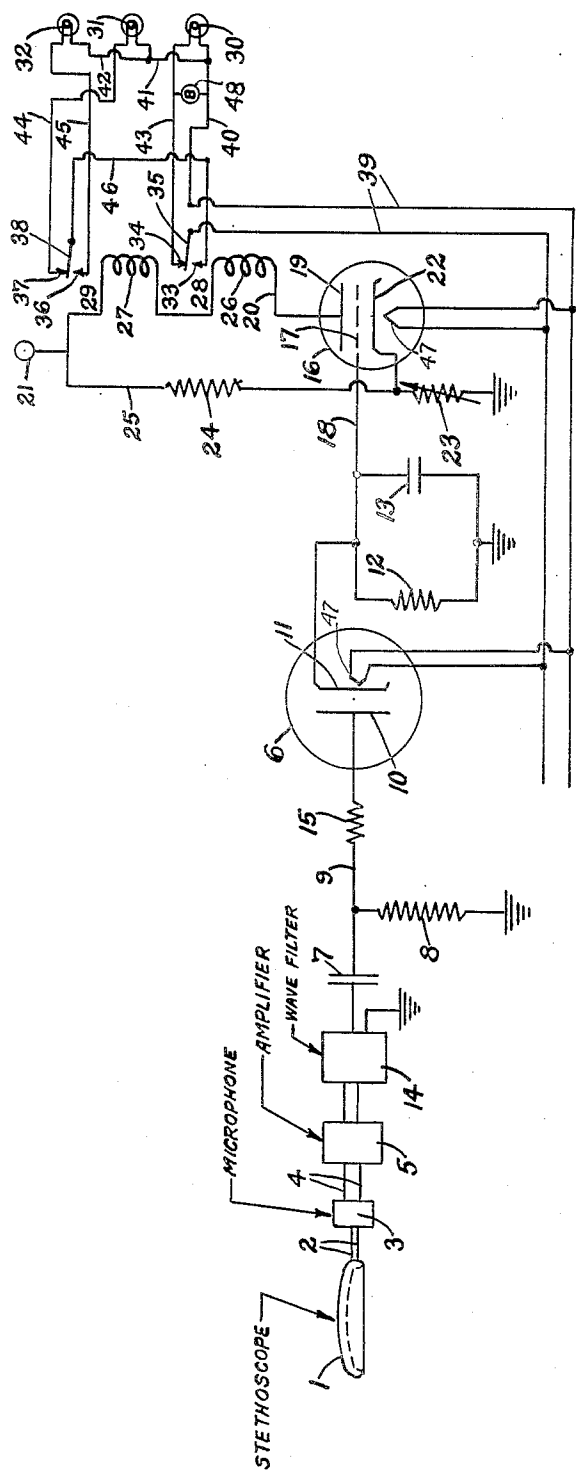


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FETAL HEART MONITOR
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FETAL HEART MONITOR

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This invention relates to a device for indicating any change in the fetal heart beat during childbirth thereby giving to the obstetrician a warning of the development of unfavorable conditions.

One of the dangers attendant on childbirth is the possibility that the fetus may have maneuvered into a position in which the umbilical cord is wrapped around its neck, thereby producing a condition which might be fatal to the fetus during delivery if this condition results in cutting off or unduly reducing its blood circulation.

An object of the present invention is to provide a device which is responsive to the combined heart beats of the mother and the fetus, and which gives an indication during childbirth of any change, whether in the way of a diminution or in the way of an increase, in said combined heart beats, thereby notifying the obstetrician of the development of an abnormal condition which may require immediate and emergency attention.

In the drawings which illustrate diagrammatically one embodiment of my invention, 1 indicates a stethoscope of usual construction, the tube 2 of which is connected to a microphone 3 of any suitable type which translates the impulses received by the stethoscope into electrical impulses.

The microphone 3 is electrically connected by wires 4 to an amplifier 5 which also may be of any suitable or usual construction, the function of which is to amplify the electrical impulses delivered from the microphone in a well known way.

The amplifier 5 is coupled to a diode 6 in any usual way, as by means of a condenser 7 and grounded resistor 8, said coupling including a wire 9 leading to the plate 10 of the diode 6. The cathode 11 of the diode is connected with a network comprising a resistor 12 and a condenser 13.

A wave filter or filter network 14 is preferably placed between the amplifier 5 and the coupling 7, 8, for the purpose of filtering out or materially reducing the higher frequencies and thus preventing them from being impressed on the diode 6.

By this means the low frequency electrical impulses emanating from the amplifier cause a direct current voltage to appear across the network 12, 13.

The wire connection 9 has a resistor 15 therein which is of such value as to make the direct current voltage across the condenser 13 a func-

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tion of both the number of heart beats picked up by the stethoscope and the amplitude of said beats.

The heart beats of the mother will normally be somewhat stronger than those of the fetus and the heart beats of the fetus may be more rapid than those of the mother. The resistor 15 will have such a value as to enable the diode 6 to respond to each heart beat whether it is that of the mother or that of the fetus, and also to respond to the strength of each heart beat. In other words the resistor 15 causes the circuit of the diode 6 to integrate the energy delivered at the output terminals of the wave filter 14 which results from the heart beats of two different series of beats. Any change, therefore, in either the rate of either series of heart beats or in the amplitude of heart beats in either series will effect the voltage across the condenser 13.

Associated with the diode 6 is a vacuum tube 16 in the nature of a control tube which responds to changes of voltage across the network 12, 13 and which operates suitable signals, either visual or audible or both types, which indicate whether the combined heart beats are normal or abnormal either in frequency or in intensity.

The grid 17 of the vacuum tube 16 is electrically connected to the network 12, 13 as shown at 18 and hence the voltage impressed on the grid will correspond to and vary with the voltage across the condenser 13.

The plate 19 of the tube 16 is connected by a circuit connection 20 to a source 21 of relatively high regulated voltage, and the cathode 22 of said tube 16 is connected to the ground through a variable resistor 23. This resistor 23 and a resistor 24 in the circuit connection 25 form a voltage divider network by which the voltage between the cathode 22 and the ground can be varied and maintained within certain prescribed limits as will be hereinafter set forth.

The plate circuit 20 of the tube 16 has therein the coils 26, 27 of two relays 28 and 29 by which three signals 30, 31 and 32 are rendered operative and inoperative, said signals being herein shown in the form of electric lights. The relay 28 includes two fixed contacts 33, 34 with which cooperates a pivoted contact 35 adapted to engage either one of the contacts 33 or 34.

The relay 29 also includes two fixed contacts 36 and 37 with which a pivoted contact 38 cooperates, and as stated above these relays control the three signals 30, 31, 32. Said electric light signals are energized by current in a supply circuit 39, and as herein shown one side of said

circuit is connected to the pivoted contact 35 of the relay 28 and the other side of said circuit is connected to one of the terminals of each of the lamps 30, 31, 32 by wire connections 43, 41, 42. The other terminal of lamp 30 is connected by a wire 43 to the contact 34 of the relay 28, and the other terminal of the lamp 31 is connected by a wire 44 to the contact 37 of the relay 29, while the other contact of the terminal of the lamp 32 is connected by a wire 45 with the contact 36 of the relay 29. The pivoted contact 38 of the relay 29 is connected by a wire 46 to the contact 33 of the relay 28.

The relays 28, 29 are adjusted so that the relay 29 will be operatively energized only when the current flow through the plate circuit 23 is greater than normal, while the relay 28 will be operatively energized by a current flow slightly less than normal.

Under normal operating conditions the voltage across the condenser 13 should be a fixed amount, for example, approximately one volt, and the variable resistor 23 should be so adjusted as to provide a current of predetermined value through the tube 16, which for purposes of illustration may be assumed to be approximately 0.9 milliamperes.

Under these conditions and with a normal current of, say, 0.9 milliamperes flowing through the circuit 20, the relay 28 will be operatively energized and the pivoted contact 35 will be held in engagement with the fixed contact 33, but the relay 29 will not be operatively energized and its pivoted contact 38 will remain in engagement with the fixed contact 37. With this condition existing a circuit is established through the signal lamp 31, which when lighted, indicates that the stethoscope is registering normal conditions. Said circuit may be traced as follows: one side of circuit 39, pivoted contact 35, fixed contact 33, circuit connection 46, pivoted contact 38, fixed contact 37, circuit connection 44, lamp 31, and circuit connections 41 and 40 back to the other side of the circuit 39.

If the heart beats of the fetus diminish appreciably in either frequency or amplitude, this will vary the voltage of the grid 17 of the control tube 16 and will result in a decrease of current flowing through the relay coils, and if this decrease falls below a predetermined value, say 0.8 milliamperes, the relay 28 will open and the pivoted contact 35 will engage the fixed contact 34 thereby closing the circuit through the lamp 30 and opening the circuit through the lamp 31. The lighting of the lamp 30 will give indication of a diminution of the combined heart beats and will thereby give the obstetrician a warning that some abnormal conditions are developing.

On the other hand if there is an increase in either the frequency or amplitude of the heart beats of the fetus, there will be an opposite change in the voltage impressed on the grid 17 of the tube 16 which will result in an increased current flowing through the plate circuit of the tube 16. Such increased current, if it equals or is greater than some predetermined amount, say 1.0 milliamperes, will operatively energize the relay 29 and close the pivoted contact 38 on to the fixed contact 36, and since the relay 28 is operatively energized at a normal current of 0.9 milliamperes, said relay will remain operatively energized with the increased current and thereby the circuit of the light 32 will be closed. This circuit includes the one side of the circuit 39, pivoted contact 35, fixed contact 33, circuit con-

nection 46, pivoted contact 38, fixed contact 36, circuit connection 45, lamp 32, circuit connections 42, 41 and 40 back to the other side of the circuit 39.

When, therefore, normal conditions exist, the lamp 31 will be lighted, while when there is a diminution in the heart beats picked up by the stethoscope, the signal light 30 will be lighted, and if there is an increase in such heart beats, the light 32 will be lighted.

In using the apparatus the stethoscope 1 will be placed on the patient in the most advantageous position to react to the heart beats of the fetus, and when in this position it may or may not pick up the heart beats of the mother.

Assuming that when the stethoscope is thus placed in position, the heart beat of the fetus and the heart beats of the mother, if the mother's heart beats are picked up, are normal, the variable resistor 23 will then be adjusted to produce a current flow through the tube 16 which is sufficient to operatively energize the relay 28 but insufficient to operatively energize the relay 29. When this condition exists, the circuit through the signal lamp 31 will be closed as stated above, thus indicating a normal condition, and so long as such normal condition continues, the signal lamp 31 will give its indication.

If there should be a diminution in the heart beats picked up by the stethoscope, the voltage impressed on the grid 17 of the tube 16 will decrease, thereby resulting in a decreased current flow through the tube 16, and if the current flow is decreased to the point below that required to operatively energize the relay 28 (which, as stated above, may be assumed to be 0.8 milliamperes), said relay 28 will become operatively de-energized with the result that the circuit through the signal lamp 31 will be opened and the circuit through the signal lamp 30 will be closed. The signal given by the lamp 30 thus indicates an abnormal heart beat condition because of a diminution in the heart beat.

On the other hand if the heart action as picked up by the stethoscope increases, the voltage impressed on the grid 17 of the tube 16 will increase and the current through said tube will also increase, and if the increase is sufficient to operatively energize the relay 29 then, as stated above, the circuits through either the lamp 31 or 32 will be opened and the circuit will be closed through the lamp 32, the lighting of which will give indication of an abnormal condition resulting from an increase in the heart action.

The circuit 39 by which the signal lamps are powered may conveniently be a 6-volt circuit and the heater elements or filaments 47 of the diode 6 and tube 16 may be connected to said circuit as shown in the drawing.

While in the above description certain values have been suggested for the voltage across the condenser 13 and for the current flowing through the tube 16, yet these particular values are not essential to the operation of the invention and may be varied so long as they are properly coordinated with each other to produce the desired result.

While the signals 31, 32 are herein shown as electric lights, yet any suitable signal, such as an audible signal, might be used in place of the electric lights without departing from the invention.

If the signals are in the nature of electric lights as herein shown, an audible signal 48, such for instance as a buzzer, will preferably be placed

in the circuit of the lamp 30 so that when there is any diminution in the heart beats, not only will the lamp 30 be lighted, but the buzzer will be sounded thus giving the audible as well as visual indication of the abnormal condition.

While I have described the invention as it would be used for monitoring the heart beats of a fetus, yet it is equally adapted for use in monitoring the heart beats of any living person, and would, therefore, be useful in those conditions where it is necessary or desirable to maintain a continuous check on the heart action of a patient.

I claim:

1. A diagnostic device comprising a pick-up member responsive to two independent but simultaneously existing series of heart beats, means for translating each beat of each series into an electrical impulse, a vacuum tube, means to impress on the grid of said vacuum tube a voltage which varies in accordance with variations in the action of the combined heart beats of the two series, two signal elements, means controlled by the electron current flow through said vacuum tube to render one signal operative when both series of heart beats are normal, and to render the other signal operative when the heart beats of either series are abnormal.

2. A diagnostic device comprising a pick-up member responsive to two independent but simultaneously existing series of heart beats, means for translating each beat of each series into an electrical impulse, a vacuum tube, means to impress on the grid of said vacuum tube a voltage which varies in accordance with variations in the action of the combined heart beats

of the two series, two signal elements, means controlled by the electron current flow through said vacuum tube to render one signal operative when both series of heart beats are normal, and to render the other signal operative when there is a diminution in the normal frequency of the heart beats of one series.

3. A diagnostic device comprising a pick-up member responsive to two independent but simultaneously existing series of heart beats, means for translating each beat of each series into an electrical impulse, a vacuum tube, means to impress on the grid of said vacuum tube a voltage which varies in accordance with variations in the frequency of the combined heart beats of the two series, three signal elements, means controlled by the electron flow through the circuit of said vacuum tube to render one signal element operative when both series of heart beats are normal, and to render another signal operative when there is a diminution in the combined heart beats of both series and to render the third signal operative when there is an increase over normal in the combined heart beats of both series.

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