

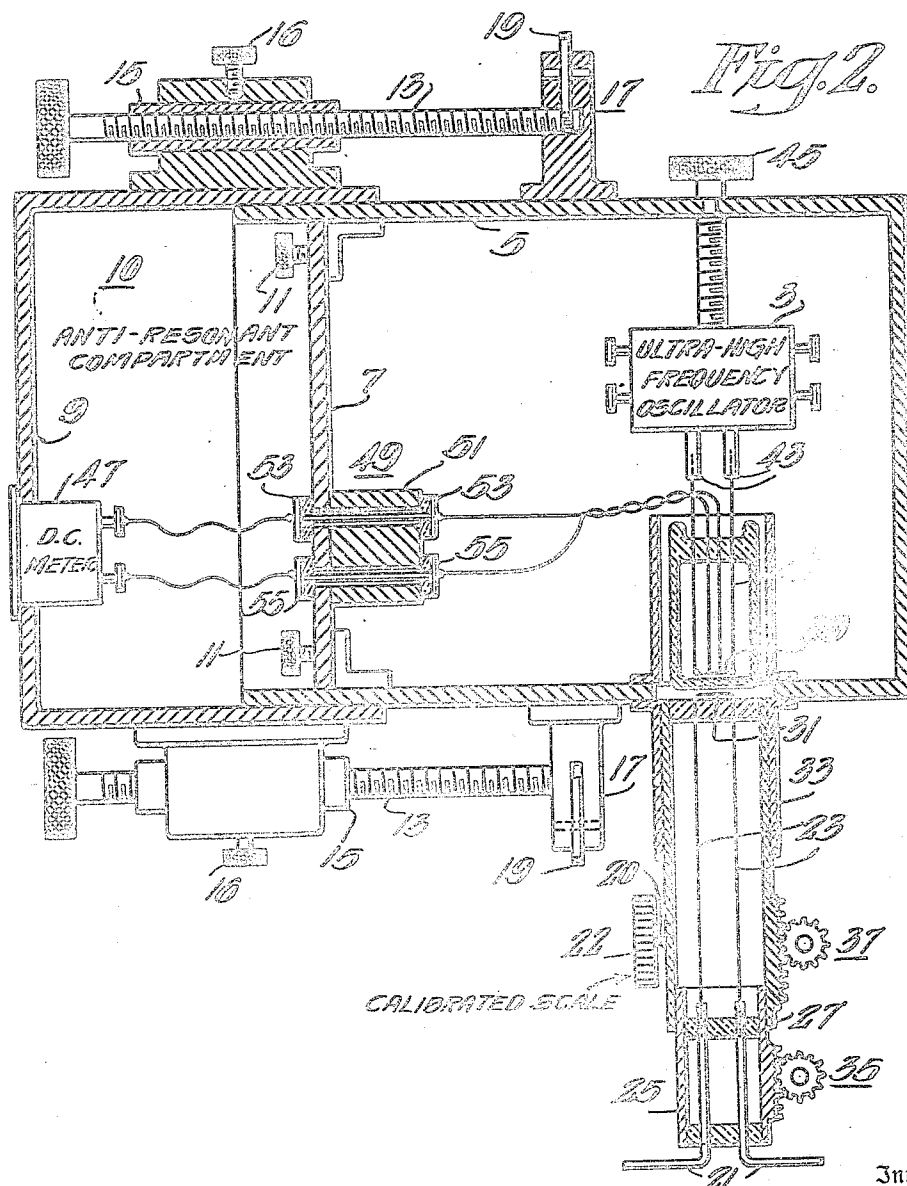
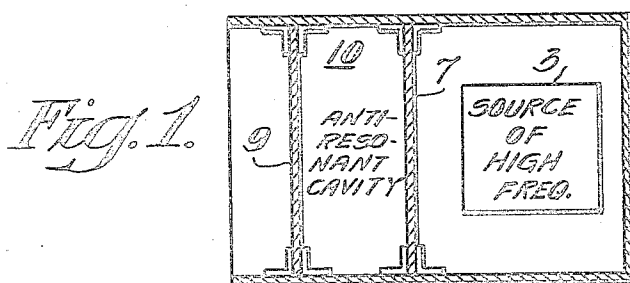
Sept. 22, 1942.

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2,296,678

ULTRA HIGH FREQUENCY DEVICE

Filed June 25, 1940



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UNITED STATES PATENT OFFICE

2,296,678

ULTRA HIGH FREQUENCY DEVICE

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Application June 25, 1940, Serial No. 342,236

9 Claims. (Cl. 250—36)

This invention relates to ultra high frequency radio devices, and more particularly to an improved shielding system for microwave radio apparatus. It has for its principal object the provision of an improved microwave signal generator.

The use of signal generators in aligning, testing and measuring radio receivers and other radio apparatus is well known. For the measurement of sensitivity, for example, the receiver is coupled to the generator and the output of the generator reduced by an attenuator until the receiver output is equal to some predetermined standard value. The amplitude of the signal generator output may be reduced to several microvolts where the receiver sensitivity is fairly high.

It is, of course, necessary for the generator output terminals to be the sole source of energy for the receiver if the measurement is to have any meaning. Unfortunately, however, this is not easily accomplished, since a certain amount of leakage is usually found, particularly at high frequencies. For this reason, signal generators are always carefully shielded. However, shielding which is satisfactory in the low and even in moderately high frequency ranges is entirely inadequate in ultra high frequency or microwave ranges.

I have discovered that the principal cause of leakage is the relatively poor contact between the main portion of the container and removable portions, such as doors and partitions, which of necessity cannot be welded or soldered into place. For example, tube replacements must sometimes be made, and it is therefore customary to provide one or more removable sections which are normally retained in place by thumb or machine screws. Phosphor bronze springs bearing on the surface of the removable section are of some help, but they do not solve the problem. The result is that it has heretofore been extremely difficult to keep the leakage radiation down to a proper level. Another source of trouble is the leakage which occurs through and around the various meters and controls which are mounted in the front panel of the generator.

In accordance with the present invention, this radiation or leakage is minimized by providing anti-resonant cavities or compartments in which the energy leaking through the removable sections of the shield is tuned out. Alternatively, the shielding container itself is made to have such a size that it is non-resonant at the desired operating frequency.

Additional objects of this invention include the provision of an improved method of and means

for preventing radiation loss from a source of ultra high frequency energy; the provision of an improved system for preventing radiation through and around instruments mounted in the panel of a radio device; the provision of an improved attenuator for a signal generator, and the provision of an improved capacitor arrangement for insuring adequate bypassing on conductors which may have standing waves along their length.

This invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope is indicated by the appended claims.

Referring to the drawing,

Figure 1 is a simplified drawing of a shielding system in accordance with the present invention; and

Figure 2 is a view, partly in cross-section, of an ultra high frequency generator embodying this invention.

Similar reference numerals refer to similar parts throughout the several figures of the drawing.

Fig. 1 illustrates a high frequency energy source 3, which is an oscillator, amplifier or any other radio apparatus which requires shielding to prevent radiation or to protect it from high frequency energy in the surrounding area. This device is mounted in a shielding container 5 which is, for example, a metallic box closed on five sides by solidly welded or soldered sections, or constructed in one piece, through which no leakage can occur. The sixth side 7 is removable to provide access to the apparatus. The removable side 7 may be a hinged door or a removable plate held in place by screws, or any other construction which is expedient. As pointed out above, however, even when the abutting surfaces are clean and tight some leakage will occur, and this increases from day to day as the contacting surfaces of the metal oxidize. To minimize this leakage radiation, a second removable shielding member 9 is provided, which forms a cavity 10 adjacent the first removable section 7. The inventor is aware, of course, that it is not new to provide merely two shields in the place of one. What is new, however, is the discovery that radiation can be more nearly eliminated by making the size of the cavity 10 such that it is anti-resonant at the operating frequency. This is true even when there is relatively poor contact between the container 5 and the two shielding members 7 and 9. They may even contain small apertures therein for ventilation without affecting their operation.

It is known that when radio frequency energy is introduced into a compartment which is relatively large with respect to the wavelength of the energy, standing waves may be set up therein by reason of the successive reflection of the waves from the walls of the compartment. By adjusting the dimensions of the compartment, an optimum value will be found at which the field intensity will be a maximum. Such a condition is utilized in the so-called "resonant cavity" oscillators, and the like, as is well known.

On the other hand, a further adjustment of the dimensions may be made to determine a condition of minimum field intensity, which is herein termed a condition of anti-resonance. These maxima and minima may readily be determined by means of a radio frequency voltmeter and a small test prod which is introduced into the cavity. I have found that when the compartment 16 is adjusted in this manner to a condition of anti-resonance, substantially all the undesired radiation from the device 3 is eliminated. The adjustment is quite critical, and means should be provided for making an accurate adjustment. Such a means is illustrated in Fig. 2, to which reference is now made.

The radio device 3 is, in this case, a magnetron oscillator which is mounted in a metallic shielding container 5, one end of which is closed by a removable partition 7, held in place by thumb screws 11, for example. The same end of the main shield is also closed by a telescoping lid 9, which snugly fits around the open end of the main compartment to form the anti-resonant compartment with the removable partition.

To facilitate quick adjustments of the apparatus, an adjusting means is provided which permits the lid to be removed and replaced exactly in its former position without making necessary a complete readjustment of the device. This is accomplished by providing one or more adjusting screws 13, preferably two, which are threaded into collars 15 mounted on the lid 9. Each adjusting screw is provided with an annular slot at its end adapted to be engaged by a ratchet 19 of a holding mechanism 17. When the ratchet is released the adjusting screw and the entire lid may be removed. It may also be replaced in exactly its former position without the necessity of making readjustments. Coarse preliminary adjustments are made by loosening the set screws 18 and 19 which hold the collars 15 in place.

Output from the generator is taken from a dipole antenna 21 which terminates a telescoping tunable transmission line 23 mounted within telescoping shielding cylinders 25 and 27. Adjustment of the length of this line for tuning it to resonance is accomplished by means of a rack and gear arrangement 33. The inner end of this line terminates in a short length of conductor 31, the entire line as well as the shielding cylinder 27 being movably mounted in a fixed shielding can 35 mounted on the main generator box 5. The entire line 23 is moved by a rack and gear 37 to vary the output. The attenuation ratio is indicated by a pointer 39 and scale 22.

The conductor 31 is parallel and coupled to the heater element 39 of a thermocouple 41. This thermocouple is mounted in an evacuated glass envelope having a flat end parallel to the heater element. The heater is placed as close as possible to the envelope to obtain the maximum coupling between the heater element and the output transmission line. The leads within the thermocouple are preferably spaced apart a distance 75

equal to the spacing of the input transmission line 43 to which they are connected, thus forming an uninterrupted continuation of the line. The couple is connected to the middle of the heater, and is at right angles to it to prevent coupling. The input line couples the oscillator or source 3 to the thermocouple. Its length is adjustable and, since the thermocouple end is preferably fixed, the entire oscillator assembly is mounted on wheels and its position is controlled by a screw adjustment 45.

The heater element of the thermocouple constitutes the terminating impedance of the line, and also functions as the coupling element between the input and output transmission lines. The output energy may be attenuated to any desired value by increasing the spacing between the two lines. An important advantage of this arrangement is that the D.-C. current derived from the thermocouple element and indicated by a meter 47 is proportional to the current flowing in the coupling element itself. This is not so in previous systems in which the thermocouple is usually connected in parallel with the line, and not used as a coupling element. In the prior arrangement the leads between the point of coupling and the heater are sufficient to cause the current in the heater to be quite different from that in the coupling conductor. In the present arrangement it will be appreciated also that this condition exists no matter how the transmission lines are tuned or detuned. On the contrary, in the former arrangement the line and the conductors to the thermocouple must be tuned at all times to maintain the calibration of the device.

It will be observed that the output meter 47 is mounted in the anti-resonant compartment. Normally the meter would permit considerable radiation from within the generator, but in the present instance the wave energy in the compartment is a minimum, as pointed out above, so that this radiation is greatly reduced. While the meter has been illustrated in the removable anti-resonant compartment 9, it will be appreciated that the meter may be mounted in the other end of the generator and a second anti-resonant compartment provided to take care of the output meter and any other controls or meters which are employed.

Particular attention is directed to the unique by-pass capacitor 49 which is utilized to remove all traces of radio frequency energy from the D.-C. leads connected to the meter 47. This capacitor comprises a block of brass, aluminum or similar material, 51, having two holes drilled therethrough. The dimension of the block along the axis of the holes is approximately a quarter wavelength at the average operating frequency. Its width is of the same order, while its length is of any convenient dimension and will depend upon the number of conductors which are to be filtered. It will be understood that any number of sections may be provided, although only two have been illustrated.

The block is securely mounted on the shielding container 5, or on the partition 7, although the former arrangement is more convenient. Each conductor passes through the holes provided in the brass block, and to increase the capacity between the lead and the grounded block discs 53, 55 may be soldered to the leads adjacent each surface of the block, and insulated therefrom by suitable insulators such as mica or the like.

The purpose of this arrangement is to make certain that the leads are grounded at a point which is not a voltage node. Since the leads are effectively grounded through a length equal to a quarter wave, some point within the block will necessarily be that corresponding to a voltage loop, and hence the grounding will be effective. This arrangement is particularly advantageous where the device is operated over a wide range of frequencies, since the bypassing will be uniform and equally effective notwithstanding changes in the standing wave distribution along the lines.

The invention thus involves an improved anti-resonant shielding system for ultra high frequency radio devices, and is not restricted to the particular embodiment thereof. It is to be understood that many different embodiments of this invention will occur to those skilled in the art. This invention, therefore, is to be limited only by the prior art and the spirit of the appended claims. Claims specific to elements shown and described but not covered by the appended claims will be found in my copending application, Serial No. 400,488, filed June 30, 1941, for Indicators.

I claim as my invention:

1. In a radio device, a shielding container enclosing a source of ultra high frequency oscillations, a removable partition dividing said container into separate compartments, one of said compartments containing said source, the size of the other of said compartments being adjusted to a condition of anti-resonance at the frequency of said oscillations whereby the electric field strength in said other compartment due to leakage around said removable partition is minimized.

2. A shielding container for preventing undesired radiations from a source of ultra high frequency oscillations, said container having a removable inner wall to provide access to the interior of said container, and an outer wall adjustably spaced from said inner wall, the distance between said walls being such that at said ultra high frequency an antiresonant condition is produced and the electric field intensity therebetween is minimized.

3. An ultra high frequency oscillation generator including a source of ultra high frequency oscillations, a shielding container enclosing said source and having a removable portion to provide access to the interior of said container, and an adjustable shielding member spaced from said removable portion and forming a closed anti-resonant compartment at the operating frequency of said generator, whereby leakage radiation around said removable portion is minimized.

4. An ultra high frequency generator including a source of ultra high frequency oscillations, a shielding container for said source having a removable end portion, leakage around said end portion causing undesired radiations from said

generator, and an adjustable shielding compartment enclosing said end portion, said compartment being adjusted to a condition of anti-resonance at the operating frequency to minimize standing waves in said shielding compartment.

5. An ultra high frequency generator including a source of ultra high frequency oscillations, a shielding container having a removable end portion, leakage around said end portion causing undesired radiation from said generator, a shielding compartment enclosing said end portion, and means for slidably adjusting one dimension of said compartment to form an anti-resonant cavity at said operating frequency to minimize standing waves therein and minimize said undesired radiation.

6. In an ultra high frequency generator, a source of oscillations, a shielding container for said source, said container having a removable end portion, a shielding compartment enclosing said end portion, means for adjusting said compartment to produce an anti-resonant condition therein at the operating frequency of said source, and means for deriving output currents from said source.

7. In a radio device, the combination comprising a shielding container, an ultra high frequency radio device within said container, said container having a removable wall portion to provide access within said container, an adjustable member constructed to slide telescopically over said shielding container so as to enclose said removable portion and form therewith an antiresonant compartment at the operating frequency of said device whereby leakage around said removable portion is minimized.

8. An ultra high frequency radio device which includes the combination of a source of ultra high frequency oscillations, a shielding container for said source, said container having a removable end portion, and means adjustably mounted on said container for forming with said end portion an antiresonant compartment at the operating frequency of said device whereby leakage around said removable portion is minimized.

9. An ultra high frequency radio device which includes, in combination, a source of ultra high frequency oscillations, a shielding container for said source, a section of said container being removable to give access to said container, means mounted on said container forming a closed compartment with said section, and means for slidably adjusting the position of said last-named means to tune said compartment to a condition of antiresonance at the operating frequency of said device, whereby standing waves in said compartment due to leakage around said section are minimized and leakage radiation from said container is also reduced.

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