Nov. 1, 1960 M. MARCHAL ET AL 2,958,781

RADIO-PHYSIOLOGICAL METHOD AND MEANS

Filed March 18, 1957

Fig.1

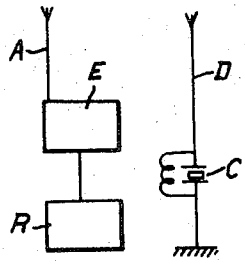


Fig.2

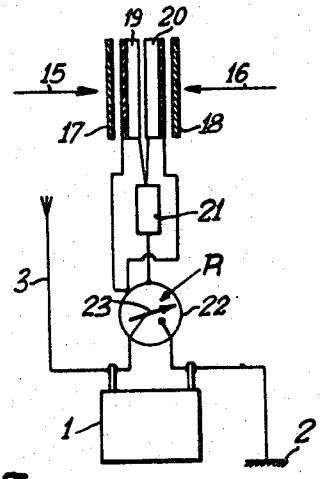


Fig.3

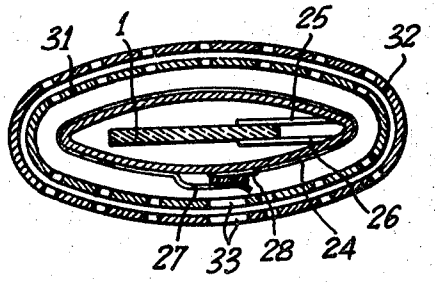
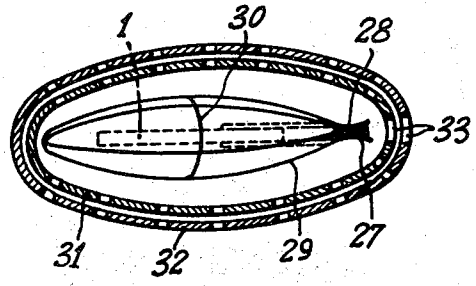


Fig.4



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RADIO-PHYSIOLOGICAL METHOD AND MEANS

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10 Claims. (Cl. 250—83.3)

The present invention relates to a process of medical exploration, leading to more precise results than the means now in use, which so often exercise a modifying action on the phenomena under investigation.

As a first example of such phenomena, and of the method by which the present invention applies thereto, a description will be given of an apparatus designed for the determination of harmful radiations such as X-rays.

As a second example of application of the same invention, the process of digestion will be investigated, in its nature and duration from its inception duly noted to its complete achievement, this latter starting then a harmless radiation in the body, so that a time difference measures the duration of the digestion period.

Both applications make a similar use of piezo-electric systems including a passive responder unit such as described by Mrs. Leo Magondeaux in U.S. Patent No. 2,812,427. Their modes of action are identical and will be briefly reviewed later on, though they are different in size, the second application having necessitated the creation of a crystal responder of extremely small size.

For a better understanding of the invention, reference should be made to the attached drawing and to the following description, which are of a non-limitative but of a mere explanatory nature.

Fig. 1 illustrates the principle of the passive piezo-electric responder, working in connection with a suitable H.F. pulse generator,

Fig. 2 represents an embodiment of a radiation detector made according to the invention, particularly intended for indicating any X-rays exceeding a safe limit,

Figs. 3 and 4 show on an enlarged scale a subminiature crystal responder, intended for ingestion so as to give immediate information on the duration of the digestive process.

In U.S. Patent No. 2,812,427, the invention involves generally the provision at a receiving station of a pulsed oscillator or power transmitter adapted to radiate successive bursts or energizing pulses of high-frequency energy or carrier wave trains of suitable frequency, the pulses being preferably though not exclusively of an equal length or duration and having a repetition frequency substantially less than the carrier frequency but greater than the highest signal frequency component to be transmitted from a cooperating remote passive station or responder. The latter may be located at a substantial distance from the energizing transmitter and comprises a suitable wave collecting or input circuit, such as an antenna, to intercept and receive the energizing wave pulses radiated by said transmitter and suitable means to delay the received energizing pulses by a predetermined time period so as to coincide with and being in turn re-radiated during the spacing intervals between the received energizing pulses. Suitable means are provided to modulate the delayed and re-radiated pulses, such as by means of key, switch, microphone, or the like, in accordance with the information or "passive" signals to be transmitted to the receiving

station for reception and demodulation in any suitable manner.

According to a preferred practical embodiment of that invention utilizing a piezoelectric crystal element, the first or receiving station comprises a superregenerative transceiver of either the self-quenched or separately quenched type and producing a continuous sequence of bursts of high-frequency energy or wave pulses transmitted to a remote passive responder at a repetition frequency equal to the quenching frequency of the transceiver. The remote responder, in order to effect the necessary time delay of the received energizing pulses prior to their re-radiation to the transceiver, includes a piezoelectric crystal (quartz crystal etc.) or an equivalent electro-mechanical vibratory element tuned to the carrier frequency of the energizing pulses and coupled to an antenna or wave collecting element, in such a manner as to cause the received pulse energy effectively to be stored with a suitable time delay as mechanical vibratory energy in the crystal and to cause the stored energy to be reapplied by the crystal, acting as a temporary resonating source or generator of high-frequency energy, to the antenna for re-radiation before the arrival of the next energizing pulse. By the proper adjustment or control of the coupling between the input circuit and crystal of the responder, the time delay of the re-radiated pulses may be caused to coincide with the interval of maximum sensitivity of the superregenerative transceiver, i.e. prior or close to the starting of the oscillations at the instant of transition of the conductance of the superregenerative circuit from positive to negative in accordance with the well known function and operation of the conventional superregenerative amplifiers.

In the transmitting and receiving system shown in Fig. 1 which operates in the manner described with reference to Figures 1 and 2 of U.S. Patent No. 2,812,427, the antenna A radiates H.F. pulses generated by a transmitter E. Those pulses are received by an antenna D, and transmitted to a piezo-electric crystal C connected between antenna D and ground and shunted by a matching inductance. The response issuing from C and D is received by a suitable receiver R and any relaying device may be added thereto according to the needs of either of the applications in view.

The devices E and R of Fig. 1 may be reduced to one device performing both functions (transmitting and receiving), a super-regenerative apparatus for instance, as described with reference to Figure 3 of the aforementioned U.S. Patent No. 2,812,427. This device would, of course, have a smaller range than the separate E and R devices, but this result is of small importance for the use of the present invention.

Though Fig. 2 shows an X-ray detector, it is obvious that all harmful radiations, such as electro-magnetic and corpuscular for instance, could be similarly detected according to the same process.

In any of those cases such an apparatus will never lose control of the radiation it is intended for, and a powerful alarm signal will be, through an appropriate relay and in any preferred way, given to the people who could be injured by the radiations.

To this end an appropriate transmitter E and receiver R, such as are shown in Figure 1, are operated in conjunction with a crystal responder 1, grounded at 2 and submitted to incoming pulses received by antenna 3 from the transmitter E.

In the case of a direct or indirect radiation (15 or 16), two appropriate screens 17 and 18 (Fig. 2) are exposed to the said radiation, and a measure of the intensity of the radiation can be deduced from the respective degrees of fluorescence of these screens.

For a material measurement of their fluorescence, the light from the screens is allowed to fall on photo-electric cells, such as 19 and 20 (Fig. 2), which are preferably photo-resistant and connected to a D.C. source 21. In this case the exciting coil of a relay 22 could be connected in series with the current from the source 21, and the relay contact 23 controls the responder, by short-circuiting it if a dangerous degree of radiation is attained resulting in an alarm signal at the receiver R.

Certain forms of radiation, from a point or a spherical source for instance may lead to the substitution of the above type of cell by a spherical cell surrounded by a spherical screen.

Instead of such screens and cells, use could be made of a suitable ionisation chamber or of a Geiger counter.

The present invention is not only effective in detecting any excess of radiation, but it also gives the proper means for recording, from a distance, the total amount of radiation. To that effect, it is sufficient to provide the receiver with an integrator designed for indicating the average flux on a counter dial which will give the number of "peaks" received.

As a useful adjunction to the electric transmission used with the crystal responder, a transistor could be added with advantage to the transmission circuit.

Figures 3 and 4 illustrate the application of the passive responder to determine the activity of the digestive secretions.

It proceeds by the precise timing of their action, in the very spot where this latter takes place, i.e. in the stomach of the patient or in any part of the intestine which it is useful to explore.

To disclose the characteristics of the very particular responder created for that use, it was necessary to give in Figs. 3 and 4, which show two embodiments of such a subminiature responder, an enlargement of a considerable value. Such are indeed actual dimensions of the responder that it can be swallowed without any difficulty, and as it was indespensable to give a complete autonomy, its components have been totally enclosed in a volume not exceeding that of a medical pill, including not only the crystal and its electrodes, but an antenna circuit of minimum size and its short-circuiting mechanism. This small responder should not, moreover, for obvious reasons, present any superficial asperities, and it should be sealed so as to leave no way for inner penetration of the liquids present in the digestive organs.

For testing selectively the efficiency of those digestive liquids in their action or any nutritive substance, a minute fragment of such a substance is inserted between the two electrodes 27—28 of a small contact device, which is thus kept open as long as the inserted substance is present. As soon as this latter comes to be digested, however, a spring or an equivalent resilient device causes the two contacts 27 and 28 to conductively bridge the crystal electrodes and short circuits the responder 1.

It is easy to identify the various components involved, in view of the above defined functions, in the sectional views given in Figs. 3 and 4, representing non limitatively two embodiments of the responder, not excluding the possible variants of the invention. Beyond the electrodes of the piezo-electric crystal 1 and respectively connected therewith, two resilient tabs can be seen, between which the test fragment has been set in advance. A tight envelope 24, of an insulating and rigid material, entirely surrounds the crystal, of which the electrodes 25 and 26 are connected respectively to the two short-circuiting means 27 and 28. The usual antenna is substituted by a special device which should not be of course, composed and shaped as a classic aerial, and it is preferably made of one or several turns of a conducting material (29 and 30) Fig. 4, either formed of a wire or of an equivalent conducting paint, or obtained, more generally, through any of the means derived from the technique of the printed circuits. Whatever may be the loop intended for use as an antenna, it is obvious that it ends should be connected to the electrodes 27 and 28 of the short-circuiting device.

The two outer envelopes 31 and 32 are to be permeated by the surrounding liquid; the envelope set nearer the crystal must be able to keep it altogether, with or without the help of intermediate stabilizing means and it is therefore made more rigid than the outer envelope; this latter is not so rigid and has a smooth outer surface. Both envelopes are fitted with an opening 33 for the introduction of the pill and the setting of the nutritive material.

The pulse generator should be preferably placed at a short distance from the body, at a level which can easily be fixed at will.

For the setting of the device, use may easily be made of radioscopic means, due to the opacity and the clear visual localisation of the pill. Once the setting has been done, a chronometer reading is made at the time origin of the digestion process. This process ends at the time corresponding to the short-circuiting of the electrodes 27 and 28, and consequently to the actuation of the receiver, with the result that its relay is put in action, so fitted that any means of action enable it to stop the chronometer and give the exact duration of the digestion process.

It may be useful to include, in a subminiature device made according to the invention, not only one piezo crystal receiver as shown in Figures 3 and 4, but two independent crystals superposed in the same envelope. The testing materials inserted between the electrode clips of those two crystals would be different and would be acted on selectively, one of them being in the nature of proteins and the other lipid.

We claim:

1. A responder unit in the form of an ingestible pill or capsule containing a piezo-electric crystal in a sealed casing of insulating material, an aerial carried by said casing, means for supporting a test fragment of a substance to be digested, said supporting means including electric contacts which close to short-circuit the crystal when the fragment is digested, and an outer casing pervious to digestive juices.

2. A responder unit as claimed in claim 1, in which the outer casing comprises a rigid perforated inner member and a smooth perforated outer member.

3. A responder unit as claimed in claim 1, in which the aerial comprises a printed circuit on the sealed casing.

4. Detecting apparatus comprising a piezo-electric crystal responder, means for feeding pulses of high frequency energy to energise said responder, means for receiving high frequency pulse signals emitted by said responder when energised, radiation sensitive means for detecting radiation of a kind other than the high frequency pulses and switch means operated by said radiation sensitive means to short-circuit said responder upon radiation detected by said radiation sensitive means reaching a predetermined level.

5. Detecting apparatus comprising a piezo-electric crystal responder, means for feeding pulses of high frequency energy to energise said responder, means for receiving high frequency pulse signals emitted by said responder when energised, radiation sensitive means for detecting radiation of a kind other than the high frequency pulses, and switch means operated by said radiation sensitive means to control the operation of the responder in dependence upon radiation received by said radiation sensitive means.

6. Detecting apparatus comprising a piezo-electric crystal responder, means for feeding pulses of high frequency energy to energise said responder, means for receiving high frequency pulse signals emitted by said responder when energised, a fluorescent screen which fluoresces in the presence of a radiation other than said high frequency pulse radiation, a photo-electric cell for measuring the degree of fluorescence of said screen, and a relay operated by the output of said photo-electric cell to short-circuit

said responder upon the radiation detected by said fluorescent screen reaching a predetermined level.

7. Apparatus for detecting a phenomenon comprising a piezo-electric crystal responder, means for energising the responder with pulses of high frequency energy and means for receiving signals emitted by said responder upon energisation by said pulses of high frequency energy, means connected to said responder for detecting the phenomenon, switch means operated by said phenomenon detecting means for short-circuiting said responder and means for indicating when said responder is short-circuited.

8. Apparatus for detecting a phenomenon comprising a piezo-electric crystal responder, means for energising the responder with pulses of high frequency energy and means for receiving signals emitted by said responder upon energisation by said pulses of high frequency energy, means connected to said responder for detecting the phenomenon and switch means operated by said phenomenon detecting means for controlling the operation of said responder.

9. A responder unit in the form of an intromittent capsule comprising a sealed casing of insulating material, a piezo-electric crystal mounted in said sealed casing, signal receiving means within said casing connected with said crystal and forming a resonating circuit with said crystal and electric contacts controlling the operation of said crystal in response to received radiation.

10. A responder unit in the form of an intromittent capsule comprising a sealed casing of insulating material, a piezo-electric crystal mounted in said sealed casing, and signal receiving means within said casing connected with said crystal and forming a resonating circuit with said crystal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,812,427 Magondeaux ---------- Nov. 5, 1957