

[54] **DEVICE FOR SUPERVISING THE HEART
AND BREATHING FUNCTIONS OF A
PATIENT**

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128/2.06 E, 2.1 R, 2.1 Z**

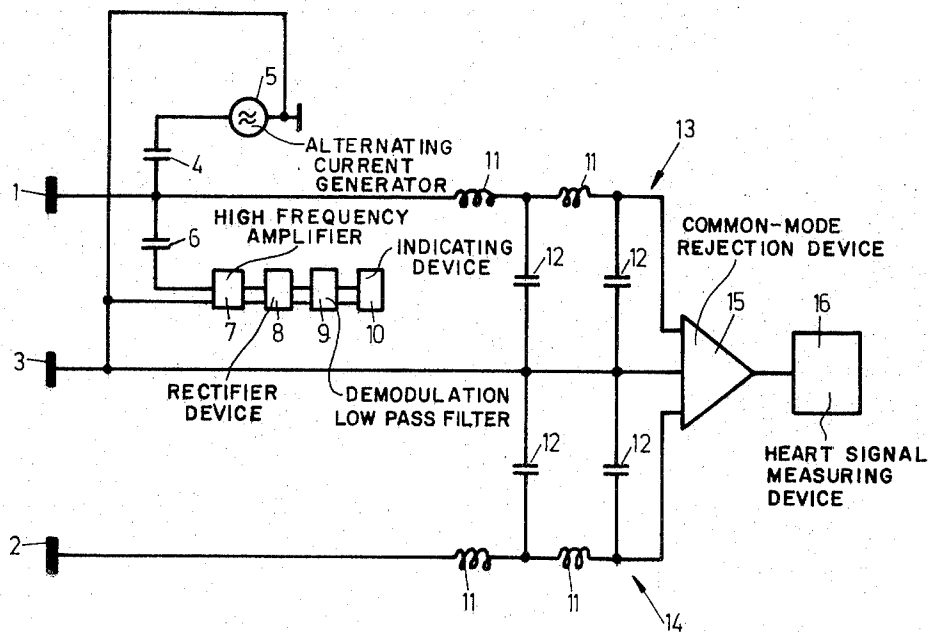
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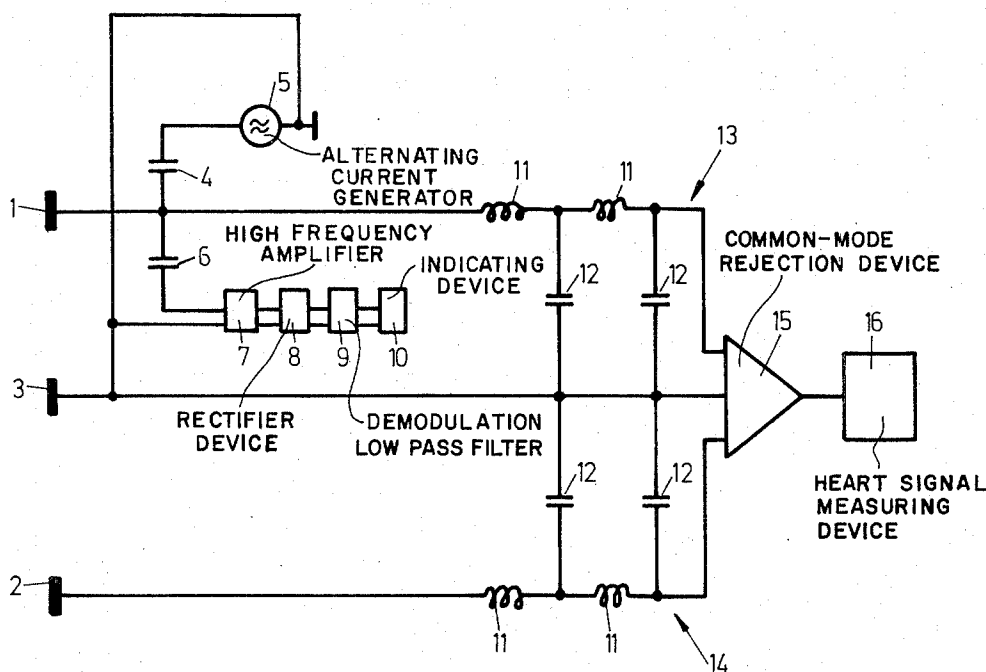
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[57] **ABSTRACT**
A device for supervising the heart and breathing functions of a patient has a common receiving member constructed as a rheographic electrode for receiving a breathing signal and a first heart signal as well as a further receiving member for receiving a second heart signal. The current feeding generator for the rheographic electrode as well as the device measuring the breathing signals at the rheographic electrode are connected by condensers and by the measuring device for the heart signals with receiving members via low pass filters as well as with a common-mode rejection device. The invention is particularly characterized in that as current feeding generator is used a an alternating current generator with a frequency lying in the kHz range and that for coupling the current feeding generator or the breathing signal measuring device to the rheographic electrode are used condensers having a capacity lying in the pf range.

4 Claims, 1 Drawing Figure





DEVICE FOR SUPERVISING THE HEART AND BREATHING FUNCTIONS OF A PATIENT

This invention relates to a device for supervising the heart and breathing activities of a patient having a receiving member constructed as a rheographic electrode for jointly receiving a breathing signal and a first heart signal and a further receiving member for receiving a second heart signal, whereby the current feeding generator for the rheographic electrode as well as the device measuring the breathing signals at the rheographic electrode are connected by condensers and by the measuring device for the heart signals with receiving members through low pass filters as well as a common-mode rejection device.

In known devices of this type the rheographic electrode is fed with current impulses at a repetition frequency of 60 kHz derived from 15 V. voltage impulses and a mark-to-space ratio of 1:1. For coupling of the current feeding generator and the device measuring breathing signals to the rheographic electrode are used solely condensers with a capacity in the nF range (5nF). This capacitive coupling makes certain that outgoing currents produced in case of a disturbance will not flow through the patient.

The drawback is that these high capacity values greatly increase the capacity of the common-mode rejection device so that common-mode rejection in heart signals is made much worse.

In practice attempts were made to provide a diminution of the capacity and thus to improve the suppression by using on the one hand low pass filters poor in capacity and on the other hand at the same time diminishing the capacity of coupled condensers. It was then found that it is possible to achieve without difficulty a small drop in the ingoing capacity by correspondingly dimensioning the low pass filters and thus to also attain a small improvement of the time measure suppression. A drop in capacity for the coupling condensers which are absolutely necessary for the safety of the patient and which would provide a more important influencing of the suppression could not be carried out for practical conditions.

The reason for this is that when there is a drop in the coupling capacities in the pf range, the middle frequency parts of the feeding current impulses which are of importance as carriers for the breathing signal information (in this frequency range at 5nF coupling capacity the optional absolute change of carrier at a carrier amplitude which is just barely sufficient for an evaluation) are so greatly damped that their informational content is greatly diminished or even lost completely.

In theory these difficulties could be overcome if in case of a drop in coupling capacities the amplitudes of the middle frequency parts of the feeding current impulses would be raised, which can be accomplished either by increasing the amplitude of the feeding current impulses or by considerably strengthening the received information. However, an increase in the amplitude of the feeding current impulses is actually impossible for reasons of the safety of the patient (even a comparatively small increase of the impulse amplitude produces a strengthening of high impulse frequency parts which are generally unuseable due to danger to patient's safety). The second way is not practical, since this solution requires amplifiers which are technically quite complicated and thus expensive (in case of less compli-

cated and cheaper amplifiers the information is lost in the sounds of the amplifier).

An object of the present invention is to improve the described prior art devices.

Another object is the provision of a device of the described type which provides a substantial improvement of the suppression with simultaneous optional evaluation of breathing signals with a minimum of technical structure and without any danger for the life of the patient.

Other objects will become apparent in the course of the following specification.

In the accomplishment of the objectives of the present invention it was found desirable to use as the current feeding generator alternating current generator with a frequency lying in the kHz range and to use for the coupling of the current feeding generator and the breathing signal measuring device to the rheographic electrode condensers having a capacity within the pf range. It was found particularly advantageous to select for the frequency of the alternating current generator a value in the range of 30 to 100 kHz and for the coupling capacities a value in the range of 20 to 100 pf.

The present invention operates with a single feeding current frequency lying in the kHz range and not with many frequencies produced during the impulse operation. Coupling capacities in the pf range dampen this frequency just as strongly as the corresponding frequency in the spectrum of the impulses. However, since there are no frequency contents having a substantially high amplitude, there is then the possibility to balance the produced damping by correspondingly raising the alternating current amplitude without endangering the patient. The technical work is small since instead of an impulse generator only alternating current generator is used, while the heretofore used cheap amplifiers for the electrode signals can be retained to a substantial extent.

According to an advantageous embodiment of the present invention, the frequency of the alternating current generator amounts to approximately 60 kHz. At this frequency the relative amplitude change is a maximum 0.5% as a rheographic resistance change of ± 0.5 ohm and a predetermined rheographic resistance of 1 kohm. An optional absolute change at a simultaneous optimal suppression (about 50 dB instead of prior about 30 dB) is attained when at a alternating current amplitude of about 75 v. condensers with a capacity of 22 pf are used. Then the capacity of the low pass filters is approximately 1.5 nf.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawing the sole FIGURE of which is a circuit diagram illustrating the device of the present invention.

The drawing shows a rheographic electrode 1 for receiving a breathing signal and a heart signal while 2 indicates a EKG electrode solely for receiving a further heart signal. The electrode 3 is the common inactive electrode for the two electrodes 1 and 2.

To the electrode 1 is connected through a 22 pf condenser 4 an alternating current generator 5 (75 V., 60 kHz) as feeding current generator for the rheographic electrode 1. To the electrode 1 is also connected through a 22 pf condenser 6 a measuring device for breathing signals consisting of a high frequency ampli-

fier 7, a rectifier device 8, a demodulation low pass filter 9 as well as an indicating device 10.

The electrodes 1 to 3 are also connected with deep low pass filters 13 and 14 consisting of inductances 11 and capacities 12 and with an amplifier 15 for common-mode rejection (differential amplifier) and a measuring device 16 for heart signals (electrocardiograph). The capacity of the low pass filters amounts to 1.5 nf, their upper limit frequency is about 1 kHz.

The operation of the device of the present invention is as follows:

The alternating current produced by the generator 5 is modulated in amplitude by breathing signals at the patient's body. The signal modulated in amplitude (electrode signal) is amplified in the high frequency amplifier 7 of the measuring device for breathing signals, it is rectified in the rectifier device 8, and demodulated in the demodulation low pass filters 9, the breathing signals thus produced being indicated in the indication device 10.

The developed EKG signals get through low pass filters 13, 14 (for locking the high frequency electrode signal) and through the suppressor 15 of the EKG indicator 16.

The described embodiment of the present invention produces a rheographic voltage at the body of the patient of a total of 1 V with a realtive change of electrode signals of about 0.5% at the assumed rheographic patient resistance of 1 kohm. The equal tact suppression for the EKG amounts to about 50 dB.

The use of small coupling capacities 4, 6 has not only the advantage of a substantially improved common-mode rejection device. The comparatively high capacitive resistances required due to the low capacitive values of these condensers and the comparatively low frequency of the alternating current generator, are used at the same time as current impressing resistances for the sinus-shaped carrier current. Thus additional curent impressing ohmic resistances, which were necessary in

prior art devices, can be eliminated.

I claim:

1. A device for supervising the heart and breathing functions of a patient, comprising in combination, a rheographic electrode for picking up a rheographic breathing signal and a first electrical heart signal, another electrode for picking up a second electrical heart signal, a third electrode, being the inactive electrode for said rheographic electrode and said another heart signal electrode, an alternating curreng generator, being electrically connected with said rheographic electrode and said inactive electrode and having a frequency in the kHz range, a first condenser inserted in the electrical connection between said generator and said rheographic electrode and having a capacity in the pf range, means for measuring picked up rheographic breathing signals, an electrocardiograph, electrically connected to said three electrodes and including means for common-mode rejection of the picked up two electrical heart signals, said device further comprising a second condenser connecting said means for measuring picked up rheographic signals with said rheographic electrode and having also a capacity in the pf range and low pass filters inserted in the elecrical connection between said electrocardiograph and said three electrodes and having a capacity in the low nf-range.

2. A device in accordance with claim 1, wherein the frequency of said alternating current generator ranges between 30 to 100 kHz and the capacity of said first and second condenser ranges between 20 to 100 pf.

3. A device in accordance with claim 2, wherein the frequency of said alternating current generator is substantially 60 kHz and wherein at a generator output voltage of substantially 75 V said condensers have a capacity of 22 pf.

4. A device in accordance with claim 1, wherein the total capacity of said low pass filters is substantially 1.5 nf.

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