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Orr et al.

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[54] **HEARTBEAT RATE MONITORS**

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[73] Assignee: **said Orr, by said Ogden**

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[30] **Foreign Application Priority Data**

Sept. 29, 1970 Great Britain 46151/70

[52] **U.S. Cl.**..... **128/205 R,** 128/2.05 P, 128/2.05 T

[51] **Int. Cl.**..... **A61b 5/02**

[58] **Field of Search** ..... 128/2.05 P, 2.05 T, 2.06 F, 128/2.05 R, 2.06 A, 2 R; 58/28 A, 28 B, 28 D, 26 R, 23 TF; 307/208

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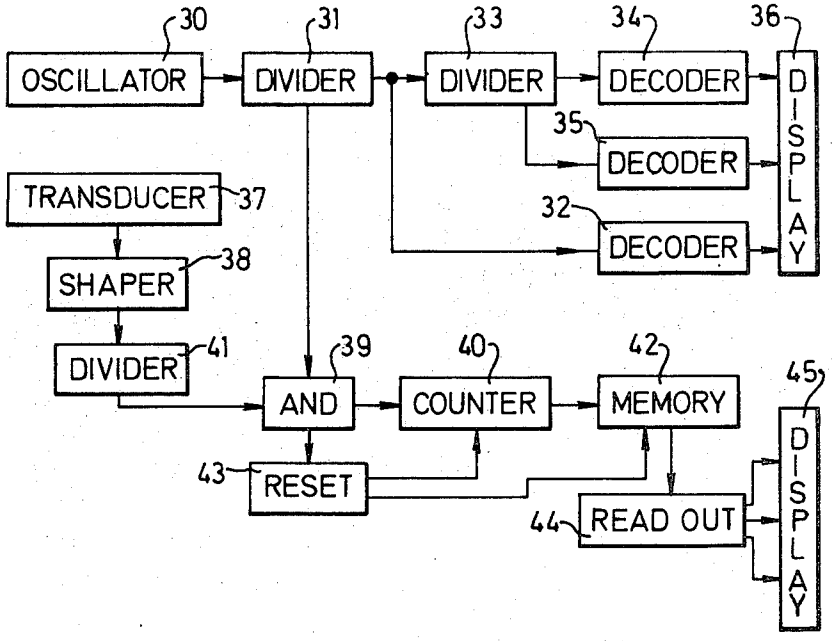
[57] **ABSTRACT**

A heartbeat rate monitor or personal pulse indicator comprises a transducer for detecting heartbeats and supplying an electric signal corresponding to the heartbeat rate, and a display for indicating the heratbeat rate. The display is incorporated in a watch casing which also incorporates means to display the time of day, the watch casing preferably being mounted on a wrist-strap which carries the transducer.

12 Claims, 8 Drawing Figures



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SHEET 1 OF 3

FIG. 1.

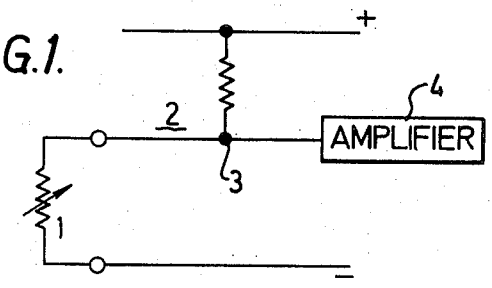
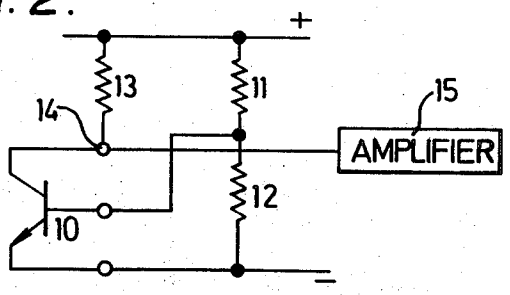


FIG. 2.



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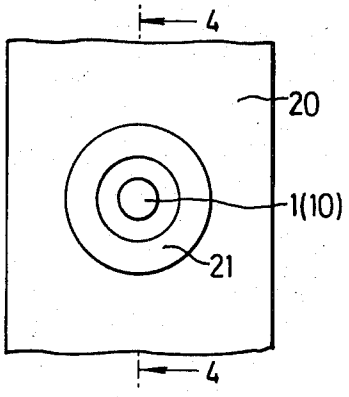

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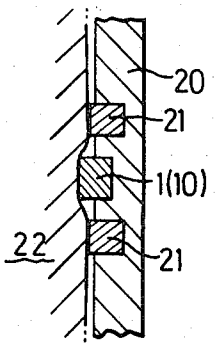

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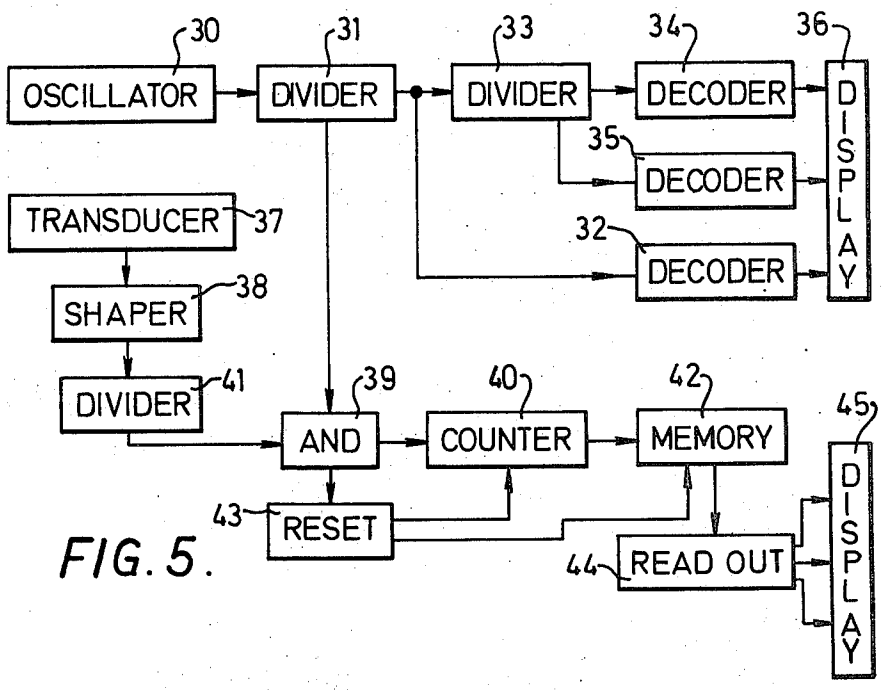

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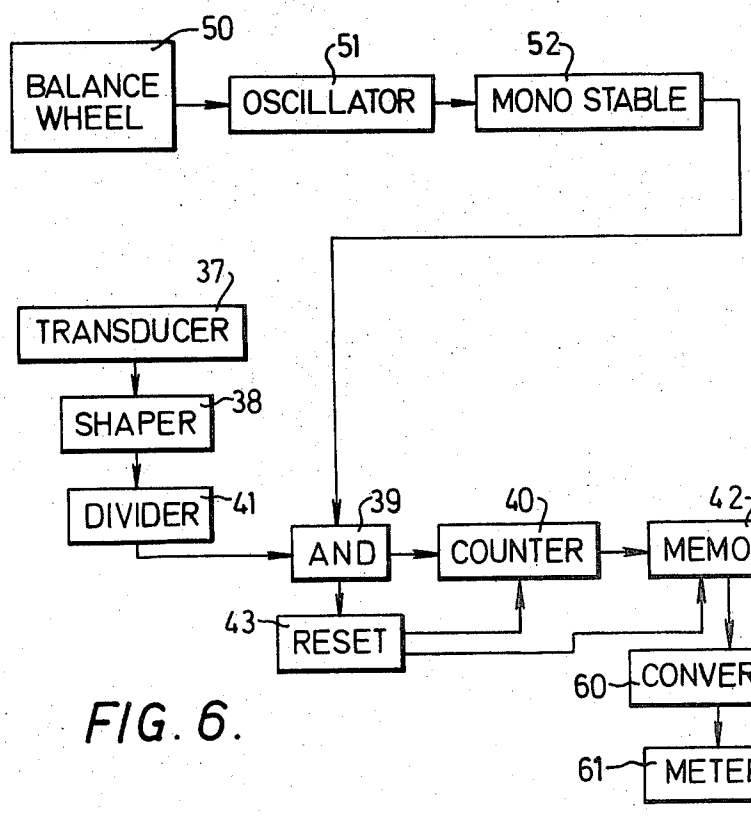

FIG. 6.

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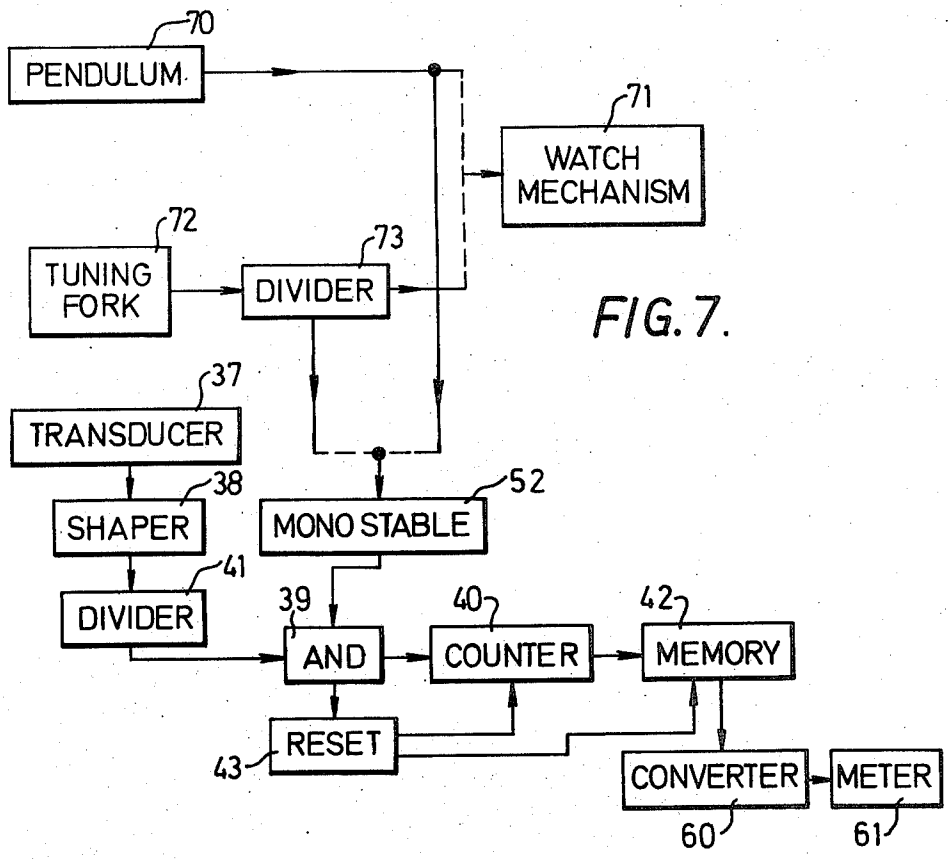

FIG. 7.

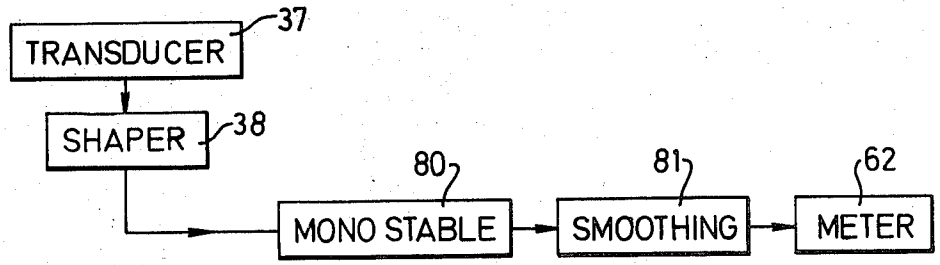

FIG. 8.

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HEARTBEAT RATE MONITORS

BACKGROUND OF THE INVENTION

The usual method of ascertaining a person's heartbeat rate is by counting heartbeats which are detected manually, usually at the wrist, over a short period timed by a watch or clock. This method is generally somewhat unsatisfactory, because the short period chosen is usually less than one minute and so errors may occur in the necessary mental arithmetic. Moreover, this method only provides a measurement of the heartbeat rate during the actual period of counting, and this somewhat time-consuming operation has to be repeated every time a fresh measurement is required. This is particularly inconvenient in the case of certain heart conditions where quick and possibly frequent measurements are required.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a heartbeat rate monitor.

Another object of the present invention is to provide a heartbeat rate monitor which is incorporated into, or is made in the general form of a wrist-watch.

According to the present invention a heartbeat rate monitor comprises a transducer to detect heartbeats and provide an electric signal corresponding to the heartbeat rate, and display means operated in dependence on said signal to display the heartbeat rate digitally or on a dial.

The invention can be embodied in various different forms. A particularly convenient form is to incorporate the heartbeat rate monitor in a wrist-watch and mount the necessary transducer in the wrist strap so as continually to be actuated by heartbeats detected in the wrist. The signal supplied by the transducer is supplied to an electronic circuit within the watch casing. The circuit also derives a timing signal from the watch mechanism for comparison with the signal supplied by the transducer, and the output is displayed on the watch face either by a pointer moving over a scale or by a digital display which may comprise light emitting diodes. Alternatively, the heartbeat rate monitor can be made in the general form of a wrist-watch for wearing on the wrist, but without being incorporated into an actual wrist-watch.

BRIEF DESCRIPTION OF THE DRAWINGS.

Four heartbeat rate monitors in accordance with the present invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 shows diagrammatically a first transducer,

FIG. 2 shows diagrammatically a second transducer,

FIG. 3 shows diagrammatically the mounting of a transducer on a wrist strap,

FIG. 4 is a section on the line 4—4 of FIG. 3, and

FIGS. 5 to 8 show diagrammatically the electric circuits of the four heartbeat rate monitors respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Each of the embodiments to be described comprises a transducer to detect heartbeats and to provide an electric signal corresponding to the heartbeat rate. Although specific transducers will be described, other suitable transducers can of course be used, the essential feature being that an electric signal corresponding to the heartbeat rate is produced. In the description which follows it will be assumed that the transducer is to be placed or worn in contact with a person's wrist, although the invention is not limited to this arrangement, because the signal can be derived from any other suitable place on the body.

Referring to FIG. 1, the transducer shown therein comprises a pressure sensitive resistor pad 1, mounted so as to project from the inner surface of a wrist strap (not shown) and electrically connected so as to be part of a resistive chain 2 connected across an electric power supply derived from a battery. In use, arterial pulses in the wrist will cause variations in the resistance of the resistor 1 and hence variations in the voltage at a terminal 3. A signal derived from the terminal 3 is supplied to an amplifier 4 which, like the remainder of the electrical circuitry, is preferably in the form of an integrated circuit, the output of the amplifier 4 being used in producing the required display.

FIG. 2 shows an alternative form of transducer making use of a pressure sensitive transistor 10. The base is connected to the junction of resistors 11 and 12 connected across the power supply, the collector is connected by way of a resistor 13 to one pole of the power supply, and the emitter is connected directly to the other pole of the power supply. This results in a constant bias on the base of the transistor 10, and as the applied pressure varies due to the pulse in the wrist, the collector current will vary, so that a signal corresponding to heartbeat rate can be derived from a terminal 14 and supplied to an amplifier 15.

Referring now to FIGS. 3 and 4, in both the cases described above, the pressure sensitive element 1 or 10 of the transducer is mounted in a wrist strap 20 and surrounded by a stabilizing frame 21 to reduce the effect of random strap movements relative to the wrist 22. The frame 21 is preferably made of a resilient material and in order to ensure that the pressure sensitive element is pressed against the wrist 22 it projects somewhat more from the strap 20 than does the frame 21.

In alternative arrangements the transducer is mounted so that it can be worn permanently or semi-permanently on some other part of the body, or alternatively is mounted in a small pad or strap which can be placed against or round an appropriate part of the body when a measurement is to be made.

Referring now to FIG. 5, this shows the electric circuit of a heartbeat rate monitor incorporated into and forming part of an electronic wrist-watch, preferably with time and heartbeat rate display by light emitting diodes.

The circuit comprises a crystal controlled oscillator 30 operating at 16.384 kHz., the output signal of which is supplied to a 15-stage divider circuit 31 which supplies an output signal of 0.5 Hz. which is suitable for deriving the time indication. This signal is supplied directly to a binary coded decimal to decimal decoder 32 to provide an output for display of seconds, and by way of a further divider circuit 33 to decoders 34 and 35 for the display of minutes and hours respectively. The outputs of the decoders 32, 34 and 35 are supplied to an array 36 of light emitting diodes so that the time is displayed digitally.

A signal derived from the oscillator **30** is also compared with the signal supplied by the heartbeat rate transducer **37** (which may be as described with reference to FIG. **1** or **2**) to provide a digital display of the heartbeat rate. The signal supplied by the transducer **37** is supplied by way of a shaper circuit **38** to an AND gate **39** to which a signal derived from the divider **31** is also supplied. For a lost or gained pulse from the divider **31** to be insignificant, the frequency of the signal supplied by the divider **31** to the gate **39** should be say 100 times the fastest heartbeat rate of say 150 beats per minute, so that the frequency required is about 250 pulses per second. To derive such a signal the divider **31** can be intercepted at the appropriate point to give an output of 256 pulses per second, this signal being supplied to the gate **39.** The output of the gate **39** is supplied to an accumulating counter **40**; the number of pulses at the minimum heartbeat rate of say 30 pulses per minute determining the capacity of the counter **40,** this being **512** in the example given above.

To reduce the possibility of occasional random heartbeat periods being displayed, it is preferable for the output of the shaper circuit **38** to be divided in frequency by a divider **41** before being supplied to the gate **39** so as to average the measurement over several heartbeat periods. This necessitates a corresponding increase in the capacity of the counter **40.** Particularly where this form of operation is used, it is desirable that the output of the counter **40** is supplied to a memory **42,** so that the measurement obtained during the preceding counting period can be displayed during each current counting period. A further output of the gate **39** is connected to a reset circuit **43** which resets the counter **40** at the end of each counting period and causes the reading then in the counter **40** to be transferred to the memory **42.** The number of pulses counted in each counting period varies inversely with the heartbeat rate and hence a suitable readout circuit **44** can be provided to give signals corresponding to 100's, 10's and units of heartbeat rate for supply to an array **45** of light emitting diodes whereby the heartbeat rate is displayed.

It is not essential that either the time display or the heartbeat rate display should be continuous, and as the electric power consumption of the arrays **36** and **45** is high relative to that of the remainder of the electronics, which is preferably in the form of integrated circuits, it may be preferable in some instances for these displays to be intermittent and to be illuminated on demand for example by operating a press-button.

As an alternative, the arrays **36** and **45** of light emitting diodes can be replaced by some suitable mechanical arrangements whereby the time is displayed in the conventional way by means of hands and a dial, and the heartbeat rate is displayed by means of a pointer and a dial graduated in heartbeats per minute.

Referring now to FIG. **6,** this shows a heartbeat rate monitor incorporated in and forming part of an ordinary mechanical watch. In this case an electric signal for timing purposes is derived from the balance wheel **50** of the watch which is oscillating at about 5 Hz. An electric signal is derived by way of an electromagnetic pick-off, wherein the passage of a suitable spoke or protrusion of the balance wheel **50** reduces the reluctance of a magnetic path and triggers a relaxation oscillator **51.** The output of the oscillator **51** is applied by way of a monostable circuit **52** to an AND gate **39.** Also supplied to the gate **39** is the output signal from the transducer **37** which is supplied by way of the shaper circuit **38** and dividing circuit **41,** the dividing circuit **41** preferably dividing by **5** so as to average the measurement over **5** heartbeats and give acceptable accuracy. The output of the gate **39** is supplied to the counter **40** which incorporates division to bring the measurement to a convenient time period. As in the previous embodiment a further output of the gate **39** is connected to a resetting circuit **43** whereby the counter **40** is reset at the end of each counting period, the count then accumulated in the counter **40** being transferred to a memory **42.** The output of the memory **42** is connected to a suitable display arrangement which comprises a binary coded decimal to analog converter **60** and a moving coil meter **61** whereby the heartbeat rate is displayed by a pointer movable over a suitably graduated scale. The meter **61** is conventional in form and employs a taut-wire suspension, but is of suitable size for incorporation into the watch.

Referring now to FIG. **7,** this shows the electric circuit of a heartbeat rate monitor incorporated into and forming part of an electric wrist-watch in which the balance wheel of the conventional mechanism is replaced by an electrically impulsed pendulum operating at the same frequency, or a tuning fork oscillator operating at a higher frequency. Both these cases are indicated in FIG. **7,** in the case of the pendulum system, a pendulum **70** supplying a signal to a mechanism **71** for driving the hands of the watch, whilst in the tuning fork system the tuning fork **72** supplies a signal by way of a divider **73** to the mechanism **71.**

In either case a signal is derived and supplied to a monostable circuit **52** the output of which is supplied to the gate **39,** this part of the circuit being similar to that described above with reference to FIG. **6.**

The tuning fork system allows a higher measurement accuracy because a high frequency signal can be derived from the dividing circuit **73** and this permits more pulses to be counted during each period defined by the dividing circuit **41.** Indeed this makes it possible in certain instances to dispense with the dividing circuit **41.** Apart from the points mentioned the operation is similar to that of the embodiments described with reference to FIGS. **5** and **6.**

Referring now to FIG. **8,** this shows the electric circuit of a heartbeat rate monitor which is independent of any watch mechanism. In this case a signal derived from the transducer **37** is supplied by way of the shaping circuit **38** to a monostable circuit **80** which incorporates a timing reference which it compares with the heartbeat period. The output of the monostable circuit **80** is a signal representing the instantaneous heartbeat period, and this is fed by way of a smoothing circuit **81** to a moving coil meter **62** the pointer of which moves over a suitable scale to indicate the average heartbeat rate. The circuit parameters are selected to avoid rapid fluctuations in the reading whilst at the same time giving an acceptable speed of response.

It will be apparent that many modifications additional to those referred to above can be made without departing from the scope of the invention as defined by the appended claims. In particular, and as mentioned above, the transducer can be incorporated into a pad which can be placed on some suitable part of the body other than the wrist. It is not necessary that the transducer is continuously connected to the display means,

and for use in hospitals and by veterinary surgeons, the display means can be incorporated into a casing to be worn by a nurse or surgeon, the transducer being mounted in a pad which is permanently or temporarily connected by means of a lead to the display means. Also for use in hospitals, the heartbeat rate monitor can be made in a form which permits a display to be given continuously for example at a patient's bed or in an operating theatre.

We claim:

1. A body worn, compact heartbeat rate monitor comprising:

a transducer to detect heartbeats and provide an electric signal the frequency of which corresponds to the heartbeat rate;

compact timing means to produce an electric timing signal;

comparison means connected in circuit with said transducer and timing means so as to compare the transducer signal with said timing signal to produce a heartbeat rate signal which represents the heartbeat rate per unit time;

a wrist watch type casing within which said compact timing means and said comparison means are incorporated; and

first and second display means operably connected with said circuit and mounted in said watch casing so as to be visible to a user;

the first display means being operable in dependence on said timing signal to display the time of day, and the second display means being operable in dependence on said heartbeat rate signal to directly display the heartbeat rate.

2. A heartbeat rate monitor according to claim **1** wherein said timing signal is derived from a crystal controlled oscillator incorporated in said watch casing.

3. A heartbeat rate monitor according to claim **1** wherein said timing signal is derived from a conventional watch mechanism by means of an electromagnetic pick-off, said watch mechanism being incorporated in said watch casing.

4. A heartbeat rate monitor according to claim **1** wherein said timing signal is derived from a tuning fork incorporated in said watch casing.

5. A heartbeat rate monitor according to claim **1** wherein said timing signal is derived from an electrically impulsed pendulum incorporated in said watch casing.

6. A heartbeat rate monitor according to claim **1** wherein the transducer comprises a pressure sensitive resistor.

7. A heartbeat rate monitor according to claim **1** wherein the transducer comprises a pressure sensitive transistor.

8. A heartbeat rate monitor according to claim **1** wherein the second display means comprises a moving coil meter.

9. A heartbeat rate monitor according to claim **1** wherein the second display means comprises a pointer movable over a scale graduated in heartbeats per minute.

10. A heartbeat rate monitor according to claim **1** wherein the first and second display means each comprise light emitting diodes.

11. A heartbeat rate monitor according to claim **1** further comprising a wrist-strap on which said watch casing and said transducer are mounted.

12. A portable, body attached directly readable heartbeat rate monitor comprising in combination:

a transducer to detect heartbeats and to provide an electric signal the frequency of which corresponds to the heartbeat rate;

said transducer being a pressure sensitive device of which the impedance varies in dependence upon applied pressure thereon;

compact timing means to produce first and second electric timing signals;

comparison means connected in circuit with said transducer and timing means so as to compare the tranducer signal with said second timing signal to thereby produce a heartbeat rate signal which represents the heartbeat rate per unit time;

a watch casing within which said timing means and said comparison means are incorporated;

a wrist-strap on which said watch casing and said transducer are mounted, the mounting of the tranducer being such that when the wrist-strap is worn on the wrist of a user the transducer detects arterial heartbeats in the wrist of the user; and

first and second display means including light-emitting diodes mounted in said watch casing so as to be visible to the user; the first display means being operable in dependence on said first timing signal to display the time of day, and the second display means being of a direct reading digital type operable in dependence on said heartbeat rate signal to display the heartbeat rate of the user in pulses per unit time.

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