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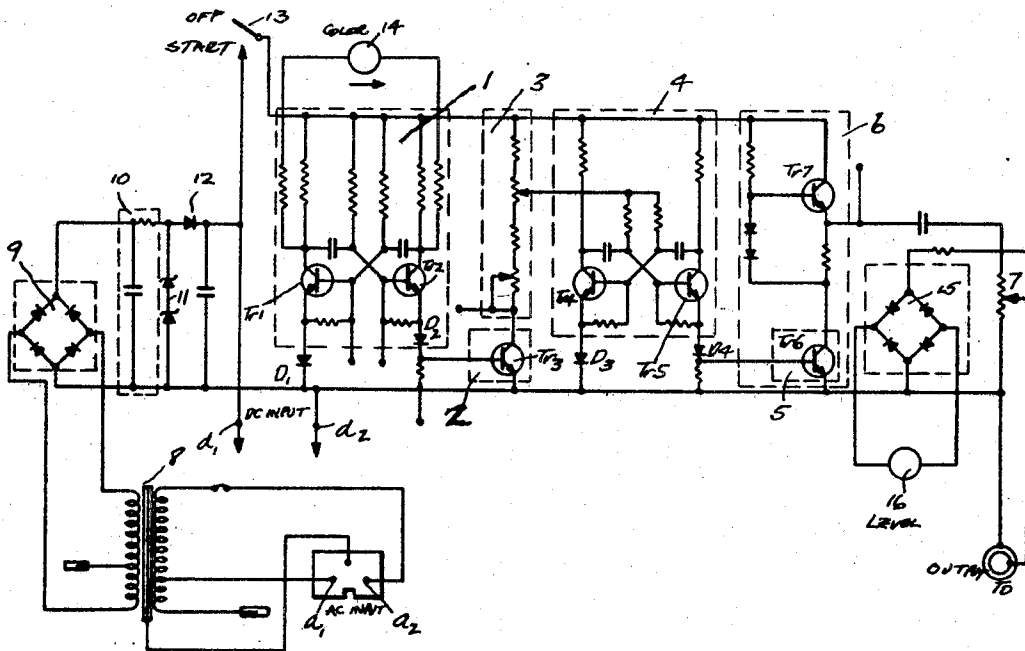
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[54] **APPARATUS FOR TREATING COLOR ABNORMALITIES, INCLUDING A SQUARE WAVE GENERATOR OPERATING ALTERNATIVELY AT FIRST AND SECOND FREQUENCIES**
3 Claims, 3 Drawing Figs.

[52] U.S. Cl. 128/422
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[50] Field of Search 331/47, 50,
52, 113, 177, 179; 128/2.1, 76.5, 410, 419, 420,
421, 422

ABSTRACT: The disclosure sets forth an apparatus for treating color abnormalities by stimulation with alternating current of 77 cycles per second for red and 42.5 cycles per second for green, in which multivibrators are utilized having time constants selected to generate square waves of alternating current, corresponding to alternating periods consisting of a pulse width of 3 seconds and an interval of 3 seconds between pulses, which are applied to the skin near the eyes of the patient to correct for color blindness in either red or green.



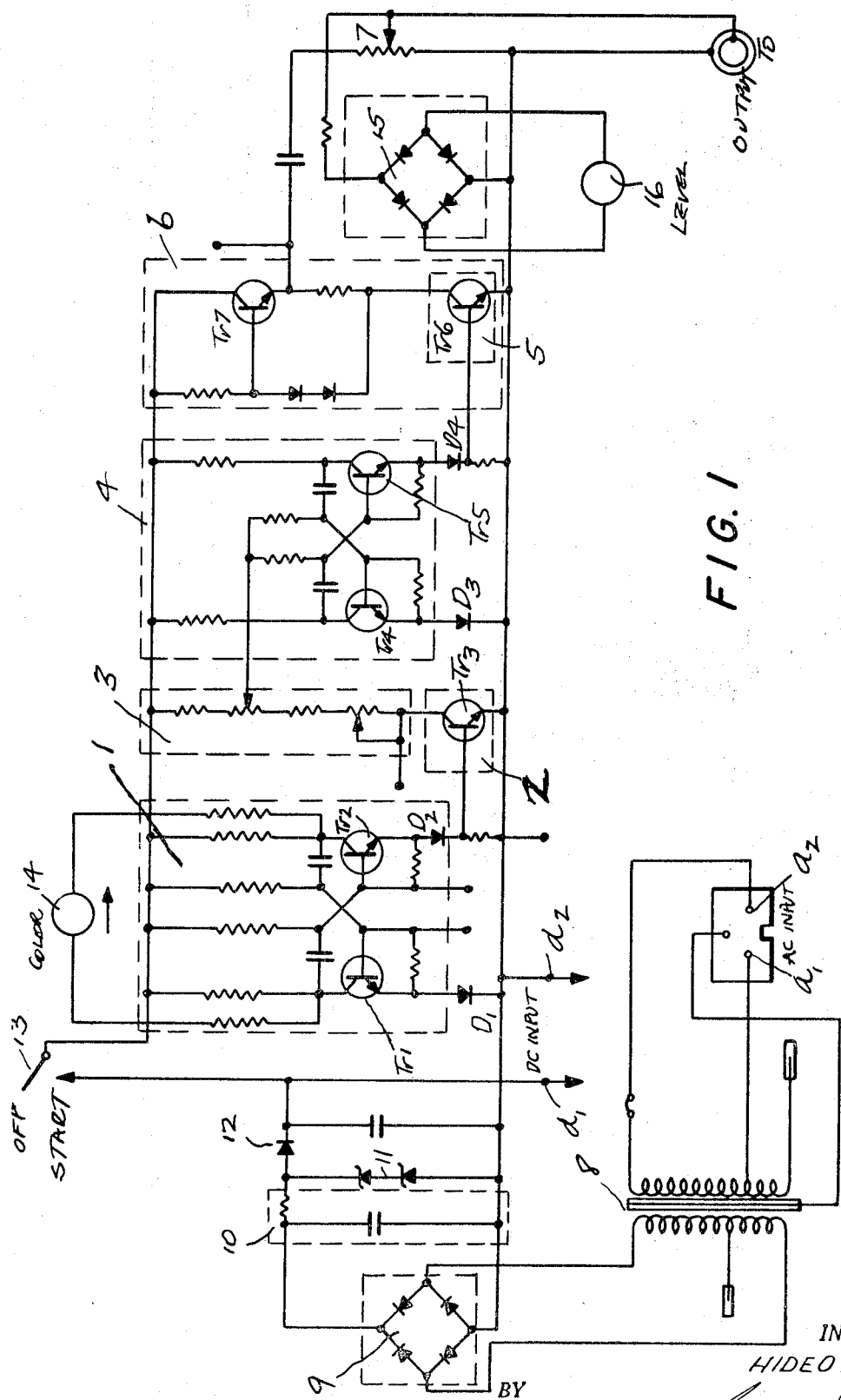
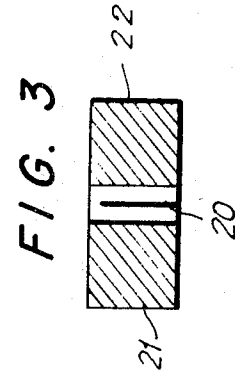
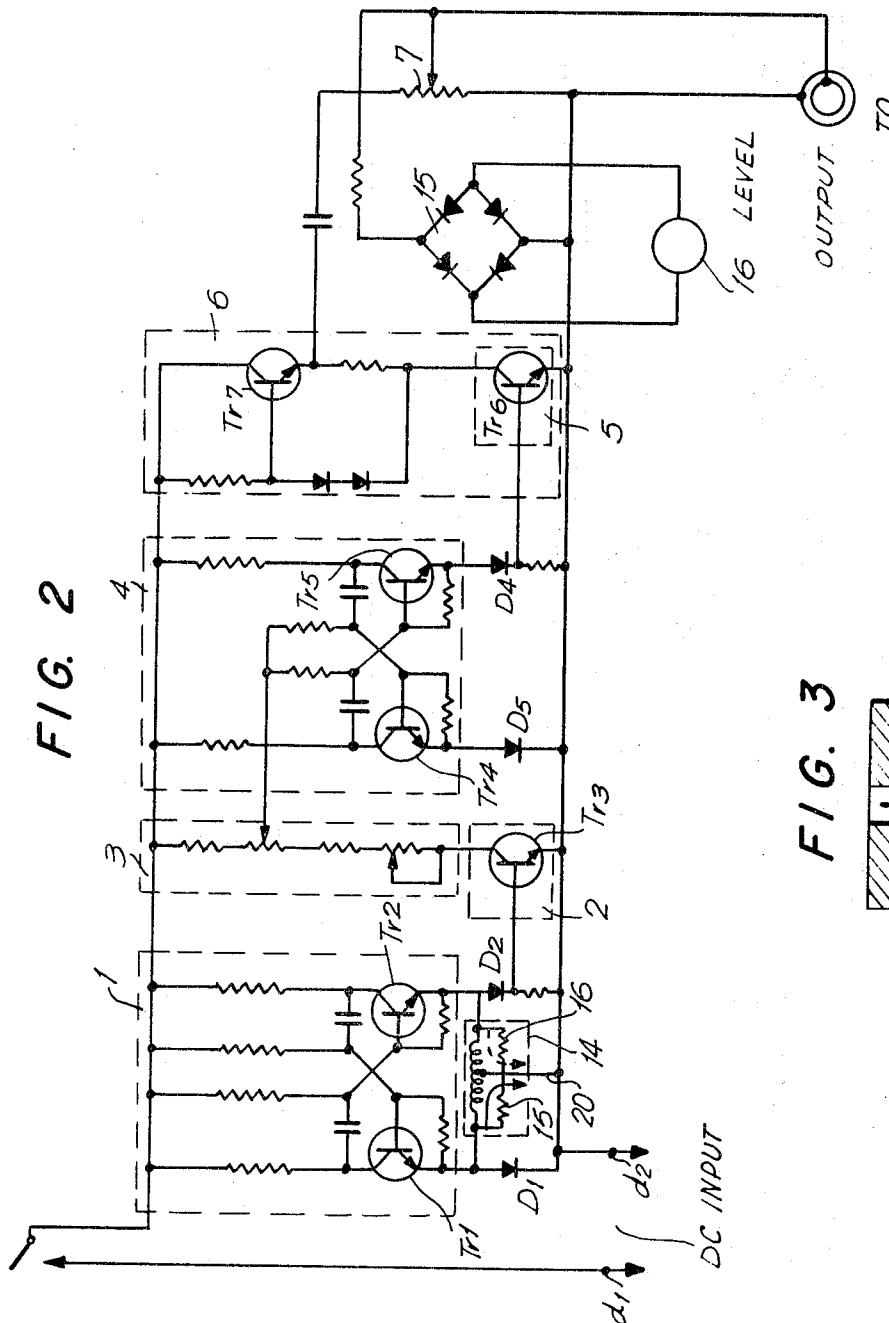


FIG. 1

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APPARATUS FOR TREATING COLOR ABNORMALITIES, INCLUDING A SQUARE WAVE GENERATOR OPERATING ALTERNATIVELY AT FIRST AND SECOND FREQUENCIES

The present invention relates particularly to an apparatus for treating color abnormalities.

The present invention will be particularly described in its application to an apparatus for treating color blindness to restore color sense by the use of alternating electrical voltages and currents in frequencies to the particular color.

The basic principle of restoring color sensitivity to red and green in human eye vision is described in copending U.S. Pat. application Ser. No. 421,570, filed on Dec. 28, 1964, now U.S. Pat. No. 3,527,230.

The apparatus described in the prior U.S. Pat. application Ser. No. 421,570 employed a relay or relays to change the frequencies and sometimes chattering, transient phenomenon and noise would arise in the apparatus.

An object of the invention is to eliminate such chattering, transient phenomenon and noise, also to make the apparatus safe and to enhance the efficiency of the apparatus as a medical instrument and provide a convenient means for testing and treating the patient with color abnormalities.

In the present invention, alternating currents of different frequencies are successively generated at intervals of several seconds by changing the bias voltage applied to an oscillator. The chattering phenomenon which is prone to occur in the relay circuit is thus eliminated and the stability will allow the smooth changing of frequencies alternately, so that undesired transient phenomenon is eliminated, reducing noises, and the efficiency during the operation is enhanced.

The intensity of the stimulation which is applied to the eyes percutaneously for the training by stimulation is not varied by each change of frequency, since the frequency of the generated current is varied by the changing of bias voltage applied to the input circuit of the oscillator.

As the apparatus is capable of operating with a battery and the circuit is transistorized, it is small and compact so that it is readily portable and the power consumption is extremely low during operation.

The intensity of the stimulation is increased and the voltage of the polarization of the skin is limited making the stimulation of the skin minimum, due to the use of square wave alternating current rather than the sine wave of prior apparatus.

This invention further employs means for maintaining the output current at a predetermined level, so that the output is effectively utilized and the battery is used for a longer time.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention:

FIG. 1 shows a circuit diagram of the complete apparatus;

FIG. 2 shows another circuit diagram of the apparatus with a detailed indicator excluding its power supply circuit; and

FIG. 3 shows the movement of the needle of the indicator.

Referring now to the drawings, in the circuit of FIG. 1, at the first stage, an astable multivibrator 1 of the collector-base coupling type comprises a.c. coupled transistors Tr1 and Tr2, the multivibrator having its time constant selected to generate square waves of alternating current corresponding to the alternating periods consisting of the pulse width of 3 seconds and the interval of 3 seconds between the pulses during the alternating flow of the square waves.

The transistors Tr1 and Tr2 are supplied with direct current fixed bias voltage to each input terminal and output terminal through suitable resistors so that the multivibrator will provide a continuous square wave signal at the predetermined frequency.

A shaping circuit 2 is connected, for example, to the emitter electrode of transistor Tr2, and a bias-changing means 3 comprising plural resistors and capable of changing the ratio of voltage division is connected to the output of the shaping circuit 2, namely to the collector electrode of the transistor Tr3.

Another multivibrator 4 of the collector-base coupling-type is provided and also comprises a.c. coupled transistor Tr4 and

Tr5, which are supplied with direct current fixed bias to the output circuit through suitable resistors, and are supplied with direct current variable bias voltage to the input circuit through said bias-changing means 3.

The multivibrator 4 functions as a square wave generator capable of changing frequencies by the changing of the ratio of voltage division, i.e., by adjusting any one of the resistors in the bias-changing means 3 as a variable element to generate square wave alternating current for example 77 c./s. or 42.5 c./s. which corresponds respectively to the resonant frequency of the optic nerve of the retina for red and green, but other frequencies may be developed.

A push-pull amplifier 6 is provided comprising transistors Tr6 and Tr7. Transistor Tr6 functions as a shaping circuit 5, connected to the emitter electrode of the transistor Tr5. A square wave alternating current signal will be provided at the collector electrode of the transistor Tr6, and will appear at the output regulator 7 and the output terminal TO, the frequency of said square wave being 77 c./s. or 42.5 c./s., changing every 3 seconds. The electric power source circuit energizing above-mentioned circuit may comprise terminals d1 and d2 which are the terminals for a direct current source such as a battery (not shown) when the system is direct current operated and terminals a1 and a2 are the terminals to which a source of alternating current may be connected.

The primary winding coil of the stepdown transformer 8 is connected to the terminals a1 and a2, and the secondary winding coil is connected to a filter circuit 10 comprising a resistor and a capacitor, through rectifying means 9 comprising four diodes to convert a.c. to d.c. Constant voltage elements 11 such as "Zener" diodes are connected in parallel with the filter circuit 10. The direct current voltage converted from alternating current may be supplied to the apparatus in parallel with the d.c. input through a diode 12. Thus, the equipment may be used with either alternating current or may be battery operated.

A time switch 13 is provided in the above-mentioned d.c. power source to open the power source circuit in a predetermined period, for example, 20 minutes which is required for a term of training by the square wave stimulation.

A frequency indicator 14 showing the square wave frequency generated by the multivibrator 4 is connected between the collector electrodes of the transistor Tr1 and the transistor Tr2 of the multivibrator 1.

An output level meter 16 is also connected to the output terminal TO through a rectifier circuit 15 comprising four diodes.

In FIG. 1, diodes D1, D2, D3 and D4 connected between each emitter and collector of transistors Tr1, Tr2 and Tr3, Tr4 which define multivibrators 1 and 4 serve to compensate for the rather lower counter voltage between said emitter and collector.

In operation, the multivibrator 1 of the first stage, generates pulses having a width of 3 seconds with an interval of 3 seconds between successive pulses. The transistor Tr2 conducts and cuts off every 3 seconds, and the transistor Tr3 also conducts and cuts off every 3 seconds. The square wave alternating current generated by the multivibrator 1 is not a good square wave because of the time constant of the circuit of capacitors and resistors, therefore, the current has to be shaped into a good-shaped wave by shaping with the transistor Tr3.

When transistor Tr3 is in conduction, the ratio of voltage division in the bias-changing means 3 is lowered, and the direct current voltage supplied to the input circuit of the multivibrator 4 is also lowered, thereby decreasing the frequency generated in the multivibrator 4, and a square wave alternating current of 42.5 c./s. is developed.

On the other hand, when the transistor Tr3 is cut off, the ratio of voltage division in the bias-changing means 3 is automatically increased, thereby increasing the frequency generated in the multivibrator 4, and a square wave alternating current of 77 c./s. will be developed.

Therefore, the second stage multivibrator 4 generates square wave alternating currents of 42.5 c./s. and 77 c./s. alternately every 3 seconds, since the first stage multivibrator 1 generates periodically with 3 seconds of pulse width and 3 seconds of interval between pulses.

The transistor Tr6 shapes the waves generated by the multivibrator 4 into a substantially perfect square wave, also repeating conduction and cutoff at the same period as above stated. The square wave current is regulated in its magnitude by output level regulator 7, and an optimum square wave current for training color abnormalities by stimulation, changing its frequency alternately at 77 c./s. and 42.5 c./s. every 3 seconds, is taken from the output terminal TO.

Suitable electrodes to be fitted on the skin near the eyes of the patient are connected to output terminal TO and the square wave alternating current is applied to the eyes of the patient through the skin.

The push-pull amplifier 6 of the last stage serves to maintain the output impedance substantially constant and operates as a balanced load for the power supply, so that it contributes to lengthen the life of the battery when battery operated.

In the amplifier 6, predetermined bias voltage is applied to the input circuit of the transistor Tr7 so that constant current will flow through the collector electrode. When the transistor Tr6 is in conduction the collector voltage applied to the transistor Tr7 will be increased thus lowering the impedance of the transistor Tr6 and increasing the impedance of the transistor Tr7. While the transistor Tr6 is cut off, the transistor Tr7 will have a low impedance. Therefore, the amplifier 6 always operates as a constant impedance to the power supply.

When the transistor Tr1 is cut off and the other transistor Tr2 is in conduction, the multivibrator 4 will generate square wave alternating current at a frequency of 42.5 c./s. while if the transistor Tr1 is in conduction and the other transistor Tr2 is cut off, the multivibrator 4 will generate square wave alternating current at the frequency of 77 c./s. Therefore, when the multivibrator 4 is oscillating at the frequency of 42.5 c./s., the potential of the collector electrode of the transistor Tr1 is nearly as high as the voltage of the power supply and the potential of the electrode of the collector of the transistor Tr2 is low minus potential, and current will flow through the frequency indicator 14 in the direction shown by the arrow.

When the multivibrator 4 is oscillating at the frequency of 77 c./s., the potential of the collector electrode of the transistor Tr1 is at the low potential and the potential of the collector electrode of the transistor Tr2 is at the high potential, and the reverse current will flow through the frequency indicator 14. A viewer will identify the frequency at a glance when the frequency indicator 14 is a type of null method and its dial is colored with different colors at each side of the needle.

At the same time, a part of the square wave alternating current taken out from the output terminal TO is rectified through the rectifier circuit 15 and the output level is indicated on the output level meter 16.

Referring to FIGS. 2 and 3, the operation of the frequency indicator is explained more definitely.

In the embodiment of FIG. 2, the frequency indicator 14 is connected to the emitter circuit of the multivibrator 1. When the multivibrator 4 is oscillating at the frequency of 42.5 c./s., the transistor Tr2 only is in conduction and a part of the emitter current of the transistor Tr2 is shunted to flow through the driving coil 16, as shown by the dotted arrow, thereby moving the needle 20 to the left to show the generation of the square wave alternating current at the frequency of 42.5 c./s.

On the other hand, when the multivibrator 4 is oscillating at the frequency of 77 c./s., the emitter current of the transistor Tr1 is shunted to flow through the driving coil 15 as shown by the solid arrow, thereby moving the needle 20 to the left to show the generation of the square wave alternating current of the frequency of 77 c./s. The needle 20 of the frequency indicator 14 must be located at the central position when the input current is zero, and the dial of FIG. 3 may be colored red

at the left side 21 and green at the right side 22, so that viewers may identify the generated frequency by the location of the needle 20.

The frequency indicator 14 indicates the frequency of the square wave alternating current generated in the multivibrator by utilizing the change of current of the multivibrator 1 either in the input circuit or the output circuit during its operation. Therefore, some elements can be reduced compared with the prior apparatus which required a relay or relays, a pilot lamp and power source for the lamp with resultant greater reliability in operation. When the apparatus is d.c. operated, it is necessary only to connect a battery across the terminal d1 and d2 for the direct current power supply.

If a rechargeable battery of the nickel-cadmium-type is employed as a direct current power source and the user wishes to charge the battery by the external power source, charging energy can be secured from the rectifier 9 with the a.c. power supply connected to the terminals a1 and a2 for the a.c. power source.

When the potential at the connecting point of the constant voltage element 11 and the rectifier 12 is arranged to be the maximum charging voltage suitable for the battery employed, the charging current will flow to charge the battery through the rectifier 12 and little current will flow through the constant voltage element 11. After charging is continued, when the terminal voltage of the battery comes to its maximum charging voltage, current begins to flow through the constant voltage element 11, and the charging current will be decreased.

When the battery is charged up at higher potential than the maximum charging voltage, the current flowing through the rectifier 9 becomes substantial and flows into the constant voltage element 11. Thus, the charging will automatically cease.

I claim:

1. An apparatus for training color abnormalities by the selective application from an electric generator of two a.c. currents, each having resonant frequency of the optic nerve for red and green comprising: a bias voltage source means, a first astable multivibrator for free-running oscillating at a period of about 3 seconds, direct connection between said bias source means and said first multivibrator to supply the fixed voltage bias from said bias source means for said first multivibrator, switching means being controlled by the output of said first multivibrator open or close at said period of about 3 seconds, two-step bias-changing means being connected to said bias source means and controlled by the output of said switching means, whereby the bias voltage from said bias source means changes stepwise to two different varied bias voltages in response to the opening and closing of said switching means, a second astable multivibrator, means for changing the output frequency of said second multivibrator in response to said different bias voltages for oscillating selectively two stimulating a.c. currents at said period, one of which has a specific frequency of 77 c./s. in resonance with the optic nerve for red and the other of which has another specific frequency of 42.5 c./s. in resonance with the optic nerve for green, connection between said second multivibrator and said two-step bias-changing means to supply selectively said two varied voltage biases for said second multivibrator, so that the oscillating frequency of said second multivibrator changes stepwise into said two resonant frequencies and electrodes to be fitted on the skin near the eyes of the patient connected to the output of the last mentioned multivibrator.

2. An apparatus as defined in said claim 1 in which said first multivibrator is of the collector-base coupling-type and comprises two coupled transistors, and frequency-indicating means showing the frequency generated by said second multivibrator is connected between the two collector electrodes of said transistors of said first multivibrator.

3. An apparatus as defined in said claim 1 in which said first multivibrator is of the collector-base coupling-type and comprises two coupled transistors each having base, emitter and

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collector electrodes, and frequency-indicating means showing the frequency generated by said second multivibrator is con-

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nected between the two emitter electrodes of said transistors of said first multivibrator.

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