March 2 1943. K. F. RODGERS 2,312,932

VARIABLE CONDENSER

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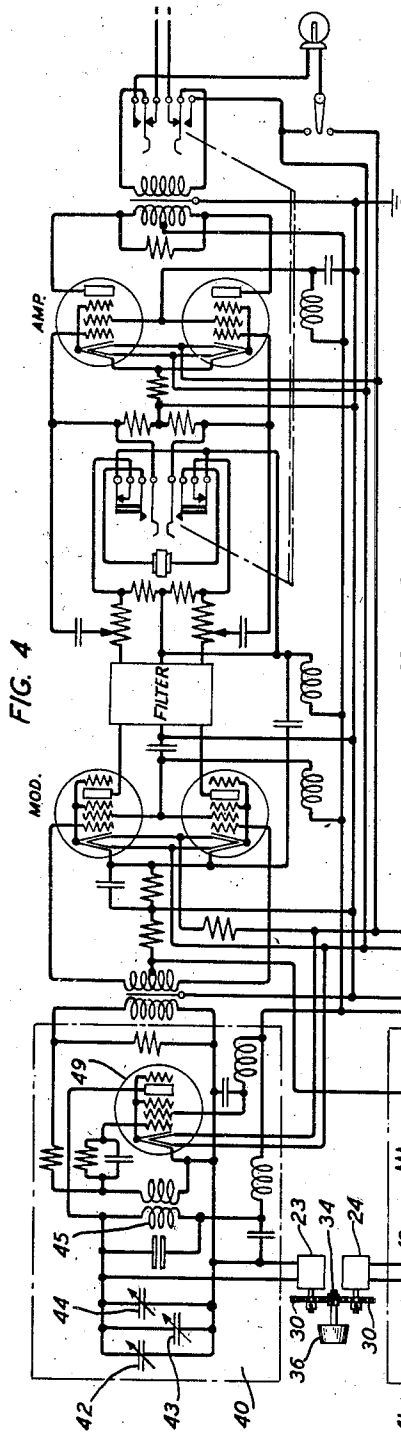

FIG. 4

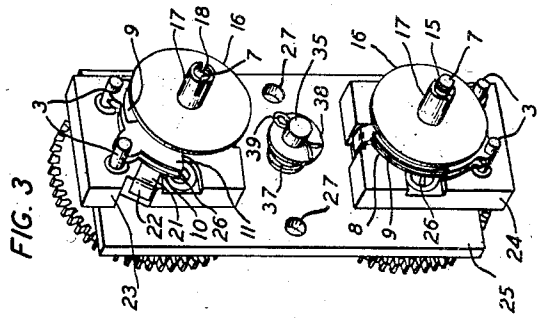

FIG. 3

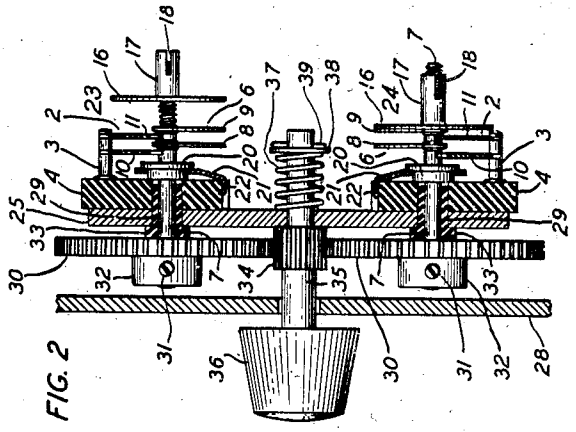

FIG. 2

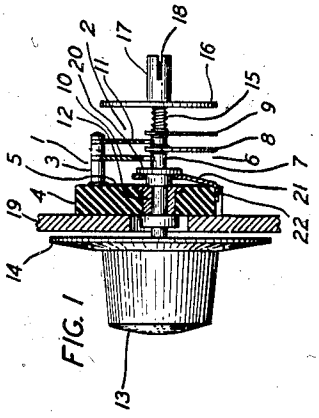

FIG. 1

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VARIABLE CONDENSER

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2 Claims. (Cl. 175—41.5)

This invention relates to variable electrical condensers and more particularly to variable electrical condensers comprising a set of stator plates and a set of rotor plates.

The object of the invention is to provide a variable condenser in which the rate of change may be varied to meet certain conditions.

A feature of the invention resides in a plate member which may be adjusted relative to another plate member to change the effect of the latter.

Other features reside in the structure and arrangement of the parts in combination.

In the drawing,

Fig. 1 is a side view, partly in section, of a condenser embodying the invention and with the condenser supported on a panel;

Fig. 2 is a side view, partly in section, of a panel, two of the condensers supported on a mounting plate and with a unitary control for the rotor shafts of the condensers;

Fig. 3 is a rear view in perspective of Fig. 2; and

Fig. 4 is a schematic diagram of an electrical system with the invention employed therein.

In electrical systems employing a variable capacitance device as a tuning element, it is sometimes found that the characteristic of one or more of the electrical elements employed in the system is slightly different from the characteristic required, or that the characteristic of one or more of the electrical elements has so changed with age or in service that the system will not operate at maximum efficiency unless the changed element is replaced by one more closely conforming to the characteristic required or the variable capacitance device is replaced by one having a rate of change different from the one present in the system.

It is well known, for instance, that in electrical systems employing so-called vacuum tubes, tuning coils and capacitance and resistance devices arranged and associated in a particular manner to obtain the required results that some of the parts may have or develop slightly different characteristics from what is required for full efficiency of the system. These differences may be due to manufacturing differences or aging or use of the parts and may be very slight and not sufficient to render the system inoperative but different enough from the ideal characteristic to reduce the efficiency of the system. The differences in some cases may be compensated simply by changing the setting of a variable condenser or other tuning element in the system. In other cases it is found that a tuning element having a different rate of change from the one already in the system is required, because a vacuum tube or other electrical element in the system may be highly efficient at a certain frequency but less efficient at others. If the tuning element is a variable condenser with the plates cut to a particular form so that as one set of plates is moved relative to another the capacitance is changed at a certain rate determined by the relative movement of the plates and the form of the plates, the rate of change of capacitance in that condenser will be at all times dependent on the speed of movement and the form of the plates. In my invention I have provided means for changing the rate of change of the capacitance of a condenser without actually changing the form of the plates or without changing the speed of movement of the movable plate or plates.

In a simple form of the invention as shown in Fig. 1 the condenser **1** comprises a set of stator plates **2** supported in spaced relation on posts **3**, only one of which is shown in the figure, the post **3** being supported at one end in a suitable block **4** of insulating material and extending normal from the rear face **5** of the block **4**. The stator plates **2** are made of electrical conducting material and extend radially from the post **3** and may be made of any particular form required. It will be assumed merely for the purpose of simplifying the explanation of the invention and not in the sense of limiting the invention to the particular form or arrangement of the stator plates that the stator plates in the stator set **2** are semicircular in form and that they are electrically connected by means of the post **3**. A set **6** of rotor plates is supported in spaced relation on a rotatable shaft **7** and is adapted to be moved relative to the stator plates **2** in a well-known manner to vary the capacitance of the condenser. The plates in the rotor set **6** may be of any particular form required with the exception of a circular form, the form employed being such that the capacitance is varied as more or less portions of the rotor plates are moved into or out of relatively close association with the stator plates. Merely for the purpose of simplifying the description, it will be assumed that the plates in the rotor set **6** are semicircular in form and comprise the rotor plate **8** and the rotor plate **9**. The stator set **2** comprises the stator plate **10** and the stator plate **11**. The rotor plate **8** may be moved to interleave more or less with the stator plates

10 and 11 by rotation of the rotor shaft 7, the rotor shaft 7 being journaled in a bearing 12 supported in the block 4 and being equipped with a turning knob 13 carrying a dial 14.

The rotor plate 9 is carried around by the rotor shaft 7 and is located rearwardly of the stator plate 11. The rotor shaft 7 is extended rearwardly of the rotor plate 9 and is externally threaded at 15. Adjustably supported on the threaded end 15 of the rotor shaft 7 is a circular plate 16. The plate 16 is centrally apertured and provided with a hub portion 17 internally threaded to receive the threaded end 15 of the rotor shaft 7. The hub portion 17 extends rearwardly of the rear face of the plate 16 and is transversely slotted at 18 so that the plate 16 may be turned on the rotor shaft 7 by means of a screwdriver, not shown. The slotted end of the hub portion 17 also permits squeezing of this portion of the hub portion 17 on the threaded end 15 of the rotor shaft 7 to maintain the plate 16 in an adjusted position. A nut, not shown, might be provided on the threaded end of the rotor shaft 7 to further insure maintenance of the plate 16 in the adjusted position. The plate 16 may be moved toward or away from the rotor plate 9 to make the rotor plate 9 more or less effective in changing the capacitance of the condenser 1. When the plate 16 is in the position shown in Fig. 1 and is thus relatively far removed from the rotor plate 9, it has practically no effect on the rotor plate 9 and the rate of change in capacitance of the condenser 1 is determined by the speed of rotation of the rotor plates 8 and 9 and the form of the plates in the stator set 2 and the rotor set 6. If the plate 16, however, is moved toward the rotor plate 9, it will have a tendency to alter the change effect of the rotor plate 9. By moving the plate 16 along the rotor shaft 7 to a position where it lies against the rotor plate 9, the change effect of the rotor plate 9 is almost completely nullified since in this position the missing semicircular half portion of the rotor plate 9 has been, in effect, replaced by the circular rotor plate 16. That is to say, since the rotor plate 9 is semicircular in form and the rotor plate 16 is circular in form, placing of the rotor plate 16 against the rotor plate 9 makes the rotor plate 9 substantially a circular plate having no or very little effect in changing the capacitance of the condenser upon rotation of the rotor set 6. With the structure above described I can therefore change the rate of change of the capacitance of the condenser to meet almost any change in the characteristic of a coil, vacuum tube or other electrical element in the system.

The condenser shown in Fig. 1 is mounted on an apertured panel 19 with the front face of its block 4 of insulating material lying adjacent the rear face of the panel 19 and with the rotor shaft 7 extending through the aperture in the panel. The rotor shaft 7 carries an enlargement or collar 20 in frictional engagement with an apertured terminal 21 supported at one end 22 in the block 4. The terminal 21, therefore, serves as a terminal for the rotor side of the condenser circuit and may be connected in any suitable manner to a conductor wire, not shown, of an electrical system. Connection for the other side of the condenser may be made in any suitable manner to the stator set 2, for instance, by connecting a wire or wires to the stator plates 10 and 11 or to the post 3.

I am aware of the fact that it is known in the art to provide an auxiliary movable plate in a condenser to serve in conjunction with another plate or portion of the condenser as a trimming condenser to vary the capacitance from an instant setting of the rotor set relative to the stator set of plates. The rate of change in such structures determined by the shape of the plates remains constant, however. In my invention the rotor plate 16 is directly associated with one of the regular rotor plates of the condenser and is moved relative to this rotor plate to more or less minimize the change effect of the regular rotor plate. This structure, therefore, is quite different from the so-called trimming condenser structures in which an extra movable plate is provided on one side of the condenser circuit to move relative to another plate on the other side of the circuit to change the capacitance of the condenser from a particular setting of the rotor plates relative to the stator plates.

In Figs. 2 and 3 are shown two condensers of the type shown in Fig. 1. Each of these two condensers 23 and 24 is constructed along the same general lines as the condenser 1 shown in Fig. 1 and like parts therein are therefore given the same identifying numerals as in Fig. 1. Since such parts have already been described in connection with Fig. 1, and no further description of them is necessary to an understanding of the invention, no further description of such parts is herein given. In the condenser 23, the circular rotor plate 16 is shown as being relatively far removed from the semicircular rotor plate 9 so that it will have little or no effect on the rotor plate 9 and hence leave unchanged the rate of change of the condenser 23 inherent in the form of the rotor plates 8 and 9 and the stator plates 10 and 11. In condenser 24 the circular rotor plate 16 is moved into face-to-face engagement with the rotor plate 9 to minimize the effect of the rotor plate 9 so far as rate of change is concerned. The rate of change of the condenser 23 has therefore not been changed and the rate of change of the condenser 24 has been changed.

The condensers 23 and 24 as shown in Figs. 2 and 3 are mounted in spaced relation on a mounting plate 25 by means of screws 26 which pass through apertures in the block 4 and into the mounting plate 25. The mounting plate 25 is apertured at spaced points 27—27 to permit mounting of the mounting plate 25 on a panel 28 by means of mounting screws or bolts, not shown. The stator set 2 in each condenser is insulated from the mounting plate 25 by means of the block 4. The rotor set 6 is insulated from the mounting plate 25 by means of a bushing 29 of insulating material, the bushing 29 being disposed about the rotor shaft 7 and in apertures in the mounting plate 25 and block 4. Mounted on each rotor shaft 7 is a gear wheel 30 secured to the rotor shaft 7 by means of a set screw 31 which passes transversely through a hub portion 32 on the gear wheel and into engagement with the shaft 7. The bushing 29 is provided with a flanged outer end portion 33 to hold the gear wheel 30 spaced from the mounting plate 25.

To provide a unitary control for the condensers 23 and 24, the gear wheels 30 are gear connected by means of a pinion 34 mounted on a rotatable shaft 35 which passes transversely through the mounting plate 25 and the panel 28. Rotation of the shaft 35 will cause simultaneous rotation of the gear wheels 30 and the rotor shafts 7 of the condensers 23 and 24. The shaft 35 may be equipped with a turning knob 36 as shown in Fig. 2 to facilitate rotation of the shaft 35 or

may be provided with a transverse end slot, not shown, to permit rotation of the shaft by means of a screw-driver. In order to permit individual rotation of the rotor shafts 7 of the condensers, the shaft 35 is arranged for longitudinal movement so that the pinion 34 may be withdrawn from engagement with the gear wheels 30. The pinion 34 is normally held in engagement with the gear wheels 30 by means of a helical spring 37 supported on the inner end of the shaft 35. One end of the spring 37 bears against the inner face of the mounting plate 25. The other end of the spring 37 bears against a washer 38 on the shaft 35, the washer being held in place by means of a cotter pin 39 extending transversely through the inner end of the shaft 35. An outward pull applied to the shaft 35 will compress the spring 37 and remove the pinion 34 from engagement with the gear wheels 30. The gear wheels 30 may then be individually rotated to rotate the shafts 7 of the condensers. Release of the outward pull on the shaft 35 will permit the spring 37 to again bring the pinion 34 into engagement with the gear wheels 30. The rotors of the two condensers may be electrically insulated from each other in the gear system by making one or more of the gear wheels 30 of insulating material or by making the pinion 34 of insulating material.

One application of the condensers shown in Figs. 2 and 3 is shown in Fig. 4. The condensers in this figure are shown as being employed as the control means for two oscillators 40 and 41 of a heterodyne oscillator system. The heterodyne oscillator system shown, exclusive of the condensers 23 and 24, is not part of the invention but is merely shown as illustrative of a use of the invention. The heterodyne oscillator comprises two component oscillators 40 and 41, the combining modulator MOD on which are impressed the output waves of the component oscillators and from which is derived the difference frequency which is the characteristic frequency of the over-all oscillator. A push-pull amplifier AMP is provided to amplify the output of the modulator MOD. The component oscillators 40 and 41 may be substantially identical and individually tuned to produce the oscillations required, the oscillator 40 being tuned by means of the variable condensers 42, 43 and 44 and the tuning coil 45, and the oscillator 41 being tuned by means of the variable condensers 46 and 47 and the tuning coil 48. The condenser 23 is connected across the oscillator 40 in parallel with the condensers 42, 43 and 44 and the tuning coil 45. Condenser 24 is connected across the oscillator 41 in parallel with the condensers 46 and 47 and the tuning coil 48. Simultaneous tuning of the oscillators 40 and 41 may therefore be made by turning the knob 36 to operate the rotor elements of condensers 23 and 24. If in tuning the two oscillators by means of the condensers 23 and 24 it is found necessary to have in the condenser 23 a different rate of change in capacitance from that obtained in the condenser 24, because one or more elements in the oscillator has a characteristic slightly different from that required, compensation may be made for this difference by adjustment of either or both of the condensers 23 and 24. The condenser 23, for instance, may be adjusted individually of condenser 24 to compensate for deficiencies in the tube 49 or the tuning coil 45 in the oscillator 40, the individual adjustment being accomplished by withdrawing the pinion 34 from engagement with the gear wheels 30 and by turning the gear wheel 30 of the condenser 23 to a required extent to meet the conditions. The condenser 24 may be individually adjusted to meet similar conditions occurring in the tube 50 or the tuning coil 48 in the oscillator 41. If it is found that elements in the oscillators have characteristics at different frequencies such that the present rate of change in capacitance of the condensers 23, 24 is not such as is required to meet the conditions, the rate of change of the condensers 23, 24 may be altered to meet the conditions by turning the circular rotor plate 16 of a condenser toward or away from the adjacent semi-circular rotor plate 9. In the structure shown in Figs. 2 and 3 the condenser 23, which as shown in Fig. 4 serves the oscillator 40, has been adjusted so that it has about its normal rate of change in capacitance while the condenser 24, which serves the oscillator 41, has been adjusted so that it has a relatively slight rate of change. The adjustments of the condensers have been accomplished by moving the circular plate 16 in condenser 23 relatively far from the rotor plate 9 and by moving the circular plate 16 in condenser 24 into face-to-face engagement with the associated rotor plate 9.

It is obvious that certain changes may be made in the condenser structure shown and described and that any particular form of rotor and stator plates may be employed without departing from the spirit of the invention, the scope of which is indicated by the following claims.

What is claimed is:

1. A variable electrical condenser comprising in combination, a non-circular stator plate, a non-circular rotor plate, a circular rotor plate, both of said rotor plates being located on the same side of said stator plate and forming an end plate of said condenser, said circular rotor plate being the outside one of said rotor plates and said circular rotor plate being adapted to be moved relative to said non-circular rotor plate and into face-to-face engagement with said non-circular rotor plate.

2. A variable electrical condenser comprising in combination, a non-circular stator plate, a non-circular rotor plate, an auxiliary rotor plate of circular form, both of said rotor plates being located on the same side of said stator plate and forming an end plate of said condenser, said auxiliary rotor plate being the outside one of said rotor plates and said auxiliary rotor plate being adapted to be moved relative to said non-circular rotor plate and into face-to-face engagement with said non-circular rotor plate.

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