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[54] **EVALUATION SYSTEM FOR CARDIAC STIMULATORS**

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[51] **Int. Cl.**[2] **A61B 5/04**

[58] **Field of Search** ..... 128/2.05 R, 2.06 R, 2.1 A, 128/419 P, 419 PG

[56] **References Cited**

UNITED STATES PATENTS

3,651,799	3/1972	Daynard	128/419 P
3,688,092	8/1972	Schlisky	128/419 P
3,726,270	4/1973	Griffis et al.	128/2.1 A
3,742,938	7/1973	Stern	128/419 P
3,768,017	10/1973	Dillman et al.	128/2.1 A
3,782,367	1/1974	Hoehbevg et al.	128/419 P

FOREIGN PATENTS OR APPLICATIONS

718,131	11/1954	United Kingdom	128/2.1 A

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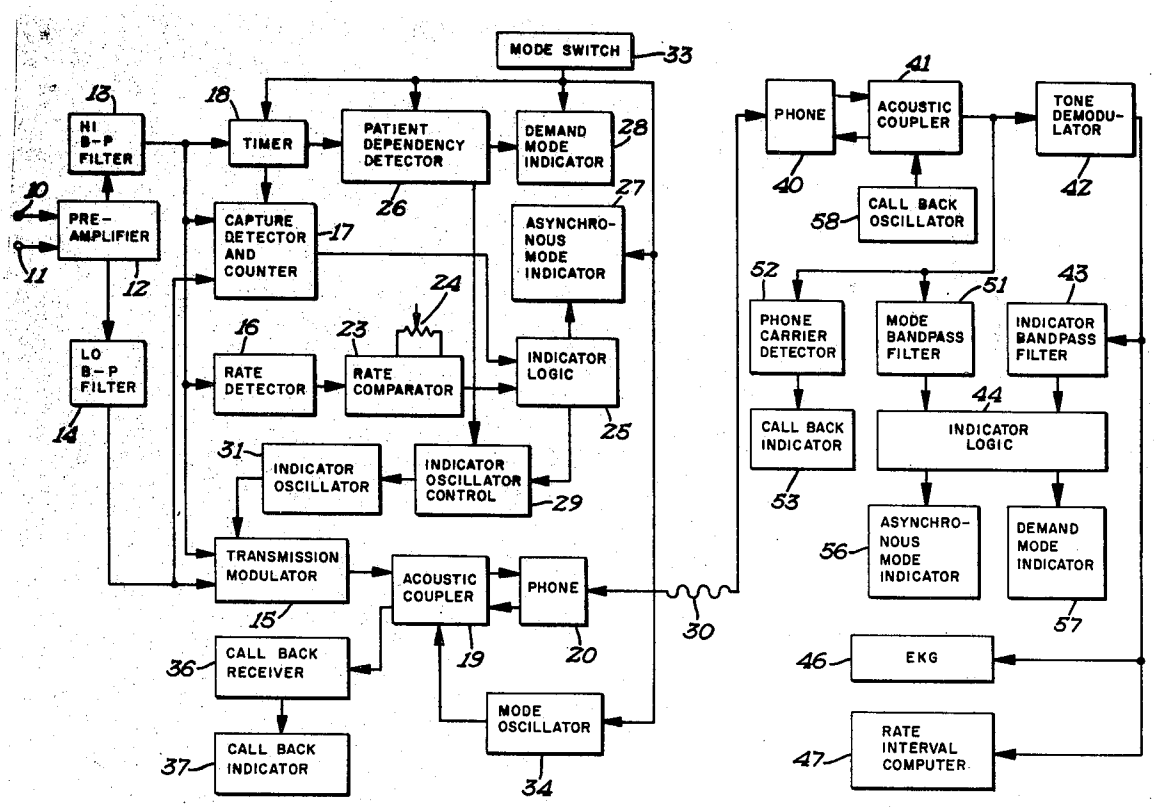
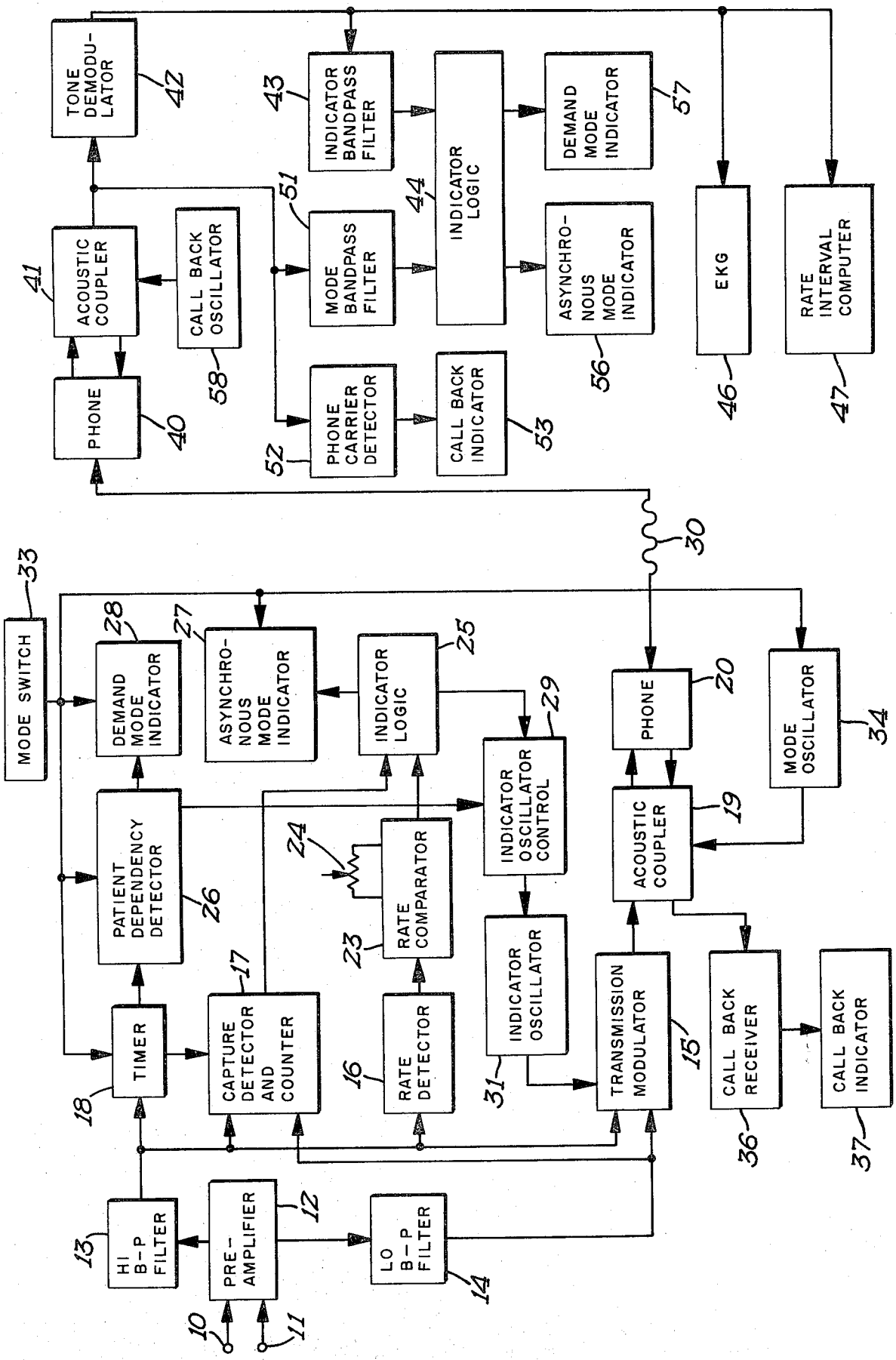
[57] **ABSTRACT**

A system for evaluation of a cardiac stimulator connected to a patient, the system having means for detecting and differentiating between stimulation pulses and cardiac response pulses, means for determining rate of stimulation pulses and whether such rate falls within a predetermined calibration, and means for determining whether heart capture results from the stimulation pulses, all such means operative when the cardiac stimulator is in an asynchronous mode; the means being operative to determine whether the patient is dependent on cardiac stimulation pulses when the stimulator is in the demand mode. Also provided are means for transmitting the information to a remote receiver.

23 Claims, 1 Drawing Figure




TONE DEMODULATOR
42
ACOUSTIC COUPLER
41
CALL BACK OSCILLATOR
58
PHONE
40
INDICATOR BANDPASS FILTER
43
MODE BANDPASS FILTER
51
PHONE CARRIER DETECTOR
52
INDICATOR LOGIC
44
CALL BACK INDICATOR
53
DEMAND MODE INDICATOR
57
ASYNCHRONOUS MODE INDICATOR
56
EKG
46
RATE INTERVAL COMPUTER
47
30
MODE SWITCH
33
DEMAND MODE INDICATOR
28
ASYNCHRONOUS MODE INDICATOR
27
INDICATOR LOGIC
25
PATIENT DEPENDENCY DETECTOR
26
24
RATE COMPARATOR
23
INDICATOR OSCILLATOR CONTROL
29
PHONE
20
MODE OSCILLATOR
34
ACOUSTIC COUPLER
19
TIMER
18
CAPTURE DETECTOR AND COUNTER
17
RATE DETECTOR
16
INDICATOR OSCILLATOR
31
TRANSMISSION MODULATOR
15
CALL BACK RECEIVER
36
CALL BACK INDICATOR
37
HI B-P FILTER
13
PRE-AMPLIFIER
12
LO B-P FILTER
14
10
11

EVALUATION SYSTEM FOR CARDIAC STIMULATORS

This application is a continuation of application Ser. No. 235,252, filed Mar. 16, 1972 and now abandoned.

BACKGROUND OF THE INVENTION

Cardiac stimulators, or pacemakers, are well-known in the art. Such devices are most often implanted in the bodies of patients with heart problems, and may work in an asynchronous mode to constantly provide heart stimulation pulses, or in a demand mode to supply heart stimulation pulses only when required. Implanted cardiac stimulators have a useful life time measured in terms of years.

It is apparent that it is necessary to make tests during the lifetime of the stimulators to determine whether they are functioning properly. These tests are normally conducted by a doctor or his staff and usually necessitate travel by the patient to the doctor's surroundings where the proper equipment is located. Obviously, the time and cost involved in such travels and tests are highly significant. The apparatus of this invention eliminates the need for travel and greatly decreases the time involved in the tests, by enabling the patient to use a localized evaluation system to determine by visual indication the status of operation of the stimulator, and to transmit, in the preferred embodiment by telephone, all necessary information to the physician or his staff at a remote location. The apparatus of this invention has the additional feature of enabling a remote recording on an electrocardiogram (EKG) machine of pulses representative of the patient's QRS complex, and of pacing rate, if desired.

SUMMARY OF THE INVENTION

Briefly described, the apparatus of this invention comprises a system adapted to be connected to electrodes which are in turn adapted to pick-up the electrical signals representing cardiac stimulation pulses and cardiac beats. The signals are amplified and filtered for detection purposes. The system has a switch which enables it to evaluate either asynchronous or demand mode operation of the stimulator. When evaluating the asynchronous mode, the system will count the number of stimulation pulses occurring in a predetermined period of time and compare the count to a predetermined rate calibration. Also, when operating in the asynchronous mode, the evaluation system will determine if heart capture is achieved by the stimulation pulses by counting the number of heart beat responses to the stimulation pulses occurring within a predetermined period of time. An indicator is provided which is actuated to visually display when the rate is within the calibrated setting and heart capture is achieved. The indicator will also provide a visual display when either the rate is not within the calibrated setting or heart capture is not achieved, or both rate and capture are not satisfactory. When operating in the demand mode, the system will determine whether any heart stimulation pulses are present, and if a predetermined number of such pulses occur within a set period of time, a visual indication is provided to indicate whether or not the patient is pacemaker dependent. The information can be transmitted to a remote location.

In the preferred embodiment, a frequency modulation device and acoustic coupler are provided to enable the evaluation information to be sent over a standard telephone hand-set. At a remote location, a receiver is provided, also connected to a standard telephone hand-set, which provides for demodulation of the transmitted signals and display of the same information provided to the patient. The remote station is also provided with outputs which may be connected to an electrocardiogram machine for recording pulses representative of the pacemaker artifacts and the QRS complexes of the patient, and a rate interval computer for determining the pacemaker rate, the EKG rate and the corresponding intervals between stimulation pulses and cardiac response pulses. The outputs may also be connected to other analyzing and recording devices, such as a computer.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing comprises a block diagram of the system of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the single FIGURE of the drawing, there is shown a complete system including the evaluation device, the transmission apparatus, and the receiver apparatus. It will be apparent that the evaluation device may be advantageously used without connection to the transmitter and receiver. Thus, the patient may use the evaluation device without transmission of the information to the physician, or may use it in the presence of the physician without need for the transmission and reception apparatus.

In the single FIGURE of the drawing there are shown a pair of terminals **10** and **11** adapted to be connected to electrodes which are in turn adapted to be placed to pick up the desired signals. These electrodes may comprise a hand-held bipolar pick-up module which can be held over the patient's chest; a non-disposal bipolar electrode system for use on limbs, for example; and a disposable bipolar electrode system pasted onto the patient's body. These or other electrode systems may be connected to the apparatus of the single FIGURE of the drawing by means such as a cable.

Terminals **10** and **11** are connected to a preamplifier **12**, which may be of a type well-known to those skilled in the art, for the purpose of amplification of the pick-up signals. Preamplifier **12** has an output connected to a high bandpass filter **13** and another output connected to a low bandpass filter **14**. The output of high bandpass filter **13** is connected to the inputs of a transmission modulator **15**, a rate detector **16**, a capture detector and counter **17** and a timer **18**. The output of low bandpass filter **14** is connected to the inputs of transmission modulator **15** and capture detector and counter **17**.

Transmission modulator **15** has an output connected to the input of an acoustic coupler **19**, which is in turn connected to a phone **20**. Rate detector **16** has an output connected to the input of a rate comparator **23** which has a calibration setting circuit indicated in schematic form as a potentiometer **24**. The output of rate comparator **23** is connected to the input of an indicator logic circuit **25**. Capture detector and counter **17** has an output also connected to the input of indicator logic circuit **25**. Timer **18** has an output connected to capture and detector counter **17**, and another output connected to the input of a patient dependency detector **26**.

Indicator logic circuitry **25** has an output connected to an asynchronous mode indicator **27**, and an output connected to an indicator oscillator control **29**. Indicator oscillator control **29** has an output connected to the input of an indicator oscillator **31**, which in turn has an output connected to transmission modulator **15**. Patient dependency detector **26** has an output connected to a demand mode indicator **28**, and an output connected to indicator oscillator control **29**.

A mode switch **33** has an output connected to each of timer **18**, patient dependency detector **26**, demand mode indicator **28** and asynchronous mode indicator **27**. The output of mode switch **33** is also connected to a mode oscillator **34**, which in turn has an output connected to acoustic coupler **19**.

Phone **20** is connected to a transmission line **30**, and is also connected back through acoustic coupler **19** to a call back receiver **36**, which is in turn connected to a call back indicator **37**.

Transmission line **30** is also connected to a phone **40**. Phone **40** is connected to another acoustic coupler **41** which has an output connected to a tone demodulator **42**. Demodulator **42** has an output connected to an indicator bandpass filter **43**. The output of demodulator **42** is also adapted to be connected to an electrocardiogram machine **46** and a rate interval computer **47**. Indicator bandpass filter **43** is connected to another indicator logic circuitry **44**, which has a pair of outputs connected to, respectively, another asynchronous mode indicator **56** and another demand mode indicator **57**.

The output of acoustic coupler **41** is also connected to the input of a mode bandpass filter **51** and a phone carrier detector **52**. The output of mode bandpass filter **51** is connected to indicator logic circuitry **44**. The output of phone carrier detector **52** is connected to another call back indicator **53**. A call back oscillator **58** is connected through acoustic coupler **41** to phone **40**.

In operation, the apparatus of the single FIGURE of the drawing will initially be calibrated to a predetermined window range of cardiac stimulation pulse rate, in the asynchronous mode, by adjustment of potentiometer **24** on rate comparator **23**. In this preferred embodiment, it has been found desirable to provide a calibration window of ±5 pulses. This calibration will normally be performed by a physician or his staff when the system is first provided to the patient.

For purposes of explanation of the operation of the apparatus of this invention, assume that mode switch **33** has been placed in position to select the asynchronous mode. In the preferred embodiment of this invention, mode switch **33** includes a magnet which is placed on or taken off of the evaluation device to actuate the switch **33** as desired. With switch **33** in the asynchronous mode, patient dependency detector **26** and demand mode indicator **28** will be locked out. Asynchronous mode indicator **27** will be turned on, and timer **18** will be set to provide a predetermined timed pulse upon receiving a trigger, which predetermined time in the preferred embodiment has been selected to be **15** seconds.

As previously described, terminals **10** and **11** are connected to a signal pick-up system. The signals are then amplified in preamplifier **12** and passed to high bandpass filter **13** and low bandpass filter **14**. Filter **13** is centered around 1Khz so that only the energy associated with the stimulation pulses will appear at its output. Filter **14** is centered around 10hz so that only the energy associated with the cardiac beats (QRS complex) appears at its output.

The output of high bandpass filter **13**, which represents cardiac stimulation pulses, will be felt at rate detector **16**, where the interval between pacemaker artifacts is determined. This information is fed to rate comparator **23** and compared to the preset intervals corresponding to the calibration window originally set into comparator **23** through potentiometer **24**.

The output of filter **13** is also fed to timer **18** where it acts as a trigger for a pulse of a predetermined period, in the preferred embodiment **15** seconds. The output of timer **18** is fed to capture detector and counter **17**. The output of high bandpass filter **13** is also fed to capture detector and counter **17**, as is the output of low bandpass filter **14** which represents cardiac beats. Detector **17** is therefore enabled for a period of **15** seconds to determine the time relationship between stimulation pulses and cardiac response. In the preferred embodiment of this invention, if a cardiac stimulation pulse is followed within 50 milliseconds by a cardiac response, this is considered to be one capture. The number of captures occurring within the 15 second time period is counted in capture detector and counter **17**. Detector **17** will provide an output signal indicating satisfactory capture if a predetermined number of captures occur during the 15 second timing of asynchronous operation. In the preferred embodiment of this invention it has been determined that a signal representing satisfactory capture will occur if three or more captures are detected and counted during the **15** second time interval.

The outputs of both capture detector and counter **17** and rate comparator **23** are fed to indicator logic circuitry **25**. If both the rate and capture signals are satisfactory, indicator logic circuitry **25** will provide a signal to asynchronous mode indicator **27** to visually indicate satisfactory asynchronous operation of the cardiac stimulator. If either capture or rate or both are not satisfactory, logic circuitry **25** will provide a different signal to asynchronous mode indicator **27** to visually show unsatisfactory operation.

For operation in the demand mode, switch **33** is changed to the demand position to lock out asynchronous mode indicator **27**, to enable demand mode indicator **28** and patient dependency detector **26**, and to provide a signal to timer **18** such that it is set for a maximum 15 seconds by an input from high bandpass filter **13** and is immediately reset by the next input from filter **13**. The turn off of asynchronous mode indicator **27** will effectively remove capture detector and counter **17**, rate detector **16** and rate comparator **23** from the circuitry.

In the demand mode operation, any cardiac stimulation pulses called for when the heart fails to have a natural beat will be picked up by the above described electrode system, and provided to terminals **10** and **11**. These stimulation signals will pass through filter **13** to set timer **18**, which then commences its **15** second output pulse. The **15** second output pulse is detected by patient dependency detector **26**, and if a second demand cardiac stimulation pulse occurs during the **15** second interval, timer **18** will be immediately reset, which will also be detected in patient dependency detector **26**. A signal will then be provided to demand mode indicator **28** from detector **26** to visually indicate that the patient is pacemaker dependent. Thus, in the preferred embodiment of this apparatus, it has been de-

termined that a minimum of two demand cardiac stimulation pulses within a **15** second interval will be considered to place the patient in a dependency status. Should the apparatus of this invention fail to sense the second pacemaker pulse during the **15** second interval, the signal from detector **26** to demand indicator **28** will be such as to give visual indication of non-dependency.

The apparatus of this invention has the distinct advantage of being able to transmit the evaluation information garnered in the above described manner to a remote location, such as a doctor's office. Referring again to the single FIGURE of the drawing, this transmission is effected in the following manner. The outputs of both of filters **13** and **14** are fed to transmission modulator **15.** There they modulate a carrier, in this preferred embodiment a telephone carrier of 1988HZ. The output of filter **13,** which represents the cardiac stimulation pulses, modulates the carrier upward, in the preferred embodiment to a frequency of 2240HZ. The output of filter **14,** which represents the QRS complexes, modulates the carrier downward, in this preferred embodiment to a frequency of 1726HZ. These modulated tones are fed to acoustic coupler **19** which couples them to a transmitter, in this embodiment a standard telephone handset **20.** The information is transmitted, in this preferred embodiment, over a phone line **30** to a receiver at the remote location, shown in this preferred embodiment to be another standard telephone handset **40.** The information from phone **40** is connected through acoustic coupler **41** to tone demodulator **42.** As shown in the single FIGURE of the drawing, the information from tone demodulator **42,** which represents the pacemaker pulses and the QRS complexes, can be fed directly to an EKG machine **46** or to a rate interval computer **47.**

The remote station is also provided with information concerning the state of mode switch **33.** This is done by turning on or off mode oscillator **34** dependent on the position of switch **33.** The output of mode oscillator **34** is connected through acoustic coupler **19** to phone **20,** and is transmitted through line **30** to phone **40** at the remote station. Acoustic coupler **41** receives the information from mode oscillator **34** and presents it to mode bandpass filter **51.** Dependent on the information received, filter **51** provides a signal to indicator logic **44** at the remote station, which is responsive to the information received to turn on either asynchronous mode indicator **56** or demand mode indicator **57.** Thus, the remote station provides a visual indication of whether mode switch **33** is in the asynchronous or demand mode.

Depending on whether the mode switch **33** is in the demand or asynchronous position, the evaluation information is transmitted to the remote station through the connections of patient dependency detector **26** and indicator logic circuitry **25** to indicator oscillator control **29.** A signal from either detector **26** or circuitry **25** will be felt at oscillator control **29** to turn on indicator oscillator **31.** The output of oscillator **31** may be caused, for example, to turn on only when the signals from detector **26** or circuitry **25** is such as to indicate, respectively, patient pacemaker dependency or satisfactory capture. The output of indicator oscillator **31** is fed to transmission modulator **15** where it again modulates the carrier frequency by yet another tone, and is thereafter coupled through acoustic coupler **19** and phone **20** to line **30.** In this preferred embodiment a low frequency oscillator is used as indicator oscillator **31.**

The presence or absence of the signal from indicator oscillator **31** is detected at the remote station through phone **40,** coupler **41** and tone demodulator **42.** The output of tone demodulator **42** is then passed through filter **43** to indicator logic **44** to affect the visual indications in the selected of indicators **56** or **57.**

Thus, it is apparent that the remote station receives information as to the mode of operation and the same evaluation information available at the local transmitter. In addition, the remote station has the advantage of providing information to a selected EKG machine or rate interval computer which would be useful for displaying stimulation pulse rate, EKG rate, and the corresponding intervals between stimulation pulses and QRS complex responses.

In addition, apparatus is provided in the form of call back circuitry by which the party at the local or remote transmitter may contact the other party, and by which system integrity can be indicated. Should the transmission circuitry not be completed, such as the handset of phone **20** being improperly positioned, the normal phone carrier frequency will not pass through line **30,** phone **40** and acoustic coupler **41** to be presented to phone carrier detector **52.** When detector **52** senses a lack of system integrity a signal is provided to a call back indicator **53** to provide visual notice. Call back oscillator **58** is normally on, if the physician wishes to call the patient, he may deactuate call back oscillator **58** which is coupled to phone **40** through acoustic coupler **41,** and the signal which normally passes through line **30** and phone **20** to acoustic coupler **19** will be interrupted. Call back receiver **36,** when it senses the interruption, will turn on a visual indicator in call back indicator **37.**

From the above description of the preferred embodiment of this invention, it is apparent that there has been provided a unique cardiac stimulator evaluation system which not only can provide immediate evaluation information to a patient, but which has the facility of transmitting the information to a remote station for review by a physician or his staff.

What is claimed is:

1. A system for cardiac stimulator evaluation, the system adapted to be connected to means for sensing stimulation pulses and cardiac pulses, comprising: input means for receiving said sensed pulses; first means for differentiating between stimulation pulses and cardiac pulses and including high bandpass filter means and low bandpass filter means each connected to the input means, the high bandpass filter means including means for passing frequencies in the range of stimulation pulses and the low bandpass filter means including means for passing frequencies in the range of cardiac pulses; second means for detecting the rate of the stimulation pulses; third means for detecting heart captures due to stimulation pulses; means connecting the input means to the first means; means connecting the first means to the second and third means; and fourth means connected to the second and third means and responsive to signals therefrom for indicating the status of operation of the stimulator being evaluated.

2. The apparatus of claim **1** in which: the means for passing frequencies in the high bandpass filter means is centered around 1Khz; and the means for passing frequencies in the low bandpass filter means is centered around 10hz.

3. The apparatus of claim **1** in which the input means includes: amplifier means connected to the filter

means.

4. The apparatus of claim 1 including: modulation means connected to the first means and including means for providing a carrier frequency modulated to a first frequency in response to a stimulation pulse and modulated to a second frequency in response to a cardiac pulse; first transmission means connected to the modulation means for transmitting the carrier frequency and the first and second modulated frequencies; second transmission means connected to receive the carrier frequency and the first and second modulated frequencies; demodulator means connected to the second transmission means and having means for detecting the first and second modulated frequencies for providing first and second output signals representative of, respectively, stimulation pulses and cardiac pulses; and means connected to the demodulator means for receiving the output signals therefrom, and selectively connectable to electrocardiogram means and rate interval counter means.

5. The apparatus of claim 4 including: oscillator means connected to the fourth means and responsive to signals therefrom indicative of the status of operation of the stimulator being evaluated; means connecting the oscillator means to the modulation means; the modulation means including means for modulating the carrier frequency to a third frequency in response to an input from the oscillator means representative of the status of operation of the stimulator being evaluated; the first and second transmission means including means for, respectively, transmitting and receiving the third modulated frequency; the demodulator means including means for detecting the third modulated frequency for providing third output signals representative of the status of the stimulator being evaluated; and indicator means connected to the demodulator means and responsive to signals therefrom for indicating the status of the stimulator being evaluated.

6. The apparatus of claim 4 including: carrier frequency detecting means connected to the second transmission means for detecting and indicating the presence and absence of the carrier frequency.

7. The apparatus of claim 4 including: selectively operable call back oscillator means; means connecting the call back oscillator means to the second transmission means for transmission of a call back signal to the first transmission means; and call back receiver means connected to the first transmission means for detecting and indicating the presence or absence of a call back signal.

8. A system for cardiac stimulator evaluation, the system adapted to be connected to means for sensing stimulation pulses and cardiac pulses, comprising: input means for receiving said sensed pulses; first means for differentiating between stimulation pulses and cardiac pulses and including high bandpass filter means and low bandpass filter means each connected to the input means, the high bandpass filter means including means for passing frequencies in the range of stimulation pulses and the low bandpass filter means including means for passing frequencies in the range of cardiac pulses; second means for detecting the rate of the stimulation pulses; third means for detecting heart captures due to stimulation pulses; means connecting the input means to the first means; means connecting the first means to the second and third means; and fourth means connected to the second and third means and responsive to signals therefrom for indicating the status of operation of the stimulator being evaluated; said second means including rate detection means for detecting the time intervals between succeeding stimulation pulses; adjustable calibration means for providing a calibration window for a desired stimulation pulse rate, means connected to the rate detection means and the calibration means for comparing the time intervals to the calibration window and including means for providing a signal to the fourth means.

9. A system for cardiac stimulator evaluation, the system adapted to be connected to means for sensing stimulation pulses and cardiac pulses, comprising: input means for receiving said sensed pulses; first means for differentiating between stimulation pulses and cardiac pulses; second means for detecting the rate of the stimulation pulses; third means for detecting heart captures due to stimulation pulses; means connecting the input means to the first means; means connecting the first means to the second and third means; and fourth means connected to the second and third means and responsive to signals therefrom for indicating the status of operation of the stimulator being evaluated; said third means including capture detector means responsive to a stimulation pulse for thereafter detecting any succeeding cardiac pulse that occurs within a first predetermined time interval following the stimulation pulse and means for counting all such detected cardiac pulses which occur during a second longer predetermined time interval, and for providing a signal to the fourth means when the number of such detected cardiac pulses reaches a predetermined total.

10. The apparatus of claim 9 in which: the first predetermined time interval is 50 milliseconds.

11. The apparatus of claim 9 in which: the second predetermined time interval is 15 seconds.

12. The apparatus of claim 9 in which: the predetermined total is at least three.

13. The apparatus of claim 9 including: timing means connected to the capture detector means, and including means responsive to a stimulation pulse for commencing the second predetermined time interval.

14. A system for cardiac stimulator evaluation, the system adapted to be connected to means for sensing stimulation pulses and cardiac pulses, comprising: input means for receiving said sensed pulses; first means for differentiating between stimulation pulses and cardiac pulses and including high bandpass filter means and low bandpass filter means each connected to the input means, the high bandpass filter means including means for passing frequencies in the range of stimulation pulses and the low bandpass filter means including means for passing frequencies in the range of cardiac pulses; second means for detecting the rate of the stimulation pulses; third means for detecting heart captures due to stimulation pulses; means connecting the input means to the first means; means connecting the first means to the second and third means and fourth means connected to the second and third means and responsive to signals therefrom for indicating the status of operation of the stimulator being evaluated; fifth means for counting a predetermined minimum number of stimulation pulses in a predetermined period of time; sixth means connected to the fifth means and responsive to signals therefrom for indicating the status of operation of the stimulator being evaluated; switch means having first and second switch positions; means operative when the switch means is in the first switch position for disabling the fifth and sixth means and en-

abling the fourth means; and means operative when the switch means is in the second switch position for disabling the fourth means and enabling the fifth and sixth means.

15. The apparatus of claim **14** including: modulation means connected to the first means and including means for providing a carrier frequency modulated to a first frequency in response to a stimulation pulse and modulated to a second frequency in response to a cardiac pulse; oscillator means connected to the fourth means and responsive to signals therefrom indicative of the status of operation of the stimulator being evaluated; means connecting the sixth means to the oscillator means; means connecting the oscillator means to the modulation means, the modulation means including means for modulating the carrier frequency to a third frequency in response to an input from the oscillator means representative of the status of operation of the stimulator being evaluated; first transmission means connected to the modulation means for transmitting the carrier frequency and the first, second and third modulated frequencies; second transmission means connected to receive the carrier frequency and the first, second and third modulated frequencies; demodulator means connected to the second transmission means and having means for detecting the first, second and third modulated frequencies for providing first and second output signals representative of respectively, stimulation pulses and cardiac pulses and for providing third output signals representative of the stimulator being evaluated; indicator means connected to the demodulator means and responsive to signals therefrom for indicating the status of the stimulator being evaluated; and further means connected to the demodulator means for receiving the output signals therefrom and selectively connectable to electrocardiogram means and rate interval counter means.

16. The apparatus of claim **15** including: mode oscillator means connected between the switch means and the transmission means and operable to provide an output to the transmission means when the switch means is in one of the first or second switch positions; mode detection means connected between the second transmission means and the indicator means for providing mode information to the indicator means.

17. The apparatus of claim **14** in which: the predetermined period of time is 15 seconds.

18. The apparatus of claim **14** in which: the predetermined minimum number is two.

19. A system for evaluating a cardiac stimulator operating in an asynchronous mode or a demand mode, the system adapted to be connected to means for sensing stimulation pulses and cardiac pulses, comprising: input means for receiving said sensed pulses; first frequency filter means for passing frequency signals from stimulation pulses; second frequency filter means for passing frequency signals from cardiac pulses; rate detector means connected to the first filter means for detecting the rate of stimulation pulses; capture detector means connected to the first and second filter means for detecting captures that comprise a cardiac pulse which follows a stimulation pulse within a first predetermined period of time; counter means connected to the capture detector means for counting the captures which occur within a second predetermined period of time; first indicator means connected to the rate detector means and the counter means and including means responsive to signals therefrom for providing visual stimulator status indications; timer means connected to the capture detector means and the first filter means, and responsive to a stimulator pulse for enabling the capture detector means for the second predetermined period of time; further detector means connected to the timer means; second indicator means connected to the further detector means and including means responsive to signals therefrom during said second predetermined period of time for providing visual stimulator status indications; switch means selectably adjustable to an asynchronous mode position and a demand mode position, the switch means including means operable in the asynchronous mode position for enabling the first indicator means and disabling the second indicator means and the further detector means, and the switch means including means operable in the demand mode position for disabling the first indicator means and enabling the second indicator means, the further detector means and means in the timer means for allowing stimulation pulses to reset the timer means during the second predetermined time period.

20. The system of claim **19** including: modulation means connected to the first and second filter means; indicator oscillator means connected to the first indicator means, the further detector means and the modulation means; first transmission means; first acoustic coupler means connected between the modulation means and the transmission means; mode oscillator means connected between the switch means and the first coupler means; second transmission means connected to the first transmission means; demodulation means; second acoustic coupler means connected between the second transmission means and the demodulation means; remote indicator means responsive to demodulated signals from the demodulator means for providing visual stimulator status indications; indicator filter means connected between the demodulation means and the remote indicator means; and mode filter means connected between the second coupler means and the remote indicator means.

21. The apparatus of claim **20** including: first call back indicator means; and carrier frequency detection means connected between the second acoustic coupler and the first call back indicator means.

22. The apparatus of claim **20** including: selectively operable call back oscillator means connected to the second acoustic coupler means; second call back indicator means; and call back receiver means connected between the first acoustic coupler means and the second call back indicator means.

23. The apparatus of claim **20** including; means connected to the demodulator means and selectively connectable to electrocardiogram means and rate interval computer means.

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