

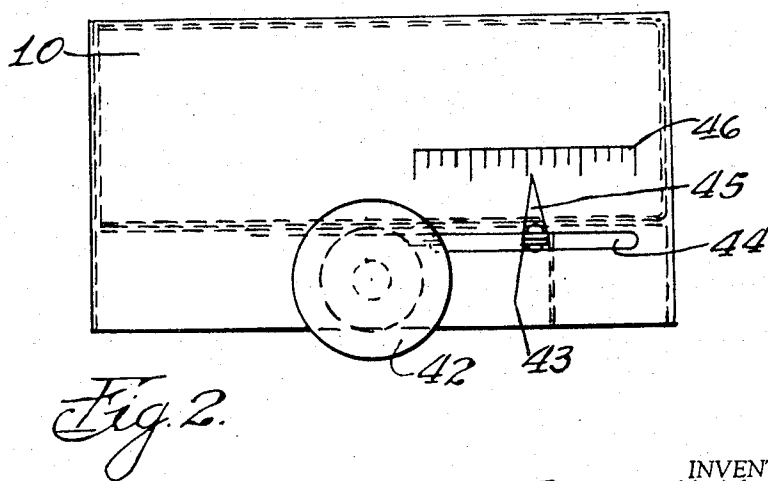
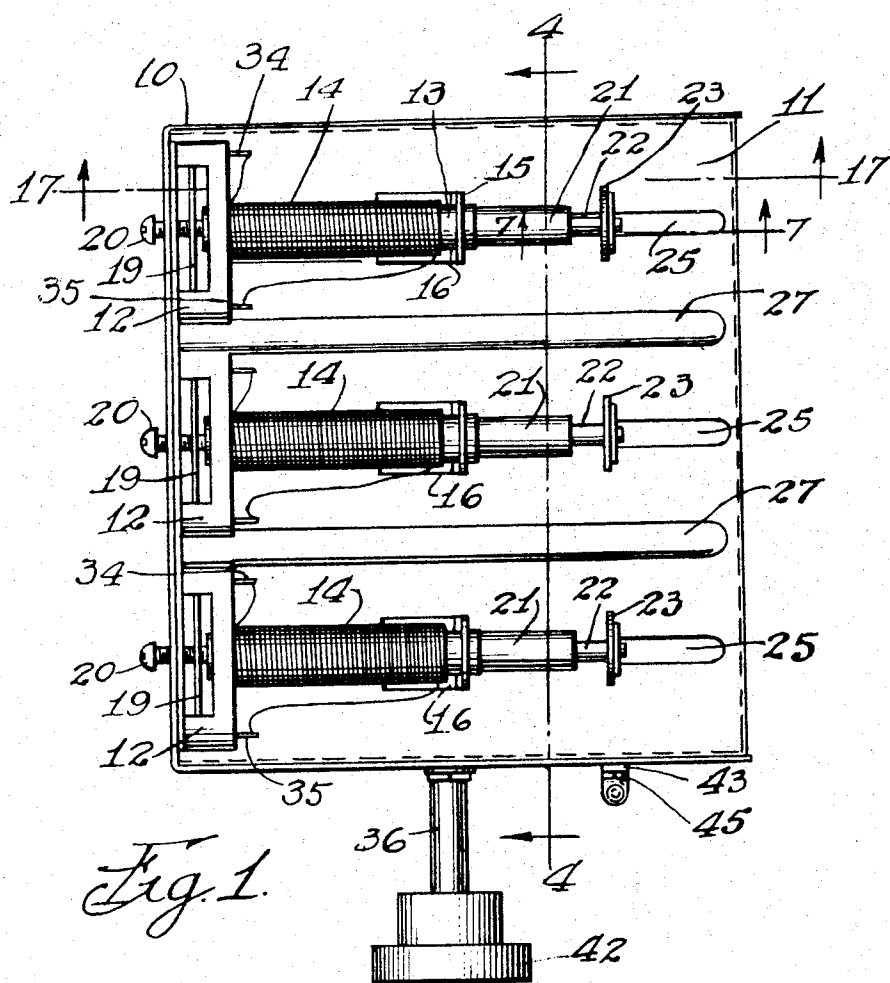
Sept. 14, 1943.

P. K. McGALL

2,329,635

PERMEABILITY TUNER OPERATING MECHANISM

Original Filed Dec. 24, 1937 4 Sheets-Sheet 1



BY

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Sept. 14, 1943.

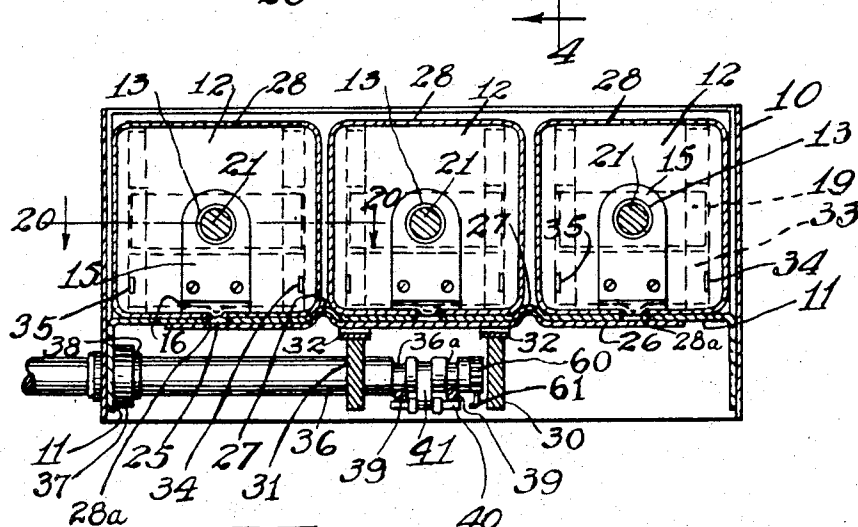
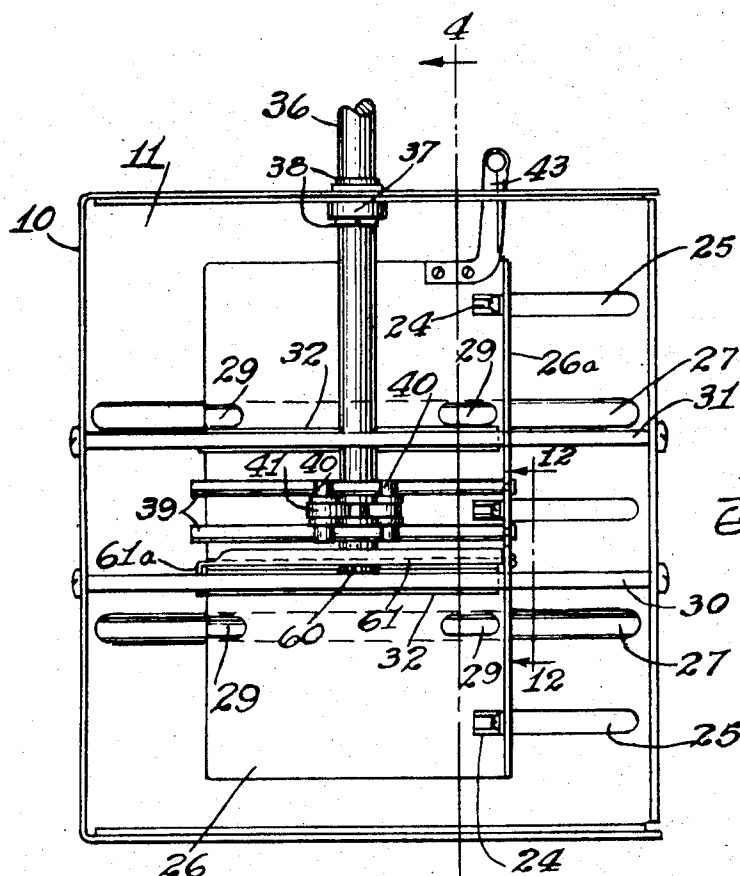
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PERMEABILITY TUNER OPERATING MECHANISM

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PERMEABILITY TUNER OPERATING MECHANISM

Original Filed Dec. 24, 1937 4 Sheets-Sheet 3

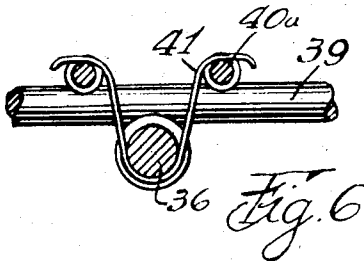


Fig. 6

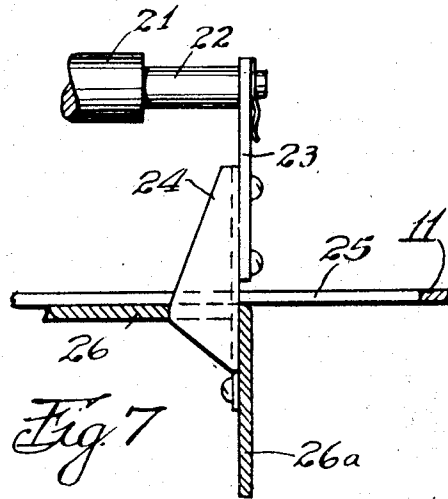


Fig. 7

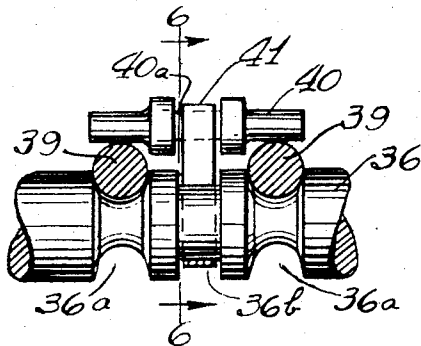


Fig. 5

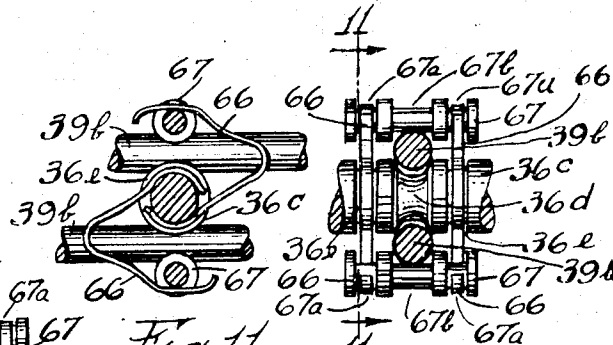


Fig. 11

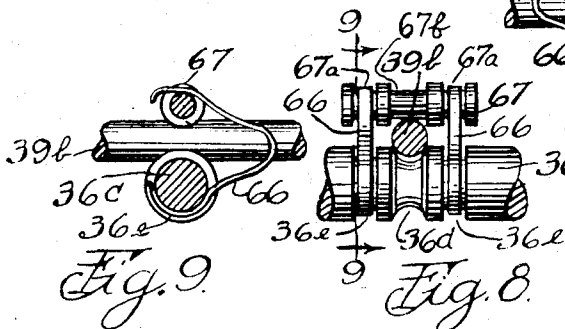


Fig. 9

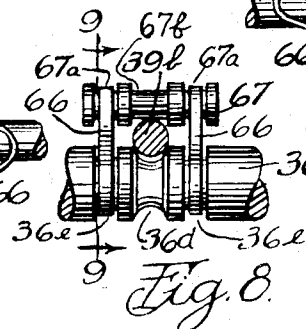


Fig. 8

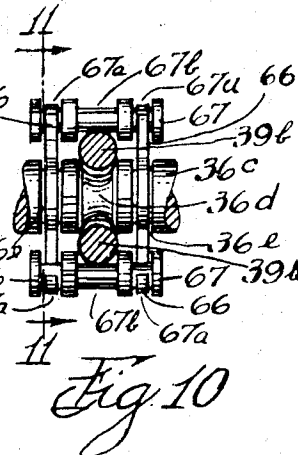


Fig. 10

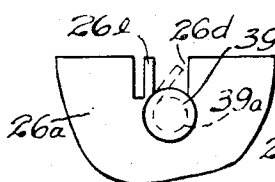


Fig. 12

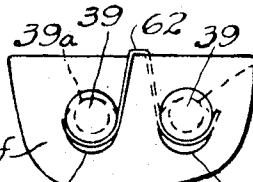


Fig. 13

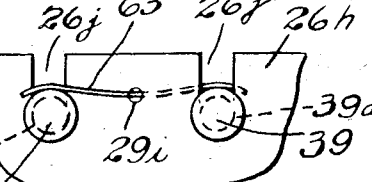


Fig. 14

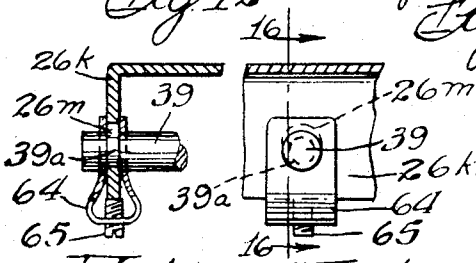


Fig. 16

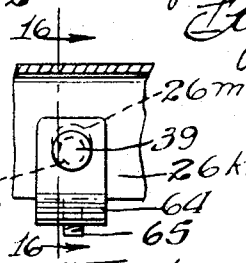


Fig. 15

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UNITED STATES PATENT OFFICE

2,329,635

PERMEABILITY TUNER OPERATING MECHANISM

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Original application December 24, 1937, Serial No. 181,674. Divided and this application May 9, 1941, Serial No. 392,657

11 Claims. (Cl. 74-91)

My invention relates to an improved construction of permeability tuner for radio receiving sets and similar purposes, comprising a plurality of combined capacitance and inductance units susceptible of being tuned to resonance at different frequencies, by changing the effective inductance of the inductance coils of said units. A tuner of the kind referred to may consist of as many stages as desired, and it has the advantage of small bulk per stage, adapting the tuner for use in receivers where the larger bulk of variable condensers would be undesirable, if not prohibitive.

My invention also includes improved operating means for simultaneously and similarly varying the effective inductance of the inductance coils of said tuner, to the end that the several tuner units or stages may be simultaneously tuned to resonance at any desired frequency of alternating current impulses, within the range of the tuner. Said operating mechanism thus constitutes a gang control for tuning said units, and it is characterized by smoothness of action, absence of lost motion, positive operation, and micrometric effect, at the same time being simple and inexpensive to manufacture. Said operating mechanism is also adapted for use for other purposes, as will more fully appear below.

This is a divisional application of my co-pending application, Serial No. 181,674, filed December 24, 1937, now Patent No. 2,253,304.

My invention will be best understood by reference to the accompanying drawings illustrating a preferred embodiment thereof, in which

Fig. 1 shows my improved tuner in plan view; Fig. 2 is a side elevation of the construction shown in Fig. 1;

Fig. 3 is a bottom view of the construction shown in Fig. 1;

Fig. 4 is a vertical, sectional view of the parts illustrated in Figs. 1 and 3, taken along the line 4-4 in the latter figures;

Fig. 5 shows in a view similar to Fig. 4 and to an enlarged scale, a part of the operating mechanism of the tuner, consisting of the devices used to hold the operating rod in operative relation to the operated rods of said operating mechanism, said operated rods being above said operating rod instead of below the latter as illustrated in Fig. 4;

Fig. 6 is a vertical, sectional view of the parts shown in Fig. 5, taken along the line 6-6 in that figure;

Fig. 7 is a horizontal, sectional view to an enlarged scale, of a part of the construction shown

in Fig. 1, taken along the line 7-7 in that figure;

Fig. 8 shows in a view similar to Fig. 5, a modified construction of operating mechanism, in which one operated rod is employed instead of two of said rods as shown in Fig. 5;

Fig. 9 is a vertical, sectional view of the parts shown in Fig. 8, taken along the line 9-9 in that figure;

Fig. 10 shows in a view similar to Fig. 5, a further modified construction of operating mechanism, in which two operated rods are moved simultaneously in opposite directions by the operating rod, instead of in the same direction as illustrated in Fig. 5;

Fig. 11 is a vertical, sectional view of the parts shown in Fig. 10, taken along the line 11-11 in that figure;

Fig. 12 is a right hand end view to an enlarged scale, of one of the operated rods shown in Fig. 3, and illustrates the manner of connecting said rods with the movable plate connected in turn with the cores of magnetic material to operate the same;

Figs. 13, 14 and 15 show respectively, modified means for connecting said operated rods with said movable plate;

Fig. 16 is a vertical, sectional view of the parts shown in Fig. 15, taken along the line 16-16 in that figure;

Fig. 17 is a horizontal, sectional view of the construction shown in Fig. 1, taken along the line 17-17, excepting that in this view the shield of the sectioned tuner unit is shown in side elevation, and the cover of the tuner is shown in place;

Fig. 18 illustrates in a view similar to Fig. 17, the combination of two tuners of the construction illustrated in Figs. 1 to 4 inclusive, to illustrate the tuning of two multi-stage tuners, by means of a single operating rod;

Fig. 19 illustrates diagrammatically, the adaptation of my improved tuner to a remote control system;

Fig. 20 is a horizontal, sectional view of a part of the structure shown in Fig. 4, taken along the line 20-20 in that figure; and

Figs. 21 and 22 illustrate respectively in views similar to Fig. 5, modified forms of operated rods for actuation by the operating rod.

Similar numerals refer to similar parts throughout the several views.

As shown in Figs. 1 to 4 inclusive, my improved tuner consists of a housing comprising a bent sheet metal plate 10 forming the front

and side walls of said housing, and a sheet metal shelf 11 having front and side flanges secured respectively to the front and side walls of the plate 10, the front flange of said shelf extending upwardly and its side flanges extending downwardly. Said shelf 11 is also provided with a downwardly extending flange at its rear edge. Above the shelf 11, the front wall of the housing has secured to it a plurality of blocks 12 of insulating material, each of which blocks supports with a sliding fit, the front end of a tubular support 13 of insulating material on which the inductance coil 14 of the corresponding unit of the tuner, is wound. The rear end of each insulating tube 13 is supported with a sliding fit, in a small plate 15 of insulating material which is in turn supported from the shelf 11 by a metal angle bracket 16. As shown in Fig. 20, the front end of the tube 13 contains a cross member 17 connected at its ends with said tube, which cross member is connected by a stud 18 with the central portion of a flat spring 19 resting at its ends against the corresponding block 12. A screw 20 threaded through the front wall of the tuner housing, rests at its inner end against the mid-portion of the spring 19, said spring having a conformation moving the tube 13 to its extreme forward position when the screw 20 is turned to move it forwardly away from the block 12. The spring 19 and the parts described as cooperating therewith, constitute a means for moving axially the tube 13 and the coil 14 carried thereby, to align said coils relatively to each other for effective and accurate gang operation of the inductance changing devices respectively associated with said coils, by the common operating mechanism below described.

Each of the tubes 13 contains a core 21 of magnetic material, preferably comminuted magnetic material compressed into solid form, which core may move freely axially in the tube 13 to change as desired, the effective permeability of the magnetic path through and around the corresponding coil 14, and correspondingly changes the inductance of said coil. The rear end of each core 21 is connected with a short rod 22, the rear end of which is connected with and supported by a small plate of insulating material 23, which, as shown in Fig. 7, is rigidly connected with the upper portion of metal bracket 24 extending through a slot 25 therefor in the shelf 11, shown in Figs. 1 and 3. As shown in Figs. 3 and 7, the lower portion of each bracket 24 extends through an opening therefor in an operating plate 26, and is rigidly secured below said plate to a flange 26a extending downwardly from the rear edge of said operating plate.

As shown in Figs. 1, 3 and 4, the shelf 11 has formed therefrom upwardly projecting ribs 27 extending from front to rear of said shelf between the coils 14, forming corresponding grooves in the lower surface of said shelf. As shown in Fig. 4, each of the ribs 27 engages the lower portions of adjacent shields 28 provided to enclose the coils 14 and their cores 21, to hold said shields against lateral movement, and centrally around said coils 14. Each of said shields 28 is provided with a longitudinal slot 28a in its bottom wall, to clear the corresponding bracket 24 and to also clear the connection between the corresponding bracket 16 and the shelf 11. The opposite side edges of the horizontal portion of each of the brackets 16, are off-set upwardly from the shelf 11, to clear the portions of the corresponding shield 28 adjacent its slot 28a, whereby

the bracket 16 serves as a guide in moving the shield around the coil 14, and holds the shield adjacent the shelf 11. Each of the blocks 12 fits in the open end of the corresponding shield 28, as a result of which the shields when in place, are held at their front ends against lateral movement in any direction. The rear ends of said shields are held against movement, as below described.

The operating plate 26 as shown in Fig. 3, is shorter from front to rear, than the shelf 11, so that its operating movement is equal to the tuning movement to be imparted axially to the cores 21. The plate 26 is provided with upwardly extending ribs 29 fitting the grooves in the ribs 27, to guide the plate 26 in its movement under the shelf 11. As shown in Figs. 3 and 4, bars 30 and 31 extend horizontally from the front wall of the tuner housing to the rear flange on the shelf 11, to which their ends are rigidly secured, the upper edges of said bars being spaced slightly from the operating plate 26, the flange 26a of which is provided with apertures through which said bars extend with sliding fits. In the spaces between the bars 30 and 31 and the plate 26, flat springs 32 carried by said plate are disposed which press the plate against the shelf 11 and hold the ribs 29 in sliding engagement with the grooves in the ribs 27. The lower edges of the bars 30 and 31 are somewhat above the bottom of the housing 10, to clear the cover of the latter, as below described. The plate 26 thus constitutes a means for imparting simultaneous and equal movement to the cores 21, making gang tuning of the several inductances possible for different frequencies within the range of the tuner.

As indicated diagrammatically in Fig. 4, each of the blocks 12 carries a flat capacitor 33 having terminals 34 and 35, for connection with the terminals of the corresponding coil 14, which terminals 34 and 35 are also the terminals of the corresponding unit of the tuner for connection as desired, according to the requirements of the circuit or hook-up with which the tuner is used, whether superheterodyne, tuned radio frequency, or otherwise. The capacitors 33 are of any kind well known in the art and preferably provided with sufficient adjustment for aligning purposes, but are otherwise fixed.

In constructing the tuner, the coils 14 are wound to have as nearly as possible, identical electrical characteristics, and the cores 21 are made as closely as possible, duplicates as to dimensions and permeability. The coils and cores are then mounted as described, and by aligning the coils by the screws 20, the same inductance relation is established between each coil and its core, as between each other coil and its core. Then, preferably with the cores drawn to the limit of their movement from within the coils, each unit of the tuner is tuned to resonance by aligning adjustment of its capacitor 33, and the tuner as to all of its units or stages, is in tune or resonance for the highest frequency of the range of the tuner. Movement of the cores 21 into the coils 14 by the operating plate 26, equally increases the permeability of the magnetic paths of the several coils for any particular position of said cores, correspondingly and equally increasing the inductance of said coils and establishing a tuned or resonant condition of all of the units or stages of the tuner for any desired frequency within the range of the tuner, which

is lower than the limiting high frequency of said range.

The means I employ to operate the plate 26, consists as shown in Figs. 3 and 4, of an operating rod 36 having rotary movement, which rod extends perpendicularly through one of the side walls of the housing 10 and through the bar 31, a bushing 37 being mounted in said side wall to constitute a bearing for said rod, which rod is prevented from moving axially in said bearing by split rings 38 carried by said rod at the ends of said bushing. Two operated rods 39 are mounted below the rod 36, between and parallel with the bars 30 and 31, with their rear ends attached to the flange 26a. The rod 36 is provided with grooves 36a in line with the rods 39, in which grooves the rods 39 are held in frictional engagement by rollers 40 below said rods 39, said rollers 40 being pressed upwardly against said rods 39 and in turn pressing said rods upwardly into the grooves 36a, by a spring 41 extending at its mid-portion over and pressing downwardly against the rod 36, and at its ends extending under and pressing upwardly against the mid-portions of the rollers 40. In Figs. 5 and 6, the relation between the rod 36 and the rods 39 is more clearly shown. In these figures the rods 39 are above the rod 36 instead of below the latter rod as shown in Fig. 4, but the relation between said rods operatively, is the same in both cases. As shown in Fig. 5, the grooves 36a are provided with inclined side surfaces diverging outwardly, said grooves being deep enough to clear the surfaces of the rods 39 which are nearest the axis of the rod 36, so that the rods 39 engage only said side surfaces. Between the grooves 36a, the rod 36 is provided with a groove 36b containing the mid-portion of the spring 41, and the rollers 40 are provided at their mid-portions with groove 40a containing the end portions of said spring. The ends of the spring 41 are extended sufficiently around the rollers 40, so that in use, rotation of the rod 36 and the resultant longitudinal movement of the rods 39, will rotate the rollers and cause them to slip at their points of engagement with said spring, without changing the general relation of the spring to the rollers 40. By engaging the surfaces of the rod 36 and of the rollers 40 which are remote from the surfaces of engagement between the rod 36 and the rods 39, the tendency of the spring 41 to elongate or straighten, presses the rollers 40 towards the rod 36, and maintains the frictional engagement between the rod 36 and the rods 39. This produces a smooth and even longitudinal movement of the rods 39 by rotation of the rod 36, without any irregularity of action, which makes possible exact and smooth operation of the movable parts of the tuner, even in imperceptible amounts, a condition greatly to be desired in effecting exact tuning. As shown in Figs. 1 and 2, the rod 36 has secured to its outer end, an operating knob 42, and the much greater diameter of the knob than the diameter of the surfaces of the rod 36 engaging the rods 39, gives the operating mechanism a micrometric action, which also facilitates exact tuning. It will be noted in Fig. 6, that the radius of curvature of the curved end portions of the spring 41 engaging the rollers 40, is substantially greater than the radius of curvature of the surfaces of said rollers 40 engaged by said spring. As a result, when the tuner is substantially in tune for a desired frequency, and exact tuning is re-

quired, a small amount of rolling action of the rollers 40 on the spring 41 occurs without slippage of said parts on each other, which further facilitates effecting exact tuning, by lessening the drag on the operating rod 36.

With the operating mechanism described, several complete rotations of the rod 36 are required to move the plate 26 through its tuning range, and to afford an indication of the frequency for which the tuner is adjusted at any time, the plate 26 is provided with an arm 43 (Figs. 1, 2 and 3), extending through a slot 44 in a side wall of the housing 10 (Fig. 2), which arm is connected with an indicating pointer 45 adjacent a scale 46 on the housing, calibrated in any desired units. Obviously, any equivalent indicating means operated by the arm 43 may be employed as desired, depending upon the location of the tuner and the parts associated therewith in any case.

To enclose the operating mechanism, a cover plate 47 (Fig. 17) is employed. With the unit shields 28 in place as above described, the upper rear flange 47a of the cover plate is located on top of the rear ends of said shields, the rear wall 47b of the said cover plate extends adjacent the rear end walls of the shields 28, and the bottom wall 47c of said cover plate extends horizontally in the bottom plane of the tuner housing 10, a front flange 47d on said cover plate extending upwardly just inside of the front wall of the plate 10 of the tuner housing. The cover plate is of a width equal to the distance between the side walls of the plate 10, and rests between said side walls and on the lower edges of the downwardly extending side flanges of the shelf 11, the flange 47d being between the front ends of said side flanges, and the front wall of the plate 10. This completely encloses the tuner, and produces a self-contained structure that is much more compact than is possible by the use of conventional interleaved variable capacitors, which structure is a complete multi-stage tuner that is thoroughly shielded and entirely enclosed, and requires in addition, only suitable radio tubes, a suitable current source, and wiring therefor, connected with the tuner in accordance with a desired hook-up or circuit, to make an operative tuning system.

It will be understood that I do not limit myself in constructing the tuners described, to the particular number of units illustrated, since each tuner may consist of as many units or stages as desired. In Fig. 18 I illustrate means that may be employed to operate and tune two complete tuners of the kind described, by a single operating rod. Part of a first tuner as above described, is shown, having a housing 10, a shelf 11, shields 28, an operating plate 26 and an operating rod 36. A second similar tuner is shown, having a housing 10a, a shelf 11a, shields 28b and an operating plate 26b, but no operating rod. The bottom edges of the housing 10 are held against the bottom edges of the housing 10a, by a cover plate 48 secured to the rear flanges of the shelves 11 and 11a, which cover plate has upper and lower flanges 48a extending over the end portions of the shields 28 and 28b. The front walls of the housings 10 and 10a are held together by a connecting plate 49 secured to said front walls. The flanges 26a and 26c of the operating plates 26 and 26b respectively, are connected by plates 50 secured to said flanges as indicated. The operating devices connecting the operating rod 36

with the operating plate 26, are the same as above described, and are omitted in Fig. 18 for the sake of clearness. As a result of the construction shown in Fig. 18, rotation of the rod 36 operates the plate 26 with the results above described, and at the same time operates the operating plate 26b of the second tuner with similar results as to the second tuner, and all of the units or stages of both tuners are thus simultaneously operated and tuned by means of a single operating rod. Thus a plurality of tuners, each complete for its intended purpose and consisting of as many stages as desired, may be simultaneously tuned by a single operating rod, and said complete tuners may be severally used for any purposes desired and either simultaneously or alternately, for example, as tuning means for different frequency bands.

As illustrated in Fig. 19, my tuner described, is adapted for use in any case where the tuning units must have one location and the operating means or controlling devices must have a second location which may be remote from said first location. In this figure my tuner is shown diagrammatically at 10, its operating rod 36 being connected by a flexible shaft 51 with an operating knob 52 on a control board 53 remote from the tuner 10. The arm 43 of the tuner, is connected with a wire 54 extending through a tube 55 to the control board 53, where said wire is connected with a pointer 56 movable by said wire along a scale 57 carried by said control board. The ends of the tube 55 are supported by brackets 58 and 59 carried respectively by the tuner 10 and the control board 53.

The manner of operating the frequency indicating pointer 56 as described, gives a correct indication at any time of the frequency to which the units of the tuner are tuned, in the system of units used in laying out the scale 57, regardless of whether there is slippage in the friction mechanism above described between the operating rod 36 and the cores 21, since the knob 52 is not relied upon to indicate by its angular position, the frequency for which the tuner is set at any time. Although there is little probability of slippage between the operating rod 36 and the operated rods 39 described in connection with Figs. 3 to 6 inclusive, such slippage is possible unless prevented. I eliminate the possibility of such slippage to an appreciable extent, by securing to the inner end of the rod 36, a pinion 60 (Figs. 3 and 4), meshing with a rack 61 disposed parallel with the operated rods 39 which rack is rigidly secured at one end to the flange 26a. The other end 61a of the rack 61 is in sliding engagement with the upper surface of the bar 30, thereby holding the rack in mesh with the pinion 60. The pitch diameter of the pinion 60 should equal the diameter of the contact circles in the grooves 36a with the rods 39 to insure against slippage between the operating rod 36 and the operated rods 39, due to the action of said pinion.

The operated rods 39 may be connected with the flange 26a of the operating plate 26, in any one of a number of ways, several of which are shown in Figs. 12 to 16 inclusive. In each of these cases, each of the rods 39 is provided with a circumferential groove 39a near its end to facilitate said connection. In Fig. 12 the flange 26a is provided with an edge slot 26d fitting the groove 39a, and after the rod 39 is pressed to the bottom of said slot, an edge tongue 26e of the flange 26a adjacent said slot, is forced over and

into the slot 26d and into the groove 39a, locking the rod 39 in said slot. In Fig. 13 the flange 26f is provided with clearance holes 26g for the rods 39, and after they are inserted in said holes with the adjacent parts of the flange 26f in the grooves 39a, the rods 39 are held in the position shown in Fig. 13 by a spring 62 bent at its mid-portion to go over the edge of the flange 26f with the ends of said spring on opposite sides of said flange and extending under and partly around and pressing upwardly on the rods 39 respectively. In Fig. 14, the flange 26h is provided with edge slots 26j fitting the grooves 39a in the rods 39, and when said rods are pressed to the bottoms of said slots, they are held in the position shown in Fig. 14 by a spring 63 bent at its mid-portion to go through a hole 29i in the flange, with the ends of said spring extending on opposite sides of said flange and over and pressing downwardly on said rods 39 respectively. As shown in Figs. 15 and 16, the flange 26k is provided with a clearance aperture 26m for each of the rods 39, and a U-shaped metal clip 64 having similar clearance apertures through its legs, is employed. The clip is placed on the flange with the clip apertures in line with the flange aperture 26m, the grooved end of a rod 39 is inserted through said apertures with the groove 39a in line with the flange 26k, and a set screw 65 threaded through the mid-portion of the clip 64 and resting against the edge of the flange 26k, is tightened, drawing the clip 64 and the rod 39 downwardly until the groove 39a is tightly against the bottom of the aperture 26m, in which position the parts are held by the set screw.

In constructing the operating mechanism above described, I do not limit myself to the form and detail shown, since said mechanism may be made in many equivalent ways as far as operation and results are concerned, without departing from my invention in its generic aspect. Essentially my improved operating mechanism includes a rotary operating rod, an operated rod to which movement is imparted axially by angular movement of said operating rod, there being frictional engagement between said rods resulting preferably from substantially opposed surfaces of or carried by one of said rods engaging correspondingly opposed side surfaces of a groove in or carried by the other of said rods, said surfaces being held in frictional engagement with each other by pressure of an amount determined by the degree of said frictional engagement required by the purpose for which said operating mechanism is used. It will be understood that said operating mechanism may be used for any purpose requiring the changing of angular motion into translatory or axial motion of an operated member or rod, as long as the force so transferred is within the limits of the frictional engagement referred to.

In Figs. 8 and 9 I show a modified form of operating mechanism in which but one pressure roller and one operated rod are used, instead of two of said rollers and two of said rods, as illustrated in Figs. 3, 4, 5 and 6. As shown in Fig. 8, the operating rod 36c is provided with a groove 36d having outwardly diverging side walls and engaging an operated rod 39b in said groove, in the same manner that each of the grooves 36a engages a corresponding rod 39 as above described in connection with Figs. 5 and 6. On each side of the groove 36d, the rod 36c is provided with a groove 36e containing one end portion of a spring 66, the other end portion of which is

in a groove 67a in a roller 67, which roller is provided with a central groove 67b receiving the operated rod 39b. The form of the springs 66 which press the roller 67 against the operated rod 39b and so press the operated rod into the groove 36d, is shown in Fig. 9, which also shows the position of the roller 67 immediately over the operating rod 36c, this view further illustrating the shape of the end portions of each of the springs 66, which permits a small amount of rolling movement of the roller 67 on said springs, in making accurate adjustments of the rod 39b. This construction is adapted to move not only rigid operated rods, but also operated rods that are more or less flexible, whereas the construction shown in Figs. 5 and 6 is adapted particularly for use with operated rods that are rigid and have little flexibility. A further advantage of the construction shown in Figs. 8 and 9, is that greater pressure of the operated rod against the operating rod may readily be obtained, as a result of using two springs per roller and per operated rod, instead of one spring as shown in Figs. 5 and 6.

In Figs. 10 and 11 I show a modification of the operating mechanism last described, in which two operated rods 39b are in frictional engagement with the inclined side walls of the groove 36d in the operating rod 36c, one of said rods 39b being above and the other being below the operating rod, and each of said operated rods 39b being held in engagement with the operating rod 36c by a pair of springs 66 in the manner described in connection with Figs. 8 and 9. The two grooves 36e in the operating rod 36c, receive the end portions of both sets of springs, the parts being of the same construction and operating in the same manner as described in connection with Figs. 8 and 9, and the only difference being that two operated rods 39b are employed. This construction provides for moving operated mechanisms in different directions from each other, by a single angular movement of an operating rod.

While I have so far illustrated the operated rods as having circular cross-sections, it will be understood that they may be of any form of cross-section that will effect frictional engagement of the kind described, with an operating rod. For example, in Fig. 21 I illustrate a flat operated rod 68 having frictional engagement at its edge portions, with the outwardly diverging side walls of a groove 69a in an operating rod 69, it being understood that the rod 68 may be held in said frictional engagement, by any of the means above described and not shown in Fig. 21, to avoid needless duplication. In Fig. 22 I show a modification of the construction shown in Fig. 21, in which a flat operated rod 70 and an operating rod 71 are employed, which have the same frictional relation to each other as the rods 68 and 69 shown in Fig. 21, and in addition, the groove 71a in the rod 71, which frictionally engages the edge portions of the rod 70, carries at its mid-portion, outwardly extending gear teeth 71b meshing with corresponding rack teeth 70a in the lower surface of the rod 70, to prevent relative displacement between the rods 70 and 71 due to slippage at their surfaces of frictional engagement, thereby avoiding the need for additional gear and a separate rack for that purpose.

With the type of operating mechanism shown in Figs. 1-22 inclusive, substantial forces are initially exerted between each operated rod and the

operating rod by the springs and rollers described, and in this case the lateral pressures developed by the small inclination of the side walls of the groove or grooves in the operating rod, produce forces which are balanced and self-contained in the operating rod, and also produce balanced lateral forces which are self-contained in the operated rod or rods, the spring pressure exerted in holding the rods together being balanced against the operating and operated rods so that the said forces are balanced within the operating mechanism considered as a whole. With this construction the only force required to move the operating mechanism, is that required to overcome the friction between the operated rod and the side walls of the groove of the operating rod.

While I have shown my invention in the particular embodiment above described, it will be understood that I do not limit myself thereto, as I may employ equivalents thereof known to the art at the time of the filing of this application, without departing from the scope of the appended claims.

Having thus described my invention, what I claim is:

1. In an operating mechanism, the combination of a plurality of elements mounted for simultaneous reciprocating movement, a member connected and movable with said elements, an operating rod having a groove with outwardly diverging side walls, an operated rod secured to said member and extending across said operating rod with its opposite side surfaces in engagement with said groove side walls, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressure against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other.

2. In an operating mechanism, the combination of a plurality of elements mounted for simultaneous reciprocating movement, a member connected and movable with said elements, an operating rod having a groove with outwardly diverging side walls, an operated rod secured to said member and extending across said operating rod with its opposite side surfaces in engagement with said groove side walls, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other, said spring means having an end configuration retaining said roller in engagement with said spring means.

3. In an operating mechanism, the combination of a plurality of elements mounted for simultaneous reciprocating movement, a member connected and movable with said elements, an operating rod having a groove with outwardly diverging side walls, an operated rod secured to said member and extending across said operating rod with its opposite side surfaces in engagement with said groove side walls, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to

move said roller and said operating rod towards each other, said spring means having an end conformation retaining said roller in engagement with said spring means and affording a limited range of rolling movement of said roller on said spring means.

4. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other.

5. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other, said spring means having an end conformation retaining said roller in engagement with said spring means.

6. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other, said spring means having an end conformation retaining said roller in engagement with said spring means and affording a limited range of rolling movement of said roller on said spring means.

7. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, said groove having outwardly diverging side walls, and said operated rod having engagement with said side walls and being otherwise free from engagement with said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other.

8. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, said groove having outwardly diverging side walls, and said operated rod having engagement with said side

walls and being otherwise free from engagement with said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other, said spring means having an end conformation retaining said roller in engagement with said spring means.

9. In an operating mechanism, the combination of an operating rod having a circumferential groove, an operated rod in said groove and extending across said operating rod, said groove having outwardly diverging side walls, and said operated rod having engagement with said side walls and being otherwise free from engagement with said operating rod, a roller crossing and engaging the side of said operated rod remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of said roller and said operating rod and tending to move said roller and said operating rod towards each other, said spring means having an end conformation retaining said roller in engagement with said spring means and affording a limited range of rolling movement of said roller on said spring means.

10. In an operating mechanism, the combination of an operating rod having a circumferential groove, operated rods in said groove on opposite sides of and extending across said operating rod, a roller crossing and engaging the side of each of said operated rods remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of each of said rollers and said operating rod and holding the corresponding operated rod in engagement with said operating rod, said groove having outwardly diverging side walls, and each of said operated rods having engagement with said side walls and being otherwise free from engagement with said operating rod.

11. In an operating mechanism, the combination of an operating rod having a circumferential groove, operated rods in said groove on opposite sides of and extending across said operating rod, a roller crossing and engaging the side of each of said operated rods remote from said operating rod, and spring means engaging and pressing with equal and opposite pressures against relatively remote sides of each of said rollers and said operating rod and holding the corresponding operated rod in engagement with said operating rod, said groove having outwardly diverging side walls, and each of said operated rods having engagement with said side walls and being otherwise free from engagement with said operating rod, said spring means having end conformations retaining said rollers respectively in engagement with said spring means.

PHILIP K. MCGALL.

CERTIFICATE OF CORRECTION.

Patent No. 2,329,635.

September 14, 1943.

PHILIP K. McGALL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 40, for "groove" read --grooves--; page 5, first column, line 70, after "for" insert --an--; and second column, line 39, claim 1, for "pressure" read --pressures--; page 6, second column, line 16, claim 9, for "divering" read --diverging--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)