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ELECTRICAL CONDENSER

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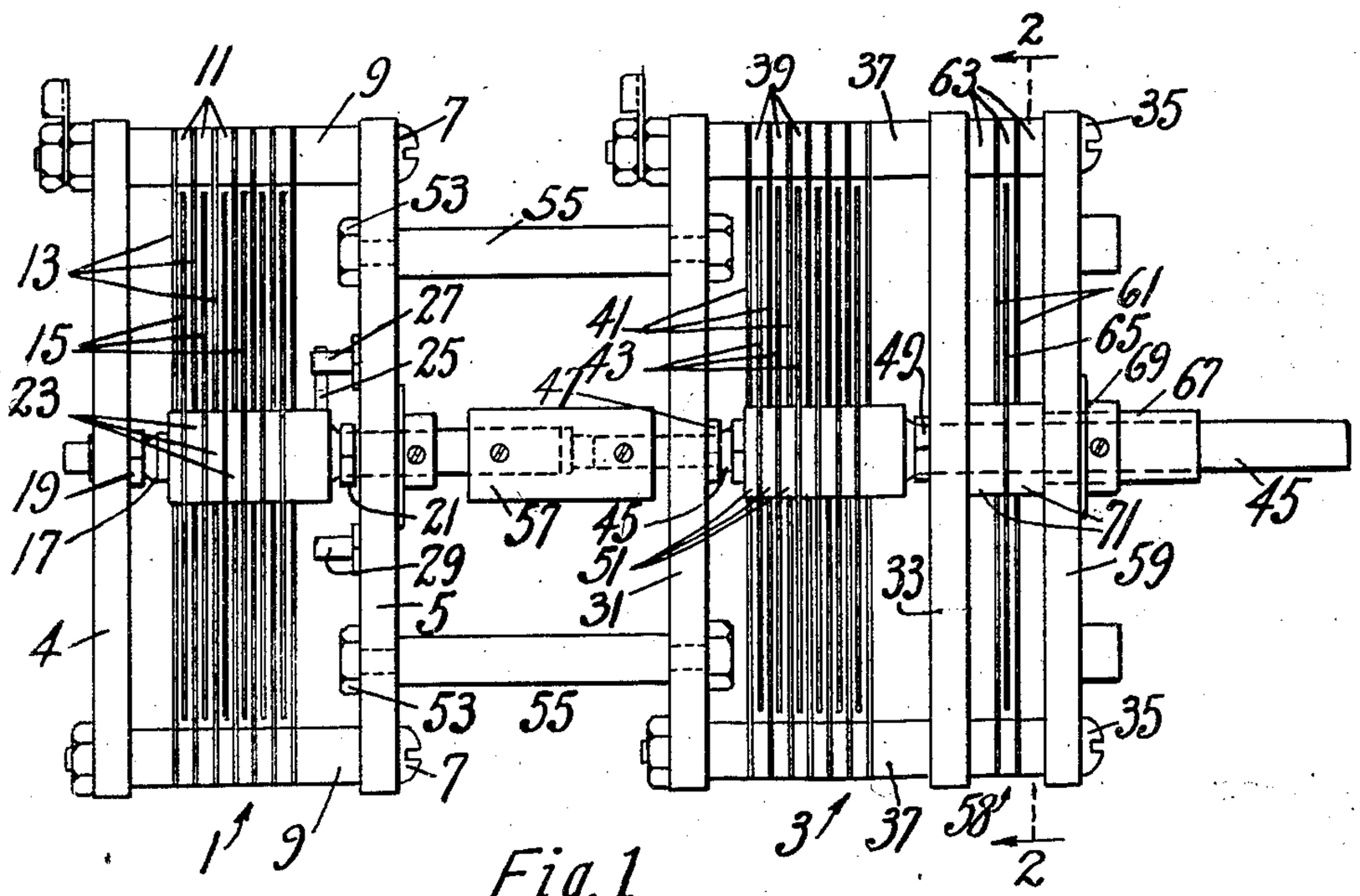

Fig. 1

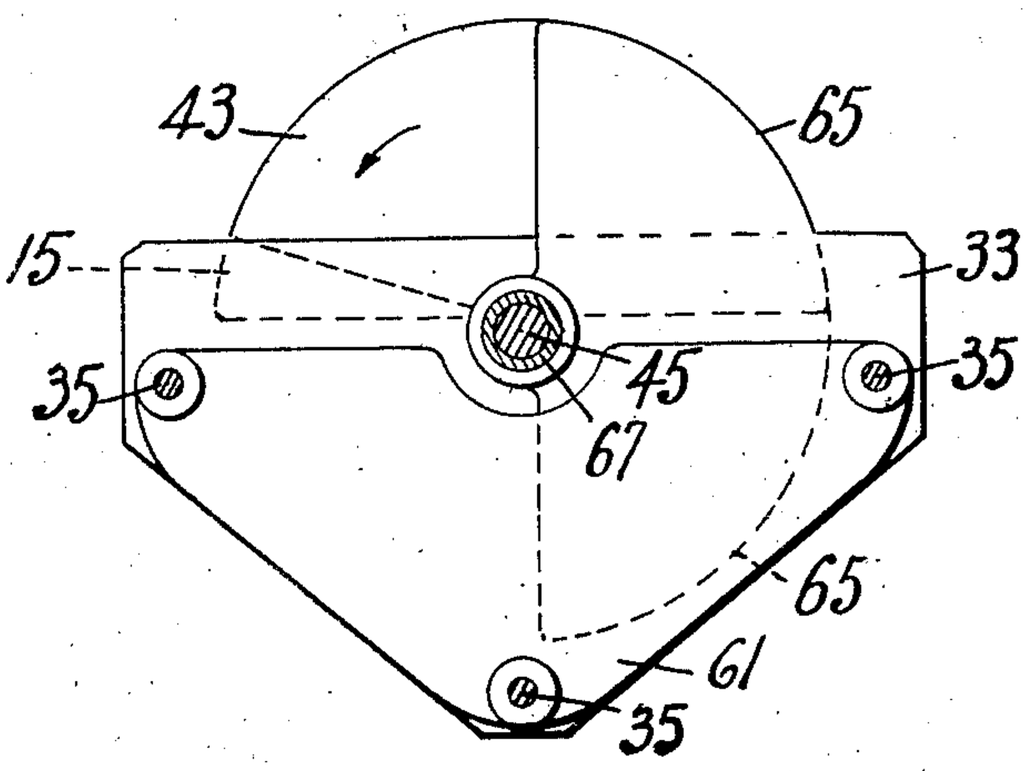

Fig. 2

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ELECTRICAL CONDENSER.

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This invention relates to electrical condensers, and more particularly to such condensers to be built into tuned radio frequency circuits.

The object of the invention is to provide an improved means for tuning two inductances wherein two variable condensers of unequal capacity may be operated mechanically, as a unit, to tune the two inductances in such a manner that the two tuned circuits are kept substantially in resonance with each other through all settings and, that the tuning is substantially accomplished by manipulation of a single control. It is impracticable to accomplish this result by merely connecting two variable condensers rigidly, as by mounting their rotors upon the same shaft, because it is impracticable under ordinary manufacturing conditions to produce in quantity precision instruments, i. e. variable condensers having identical capacity curves. It is likewise commercially impracticable to produce two inductances, which constitute the other elements of the tuned circuits, that are absolutely identical in their characteristics. The tuning of each circuit always is more or less affected by external influences, such for example as the presence of neighboring current carrying wires and the like.

According to this invention a variable balancing condenser of small capacity is provided, being so arranged that it may be utilized to establish a state of perfect resonance between the two circuits which are approximately tuned to each other by the two condensers, known to be of unequal value, whose rotors are operated by the common control. The capacity of the balancing condenser must be at least equal to the maximum difference between the capacities of the two main tuning condensers at any setting of the latter, and in practice the balancing condenser may conveniently be connected in parallel with one of the main tuning condensers which has one set of its plates sufficiently reduced in size so that its capacity at all settings is certain to be somewhat less than that of the other tuning condenser. The capacity of the balancing condenser may conveniently be approximately twice the difference between the capacities of the main tuning condensers at any setting of the latter, thereby providing a margin of adjustment sufficient to balance inequalities between the two tuned circuits, throughout the entire range of adjustment of the tuning condensers.

To the accomplishment of this object and such others as may hereinafter appear, as will readily be understood by those skilled in the art, the invention comprises the features and combinations of parts hereinafter described and then particularly pointed out in the appended claims.

The various features of the invention will best be understood from a description of the preferred embodiment thereof illustrated in the accompanying drawings, in which:—

Fig. 1 is a plan of two tuning condensers of unequal capacities provided with means for balancing their capacities in accordance with the present invention, specifically the illustrated condensers may be used for tuning the secondary of the antenna coupling transformer and the secondary of the radio-frequency amplifying transformer; and

Fig. 2 is a vertical section taken on line 2—2 of Fig. 1, looking in the direction of the arrows and showing the balancing means adjusted to increase the capacity of the adjacent tuning condenser.

In the embodiment of the invention illustrated in the drawing two variable condensers 1 and 3, of any preferred commercial type but the capacity of one being altered as hereinafter explained, are coupled together so as to form a single tuning unit for the two inductances that are to be maintained in resonance thereby.

As illustrated the condenser 1 is supported in the usual frame comprising a pair of end plates 4 and 5 held in the desired spaced relation by through bolts 7 provided with spacing sleeves 9 interposed between the plates. Each of these spacing sleeves 9 includes a series of washers 11 interposed between the seven fixed plates 13, which compose the stator, having holes therein through which the bolts 7 extend. Adjustable relatively to the stator is the rotor, composed of six plates 15, mounted on a rotatable shaft 17 journalled in bearings 19 and 21 carried by the end plates 4 and 5 respectively. The rotor plates 15 are held in proper spaced relation relative

to the stator plates 13 by washers 23 mounted on the shaft 17.

The condenser 3 is generally similar to the condenser 1 being supported in a frame comprising a pair of end plates 31 and 33 held in proper spaced relation by through bolts 35 entered through spacing sleeves 37 interposed between the end plates 31 and 33. These sleeves include a series of washers 39 between which are a series of seven fixed plates 41, which comprise the stator having holes therein through which the bolts 35 extend. Similarly to the condenser 1, the condenser 3 is provided with an adjustable rotor, comprised of six plates 43, mounted on a rotatable shaft 45 journalled in bearings 47 and 49 mounted in the end plates 31 and 33 respectively. The rotor plates 43 are held in proper spaced relation relative to the stator plates 41 by a series of washers 51 on the shaft 45. A very material difference between the rotors of the two illustrated condensers will presently be described.

In the present instance of the invention, the two main condensers 1 and 3 may conveniently be coupled together, so as to be under a single control, by through bolts 53 entered through the adjacent end plates 5 and 31, the two condensers being held apart by sleeves 55 through which the bolts extend to provide space between them for a coupling 57 secured to the abutting ends of the shafts 17 and 45. With this construction both rotors are adjusted to equal angular positions whenever the shaft 45 is rotated by means of the usual dial fixed thereon. The shaft 17 is provided with a radial pin 25 adapted to engage one or another of the stops 27 and 29 projecting inwardly from end plate 5, thereby to limit the rotative movement of both rotors when positioned either wholly within or wholly without the field of their respective stators.

In carrying out the object of the invention each of the six rotor plates 43 of the condenser 3 has an area substantially less than any rotor plate 15 of the condenser 1. As illustrated by Fig. 2 each rotor plate 43 is seen to have about eleven-twelfths of the area of any rotor plate 15. This construction makes certain a substantial difference between the several capacities of the two variable condensers and provides two condensers of a known predetermined unequal value. Furthermore, the difference in capacities is so material that the capacity curve of the condenser 3, remains below the capacity curve of the condenser 1 at all settings. It is highly important to the present invention that, when plotted, the capacity curves of the two condensers show that the ordinates of one curve are consistently somewhat less than the ordinates of the other. In other words, the two capacity curves are such that for any common abscissa, that is, for any like setting of the two condensers when tuning, the corresponding ordinates of the two curves will never be equal. More than this, the capacity curves will not cross each other, as may be true of two condensers taken at random from stock. Briefly, one condenser is certain to be of somewhat less capacity than the other for any tuning adjustment.

To balance, or compensate for, this difference in the capacities of the two condensers so that when operated mechanically as a unit the two circuits may be tuned identically or in resonance, a balancing condenser 58 is provided. This balancing condenser is associated with the condenser 3, of reduced capacity, and comprises an end plate 59, opposed to the end plate 43, mounted on the through bolts 35 which are extended forwardly for this purpose. Fixed plates 61, forming the stator of the condenser 58 have holes through which the bolts 35 project, said plates being held in proper spaced relation by washers 63 on said bolts. Since the required capacity of the balancing condenser is small, two stator plates 61 are sufficient. Between the stator plates 61 is an adjustable rotor comprising a single plate 65, mounted on a sleeve shaft 67 supported by the shaft 45 and journalled in a bearing 69 carried by the end plate 59. The rotor 65 is held spaced relative to fixed plates 61 by a pair of washers 71 mounted on the sleeve shaft. The balancing condenser just described may be the ordinary three plate so-called vernier, and is so illustrated.

It will be observed that both the sleeve shaft 67 and the solid shaft 45 project forwardly beyond the end plate 59 a sufficient distance to pass through the panel board and receive dials or other means enabling rotation of said shafts and adjustment of the rotors supported thereby.

The rotor plate 65 of the balancing condenser is similar to the rotor plates 15 of tuning condenser 1 and hence the capacity of the balancing condenser is sufficient to bring the two main tuning condensers to a like value with a sufficient margin of safety. It is obvious that the capacity of the balancing condenser must be at least equal to the difference in capacity of the condensers 1 and 3 that is produced by cutting off one-twelfth of each of the six rotor plates 43 of condenser 3 i. e. a total reduction in area equal to one-half of a single plate. In order to provide a margin or adjustment sufficient to compensate for or balance inequalities between the two tuned circuits throughout their entire ranges of adjustment the illustrated balancing condenser (see Fig. 2) has a capacity of approximately twice the difference between the capacities of the two main tuning condensers. By making the total area of the rotor plates of one of the main tuning condensers substantially less than the total area of the rotor plates of the other main tuning condenser, a sufficient difference in the capacities of the two cor-

densers is established to enable this difference to be compensated for by the balancing condenser with fine adjustment.

By means of this invention there is provided a simple and efficient construction whereby two condensers of unequal capacity, connected for control from a single dial, may be perfectly balanced. The simplicity of tuning will be understood from the following. If the difference in the length of the ordinates of the two capacity curves at different settings of the two tuning condensers is substantially constant, then one initial setting of the variable balancing condenser will be sufficient for the entire range of adjustment. The two circuits can be accurately tuned to all other wave lengths by an adjustment of the single condenser-shaft. If the difference in length of said ordinates varies, for example by becoming consistently greater or less as the two circuits are tuned for higher wave lengths, then this variation, for the sharpest tuning, may be compensated for by a further adjustment of the balancing condenser which in any event will be extremely slight.

Those skilled in the art will recognize that in this construction there are really but two variable condensers, one having an unvariable capacity curve and the other having a capacity curve the shape of which can be varied slightly. By means of this invention absolute accuracy is obtained with condensers that are not accurately made. It is within the scope of the invention to provide any suitable means for transmitting rotation from one condenser shaft to the other.

While it is preferred to employ the specific construction and arrangement of parts shown and described it will be understood that this construction is not essential except so far as specified in the claims, and may be changed or modified without departing from the broader features of the invention.

What is claimed as new, is:—

1. The combination of two tuning condensers operated mechanically as a unit, one of which has a value less than the other at all settings, and a variable balancing condenser having a value equal at least to the maximum difference in value between said two tuning condensers and connected in parallel with the tuning condenser of lesser value.

2. The combination of two tuning condensers operated mechanically as a unit, one of which has a value less than the other at all settings, and a variable balancing condenser having a value of approximately twice the maximum difference in value between said two tuning condensers and connected in parallel with the tuning condenser of lesser value.

3. The combination of two variable tuning condensers, said condensers having unequal capacities for all settings, means for operating said condensers as a unit, and means for compensating for the inequality in the capacities of said condensers at all the settings thereof.

4. The combination of a pair of variable tuning condensers connected to be operated mechanically as a unit, each comprising a stator and an adjustable rotor, said stators being of like area but the rotor of one of said condensers being formed to have an area substantially less than the area of the rotor of the other condenser, so that the capacity of one of the condensers at all settings is necessarily less than the capacity of the other condenser, and a balancing condenser connected in parallel having a stator and an adjustable rotor the area of which is at least equal to the difference between the areas of the rotors of the tuning condensers.

5. The combination with two tuning condensers, each comprising fixed and adjustable plates, each of the adjustable plates of one of the condensers having a portion removed to make certain that there is a substantial difference in capacity between the two condensers, of a balancing condenser adjustable to compensate for the capacity difference between the condensers at all settings thereof, and means for adjusting said two tuning condensers as a unit and said balancing condenser individually.

6. The combination with two variable condensers having stator plates equal in number and area and rotor plates equal in number but substantially unequal in area, common means for adjusting said condensers to approximately tune two equal inductances, and adjustable means co-operating with the variable condenser of lesser capacity operable to increase its capacity to equal that of the other variable condenser for any tuning adjustment thereof.

7. In combination, two variable tuning condensers of a predetermined unequal value and mounted in parallel, a common adjusting shaft for the respective rotors thereof whereby the capacities of said two condensers may be simultaneously varied by a single control, a balancing condenser also in parallel and adjacent the tuning condenser of lesser value, and a rotary adjusting sleeve on said shaft for the rotor of said balancing condenser, whereby the capacity of the condenser of lesser value may be increased to equal that of the other condenser.

8. In combination, two variable tuning condensers, one of said condensers having a capacity curve the ordinates of which are consistently shorter, throughout the entire range of adjustment, than the ordinates of the capacity curve of the other condenser, means for adjusting said two condensers as a unit, and means independently adjustable at any setting for inceasing the capacity of the condenser of lesser value to equal the greater capacity of the other condenser.

9. The combination of two tuning condensers, mechanical means for operating said condensers as a unit, said condensers having unequal capacities at all settings, and variable means for compensating for the inequality in the capacities of said condensers for all positions of said mechanical means.

10. The combination of two tuning condensers operated mechanically as a unit, one of which has a value different from the other at all settings, and a variable balancing condenser having a value equal at least to the maximum difference in value between said two tuning condensers and electrically associated therewith.

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