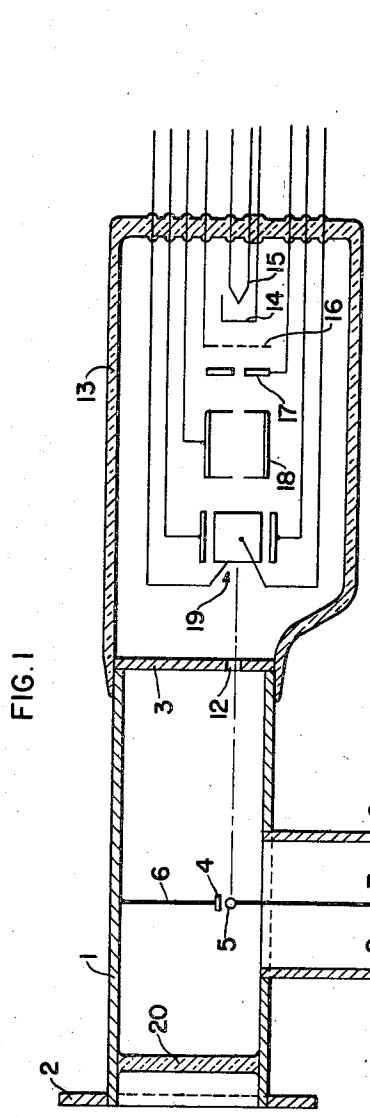
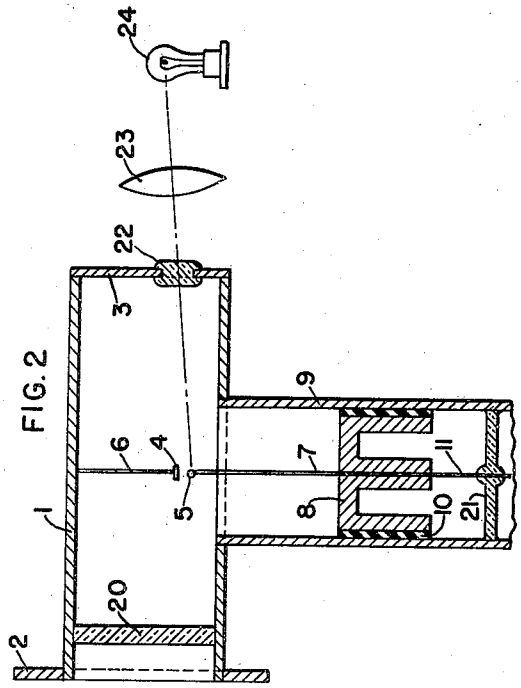
July 15, 1947. J. D. SCHANTZ 2,423,998

ELECTRON DISCHARGE DEVICE

Filed April 30, 1943





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Patented July 15, 1947 2,423,998

UNITED STATES PATENT OFFICE

2,423,998

ELECTRON DISCHARGE DEVICE

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Application April 30, 1943, Serial No. 485,172

7 Claims. (Cl. 250—174)

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This invention relates to electron discharge devices and particularly to devices of this character suitable for use as signal translators in systems employing ultra high frequency waves propagated through dielectric wave guides.

According to conventional practice with ultra high frequency apparatus including dielectric wave guides utilized for the propagation of electric waves, it is necessary to employ electron discharge devices for numerous purposes, such as generators, modulators, frequency converters, demodulators and the like. These devices of necessity are located within the wave guide.

As is well understood in the art, new techniques are required to operate the electronic devices because of the extremely high frequencies employed. Many problems have arisen in connection with these new techniques and some have been solved more or less satisfactorily. One of the problems still confronting those skilled in the art is that of supplying power to the electronic devices from a source located externally of the wave guide.

Certain arrangements heretofore have been devised for supplying power to the cathode heater element of an electron discharge device disposed within a wave guide. One expedient has been to place the lead-in wires to the heater element within the central conductor of a coaxial transmission medium connecting with the wave guide. This practice has been attended with a number of difficulties including those arising as a consequence of thermal expansion. Consequently, it is now generally preferred to use a crystal detector as a demodulating or frequency converting element. However, this type of device has not proved to be completely satisfactory for the reason that the operating characteristics thereof are subject to relatively frequent and radical changes.

It is an object of the present invention therefore, to provide novel means to energize for electron emission, the cathode of an electron discharge device disposed within a dielectric wave guide which will obviate the difficulties heretofore encountered.

Another object of the invention is to provide means to energize for electron emssion, the cathode of an electron discharge device disposd within a dielectric wave guide from a source external to the guide without employing a physical connection between the cathode and the external source.

A further object of the invention is to provide means to energize for electron emission, the cathode of an electron discharge device disposed

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within a dielectric wave guide by the electronic bombardment thereof from a source of electrons located outside of the guide.

Still another object of the invention is to provide means to energize for electron emission, the cathode of an electron discharge device disposed within a dielectric wave guide by the impingement thereon of light energy from a source external to the guide.

In accordance with the invention, there is provided a section of a dielectric wave guide in which there is disposed an electron discharge device having an anode and a cathode. A source of spatially projectable energy is located externally of the guide and means are provided for impinging upon the cathode electron emission—producing energy derived from the external source through a portion of the guide pervious to the energy.

More specifically there is provided, in accordance with one of the illustrated embodiments of the invention, a terminating section of a dielectric wave guide in which there is disposed an anode and a cathode. The anode and the cathode are located in the wave guide in a position effective to translate the ultra high frequency wave energy propagated through the wave guide. A small aperture is provided in the guide in alignment with the cathode and there is provided externally of the guide in alignment with the cathode and the aperture, a conventional electron gun by means of which the cathode may be bombarded by an electron stream. The electron bombardment is utilized to condition the cathode for either the thermionic or secondary emission of electrons therefrom.

Alternatively, the cathode may be made of, or coated with, photoelectric material and the external energy source may be a light. The light energy is directed upon the cathode through a light pervious aperture in the wave guide, whereby to effect the emission of photoelectrons by the cathode.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the accompanying drawing:

Fig. 1 is a diagrammatically illustrated embodiment of the invention employing a source of electron energy as the electron emission producing agent; and

Fig. 2 is another diagrammatically illustrat-

ed embodiment of the invention employing a source of light energy as the electron emission producing agent.

Referring now to Fig. 1 of the drawing, there is shown a terminating section 1 of a hollow dielectric wave guide including a flange 2 for connection to other wave guide structure and an end plate 3. An electron discharge device, illustrated as a diode, is mounted within the wave guide 1 and includes an anode 4 and a cathode 5. The anode is connected by a small stiff wire 6 to the upper wall of the wave guide. The cathode also is connected by a thin stiff wire 7 to a wave filter member 8.

The filter member 8 is generally cylindrical in form and is disposed in a duct 9 connected with the wave guide 1. Interposed between the filter member 8 and the inside wall of the duct 9, is a thin sheet of insulating material 10 such as a polystyrene ribbon. There is connected to the underside of the filter member 8, the central conductor 11 of a coaxial transmission line of which the duct 9 is the outer or concentric conductor.

The end plate 3 of the wave guide is provided with a small aperture 12 which is in alignment with the cathode 5. Sealed to the end of the wave guide 1 beyond the end plate 3 is an envelope 13 which may be of glass or metal as desired. Disposed within the envelope 13 is a conventional electron gun structure including a cathode 14 with a heater 15, a control grid 16, an accelerating anode 17, of focusing anode 18 and a set of deflecting plates 19. The longitudinal axis of the electron gun is disposed in alignment with the end plate aperture 12 and the cathode 5.

In the wave guide 1, adjacent the flange 2, is a glass plate 20 which is sealed to the inside walls of the wave guide. There also is provided, in the duct 9 beyond the filter member 8 from the point of junction with the wave guide 1, a glass plate 21 through which the central coaxial conductor 11 extends. This plate is sealed to the side walls of the duct 9 and also the conductor 11.

The wave guide 1, housing the anode 4 and the cathode 5, the envelope 13 and the portion of the coaxial cable above the glass plate 21 are evacuated. The glass plate 20 is substantially pervious to the electric waves propagated into the wave guide 1 and the relatively small effect produced upon the propagation of the wave by the glass plate may be compensated by means of suitable matching devices located in a preceding connecting section of the guide in a manner well known in the art. However, the end plate 3 is impervious to the electric waves and, therefore, serves to prevent their propagation beyond the end of the guide and to effect their reflection back into the guide. The small aperture 12 in the end plate 3 does not affect appreciably the functioning of the plate.

For optimum performance, the anode 4 should be spaced from the upper wall of the wave guide 1 a distance which is substantially equal to one-fourth of the wave length of the high frequency waves. Also the cathode 4 should be spaced from the upper surface of the filter element 8 a distance which is substantially equal to one-half of the wave length of the high frequency waves. In order to minimize the electrostatic capacity between the anode and the cathode, the respective elements are made as small as practical and the spacing

therebetween is maintained at a minimum. Additionally, the anode and cathode are spaced from the end plate 3 at a suitable distance to derive the benefit of the wave energy reflected from the end plate as well as the wave energy directly propagated into the wave guide.

Referring now to the operation of the described apparatus, the diode formed by the anode 4 and the cathode 5 may be employed for any of the customary purposes of a diode, that is, it may be used as a demodulator of the ultra high frequency signals impressed thereon or it may be utilized as a frequency converter. In the latter case there is introduced into the wave guide 1, from a preceding section connecting therewith (not shown), the ultra high frequency wave and a wave having a frequency to beat therewith in accordance with conventional superheterodyne practice. In this case the diode formed by the anode 4 and the cathode 5 functions to convert the modulated high frequency waves into the modulated intermediate frequency wave.

The load or utilization circuit for the diode should be connected to the coaxial line formed by the concentric and central conductors 9 and 11 respectively, in any well known manner (not shown). The load circuit may include low frequency coupling apparatus or intermediate frequency amplifying apparatus depending upon whether the diode serves as a demodulator or as a frequency converter. Also, associated with the diode load circuit, there is assumed to be employed a suitable conventional direct current connection, whereby to provide an external circuit between the electron gun cathode 14 and the diode cathode 5. Such a connection is not shown since it is considered to be obvious to those skilled in the art and, of course, also should provide means for maintaining the potential of the diode cathode 4 at a higher positive value than that of the electron gun cathode 14.

In order to condition the cathode 4 for electron emission, whereby to enable the diode to perform its desired function, a stream of electrons derived from the electron gun housed in the envelope 13 is impinged upon the cathode. The cathode may be provided with material which is heated by the electron impingement sufficiently to cause thermionic electrons to be emitted therefrom. Alternatively, the cathode may be formed of secondary electron emissive material whereby, upon impingement by the electron stream derived from the gun, there is emitted by the cathode, secondary electrons in sufficient quantities to enable the diode to function.

It also is contemplated that the invention may be embodied in a device wherein the cathode 5 is formed of photo-electric material. Such an embodiment is illustrated in Fig. 2 to which reference now will be had. Components of this structure which are similar to corresponding components of the structure illustrated in Fig. 1, are given like characters of reference. In the illustrated form of such a device, there is sealed into a small aperture formed in the end plate 3, a glass bead or small lens member 22.

External to the wave guide 1, there is disposed an optical system represented by a lens 23 and a source of light represented by the lamp 24. The lamp and the two lens members 22 and 23 are disposed relatively to the cathode 5 in a manner to direct a concentrated beam of light energy at the cathode. The cathode is provided with photoelectric material so that, as it is impinged

by the beam of light energy, it is conditioned to effect an emission of photoelectrons, whereby the diode is rendered operative.

This latter arrangement has the advantage that, if desired, the diode alone including the anode 4 and the cathode 5 may be disposed in a small evacuated envelope from which suitable conductors are brought out much in the manner of a conventional device of this character. In this case, it then is possible to dispense with the sealed glass plates 20 and 21 and thereby to render unnecessary the evacuation of a substantial portion of the wave guide 1 and the connecting coaxial line formed by the concentric and central conductors 9 and 11 respectively.

It is apparent that a device in accordance with the instant invention possesses distinct advantages over the prior art means of conditioning for electron emission, the cathode of an electron discharge device disposed within a dielectric wave guide. It provides a means for accomplishing this result without the use of lead-in wires to the interior of the wave guide and thus avoids the difficulties encountered by such practice. It is obvious that the invention may be employed to energize the cathodes of electron discharge devices other than the diode used for illustration herein.

While there has been described what, at present, is considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electron discharge device comprising, a dielectric wave guide having a portion pervious to spacially projectable energy, an anode and a cathode disposed within said guide, said cathode being capable of electron emission by impingement thereof by spatially projected energy, a source external of said guide of spatially projectable energy, and means including directive apparatus located external of said guide for projecting energy derived from said source through said pervious wave guide portion for impingement upon said cathode.

2. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of electron emission by impingement thereof by spatially projected electronic energy, a source external of said guide of spatially projectable electronic energy, and means external of said guide for projecting electronic energy derived from said source through said wave guide aperture for impingement upon said cathode.

3. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of thermionic electron emission by impingement thereof by spatially projected electronic energy, and means including an electron gun external of said guide for projecting electronic energy through said wave guide aperture for impingement upon said cathode.

4. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of secondary electron emission by bombardment thereof by spatially projected electronic energy, and means including an electron gun external of said guide for projecting electronic energy through said wave guide aperture for the bombardment of said cathode.

5. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of photoelectron emission by the impingement thereof by a beam of light, a source of light disposed externally of said wave guide, and means adjacent said wave guide for projecting a concentrated beam of light derived from said source through said wave guide aperture for impingement upon said cathode.

6. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of photoelectron emission by impingement thereof by a beam of light, a source of light disposed externally of said wave guide, and means disposed between said light source and said cathode for projecting a concentrated beam of light derived from said source for impingement upon said cathode.

7. An electron discharge device comprising, a dielectric wave guide having an aperture, an anode and a cathode disposed within said guide, said cathode being capable of photoelectron emission by impingement thereof by a beam of light, a source of light disposed externally of said wave guide, and means located externally of said guide for projecting a concentrated beam of light derived from said source through said wave guide aperture for impingement upon said cathode.

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