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TRANSMISSION LINE APPARATUS HAVING A NON-LINEAR DETECTOR ELEMENT AND A DIRECT-COUPLED LINE-TERMINATING RESISTOR IN CLOSE ELECTRICAL PROXIMITY

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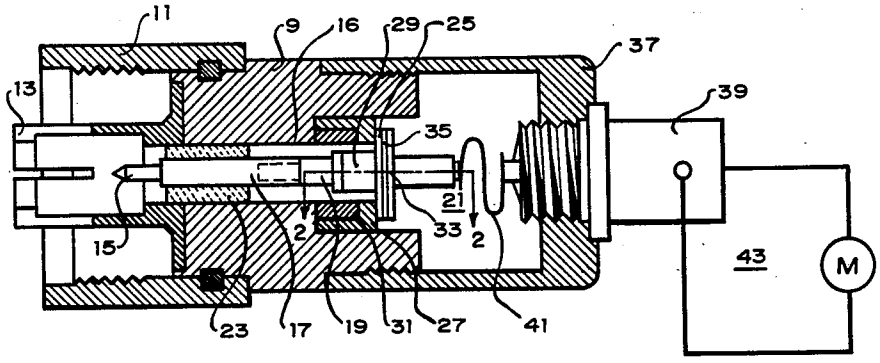


Fig. 1

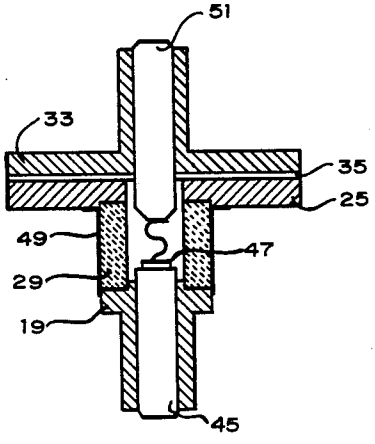


Fig. 2

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TRANSMISSION LINE APPARATUS HAVING A NON-LINEAR DETECTOR ELEMENT AND A DIRECT-COUPLED LINE-TERMINATING RESISTOR IN CLOSE ELECTRICAL PROXIMITY

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This invention relates to power detecting devices and more particularly to a crystal rectifier and mount therefor which provide substantially flat power detection and low voltage standing-wave ratio over a wide band of frequencies.

Crystal detectors for monitoring power in coaxial transmission lines generally comprise commercially available crystal rectifiers and other circuit elements contained within a mounting fixture. These elements are disposed within the fixture to provide not only a detector output signal but also termination for the transmission line. The power which is applied to the detector from a coaxial line is received within the fixture by the crystal rectifier and by a resistive device. The output signal is provided by the crystal rectifier and the line termination is provided by the resistive device. Since the package which surrounds the crystal rectifier of a commercially available unit is fairly bulky, the resistive device is generally located a considerable distance from the crystal rectifier. Crystal detectors of this type are described in U.S. Patent 2,810,829 issued to N. B. Schrock on Oct. 22, 1957.

Crystal detectors of this type generally provide, over a wide band of frequencies, power detection signals having characteristic curves which are flat only to within three decibels and voltage standing-wave ratios of the order of 2.5 to 1. Variations in the output signal and in the standing-wave ratio are due primarily to the distance between the crystal rectifier and the resistive device, and are particularly large if this distance is around one-quarter wavelength of the applied signal. In addition, large reflections are produced by the crystal rectifier. Thus, the impedance of the rectifier as seen at the terminals of the resistive device may vary widely with changing frequency. This impedance may be quite low at frequencies for which the distance approaches one-quarter wavelength. It is necessary to insert an additional resistance in series with the crystal rectifier to maintain high impedance at these critical frequencies. At other frequencies the impedance of the crystal rectifier as seen at the terminals of the resistive device can become very high. Thus the design of a broadband crystal detector which properly terminates the transmission line over a wide range of frequencies involves a compromise between these two extreme conditions. The disadvantages generally inherent in the resulting design include poor line termination and the development of power detection signals having characteristic curves which are flat only to within a few decibels substantially over the entire operating band. Thus, in applications requiring power detection signals having characteristic curves which are flat to within 0.5 decibel or less and requiring low voltage standing-wave ratios over a broadband of frequencies, it is desirable to eliminate the effects of the distance between the crystal rectifier and the resistive device. In addition, it is desirable to provide a simple mounting fixture for these elements which can be readily manufactured.

Accordingly, it is an object of the present invention to provide an improved power detector.

It is another object of the present invention to provide a crystal rectifier which can be used in a simple mounting fixture to terminate a transmission line and to provide a power detection signal.

It is still another object of the present invention to provide a power detector in which the crystal rectifier and terminating resistance are combined in a single unit.

In accordance with the illustrated embodiment of the present invention the required terminating resistor and crystal rectifier are contained in a single unit. The unit includes two sections which are adapted to be connected to the conductors of a transmission line and which are separated by an insulator. A resistance film deposited about the insulator connects the two sections. A capacitor to pass the high-frequency energy is provided by a third section disposed near one of the two sections. A crystal rectifier is connected between the other of the two sections and the third section. The unit is contained in a fixture or mount which includes a conventional type-N coaxial connector and an output connector. A ring of lossy material is disposed about the unit to improve the standing-wave ratio and flatten the characteristic curve of the detector output signal over the operating band of frequencies.

These and further objects of the present invention will be apparent from a reading of this specification when taken in connection with the accompanying drawing in which:

FIGURE 1 is a cross-sectional view of a coaxial power detector in accordance with the present invention, and

FIGURE 2 is an enlarged cross-sectional view of the apparatus used in the detector of FIGURE 1.

Referring now to the cross-sectional view of the detector in FIGURE 1, there is shown an envelope **9** attached to the outer ring **11** and the ground conductor **13** of the conventional type-N connector. The high frequency signal under test is applied to the power detector through the ground connector **13** and connector pin **15** from a coaxial transmission line. A short section of transmission line is provided by the inner surface **16** of envelope **9** and the conductive path including connector pin **15**, inner conductor **17** and the first section **19** of apparatus **21**. The elements of this transmission line are held in coaxial alignment by insulator **23**. Apparatus **21** is connected to receive the signal appearing on this transmission line between the first section **19** and the second section **25**. These two sections of the apparatus **21** are coaxially aligned and are bonded to the opposite ends of the cylindrical insulator **29**. A resistive film **49** deposited on the insulator **29** and connected between the two sections thus serves as a terminating resistor for the transmission line. A third section **33** of apparatus **21** is attached to the second section **25** and is insulated therefrom by a layer of dielectric material **35**. These two sections provide a capacitive path to ground for high frequency signals appearing on section **33**. A non-linear device such as a semi-conductor diode **47** or variable reactor is disposed within the insulator **29** and is connected between the first and third sections of the apparatus. A ring of lossy material **31** is disposed about the first section **19** and is held in place by the ground ring **27**.

An outer cap **37** is attached to envelope **9** and contains a coaxial connector **39**. Spring means **41** attached to the center conductor of connector **39** bears against the third section **33**. The second section **25** of the apparatus thus bears against and is in electrical contact with the ground ring **27**. The spring means not only provides electrical connection but also maintains the components of the power detector in the proper positions. An utilization circuit, which may be a meter circuit or other indicating circuit **43**, is connected between the inner and outer conductors of connector **39**.

The electrical separation between the line terminating

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resistor and the non-linear detector element is reduced substantially to zero in the present invention. The critical relationship which exists in conventional power detectors between the spacial separation of elements and the wavelength of an applied signal at a particular frequency is thus eliminated. Substantially constant line termination and hence, low voltage standing-wave ratio over a broadband of frequencies is obtained. In addition, the flatness of the detector output signal is improved by the ring **31** of lossy material about the conductive path of the transmission line. This material may be of a type which is responsive to the magnetic fields about the conductive path and increases the power loss in the transmission line as the frequency of the applied signal increases. It is believed that this material has the effect of introducing resistance in the transmission line in series with the non-linear detector element. This effect further improves the voltage standing-wave ratio and flattens the frequency response characteristic of the detector. In one embodiment of the present invention the impedance of the power detector decreases with increasing frequency. This causes the voltage standing-wave ratio to increase. Placing the ring **31** of lossy material around the conductive path has the effect of inserting resistance in series with the power detector. This effective series resistance adds to the impedance of the power detector. The combination of the effective series resistance and the impedance of the power detector terminates a coaxial line with a lower voltage standing-wave ratio than is possible without the aid of the lossy material.

The apparatus **21** of FIGURE 1 is shown in cross-sectional view in FIGURE 2. The first section **19** includes a wafer post **45** to which is attached a wafer **47** of semiconductor material. The first section **19** is bonded to one end of the cylindrical insulator **29** and the second section **25** is bonded to the opposite end of the insulator **29**. A film of resistive material **49** is deposited on the surfaces of insulator **29** in contact with the first section **19** to the second section **25**. The third section **33**, which includes whisker post **51**, is attached to the second section **25** by a layer **35** of dielectric bonding material. The high frequency signal is applied to the apparatus between the first and second sections, as shown in FIGURE 1. The second section **25** is connected at ground potential. A signal thus appearing on the first section **19** is terminated by the resistive film **49** which has a resistance that is substantially equal to the characteristic impedance of the transmission line to which the apparatus is connected. In addition, the signal appearing on the first section **19** is rectified by the non-linear element including wafer **47** and appears on the third section **33** as the detector output signal. The second and third sections of the apparatus constitute a by-pass capacitor for shunting any high frequency signal appearing on the third section **33** to ground.

The apparatus of the present invention thus reduces the spacial separation between the line terminating resistor and the crystal rectifying unit substantially to zero. The advantage of combining these elements in a single unit is that the operating characteristics of the present apparatus are substantially free from the variations in response with changing frequency inherent in conventional power detectors. In addition, the apparatus and mount therefor of the present invention provide extremely flat frequency response and low voltage standing-wave ratios over a broadband of operating frequencies. Further, the power detector of the present invention combines desirable operating characteristics with ease and simplicity of manufacture.

We claim:

1. High frequency signal apparatus comprising a first section and a second section axially separated from said first section by an insulator, an output section disposed near said second section and insulated therefrom, a non-linear circuit element within said insulator and connecting said output section and the first section, and resistance means on said insulator and connecting the first and second sections.

2. High frequency signal apparatus comprising a first section and a second section axially separated from said first section by an insulator, an output section, a rectifying element connecting said output section and the first section, resistance means disposed about said insulator and connecting said first and second sections, and capacitance means connecting the output section and said second section.

3. High frequency signal apparatus comprising first and second sections separated by an insulator, an output terminal, a non-linear circuit element connecting the output terminal and said first section, the apparatus being adapted to receive a high frequency signal between the first and second sections, and resistance means on said insulator connecting said first and second sections.

4. High frequency signal apparatus comprising first and second sections disposed coaxially at opposite ends of a cylindrical insulator, the apparatus being adapted to receive a high frequency signal between the first and second sections, a third section disposed near said second section and separated therefrom by a dielectric, an unidirectional conduction element within the insulator and connecting the first and third sections, a resistive film deposited about said insulator and connecting the first and second sections, and means connected to said second and third sections for deriving an output from said device.

5. A signalling device comprising an envelope and means forming a conductive path within said envelope, apparatus within said envelope and including first and second conductive sections disposed at opposite ends of a cylindrical insulator, said first section being connected to said means forming said conductive path and said second section being connected to said envelope, resistance means disposed about said insulator and connecting said first and second sections, a third conductive section disposed near said second section and separated therefrom by a dielectric, a non-linear device within said insulator and connecting said first and third sections, a ring of lossy material disposed coaxially about said insulator, the material being responsive to the electromagnetic field about said conductive path and introducing power loss that increases with frequency, and means connected to said envelope and said third section and forming an output circuit for said device.

6. A signalling device comprising an envelope and means forming a conductive path therewithin, apparatus within said envelope including first and second conductive sections separated by an insulator, said first section being connected to said means forming said conductive path and said second section being connected to said envelope, resistance means disposed about said insulator and connecting said first and second sections, a third conductive section disposed about said second section and separated therefrom by a dielectric, a non-linear element within said insulator and connecting said first and third sections, and means connected to said third section and to said envelope and forming an output circuit for said device.

References Cited by the Examiner

UNITED STATES PATENTS

2,510,613	6/50	Weber et al.	333—81
2,557,122	6/51	Leiphart	329—162
2,636,120	4/53	Bird et al.	329—162 X
2,810,829	10/57	Schrock	329—162

ROY LAKE, *Primary Examiner.*