Oct. 7, 1958 G. M. WRIGHT 2,854,968

INDICATING AND SIGNALING DEVICE FOR CIRCULATORY SYSTEMS AND THE LIKE

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Fig. 1.

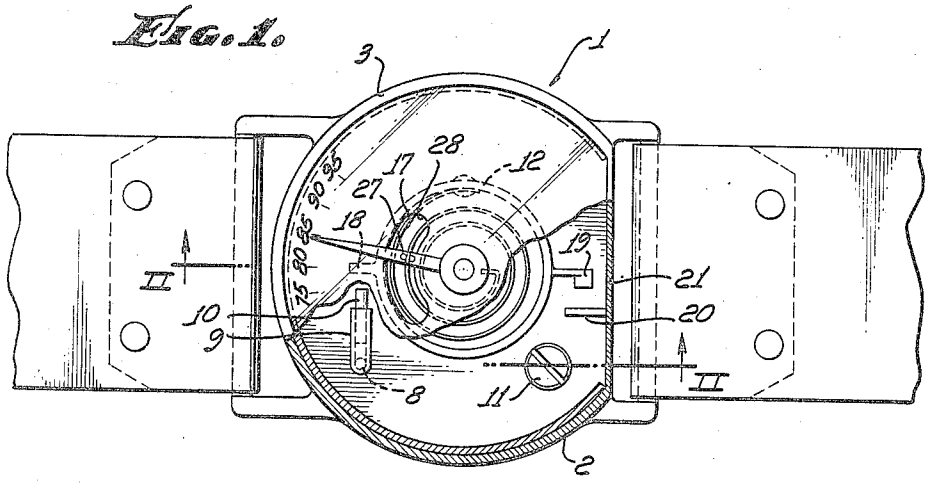

Fig. 2.

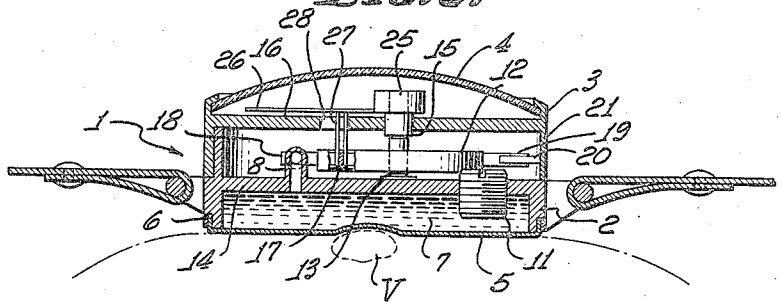

Fig. 3.

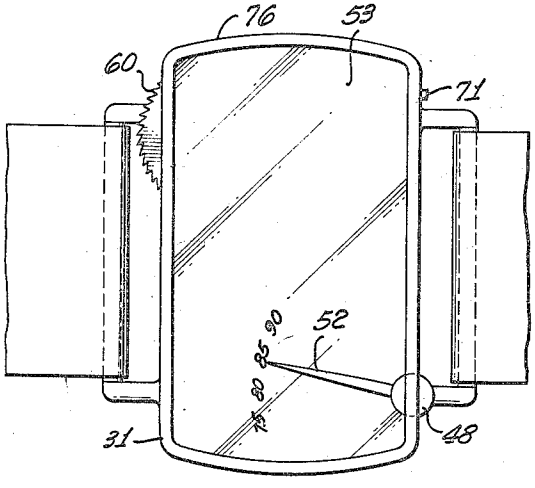

Fig. 8.

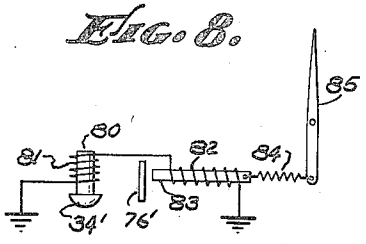

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FIG. 4.

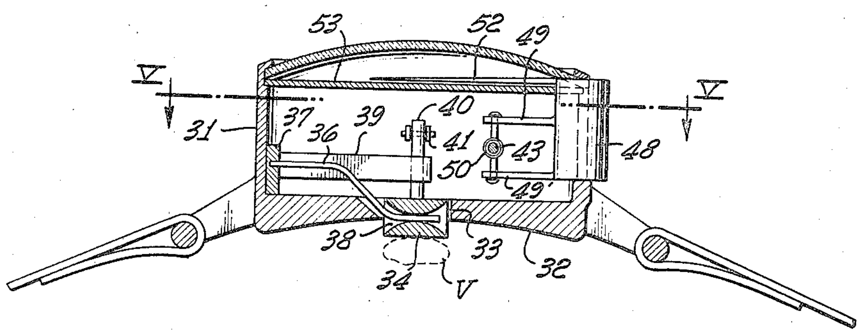


FIG. 5.

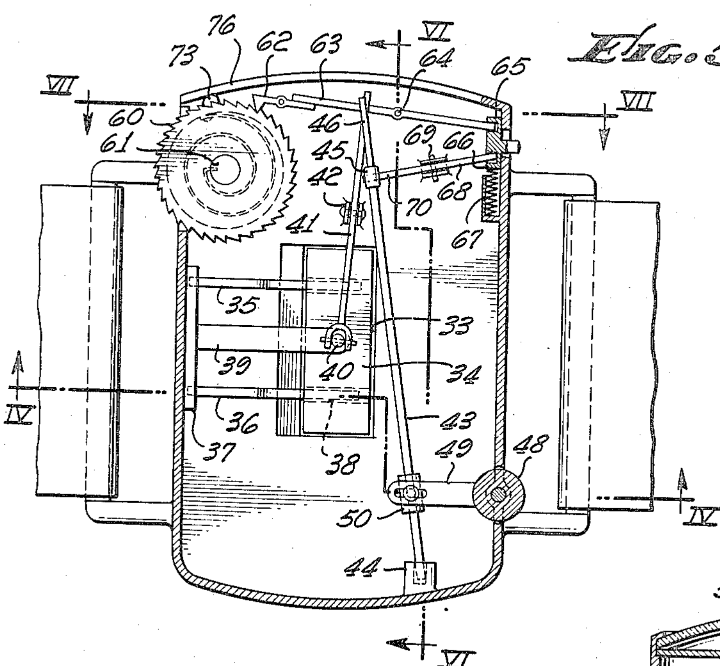


FIG. 7.

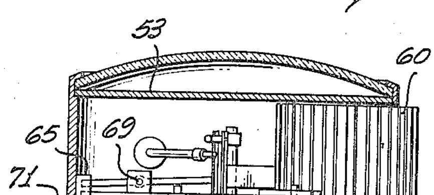
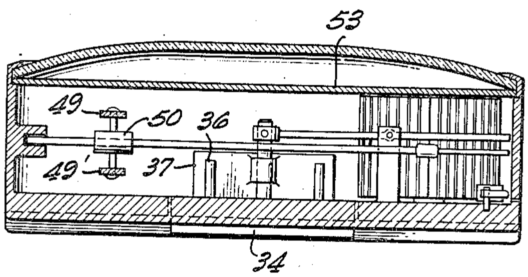


FIG. 6.



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INDICATING AND SIGNALING DEVICE FOR CIRCULATORY SYSTEMS AND THE LIKE

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Application April 15, 1957, Serial No. 652,732

9 Claims. (Cl. 128—2.05)

The present invention is particularly directed to light weight portable devices capable of being worn by a human or other animate animal for the purpose of indicating or signaling when the rhythmic pulsations of the circulatory system of such human or animal reach a predetermined frequency. In addition the devices of the present invention are capable of being used for the purpose of indicating or signaling whenever pulsations of relatively small magnitude reach a preselected frequency.

Hundreds of thousands of persons suffer from various forms of diseases of the heart or of the circulatory system and their lives depend upon adherence to rules which preclude overexertion, excitement, overindulgence in tobacco or alcohol, etc., which may impose additional strain on their heart and cause a breakdown of compensation and possibly fatal results. Although these thousands of patients have been carefully instructed to conduct themselves in such a way as to prevent increase in their pulse rate beyond a maximum, it is almost impossible for these patients to be constantly checking their own pulse rates. As a result many patients suffer attacks caused by inadvertence; they have overexerted themselves or have become so engrossed in a discussion or argument as to forget the effect being caused thereby upon their pulse rate.

The present invention is primarily directed to a very light weight portable device capable of being worn on the wrist in much the same way that a wrist watch is worn, this device containing a control assembly having a preselected resonant characteristic. It is also provided with a sensing element adapted to receive the rhythmic pulsations of the pulse and transmitting the energy of the pulse to the control assembly. The device also includes alarm or signal means which are energized when the frequency of the pulses transmitted thereto reaches a preselected resonant characteristic of the control assembly. In other words the device of the present invention is capable of being worn by a patient and when such patient's pulse rate reaches a preselected rate (say 85 or 90 per minute) the patient is actually notified by the device that his pulse rate has reached the preselected maximum and he better rest or stop doing whatever he is doing which has caused his pulse rate to increase to such dangerous proportions.

Furthermore, the device may be set so that in the event the pulse rate reaches a dangerously slow rate (as in certain cases of bradycardia) the device will energize the signal means. Devices of the character contemplated by this invention may be readily attached to bedridden patients as in a hospital and the signal means may be located at a central desk, as for example in the dispensary or nurses' room for the purpose of signaling to the nurse or attendant that the pulse rate of a particular patient in a particular bed has either reach a preselected maximum or has dropped to a dangerously low rate.

It is an object of the present invention, therefore, to disclose and provide a simple light weight portable signaling device which utilizes the energy of the rhythmic pulsations of the circulatory system and operates a signal or alarm means when the frequency of such pulsations reaches a predetermined value.

Another object of the invention is to disclose and provide a simple and effective device capable of being worn by a human for the purpose of indicating when the pulse rate of such human has reached a preselected frequency.

Again an object of the invention is to disclose and provide a light weight and portable device including a control assembly having a preselected resonance characteristic, such device being adapted to receive rhythmic pulsations of small magnitude and when such pulsations so received reach a frequency correlated to the resonance characteristic of the control assembly, then said control assembly actuates or energizes a signaling means. These and various other objects, advantages and modifications of the present invention will be apparent to those skilled in the art from the following description of certain exemplary forms of devices utilizing the mode of operation herein contemplated for the purposes herein set forth.

In the drawings:

Fig. 1 is a plan view, portions being broken away, of one form of signalling device adapted to be worn on the wrist in the manner of a wrist watch.

Fig. 2 is a transverse section taken along the stepped plane II—II in Fig. 1.

Fig. 3 is a plan view of a modified form of device.

Fig. 4 is a transverse section taken along the plane IV—IV in Fig. 3.

Fig. 5 is a horizontal section taken along the plane V—V in Fig. 4.

Fig. 6 is a side elevation, portions being broken away.

Fig. 7 is a transverse section taken along the plane VII—VII in Fig. 5.

Fig. 8 diagrammatically illustrates a still further modification.

The form of device illustrated in Figs. 1 and 2 comprises a case 1 which may consist of a lower portion 2 and an upper portion, generally indicated at 3, said upper portion being adapted to receive and hold a protective, transparent cover 4. The sensing element in this form of device comprises a hydraulic means, more particularly a resilient, flexible diaphragm 5 connected to the lower portion 2 of the case as by means of a suitable sealing ring 6. This diaphragm (adapted to rest against a patient so as to sense the pulsations in a vein, diagrammatically illustrated at V) forms one wall of a chamber 7 containing a suitable hydraulic fluid, said chamber being provided with an upwardly directed conduit 8 terminating in a horizontally directed portion 9, such horizontally directed portion of the conduit containing a slidable piston 10 adapted to move in accordance with volumetric changes of the chamber 7 caused by deformation of the diaphragm 5 in response to rhythmic pulsations in the vein V. It will be noted that the diameter of the conduit 8—9 is very small in comparison with the volumetric capacity of the chamber 7, so that relatively minor changes in the size of chamber 7 are reflected as amplified movements of the piston 10. In order to completely fill the chamber 7 and the conduit 8 with hydraulic fluid and in order to properly adjust the device, the filler opening is provided with a large, adjustable plug 11. It will be evident that by adjustably positioning the threaded plug 11 the volumetric capacity of the chamber 7 and the piston 10 may be modified.

A balance wheel 12 having a rim of considerable mass is mounted in suitable bearings, such as 13, carried by the horizontal partition 14, and an upper bearing 15 carried by the horizontal partition 16 of the upper portion of the case portion 3. The balance wheel has a hair spring 17, one end of which is connected to the rim and

the other to the centrally disposed axle which is journaled in the bearings 13 and 15. The rim of the balance wheel is shown provided with two protuberances, preferably diametrically opposed, one of such protuberances or lugs 18 being normally positioned within striking distance of the piston 10. The other protuberance 19 is adapted to strike a key 20 connected to a relatively thin wall portion 21 of the upper case portion 3.

Adjustably mounted upon the upper end of the stationary bearing 15 is a knob 25 provided with an index member or pointer 26. This pointer may carry a downwardly extending forked element 27 adapted to straddle one spiral portion of the spiral recoil spring 17 of the balance wheel. This forked element 27 preferably extends through an arcuate opening 28 formed in the upper partition 16. The upper surface of this partition 16 carries indicia in visual relation to the pointer 26 and, as indicated in Fig. 1, such indicia may consist of the numbers 80, 85, 90, 95, or the like, such numbers representing a pulse rate at which the instrument is set to respond.

It will be evident, therefore, that the instrument comprises a sensing element responsive to the pulsations of a vein, transmits such pulsations in the form of small hammer blows delivered by the piston 10 upon the lug 18 to the resonant control assembly or balance wheel and when the frequency of the pulsations so imparted to the control assembly or balance wheel reaches the resonant characteristic of the control assembly, the balance wheel will oscillate to its maximum amplitude and deliver blows by the striker 19 against the key 20. The tapping noise thus generated is amplified by the very thin diaphragm wall 21 and the patient wearing the device is therefore audibly and physically warned that his pulse rate has reached the maximum determined by the position of the index member 26. It is to be understood that movement of the index member 26 to any desired or preselected position with respect to the indicia automatically changes the resonant characteristics of the control assembly or balance wheel by effectively limiting the active length of the coil-recoil spring 17.

The sensing element need not be of hydraulic type as illustrated in Figs. 1 and 2, nor is it necessary to employ a coil-recoil spring as a control assembly. Figs. 3 to 7, inclusive, illustrate a form of device where a mechanical sensing element is employed and a resilient rod or wire is used as the control assembly.

As illustrated in Figs. 3 to 7, the case 31 may be provided with a contoured, concave lower surface 32 adapted to more or less conform to the contours of a wrist. The bottom wall of the case 31 is provided with a rectangular or other suitably shaped aperture 33 in which a sensing element in the form of a rectangular block 34 is yieldably held as by means of two flat spring elements 35 and 36, one end of such element being firmly attached to a mounting block 37 and the other end of each spring extending into a channel such as 38 formed in the sensing block 34. Normally the sensing block presents a lower surface extending slightly beyond the surface 32 and is of a width and length to permit ready positioning above a vein.

The mounting block 37 is also provided with an arm 39 having an aperture therein adapted to slidably receive an upstanding post 40 carried by the sensing block 34. The upper end of such post 40 is pivotally connected to a lever arm 41, the lever being pivoted about a fulcrum post 42.

The control assembly comprises a resilient rod 43 having one end firmly connected to the case as at 44. In many instances it is desired that the relatively free end of the rod 43 be provided with an added mass, indicated at 45, and terminate in a thinner, more flexible portion 46. As best shown in Figs. 6 and 7, the free end of lever 41 is adapted to strike against the end portion 46 of the control rod 43. It will be evident, therefore, that the sensing element 34 will respond to the rhythmic pulsations of the pulse and transmit such pulsations in the form of light blows to the end of the control rod 43. The control rod has a preselected resonant characteristic and when the rod is subjected to a series of such periodical impulses properly timed or at the desired frequency, a vibration of large amplitude will be generated in the control rod 43, the end of the rod becoming the antinode.

In order to vary the resonant characteristic of the control assembly or rod 43, the side wall of the case 31 includes an adjustment roller 48 provided with a pair of spaced, slotted arms 49 and 49'. Slidably movable about the rod 43 is a ring 50 provided with upper and lower arms extending through the slots of the slotted arms 49 and 49'. Partial rotation of the adjustment roller 48 will therefore move the damping ring 50 along the control rod 43, thereby varying its resonant characteristic. The upper end of adjustment roller 48 is provided with a pointer or index element 52 extending above horizontal partition 53. Along an arcuate path adjacent the end of the pointer 52 are indicia, such as the numbers 70, 75, 80, 85, 90, indicating the resonant characteristic of the control assembly as determined by said pointer and the location of the damping ring 50 along the length of the rod 43. In this manner the instrument may be said to respond to any desired pulse rate from 70 to 90 or any other pulse rate within the range of frequency to which the element 43 is adapted to respond.

The upper end of the control element 43 may be caused to tap against the cover or partition 53, or it may be set to actuate any desired signalling means or the like. Those skilled in the art will readily appreciate that while vibrating at a resonant frequency the upper end of rod 43 may energize an electrical circuit by closing a microswitch, or it may actuate a trigger, latch, or other means designed to place an audible or visible signal in operation. The form of device illustrated herein includes a relatively strong spring contained within a cylindrical housing indicated at 60, such housing containing a coiled, ribbon spring, one end being attached to the inner wall of the cylindrical housing 60 and the other to a fixed, centrally disposed pin 61. A portion of the cylindrical surface of the housing extends through a suitable partition formed in the side wall of the case so that the wearer of the device may wind the spring by simply rotating the exposed portion of the housing 60. The wound spring is held in wound position by means of a pivoted dog 62 which is lightly urged against the serrations of the outer wall of the cylindrical housing 60 by a light spring. This dog is automatically released when the control assembly or rod 43 has been set into its resonant frequency by the pulse transmitted to it. Such means may comprise a lever 63 pivoted at 64, such lever having a connection with a spring-biased block 65 slidable in a guideway and provided with an upstanding lip 66 at one end. The block 65 is urged into operative position by means of a spring 67 but is normally retained in inoperative position by the end of a lever 68 pivoted at 69, the free end 70 of such lever being beneath the mass 45 of the control rod 43. It may be noted that the block 65 is provided with an adjustment button 71 extending through a suitable slot in the wall of the case. When the control rod 43 reaches its maximum amplitude, it strikes the free end 70 of the lever 68, causing the lever to disengage from engagement with lip 66 of block 65, permitting the spring 67 to forcibly move the block 65 and lever 63 about its pivot point 64 so as to disengage the dog 62. The wound spring so released rapidly rotates the cylindrical housing 60, causing protuberances such as 73 to strike the end wall 76. This end wall 76 may be made of resonating metal to thereby produce a relatively loud, ringing sound, audibly warning the wearer that his pulse rate is at a dangerous frequency. The instrument can then be reset by movement of the control button 71 so as to cause re-engagement of the lip 66 of block 65 with

the end of lever **68** and the spring within housing **60** may be readily rewound.

Those skilled in the art will appreciate from the examples herein given that the instrument may be of any desired size, can be preset to any desired frequency of incoming pulses and may be caused to operate a great variety of signalling devices. Those skilled in the art will further observe that various arrangements and materials may be used. The control element may be of any desired metal or of suitable plastic, such as a methacrylate, styrene polymer, glass, etc.; it may be coiled, bent or in rod form. In some instances the control element may be designed to energize the signal only at its inherent, natural and resonant frequency, while in other instances the device may be provided with tuning means (such as the fork **27** or damping ring **50**) operated by the adjusting knob and its pointer, so as to obtain a signal at any one of a number of desired frequencies or pulse rates. The device is not limited to a given range of frequencies; the control assembly may be preselected to respond and energize a signal at any desired frequency and can be used to signal when vibration of an object reaches a predetermined frequency. It may be noted that amplitude of incoming pulses is not critical and only their frequency causes the device to respond.

The device may also include and utilize electrical means to perform the desired functions. In the diagrammatic representation, Fig. 8, the sensing element 34' moved by the pulse, moves the permanent magnet 80 within coil 81 which is connected to coil **82**. The current generated in coil **81** therefore passes through coil 82 which slidably receives magnet **83** of the control assembly which includes spring **84** connected to the magnet and adjustably positionable pointer **85**, position of the pointer determining the frequency at which movable magnet will respond and reciprocate to strike signal element **76'**.

All changes and modifications coming within the scope of the appended claims are embraced thereby.

I claim:

1. A lightweight signaling device adapted to respond to and be energized by rhythmic pulsations when such pulsations reach a predetermined frequency, comprising: a housing; a sensing element carried by the housing and adapted to receive the rhythmic pulsations of small magnitude; a control assembly having a preselected resonance frequency characteristic and including a resilient member and selectively adjustable means for tuning said resilient member to a preselected resonance frequency characteristic; means for transmitting pulsations received by the sensing element to the control assembly; and signal means energized by the control assembly when the frequency of pulses transmitted thereto reaches the preselected resonance characteristic of the control assembly.

2. A lightweight alarm device adapted to be worn by a human and respond to and be energized by a predetermined pulse rate in the circulatory system of the human, comprising: a housing; a sensing element carried by the housing and adapted to receive rhythmic pulsations from a portion of the circulatory system of a human; a control assembly including a resilient member; adjustable means for tuning said resilient member to a selected resonance frequency characteristic; means for transmitting pulsations received by the sensing element to the control assembly; and alarm means energized by the control assembly when the frequency of pulses transmitted thereto reaches the preselected resonance characteristic of the control assembly.

3. A device as stated in claim 2 wherein the sensing element includes a body of fluid retained by a resilient wall of the housing, said wall being adapted to be placed in operative contact with a vein of the circulatory system.

4. A lightweight portable signaling device adapted to be energized by a predetermined pulse rate in the circulatory system of a human, comprising: a housing; a coil-recoil spring provided with a rim and mounted for oscillation about an axis in said housing; means for imparting force impulses to the rim of said recoil spring in timed relation to rhythmic contraction and expansion of a portion of a circulatory system of a human, including a sensing element carried by the housing and responsive to the pulse rate in the circulatory system; means for amplifying the response of said sensing element and applying such amplified response to the force-imparting means; and signal-energizing means carried by said rim and becoming effective to energize a signal when said rim is at resonant frequency.

5. A device as stated in claim 1, including mechanical means for amplifying the pulsations received by the sensing element and transmitted to the control assembly.

6. A device as stated in claim 1, including hydraulic means for amplifying the pulsations received by the sensing element and transmitted to the control assembly.

7. A device as stated in claim 1, including a housing and wherein the signal means comprises a resonant portion of the housing adapted to be struck by the control assembly when at resonant frequency.

8. A light weight, portable device adapted to be worn by a human to indicate rhythmic contractions in the circulatory system comprising: a coiled recoil spring provided with a rim and mounted for oscillation about an axis; means for imparting force impulses to the rim of said recoil spring in timed relation to rhythmic contraction and expansion of a portion of the circulatory system of a human, said means including a sensing element responsive to contraction and expansion of the circulatory system and means for amplifying the response of said sensing element and applying such amplified response to the force imparting means; means including an index member adjustably positionable with respect to said recoil spring for varying the resonance characteristics of said spring; indicia in visual relation to said index member, and signal energizing means operable by said spring and rim at resonance frequency established by said index member.

9. A device as stated in claim 8, wherein the sensing element includes a body of fluid retained by a resilient wall adapted to be placed in operative contact with a vein of the circulatory system, and the force-imparting means comprises a piston movable by the body of fluid.

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