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ELECTRICAL VARIABLE CAPACITANCE DEVICE WITH AUXILIARY

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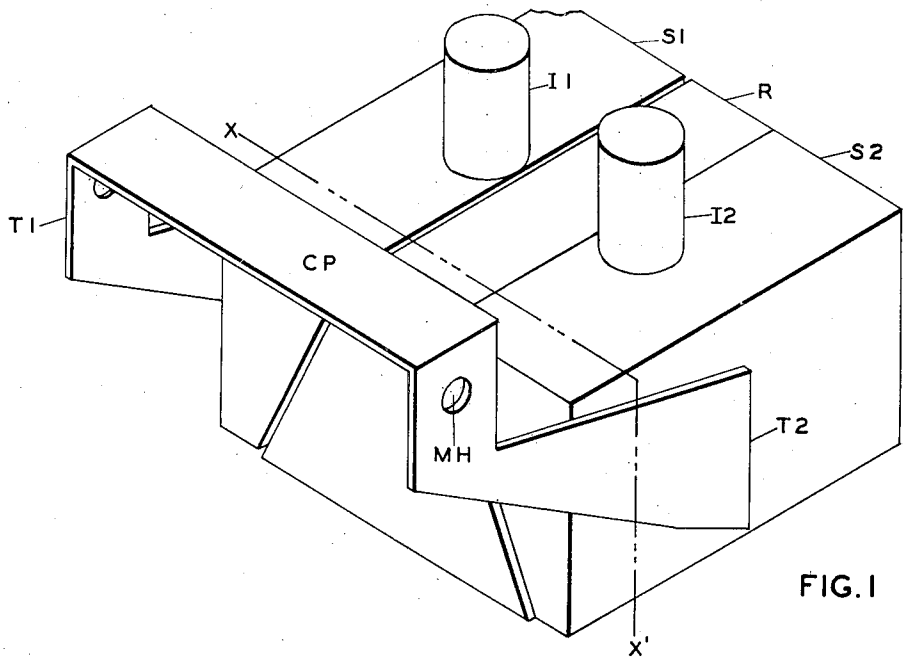


FIG. 1

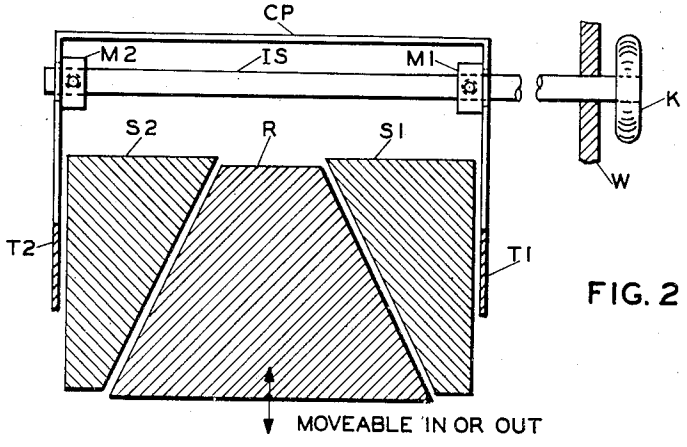


FIG. 2

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ELECTRICAL VARIABLE CAPACITANCE DEVICE WITH AUXILIARY

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3 Claims. (Cl. 175—41.5)

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My present invention broadly relates to an electrical capacitance device and more particularly to such a device designed particularly to function as an auxiliary to a primary electrical capacitance device with both of the devices being capable of widely varying their respective capacitance values.

An object of my present invention is to have the stators of a primary capacitance device also serve as the stators of my herein described and claimed auxiliary electrical capacitance device.

In the art of dealing with electrical alternating currents in manners calling for using tunable electrical circuits over wide and quite often very wide ranges of frequencies, the resonant frequencies of which circuits are more often than not controlled by variable electrical capacitance devices commonly termed variable condensers, it often becomes desirable and/or necessary to make small changes in the resonating status of one or more circuits, and particularly so where a plurality of such circuits are so connected in cascade as to operate in response to the same electrical alternating currents with all depending upon the same single adjustment in an effort to make all of the circuits involved equally resonant at each of the same frequencies over the wide or very wide range of frequencies involved, commonly termed "resonant tracking." For example, I have been called upon to make three cascade variable electrical circuits resonantly track over the exceptionally very wide range of frequencies of from 20 to 250 megacycles in order that the special signal generator requiring this performance can be reliably depended upon for checking the respective over-all performances of radio receivers and the like using these frequencies for the first time in the present war. In undertaking to find a suitable answer to this unsolved wartime emergency problem, I found it to be absolutely imperative that the last or final stage had to be subject to auxiliary adjustment of its resonant status independent of the other stages for the following technological reasons:

That otherwise there would be an inherent grave difficulty in maintaining substantially perfect tracking of the three circuits throughout the extraordinary wide range even though the final stage worked into substantially no load or a substantially constant load; that, therefore, it would be foolish to hope to maintain substantially perfect tracking in the presence of the variable output loading that could be counted upon in the case of the operations involved; that the same would be true in the presence of the modulation of the carrier currents normal to signal generator operations; that the adjusting from substantially a negligible capacitance to the maximum required would have to be smooth and substantially devoid of irregularities; that it must not couple into the circuit any appreciably greater losses in being operated to increase the capacitance involved than would a corresponding increase of the primary capacitance; that it must not couple into the circuit any extraneous electrical conductance that would thereby be capable of resonating at any frequency at which the instrumentality involved is capable of operating; that it should of itself be fitted for such physical adjusting that its maximum capacitance can be increased or decreased to some effective extent; and that it should be simple to adjust and not likely to get out of order.

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With these and other objects that may be readily apparent in view, and with the aid of the figures of the accompanying drawing in which like symbols refer to parts like in kind or function so far as practical, the following is a description of my present invention and how I practice the same:

Fig. 1 illustrates in perspective a majority of the elements necessary to practicing my present invention, and Fig. 2 illustrates a cross-sectional view of Fig. 1 on line XX' viewed from its far end plus the necessary elements missing from Fig. 1.

Referring to Fig. 1, the elements referable to by the symbols S1, S2, I1, I2 and R in the relations therein shown illustrate an electrical variable capacitance device illustrated and described in an application of Harold E. Barnes, Serial No. 542,192, filed June 26, 1944, and referred to by me in an application of mine Serial No. 574,533, filed January 25, 1945, now Patent No. 2,458,187, issued January 4, 1949. As clearly displayed, the illustrated elements S1 and S2 indicate unusually massive stators of sloping insides having interposed therebetween an unusually massive rotor of sloping sides forming an electrical variable capacitance device, the technological reasons for which massivenesses in connection with dealing with electrical alternating currents of the high, very high and ultra high frequencies within the range of from 20 to 250 megacycles are most fully propounded in the specification of the said Barnes' application, with all of which, from the actual experience therewith I have had, I fully agree. However, Fig. 1 further illustrates as an addition to the primary variable capacitance device of the said Barnes auxiliary variable capaci-

tance means comprising a cross-wisely disposed plate CP having right-angularly affixed thereto at its respective ends the extending downwardly shaped blades T1 and T2 in planes more or less paralleling the respective outsides of the stators S1 and S2. The visible hole MH in element T2 indicates that the auxiliary variable capacitance means are subject to being rotatably mounted in the relation shown with respect to the primary variable capacitance device.

Referring to Fig. 2, the element IS illustrates a mounting shaft for the auxiliary variable capacitance means which closely fits in mounting holes MH of elements T1 and T2, the said means being held in the proper position on the said shaft by the indicated set screw bands M1 and M2, and the said shaft being indicated as terminating in an operable knob K after passing through an indicated panel W. Fig. 2 further indicates that there are air spacings between the element or trimmer T1 and the outer flat side of the stator S1 and the element or trimmer T2 and the outer flat side of the stator S2, and by the oppositely pointing arrows labeled "Moveable In or Out" that the rotor R is by some suitable mechanism, not shown because of not being a part of my present invention, moveable in or out. In other words, because the rotor R is intended to be equipped with means for moving it in or out it forms with stators S1 and S2 a primary variable capacitance device with the dielectric being the air spaces therebetween.

As to operations, referring again to Fig. 1, the usual electrical circuit would comprise an electrical inductance element connected across the terminals I1 and I2 which would bring the air spaces between S1 and R and between R and S2, and vice versa, in series to, as is well known, substantially cut in half the amount of capacitance that would otherwise exist between the elements separated by a single air space assuming that the air spaces are substantially equal in all respects; and the same necessarily holds true irrespective of the in or out position of the rotor R. Certainly, it is easy to understand that to build for and set up two or more such electrical circuits including inductance and capacitance so perfectly that they would perfectly track at all frequencies from 20 to 250 megacycles would be utterly impossible, so that the question naturally arises as to whether or not reaching such a goal should be earmarked as totally outside the realm of human attainment.

In my heretofore identified patent application it is brought out that although I obtained all of the success required in lining up or tracking two 20 to 250 megacycle circuits operating in cascade with another type of trimming device, I had used a special controllable from the panel trimmer for the capacitance device in the third circuit. It so happens that the special trimmer there casually mentioned is the subject of my present invention which I found to have been necessary to satisfactorily reaching the "such a goal."

Assuming that as is usual material highly conductive of electricity is preferably used in the case of all of the parts in which there is active electrical current movement or flow without further reference thereto, it is readily apparent from the illustrated dimensions thereof that the electrical current movements in the elements CP, T1 and T2 meet with very low resistances so that the main reaction to the electrical alternating current effects reaching them through terminals I1 and I2 and the respective massive stators is

capacitive, the inherent distributed inductances therein being so low due to the massive construction used as to be almost negligible in the matter of effectively reacting until the frequencies become of the very high kind; and it is also readily apparent that this capacitive reaction is in the circuit involved, in parallel to and adds to any temporary capacitive reaction of the primary variable capacitance device in said circuit. However, it is clearly apparent that due to the low resistances met with in said auxiliary elements this coupling in of them does not add any losses greater than would be added if the primary capacitance alone was responsible for the particular capacitance increase, and that due to the paralleling of the respective elements involved it is doubtful that any increase in loss of energy takes place in the circuit involved.

Referring again to Fig. 2, the shaft IS is preferably made of some excellent electrically insulating material, and it is evident that plate CP, overlapping substantially to the same extent as it does both stators in addition to being substantially removed therefrom from a capacitance creating point of view, contributes little or nothing towards the total amount of any of the auxiliary capacitance herein contemplated; from which it is further evident that if trimmers T1 and T2 are rotated so as to be well clear of their respective stators the resulting auxiliary capacitance will be at a minimum of almost zero, which, of course, can be done from the knob K. From there on the auxiliary capacitance can readily be increased to its maximum possible the more the trimmers T1 and T2 are made to overlap their respective stators simply by turning the knob K in the right direction, and if the maximum turns out to be insufficient with the planes of the trimmers paralleling their respective stator sides, an increase in maximum can readily be had by bending the trimmers towards their respective stators. Furthermore, the rate of change of capacitance versus change of angle of knob K can be almost infinitely controlled by proper shaping of the said trimmers.

Summarizing the advantages of such an auxiliary capacitance device they are: easy to produce, install and adjust and not likely to get out of order; minimum capacitance of almost zero; very low resistances; very low dielectric losses since the insulating shaft IS of higher dielectric constant than air is located outside of any strong field; maximum capacitance obtainable increasable by easy bending of trimmers; rate of change of capacitance with angle of rotation easily controllable by proper shaping of trimmers; does not couple to the electrical tunable circuit any conductor capable of resonating at any frequency at which the instrumentality involved is capable of operating; and permits of providing for varying its capacitance from a minimum of substantially zero to an effective maximum with smoothness devoid of irregularities.

Although I have described the auxiliary capacitance device of my present invention particularly with respect to its application to an ultra modern type of primary electrical variable capacitance device, it is clearly also applicable to any type of such device in which suitable surfaces are available if the amount of variation desired is not outside of the amount that can be obtained without introducing the danger of encountering a tendency to flash over.

Normally, the cascaded circuits with which I have dealt would each be in a separate compart-

ment highly shielded from everything else and all in a totally enclosing housing also capable of effectively shielding the whole from the outside, so that the lining up of the first two circuits would have to be undertaken before the housing is finally fully closed with it also being made certain that the third and final circuit is lined up close enough to make final commercially acceptable lining up from the panel knob possible.

While I have described my present invention in certain confined respects, it is apparent that modifications may be made and that no limitations are intended other than those imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In association with a primary variable electrical capacitance device suitably constructed for providing the major components of capacitive reactions in an electrical circuit that with suitably selected inductances is called upon to resonate at frequencies ranging from the order of 20 megacycles to the order of 250 megacycles in which the construction includes two stators and an interposed therebetween variable rotor all of such low resistance material in such massive quantities of it that the consequential inherent distributed inductances set up thereby are so low that even at frequencies of the order of 250 megacycles some small but tangible amount of external inductance can be used in the circuit involved without the essential amount of circuit inductance for maintaining operations at such frequencies being exceeded, said stators each preferably having one of its major surfaces flat in a plane paralleling the plane of the other: the combination of means constructed and operable for acting with said primary device as an auxiliary variable capacitance device to change the tuning of said circuit to thereby bring about resonance of it when further movement of said rotor of said primary device is desirable, comprising a plate preferably made of a very low electrical resistance material long enough to span with margin to spare the distance between said flat stator surfaces having preferably integral therewith at each of its ends substantially duplicating, specially shaped blades extending in the same direction in planes substantially paralleling said stator surfaces, said plate and blades having adequate cross-sectional dimensions for making the reactions of the same to the electrical alternating effects shunted therethrough mainly capacitive and thereby free enough of resistances to assure effective operation throughout said range of frequencies; and means for supporting said plate at a material distance from said stators and rotor and rotating it and its affixed blades in substantially duplicating relations to said stator surfaces comprising a supported shaft of preferably excellent insulating material extending through closely fitting holes in corresponding places in respective parts of said blades near their respective junctions with said plate, said shaft being preferably terminated at one of its ends with enlarged means for facilitating its being rotated.

2. In an electrical variable capacitance device for creating with substantial precision the necessary variable capacitive reactions in any electrical circuit designed to resonate with substantial precision at high, very high and ultra high frequencies which has provisions for majorly and minorly varying said reactions independently of each other: the combination of two like-shaped stators preferably having flat sides and ends, the sides of which are made to in line face each other being so correspondingly like sloped that they progressively slope away from each other materially, and a variable, interposed between said sloping sides rotor also preferably having flat sides and ends two of which sides slope and extend substantially to the same extents as said stator sloping sides, said rotor and stators being preferably composed of very low electrical resistance material so massive in quanity in all relevant directions as to offer such low inherent distributed inductive reactions to even the ultra high frequency current flows therein that some low but tangible amount of circuit inductance for maintaining operations at said frequencies may be used without exceeding the necessary amount of circuit inductance required for resonating at the highest of the ultra high frequencies being used, which said capacitance elements provide for majorly varying the capacitance reactions involved; and a plate preferably made of a very low electrical resistance material long enough to span with margin to spare the distance between the sides of said stators facing away from said sloping sides of the same having preferably integral therewith at each of its ends substantially duplicating, specially shaped blades extending in the same direction in planes substantially paralleling said last named stator surfaces, said plate and blades having adequate cross-sectional dimensions for making the reactions of the same to the electrical alternating effects shunted therethrough mainly capacitive and thereby free enough of resistances to assure effective operation throughout said range of frequencies; and means for supporting said plate at a material distance from said stators and rotor and rotating it and its affixed blades in substantially duplicating relations to said stator surfaces comprising a supported shaft of preferably excellent insulating material extending through closely fitting holes in corresponding places in respective parts of said blades near their respective junctions with said plate, said shaft being preferably terminated at one of its ends with enlarged means for facilitating its being rotated; which said last named capacitance elements together with said stators provide for independently and minorly varying the capacitance reactions in the circuit involved.

3. A variable capacitance device for an electrical circuit adapted for very precisely tuning the same in co-operation with interchangeable different value inductances over a frequency range of the order of 200 megacycles comprising: the combination of two unusually massive stators sufficiently spaced to accommodate a correspondingly unusually massive, movable with respect thereto rotor to thereby make the capacitance relations between said rotor and stators adaptable for acting in an in series relation; an elongated, highly conductive of electricity plate of sufficient length to at least span the distance between the respective outsides of said stators; specially shaped for the purpose, highly conductive of electricity blades right angularly terminating the respective ends of said plate in planes adjacent to and substantially paralleling said outsides of said respective stators to thereby make the capacitance relations between said stators and blades adaptable for acting in an in series relation in parallel to said capacitance relations between said rotor and stators, said

plate and blades having adequate cross-sectional dimensions for making the total reactions of the same to the electrical alternating effects shunted therethrough mainly capacitive and thereby free enough of resistances to assure effective operations of the same in co-operation with said rotor and stators throughout said range of frequencies; and means for supporting and rotating said plate and blades combination to thereby make said capacitance relations with said stators adequately variable for the purpose intended comprising a supported shaft of electrical insulating material extending through closely fitting holes in corresponding places in respective parts of said blades near their respective junctions with said plate, said shaft being terminated at one of its ends by means facilitating its being rotated.

SURRIUS RECTOR MONTCALM.

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