Feb. 13, 1934. L. G. THOMAS 1,947,069

VARIABLE CONDENSER

Filed March 9, 1933 2 Sheets-Sheet 1

Fig. 1.

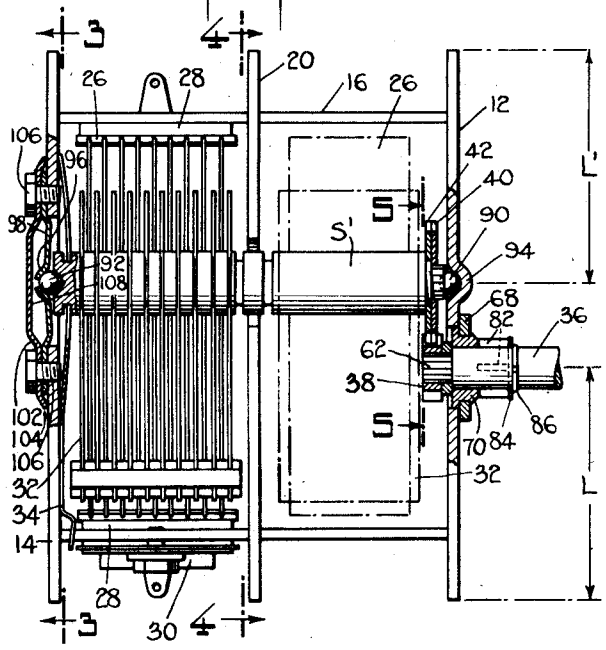


Fig. 2.

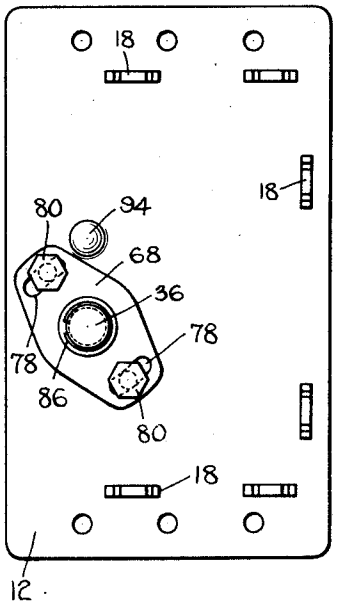


Fig. 3.

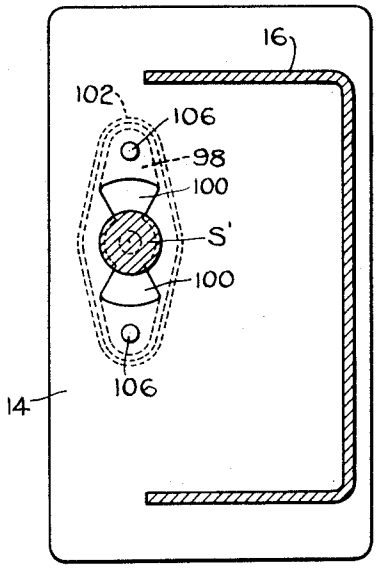
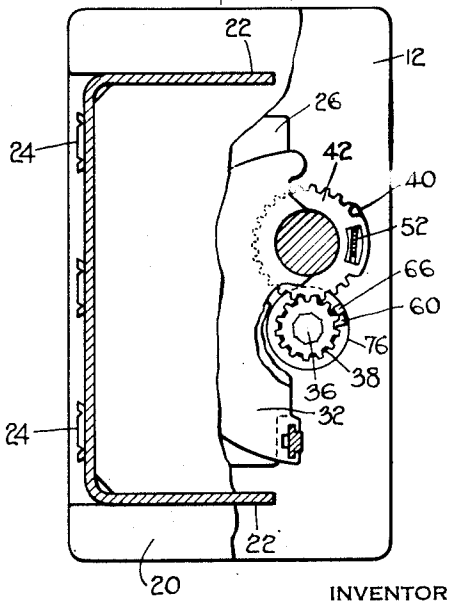


Fig. 4.



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Fig. 5.

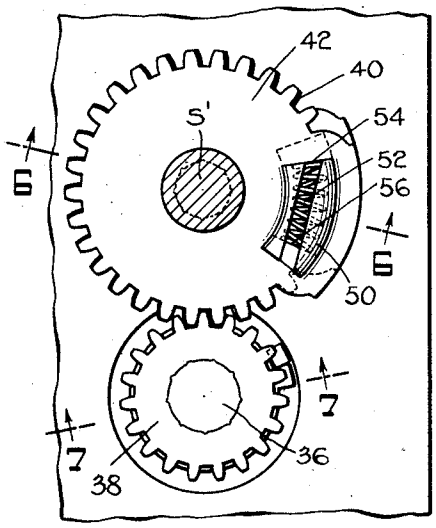


Fig. 8.

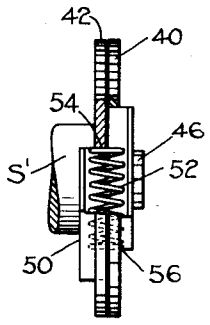


Fig. 6.

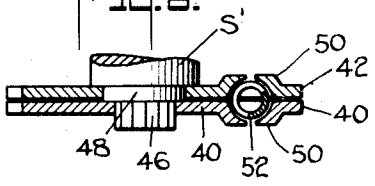


Fig. 7.

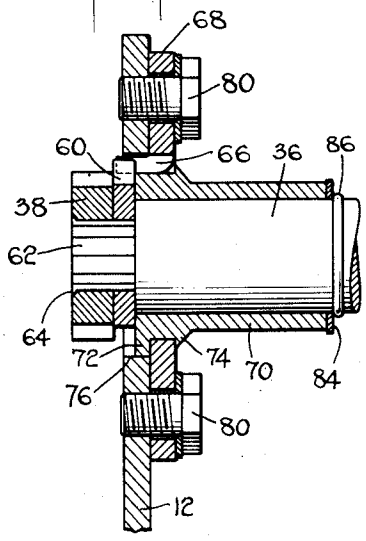
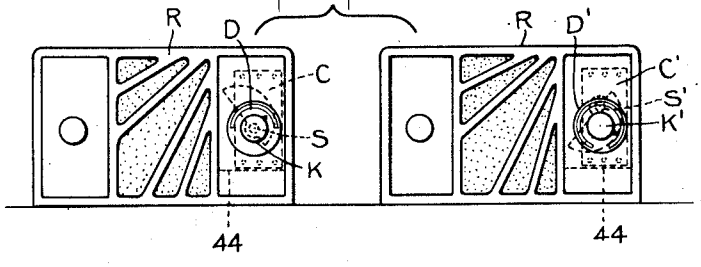


Fig. 9.



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UNITED STATES PATENT OFFICE

1,947,069

VARIABLE CONDENSER

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Application March 9, 1933. Serial No. 660,120

5 Claims. (Cl. 74—7)

This invention relates to variable condensers, and more particularly to such condensers designed for use with miniature radio sets.

A form of radio set which has come greatly into vogue in recent years is a miniature radio set made so compact that it occupies negligible space and is readily portable during trips, on vacations, and the like. The primary object of the present invention is to generally improve variable radio condensers, particularly of the gang type, and especially such condensers intended for use in miniature radio sets of the type referred to.

These radio sets are constructed so compactly that there is no room for the customary vernier control mechanism for the gang condenser, nor even for an expanded drum or indicator dial of conventional type. On the contrary, the current practice is to permit the rotor shaft of the condenser to project directly through the front wall of the receiver and to mount thereon a relatively tiny knob such as is ordinarily used on a volume control resistor or a vernier drive. This results in a control which is extremely critical and difficult to manage because the small knob employed is revolved only a half revolution for the entire frequency range of the receiver. One object of the present invention is to overcome this difficulty and to provide a condenser for such receivers which will be far less critical in adjustment and which will make available a greatly spread station dial without in any way changing the favorable compact arrangement and indicator system heretofore adopted because space is at such premium in this type of receiver. With this object in view, the condenser is provided with a drive shaft separate from the rotor shaft, and the said drive shaft is geared to the rotor shaft by means of reduction gearing having a ratio so selected that the drive shaft turns nearly but not in excess of one complete revolution when changing the condenser from minimum to maximum capacitance. In the ordinary case the rotor shaft turns through 180° and the gear ratio is nearly but not in excess of 2 to 1, so that the drive shaft is turned through a nearly doubled angle not exceeding 360°. Because the rotation of the control knob does not exceed 360°, it may be provided with a pointer and act as its own dial. At the same time, the spread of the scale is nearly doubled, thereby making the receiver only half as critical and, in practical operation, manageable with ease.

Still another object of the present invention is to so arrange and proportion the parts of the new condenser that the condenser may be used to replace the simple direct drive condenser heretofore employed, without necessitating any change in the chassis layout, cabinet proportion, or panel layout of miniature receivers already undergoing manufacture. With this object in view, the new condenser is arranged symmetrically as regards the rotor and drive shafts, so that the drive shaft is spaced from the nearby edges of the frame by distances equal to the spacing of the rotor shaft from the nearby edges of the frame. As will later appear, the new condenser, both in respect to dimension and direction of rotation, may therefore be substituted for the direct drive condenser ordinarily used.

The use of gearing ordinarily introduces play or back-lash which is obviously undesirable when, as is here the case, the drive shaft is used as its own indicator. Accordingly, still another object of the present invention is to obviate any play or back-lash between the drive shaft and rotor shaft, for which purpose resilient means is introduced to take up any such play or back-lash. In preferred form the gear on the rotor shaft is made of a plurality of relatively rotatable laminations provided with spring means tending to relatively displace said laminations and thereby spread the gear teeth as far as may be permitted by their engagement with the pinion on the drive shaft. Any shaking of the drive shaft, which is preferably a stub shaft terminating at the end plate of the condenser, may manifest itself to the operator as an apparent back-lash; and, in accordance with a further feature and object of the present invention, this possibility is overcome by slitting the bushing carrying the drive shaft so that it resiliently engages the drive shaft.

Further features and objects of the present invention center about the stop mechanism for limiting the condenser movement. Considerable strain is applied to the gearing and condenser mechanism if the rotor is itself used as an end stop, for the operating torque is applied to the drive shaft. In the present construction a positive stop for limiting the movement of the condenser is applied to the drive shaft ahead of the gearing interconnecting the drive shaft and the rotor of the condenser, so that any forceful twisting moment applied to the drive shaft is received and opposed without being applied to the gearing and condenser mechanism at all. A single stop is made available for limiting the condenser movement at both ends of the working range. This stop is made adjustable to correlate

the motion limiting action with the position of the condenser rotor.

Further objects of the present invention center about the bearings for the condenser rotor. In the present construction the rotor is accurately positioned and maintained under predetermined desired degree of friction by exceedingly simple and inexpensive bearings including a single ball bearing at each end of the rotor shaft. One of these ball bearings may be carried in a simple recess formed directly on the end plate of the condenser. The other is preferably carried on a resilient support plate. A rigid thrust plate is mounted just outside of the resilient support plate for positively limiting the yieldability of the support plate to a desired small value. In this manner all of the advantages of a yieldable support, together with all of the advantages of a rigid support, are combined without introducing the ordinary known disadvantages of either type of support when used alone.

The effective length of the projecting control shaft of the condenser is a variable dependent upon the particular requirements of each manufacturer. It has heretofore been necessary to make the rotor shaft of different lengths to meet these requirements. In accordance with still another object and feature of the present invention, the rotor shaft is standardized in length and is in all cases unchanged, while the drive shaft, an independent and exceedingly simple element of the condenser, is readily varied in length to meet the desires of different manufacturers.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the condenser elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawings in which:

Fig. 1 is a partially sectioned plan view of a condenser constructed in accordance with the present invention;

Fig. 2 is an end view thereof;

Fig. 3 is a section taken in the plane of the line 3—3 in Fig. 1;

Fig. 4 is a section taken in the plane of the line 4—4 in Fig. 1;

Fig. 5 is an enlarged section taken in the plane of the line 5—5 in Fig. 1, showing the reduction gear mechanism;

Fig. 6 is a section taken in the plane of the line 6—6 in Fig. 5;

Fig. 7 is an enlarged detail section taken in the plane of the line 7—7 in Fig. 5;

Fig. 8 is a detail explanatory of the gear mechanism; and

Fig. 9 is a schematic comparison of the prior and the new pratices, explanatory of certain advantages of the latter.

Referring to the drawings and more particularly to Fig. 9 thereof, the present invention especially concerns the variable gang condenser C employed in miniature radio sets known under various names, such as "Midget", "Treasure Chest", "Jewel Box", and the like, such a receiver being generally designated by the letter R. In these receivers, space is at a premium and it is therefore the practice to employ a simple compact form of gang condenser the shaft S of which projects through the wall or panel of the receiver and has applied thereto a small control knob K, this knob cooperating with an appropriate fixed dial D. The condenser shaft, and consequently the knob K, rotates through only 180°, as a result of which the tuning or adjustment of the receiver is extremely critical, the slightest movement of the knob often resulting in a complete change from one station to another.

In accordance with the present invention, the condenser C' is provided with a drive shaft geared to the condenser shaft S' by reduction gearing, and it is the drive shaft, rather than the condenser shaft, that is provided with a knob, K'. The reduction is, however, not made of the vernier type, but rather is made near but not in excess of 2 to 1, so that the knob K' rotates nearly but not in excess of 360°, thereby making it possible to associate with the knob K' a simple direct reading dial D'. The scale of this dial is, however, magnified nearly double, thus tremendously increasing the ease and convenience with which the set may be operated. In passing, it should be noted that the condenser C' is so dimensioned and mounted as to readily replace the condenser C; that the knob K' is located in the same position as the knob K; and, finally, that increase or decrease of capacitance is obtained by rotating the knob K' in the same direction as the knob K.

The improved condenser will now be described in greater detail by reference to Figs. 1–8 of the drawings. The particular condenser here shown employs two units arranged in gang formation on a single shaft S'. The condenser frame may be of conventional type and comprises metallic end plates 12 and 14 spaced by a generally U-shaped bed 16 secured between the end plates 12 and 14 by tongues 18 which project through the end plates and are there riveted or expanded. The frame is further provided with a partition plate 20 interlocked with the upper edges of the bed plate 16 at the points 22 (Fig. 4) and riveted to the bottom of the condenser by tongues 24. The condenser frame carries stator units 26 of conventional type through the medium of the customary insulation slabs 28, and these stator units may, if desired, be additionally provided with appropriate trimmer condensers 30. The frame additionally carries the rotor shaft S' on which there are mounted rotor units 32, also of conventional type and arranged to interleave the plates of the stator units in the usual fashion. Electrical connection with the rotor sections 32 may be obtained through forked spring members 34 in known manner.

In accordance with the present invention the condenser is provided with a drive shaft 36 which is geared to the rotor shaft S' by means of reduction gearing including a pinion 38, secured to the drive shaft 36, and a gear 40, 42, secured to the rotor shaft. The gear reduction is so selected that the drive shaft 36 turns nearly but not in excess of a complete revolution. Specifically, the present condenser is so proportioned that the drive shaft 36 turns 320° while the rotor shaft turns 180°.

It will be noted, from an inspection and comparison of Figs. 1 and 2 of the drawings, that the distance L of the drive shaft 36 from the lower edge of the condenser frame, is equal to the distance L' of the rotor shaft S' from the upper edge of the condenser frame. The proportioning of this type of condenser has become practically standardized, so that the dimension L' of the condensers of the major manufacturers is uniform. In the present condenser the drive shaft 36 is spaced from the opposite edge of the

condenser frame by a similar distance, and the difference or resulting space between the two shafts is appropriately subdivided by the pinion 38 and the gear 40, 42 to yield the desired reduction ratio. Of course, in the interests of standardization of the gearing exact equality of the dimensions L and L' may be departed from slightly, a difference of as much as one-sixteenth of an inch, for example, being readily accommodated by the ordinary over-sized opening provided in the front cabinet wall. It will further be observed, from inspection of Fig. 2, that the axes of the rotor shaft and the drive shaft are on a line parallel to the vertical edges of the condenser frame, so that the entire condenser layout, as respects the location of the rotor and drive shafts relative to the condenser frame, is a perfectly symmetrical one.

It will be understood that, from the viewpoint of the manufacturer, the end plates of the condenser may be interchanged, so that a set manufacturer already using a direct drive condenser is readily supplied with the present condenser suitably arranged to be inserted in the receiver just as before. Thus, reverting to Fig. 9, the condenser C, a direct drive condenser, is mounted on a chassis plate 44, the bulk of the condenser being disposed above and to the right of the knob K, clockwise rotation of which increases the capacitance. By locating the drive shaft 36 of the new condenser C' on the opposite end plate and turning the condenser end for end, the new condenser C' may be used in place of the old condenser C. The bulk of the condenser C' again extends above and to the right of the knob K'. Clockwise rotation of the knob, because of the reversal in direction caused by the gearing, again produces an increase in capacitance. Consequently the condenser manufacturer, in employing the new condenser in lieu of the old, need only replace the dial plate D by a new dial plate D'.

To avoid play or back-lash in the control of the condenser, the gearing is provided with resilient means tending always to take up or absorb any such play. In the specific case here illustrated, the gear 40, 42 is made of two laminations indicated by the respective numerals. The outer lamination 40 is forced over the splined end 46 (Fig. 6) of the condenser shaft S'. The hole of the lamination 40 may, if desired, be made somewhat elliptical rather than circular, and the end 46 of the condenser shaft may be pressed to swell the metal and thereby securely lock the gear on the shaft. The inner lamination 42 is exactly like the outer lamination 40 except that it is provided with a larger center hole and is rotatable upon a shoulder 48 intermediate the splined end 46 of the condenser shaft S'. The laminations 40 and 42 are each struck outwardly to provide spring housing walls 50. When the gear 40, 42 is assembled in meshed relation with the pinion 38, the gear laminations 40 and 42 are initially relatively displaced by, say, one entire tooth, as will be apparent from an inspection of Figs. 4 and 5. A compression spring 52, housed within the walls 50, bears against the innermost ends 54 and 56 (Fig. 8) of the spring housing and consequently tends constantly to relatively displace the gear elements 40 and 42, or, more specifically, to spread the gear teeth so far as may be permitted by their meshing engagement with the pinion 38, this spread of the gear teeth being clearly evident from an inspection of Fig. 5. It is evident that all play or back-lash in the gearing is thus automatically taken up, and, further, that any increase in gear spacing occasioned by wear of the condenser over a long period of use is likewise continually compensated for by the resulting increased displacement of the gear members 40 and 42.

The motion of the condenser is limited by stop mechanism preferably located directly on the drive shaft 36, thus avoiding the application of extreme gear stress such as would frequently occur if the limitation of movement were obtained on the rotor or rotor shaft. Referring to Figs. 4 and 7 of the drawings, the drive shaft 36 is provided with a stop arm 60, this stop arm being forcibly driven upon the splined end 62 of the drive shaft. The stop arm is additionally held in place by the pinion 38 which is itself forcibly driven on the splined end 62 of the drive shaft the extremity of which is preferably swaged or riveted, as is indicated at 64, to hold the parts securely in assembled relation. The stop arm 60 coacts with a stop lug 66 struck inwardly from a plate 68, best shown in Figs. 2 and 7. It will be evident that the stop arm 60 and stop lug 66 operate to limit the movement of the drive shaft 36 in both directions. The arm and lug are so dimensioned in the present case as to occupy 40° of arc, thereby permitting a 320° movement of the drive shaft.

The plate 68 is preferably oscillatable to permit adjustment or centering of the stopping points of the drive shaft 36 relative to the desired stopping points of the rotor of the condenser. The plate 68 carries a bushing 70 which in turn carries the drive shaft 36. The bushing 70 is secured to the plate 68 by inner and outer flanges 72 and 74. The end plate 12 of the condenser frame is provided with a hole 76 fitting the inner flange 72 of bushing 70, thus fixing the location of the plate 68 and providing a center about which the plate 68 may oscillate. To afford this oscillation the plate 68 is provided with arcuate slots 78 through which bolts 80 pass, these being threaded into the end plate 12 of the condenser. It will be evident from an inspection of Fig. 2 that by loosening the screws 80 the plate 68 may be oscillated slightly to properly center or locate the stop lug 66, after which the screws 80 may be tightened to lock the plate 68 in the desired location.

Any freedom or play of drive shaft 36 in bushing 70 may manifest itself to the operator of the set as an apparent back-lash. To prevent this, the bushing 70 is preferably longitudinally slit by a plurality, say four, slits 82, best shown in Fig. 1. With this construction the shaft 36 is resiliently engaged and clamped by the bushing. Axial movement of the drive shaft is prevented by the provision of a thrust washer 84 bearing against the end of bushing 70 and held in place by a split contractable spring ring 86 fitting in a mating groove on the drive shaft.

The rotor shaft S' is supported in place by single end thrust ball bearings 90 and 92. The ball bearing 90 is seated in an appropriate center hole in the end of the rotor shaft and in a depression 94 struck in end plate 12. Ball bearing 92 is seated in an appropriate center hole at the end of the rotor shaft and in a recess 96 formed in a resilient support plate 98, this support plate being best shown in Figs. 1 and 3. The end plate 14 is cut away at 100 to help locate and at the same time to permit yielding of the correspondingly shaped center portion of the resilient support plate 98. The support plate

is preferably surmounted by a rigid end thrust plate 102 which is lozenge shaped and somewhat flanged at 104 to impart rigidity to the thrust plate and to enclose the matingly shaped ends of the support plate 98. The assemblage is secured to end plate 14 of the condenser frame by means of appropriate screws 106 threaded thereinto. It may be remarked that the central or limiting surface 108 of thrust plate 102 is so dimensioned that it permits of but slight outward movement of resilient support plate 98. In a specific case this movement is limited to twelve thousandths of an inch. It will be understood that the normal spacing between the support plate 98 and the thrust plate 102, when these parts are removed from the condenser, is far greater than twelve thousandths of an inch, their separation being reduced, however, by the thrust of the condenser shaft on the support plate when the parts are assembled. It should be understood that with this arrangement the advantages of yieldable thrust bearings are retained, for the friction of the condenser shaft is constant and any wear over a long period of use is negligible. At the same time, the advantage of fixed bearings is also obtained, for, with respect to any accidental destructive force applied to the condenser rotor, the permitted movement is so slight as to be equivalent to the use of fixed bearings. The axial location of the rotor is, of course, fixed by the disclosed bearing system, and centering of the rotor and stator plates, should this prove necessary, is accomplished by adjustment of the location of the stator plates in the condenser frame.

It should be noted that the drive shaft 36 is a stub shaft the inner end of which is localized immediately at the adjacent end plate 12 of the condenser. This is of advantage because it permits the gear arrangement to be included in the condenser without noticeably changing the overall dimension of the condenser. It is further of value because with the present invention the rotor shaft S' is fixed and standardized in length, it terminating, so to speak, between the end plates 12 and 14 of the condenser. The requirements of different set manufacturers for different amounts of control shaft projection is readily accommodated by merely changing the length of the drive shaft 36. It is entirely unnecessary to change the length of the rotor shaft, as has heretofore been necessary with a direct drive condenser. A further advantage of the present geared arrangement is that it makes possible the use of simple end thrust ball bearings at both ends of the condenser shaft, a type of bearing support which is eminently satisfactory in use.

It is believed that the mode of constructing and using, and the many advantages of the improved condenser here disclosed, will be apparent from the foregoing detailed description thereof. It will also be apparent that while I have shown and described the present invention in preferred form, many changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, defined in the following claims.

I claim:

1. A radio condenser comprising a frame having metallic end plates, stator plates insulatedly mounted in said frame, a rotor shaft terminating at both ends at the end plates of the frame, means mounting the same in the frame, rotor plates on said shaft interleaving with the stator plates, a control shaft projecting from one of said end plates at a point offset from the rotor shaft, the inner end of said control shaft terminating just inside of the end plate, said end plate having a relatively large opening therein and a bushing detachably mounted on said end plate at said opening and carrying said control shaft, and reduction gearing interconnecting the control shaft and the condenser shaft, said gearing including a pinion mounted at the inner end of the control shaft and a gear mounted on the adjacent end of the rotor shaft, said pinion being sufficiently small in diameter to pass through the aforesaid opening in the end plate.

2. A radio condenser comprising a frame having metallic end plates, stator plates insulatedly mounted in said frame, a rotor shaft, means mounting the same in the frame, rotor plates on said shaft interleaving with the stator plates, a control shaft projecting from one of said end plates at a point offset from the rotor shaft, the inner end of said control shaft terminating just inside of the end plate, said end plate having a relatively large opening therein and a bushing detachably mounted on said end plate at said opening and carrying said control shaft, and reduction gearing interconnecting the control shaft and the condenser shaft, said gearing including a pinion mounted at the inner end of the control shaft and a laminated gear mounted on the adjacent end of the rotor shaft, said laminated gear consisting of two laminations of sheet metal each having means formed thereon portion between which there is carried a coiled compression spring, the laminations being generally similar except that one is secured to and the other is movable on the rotor shaft, the laminations being displaced relative to one another against the compression spring when the pinion is meshed therewith, said pinion being sufficiently wide to simultaneously engage the gear laminations and sufficiently small in diameter to pass through the aforesaid opening in the end plate.

3. A radio condenser comprising a frame having metallic end plates, stator plates insulatedly mounted in said frame, a rotor shaft terminating at both ends at the end plates of the frame, means including a single ball bearing at each end of the shaft for mounting the same in the frame, rotor plates mounted on said shaft and interleaving with the stator plates, a control shaft projecting from one of said end plates at a point offset from the rotor shaft, the inner end of said control shaft terminating just inside of the end plate, said end plate having a relatively large opening therein and a bushing detachably mounted on said end plate at said opening and carrying said control shaft, and reduction gearing interconnecting the control shaft and the condenser shaft, said gearing including a pinion mounted at the inner end of the control shaft and a gear mounted on the adjacent end of the rotor shaft, said pinion being sufficiently small in diameter to pass through the aforesaid opening in the end plate.

4. A radio condenser comprising a frame having metallic end plates, stator plates insulatedly mounted in said frame, a rotor shaft terminating at both ends at the end plates of the frame, means including a single ball bearing at each end of the shaft for mounting the same in the frame, rotor plates mounted on said shaft and interleaving with the stator plates, a control shaft projecting from one of said end plates at a point offset from the rotor shaft, the inner end of said control shaft terminating just inside of the end

plate, said end plate having a relatively large opening therein and a bushing detachably mounted on said end plate at said opening and carrying said control shaft, and reduction gearing interconnecting the control shaft and the condenser shaft, said gearing including a pinion mounted at the inner end of the control shaft and a laminated gear mounted on the adjacent end of the rotor shaft, said laminated gear consisting of two laminations of sheet metal each having means formed thereon between which there is carried a coiled compression spring, the laminations being generally similar except that one is secured to and the other is movable on the rotor shaft, the laminations being displaced relative to one another against the compression spring when the pinion is meshed therewith, said pinion being sufficiently wide to simultaneously engage the gear laminations and being sufficiently small in diameter to pass through the aforesaid opening in the end plate.

5. A radio condenser comprising a frame having metallic end plates, stator plates insulatedly mounted in said frame, a rotor shaft terminating at both ends at the end plates of the frame, means mounting the same in the frame, rotor plates on said shaft interleaving with the stator plates, a control shaft projecting from one of said end plates at a point offset from the rotor shaft, the inner end of said control shaft terminating just inside of the end plate, said end plate having a relatively large opening therein and a bushing detachably mounted on said end plate at said opening and carrying said control shaft, and reduction gearing interconnecting the control shaft and the condenser shaft, said gearing including a pinion mounted at the inner end of the control shaft and a gear mounted on the adjacent end of the rotor shaft, said pinion being sufficiently small in diameter to pass through the aforesaid opening in the end plate, and the gear ratio being such that the control shaft is turned nearly but not more than a full revolution for the entire range of the condenser.

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