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ULTRASHORT WAVE RECEIVER

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Fig. 1

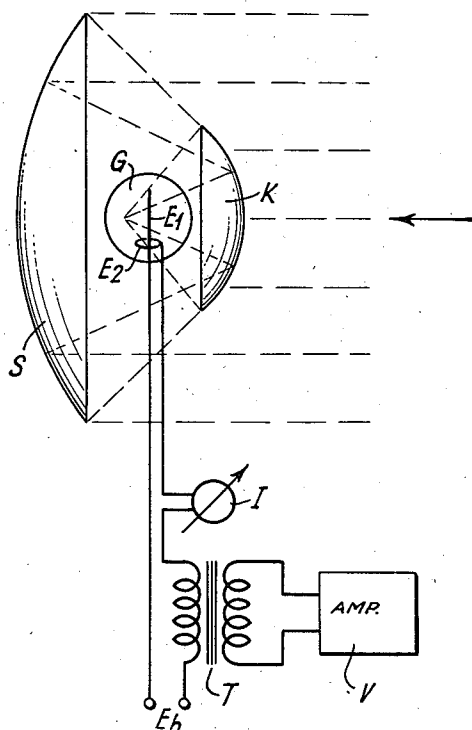


Fig. 3

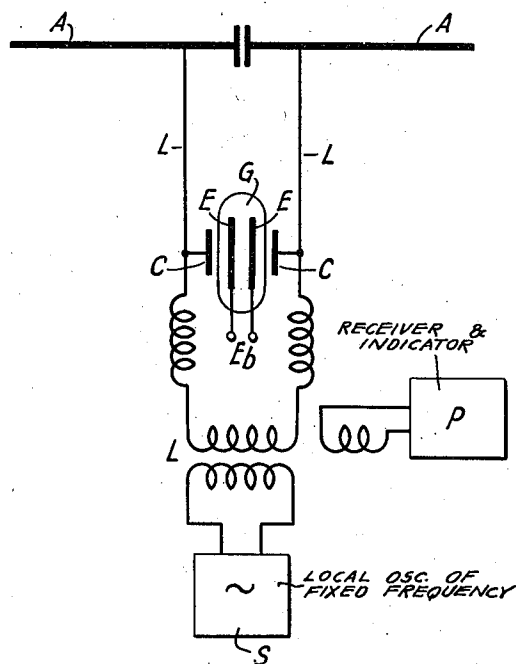


Fig. 2

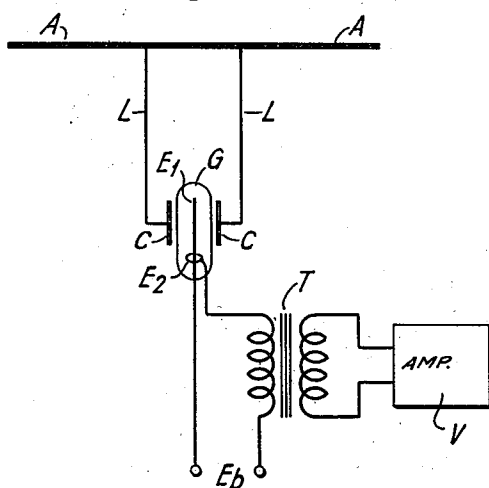
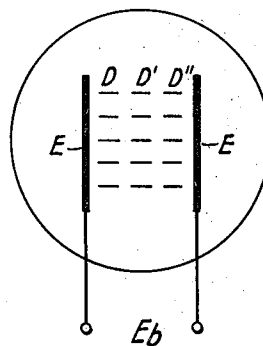


Fig. 4



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ULTRASHORT WAVE RECEIVER

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2 Claims. (Cl. 250—27)

The invention relates to an arrangement for receiving and detecting ultra-short electrical waves and which can be employed up to the region of the millimeter waves. The indication of extremely high frequencies is based upon the influencing of an ionized gas by impinging electrical waves, or by a corresponding ultra-high frequency field.

It is generally known that reception and detection of electro-magnetic waves involves more difficulties the shorter the wave length. The receiving methods taken over from the ordinary high-frequency methods, and the detector, the audion, and the simple diode lose their effectiveness and sensitivity in the decimeter band, or they show uncontrollable anomalies. Hence it will be necessary to employ methods for reception of decimeter waves which afford the production of the respective frequencies, i. e. the so-called retarding audion in its various modifications and the magnetron. But also in this case the difficulties increase the higher the frequency to be received, and this not only owing to the proportional decrease in sensitivity with frequency, but also owing to the necessary resonance tuning. In order to disclose waves of millimeter length and shorter ones, there remain today only the receivers known from the long wave field of the optical radiation spectrum, such as thermoelements, molometers, as well as radio-meters. Hereby there are considered without exception the integrating detectors by which ultra-short waves can at the most be detected, while owing to their inertia such indicators cannot be used for reception of a modulated carrier wave.

The present invention however, is based on an entirely novel physical effect, namely the effect exerted on an ionized gas by electrical waves of any length, whereby the pressure of said gas is so chosen that the said waves are appreciably absorbed in this gas.

In general it is known that an ionized gas has a definite dielectric constant for an electro-magnetic oscillation, and reveals a certain conductivity both depending in a complicated way on the ion- and electron density as well as on the gas pressure. This effect is most clearly revealed in the Heaviside layer in which at the low gas pressure and at the correspondingly long free path of the electrons even long waves can be transmitted as in a conductor over the longest terrestrial distances. If the gas pressure is more and more increased, the free mean path of the electrons decreases and hence also the wave lengths for which the ionized gas shows dispers-

ing properties, become more and more reduced in length. At gas pressures of some tenth or hundredth millimeter of mercury the maximum absorption and dispersion properties of an electron gas are in the ultra-short wave region and extend down to decimeter and millimeter waves. Since the absorption of such short waves is a direct function of the density of the ionization of the electron gas, it is known that an ultra-short wave beam of rays can be modulated by passing it through a gas layer whose density of ionization is controlled simply by varying the ignition voltage in the rhythm of the modulation.

In the present invention this performance is reversed, i. e. the electrical properties of an ionized gas path are varied by impinging electrical waves, and indicated in various ways. That this performance actually takes place is proven by the known lateral modulation in the Heaviside layer. Hereby, the waves entering the Heaviside layer and which are sent out by a broadcast transmitter, transmit their modulation to the penetrated ion gas and electron gas and vary its electrical properties in the rhythm of the modulation. If the region traversed by the waves is penetrated at the same time by other waves which may have been radiated without modulation by a second transmitter, then the variations in the modulation will be transferred from the first wave ray to the waves of the second transmitter, so that the modulation becomes audible on its carrier wave which originally was not modulated. Through this crosswise modulation it is proven that in fact the electrical properties of an ionized gas can be controlled by impinging waves.

The present invention makes a practical use of this effect, and provides a novel wave detector or indicator based upon this effect. There exist various possibilities to cause the waves received to act upon an ionized gas, and to transform into modulation currents the variations which the impinging gas path undergoes from an electrical point of view. Various possibilities will be described in the following examples of construction:

Fig. 1 shows one modification of the invention.

Figs. 2 and 3 show receiver arrangements.

Fig. 4 shows a further modification of the invention.

The simplest case is shown in Fig. 1. In a gas filled discharge vessel G a glow discharge is maintained between the electrodes E₁ and E₂. In order to subject this gas discharge to a possibly intense ultra-high frequency oscillation field, the vessel G is in the focal point of an

electrical reflector system which may consist of the main reflector S and a hollow reflector K disposed in front thereof. The appearance of ultra-high frequency oscillations now changes the state of ionization and hence also the electrical resistance of the gas discharge. The variations in the resistance thus reproduce the incidental intensity of the impinging radiation or its modulation, and produce corresponding fluctuations of the ignition current, which are read in a galvanometer I, or which are conducted across the transformer T to a receiving amplifier V. On the basis of the considerations given in the introduction, the sensitivity of the gas detector can be brought to a respective optimum by adjusting the gas pressure according to the range of frequencies to be received.

In this arrangement only the part of the wave radiation which is actually absorbed in the gas layer can obviously be indicated. In accordance with the invention, the measure can however be such that the ultra-high frequency carrier oscillations are caused to induce high resonance potentials in a suitable receiving system, and to have these potentials act on the gas discharge. A receiver arrangement constructed on the basis of this principle is shown, for example, in Fig. 2. Herein A denotes a dipole antenna coupled to the resonance system L—C. Between the plates of the condenser C the discharge vessel is arranged, in which the glow discharge is produced. The variations in the resistance of the glow path obtained by the action of the ultra-high frequency field of the condenser cause as in the preceding example, corresponding variations of the ignition current.

In the examples of construction hitherto herein described, the variation in the conductivity of the electron gas impinged by the waves is utilized for the indication and demodulation of ultra-short waves. Aside from the conductivity there also occurs as already stated, an appreciable change of the dielectric constant, which on the basis of the principle of the invention, can likewise be utilized for reception and detection of the waves. In order to obtain a highly sensitive indication of the reception, it is important in this reception method to indicate very small variations of the capacity of the condenser containing the electron gas as dielectric. This is accomplished in the receiver arrangement shown schematically in Fig. 3, by means of a high frequency detuning, in that the condenser containing the electron gas forms at the same time the tuning capacity of a secondary circuit, and detunes the latter relative to an auxiliary oscillation that remains constant. The entire arrangement thus operates in the following way: The oscillations received at the receiving antenna A will be transmitted as before mentioned to the ultra-short wave resonance circuit L and C and influence the glow path G between the condenser plates which is maintained by the ignition voltage E_b at the electrodes E. The entire ultra-short wave resonance system forms together with the coil L' a secondary circuit which is energized by the local oscillator S with constant wave length λ_0 and constant energy. The adjustment is now so carried out according to the "method of the half resonance curve" that the locally produced wave λ_0 just deviates to such an extent from the natural wave λ_s of the secondary circuit that in the secondary circuit there flows the half resonance current. If now the capacity of the condenser C changes owing to a receiving wave impinging on

the ultra-short wave system A—L—C, the secondary circuit will be detuned relative to the locally produced wave and the high-frequency auxiliary current in the secondary circuit increases or decreases in accordance as to whether the detuning is directed towards or away from the resonance maximum. In order that these modulation variations of the intermediate frequency current be indicated it is possible either to utilize the reaction of the detuning of the secondary circuit upon the auxiliary oscillator S, or it can be heard in a special receiver P coupled to the secondary circuit. By a loss-free structure of the entire secondary system and by choosing a possibly high auxiliary frequency for instance in the region of 10^8 cycles per second, it can be arranged so that the ultra-short wave modulation will be transmitted with extreme sensitivity to the slower auxiliary frequency.

It is apparent that the ultra-short wave receiving systems A—L—C shown in Figs. 2 and 3 can be considered at the most up to waves of a few centimeters in length for reasons of the possibilities in their production. In order that also shorter waves may be indicated through the capacitive detuning effect, the waves in a manner similar to Fig. 1, can be applied directly to the electron dielectric between the plates of the condenser of the secondary circuit. The transformation of energy in the electron gas may also be improved further if in accordance with Fig. 4 a large number of small dipoles D, D', D'' . . . insulated from each other are arranged within the gas discharge and preferably in such manner that their axes are situated in the direction of the glow current. For mounting them, the small dipoles which may be produced as metal chips also for waves of a fraction of a millimeter, are simply glued on a glass disk or mica disk. The walls of the gas discharge chamber and the electrodes may be so constructed that the radiation energy is simultaneously concentrated upon the dipoles, in other words they may be formed as hollow reflectors or as a reflecting cup placed in front. If the small resonators undergo oscillations the resonance voltages appearing at the ends thereof affect the conductivity and dielectric constant of the surrounding electron gas, so that the resultant parallel resistance as well as the capacity of the glow discharge of the impinging oscillation energy vary proportionately. It is seen that in accordance with this method waves below 1 mm. in length can be detected and can even be demodulated.

Having described my invention, what I claim as novel and desire to secure by Letters Patent is:

1. A circuit for receiving and detecting ultra-high frequency electrical waves, comprising a body of gas and means for causing ionization therein, an oscillatory circuit having capacity which includes at least a portion of said gas as its dielectric, means for exciting said circuit at a frequency near its natural frequency, means for impressing on said gas an ultra-high frequency electric field whereby to affect an electrical property of said gas and thereby the impedance of said circuit, and means to indicate the variation in impedance of said circuit and thereby to indicate said high frequency field.

2. A circuit for receiving and detecting ultra-high frequency electrical waves according to claim 1 wherein the body of gas has contained therein a plurality of dipoles which are tuned to the received ultra-high frequency waves.

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