and means for delivering the amplified output audibly therefrom.

5. A stethoscope comprising an enlarged end 5 having a hollow interior and an outlet the enlarged end being adapted to be placed in contact with a surface that is under observation, a projection in the enlarged end for controlling the outlet, electrical means for transmitting the
10 most minute sound disturbances raised within the stethoscope to another point without modification by external influences, and direct current means for amplifying the sound disturbances as desired.

6. A microphone receiver, comprising a flanged member having a larger diameter projection on one side and a smaller diameter projection on the other side having hollow passages therein, the larger projection having circular concentric
20 recesses in its face, means comprising a single passage way from the hollow passages of the smaller projection to the inner recess.

7. A shielded pre-amplifier comprising an associated microphone, a source of direct current
25 for the microphone, an elastical support for the microphone, a shielded casing enclosing the parts, ebonite reinforcements at one end of the casing, a pair of soft rubber bushings passing through the casing and reinforcement, and a
30 separate sound proof tube passing through each bushing, means for uniting the tubes into a passage way common to both tubes within the casing, and means for actuating the microphone by impulses passing through such tubes.

8. A microphone having a diaphragm, a receiver for use in close proximity to the diaphragm of the microphone, comprising a plurality of separate concentric chambers of curved outline in cross section formed in the face of the receiver opposite the diaphragm, and a passage way leading from the exterior of the receiver to its interior.

9. A microphone having a diaphragm, a receiver for use in close proximity to the diaphragm of the microphone, said receiver comprising a plurality of narrow rings of different radii the curved space between the rings forming compensating chambers which are interconnected through the small space between the rings
45 and the diaphragm, means for excluding external air from the chambers, and means for conveying impulses to the chambers for actuating the diaphragm.

10. A microphone having a diaphragm, a receiver for use in close proximity to the diaphragm of the microphone, said member having a central concave recess formed opposite the diaphragm, and a passage way leading from the exterior of the receiver to the recess.

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