

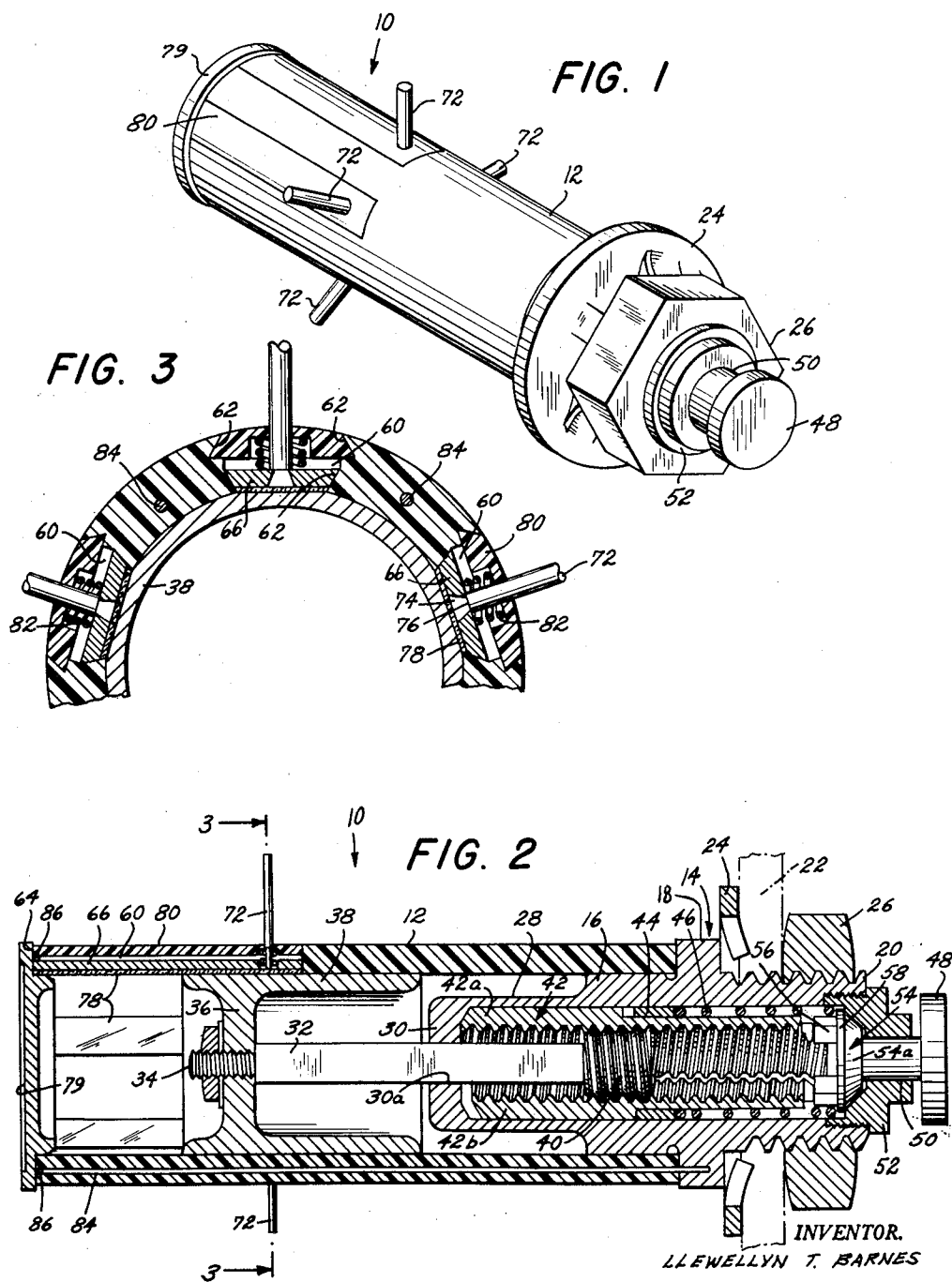
Dec. 11, 1962

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3,068,384

MULTI-CHANNEL TUNER

Filed Nov. 28, 1960



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MULTI-CHANNEL TUNER

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Filed Nov. 28, 1960, Ser. No. 71,974

7 Claims. (Cl. 317-249)

This invention relates to capacitors, and in particular to an improved multi-channel tuning capacitor.

In various communication applications it is desirable to effect coarse tuning by shifting discontinuously from one frequency channel to another, but then to tune continuously within the frequency range of the selected channel for fine adjustment. For this purpose multi-channel tuners are provided which have several alternative predetermined capacitance ranges, each corresponding to one of the frequency channels, with provision for adjustment of capacitance within each such range.

It is an object of this invention to provide an improved tuner of the foregoing type which provides the advantages of simplicity, compactness, rugged construction, ease and economy of manufacture, and ease and accuracy of calibration and tuning. As a further object of the invention, improved performance is achieved by a novel construction which provides electrostatic shielding between the electrodes corresponding to the several channels.

In accordance with an illustrative embodiment of the invention, there is provided a capacitor comprising a supporting tube formed with at least one axial slot opening into the interior thereof, an elongated fixed electrode having a dielectric coating bonded to one face thereof disposed axially within each such slot with the dielectric coating facing the supporting tube interior, and another electrode disposed within the supporting tube and movable axially for adjustment of capacitance.

The foregoing brief summary, as well as additional features and objects of the invention, will be best appreciated by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a multi-channel tuner in accordance with this invention;

FIG. 2 is a longitudinal section of the tuner of FIG. 1; and,

FIG. 3 is an enlarged transverse section of the tuner of the previous figures, taken along the lines 3-3 of FIG. 2.

Referring in detail to the drawings, FIG. 1 shows a multi-channel tuner 10 in accordance with this invention. As best seen in FIG. 2, the tuner includes a hollow, open supporting tube 12 fabricated of an electrically insulating material such as any ceramic. At one end of the supporting tube 12 is inserted a hollow tubular metal plug 14 which serves to mount the tuner on a grounded chassis panel. The plug 14 is formed with a thickened barrel 16 which is inserted into the tube 12 and is sized for a tight fit therewith. A flange 18 formed on the plug 14 abuts the end of the tube 12 to limit insertion thereof. An externally threaded collar 20 projects outwardly to pass through a mounting aperture formed in a chassis panel 2, and receives a lock washer 24 and hexagonal nut 26 which cooperate to secure the tuner 10 to the chassis panel 22 in the conventional manner. This mounting arrangement also serves to make electrical contact between the chassis panel 22 and the plug 14 so that the latter is at ground potential.

The plug 14 is formed with a cylinder 28 of reduced size which projects partway into the interior of the supporting tube 12 and terminates in an end wall 30. The

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latter is formed with a square aperture 30a which acts as a slide bearing for a square reciprocating shaft 32. The shaft 32 has a threaded tip 34 to which is secured, by means of a conventional nut and washer, the central web 36 of a cylindrical metal piston 38. This piston serves as the movable electrode of the tuner 10 and is axially reciprocable along the interior of supporting tube 12 to vary the capacitance for fine tuning within each channel. The piston 38 fits closely but slidably within the bore of supporting tube 12 so that the tube interior provides a further bearing surface for axial reciprocation of the piston 38 and shaft 32. The structure described also serves to establish electrical contact from the chassis panel 22 through the plug 14 and shaft 32 to the electrode piston 38, so as to ground that side of the capacitor.

Axial movement of the electrode piston 38 is achieved by means of a backlash-free drive housed within the bore of plug 14. The end of reciprocating shaft 32 which passes through opening 30a and into the bore of plug 14, terminates in a short externally threaded shank 40 of somewhat larger diameter. The shank 40 is screwed into the internally threaded bore of a cylindrical nut 42 which is rotatably mounted within the bore of plug 14. Rotation of the cylindrical nut 42 is thus translated by the threaded connection into reciprocation of the assembly of the shank 40, shaft 32, and piston 38. The square cross-sectional shapes of shaft 32 and the opening 30a through which it passes serve to hold this assembly against rotation with the cylindrical nut 42. The end of the cylindrical nut 42 nearest the end wall 30 has an outside diameter selected to make a freely rotatable bearing contact with the bore of plug 14.

At the other end of the cylindrical nut 42, however, its outside diameter is reduced to provide a clearance space between the nut 42 and the bore of plug 14 for the non-backlash mechanism, which includes a cylindrical sleeve 44 and a helical compression spring 46. The cylindrical nut 42, though rotating as a unit, is split longitudinally (along the division line seen in FIG. 2) into two segments 42a and 42b which are displaceable longitudinally relative to each other. The portion of lower segment 42b which is of thicker outside diameter is somewhat longer than the corresponding portion of upper segment 42a, so that the sleeve 44 is thrust against the thicker portion of the lower segment, but not against that of the upper segment, by the pressure exerted thereon by one end of spring 46. This causes the two segments 42a and 42b to be displaced longitudinally from each other to the extent that their threaded engagement with shank 40 will allow, thereby keeping both segments 42a and 42b tight against the threads of the shank 40 at all times, to absorb any looseness in the threaded connection which might otherwise give rise to backlash in the fine tuning.

Operator control over the driving movement is achieved by means of a thumb wheel 48 which is mounted outside the tuner 10 and in front of the chassis panel 22 for access by an operator. The wheel 48 is affixed to a shaft 50 which is journaled in an insert 52 threaded into the front end of the bore of plug 14. A driver member 54 secured to the end of shaft 50 inside the bore of plug 14 is formed with cleats 56 projecting into recesses in the cylindrical nut 42 to make the desired rotary driving connection thereto to actuate the mechanism which drives the movable electrode 38. A flange 58 formed on the driver 54 receives the thrust of the other end of spring 46, thus keeping the latter in a state of compression to maintain the anti-backlash pressure against sleeve 44. The pressure of spring 46 against flange 58 also serves to press a conical face 54a of driver 54 against a correspondingly shaped face of the insert 52 to deter acci-

dental movement of the capacitance adjustment drive.

In accordance with this invention, the end of supporting tube 12 nearest the movable electrode piston 38 is formed with a number of axially extending slots 60 which are spaced from each other circumferentially about the tube. Each such slot 60, as best seen in FIG. 3, has a depth extending entirely through the thickness of the wall of supporting tube 12, and the opposing sides of each slot 60 have surfaces 62 which slope in such a direction that they converge toward each other at both the exterior and interior surfaces of the tube wall. Each slot 60 opens through the rear end wall of the supporting tube 12, as at 64, to permit axial insertion of an elongated electrode plate 66 into each slot from the rear thereof.

A separate electrical connection is made to each of the fixed electrode plates 66 by means of a lead 72. These leads are lengths of stiff wire which radiate from the tuner 10. The inner ends 74 of leads 72 terminate in electrical contact with the respective fixed electrode plates 66 and are secured thereto in the following manner. The inner ends 74, which are of reduced diameter, are inserted within frusto-conical openings in the respective fixed electrode plates 66 which taper radially outwardly, and the ends 74 are then upset and are thereby spread to dovetail with the taper of the electrode plate openings and thus prevent outward retraction of the leads 72. Inward movement of the leads 72 is prevented by the abutment against the outer surface of the electrode plates 66 by the shoulder 76 formed by the reduced diameter of the tips 74.

The fixed electrode plates 66 are mounted in the slots 60 near the interior surface of the wall of tube 12 so that they are very close to the movable electrode piston 38, and a capacitance is thus developed therebetween. A thin dielectric coating 78 is bonded to the inwardly facing surface of each fixed electrode plate 66. The coating 78 preferably consists of a thin layer of glass which is fired by well known techniques to the inner surfaces of the electrode plates 66 after the leads 72 have been secured thereto. The glass coating 78 is then carefully ground and lapped to the precise thickness necessary to produce the desired different capacitance range for each such fixed electrode. The end-insertion feature of the construction described makes it easy to insert the electrode plates 66 into their respective slots 60 for repeated trials and then withdraw them each time for additional grinding and lapping during the manufacture and calibration of the tuner 10. A plastic cap 79 may be removably snapped into place to seal off the rear of the tube 12 after the calibration process is completed.

Also inserted and withdrawn axially together with the fixed electrode plates 66 are respective cover panels 80 fabricated of any fairly rigid insulating material, for example a hard plastic, and formed with openings through which the leads 72 pass. The cover panels 80, in addition to closing off the slots 60, form part of an assembly for positioning the fixed electrode plates 66 accurately with respect to the electrode piston 38. The cover panels 80 are mounted near the exterior surface of the supporting tube 12, while the fixed electrode plates 66, as was noted, are mounted near the inside surface. Both the cover panels 80 and fixed electrode plates 66 are formed with tapered sides which, when the two are spread as far apart as possible, dovetail with the tapered sides 62 of the slots 60 in such fashion that outward displacement of the cover panels 80 and inward displacement of the fixed electrode plates 66 is limited by engagement therewith. Then, to insure that these elements are kept spread to these limits so that the electrode plates 66 are held fixed in their inwardmost position, small coil springs 82 mounted between the respective cover panels 80 and fixed electrode plates 66 operate compressively therebetween. The coil springs 82 surround the leads 72 in the region between the cover panels 80 and fixed electrode plates 66, so that the leads 72 serve as guides which hold the coil

springs 82 in place. Adjacent these springs 82 the cover panels 80 may be formed with recesses receiving one end of the springs as shown in the drawing, so as to accommodate a somewhat longer spring in the space between the cover panels 80 and the fixed electrode plates 66. It will be apparent that the springs 82 require that upon withdrawal and insertion of the fixed electrode assemblies, as for example during the manufacture and calibration of the tuner 10, the cover panel 80 and fixed electrode plate 66 be squeezed together somewhat in order to be withdrawn from or inserted into the slots 60, after which they may be released to assume the positions which they are biased by such springs 82.

Each of the fixed electrodes 66 corresponds to a different frequency channel to which the capacitor may be tuned. In order to shield these fixed electrodes from each other so that their capacitance is developed primarily with respect to the movable electrode 38, there is provided a grounded shielding cage including a number of conductive wires 84, one between each of the fixed electrodes 66 and those on either side of it. The wires 84 are embedded in the ceramic supporting tube 12 at the time of its manufacture, and they extend the length thereof and protrude from the forward end. The protruding ends of wires 84 are tightly received within apertures in the flange 18 of grounded plug 14, so as to make electrical contact therewith for holding the shielding cage at ground potential. The presence of this mode of ground potential between adjacent fixed electrodes 66 serves to insulate them from the electrostatic forces that they would otherwise exert on each other. A circular wire ring 86 is mounted on the inner face of the cap 79 and engages and contacts the rear ends of the wires 84 when the cap 79 is inserted in the tube 12.

It will now be appreciated that the novel structure of the tuner of this invention provides numerous advantageous features, among which are the electrostatic shielding feature, the ease of removal and replacement of the fixed electrode assemblies, the accurate method of calibration, and the exactness of tuning, as well as the overall simplicity, compactness, and ruggedness of the tuner construction and the ease and economy of its manufacture.

A latitude of modification, substitution and change is intended in the foregoing disclosure and in some instances some features of the invention will be used without a use of other corresponding features. Accordingly, the claims herein should be construed broadly and in a manner consistent with the spirit and scope of the invention.

What I claim is:

1. A variable capacitor comprising a supporting tube formed with an axial slot opening into the interior thereof and through one end thereof to permit axial insertion of an electrode into said slot, an elongated electrode having a dielectric coating bonded to one face thereof disposed axially within said slot with said dielectric coating facing said supporting tube interior, cover means closing off said slot at said one supporting tube end, and another electrode disposed within said supporting tube and movable axially for adjustment of capacitance, and spring means disposed between said cover means and said elongated electrode urging said elongated electrode towards said another electrode.

2. A variable capacitor comprising a supporting tube formed with an axial slot opening into the interior thereof, an elongated electrode plate disposed axially within said slot, a lead radiating from said supporting tube and making electrical contact with said electrode plate, a dielectric coating bonded to the surface of said electrode plate facing said supporting tube interior, another electrode disposed within said supporting tube and movable axially for adjustment of capacitance, and spring means engaging said elongated electrode plate urging said elongated electrode plate toward said another electrode.

3. A variable capacitor comprising a supporting tube formed with an axial slot extending entirely through the

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wall thereof, the opposite sides of said slot converging toward each other at both the exterior and interior surfaces of said supporting tube, an elongated insulating cover panel disposed axially within said slot adjacent the exterior surface of said supporting tube and shaped to engage said outwardly converging slot side portions to limit outward movement thereof, an elongated fixed electrode plate disposed axially within said slot adjacent the interior surface of said supporting tube and shaped to engage said inwardly converging slot side portions to limit inward movement thereof, a coil spring positioned between said cover panel and said electrode plate to thrust thereagainst for biasing said electrode plate to its inwardmost position, said cover panel being formed with an opening in alignment with the center of said coil spring, a lead radiating from said supporting tube passing through said cover panel opening and said coil spring center and making electrical contact with said electrode plate, a dielectric coating bonded to the surface of said electrode plate facing said supporting tube interior, and another electrode disposed within said supporting tube and movable axially for adjustment of capacitance.

4. A variable capacitor comprising a supporting tube formed with an axial slot extending entirely through the wall thereof, the opposite sides of said slot converging toward each other at both the exterior and interior surfaces of said supporting tube, an elongated insulating cover panel disposed axially within said slot adjacent the exterior surface of said supporting tube and shaped to engage said outwardly converging slot side portions to limit outward movement thereof, an elongated fixed electrode plate disposed axially within said slot adjacent the interior surface of said supporting tube and shaped to engage said inwardly converging slot side portions to limit inward movement thereof, a coil spring positioned between said cover panel and said electrode plate to thrust thereagainst for biasing said electrode plate to its inwardmost position, said cover panel and electrode plate being formed with openings in alignment with the center of said coil spring, a lead radiating from said supporting tube passing through said cover panel opening and said coil spring center and formed with a tip secured within the opening of said electrode plate to establish electrical contact therewith and prevent outward extraction of said lead, a dielectric coating bonded to the surface of said electrode plate facing said supporting tube interior, and another electrode disposed within said supporting tube and movable axially for adjustment of capacitance.

5. A multi-channel tuner comprising an electrically insulating supporting tube open at one end and formed with axial slots spaced circumferentially thereabout, elongated electrodes within said respective slots each corresponding to a frequency channel, an electrically conductive plug secured within said supporting tube open end for

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mounting said capacitor on a chassis and establishing electrical contact therewith, electrically conductive wires embedded in said supporting tube extending axially between said slots and terminating in contact with said plug for electrostatic shielding of said fixed electrodes, another electrode disposed within said supporting tube spaced from said elongated electrodes and mounted on said plug in electrical contact therewith to ground one side of said tuner and axially movable thereon for fine tuning within each frequency channel, and spring means engaging said elongated electrodes urging said elongated electrodes towards said another electrode.

6. A variable capacitor comprising a supporting tube formed with an axial slot extending entirely through the wall thereof, the opposite sides of said slot converging toward each other at both the exterior and interior surfaces of said supporting tube, an elongated insulating cover panel disposed axially within said slot adjacent the exterior surface of said supporting tube and shaped to engage said outwardly converging slot side portions to limit outward movement thereof, an elongated electrode plate disposed axially within said slot adjacent the interior surface of said supporting tube and shaped to engage said inwardly converging slot side portions to limit inward movement thereof, and another electrode disposed within said supporting tube and movable axially for adjustment of capacitance.

7. A variable capacitor comprising a supporting tube formed with a plurality of spaced axial slots extending entirely through the wall thereof, the opposite sides of each of said slots converging toward each other at both the exterior and interior surfaces of said supporting tube, elongated insulating cover panels disposed axially within each of said slots adjacent the exterior surface of said supporting tube and shaped to engage said outwardly converging slot side portions to limit outward movement thereof, elongated electrode plates disposed axially within said slots adjacent the interior surface of said supporting tube and shaped to engage said inwardly converging slot side portions to limit inward movement thereof, spring means positioned between said cover panels and said electrode plates to thrust thereagainst for biasing said electrode plates to their inwardmost positions, and another electrode disposed within said supporting tube and movable axially for adjustment of capacitance.

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