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[54] APPARATUS FOR EFFECTING MASSAGES SYNCHRONOUSLY WITH THE HEART ACTIVITY

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[58] **Field of Search** 128/32, 44, 51–53, 128/64

[56] **References Cited**

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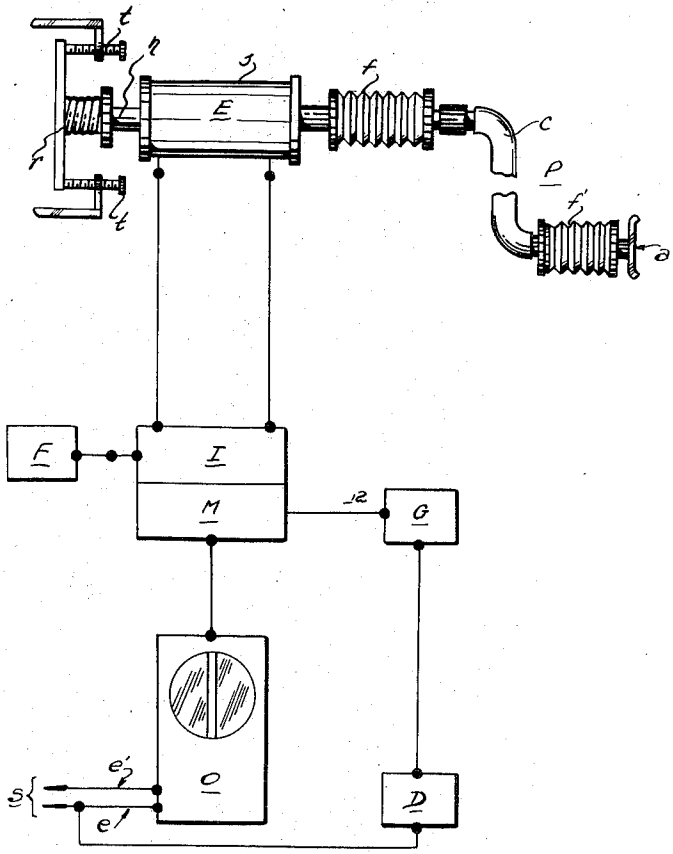
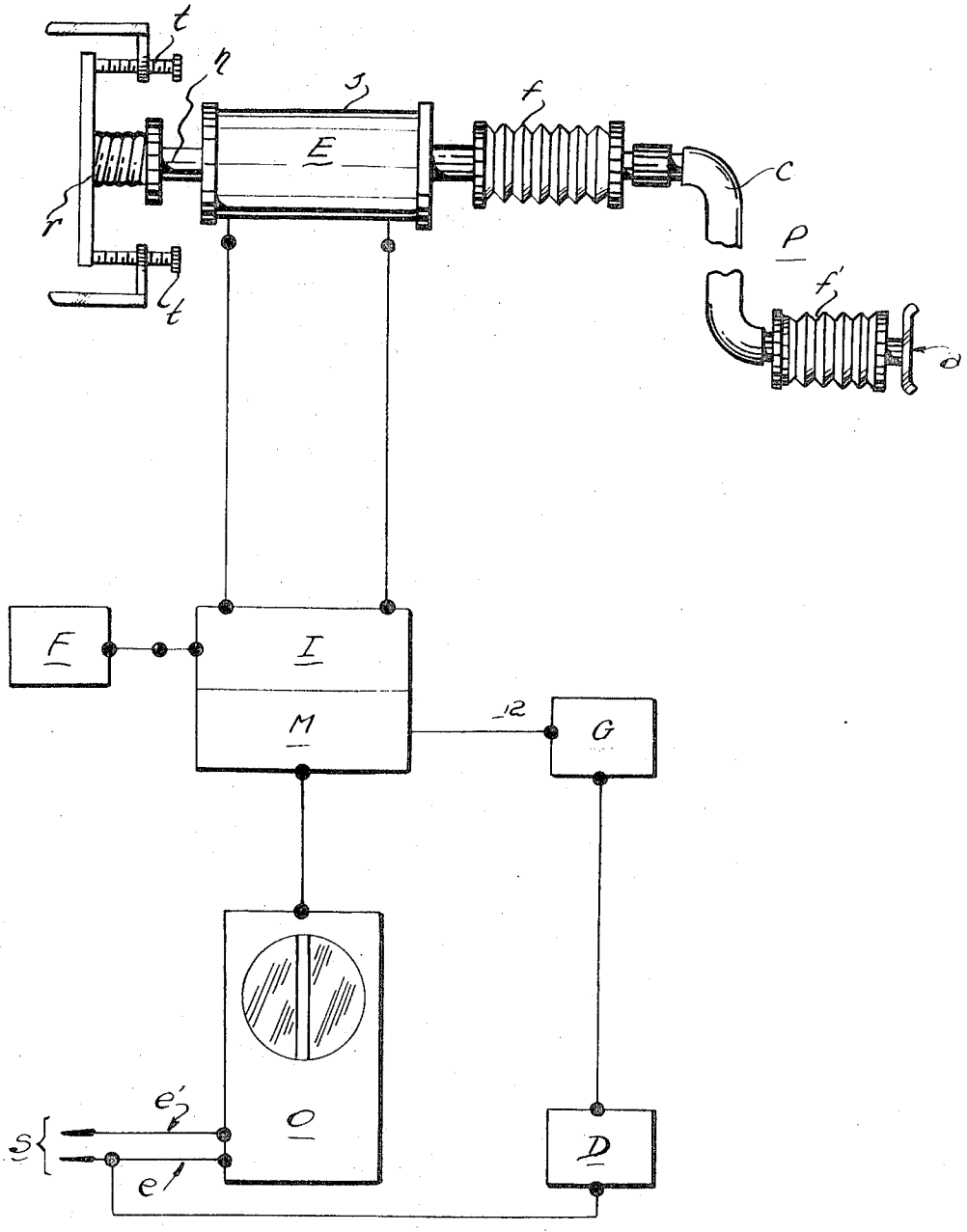
[57] **ABSTRACT**

Apparatus for effecting massages synchronously with the heart activity, and particularly with the interphases of this activity, and comprising, in combination, a visual indicator of electrical pulses provided with two independent input channels, both connected to respective sensors applicable to the individual; a discriminator parallel-connected to one of said visual pulse-indicator units, while the output thereof is fed to a signal generator which, in turn, is connected to at least one time marker, preferably electronic, which is connected on the one part to a third input of said visual indicator and, on the other, to a relay device linked with a power source and with at least a massaging assembly applicable to the desired area of the body of the patient.

10 Claims, 1 Drawing Figure





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APPARATUS FOR EFFECTING MASSAGES SYNCHRONOUSLY WITH THE HEART ACTIVITY

The present invention relates to an apparatus for effecting massages synchronously with the heart's activity, and particularly capable of automatically carrying out its function.

By means of the apparatus of the invention it is possible to improve cardiac activity and/or blood circulation in a given area of the body, and even in the whole body generally, by means of gentle massaging, the rhythm of which not only takes into account the overall systole and diastole beating cycle, but also the multiple sub-phases of the heart auricles and ventricles occurring during each of these periods.

The apparatus is capable of effecting one, two or more compression and decompression (or vice versa) rhythmic actions, synchronous or independent therebetween, on any area of a human or animal body, promoting a massage in which each action can be regulated both in intensity and length; it is also possible to synchronize each of said actions with any phase or even plurality of phases of the heart mechanical working, and/or pulse both arterial and venous.

Such a versatile assembly of means has not been obtained up to date and requires a particular combination of technical features, all of them attainable with present means.

There are at present certain devices for heart resuscitation by means of strong closed thorax massage, which are directed to a very particular use, such as maintaining cerebral circulation in an organism in which the heart has stopped beating. This massage is effected through violent compression and decompression actions on the sterno-costal cage, with a frequency to which the apparatus is set. The operation is continued until heart resuscitation is achieved or until the heart can be subjected to a suitable treatment (defibrillation, etc.).

Another known device is one adapted to improve exclusively peripheral circulation and which operates syncronously with the pulsatile wave. It produces overpressure pulses in the descending phase of arterial pulse, adapted to counterbalance loss of elasticity of the arteries which has been observed in different pathological cases.

However, none of these prior art devices have the features which are peculiar to the present invention. On the one hand, the latter is not conceived as a resuscitator, but rather is capable of effecting more than one rhythmic action. It furthermore provides gentle actions on a working heart and not only synchronously with systole and diastole, but also with any of the inter-phases of heart activity.

According to another aspect of the invention, this apparatus is capable of effecting a much more varied peripherical action and can even act on central circulation, helping the heart by means of gentle massaging exercised on the thorax. Its use is even effective in simultaneous peripherical and central actions, adapted to improve blood circulation in healthy or apparently healthy persons, with prophylactic purposes.

In short, the essential novelty of the invention is evidenced by the possibility of simultaneously and automatically perform a plurality of actions, to wit: effecting one or more adjustable intensity massages, with the possibility of selecting at will the exact moment at which each action of compression and decompression (or vice versa) starts and ends, synchronously with the inter-phases of heart activity, it being possible to obtain a visual reference of what is being done at the exact time it is occurring. It is quite evident that all this allows great ease and safety in the massaging actions performed.

The novel combination of means allowing these advantageous results is comprised of the following sequence of devices: a visual indicator of electrical pulses provided with two independent input channels, both connected to respective sensors applicable to the individual; a discriminator parallel-connected to one of said visual pulse-indicator inputs, while the output thereof is feeded to a signal generator which in turn is connected to at least one time marker, preferably electronic, which is connected on the one part to a third input of said visual indicator and, on the other, to a relay device linked with a power source and with at least a massaging assembly applicable to the desired area of the body of the patient.

Thus, each massaging device is capable of exercising alternatively a compression and decompression (or vice versa) force, which may be adjustable, on any region of the human or animal body, and wherein the moment at which the action starts as well as the moment at which it diminishes, are controlled by the corresponding time marker, which is adjustable at will and in conjunction with the visual indicator, which simultaneously shows at least two oscillograms originating in the cardiovascular activity of said organisms, together with the discriminator allowing an electrical isolation of a distinguishable fraction of one of said oscillograms, said fraction being employed to start the triggering signal in said time marker.

In order that the present invention may be better understood, a particular embodiment thereof will be described hereinbelow, as only illustrative but in no way limitative of the invention. In the course of the following description reference will be made to the schematic FIGURE of the attached drawing, which contains the main components of the apparatus and shows their inter-relationship.

It can be seen that in the embodiment shown the visual pulse indicator is comprised of a two-channel oscilloscope O inputs *e* and *e'* of which are connected with respective conventional sensors S. One of these sensors, which in the illustrated embodiment is the sensor connected to input *e*, is also connected with an electronic discriminator device D which may preferably include at least one amplification stage, a clipper and a differentiating stage.

Output of said differentiating stage feeds a signal generator C, preferably a square wave generator which may be, for example, a Schmitt trigger the output whereof in turn is addressed to an electronic time marker M which is likewise connected to an input corresponding to the oscilloscope Z axis, with a purpose hereinafter discussed.

Said marker M may include or be connected to a likewise electronic switch or relay I conveniently linked to an electric source F and to terminals of solenoids of an electromagnet E having a moving core *n*, operatively connected to massaging assembly P proper.

As shown in the attached schematic drawing, core *n* has one end subjected to a resilient traction load which may be produced by a helical spring *r* intensity of action whereof is adjustable by means of screws *t*, although any other suitable conventional resilient pressure means may be employed.

The other end of core *n* bears against the base of a bellows member *f*, preferably metallic, which at its opposite base is connected through a flexible conduit *c*, or any other suitable means, to a second bellows member *f'* carrying a massaging or applicator member *a*. This assembly is filled with a liquid having a preferably low density.

This description will now be completed with a detailed explanation of the operation of the apparatus.

By means of sensors S, two physical changes provoked by heart activity at epidermal level are taken from the patient's organism. Examples of such sources of change include electrical changes of heart activity, or electrocardiogram, and the pulse arterial wave which may be taken at any convenient point such as the radial artery, by means of a suitable conventional sensor which will use, for example, the mechanoelectrical properties of Rochelle salt transforming mechanical pulses produced by the artery into corresponding variations in electric potential.

Both electric signals are transmitted to inputs *e* and *e'* of two-channel oscilloscope O which, thanks to the electronic switch incorporated therein, allow simultaneous observation of both signals on the screen. At the same time, discriminator D electrically processes the informative signal produced by the electrocardiogram so as to divide therefrom the peak in the R wave in said electrocardiogram.

It is possible and at the same time convenient to take the precaution of locating the live-ground pair of electrodes so that the signal obtained will have a large R wave relative to the other two main waves, T and P respectively, of said electrocardiogram. In man, a tap satisfying this condition is obtained by

placing the live electrode on the sternum at the level of the right auricle and/or slight above it, while the ground electrode is placed approximately at the height of the sixth left intercostal space, at the level of the front edge of the left axilla.

The ground connection must be good to prevent as far as possible introduction of undesired signals, such as the 50 c/s of the electric mains. Anyway, it is also convenient to take the additional precaution of introducing a preamplifying stage followed by filters for undesirable frequencies, before continuing with amplification of the signal.

Once an adequate level signal has been obtained through said amplification stage, the peak of wave R is divided from the remainder of the oscillogram by means of a clipping stage, readily obtained by grid bias, in the event that thermionic vacuum tubes are employed, or by base bias in the event that transistors are used.

Having separated the T wave peak, it is passed to a differentiating stage within the discriminator itself. The positive pulse produced at the outlet of said stage is passed to signal generator G, which may be a Schmitt trigger, at the outlet of which the corresponding square wave will be obtained at convenient intervals, i.e., each time a R wave appears, said square wave being passed to time meter M, which may include two chained RC type timing stages.

Manual controls, such as potentiometers modifying the resistive component of said RC pair, permit adjustment of both the moment at which the second of said stages begins to operate, after the delay introduced in the first, and duration of actuation of said second stage.

From the latter, and during actuation thereof, two informative signals are derived. One of them is passed to the oscilloscope for application to the Z axis; connections should be arranged so that during actuation of said second stage an overbrightness occurs in the images reproduced on the screen.

The other signal is applied to the switching or relay stage I, which is also, as indicated above, of the electronic type. Thus, the conducting interval of this stage corresponds with the actuation stage of the second time stage.

Upon stage I being placed in conducting condition, power source F energizes the solenoid of electromagnet E, with the result that both the moment at which said energization starts, relative to the moment at which electrocardiogram R wave occurs, as well as the time of actuation of said electromagnet, are adjustable at will by means of first and second time stage manual controls, respectively. Simultaneously, time of actuation of the electromagnet may be observed on the oscilloscope screen, by higher brightness of oscillograms inscribed therein on the trace portion occurring during the corresponding interval.

Electromagnet E may be of the plunger type, the core *n* of which is slidable in an internal bronze bushing.

Said core is urged at one end by adjustably arranged tension spring *r* or the like, while at its other end it is integral with the metal bellows base *f*, the other face of which is unmovable and open through an aperture provided with an integral conduit, the latter being connected with flexible and unextendable pressure-resistant tube *c*, which in turn is connected to a bellows *f'* having like features, provided with pressing member *a*.

The pair of bellows *f* and *f'*, together with tube *c*, form a closed system containing any suitable liquid, preferably having a low density, water being usable with no difficulty at all.

Thus, any movement of core *n* will produce practically simultaneously a corresponding displacement in pressing member *a*, movement whereof is transmitted to the body at the point where it is applied and from which electrocardiogram and pulse signals are taken.

At each actuation cycle of the second time stage a mechanical oscillation of the pressing member will then occur which will produce a massaging action in any region of the body, and at a time zone of the oscillogram, exact location of which may be selected by the operator as a function of cardiovascular activity and which appears clearly identifiable on the oscilloscope screen.

The pressing force is adjustable by means of suitable adjustment of said spring *r*, as well as by means of a variable resistor series-inserted relative to solenoid *s*.

It is thus seen that intensity of massaging as well as the time at which it is effected relative to cardiac activity of the patient may be readily and effectively controlled.

It is evident that the present invention is capable of being modified and improved without affecting at all its novel and inventive spirit, such as expressed in the attached claims.

What I claim is:

1. Apparatus for effecting massage synchronous with heart activity, which comprises, essentially, the following combination of devices: a visual indicator of electric pulses having two input channels both independently connected to respective sensors applicable to the subject; a discriminator parallel connected to one of said visual pulse indicator inputs, while the output thereof feeds a signal generator which, in turn, is connected to one or more time markers, preferably electronic, which on the one hand is connected to a third input of said visual indicator and, on the other, is connected to a relay device linked to a power source and to at least one massaging assembly applicable to the desired region of the subject's body.

2. The apparatus according to claim 1, wherein the visual electric pulse indicator is a cathode ray oscilloscope.

3. The apparatus according to claim 1, wherein the discriminator includes at least one amplifying stage, a wave clipper and a differentiating stage.

4. The apparatus according to claim 1, wherein the signal generator includes a square wave generator circuit.

5. The apparatus according to claim 1, wherein the electronic time marker includes more than one timing stage.

6. The apparatus according to claim 5, wherein said time marker includes triggering and timing controls.

7. The apparatus according to claim 6, wherein said timing stages are chained and are of RC type.

8. The apparatus according to claim 7, wherein said controls are linked to the resistive component of the RC pair.

9. The apparatus according to claim 2, wherein said electronic time marker is connected to the corresponding input to Z axis of said oscilloscope.

10. The apparatus according to claim 1, wherein the massaging assembly is comprised of a pressing member comprising an electromagnet of the plunger type operatively coupled to a bellows connected to a similar bellows through a flexible conduit and all three of these elements containing a liquid, the second of said bellows having attached at one end the pressing member proper.

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