Feb. 16, 1932. N. CAHUSAC 1,844,930

ELECTRIC CONDENSER

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Fig. 1.

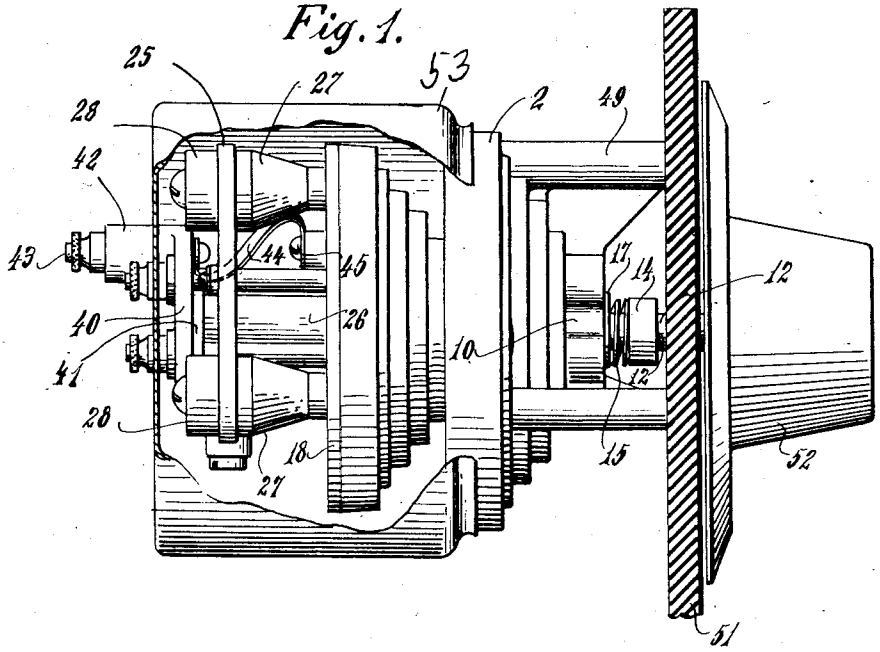
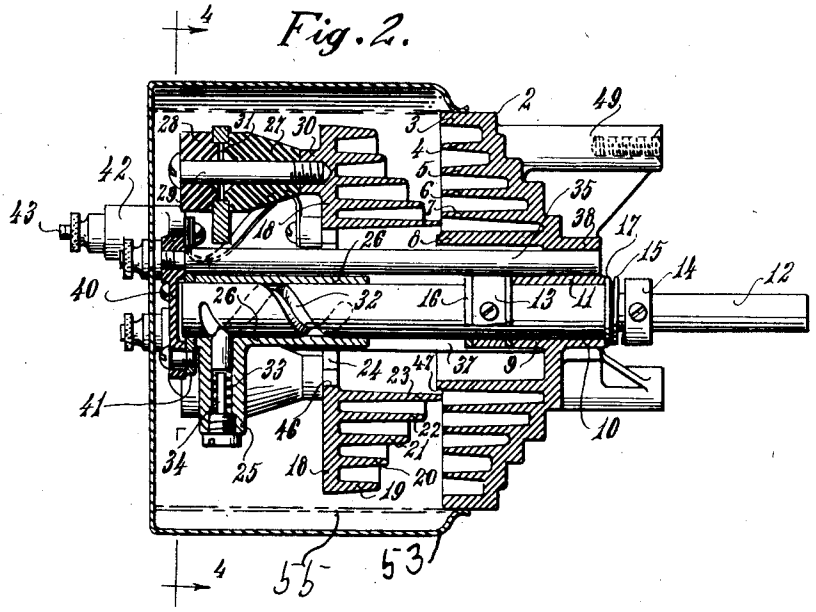


Fig. 2.



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Fig. 3.

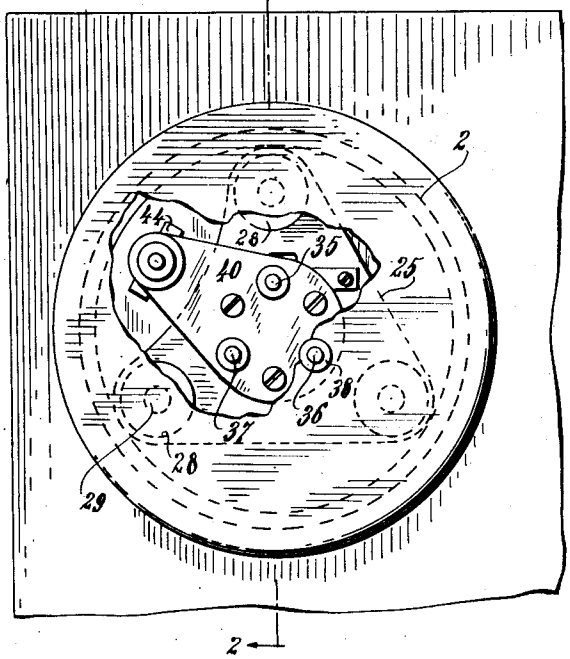


Fig. 6.

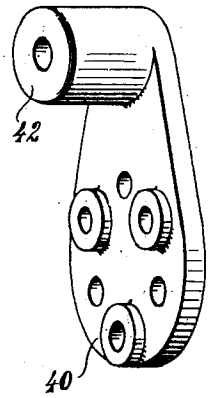


Fig. 4.

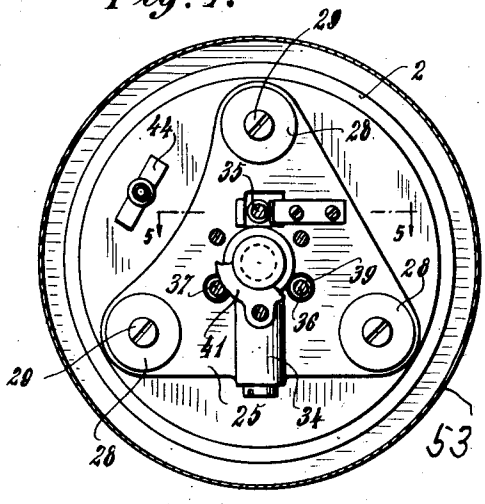
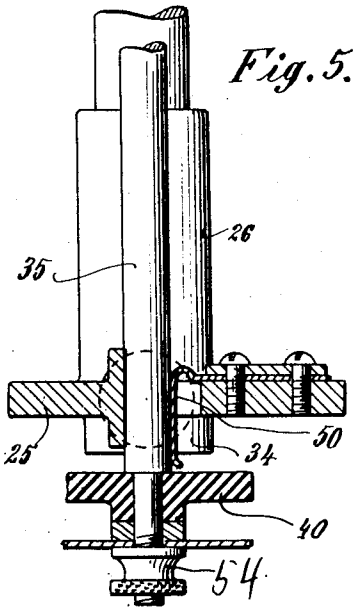


Fig. 5.



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Fig. 7

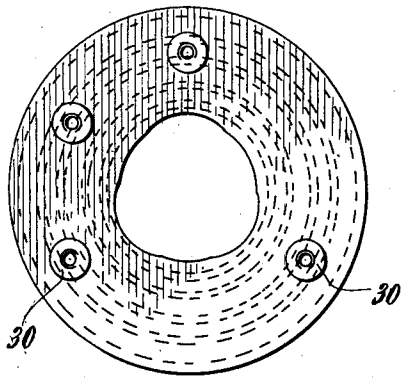


Fig. 8

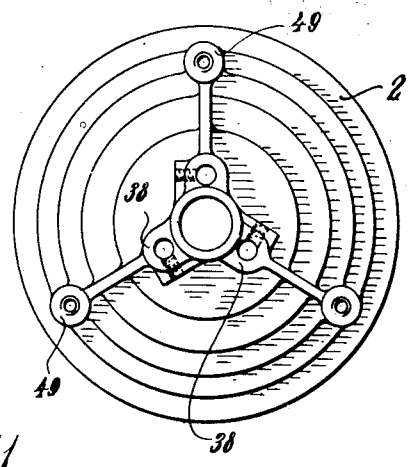


Fig. 11

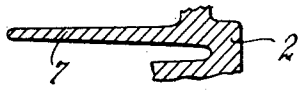


Fig. 10.

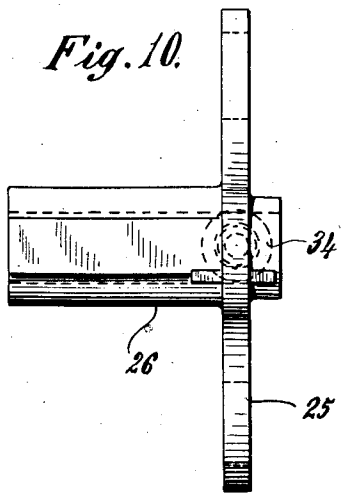
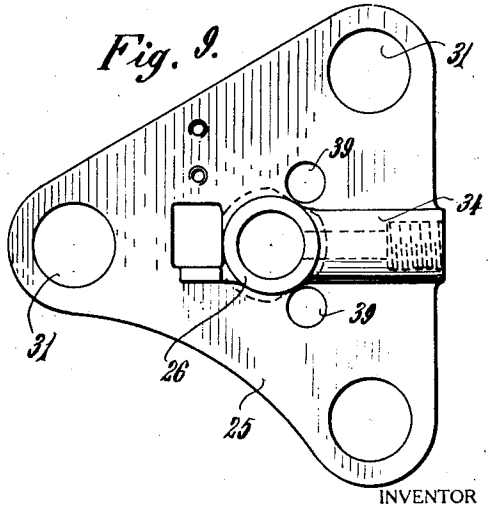


Fig. 9.



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UNITED STATES PATENT OFFICE

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ELECTRIC CONDENSER

Application filed March 29, 1926. Serial No. 98,141.

This invention relates to electric condensers of the form in which each element comprises members that are relatively movable and each provided with a number of concentric tubes or convolutions, which are caused to interleave when the members are brought together, to vary the capacitance by the amount of such convolutions that register in the different positions.

One object of the present invention is to provide elements of this character in which the tubes or convolutions of suitable conducting material are connected with a base by a casting operation, and which preferably comprise an integral construction of the tubes or convolutions and the base, formed in a suitable mold by casting, and which may be effected by the process known as die-casting.

Another object of the present invention is to provide elements of this character in which the tubes or convolutions have the meeting surfaces arranged at an angle to the perpendicular from the base, whereby as the area of the cooperating surfaces of the two elements increases, the actual distance apart of these surfaces will diminish, to thereby increase the amount of capacitance with the effect known as straight line frequency.

A further object is to provide an improved form of frame member for mounting such elements to facilitate their adjustment.

In the accompanying drawings showing the embodiments of my invention, Fig. 1 is a side elevation of the device.

Fig. 2 is an axial section on line 2—2 of Fig. 3.

Fig. 3 is an end view.

Fig. 4 is an axial section on the line 4—4 of Fig. 2.

Fig. 5 is a detail of bearing member.

Fig. 6 shows the bearing plate.

Fig. 7 is an end view of the movable element.

Fig. 8 is an end view of the fixed element.

Figs. 9, 10 and 11 show details.

As shown in the drawings the device comprises two capacitance elements, each in the form of a nest of coaxial tubes connected preferably integrally, at one end, said elements being mounted to reciprocate on their common axis with the tubes of one element in staggered relation to the tubes of the other so that each tube enters between a pair of tubes of the other element except the inner and outer tubes in one member. The device also includes a shaft mounted to turn in one element and having a screw-and-nut connection with the other element which connection by one rotation of the shaft will advance the movable member its desired range of adjustment relative to the other member.

As shown in the drawings, one member comprises a base denoted generally by 2 connected integrally with a series of concentric tubes 3, 4, 5, 6, 7, 8. These tubes, except the tube 3, are of varied length from the outermost inwardly, and are connected with the base 3 by being cast therewith, preferably in the form of a die-casting. This will give somewhat conical form to the base, but for convenience it is stepped at each tube as shown. Inside of the innermost tube 8 the base is of disk form, and provided with bosses 9 and 10 to form a bearing sleeve 11 for the main shaft 12, as shown in Fig. 2. The shaft projects through this bearing sleeve and is provided with collars 13 and 14 to prevent endwise movement of the shaft, and preferably with a coil spring 15 tending to keep the collar 14 against the end of the sleeve 9, with an interposed fibre washer 16, and also a fibre washer 17 between the spring and the end portion 10 of the sleeve.

The second element comprises a base 18 and a series of concentric tubes 19, 20, 21, 22, 23. The base is preferably a flat disk or ring with a large central opening 24 and the said tubes vary in height. It has been found to give the best results when the inner tube is longer than the next tube by certain amount, the second longer than the third tube by approximately by the same amount, and the third tube longer than the fourth tube approximately by the same amount or distance. In other words, they are equally stepped. But the outermost tube 19 is shorter than the said fourth tube by an amount or distance approximately one-half the difference of height of either of the other said tubes, as clearly shown in Fig. 2. It will be

further seen from this view that the tubes in the two elements are in such arrangement that the center lines of the walls or cylinder of each tube projection will pass through the middle of the space between the tubes of the other element. This second element is mounted to slide on the shaft 12, and all of these tubes are concentric with the axis of this shaft. When this member is advanced on the shaft the tubes of such member will enter between the tubes of the other member, and bring the sides or faces of the tubes into proximity, and obviously the area of such cooperating faces increases as the members are brought together and the tubes interleave.

If the tubes were true cylinders with their sides parallel with the axis, the distance apart of the opposed surfaces would not vary with such movement, but only the area would be increased or diminished as the member moved in and out of the other member. But it has been found by experiment that the resulting capacitance approaches to a true straight line frequency calibration if these tubes are given a certain amount of conical formation at their cooperating faces, in other words, the sides in any axial section converge from the base toward the free end of the tube, as clearly shown in Fig. 2. It has been found that the best results are obtained when this angle is approximately two degrees on each side, that is, the linear elements of the side walls make two degrees angle with the perpendicular to the base. This means the included angle of each tube in a cross section will be four degrees. If the linear elements of the side walls were continued to intersection they would form an included angle of four degrees.

From this it follows that as the tubes of one element enter between the tubes of the other element, the shortest line distances apart of cooperating faces of the tubes decrease as the areas of such cooperating faces increase; and obviously the reverse condition takes place as the two elements recede or move away from each other. It is further obvious that the cooperating tubes in the members will have a substantially equal height from the base. While the movable element has the tubes of varied length, the fixed element has the tubes with their free ends in the same plane as shown, which results in the fixed element having the base 2 of a substantially frusto-conical general form, but which for convenience and minimum amount of material is formed in steps of circular arrangement as shown.

The movable element has its base 18 connected to slide on the shaft 12, and I provide a supporting plate 25, see Fig. 4, of somewhat triangular shape, at the center of which is an opening and an extended sleeve 26 forming a bearing for the shaft 12. This supporting plate is connected with the base 18 of the movable member through bushings three of which are shown, made in two parts 27, 28, to receive clamping bolts 29 that screw into bosses 30 on the base 18, the bolts passing through suitable openings 31 in the plate whereby the bolts do not contact with the plate, and hence the base 18 is well insulated from this plate. The sleeve 26 is slidable on the shaft 12 and a screw-and-nut connection is provided between the plate and the shaft. A spiral groove 32 in the shaft is engaged by a spring plunger 33 carried by a boss 34 in the supporting plate, whereby the rounded end of the plunger is pressed into this rounded spiral curve. On turning the shaft the groove wall engaging this plunger will advance the plate and movable element provided the element is prevented from turning. For this purpose and to connect the members, I provide a frame in the form of three bars 35, 36 and 37 that are secured at one end of each in suitable bosses 38 in the base portion of the fixed element. These bars project between the innermost tube 8 and the shaft and pass through suitable openings 39 in the supporting plate 25. At their outer ends these bars are secured to a transverse plate 40 and suitably bolted in openings therein, see Fig. 6. This transverse plate is thus rigidly secured to the base member 2 by these three bars, forming a suitable mounting for a bearing plate 41 for the end of the shaft 12, which bearing plate is suitably secured to the cross plate by screws or bolts. This transverse plate may be of metal, but preferably is made of hard rubber or suitable rigid insulating material, and may have integral therewith a boss 42 to receive a terminal bolt 43. This bolt may receive a flexible connection 44 whose other end is attached to the movable element base 18 by bolt 45. This connection is flexible and of bent or S form because the movable element moves to and from the supporting plate 25. The fixed element may have a terminal on the supporting plate.

For convenience in assembling, the movable element before it is attached to the supporting plate at the bushings 27, can be advanced into the fixed element until the inner corner 46 at the opening 24 engages a shoulder 47 on the inner tube 8, which will serve to center the two members in proper positon relative to each other and to the shaft. Thereupon the openings in the supporting plate 25 for the bushings can be located. But when later the parts are assembled the fibre washer 16 is placed on the shaft 12, and will be engaged at the end of the sleeve 26 that will serve to prevent the parts 46 and 47 engaging, and limit the rotation of the shaft 12. These parts are so designed that one complete rotation of the shaft will move the element from the open position shown in Fig. 1, to the closed position which

is the range of the instrument. The movement to open position is determined by the supporting plate 25 engaging the bearing plate 41. The fixed element base 2 may be provided with suitable bosses 49 having threaded bores for the usual attachment to the panel of the apparatus.

As stated the three bars passing from the fixed element to the supporting plate, prevent rotation of the supporting plate and movable element. Two of these bars pass freely through the openings in the supporting plate, while one of them, as 35, is engaged by a spring 50 and held against the bore through which it passes, thus forming a guide bearing.

It will be seen from Fig. 2 that the device is mounted on a panel 51 by the bosses 49, with the shaft 12 projecting through the panel and carrying the usual dial 52. The fixed element is thereby secured to the panel, and turning the dial and shaft will, through the screw-and-nut connection advance the movable element, and cause the tubes to interleave to the desired amount. One complete rotation of the dial moves the two elements from the open position to the fully closed position. It will be seen that the longer or inner tubes of each element will first enter corresponding spaces between the tubes of the other elements. Then continued movement of the dial will bring the other tubes to interleave progressively until they all are in position for action. It will be understood that as the area of the adjacent side faces of the tubes increases, the shortest line distance between such faces is reduced, whereby the capacitance increases by reason of these two features. This design as set forth will result in the stations having wave length of small meters being shown in divisions on the dial farther apart at the beginning of the insertion of the tubes.

The two elements as shown have the bases and tubes in one integral structure, conveniently formed by casting, but obviously these members may be separately constructed and afterwards secured together by any suitable means.

The movable element and connected parts are preferably enclosed by a casing 53 of suitable material. If this is of thin sheet metal such as aluminum, it will act as a shield and intercept radiating lines. This is preferably in the form of a cup with the flat portion removably secured by nuts 54 on the rods 35, 36. These nuts can also serve as one terminal for securing the conductor that thus is in direct connection with the fixed element. The insulated post 43 will project through a suitable aperture in this casing which forms the other terminal for the circuit. The casing is shown somewhat offset to be spaced from the movable element. If desired the casing may be of insulating material such as celluloid, in which case it can be of smaller diameter as indicated by the broken line 55.

What I claim is:

1. In an electric condenser, a pair of capacitance members each comprising a base and a plurality of tubular elements, the members being relatively movable with all of the elements on a common axis, the said tube in one of the elements being of increasing height from a transverse base plane from the outermost tube inwardly, the other element having the tubes at their free end located in the same transverse plane, said tubes being connected with a stepped base whereby the actual height of the space between adjacent tubes increases from the outer tube inwardly to the inner tube.

2. In an electric condenser, a pair of capacitance members each comprising a base and a plurality of tubular elements, the members being relatively movable with all of the elements on a common axis, said elements being so arranged that those of one member interleave with those of the other when said members are relatively moved; one of the elements having the free ends of the tubes located in the same transverse plane, said tubes having their length increasing from the outer tube inwardly, and a base integrally connecting the tubes extending in a general conical form.

3. In an electric condenser, a carrier base, a capacitance element mounted on said base, a second carrier base, a capacitance element on the latter adapted to interleave with said capacitance element as the elements approach and recede, a shaft mounted to rotate in the first carrier base projecting through both said elements and locked against endwise movement, a plurality of bars secured to the first carrier base and projecting through both of said elements, a cross plate secured to said bars at their outer ends, a bearing on said cross plate for said shaft, a screw-and-nut connection between the shaft and the second carrier base whereby turning of the shaft will reciprocate the second element on the other element, and guide means for the second element cooperating with one of said bars to prevent its rotation on said shaft.

4. In an electric condenser, a carrier base, a capacitance element mounted on said base, a second carrier base, a capacitance element on the latter adapted to interleave with said capacitance element as the elements approach and recede, a shaft mounted to rotate in the first carrier base projecting through both said elements and locked against endwise movement, a plurality of bars secured to the first carrier base and projecting through both of said elements, a plate of insulating material secured to said bars at their outer ends, a supporting plate having a bearing engaging said shaft, insulating bushings connecting said plate with said second base, said bars passing through said supporting plate and one of said bars having a bearing on said

plate to prevent turning of the element on the shaft, and a screw-and-nut connection between the shaft and said supporting plate whereby turning of the shaft will reciprocate the second element on the other element.

5. In an electric condenser, a pair of capacitance elements each composed of a base and a plurality of tubular members extending therefrom in the same general direction and all having a substantially common axis the elements being relatively movable by reciprocation on said axis to cause the members to interleave, one or both of said elements having the walls of the tubular members decreasing in thickness from the base toward the free edge, whereby when said members interleave the opposed adjacent faces are caused to approach and recede as the members reciprocate, the said tubular members in one of said elements being of increasing height from a transverse base plane from the outermost member inwardly and the other element having the tubular members at their free ends located in the same transverse plane.

6. In an electric condenser, a pair of capacitance elements each composed of a base and a plurality of tubular members extending therefrom in the same general direction and all having a substantially common axis, the elements being relatively movable by reciprocation on said axis to cause the members to interleave, said tubular members in one of the elements being of increasing height from a transverse base plane from the outermost member inwardly, the outermost tubular member being shorter than the adjacent member by a certain amount, each of the other tubular members being longer than the adjacent shorter member by an amount approximately twice the said height difference between the outer members.

7. In an electric condenser, a pair of capacitance elements each composed of a base and a plurality of tubular members extending therefrom in the same general direction and all having a substantially common axis, the elements being relatively movable by reciprocation on said axis to cause the members to interleave, said tubular members in one of the elements being of increasing height from a transverse base plane from the outermost member inwardly, the outermost tubular member being shorter than the adjacent member by a certain amount, each of the other tubular members being longer than the adjacent shorter member by an amount approximately twice the said height difference between the outer members, the other element having the tubular members at their free ends located in the same transverse plane.

8. A condenser construction comprising a stationary element having cylindrical condenser plates and a movable element having cylindrical condenser plates cooperating with said stationary plates, manually operable means for actuating the movable element for increasing or decreasing the capacity, said stationary element comprising a casting having a circular head portion, the cylindrical plates being integral with said head portion, and a cylindrical shell surrounding said movable element and having its circular edge engaging said head whereby said head and shell cooperate to form a housing for the condenser plates.

9. A condenser construction comprising a stationary element having cylindrical condenser plates and a movable element having cylindrical condenser plates cooperating with said stationary plates, manually operable means for actuating the movable element for increasing or decreasing the capacity, said stationary element comprising a casting having a circular head portion, the cylindrical plates being integral with said head portion, and a cylindrical shell surrounding said movable element and having its circular edge engaging said head whereby said head and shell cooperate to form a housing for the condenser plates, said shell being of metal whereby it acts as a shield to prevent external electrical fields from affecting the action of the condenser.

10. A condenser construction comprising a stationary element having cylindrical condenser plates and a movable element having cylindrical condenser plates cooperating with said stationary plates, manually operable means for actuating the movable element for increasing or decreasing the capacity, said stationary element comprising a head portion on which the cylindrical condenser plates are mounted and a cylindrical shell surrounding said movable element and having its circular edge engaging said head whereby said head and shell cooperate to form a housing for the condenser plates.

Signed at Newark, N. J., on this 11 day of March, 1926.

NOEL CAHUSAC.