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Miner et al.

[11] **3,789,331**

[45] **Jan. 29, 1974**

[54] **VERNIER TUNING MEANS FOR UHF TUNER OR THE LIKE**

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[52] U.S. Cl. **334/82,** 334/78, 334/83, 317/253, 317/254

[51] Int. Cl. **H03j 3/20**

[58] Field of Search 334/78, 79, 82, 83; 317/253, 317/254

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[57] **ABSTRACT**

In a conventional variable capacitor type tuner, in which the rotor plates optionally may be provided with positionally adjustable sections which sequentially and cumulatively come into capacitive relationship with a stator plate of appreciable area, vernier tuning is accomplished by providing an additional stator plate of limited area which cooperates with its own rotor having individually positionable sections of substantially the same angular extent as the corresponding stator and which come sequentially and non-cumulatively into operative relationship with the stator. The individually positionable sections of the vernier rotor may be staggered with respect to the individually positionable sections of the standard rotor for optimum results. The vernier rotor can generally be similar to the standard rotor in having its sections extend generally at right angles to the axis of rotation, in which case where many channels are to be tuned the individual sections of the vernier rotor may encompass the tuning of a limited plurality of said channels, or the sections of the vernier rotor may comprise extensions thereof extending generally parallel to the axis of rotation thereof, in which case a larger number of individual sections can be provided than with conventional rotors.

18 Claims, 10 Drawing Figures

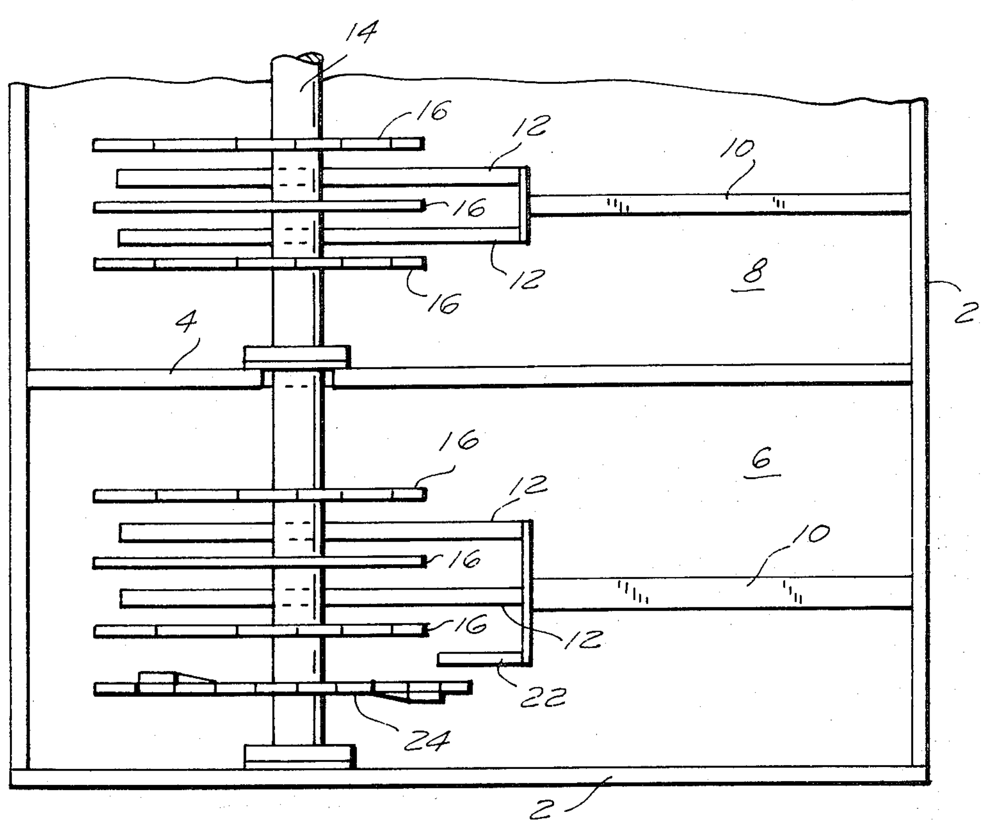
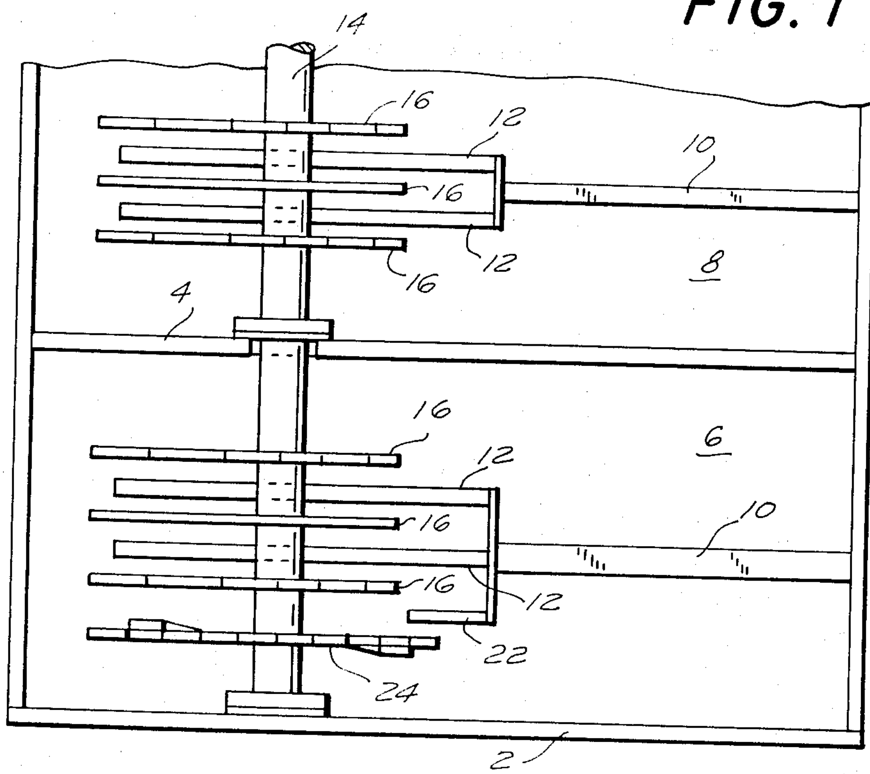


FIG. 1


14
16
12
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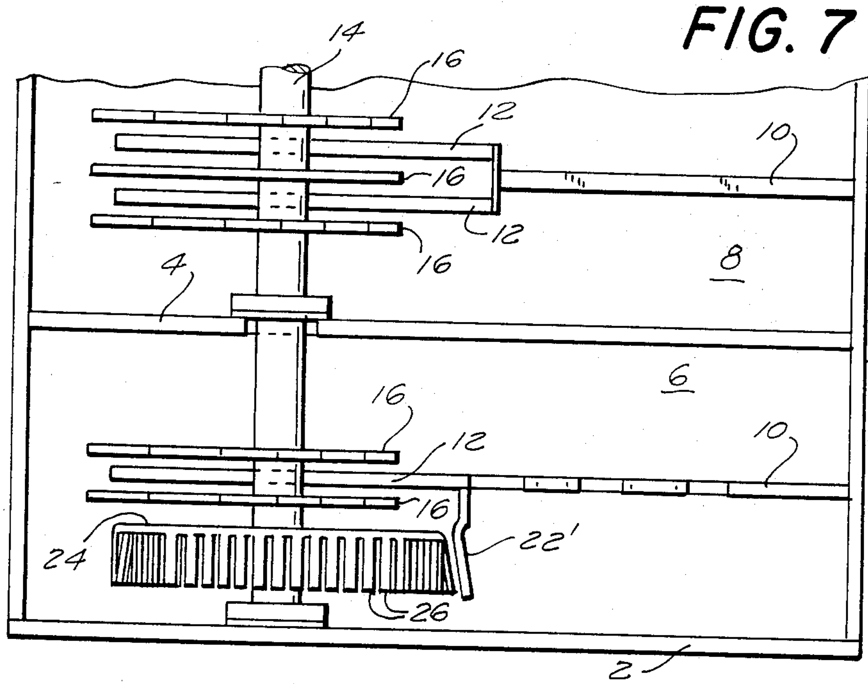
22
24
2

FIG. 7


14
16
12
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12
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16
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22'
26
2

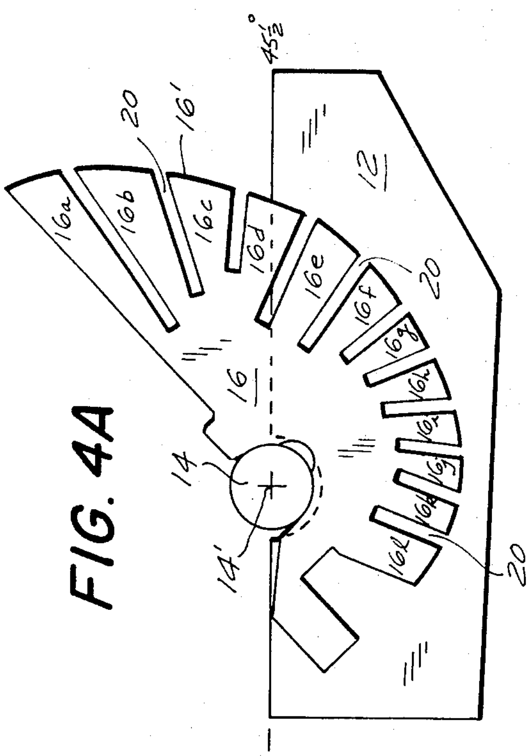


FIG. 4A

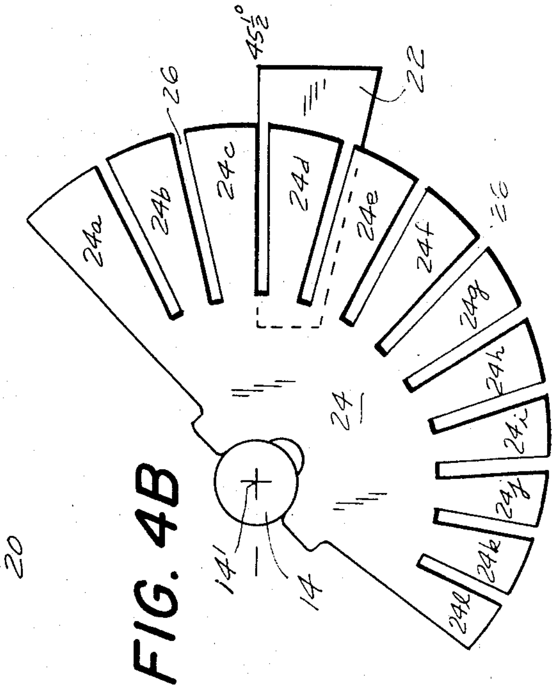


FIG. 4B

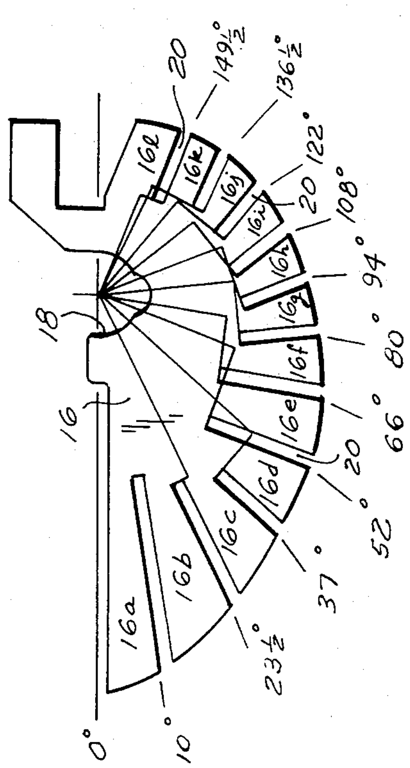


FIG. 2

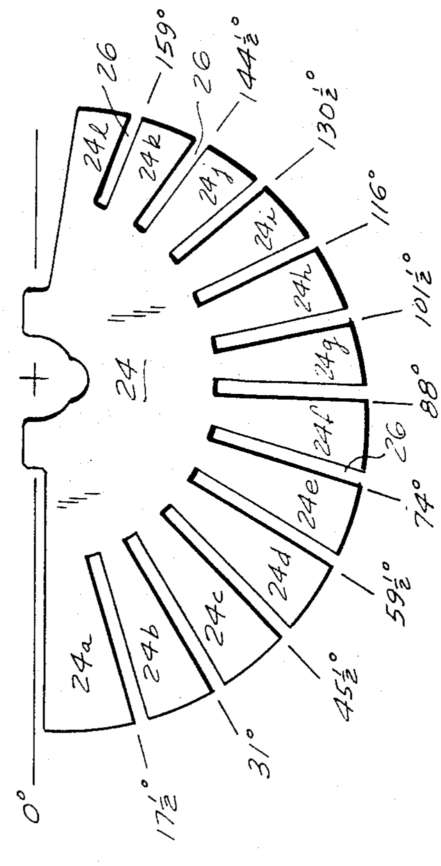


FIG. 3

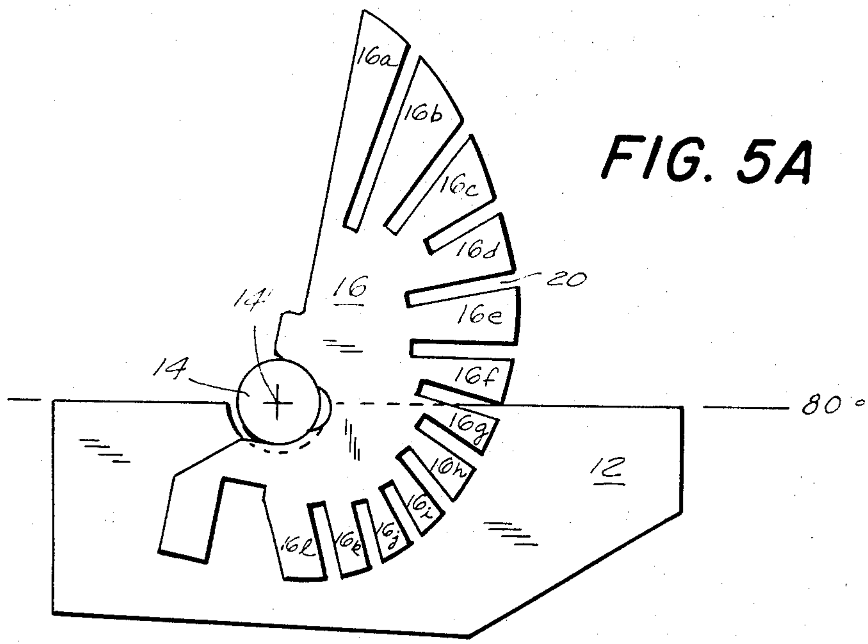
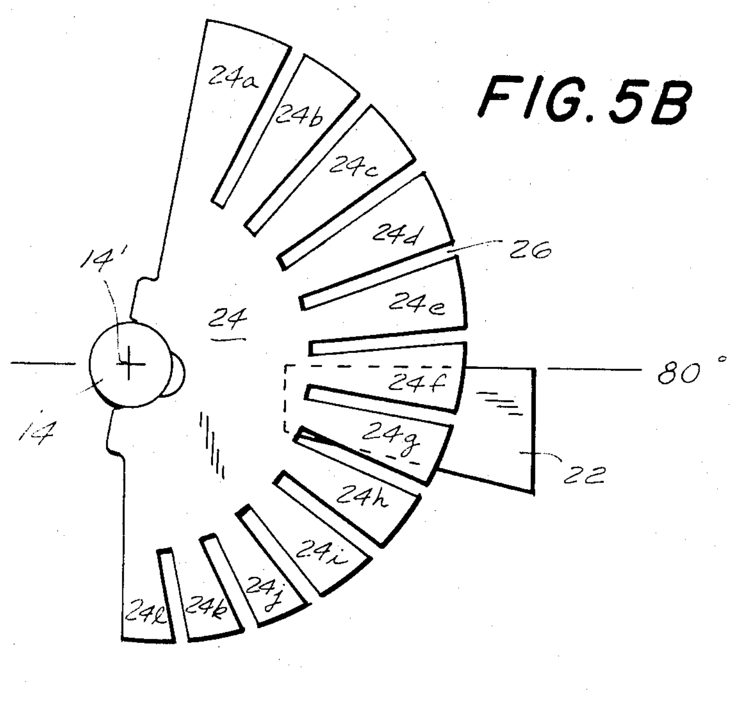

16a
16b
16c
16d
20
16
16e
14'
14
16f
16g
80°
16h
12
16i
16j
16k
16l

FIG. 5A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24b
24c
24d
26
24e
14'
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24f
80°
14
24g
22
24h
24i
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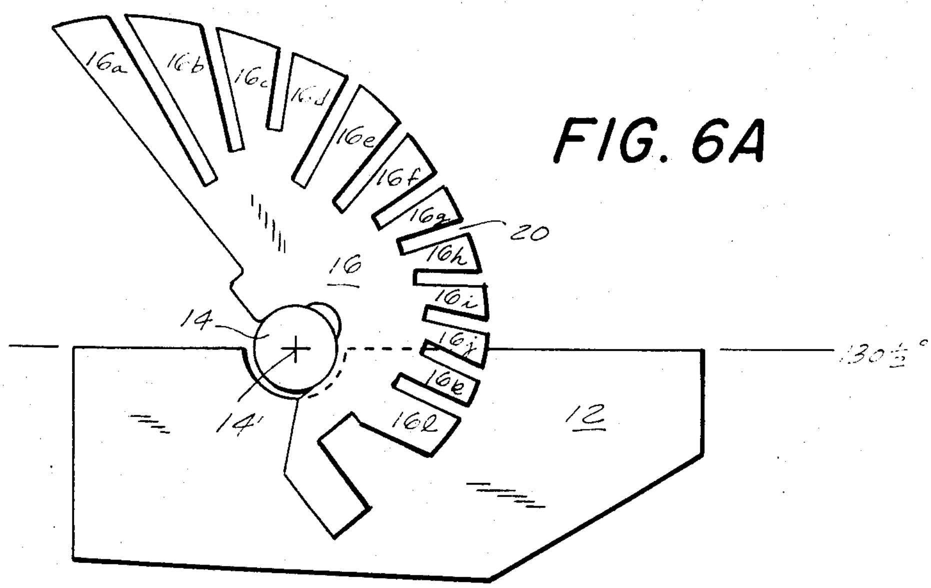
24k
24l

FIG. 5B


16a
16b
16c
16d
16e
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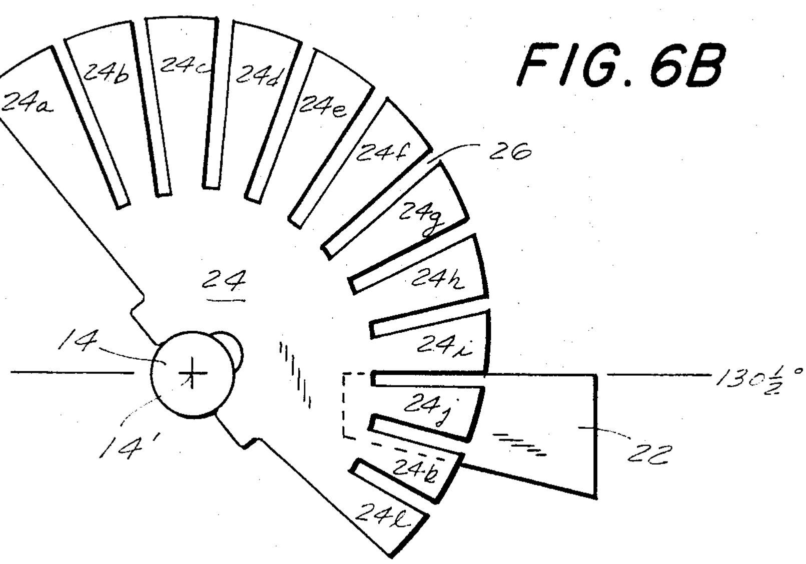
16g
20
16h
16i
16j
16k
16l
16
14
14'
12
130½°

FIG. 6A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24b
24c
24d
24e
24f
26
24g
24h
24i
24j
24k
24l
24
14
14'
22
130½°

FIG. 6B

VERNIER TUNING MEANS FOR UHF TUNER OR THE LIKE

The present invention relates to means for achieving vernier control of tuning in tuners such as those designed for use in the UHF reception band.

It has long been known that the various circuits of a communications receiver such as a television receiver may be tuned by gang condenser means, comprising a plurality of rotary variable condensers the rotors of which move simultaneously and overlap their corresponding stator plates to cumulatively progressive degrees. It is necessary that the individual circuits thus simultaneously tuned track one another over the entire range of tuning, that is to say, the variation in capacitance, and hence in tuned frequency, accomplished in each of the circuits should correspond in desired fashion to the variation accomplished in all of the other circuits. In addition, it is usually desired that there be a certain desired relationship between tuned frequency and angular rotation of the operating shaft. To these ends it is conventional to provide in rotary variable condensers some means for manual adjustment of the capacity curve of one or more of the tuning sections. This is commonly done by serrating or slotting one or both of the outer blades so that the sections of the blades thus formed between the serrations or slots may be bent toward or away from the stator plates, thereby to change the incremental capacity value achieved at discrete angles of rotation. This approach has proven to be adequate in many tuning requirements to comply with tracking requirements and conformance to a desired calibration curve.

The UHF television band in this country contains 70 channels each 6 mc. wide between 470 MHz and 890 MHz. The tuner is conventionally of the superheterodyne type using an intermediate frequency 45.75 MHz., for the visual carrier of the television signal, thus giving rise to the requirement of a local oscillator range of 517–931 MHz. Recent governmental requirements relating to tuners capable of tuning all seventy of the available UHF channels explicitly and implicitly require tuning accuracies over the large frequency range involved which have not been achievable by prior art approaches. For example, it is required that each channel selected must tune within one-half a channel width of the correct frequency without the aid of manual fine tuning. This involves an accuracy of plus or minus 3 MHz. In terms of the absolute frequency of the local oscillator, this represents a variation of approximately plus or minus 0.3 percent, and in terms of the band coverage, this represents approximately plus or minus 0.7 percent. Even these rigorous requirements will not permit automatic fine tuning; if automatic fine tuning is desired, the problem becomes most forbidding, requiring approximately six times the precision specified above.

In the UHF band tuning is typically accomplished by the rotation (usually through 180° or less) of a variable capacitor which terminates a quarter wave or half wave distributed constant transmission line which is the resonant element of either a tube or solid state amplifier or oscillator circuit. The relationship between capacitance of the terminated variable condenser of a resonant transmission line and the frequency to which that line is tuned is quite complex, but to a rough approximation the capacitance varies inversely as the square of the frequency tuned. In UHF tuners it is desirable for the frequency to vary linearly with tuning so that equal angular rotation will generate equal tuning changes, thus providing for tuning from one channel to another by equal angular rotation no matter where those channels may be in the UHF band. This can be done, as has been known to the art, by using specially shaped capacitor plates, generally of the conventional rotary variable condenser type, in which the stator plate or plates have an area or angular extent, considered in terms of the movement of the rotor plate between one tuning extreme and the other, which encompasses substantially the full degree of movement of the rotor plate, the rotor plate being movable from one extreme position where it overlaps the stator plate either not at all or to a minimal degree (minimum capacitance and maximum frequency) to another extreme position in which it overlaps the stator plate to a maximum degree (maximum capacitance and minimum frequency). Thus the individual segments of the rotor plate move sequentially into operative engagement with the stator plate as the rotor plate is moved from its position of minimal overlap to its position of maximum overlap, with a segment of the rotor plate once moved into overlapping relation with the stator plate remaining in that overlapping relationship as the rotor plate moves further to its position of maximum overlap. Hence each segment of the rotor plate, once it comes into overlapping relationship with its stator plate, acts cumulatively with those segments of the rotor plate which had theretofore overlapped the stator plate and those segments of the rotor plate which thereafter come to overlap the stator plate.

As has been mentioned, the conventional approach to vernier control of capacitance with variable capacitance tuners of the type described is to serrate one or more of the rotor plates into sections and then to bend those sections individually toward or away from the corresponding stator plate. If the section is bent toward the corresponding stator plate it will, when it comes into overlapping relationship therewith, produce a higher capacitance therewith than when it is bent away therefrom. The conventional alignment approach when using a serrated rotor blade of the type described is to start at the high frequency end of the band, when the rotor is at its position of minimum overlap with the stator, adjust the first section of the stator, and move respectively to lower frequencies as succeeding sections come into operative engagement with the stator plate and then adjust those other sections in appropriate fashion. The effects of these adjustments are cumulative in that the total tuning capacity at any point of rotation includes the sum of the effects of each of the adjustments made up to that point on the rotor blade sections overlapping the stator plates.

This system has two primary disadvantages - first, because the adjustments are effectively cumulative, if, after the alignment is accomplished, an additional correction is needed at some point in the band and a readjustment is made, all frequencies in the band lower than the frequency at which the adjustment is made are affected and it is necessary then to readjust all of those other sections. Second, each section optimizes the tuning for but a single point over a range of frequencies, and hence the degree to which the tuning curve is affected for all frequencies is often far from optimal.

The adjustment problems presented by normal tuning requirements are greatly intensified when a very large number of channels must be tuned, such as the seventy channels involved in the UHF band. If an individual segment is to be provided in the rotor plate for each of those bands, and because as a practical matter the rotor plates cannot be turned more than 180°, the physical constraints required in attempting to provide seventy tabs or segments, each individually adjustable, are prohibitive. In tuning over the VHF band where only 12 channels are involved, providing an individually adjustable segment on the rotor plate for each channel would require segments occupying 15° of rotation about the axis of rotation of the rotor. This is an entirely practical value. However, if 70 individual segments must be provided, those segments could be only 2.6° wide. This would leave only about 0.02 inch of metal at a ½ inch radius from the axis of rotation. Closer to the axis of rotation the width of the tab would become vanishingly small. These values do not even take into consideration the fact that some spacing would have to be left between the tabs where material was removed from the rotor plate.

Thus both physical requirements and electrical requirements, including the realities of adjustment procedure, appear to rule out the use of individually adjustable rotor plate segments in order to provide vernier tuning in the UHF band.

It is the prime object of the present invention to provide means for control of tuning by a variable capacitor tuner which is accurate, which is easily accomplished by means of practical and sturdy structure, and which is particularly adaptable for tuning requirements where a very large number of channels or stations must be tuned.

It is another object of the present invention to provide a vernier-controlled tuning system which utilizes conventional rotary variable condenser-type tuners and which adds thereto, for vernier tuning control, structure which takes up but a minimal amount of space and costs but a minimal amount of money and which requires no great precision in manufacture.

It is yet another object of the present invention to provide a rotary variable condenser-type of tuner with a much greater degree of tracking adjustability in its tuning operation and has not heretofore been achievable except through the use of the most complex, expensive and easily misaligned equipment.

It is a still further object of the present invention to devise a vernier tuning system of a rotary variable type of capacitor tuner in which vernier adjustment of the tuning effect at a given location in the tuning band may be carried out independently, and without requireing any modification of the tuning band.

To these ends, we provide a second variable capacitor means electrically connected to the standard capacitor means, but differing therefrom in that the stator plate, instead of having an area or angular extent in the direction of movement of the rotor substantially corresponding to the entire tuning movement of the rotor and therefore to the entire tuning range, in fact has an area or angular extent of much lesser size, corresponding to a single channel to be tuned or to a small plurality of channels to be tuned. The rotor plate of this second capacitor means comprises a plurality of individually adjustable sections each having an area or angular extent in the direction of movement of the rotor, substantially corresponding to that of the stator plate with which it cooperates. Consequently as the rotor is moved these sections will be brought sequentially into overlapping relationship with the stator plate, but in a non-cumulative manner - one such section will be moved away from the stator plate as the next section is moved into overlapping relationship with the stator plate. This type of tuning arrangement has been known. It has, however, been used only per se, as the tuning device in a given installation. What we have discovered, considered broadly, is that by using this non-cumulative type of tuning arrangement in conjunction with the conventional cumulative type of capacitive tuner, a very high degree of accuracy in tuning relationship, sufficiently high to satisfy the exacting modern requirements for a seventy-channel UHF tuners, can be achieved.

Where physical requirements make it impractical or impossible to provide individually adjustable rotor sections for each of the channels to be tuned, as is the case in connection with 70-channel UHF tuning, each of the individually adjustable rotor sections may be made of sufficient area or angular extent to correspond to a small plurality of the channels to be tuned, to wit, five to seven channels out of 70, and an even greater degree of precision is obtained when the conventional rotor is provided with the usual cumulatively acting adjustable sections, but with the sections on the conventional rotor rotationally staggered with respect to the sections of the vernier rotor.

In the usual type of variable capacitor tuner, the rotor and stator blades, parallel to one another, extend in a direction substantially at right angles to the axis of rotation of the rotor blades. The vernier tuning capacitor involved in the present invention may be similarly constructed. However, for even greater accuracy, and for more individual control of the many channels involved, a special form of vernier condenser is disclosed in which the individually adjustable sections of the rotor extend in a direction substantially parallel to the axis of rotation of the rotor and are arranged circumferentially around a disk-like support. With this structure a much larger number of strong and reliably adjustable sections can be produced mechanically than with the convential rotor plate construction where the sections must extend radially outwardly from the axis of rotation.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to the structure and arrangement of a tuning instrumentality as defined in the appended claims and as described in this specification, taken together with the accompanying drawings, in which:

FIG. 1 is a top plan view of a section of a tuner constructed in accordance with the present invention showing two tuning circuits such as might be employed for the detector and the local oscillator of a superheterodyne receiver;

FIG. 2 is a front elevational view of a convential rotor plate used in the main tuning portion of a given tuning section;

FIG. 3 is a front elevational view of the rotor plate used in the vernier tuning section of the tuner of the present invention;

FIG. 4*a* is a composite rear elevational view of the conventional rotor plate of FIG. 2 and the stator plate with which it cooperates, the rotor plate being shown in a position toward the low frequency end of the tuning band;

FIG. *4b* is a composite rear elevational view of the rotor plate of FIG. 3 and the stator plate with which it cooperates, showing the same relative rotational position as corresponds to that of the rotor and stator plates in FIG. *4a;*

FIGS. *5a* and *5b* are views similar to FIGS. *4a* and *4b* respectively but showing the rotor plates in their respective positions relative to their respective stator plates at a higher tuning frequency than that shown in FIGS. *4a* and *4b;*

FIGS. *6a* and *6b* are views similar to FIGS. *5a* and *5b* respectively but showing the parts in the positions which they assume at a still higher tuning frequency; and

FIG. 7 is a view similar to FIG. 1 but showing a specifically different construction for the vernier tuning capacitor.

The invention is here specifically disclosed in connection with a tuner designed to tune all seventy of the channels in the UHF band, that being done because the tuner of the present invention is exceptionally well adapted to meet the tuning requirements there involved, while other tuning arrangements have failed to meet those requirements. It will be appreciated, however, that the invention is not limited to that particular application, but may be applied more broadly. Moreover, while the capacitive tuners have been here disclosed as of the rotary variable type, the terms "rotor" and "stator" therefore being applied to the relatively movable and stationary parts thereof in conventional fashion, it will be understood that rotary movement of the parts relative to one another is not essential to their operative tuning relationship, nor is it essential that one of the elements stand still while the other moves - they both could move, either in the same direction at different speeds or in opposite directions. Hence it will be appreciated that the terms "rotor" and "stator" are used generically, the term "rotor" referring to a movable element and the term " stator" referring to an element which may either be stationary or movable but with respect to which the "rotor" moves. It will further be understood that although the tuners are here disclosed as embodied in quarter wave or half wave transmission line structures, that is exemplary only, and they could be used in conjunction with any circuitry or structure by means of which an electrical tuning condition is produced.

FIG. **1** is an idealized view on an enlarged scale, of a tuner such as might be employed, in accordance with the present invention, for tuning over the entire seventy channel range of the UHF band. It comprises conductive side walls **2** and partitions **4** which divide the interior structure into compartments **6** and **8** which house the tuning structure for two different circuits, such as the detector and the local oscillator. Each of those individual tuning devices, as hereby specifically disclosed, are of the transmission line type, including an elongated conductive element **10** which extends from one end wall of a given compartment **6** or **8** toward the other end wall thereof and spaced from the bottom wall thereof, and which carries at its end a plurality of electrically connected stator plates **12.** Mounted for rotation in the tuner is a shaft **14** which, in each compartment **6** and **8,** has rotor plates **16** secured thereto and rotatable therewith. The plates **12** and **16** define a variable capacitor which, in conjunction with the conductor **10** and the walls **2** and **4,** define a resonant cavity transmission line the resonant frequency of which is determined by the capacitance defined between the stator plates **12** and the rotor plates **16.** As is shown in FIG. *4a,* the stator plates **12** are of a considerable area and, considering that area in terms of angular rotation about the axis of **14'** of the shaft **14,** the plates **12** extend about the axis **14'** over approximately 180°, that being the full extent of rotation of the shaft **14** from one extreme of the tuning range to the other. As may be seen from FIGS. **2** and **4**A, the rotor plates **16,** mounted fast on the shaft **14** by means of the recess **18** formed in the plates **16** which snaps over shaft **14,** is likewise of a considerable area, and extends rotationally around the axis **14'** of the shaft **14** over approximately 180°. Its radially outer edge **16',** while curved, is neither circular nor coaxial with the axis **14'** the radial extent of the rotor plate **16** varying from one end thereof to the other, this being a well-known and conventional approach to the objective of providing, at least roughly, a desired relationship between tuning frequency and angular rotation of the plate **16,** in this case providing for equal frequency changes for a given degree of angular rotation from one end of the tuning range to the other. Moreover, and again as is conventional and well known, one or more of the outermost rotor plates **16** in a given section - the plates that are not interposed between stator plates **12** but instead are outside one or the other of the end stator plates **12** - is provided with a plurality of inwardly extending notches or slots **20,** thereby to divide the radially outer portion of the plate **16** into a plurality of circumferentially separated sections **16*a*–161.** Each of these sections **16*a*–161** may be bent out of the plane of the rotor plate **16** toward or away from the stator plate **12** with which the rotor plate is adapted to cooperate, thereby to trim or adjust the capacitance of the device. When the shaft **14** is rotated clockwise as far as it will go, thus bringing the rotor plates **16** into substantially completely overlapping relationship with their corresponding stator plates **12,** the capacitor will be at the low frequency end of its tuning range, and all of the sections **16*a*–161** will be in a capacitance-producing relationship with the stator plates **12.** As the shaft **14** is then rotated in a counterclockwise direction to increase the tuning frequency, the rotor plate **16** will move to its positions shown in FIGS. **4**A, **5**A and **6**A and then even further in a counter-clockwise direction, thereby progressively removing portions of the plate **16,** including selected ones of the sections **16*a*–161,** from overlapping or capacitance-producing relationship with the stator plates **12.** In FIG. **2** the angular locations of the slots **20** in the rotor plate **16** are indicated in terms of the degrees of rotation of the shaft **14** from its maximum clockwise position for low frequency tuning to its maximum counterclockwise position for high frequency tuning. Thus in one typical embodiment the slot **20** between sections **16*a*** and **16*b*** will come into approximate alignment with the upper edge of the stator plate **12** when the shaft **14** has been rotated **10** degrees from its full counterclockwise position, the slot **20** between sections **16*b*** and **16*c*** will register with the upper edge of the stator plate **12** after **23-1/2** degrees of rotation, the slot **20** between sections **16*c*** and **16*d*** will come into registration with the upper edge of plate **12** after **37** degrees of rotation, and so on. FIG. **4*a*** illustrates a rotation of the shaft 14 of 45-½°, and it will be seen that the slot 20 between sections 16*c* and 16*d* has already moved above the upper edge of the plate 12, while the slot 20 between sections 16*d* and 16*e* is just beginning to move into registration with the upper edge of the plate 12. As shown in FIG. 4A, the sections 16*a*, 16*b* and 16*c* no longer have any substantial capacitance-producing effect in conjunction with the plate 12, the sections 16*e*–161 are still fully in capacitance-producing relationship with the plate 12, and the section 16*b* is partially in and partially out of capacitance-producing relationship with plate 12. FIGS. 5A and 6A show the relationship between the rotor plate 16 and its corresponding stator plate 12 for rotations of 80° and 130-½° respectively, the slot 20 between sections 16*f* and 16*g* being in substantial registration with the upper edge of the plates 12 in FIG. 5A, while in FIG. 6A the plate 16 is shown in a position intermediate between registration of the upper edge of the plate 12 with the slot 20 between section 16*i* and 16*j* and the slot 20 between sections 16*j* and 16*k* respectively.

Because of the cumulative capacitance-producing effect of those sections 16*a*–161 which are at any point in time in overlapping and capacitance-producing relationship with the corresponding stator plate 12, it is not possible, as a practical matter, to adjust the positions of the individual sections 16*a*–161 and achieve accurate tracking and tuning of the circuits involved over all seventy channels of the UHF range. Because of the physical limitations on the size (circumferentially) of the sections 16*a*–161 it is not possible to provide an individual section for each channel, and because of the cumulative effect of those sections in producing capacitance, even if individual sections were provided for each channel it would still not be practical to align the various circuits and to maintain them in alignment and to make corrections in alignment as time went on with regards to individual channels to be tuned.

The tuning device in compartment 6 of FIG. 1 is modified in accordance with the present invention in order to provide for the desired tuning and tracking accuracy. To that end an auxiliary stator plate 22 is electrically connected to the stator plates 12, but differs from the stator plates 12, as may clearly be seen from FIG. 4B, in that its angular or circumferential extent is very much smaller than that of plates 12, and, instead of extending around the rotor shaft axis 14′ by 180°, as is the case with the plates 12, it has an angular extent of only about 15 degrees. Moreover, while the standard stator plates 12 extend all the way to the rotor shaft 14, the stator plate 22 extends only a fraction of that distance toward the shaft 14. Fast on the rotor shaft 14, and cooperable with the stator plate 22, is a rotor plate 24 the outer periphery of which is divided, by slots 26, into a plurality of sections 24*a*–241, each of those sections having an angular extent of approximately 15° except for section 24*a*, which has an angular extent of approximately 17 ½°. Thus, as may be clearly seen from FIG. 4B, the angular extent of each of the sections 24*a*–241 is closely the same as that of the stator plate 22. It will moreover be apparent from FIG. 4B that the extent to which the stator plate 22 extends radially inwardly toward the shaft 14 is roughly commenserate with the radial extent of the sections 24*a*–241. Consequently, as the rotor shaft 14 is rotated, each of the sections 24*a*–241 will be moved into overlapping capacitance-producing relationship with the stator plate 22 and then moved out of that relationship. In FIG. 4B section 24*d* is in capacitance-producing relation with plates 22, sections 24*c* and 24*e* and in perhaps peripheral minor capacitance-producing relationship therewith, and all of the other sections of plate 24 are out of capacitance-producing relationship with the plate 22. When the rotor shaft 14 is rotated to the position shown in FIG. 5B sections 24*f* and 24*g* are each partially in capacitance-producing relationship with plates 22, while the other sections of the plate 24 are not, and when the rotor shaft 14 is rotated to the position shown in FIG. 6B it is section 24*j* which is in capacitance-producing relationship with plate 22, sections 24*k* and 24*i* are perhaps peripherally in that condition, and the other sections are not in that condition.

Thus each of the sections 24*a*–241 produces with the stator plate 22 a certain amount of capacitance, the particular amount being dependent upon the spacing between the plates when they overlap and hence being adjustable by bending a corresponding section out of the plane of the plate 24 either toward or away from the plate 22. In a tuner designed to tune seventy channels and provided with 12 sections 24*a*–241 as described, each section will provide tuning control for approximately 6 channels. The non-cumulative type of capacitance-production derived from the plates 22 and 24, when added to the capacitance produced by the plates 12 and 16, results in an accurately attainable and highly reliable type of tuning. Tuning accuracy over the entire range is further enhanced if, as is specifically disclosed, the sections 24*a*–241 or rotor plate 24 are disposed around the axis of rotation 14′ of the rotor shaft 14 in a staggered manner relative to the sections 16*a*–161 of the rotor plate 16. Thus, while in a typical installation the slots 20 separating the rotor sections 16*a*–161 may occur at rotational values of 10°, 23 ½°, 37°, 52°, 66°, 80°, 94°, 108°, 122°, 136 ½°, and 149-½° respectively, the slots 20 separating the sections 24*a*–241 may occur at rotational values of 17-½°, 31°, 45 ½°, 59-½°, 74°, 88°, 101 ½°, 116°, 130 ½°, 144 ½° and 159° respectively. If 13 or 14 individual sections are provided instead of the twelve sections here specifically disclosed by way of example, the actual angular values separating the individual sections will be correspondingly varied, but preferably without departing from the overlapping or alternate arrangement here disclosed.

Thus, as may be seen from comparing FIGS. 4A and B, FIGS. 5A and B and FIGS. 6A and B, when a slot 20 on one rotor blade 16 or 24 is approximately in line with the upper edge of its corresponding stator plate 12 or 22, the upper edge of the other stator plate 22 or 12 is located approximately between a pair of adjacent slots 20 on its corresponding rotor plate.

As has been indicated, ideally it would be preferable to provide, on the rotor plate 24, an individual section for each channel to be tuned but as a practical matter it is not feasable to do this with seventy channels because individual angularly oriented sections would be too small to be manipulatable or to reliably withstand shock or vibration. The use of twelve to fourteen subsections on the rotor plates 24 provide an acceptable degree of accuracy and adjustability, particularly when the sections on the two cooperating rotor plates are angularly or circumferentially staggered. However, an even greater degree of precision and adjustability can be obtained by using the construction shown in FIG. 7

for the vernier tuning means. As there disclosed the size of plate **22'** is of limited angular extent relative to the rotation of the rotor shaft **14**, is located radially outside the rotor plates **16**, and extends in a direction substantially parallel to that of the rotor shaft axis **14'**. The rotor **24'** in FIG. **7** comprises a disc or some like part fast on shaft **14** from the periphery of which a plurality of finger-like sections **26** extend, those sections **26** being oriented substantially at right angles to the disc-like portion of the rotor **24'** and therefore being substantially parallel to the plane of plates **22'** and the axis **14'** of the rotor shaft **14**. Because of the location and orientation of the finger-like sections **26**, many more of them can be provided within a given spatial limitation than is the case with the radially extending sections of the embodiment previously disclosed. Individual adjustment of the capacitance produced by each of the sections **26** relative to the stator **22'** is accomplished by bending the appropriate section **26** toward or away from plate **22'**. The angular extent of plates **22'** relative to the rotor shaft axis **14'** preferably will be substantially the same as the corresponding angular extent of the individual finger-like sections **26**.

With the staggered or alternating section arrangement of the embodiment shown in FIGS. **1–6**, if the cumulatively acting rotor plate sections **16*a*–161** line up with their respective stator plates at channels **83, 77, 71, 65, 59**, etc., then the sections **24*a*–241** on the rotor plate **24** will line up with their respective stator plates **22** at channels **80, 74, 68, 62**, etc., thus effectively providing an alignment every three channels and permitting positive, accurate and smooth alignment of the complete band according to a prescribed procedure without the need for a continual touch-up adjustment as would be required if a cumulatively acting system alone were used. The addition of the non-cumulatively-acting tuning portion acts to correct residual error in the cumulatively-acting portion and makes for easier adjustment of the cumulatively-acting portion itself. Through the use of the present invention alignment accuracies are achieved which are three times greater than what could be obtained formerly by the cumulative-acting system alone.

It will be understood that the tuning arrangement here disclosed can be used whether or not the normal variable capacitor tuning means is provided with adjustable sections such as the sections **16*a*–161** or not, particularly if the vernier tuning means of FIG. **7** is employed where a large number of individual adjusting sections may be provided. While but a limited number of embodiments of the present invention have been here specifically disclosed, it will be apparent that many variations may be made therein, all within the scope of the instant invention as defined in the following claims.

We claim:

1. In a high frequency tuner, variable capacitor means comprising first and second capacitors each comprising a stator and a rotor, the stators of said two capacitors being directly electrically connected, the rotors of said two capacitors being directly electrically connected and operatively mechanically connected for simultaneous movement over first and second given distances respectively to tune over the desired range, said stator of said first capacitor having a dimension extending in the general direction of said movement of said rotor of said first capacitor which at least substantially corresponds to said first movement distance, said rotor of said first capacitor having a dimension extending in the said general direction of said movement of said rotor which at least substantially corresponds to said first given distance, said rotor being movable over said first given distance between positions of minimum and maximum operative overlap with said stator, said stator of said second capacitor having a dimension extending in the general direction of movement of said rotor of said second capacitor which is only a minor fraction of said second given distance, said rotor of said second capacitor having a dimension extending in the said general direction of movement of said rotor which is much larger than the corresponding dimension of said stator of said second capacitor and being divided into a plurality of sections each having a dimension in the said general direction of movement of said rotor approximately that of said stator of said second capacitor and movable sequentially into and out of operative overlap with their corresponding stator as said rotor is moved from end of the desired range to the other, the spacing of said sections relative to their corresponding stator when overlapping said stator being individually adjustable, thereby to facilitate the adjustment of the capacitance-rotation characteristic of said capacitor means for a multiplicity of rotational points.

2. The tuner of claim **1**, in which said rotor of said first capacitor is divided into a plurality of sections each having a dimension in the general direction of movement of said rotor which is a fraction of the corresponding overall dimension of said rotor and movable sequentially into cumulative operative overlap with their corresponding stator as said rotor is moved from one end of the desired tuning range to the other, the spacing of said sections relative to their corresponding stator while overlapping said stator being individually adjustable.

3. The tuner of claim **2**, in which said sections of said first capacitor are separated from one another at a first set of points spaced from one another in the general direction of movement of said rotor and said sections of said second capacitor are separated from one another at a second set of points spaced from one another in the general direction of movement of said rotor and differing from said first set of points.

4. The tuner of claim **3**, in which said first set of points and said second set of points alternate with each other in the general direction of movement of said rotor.

5. The tuner of claim **3**, in which said first set of points and said second set of points alternate with each other substantially uniformly in the general direction of movement of said rotor.

6. The tuner of claim **1**, in which said tuner is a UHF tuner designed to tune over substantially the seventy channels of the UHF band, and said dimension of said stator of said second capacitor corresponds to the tuning of about six channels in the UHF band.

7. The tuner of claim **6**, in which said rotor of said first capacitor is divided into a plurality of sections each having a dimension in the general direction of movement of said rotor which is a fraction of the corresponding overall dimension of said rotor and movable sequentially into cumulative operative overlap with their corresponding stator as said rotor is moved from one end of the desired tuning range to the other, the spacing of said sections relative to their corresponding stator while overlapping said stator being individually adjustable.

8. The tuner of claim **7**, in which said sections of said first capacitor are separated from one another at a first set of points spaced from one another in the general direction of movement of said rotor and said sections of said second capacitor are separated from one another at a second set of points spaced from one another in the general direction of movement of said rotor and differing from said first set of points.

9. The tuner of claim **8**, in which said first set of points and said second set of points alternate with each other in the general direction of movement of said rotor.

10. The tuner of claim **8**, in which said first set of points and said second set of points alternate with each other substantially uniformly in the general direction of movement of said rotor.

11. The tuner of claim **7**, in which said sections of said rotor of said first capacitor have a said dimension corresponding to the tuning of about six channels in the UHF band.

12. The tuner of claim **8**, in which said sections of said rotor of said first capacitor have a dimension corresponding to the tuning of about six channels in the UHF band.

13. The tuner of claim **9**, in which said sections of said rotor of said first capacitor have a said dimension corresponding to the tuning of about six channels in the UHF band.

14. The tuner of claim **10**, in which said sections of said rotor of said first capacitor have a said dimension corresponding to the tuning of about six channels in the UHF band.

15. The tuner of claim **1**, in which said rotor and said stator of said first capacitor comprise parallel plates with said rotor rotatable about an axis substantially at right angles to said plates, and said rotor and stator of said second capacitor comprise parallel plates substantially perpendicular to the corresponding parts of said first capacitor.

16. The tuner of claim **1**, in which said rotor and said stator of said first capacitor comprise parallel plates with said rotor rotatable about an axis substantially at right angles to said plates, and said rotor and stator of said second capacitor means comprise parallel plates substantially parallel to the corresponding parts of said first capacitor.

17. The tuner of claim **1**, in which said rotor of said second capacitor comprises a member rotatable about an axis and having said sections extending therefrom substantially in the same direction as said axis, the stator of said second capacitor being mounted adjacent said sections to extend in a direction substantially parallel thereto.

18. The tuner of claim **1**, in which said rotor of said second capacitor comprises a disk rotatable about an axis, said sections of said capacitor means being defined by fingers arranged circumferentially around said disk and extending therefrom in a direction substantially parallel to said axis, the stator of said second capacitor being mounted adjacent said sections to extend in a direction substantially parallel thereto.

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