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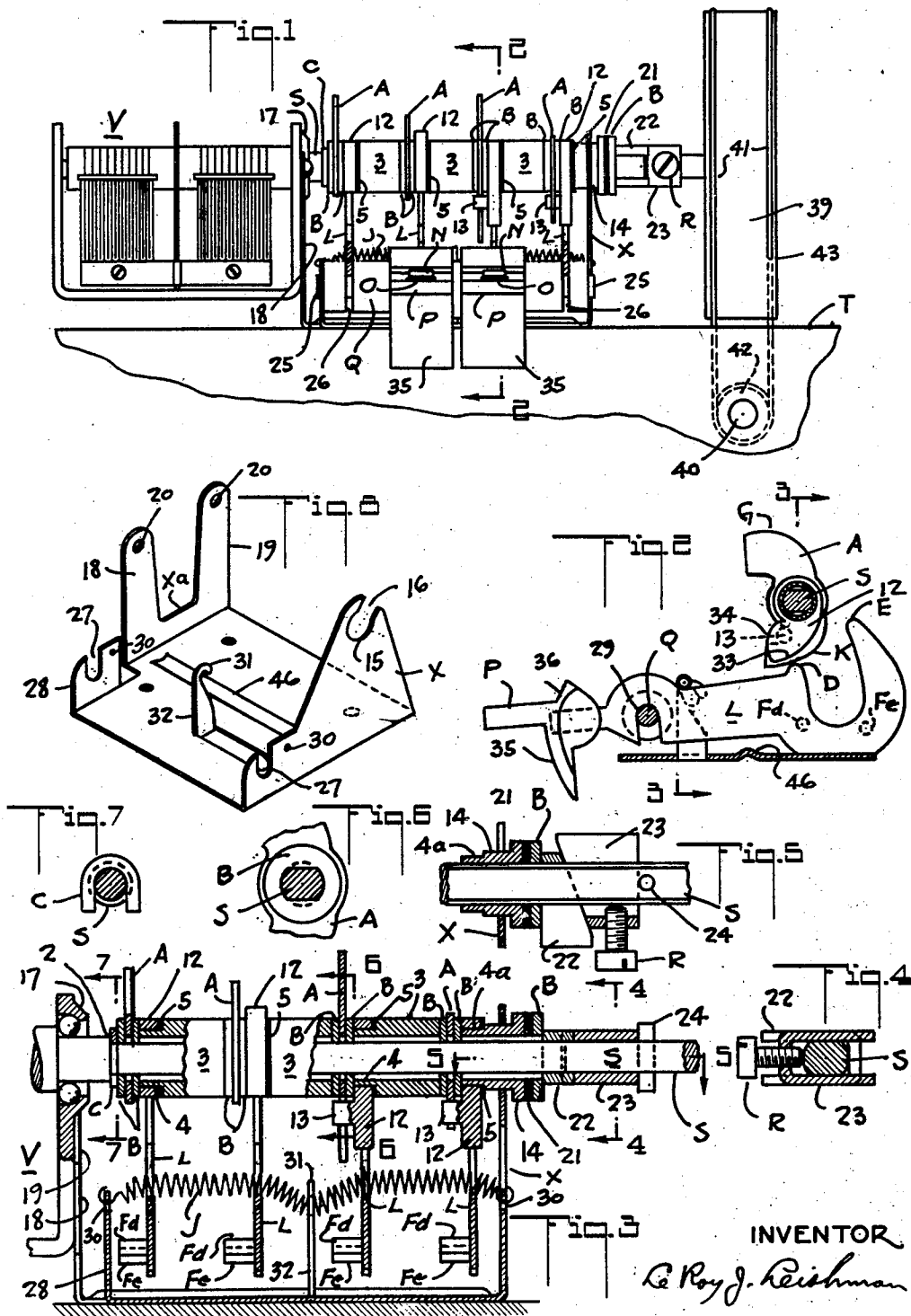
LE ROY J. LEISHMAN

2,374,824

AUTOMATIC TUNER

Filed Aug. 3, 1940

3 Sheets-Sheet 1



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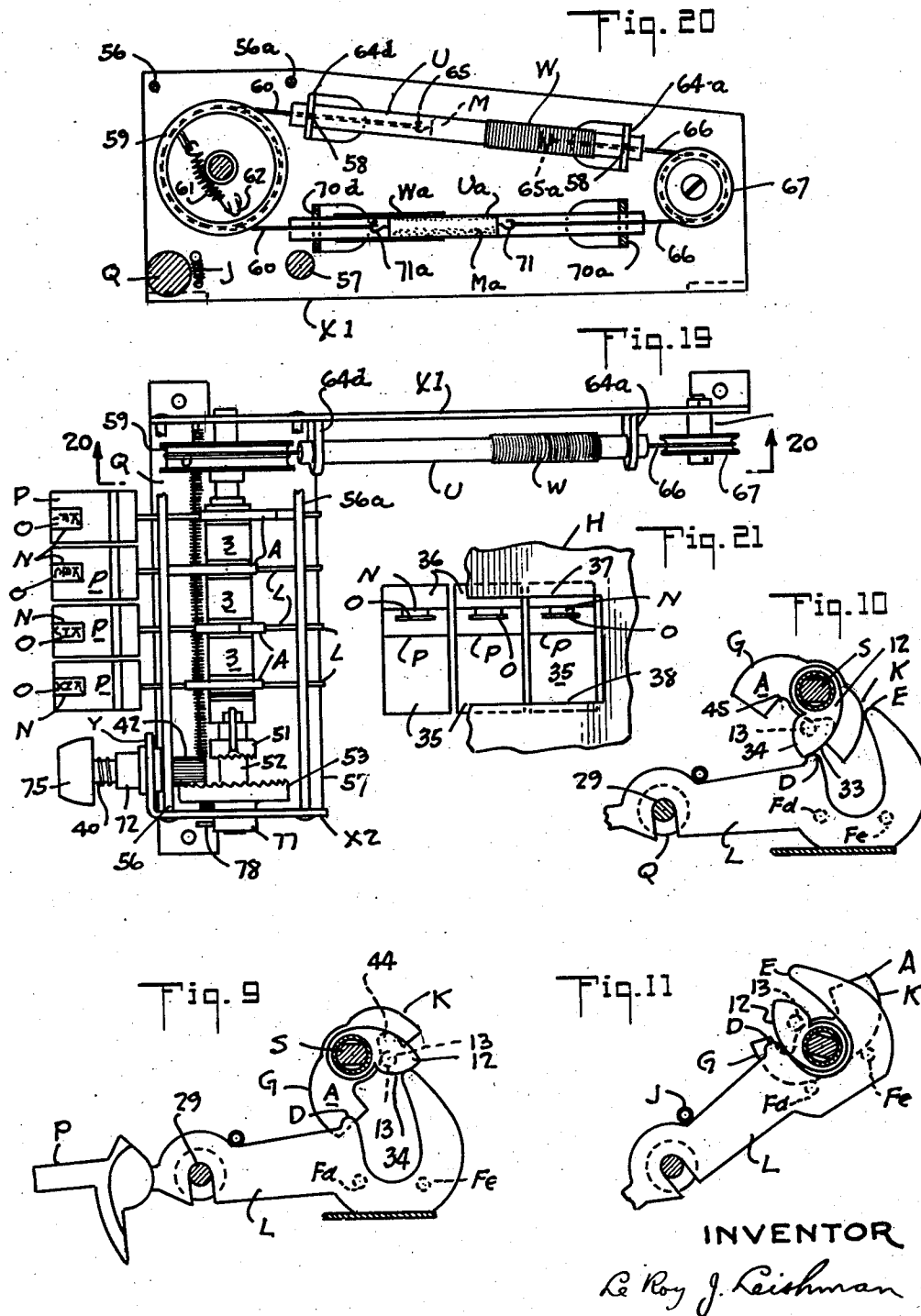
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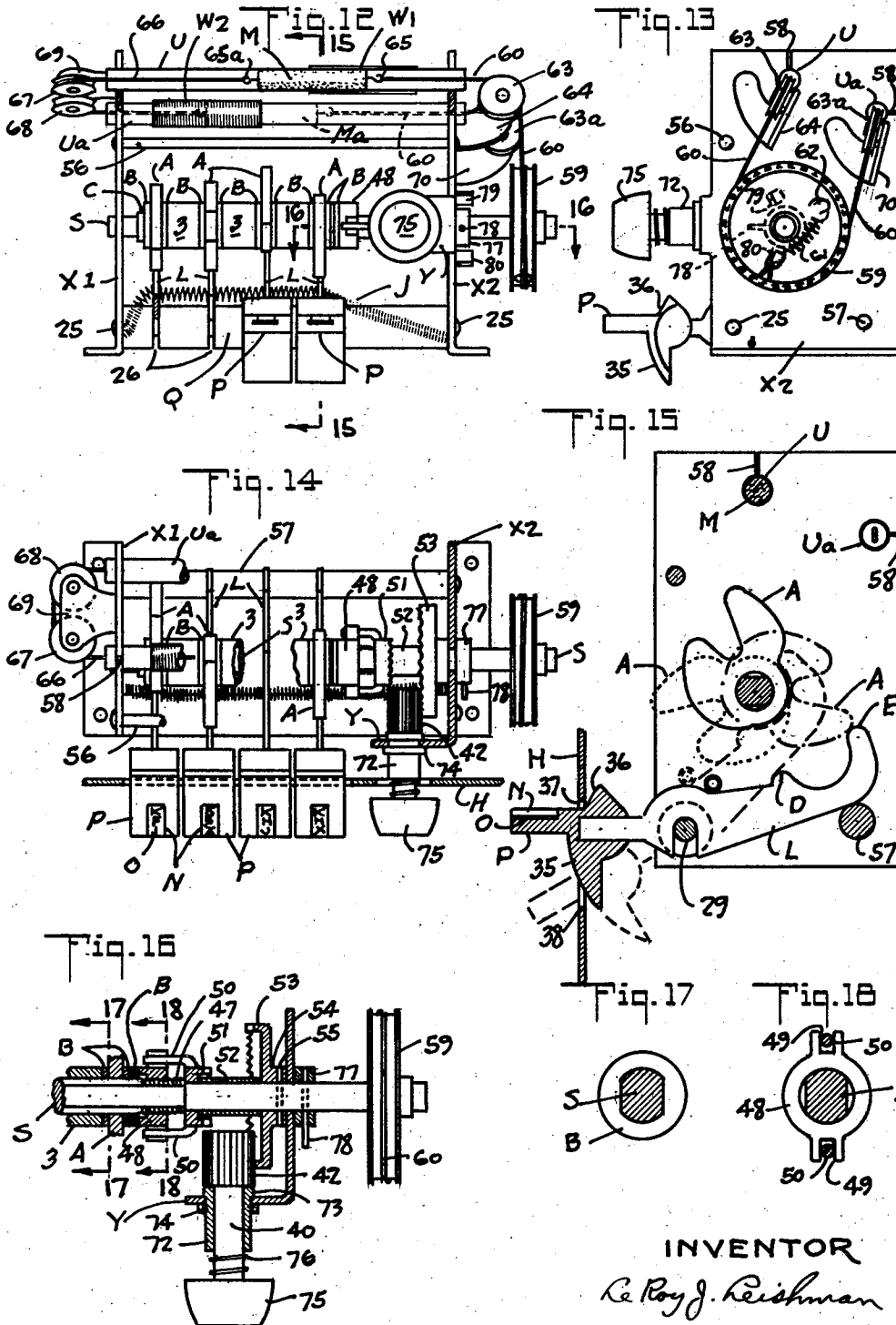
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AUTOMATIC TUNER

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6 Claims. (Cl. 74-10)

The present invention relates to automatic tuning devices, and more particularly to such devices in which the pressure of the operator's finger operates the mechanism.

In most mechanical automatic tuners, the buttons press straight in. This is disadvantageous, excepting perhaps in automobile sets. On small table model radio receivers, the pressing in of a button usually moves the set, especially if there is a cloth cover over the surface on which the receiver rests. Buttons that press straight in must either protrude from the cabinet the full length of the stroke or be so arranged that the operator's finger passes beyond the front of the operating panel or escutcheon. The last alternative is bad from a sales standpoint, because the wary purchaser hesitates to push his finger inside the set. If the stroke is shortened to reduce the amount that the button protrudes without necessitating that the end of the button move into the set, greater pressure is required to press it. Furthermore, all true push buttons are apt to mar fingernails, a feature which the women find particularly objectionable. If the buttons press down on the top of the set, the light shows through the openings, and the arrangement is also a bad dust collector.

On the other hand, if the buttons press down on the front of the set, all the above enumerated objections are avoided. There is no tendency to move the set; the buttons do not have to protrude so far; the button moves entirely in the open; and there is no possible injury to fingernails.

In the prior art, however, buttons that press down have been attached to the visible shanks of levers protruding through open slots, creating an appearance to which many people object. An object of the present invention is to eliminate the first mentioned objections without encountering this last.

Another object to make a button stroke of $\frac{3}{8}$ " to $\frac{3}{4}$ " possible without making the length of the stroke apparent.

Plunger-operated tuners have certain inherent inaccuracies due to the play that must be provided in the plunger guides. Lever operated tuners are not subject to these defects, but prior to the present invention they have been too large and required too much button pressure. An object of the present invention is to produce a tuner that is both accurate and compact.

Heretofore, each selector or manual has been supplied with an individual retracting spring, an

expense that the present invention avoids by making one spring serve for all the selectors.

Additional objects of my invention are to eliminate a coupling to the condenser shaft by assembling cams directly on such shaft, and to provide the otherwise free end of the shaft with an additional bearing without appreciably increasing the torque or encountering aligning problems.

Another object is to make it possible for the selector-retracting spring to hold several parts of the tuner in their assembled positions.

A further object is to decrease the cost of the tuner frame by forming it all in one piece.

An additional object is to afford a tuner design of low assembly cost.

Another objective is to provide an improved tuner that will rotate a shaft in either direction through an angle of 180° with low button pressure and great accuracy.

A further aim is the provision of a positionable structure for each button comprising two cams employing an improved means whereby one cam may impart motion to the other.

It is also an object of my invention to provide positionable cams and operating devices of greater efficiency than those of the prior art.

In many tuners that have appeared on the market, the starting pressure on the button has varied for different required angles of rotation, and on some the pressure has been higher at the end of the button stroke. It is an objective of the present invention to provide positionable and positioning devices involving substantially the same button pressure regardless of the required angle of rotation of the tuning shaft, or that require less pressure near the end of the button stroke.

Another object is to afford means for eliminating undesirable noises from the mechanism.

Other objects are to provide improved means for setting the tuner to bring in the desired stations automatically, and to make it possible, if desired, to adjust and lock the positioning cams from the manual knob by more efficient instrumentalities than have heretofore been available.

It is also an object of my invention to produce a simple automatic variable permeability tuner of compact construction and low torque.

Another object is to achieve all these ends with mechanism having few and inexpensive parts.

Still other objects will appear as the specification proceeds.

In the drawings:

Fig. 1 is a front elevation of one form of my

invention with part of the button structure broken away to show other details of construction.

Fig. 2 is a cross section of the device of Fig. 1, taken on line 2—2 of Fig. 1.

Fig. 3 is a long section of the device of Figs. 1 and 2, taken substantially on lines 3—3 of Fig. 2.

Fig. 4 is a cross sectional view of the cam-locking device shown in Figs. 1 and 3, and is taken on line 4—4 of Fig. 3.

Fig. 5 is a long section of the locking device and bushing forming the bearing for the end of the condenser shaft, taken on line 5—5 of Fig. 4.

Fig. 6 is a cross section taken on line 6—6 of Fig. 3 showing the keyed shaft and washer and a portion of a cam.

Fig. 7 is a cross section taken on line 7—7 of Fig. 3, and shows the C washer that fits in an annular groove in the shaft and receives the end thrust of the cams and spacers when clamped together by the locking device.

Fig. 8 is an isometric view of the frame on which the tuner is assembled.

Fig. 9, on the third page of the drawings, is a view of one of the operating levers and cam structures, showing the primary cam in one position within its 180° angle of rotation and the secondary, or lost motion, cam in a position in which a slight movement of the lever will cause the lost motion or play to be taken up and the primary cam to be turned in a counter-clockwise direction.

Fig. 10 is a similar view to that of Fig. 9, excepting that in this illustration the primary cam will turn in a clockwise direction when the lost motion between the secondary and primary cams has been taken up by the clockwise movement of the secondary cam under action of the operating lever.

Fig. 11 shows the operating lever and primary cam in the tuned-in position.

Fig. 12 is a front elevation of another embodiment of my invention, with part of the button structure broken away to show other details more clearly, and with the upper portion above the cams partly in section.

Fig. 13 is a right end view of the device of Fig. 12.

Fig. 14 is a top view, partly in section, of the device of Fig. 12, with various portions broken away to show structural details.

Fig. 15 is a cross section taken on line 15—15 of Fig. 12.

Fig. 16 is a long section taken substantially on line 16—16 of Fig. 12.

Fig. 17 is a cross sectional view taken on line 17—17 of Fig. 16.

Fig. 18 is a cross section taken on line 18—18 of Fig. 16.

Fig. 19 is a top view of a modification of the device of Figs. 12 to 16 in which the coils and cores are carried on one of the end plates.

Fig. 20 shows the long end plate of Fig. 19 with the coils and cores mounted thereon.

Fig. 21 is a front view of a portion of the front panel of a radio set and three of the operating buttons, showing how the "skirt" on each of the buttons serves to close the opening that would otherwise remain below the extended part of the button.

The same reference characters are used in the various figures for similar parts or parts that serve the same or a similar function.

In the automatic tuning device illustrated in Figs. 1 to 11, inclusive, a plurality of cam struc-

tures, each comprising an adjustably mounted primary cam and a secondary cam having a lost motion connection with the primary cam, is mounted upon the shaft S of the variable gang condenser V.

From point 2, Fig. 3, to its outer end, the shaft is keyed in some manner, as by providing it with two flat sides as illustrated in Fig. 6. This shape of shaft is commonly referred to as a "double D" shaft and is usually formed in a broaching operation that shears off opposite portions.

An annular groove having an inside diameter that may conveniently be equal to the distance between the flat sides of the shaft, is cut in the shaft adjoining point 2, and into this groove is pressed a C-shaped washer C, as shown in Fig. 7. Next to this C washer is placed a keyed washer B, having a hole to fit the double D shaft, as indicated in Fig. 6. A cam A, forming part of the adjustable positionable structure and having a round hole to receive the shaft, is mounted on the shaft next to the keyed washer. This cam is followed by another keyed washer.

Although each lost motion or secondary cam 12 cooperates with the associated primary cam, it is preferably mounted on the reduced end 4 of the spacer sleeve 3. For purposes to be explained later, a very thin cupped or waved spring washer 5 (which may be stamped from bronze of .004" or .005" thickness) is placed on this reduced end between the cam 12 and the shoulder formed by the adjoining larger portion of the spacer sleeve, and these three pieces are slipped on the shaft together so that the pin 13 of secondary cam 12 projects between the two curved arms of the primary cam, as indicated in Figs. 3, 9, 10 and 11. The reduced end 4 is slightly longer than the combined thickness of washer 5 and the secondary or lost motion cam 12 so that cam 12 may easily be rotated when the reduced end 4 is tight against the adjacent keyed washer B. Instead of providing spacer 3 with a reduced end, an independent sleeve having the same dimensions as the reduced end may be used for mounting the lost motion cam, or a hub of like dimensions may be formed on the primary cam and the secondary cam mounted thereon.

Additional primary cams are mounted on shaft S between keyed washers as shown in the drawings, and a lost motion cam 12 is provided for each of them on the reduced end of the spacer sleeve, excepting in the case of the secondary cam at the extreme right end which cooperates with the primary cam nearest the free end of the shaft. In the completely assembled tuner, this last lost motion cam 12 turns on the reduced end 4a of the bushing 14, but as this bushing cannot be placed on the shaft until later in the assembly process, the last secondary cam 12 is merely slipped over the shaft and disposed against the last keyed washer B that intervenes between this cam 12 and the last primary cam A with which it cooperates. This is followed by the final thin wave washer 5.

After the last lost motion cam 12 has been properly positioned on the shaft, the outer portion of the shaft beyond the parts already mounted thereon is slipped sideways through the gap 16 in the upright part X of the supporting frame (shown in Fig. 8) into the enlarged circular part 15. The boss 17 usually found on the variable condenser is placed between the uprights 18 and 19 at the other end of the frame, and by means of machine screws inserted through the holes 20 and into tapped holes provided in the

condenser end plate, the frame and condenser are joined securely together as illustrated in Fig. 1.

Bushing 14 is now placed over the shaft and inserted through the round opening 15 in the frame and then through the adjoining wave washer 5 and cam 12, as shown in Fig. 3. The inserting of bushing 14 through hole 15 aligns the three bearings for the shaft—the two provided by the condenser and the third formed by the bushing. Inasmuch as the frame is formed of very light stock, the narrow uprights 18 and 19 are very flexible and consequently permit the bushing 14 to position the shaft concentrically with hole 15 without introducing any appreciable amount of friction due to any imperfections in the forming of the frame or condenser or the location of the screw holes. Even if the shaft touches the edge of the recess 15 before the bushing has been inserted, it will be found after the bushing is in position and the bearings thus aligned that the shaft encounters very little resistance to rotation.

After the bushing 14 is in position, the following parts are mounted on the shaft in the order named: the relatively heavy cupped or waved spring washer 21, washer B, the thrust-receiving member 22, the wedge 23, and the pin 24 which is pressed into a hole in the shaft. Wedge 23 carries a clamping screw R, the function of which will be explained further on in the specification in connection with the setting or adjusting of the cams. Screw R, however, must be accessible from outside the radio cabinet when shaft S is at one extreme of its possible rotation, these extremes being determined by stops usually provided on the condenser itself. If it is desired to reach screw R from the back of the set or through a closable aperture in the front panel, the condenser shaft is milled or broached so that the flat sides are horizontal when the condenser is completely open or closed; but if screw R is to be reached through an aperture in the bottom or a closable opening in the top, the flat sides of the shaft are arranged to be vertical when the condenser is at the open or closed extreme of its rotation.

The reduced ends 25 of the lever-pivoting shaft Q, Fig. 1, are pressed down into the recesses 27 in brackets X and 28. Shaft Q is provided with annular grooves 26 to receive the operating levers L, which are recessed as shown in Figs. 3, 9, 10 and 11 to fit into the grooves 26 and over the round parts 29 at the bottom of the grooves, as shown in these last mentioned figures. After the levers are thus mounted, spring J is hooked through one of the holes 30 in the frame, then extended over the levers and hooked into the other hole 30. The central portion of the spring is then hooked under the hook 31 on lug 32, which may be sheared and formed from the stock of the frame. Spring J serves the double purpose of holding the levers and lever shaft in place, and of returning each lever to its normal rest position after each operation thereof.

Each lever has two contact portions E and D that engage the peripheral contact portions 33 and 34 respectively of the lost motion cam 12, and each lever is further provided with pins Fd and Fe that engage the peripheral contact portions K and G respectively of the primary cam A.

For the sake of appearance and convenience of operation, an operating "button" is attached to the external end of each lever. Each button preferably consists of a digital P having an upper

surface adapted to be engaged and pressed by a finger of the operator, and a lower extension or "skirt" 35. When the tuner is installed in a radio set, the digital P and part of the skirt 35 extends through an opening in the panel H, as shown in Figs. 21 and 15, which last mentioned figure, although it illustrates a different adaptation of the tuner, nevertheless may employ the same button structure as the species being described. The upper surface of the digital extends through the opening in the panel just below the upper edge 37 of the opening. If the digital projects beyond the skirt, as shown in the various illustrations of the button, the lower surface of the digital in its depressed position must clear the lower edge 38 of the panel opening, and the opening must therefore be of suitable dimensions to permit this condition to prevail. If the lower skirt 35 were omitted, the portion of the opening below the lower edge of the digital in its upper or rest position would be open and unsightly, and the skirt is therefore provided for the sake of appearance. The button may also have an upper skirt 36 to conceal the parts within the cabinet that would otherwise be partially visible through the slight opening that must be provided for clearance between the upper surface of the digital and the upper edge 37 of the opening in the panel itself.

If the buttons are all to protrude through the same opening in the panel, they should be arranged to come quite close together as shown in Figs. 1, 12, 14, 19 and 21, and the visible portions should preferably have a uniform width as indicated in the figures. It is possible, however, to use narrower buttons in order to place more within a space of given width, and to prevent the finger from engaging more than one digital by shaping the digitals so that the outer part is narrower than the skirt or the portion of the digital nearer the panel. Such buttons are preferably molded from a plastic and are each provided with a slot to snugly fit the shank of the operating lever, as shown in Figs. 2 and 15.

If it is desired to have the station call letters on the buttons rather than on the front panel of the radio cabinet, the top of each digital is provided with an undercut opening N to receive an index tab O on which the station call letters are printed.

While it is more convenient from an operating standpoint for the levers and buttons to be shaped and disposed so that the top of the digitals are horizontal, it is sometimes desirable for purposes of design and to facilitate the reading of the call letters to slope the digitals slightly as pictured in Figs. 3 and 9.

The tuner must be provided with some sort of manual drive, one fairly satisfactory type of which is illustrated in Fig. 1. A drum 39 is attached to the outer end of shaft S, and beneath the chassis T a manual drive shaft is suitably supported and provided with a small drum 42. A cord 41 is either attached to drum 39 at some point 43 or else extends from the interior of the drum through a hole located at 43. The cord then extends over and around drum 39 and is wrapped around pulley 42 in a clockwise direction from the rear forward and then extends over and partially around drum 39 where it is attached to move with the drum. One common practice is to extend the two ends of cord 41 through individual holes in the drum 39 and attach them together by means of an extension spring which keeps the cord taut and eliminates

play and back lash in the manual drive. A knob is of course attached to the external end of shaft 40 on the exterior of the cabinet, but as this is common practice and forms no part of this invention, further illustration is superfluous.

The operation of this automatic tuning device will perhaps be best understood if the method of setting is first explained. The initial step in setting the tuner is to loosen the screw R in the clamping device. This requires that the manual knob be turned as far as it will go in the direction that brings shaft S to the extreme of its rotation that renders screw R accessible through whatever channel has been provided from the exterior of the cabinet. After the screw has been loosened, the pressure of the spring washer 21 forces the adjacent keyed washer B and member 22 to the right, and the pressure of the sloping side of member 22 against the sloping side of the wedge member 23 forces the wedge 23 to move in the direction that its base faces, thus leaving a narrower part of the wedge between the pin 24 and member 22. This action relieves the tension on spring washer 21, which even in this partially released condition nevertheless still exerts a little pressure on all the parts assembled on the shaft between the C-washer C and the pin 24, excepting the cams 12. This pressure is sufficient to keep the cams from turning on shaft S under the influence of gravity on the gravitational centers of the cams, which are eccentric to their rotational axes because of their irregular contour. If one of the buttons is now pressed down as far as it will go, the associated lever rotates the cooperating primary cam A, in a manner to be explained later, to the position shown in Fig. 11; and as long as the button is held at the bottom of its stroke, the cam is maintained in this position by the pins Fd and Fe. While thus holding the button down, the operator tunes in the desired station by means of the manual knob, not shown, and shaft S turns inside the cam until the manual tuning operation has been completed. This establishes a definite angular relationship between the primary cam and the shaft, and when the button is released and returned to its rest position under action of spring J, the cam is held in its adjusted position by the pressure exerted by spring washer 21. Another button is now pressed down and its associated primary cam adjusted for another station in the manner just described.

While this second cam is being adjusted, there is relative angular movement between the cam and shaft S, and at least part of this movement would be transmitted to the previously adjusted cam through the intervening parts by means of their frictional contact with each other were it not for the keyed washers which isolate such angular movement and prevent its transmission to other cams.

After all the cams have been set in the manner described, the manual knob is turned until a screw driver may again be inserted in screw R, and the screw is tightened. This causes a wider portion of wedge 23 to come between pin 24 and the thrust-receiving member 22, which moves to the left, forcing the adjoining keyed washer B to flatten the spring washer and to clamp all the parts tightly on the shaft against the C-washer, thus locking all the primary cams in their adjusted positions.

The pressing of any digital will now tune in the particular station for which its associated primary cam was set. If this cam happens to be

in a position similar to that shown in Fig. 9, the downward movement of the button will cause lever L to pivot on the reduced portion 29 of the lever shaft, which thus serves as a fulcrum, and the ascending contact portion E will engage the contact portion 34 of the lost motion cam 12, causing it to turn freely until its pin 13 engages the inner edge 44 of the primary cam. The further movement of cam 12 will now rotate the primary cam in a counter-clockwise direction by means of pin 13 until the contact surface G is in a position to be engaged by pin Fe, which will rotate the primary cam until its contact surface engages pin Fd, thus preventing further rotation. After pin Fe has engaged the contact portion K, the contact part E on the lever will have moved the secondary cam to the position shown in Fig. 11, where it will stop, permitting the primary cam to turn without further movement of the secondary cam.

If the primary cam is in a position similar to that illustrated in Fig. 10 when the lever is operated, the contact projection D will engage the contact portion 33 of the secondary cam 12 and move it until its pin 13 engages inner edge 45 of the primary cam A, after which the further movement of cam 12 in a clockwise direction will rotate cam A in the same direction, bringing its peripheral contact portion K into a position where it is engaged by pin Fd, which moves cam A until its contact portion G engages the other pin Fe, the collision arresting further rotation. The contact portion D on the operating lever will not move the lost-motion cam 12 any farther than the position indicated in Fig. 11, in which position it rests in the recess between the projecting portions of the lever, permitting cam A to turn without its associated secondary cam.

If the cams should be in such a position as that shown in Fig. 3 when the lever is operated, projection D will of course engage the contact surface 33 of cam 12 and move it substantially to the position shown in Fig. 11, but its pin 13 will not engage the primary cam A, as this cam is already in a position beyond the range of the secondary cam, and its contact surface K is thus directly engageable by pin Fe, which can therefore rotate the cam to its tuned-in position without any assistance from cam 12.

The primary and secondary cams may be shaped so that there is a smooth transition from one cam to the other.

Inasmuch as the secondary cams 12 are not rigidly mounted to the shaft, they would flop around and make clicking sounds when the shaft is rotated unless enough friction were provided to prevent this. The very thin cupped or waved washers 5 prevent this by applying a pressure of a fraction of an ounce to the lost motion cams, only enough pressure being required of each washer to counteract the small weight of the cam.

The construction and operation of tuners comprising primary and secondary cams is disclosed and claimed in my co-pending application Serial No. 179,910, but the present specification discloses many improvements. In view of the earlier application, however, the basic idea needs no further elaboration here.

In the operation of the automatic tuner just described, it will be observed that the frame is subject to no stresses excepting those caused by the pressure of the levers on the lever shaft Q, which is negligible, and by the upward pull on the uprights 18, 19 and X, due to the pressure

of the lever pins on the cams carried by the shaft. As this latter strain is a direct pull, no difficulty is encountered in using the light stock required to render the uprights 18 and 19 sufficiently flexible for the aligning purposes previously explained, providing there is no distortion of the base of the frame. Such distortion is guarded against by providing the base with a plurality of holes for bolting it to the chassis, and by forming one or more beads or ribs 46 in the base to strengthen it and render it more rigid.

Figs. 12 to 18 illustrate a modification of the tuner in which the lost motion cam is not required, as the shaft rotates only 120 degrees, and the cams A are shaped to rotate through an arc of this size under direct action of either of the contact protections D and E, depending, of course, upon the angular position from which the shaft must be rotated. The greater part of the shaft is of the "double D" construction, and a C-washer is employed in the manner already explained. Because of the thinness of the stock from which the levers are stamped, the cams A are about $\frac{1}{8}$ " in thickness to make sure that the lever projections always engage the cam surfaces despite manufacturing inaccuracies. Keyed washers B are disposed on opposite sides of each cam for the reasons given in connection with the description of the embodiment previously discussed, and spacing sleeves are similarly employed. These sleeves, however, are of uniform cross section throughout, as the omission of the lost-motion cams of the previously described embodiment make the reduced ends and thin bronze washers unnecessary.

In the species of Figs. 12 to 18, there are modifications in the frame structure and the cam-clamping arrangement, and the actuating mechanism is shown in combination with a variable permeability tuning device.

A spring washer is placed on shaft S next to washer B on the right side of the cam furthest to the right, and another keyed washer is disposed on the right side of the spring washer. Beginning at a point immediately to the right of this final keyed washer, there is a threaded section, the threads having a pitch of about 24. This threaded section carries a nut 48 having a recess on the left side to clear the circular part of the shaft to the left of the threads and engage the outermost keyed washer B. The nut is provided with holes or recesses 49, Fig. 18, to slidably receive pins 50 attached to small crown gear 51 mounted on the reduced and round portion of the shaft to the right of the threads and abutting against the shoulder formed at the juncture of the threaded and reduced parts of the shaft. This nut is followed by a spacing sleeve 52 against which is mounted a larger crown gear 53 having a hub 54 attached to the shaft by a pin 55.

Shaft S is journaled in the side plates X1 and X2 held together by tie rods 56 and 57, which latter rod also serves as a rest for the levers, and by the lever-pivoting shaft Q. The end plates may be staked to shaft Q and to the tie rods, or the ends of the tie rods and lever shaft may be provided with threaded holes to receive screws passing through holes stamped in the end plates for this purpose.

A bracket Y is formed on, or attached to, end plate X2 at right angles, and the bracket is provided with a hole to receive a bushing 72 inserted from the inside of the frame so that its shoulder 73 will abut against the bracket itself.

At least a portion of the protruding part of the bushing is threaded to receive nut 74, which holds the bushing tightly in position. Through this bushing, from the inside, is inserted shaft 40 bearing the pinion gear 42 which normally meshes only with the large crown gear 53. A compression spring 76 surrounds the external part of shaft 40 and is prevented from coming off either by a pin against which it presses, or by the manual knob itself attached to the end of shaft 40.

Two non-ferrous, and preferably non-metal, tubes U and Us are mounted in holes in the upper portions of the end plates X1 and X2. Around these tubes at opposite ends are wound the tuning coils W1 and W2.

Rigidly mounted on the right end of shaft S is a pulley 59 having a hole in the periphery through which passes cord 60 over which is hooked one end of the extension spring 61 having its other end hooked over the ear 62 sheared and formed from the stock of the pulley. One part of cord 60 passes over idler pulley 63, mounted on bracket 64 sheared and formed from the end plate X2. This part of cord 60 is then attached to hook 65 in the end of permeability core M. Another cord 66 is attached to hook 65a on the opposite end of core M and it passes over idler pulleys 67 and 68, both mounted on bracket 69 formed from the stock of end plate X1. The other end of cord 66 is attached to the hook in one end of core Ma in tube Ua. The heretofore unmentioned end of cord 60 passes over idler 63a on bracket 70 and is attached to the hook 35 in the opposite end of core Ma.

These cores are arranged so that both pass into their respective coils simultaneously. The initial alignment is effected by sliding one of the tubes longitudinally in the frame. The electrical features of the permeability tuning arrangement will not be discussed in this specification, as they are well known in the art and form no part of this invention.

The mechanical structure just described forms a very compact permeability tuning arrangement with very little torque, as both cores are moved by the same moving system from which play is eliminated by a single spring. A further advantage lies in the fact that no special mounting means is required for the tubes. To set this automatic tuner, the manual knob 75 is first turned to the right as far as it will go, the rotation in this direction being limited by stop 79 with which pin 78 in shaft S comes in contact. Knob 75 is now pushed in against the action of spring 76, causing gear 42 to mesh with the small crown gear 51 while still remaining in mesh with the large crown gear 53. The manual knob, held in the inward position, is now turned to the left as far as possible, thus rotating the two gears in opposite directions simultaneously. The pins 50, which are integral with small gear 51, cause nut 48 to turn in a counter-clockwise direction while the threaded portion of the shaft is moving in a clockwise direction due to the rotation of large gear 53. This action produces a relative rotation between the nut and shaft of $1\frac{1}{2}$ revolutions when the gears are of the relative sizes illustrated, and since the threads are 24 pitch the nut moves to the right approximately $\frac{1}{20}$ ", thus releasing the pressure on the adjoining keyed washer and the spring washer on the opposite side thereof. Enough pressure remains, however, to keep the cams from turning by their

own weight. The manual knob is now permitted to move outward to its normal position under action of spring 76. The cams are next adjusted for various broadcasting stations in the manner already described in connection with the device of preceding figures. After they have all been adjusted, the manual knob is turned to the left as far as possible—that is, until further rotation is prevented by the pin 78 colliding with the detent 80 on the end plate. The knob is now pushed in so that the pinion gear 42 meshes with the small crown gear, and while the knob is held in this inward position, it is rotated in a clockwise direction as far as possible. This moves nut 48 to the left, thus clamping the cams in their adjusted positions.

Figs. 19 and 20 illustrate a modification in which the tubes and coils are mounted on a single end plate XI, the lugs 64a, 64d, 70a and 70d being provided with slotted holes for this purpose. The operation of this embodiment is obvious from previous descriptions, but attention might be called to the fact that only two pulleys in all are required and that the torque is therefore even less than with the arrangement shown in Figs. 12, 13 and 14. If desired, the long end plate carrying the tubes may be placed on the right end of the tuner and a bracket provided thereon for the manual knob, in which case a small end plate without such bracket would be used on the left end.

In automatic tuners that are operated by the pressure of the operator's finger, it is very important that there be no increase in the required pressure near the tuned-in position—that is, near the bottom or end of the operating stroke of the button; in fact, it is desirable that there be a decrease in the button pressure as the bottom of the stroke approaches. If the button pressure is high when the shaft is to be turned from an initial position that is close to the tuned-in position for the desired station, the operator is apt to feel that he has pressed the button all the way to the end of the stroke, when as a matter of fact the plunger or lever will merely have encountered the cam. The lighter the button pressure at this part of the stroke, the less apt this error is to occur. If the tuning shaft must be rotated a considerable distance to bring in the desired station, the cam is engaged near the top of the stroke; and if the pressure decreases as the bottom of the stroke approaches, there is a feeling that the mechanism coasts to the tuned-in position.

Other things being equal, if the button pressure is less near the bottom of the stroke, the button is actually moving further for a given angular rotation of the shaft than it is near the top of the stroke. This has two advantages in addition to those already mentioned. First, if the button is not close to the end of its stroke when the cam is engaged for turning the shaft a short distance, the operator, when this engagement occurs, has no sensation that he has completed the tuning operation and he therefore continues to press the button the rest of the way. Second, when these conditions prevail, the shaft moves more slowly as the stopping position approaches, thus reducing the momentum and largely eliminating the jar and bounce that sometimes occurs when the devices driven by the automatic tuning mechanism are not properly designed and engineered.

When the desirability of the features just mentioned are recognized, cams may be designed to bring them about, and such cams will be found to operate very satisfactorily if the principles and

design characteristics hereinafter discussed are incorporated.

The so-called cams in these tuners operate more as levers that are directly pushed by applied forces than as cams that operate on the principle of a wedge, such as heart-shaped cams. The greatest efficiency is obtained from a lever when the force is applied at right angles to a line passing through its center of rotation. The cams of the device of Figs. 12 to 18 were designed to meet this condition at the tuned-in position. A line tangent to both the rounded force-applying projections D and E passes substantially through the centers of rotation of both the lever and the cam.

The device of Fig. 15 incorporates cams that substantially achieve the desirable ends discussed in the foregoing paragraphs, and certain of their salient structural features are therefore described in the appended claims.

In designing cams and operating plungers or levers for meeting the desirable requirements hereinbefore discussed, it has been found that the performance improves as the ratio of S to

$$\frac{2\pi r A}{360}$$

increases, where S is the stroke of the cam-contacting portion, r the distance between said cam-contacting portion and the rotational axis of the cam when the cam-contacting portion is engaging the cam at the tuned-in position, and A is the angle of rotation of the cam. The tuner operates very satisfactorily when S and

$$\frac{2\pi r A}{360}$$

are equal, but when S is the lesser the performance becomes less smooth and irregularities in the periphery of the cam increase the friction more than would otherwise be the case.

In the form of my invention illustrated in Figs. 1 to 10, the total angle of rotation of the two cams is 180°. As this is 50% more than the angle of rotation of the cams shown in Fig. 15, S would have been less than

$$\frac{2\pi r A}{360}$$

if both S and r had been left the same as in the species of Figs. 12 to 18. In order to meet the requirements of the formula, it was necessary to increase S and/or reduce r . It was practical to do both. The distance between the lever shaft and the cam shaft was increased and the contact projection D, which has a shorter stroke than its companion projection E, was moved closer to the axis of the cam than E in order to reduce r sufficiently. Inasmuch as cam 12 is logically a die-cast part, it can have a relatively thin wall around the shaft between the cam surfaces, and projection D can therefore approach closer to the shaft without touching this wall than would be the case on a stamped cam. In designing the primary cam A, it was not possible to arrange for the contact pins Fd and Fe of the lever to be on the cam center line in the tuned-in position, because this would have reduced the distance between edge 45 and cam surface K to a point where it would not have been possible to stamp the cam. This could have been avoided, however, by increasing the distance between the lever and cam shafts, but this would have increased the size of the mechanism unduly. Nevertheless, pins Fd and Fe pass beyond the periphery of the portion of the cam extending around the shaft be-

tween the two cam surfaces, and excellent operation is attained by the ratios of S and r notwithstanding the fact that the primary cam moves through an angle of approximately 90° for approximately a 15° movement of the lever, the total lever movement being 30° for the 180° rotation of the two cams 12 and A.

As a result of incorporating the principles herein discussed into the design of the three differently shaped cams shown in the drawings, marked resemblances are apparent. Cams A of Figs. 3, 9, 10 and 11 will be found to have various physical characteristics in common with cams A of Fig. 15, and the latter cams and cam 12 of Figs. 3, 9, 10 and 11 exhibit various similar features. Side 33 of cam 12 and side G of cams A, Fig. 15 have markedly similar contours, as do sides 34 and K of these respective cams.

Those skilled in the art will recognize that the inventions embodied in the devices described in this specification and shown in the drawings may be embodied in vastly different structures, as the forms discussed in this specification are merely illustrative embodiments. Numerous modifications, substitutions, additions and even omissions may be made without departing from the broad scope and spirit of the invention.

My claims are:

1. In a radio tuning mechanism, a combination including: a rotatable control element; a rotatable positionable structure operatively connected to said element and comprising an angularly adjustable member having two peripheral contact portions; and a rotatable positioning device comprising two contact portions disposed on opposite sides of a throat in said device, each of said portions adapted to engage one of the contact portions of said member and rotate the member and element to a tuned-in position in which the other contact portion of said member engages the other contact portion of said device, said member and device so constructed and arranged that a line connecting the two points of engagement of said device and member in said tuned-in position will pass substantially through the rotational axis of said member.

2. In a radio tuning mechanism, a combination including: a rotatable control element; a rotatable positionable structure operatively connected to said element and comprising an angularly adjustable member having two peripheral contact portions; and a rotatable positioning device comprising two rounded contact parts separated by an open space, each of said parts adapted to engage one of the contact portions of said member and rotate the member and element to a tuned-in position in which the other contact portion of said member engages the other contact part of said device; said portions having at all points a greater radius of curvature than said parts.

3. In a radio tuning mechanism having a pair of positioning cams for each actuating device, means for transmitting equal angular motion from one cam to the other, said means comprising a recess in one cam and a projection on the other cam intermediate its outermost point and its rotational axis for engagement with alternative edges only of said recess.

4. In a radio tuning device, a combination including: a rotatable structure comprising two pairs of contact portions, said pairs rotatable in different planes; and a movable positioning device having two spaced forwardly projecting portions each disposed to engage one of the contact portions in the same pair, and a pair of laterally projecting pins each disposed to engage one of the contact portions in the other pair.

5. In a radio tuning mechanism having a plurality of positionable members adjustably mounted on a control shaft and spaced by sleeves, locking means for exerting pressure longitudinally of said shaft for clamping said members in their adjusted position, said locking means including: means on one end of said shaft for limiting the movement of said cams in one direction; a reduced portion adjacent the other end of said shaft; a threaded portion adjacent said reduced portion; a nut on said threaded portion for tightening said members and sleeves against said motion-limiting means; a first crown gear on said reduced portion adjacent said threaded portion; motion transmitting means for rotating and moving said nut along said threaded portion upon rotation of said first gear; a second crown gear rigidly attached to the reduced portion of said shaft; a manual drive shaft; a pinion gear on said drive shaft, said pinion gear meshing only with said second crown gear when said shaft is in an outward position and meshing with both crown gears when said drive shaft is in an inward position.

6. In a radio tuning mechanism, a combination including: a rotatable positionable structure having a plurality of peripheral contact portions; and a movable positioning device having a plurality of driving contact portions each arranged to engage only one of the contact portions of said positionable structure and to rotate at least part of said structure; each pair of cooperating contact portions so arranged, disposed and shaped that S is at least as great as

$$\frac{2rA}{360}$$

where S is the length of the path of movement of the driving contact portion of said pair, r the shortest length of the moment arm of the force applied by said portion, and A is the total angle in degrees through which the structure rotates upon said movement of said driving contact portion.

LE ROY J. LEISHMAN.