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MIXER TRACKING CAPACITOR

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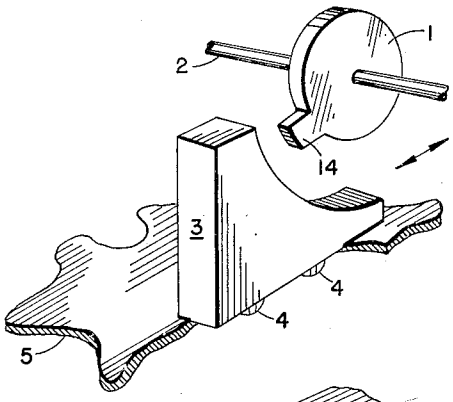


FIG. 1

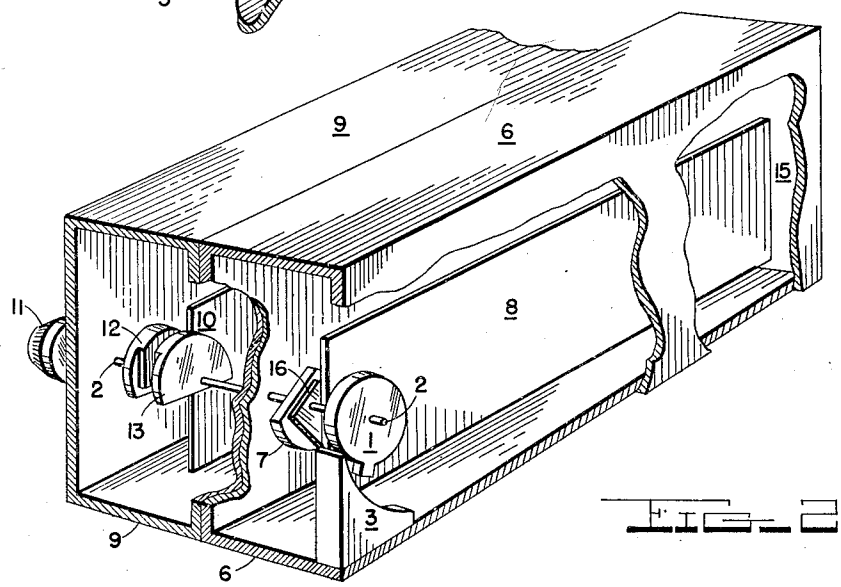


FIG. 2

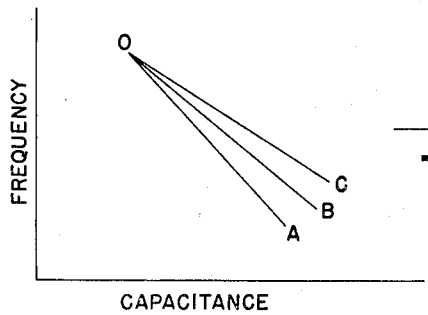


FIG. 3

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MIXER TRACKING CAPACITOR

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4 Claims. (Cl. 178—44)

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This invention relates to variable condensers and more particularly to a novel condenser tuning assembly for use in ultra-high-frequency apparatus.

At frequencies in the ultra-high-frequency regions of the radio spectrum, transmission lines of the two-wire or coaxial type and resonant cavities are commonly used as resonant circuits. When transmission lines and associated thermionic tubes are used at ultra-high-frequencies, the inter-electrode impedances of the tubes have a marked effect on the results obtainable. The natural capacity between the various electrodes, as well as electrode leads, offer large reactive effects at ultra-high-frequencies. These effects render very difficult the proper matching of tuned circuits as, for example, those associated with the heterodyne oscillator and mixer stages of a receiver.

In an ultra-high-frequency superheterodyne receiver it is necessary for proper operation that the heterodyne oscillator frequency track the mixer frequency with a constant frequency difference equal to the intermediate frequency of the receiver. The resonant circuits of both oscillator and mixer consist of similar coaxial line arrangements, the oscillator having in addition a thermionic tube electrically connected to one end of the oscillator coaxial line resonant circuit. The reactive effects of the inter-electrode capacitances of the oscillator thermionic tube change the electrical characteristics of the oscillator line so that at various frequencies the two lines are no longer electrically similar and are separated by a frequency other than the intermediate frequency of the receiver. In accordance with one embodiment of the invention the coaxial transmission line mixer is caused to track properly and simultaneously the frequency changes of the heterodyne thermionic tube oscillator, a common control device being used.

Another object of the invention is to provide a novel condenser assembly for use as a tuning or compensating condenser with coaxial transmission lines.

The nature of the present invention together with other objects and features thereof will appear more fully in the following description of a specific embodiment, reference being made to the appended drawing, in which:

Fig. 1 illustrates in perspective the condenser assembly of the invention;

Fig. 2 shows in perspective an ultra-high-frequency mixer and oscillator employing the new condenser assembly;

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Fig. 3 is a curve showing the variation of frequency with capacity change of the subject condenser.

Referring now to Fig. 1 in more detail, the condenser assembly there shown consists of a disk or flat circular plate 1 having a sector of increased radius 14 and mounted on a shaft 2, the disk being the rotatable or rotor part of the condenser. The non-conducting shaft 2 is so mounted that the rotor plate will easily turn when the shaft is turned by manual or mechanical means. A special-shaped block 3 of brass or other conducting material, having a curved face on the side nearest the rotor and mounted in the same plane as the rotor forms the stationary grounded plate or stator of the condenser. The position of the stator block 3 may be changed or varied in the plane of the rotor and in a direction tangent to the curved face at the ends of the block so that the spacing between the rotor and stator plates of the condenser may be varied. At some position, arbitrarily designated as position B, the curve on the condenser face of the stator block is that of a ninety degree arc of a circle with its center at the center of the shaft 2. The arrow in Fig. 1 designates the direction of motion, the stator being shown in position B.

The stator block may be held in position by any of several means, probably the simplest method being shown in the drawings. Two or more screws 4 pass through a slot in the mounting or base plate 5 of the stator and turn into tapped holes in the stator. By loosening the screws, the stator can be slid back and forth to any desired position and then locked in place by tightening the screws.

The tuning position of the rotor is with the sector of increased radius 14 turned toward the stator block, and extends through that approximately ninety degrees of arc on the curved face of the stator block. When the stator block is fastened in position B, or that position in which the centers of curvature of both the face of the stator block and the rotor plate are coincident, there will be no change in capacitance between the rotor and stator block as the rotor is turned through its normal ninety degree tuning range. When connected in parallel with another variable condenser as is the usual procedure, the net total capacitance during tuning will be that of the usual condenser plus a constant fixed amount depending on the structure of the subject condenser. It is known in the art that the capacitance between two plates is directly proportional to the common area presented by the two plates

and inversely proportional to the distance between them. Therefore, the larger the tooth or sector of increased radius 14 of the rotor, the greater is the maximum capacity of the condenser. Fig. 3 shows the effect of tuning in curve B when the usual condenser is one having linear frequency-capacitance characteristics.

When the stator block is moved closer to the rotor, the tooth or sector of increased radius 14 of the rotor is no longer equidistant from the face of the stator block throughout the ninety degree turn. When the tooth 14 lies parallel to the direction of movement of the stator block, i. e., pointing toward the top of the stator as shown in Fig. 1, the spacing between stator and rotor is a minimum, hence the capacity is maximum. As the rotor is turned through its ninety degree range, the spacing increases, thus decreasing the capacitive effect of the condenser. This effect is shown in curve A of Fig. 3. Similarly, if the stator block is moved away from the rotor, the maximum spacing, hence minimum capacity, is found when the rotor tooth is parallel to the direction of movement of the stator block. Therefore, as the rotor is turned, the spacing will decrease and the capacity will increase. This characteristic is shown in curve C of Fig. 3.

Referring to the curves of Fig. 3, all are seen to intersect at a point 0. This is the point where the capacitance of all curves is substantially equal, occurring when the rotor tooth is at right angles to the direction of movement of the stator block. The curves in Fig. 3 are shown, for explanatory purposes only, to intersect at point 0. It is to be understood that the points of intersection of the curves may vary slightly from a condition of exact coincidence. If, however, the lower end of the stator block extended tangentially to the curvature thereof, and the movement of the stator block, with respect to the rotor tooth when at right angles to the direction of movement, were to be limited to the extended portion, all curves would theoretically intersect at point 0. For a practical working capacitor constructed in accordance with the present invention, the deviations of the curves from point 0 is so slight as to be negligible, therefore eliminating the need for the extended portion of the lower end of the stator block. Hence, it can be seen that the subject condenser acts to change the slope of the frequency-capacitance curve when used in parallel with another condenser. When the stator block is in position B, the characteristic of the curve is that of the standard paralleling condenser. In position C the capacitance increases less rapidly than in position B as the rotor is turned from the point 0, and in position A the capacitance increases more rapidly.

A practical application of this invention is shown in Fig. 2, describing a mixer-oscillator assembly. The problem involving the difficulties of proper tracking between mixer and oscillator stages in an ultra-high-frequency receiver has been stated earlier. To overcome these difficulties the subject condenser is used. The assembly consists of two resonant line sections, a coaxial mixer chamber having a hollow rectangular-shaped outer conductor 6 and a solid rectangular inner conductor 8, and a coaxial oscillator chamber having a hollow rectangular-shaped outer conductor 9 and a solid rectangular inner conductor 10. One end of the oscillator chamber is open, the other end being connected to an electronic tube which is not shown in the drawing since it does not form a part of the invention. One end of the mixer inner conductor is electrically connected to the outer conductor at 15 through a short-circuiting plate, and the other end is open. The two rectangular chambers are placed side by side with the open ends together and a single insulating shaft 2 passes through the two outer conductors, but off the ends of the inner conductors. One end of the shaft terminates in a bearing of suitable type; the other end is connected to a knob 11 or other turning means. Mounted on the shaft in the oscillator chamber are two standard condenser rotor plates 12 and 13. These plates are disk-shaped with a rectangular boss or raised area 16 on the face of the disk extending from the edge of the plate to beyond the center of the disk on the opposite side of the same face. Midway between the center and the edge the disk is cut off, the cut being square with the boss. The plates are positioned with the bosses facing the inner conductor, one on either side of the inner conductor, so that a capacitive effect is obtained between the rotor plates and the inner conductor and the rotor plates and the outer walls of the chamber. Fastened on the shaft in the mixer chamber is one standard rotor plate 7 and the special rotor plate 1 of this invention, one on either side of the inner conductor 8. Facing the special rotor 1 in its proper plane is the movable stator block 3. The two rotors in the mixer chamber also have a capacitive effect to the inner conductor and to the walls of the chamber. Energy is coupled by any suitable known method from the oscillator cavity to the mixer, from the mixer to the first intermediate frequency stage, and from the incoming signal source to the mixer.

The oscillator is tuned through its normal oscillating range by varying the capacitive coupling between the inner conductor plate line and the outer conductor. The frequency - capacitance characteristic curve of the oscillator is essentially a straight line in its usable portion. Hence, in order to obtain the desired intermediate frequency, the mixer signal must be displaced by a constant frequency from the oscillator frequency, or the mixer frequency must lie parallel to the oscillator frequency throughout the tuning range. As stated before, it is very difficult to construct an assembly using conventional equipment which will accomplish this paralleling of frequencies, but by using the subject condenser, proper tracking may be obtained.

Referring again to Fig. 3, the common frequency point 0 is adjusted to the desired value by changing the relative phase of the rotors 7, 12 and 13 of the mixer and oscillator condensers. The other end of the curves, hence the slope of the curves, is determined by moving the grounded stator block 3 through its various and infinite positions. When the proper position of the stator block is obtained, or that one which will give parallel tracking over the oscillator tuning range, the holding screws 4 which are hidden in Fig. 2, are tightened, fastening the stator block in place.

Thus an ultra-high-frequency device has been described which forms a condenser having novel operating characteristics and which may be used to improve the performance of much ultra-high-frequency equipment. It has been shown, for example, that when used in conjunction with a receiver mixer circuit, the mixer chamber will resonate at the frequency of the incoming signal, and the resonant frequency of the mixer will

follow the oscillator frequency at a fixed difference, producing a constant intermediate frequency output. It is obvious that this invention may be applied equally well to other ultra-high-frequency transmitting and receiving circuits.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A variable condenser comprising a disk-shaped part rotatable about its axis of construction with a sector of extended radius, a grounded stator block placed in the same plane as and opposing the rotor, said stator being a block of conducting material having a curved face on the side nearest the rotor, the curve being a ninety degree arc of a circle with its center coincident with that of the rotor when the stator is placed in one arbitrary position, said stator having a means for adjustably fixing its location with respect to the rotor, the movement being in the same plane as the rotor but in a direction tangent only to the lower end of the curve of the stator block.

2. A variable condenser, comprising a disk-shaped part rotatable about its axis of construction with a sector of extended radius, a stator block including an integrally formed 90° concaved surface cut therein, said block placed in same plane as and opposing the rotor with its concaved surface in capacitative relation to the periphery of the rotor, and means for fixing the stator in relation to the rotor the movement being in the same plane as the rotor but in a direction tangent only to the lower end of the curve of the stator block.

3. A variable condenser comprising a rotatable part of a disk-shaped construction with a sector of extended radius, said rotor being mounted on an insulating shaft, the shaft passing through the center of the rotor and being rotatable during tuning, a grounded stator block including an integrally formed 90° concaved surface cut therein, said block placed in the same plane as and opposing the rotor with its concaved surface in capacitative relation to the periphery of the rotor, said stator block having means for adjustably fixing its location in the plane of the rotor but in a direction tangent only to the lower end of the curve of the stator block to produce a differential

capacitative relationship between the rotor and the extremities of the concaved surface of the stator.

4. In combination a resonant line oscillator section comprising a flat solid rectangular inner conductor centrally positioned within a hollow rectangular outer conductor and a resonant line mixer section comprising a flat solid rectangular inner conductor centrally positioned within a hollow rectangular outer conductor, the sections being so disposed in relation to each other to be individually but simultaneously tuned by condenser plates rotatably mounted on a common shaft, said plates in said oscillator section being mounted one on either side of said flat solid rectangular inner conductor within said oscillator section, said plates in said mixer section also being mounted one on either side of said flat rectangular inner conductor within said mixer section; either side of said flat solid inner rectangular conductors and the inner walls of said hollow rectangular conductors forming the other plates of the individual capacitor elements, one of said plates in said mixer section comprising a disk-shaped part rotatable about its axis of construction with a sector of extended radius, a grounded stator block placed in the same plane as and opposing the rotor, said stator being a block of conducting material having a curved face on the side nearest the rotor, the curve being a ninety degree arc of a circle with its center coincident with that of the rotor when the stator is placed in one arbitrary position, said stator block being movably positioned along the bottom of the mixer hollow rectangular outer conductor and having a means for adjusting and fixing said stator in any desired position.

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