Aug. 10, 1943. G. M. EHLERS ET AL 2,326,341

VARIABLE CONDENSER

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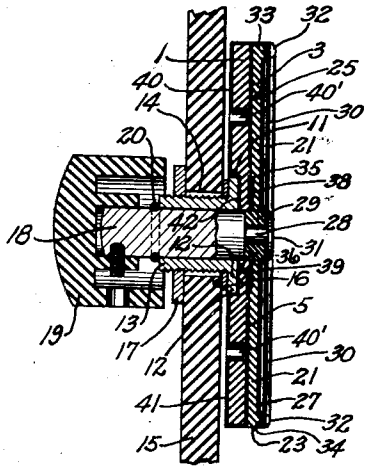


Fig: 1

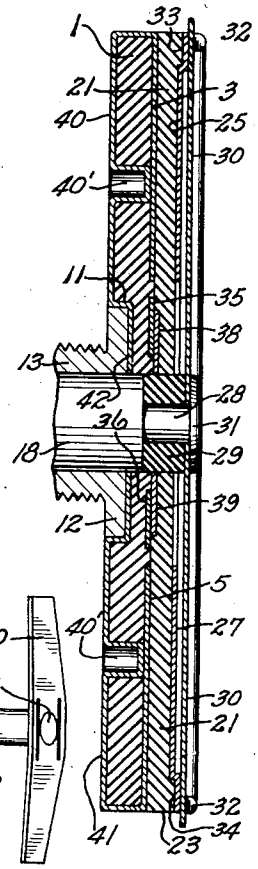


Fig: 1-A.

Fig: 2

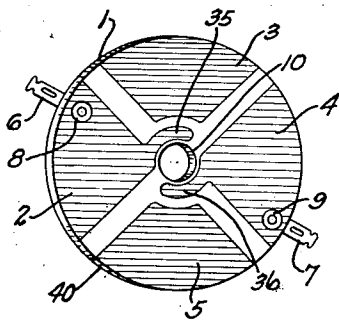
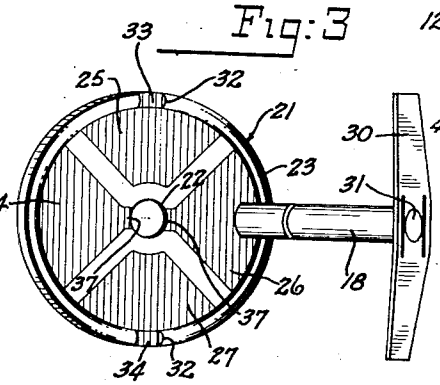


Fig: 3



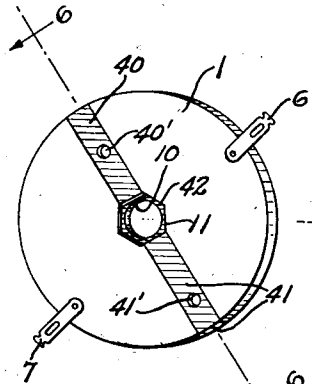


Fig: 4

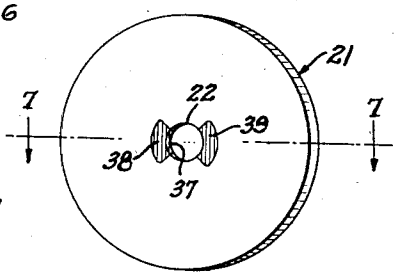


Fig: 5

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Fig: 9.

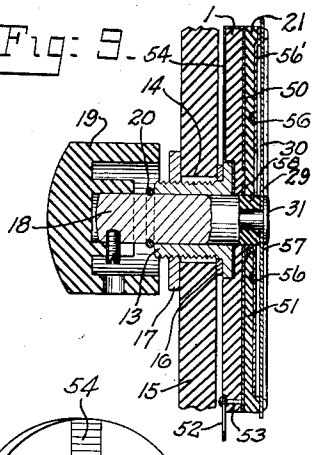
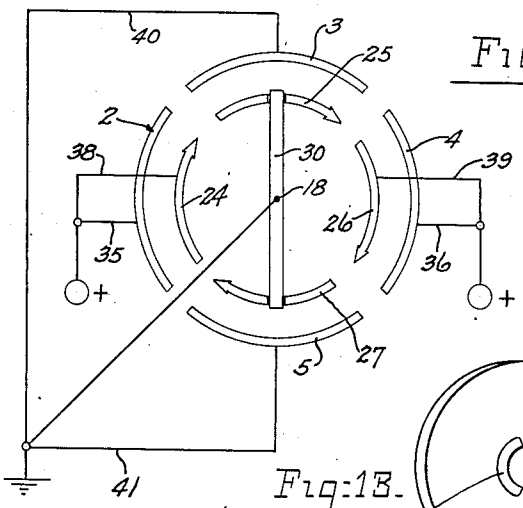


Fig: 8.



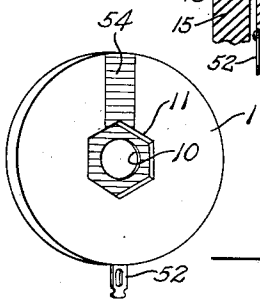


Fig:10.

Fig:13.

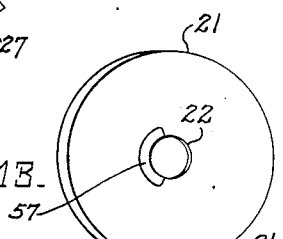


Fig:12.

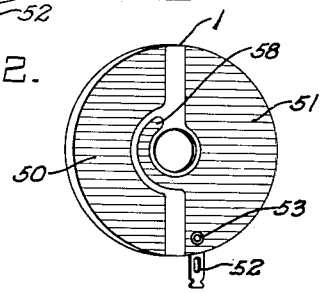
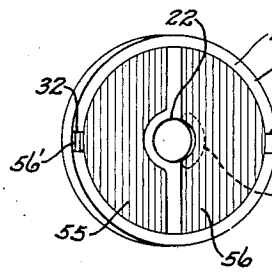


Fig:11.



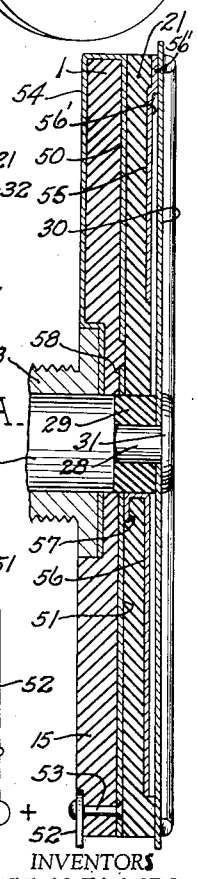


Fig:9-A.

Fig: 6.

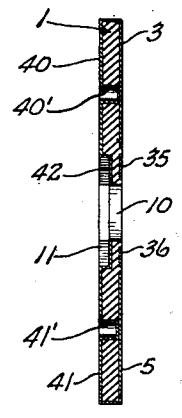
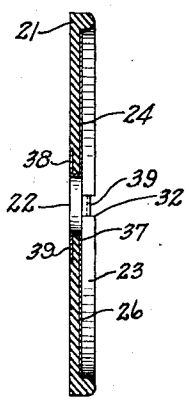


Fig: 7.



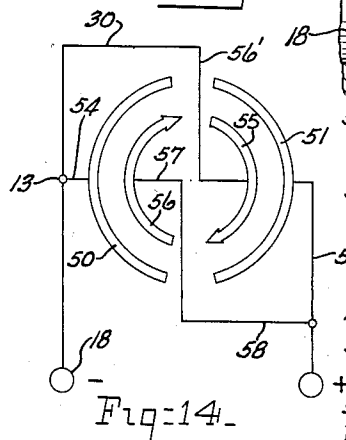


Fig:14.

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UNITED STATES PATENT OFFICE

2,326,341

VARIABLE CONDENSER

George M. Ehlers and George Kodama, Milwaukee Wis., assignors to Globe-Union Inc., Milwaukee, Wis., a corporation of Delaware

Application May 31, 1941, Serial No. 396,087

4 Claims. (Cl. 175—41.5)

This invention relates to an improvement in variable condensers.

An object of the invention is to provide a condenser wherein the individual conductor elements are of novel construction, are combined in an advantageous and special manner with each other, and are organized in an unique manner with their insulating support and with their dielectric respectively.

A still further object of the invention is to provide a condenser of this character, which is simple, compact, and closely organized in construction, reliable and efficient in operation, which makes available a range of capacities heretofore not obtainable, and which is susceptible to convenient and economical production on a commercial scale.

Other objects and advantages reside in certain novel features of the construction, arrangement, and combination of parts, which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawings forming a part of this specification, and in which:

Figure 1 is a view in central, vertical, longitudinal cross section illustrating a variable condenser constructed in accordance with the present invention;

Figure 1*a* is a fragmentary, sectional view similar to Figure 1 but showing the insulating stator and rotor and the condenser plates combined therewith on an enlarged scale for the sake of clearness and illustration.

Figure 2 is a perspective view illustrating the fixed plates of the condenser, their insulating disc support and the terminals combined with certain of the plates;

Figure 3 is a group view in perspective showing the rotatable plates of the condenser, the dielectric disc on which they are mounted, the adjusting shaft of the condenser, and a combined driving and conducting arm which rotatably couples the shaft to the rotatable dielectric disc and plate assembly and electrically connects certain of the movable condenser plates to the shaft;

Figure 4 is a perspective view illustrating the opposite face of the insulating disc support from that shown in Figure 2;

Figure 5 is a perspective view showing the opposite face of the dielectric disc from that shown in Figure 3;

Figures 6 and 7 are cross sectional views taken on lines 6—6 and 7—7, respectively, of Figures 4 and 5;

Figure 8 is a diagram illustrating the manner in which the fixed and movable plates of the condenser shown in Figures 1 to 7 are connected in an electrical circuit;

Figure 9 is a view similar to Figure 1 but showing another embodiment of the invention;

Figure 9*a* is a fragmentary sectional view similar to Figure 9, but illustrating the insulating stator and rotor and their condenser plates on an enlarged scale for the sake of clearness and illustration.

Figure 10 is a perspective view showing the fixed condenser plates, their insulating support, and the terminal combined with one of the plates, in the form of the invention shown in Figure 9;

Figure 11 is a perspective view, illustrating the rotary condenser plates and the dielectric disc on which they are mounted when the construction takes the form illustrated in Figure 9;

Figure 12 is a view similar to Figure 10 but showing the opposite side of the insulating disc from that shown in Figure 10;

Figure 13 is a perspective view further illustrating the dielectric disc shown in Figure 11, the view being from the opposite side from that shown in Figure 11; and

Figure 14 is a diagram showing how the condenser plates shown in Figures 8 and 13 are connected in an electrical circuit.

Referring to the drawings, and more particularly to Figures 1 to 8, inclusive, it will be seen that in the form of the invention illustrated in the views mentioned, the condenser comprises an insulating support or stator 1 preferably in the form of the disc of moulded insulating material, such as a moulded ceramic having appropriate insulating properties. To one face of the disc 1 the fixed plates of the condenser, designated at 2, 3, 4, and 5, are applied. The plates 2, 3, 4, and 5 may be applied as metallic films, coatings, or platings, painted or sprayed on the face of the insulating disc. Usually silver salts are applied and then reduced either chemically or by heat. Where the condenser plates are constituted as a silver film they may be copper-plated, if desired. Terminals 6 and 7 are applied to the face of the insulating disc 1 opposite that which carries the condenser plates 2, 3, 4, and 5, and they are electrically connected to the condenser plates 2 and 4 by means of suitable metal eyelets or rivets 8 and 9. The eyelets 8 and 9 are countersunk in the metallic films constituting the condenser plates 2 and 4 and hence leave the outer surfaces of the condenser plates smooth and plane. The terminals 6 and 7 facilitate the connection of the

plates 2 and 4 in an electrical circuit, and as illustrated in Figure 8 they connect the plates 2 and 4 to the same side of an electrical circuit which is indicated for the purpose of simplicity in description as the positive side of the circuit so that the plates 2 and 4 are of the same polarity. The plates 2, 3, 4 and 5 are approximately segmental in form and more specifically take the approximate dimensions of a quadrant although their radial edges as well as their inner portions are spaced from each other so that the plates themselves are electrically insulated from each other.

To mount the insulating disc or stator 1 on a suitable support, as for example on the chassis of a radio receiver, the disc is centrally apertured, as indicated at 10, and the face of the disc opposite that on which the condenser plates 2, 3, 4, and 5 are carried is provided with a hexagonal or non-circular socket 11 which circumscribes the aperture 10, as illustrated in Figure 4. The hexagonal flange 12 of a metallic mounting bushing 13 is snugly fitted in this socket 11 in the assembly. The bushing 13 is supported in the aperture 14 of a mounting panel or bracket 15 which may be insulating material. As shown in Figure 1, the body of the bushing extends through the opening 14. A washer 16 is interposed between the flange 12 of the bushing and the margin of the opening 14 on one side of the panel 15. On the opposite side of the panel 15 a nut 17 is threaded on the bushing 13 and has clamping engagement with the panel 15 so as to coact with the flange 12 and washer 16 to fixedly support the bushing 13 on the panel 15.

A metallic adjusting shaft 18 is rotatably fitted in the bearing bushing 13. The outer end of this shaft has an adjusting knob 19 releasably secured thereto to facilitate turning of the shaft. A C-ring or snap ring 20 is snapped into an annular groove provided on the periphery of the shaft 18 and bears against the outer end of the bushing 13 to limit the extent to which the shaft 18 may move axially through the bushing in a direction toward the right, as viewed in Figure 1. The inner end of the shaft projects beyond the flanged end 12 of the bushing 13 and is combined with a dielectric disc or rotor 21 in a manner which will hereinafter be more fully described.

The dielectric disc or rotor 21 may be conveniently and advantageously constituted of moulded and fired ceramic material of high dielectric constant or of other suitable insulating material. While the material of which the dielectric disc or rotor 21 is formed may be of various suitable compositions, it is preferably composed of titanium dioxide and rare earth. For example, it may be any one of the compositions disclosed in the application of George M. Ehlers and Rolland R. Roup, filed August 25, 1938, Serial No. 226,734, for "Electric capacitators and dielectric for the same," which application is assigned to the assignee of the present application. The dielectric disc or rotor 21 is formed with a central aperture 22 and with a flanged or thickened rim portion 23. The movable plates of the condenser, designated at 24, 25, 26 and 27, are applied, preferably as metallic films, platings or coatings, to the outside face of the dielectric disc or rotor 21, and are for the most part located within the confines of the rim 23 thereof. These movable condenser plates 24, 25, 26, and 27 are similar in form, as well as in structure, to the fixed condenser plates 2, 3, 4, and 5 of the stator, and like them are approximately of segmental form, but have their radial edges, as well as their inner portions, spaced from each other to an extent sufficient to electrically insulate the plates 24, 25, 26, and 27 from each other.

The shaft 18 has a reduced portion 28 which extends through and beyond the central aperture 22 of the dielectric disc 21. This reduced portion 28 of the shaft is surrounded by an insulating collar or washer 29. The reduced portion 28 of the shaft also extends through a central opening provided therefor in a combined driving and conducting arm 30. The extreme outer end of the reduced portion 28 of the shaft is riveted or staked over, as at 31, so as to be rigidly connected to the central portion of the arm 30. The arm 30 is of spring or resilient metal of good electric conductivity, such as spring steel, and its outer ends are adapted to be received or fitted in diametrically opposite notches 32 formed in the rim 23 of the dielectric disc or rotor 21 thereby rotatably coupling or establishing a driving connection between the adjusting shaft 18 and the dielectric disc or rotor 21. The parts are so dimensioned and proportioned that the driving arm 30, which is initially slightly bowed, must be flexed and placed under tension when its ends are seated in the notches and the C-ring 20 is snapped into its groove, so that these parts perform the further function of pressing the smooth inner face of the dielectric disc firmly against the smooth faces or surfaces of the fixed plates 2, 3, 4, and 5 of the condenser. The arm 30 is also made to perform the additional function of electrically connecting the plates 25 and 27 in electric circuit, and for this purpose the condenser plates 25 and 27 have their films or coatings formed with extensions 33 and 34 which cover the floors of the notches 32 and have good electrical contact with the ends of the arm 30 fitted in said notches. As illustrated in Figure 8, the shaft 18, and consequently the arm 30, are at ground potential—that is, they may be regarded as connected to the negative side of the circuit in which the condenser is incorporated. The arm 30 is however spaced and consequently electrically insulated from the condenser plates 24 and 26.

Provision is made for connecting the plates 24 and 26 to the positive side of the electrical circuit, and to accomplish this in a simple and advantageous way. For this purpose the fixed condenser plates 2 and 4 are formed with arcuate connecting or collecting strips 35 and 36 which curve or arc about the aperture 10 of the insulating disc 1 in the manner illustrated in Figure 2. The movable condenser plates 24 and 26 have extensions 37 and 37' which extend radially to the aperture 22, then axially across the inner peripheral wall of this aperture 22, and then around the margin of the opening and on the inner face of the dielectric disc 21 to form contact shoes 38 and 39 of the form shown in Figure 5. In the assembly the contact shoes 38 and 39 have wiping contact with the collector or conductor strips 35 and 36 so that a positive potential is impressed on the condenser plates 24 and 26 as well as on the fixed condenser plates 2 and 4. The fixed condenser plates 3 and 5 are connected up to the negative side of the electrical circuit, and this may be conveniently accomplished by extending the film constituting the plates 3 and 5 across the outer edge of the disc 1 and then radially across the opposite face thereof, to form conducting arms 40 and 41 which continue down and merge into a

metallic film-like covering 42 for the floor of the socket 11. The conducting arms 40 and 41 are embedded in the material of the insulating disc 1 and are interlocked therewith by means of keying projections 40' and 41' which are embedded in the material of the disc 1. The covering 42 for the floor of the socket 11 has good electrical contact with the flanged end 12 of the bearing bushing 13, and since the shaft 18 is a working fit in the bushing 13, the condenser plates 3 and 5 are also at ground potential or may be regarded as connected to the negative side of the electrical circuit.

In this construction, when the knob 19 is adjusted to cause the shaft to so move the disc-like rotor 21 as to bring its plates 24, 25, 26, and 27 into opposed relationship with the plates 2, 3, 4, and 5, respectively, the capacitance of the condenser is at its minimum since plates of the same polarity are opposed to each other. The maximum capacity of the condenser may be had by so turning the knob 19, shaft 18, and rotor 21 as to bring the plates 24, 25, 26, and 27 of the rotor into opposed relationships with the plates 3, 4, 5, and 6, respectively, since in such an adjustment plates of opposite polarity have their full areas in opposed relationship. Intermediate adjustments of the rotor 21 with respect to the stator 1 provide for a wide range of intermediate capacity variations.

The form of the invention shown in Figures 9 to 14 inclusive is in all broad and substantial respects the same as that shown in Figures 1 to 8, the difference being in the fact that the stator and the rotor each are provided with two condenser plates of opposite polarity rather than four. In the construction shown in Figures 9 to 14, the stator 1 and rotor 21 are provided as before. The stator is mounted on the supporting panel 15 by bushing 13, washer 16, and nut 17 as before. The rotor 21 is adjusted by the shaft 18 which is equipped with a knob 19, the inner end of the shaft being reduced and provided with the insulating washer 29 and also being staked as at 31 to a coupling and conducting arm 30.

As shown in Figure 10, the stator 1 has two condenser plates, designated at 50 and 51, the condenser plates being substantially of semi-circular form or segmental form, rather than quadrant or sector shape, as in the other embodiment. The plates 50 and 51 are metallic films, platings or coatings of the same character as the plates of the other form of the invention, and have their edges spaced slightly so as to be electrically insulated from each other and yet just as in the other embodiment the plates 50 and 51 are otherwise substantially coextensive with the entire surface of the stator to which they are applied. The terminal 52, like the terminal 6, is connected by a rivet 53 to the plate 51, as in the other embodiment of the invention, and provides a convenient means for connecting the plate 51 to one side of an external circuit, as for example to the positive side of the external circuit, as indicated diagrammatically in Figure 14. The plate 50 has its film extended across the edge of the disc-like stator 1 and down to the outside face thereof to provide a conducting arm 54 corresponding to the conducting arm 40 and in electrical connection with the bushing 13, as in the other embodiment, so that the condenser plate 50 is at ground potential, or, as illustrated diagrammatically in Figure 14, is connected to the negative side of the power source. The disc-like rotor 20 of dielectric material is in this form of the invention the same as in the other except that instead of having four movable condenser plates it has two semi-circular or segmental condenser plates, designated at 55 and 56, the adjacent edges of these plates being slightly spaced from each other so that the plates are electrically insulated from each other. Only one of the movable condenser plates, namely the plate 55, has an extension 56 covering the floor of one of the notches 32 since only one of the movable condenser plates is to be connected to the negative side of the power source. The outer peripheral edge of the other condenser plate 56 lies entirely within the confines of the rim 23 of the rotor. The arm 30 serves to place the plate 55 at ground potential, as before. The movable condenser plate 56 has an extension from its inner periphery which goes across the inner peripheral wall of the aperture 22 of the rotor and is formed into a contact shoe 57 on the inner face of the disc-like dielectric rotor, and is arranged and adapted to have wiping contact with an arcuate conducting or collecting strip 58 formed as an integral extension of the fixed condenser plate 51, the shoe 57 and strip 58 serving to impress a charge of the same polarity on the plate 56 as that impressed on plate 51. In this instance, as before, the maximum value of the condenser capacity is realized by bringing the movable plates of the rotor into opposed relationship with the fixed plates of the stator of opposite polarity, whereas minimum capacity is realized by rotating movable plates of the rotor into opposed relation with the fixed plates of the stator of the same polarity.

While we have shown and described several constructions in which the invention may be advantageously embodied, it is to be understood that the constructions shown have been selected merely for the purpose of illustration or example, and that various changes in the size, shape, and arrangement of the parts may be made without departing from the spirit of the invention or the scope of the subjoined claims.

We claim:

1. A variable condenser of the character described comprising a disc-like stator of insulating material, a disc-like rotor of dielectric material in face-to-face engagement with said stator, a pair of fixed condenser plates applied as metallic films to the face of the stator engaged with the face of the rotor, a pair of similar movable condenser plates applied as metallic films to the outside face of the rotor, a terminal carried by the stator and in electrical contact with one of its plates for connecting said plate in an external circuit, a collector strip provided adjacent the center of the stator as an extension of the plate to which the terminal is connected, a contact shoe carried by the rotor having wiping contact with said strip and electrically connected to one of the plates of the rotor, a metallic bearing bushing carried by said stator, a connecting arm between the bushing and the other condenser plate of the stator, a rotary adjusting shaft supported in said bearing bushing, and a metallic driving arm fastened to the shaft and having driving engagement with the rotor and also electrically connected with one of its condenser plates whereby positively and negatively charged condenser plates are provided on both the rotor and on the stator and the capacitance of the condenser is variable by rotating the rotor relative to the stator to vary the ex-

tent to which the positively and negatively charged plates overlap.

2. A condenser of the character described comprising a disc-like stator of insulating material, a disc-like rotor of dielectric material concentrically disposed with respect to the stator and supported for rotation about the common axis of the stator and rotor and in face-to-face relation therewith, a plurality of fixed condenser plates applied as metallic films to angularly spaced portions of the face of the stator engaged with the face of the rotor, a plurality of similar movable condenser plates applied as metallic films to angularly spaced portions of the outside face of the rotor, terminals carried by the stator and in electrical connection with alternate condenser plates thereof for connecting such plates to the positive side of an external electrical circuit, cooperable contact strips and contact shoes carried respectively by said positively charged plates of the stator and corresponding alternate plates of the rotor whereby said alternate plates of the rotor are also impressed with positive charges, a metallic bearing bushing carried by the stator, a metallic shaft rotatably fitted in and in electrical connection with said bushing, said shaft and said bushing being at ground potential, means connecting the bushing with condenser plates of the stator intermediate alternate positively charged plates thereof, and a combined driving and conducting arm interconnecting the shaft and the rotor to rotatively couple the rotor to the shaft and electrically connect the plates hereof inermediate its positively charged alternate plates to the negative side of the circuit.

3. A condenser of the character described comprising a metallic bearing bushing, a disc-like stator of insulating material supported on said bushing, a metallic adjusting shaft rotatably supported in said bushing, said shaft and said bushing being at ground potential, a rotor of dielectric material fixed to and rotatable with said shaft, condenser plates applied as metallic films to the rotor and stator, means for connecting certain of the condenser plates of the stator in an external circuit so as to impress a positive charge thereon, means for transferring the potential impressed on said plates of the stator to plates of the rotor, and means for connecting plates of the rotor and stator to the negative side of the circuit and including connections from the last mentioned stator plates to the bushing and from the last mentioned rotor plates to the shaft.

4. A condenser of the character described comprising a bearing bushing, a disc-like stator of insulating material supported on said bushing and having a central opening aligned with the opening of the bushing, an adjusting shaft rotatably supported in said bushing and projecting beyond the same, a disc-like rotor of dielectric material disposed in face-to-face engagement with the stator and having a central opening through which said shaft projects, condenser plates applied to the face of the stator engaged with the face of the rotor and to the outside face of the rotor, means for limiting the extent to which the shaft may move axially in the bushing in the direction toward the rotor, and a resilient metallic driving arm fastened to the inner end of the shaft and having its ends pressing against the rotor to press the rotor against the stator, said ends also having driving engagement with the rotor whereby when the shaft is turned the rotor is adjusted relative to the stator.

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