April 18, 1961

F. G. MASON

2,980,796

RADIO-FREQUENCY TUNER

Filed Dec. 18, 1957

2 Sheets-Sheet 1

FIG. 1

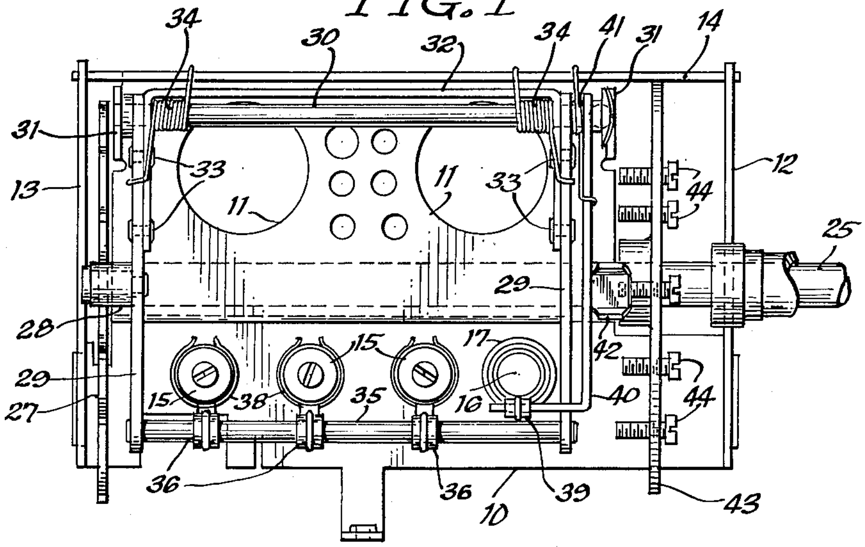
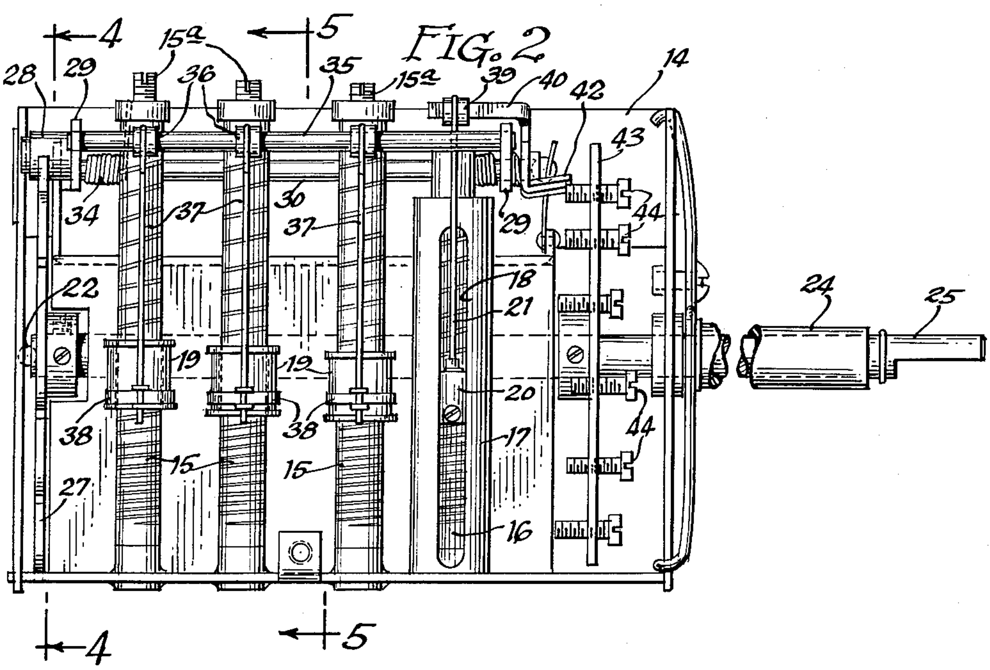


FIG. 2



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RADIO-FREQUENCY TUNER

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FIG. 3

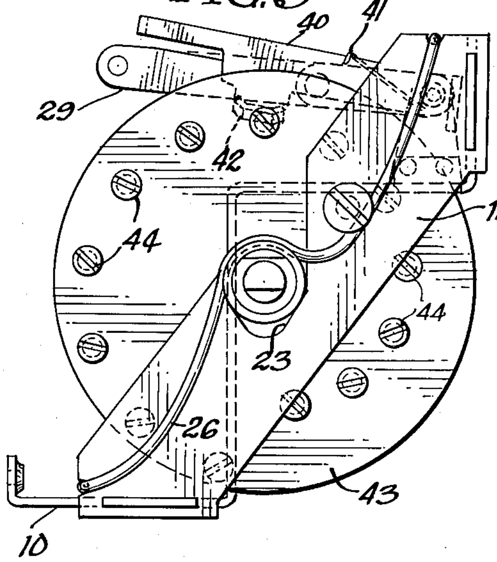


FIG. 4

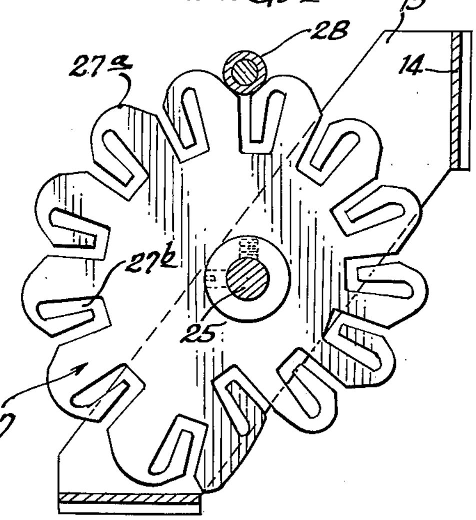


FIG. 5

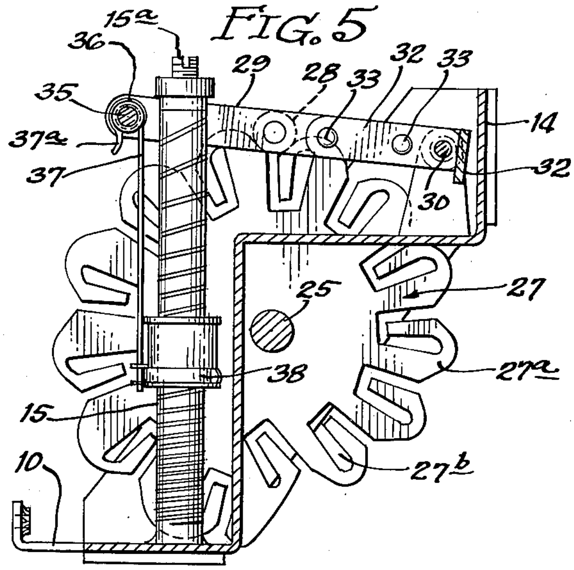
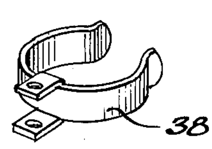


FIG. 6



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RADIO-FREQUENCY TUNER

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Filed Dec. 18, 1957, Ser. No. 703,604

4 Claims. (Cl. 250—40)

This invention relates to the field of radio-frequency tuners. In particular, it is directed to a tuner, such as is employed in television receivers, wherein a plurality of pre-selected and pre-adjusted tuning positions are manually selectable.

One of the features commonly found in tuners of this type is a detent means for defining each of the various predetermined tuning positions which correspond to the signal channels to be received. A feature and object of the present invention is to provide a tuner wherein the cam drive which operates the tuned circuits provides its own detenting action, thus eliminating the need for conventional detent mechanisms such as spring-loaded balls, etc.

Another object of the present invention is to provide a tuner having a cam drive which may be individually adjusted for each of the channel settings and which at the same time is characterized by structural simplicity and low cost.

A still further object of the invention is to provide, in a tuner having a plurality of tuned circuits, means whereby one or more of such circuits having critical tuning characteristics can be individually adjusted for each channel setting without disturbing the tuning adjustments of the other tuned circuits.

Still another object of the invention is to provide a multi-circuit tuner in which all the circuits are tuned by sliding conductive slide members along tuning coils, means being provided for individual adjustment of the circuits in each channel position of the tuner and special adjusting means being provided for any particularly critical tuned circuit.

Yet another object of my invention is to provide a multi-circuit tuner in which coarse adjustment of all the tuned circuits for the various channels is achieved by means of a single cam, while providing auxiliary adjusting means for any critical circuits that can be individually tuned for each channel during initial factory adjustment and which is ganged with the cam for manual operation by a single knob.

Other objects and advantages of the invention will appear from the following detailed description of a typical embodiment of the invention.

In the appended drawing, Figure 1 shows a typical tuner embodying the present invention as it appears in plan view. Fig. 2 is a side elevation view of the Fig. 1 tuner. Fig. 3 is an end view of the Fig. 1 tuner, as viewed from the right-hand side of Fig. 1. Fig. 4 is a fragmentary view partially in section, along the line 4—4 of Fig. 2, looking toward the rear of the tuner. Fig. 5 is a sectional view of the tuner, looking toward the rear, along the line 5—5 of Fig. 2. Fig. 6 is a perspective view of one of the contactor clips employed in the tuning assembly.

For illustrative purposes in the present specification, I shall describe a typical tuner adapted for use in a modern television receiver. While the circuit details do not of themselves form a part of the present invention,

it may be assumed that the circuit is of generally conventional character, consisting of a radio-frequency amplifier, a mixer stage, and a local oscillator. Such a tuner will normally comprise a plurality of tuned circuits employed in the radio-frequency and mixer stages, plus an additional tuned circuit for the oscillator stage. The oscillator stage in such a tuner must be adjusted to cover a somewhat different frequency range than the other circuits, to provide for each channel the appropriate beat frequency necessary for signal conversion to the intermediate frequency used in the receiver. Moreover, the tuning of the oscillator is, in such a tuner, more critical than the tuning of the other circuits. Accordingly, as I shall presently explain, my tuner embodies special means permitting individual adjustment of the oscillator circuit in each channel position.

Inasmuch as my invention does not directly involve the circuit details, I have in the drawing omitted a number of conventional circuit elements, such as vacuum tubes, fixed capacitors, resistors, choke coils, and other parts which enter into a conventional tuner of the type described. This has been done both in the interest of simplifying the present description and for the purpose of bringing out more clearly mechanical features which might otherwise be obstructed by such electrical circuit elements.

As shown in Fig. 1, my tuner is mounted on a rigid metal chassis or frame **10**, having a flat bed portion suitably punched, as at **11**, with apertures to receive tube sockets and other circuit elements. At both the front and rear ends of the bed portion of the chassis I provide end plates **12** and **13**, rising at right angles from the bed plate and providing support means for the tuning shaft presently to be described. A vertically positioned strip **14** joins the front and rear plates **12** and **13** to give rigidity to the structure.

The tuned circuits employed in my tuner consist, in the embodiment shown, of four tuning coils which are mounted in a vertical position on the bed plate of frame **10**. Of these tuned circuits, three are used for tuning the radio-frequency amplifier and mixer circuits and may be essentially identical. These are all marked with the reference numeral **15**. The fourth tuned circuit, used for tuning the oscillator, will have somewhat different electrical characteristics from those of coils **15**, and it is designated with the reference numeral **16**.

The tuning coils **15** are of the same general type as those disclosed in my copending application No. 679,172, filed August 20, 1957. They consist of a flat, generally helical ribbon of copper or other conducting material, supported on a cylindrical form made of glass or other low-loss insulating material. Preferably the coils **15** are made by circuit-printing methods which are known to those skilled in the art and need not be described. The coils **15** are coated with a thin layer of insulating material such as epoxy resin, which afford electrical insulation and mechanical protection for the coil. Both the coil ribbon and the insulating coating are very thin.

The coil **16**, used for oscillator tuning, is structurally similar to coils **15**. Because of the different requirements of the oscillator circuit, however, the oscillator coil **16** is surrounded by a tubular shield **17** having an axial slot along the greater part of its length, as indicated at **18**.

The coils **15** and **16** are tuned by means of conducting rings or slide members, marked **19** in the case of coil **15** and marked **20** in the case of coil **16**, which overlie the respective coils and slide therealong responsively to operation of the mechanism presently to be described. Each of the coils forms a two-terminal circuit, one of the terminals being fixedly situated at the upper end of the coil, and the other terminal being the sliding sleeve **19** or **20**. The effective tuned circuit in each case consists of the portion of the coil between the sliding sleeve and the top terminal, the resonating capacitance consisting of the distributed capacitance of the active portion of the coil, together with the capacitance between the sleeve and the coil in series with any distributed or lumped capacitance provided by the external circuit connected to the coil terminals.

Connection between the respective tuning sleeves and the external circuit is provided differently in the case of the coils **15** and the oscillator coil **16**. In the case of the coils **15**, circuit connections to the respective sleeves **19** are provided by means of pigtail leads (not shown) soldered to the outer surfaces of the sleeves **19**. These pigtail leads may be made of a suitable flexible wire such as Tensolite, and they have proved to be highly satisfactory in life tests, having undergone more than 100,000 complete tuning cycles without breaking. Since these pigtail connections have no bearing on the mechanical tuning mechanism which is the subject of the present invention, there will be no need to describe them further.

Because the use of a pigtail circuit connector to the tuning slide **20** of coil **16** would have an adverse effect on the reset characteristics of the oscillator circuit, I have provided for the oscillator coil **16** a fixed circuit connection in the form of the slotted shield **17**. Tuning slide **20** is provided on its outer surface with a thin layer of epoxy insulation similar to that which covers the coil **16**, and the electrical connection to the tuning slide **20** is thus made capacitively by means of the capacitance defined by the inner surface of the shield **17** and the outer surface of the slide **20**. The slot **18** provides for mechanical access to the slide **20** permitting it to be moved up and down by means of the rod **21**, presently to be described. It will of course be understood that a fixed external circuit connection may be made to the shield **17** in any manner desired. If the oscillator circuit calls for one of the terminals of coil **16** to be grounded, this can be accomplished by soldering the lower end of the shield **17** to the chassis **10**.

In tuners of the type illustrated, the particular coil design employed will depend on the frequency range to be covered and the relative distribution of the desired channels within that range. It should accordingly be understood that the coils shown in the drawing are intended to be diagrammatic, so far as the number of turns, pitch of turns, etc. are concerned.

A main tuning shaft **25** is mounted in suitable bearings provided in the end plates **12** and **13**. The rear bearing for shaft **25** is preferably of the ball type, as indicated in Fig. 2 by the reference numeral **22**. The front bearing is illustrated in Fig. 3 and includes a fine-tuning mechanism of the general type disclosed and claimed in the copending application of Louis E. Coutermash, Serial No. 499,269, filed April 5, 1955, now Patent No. 2,872,824. In this arrangement, the front end plate **12** is notched at **23** to receive an outer shaft **24** of larger diameter than main shaft **23**, and a strong wire spring **26** is mounted with its ends secured to end plate **12** and positioned to press the shaft **24** into the notch **23**. For mechanical stability, the outer surface of the shaft **24** may be provided with a shallow annular grove to receive the spring **26**. Shaft **24** is drilled axially to provide a passage for the shaft **25** therethrough, the shafts, however, being slightly eccentric. With this arrangement, rotation of the shaft **24**, as by means of a manual knob carried thereon, will produce a slight rocking of the shaft **25** and will thereby move very slightly the tuning mechanism presently to be described.

Since this fine-tuning mechanism is not part of the present invention, it need not be more fully treated in this description.

Keyed to the rear end of shaft **25**, immediately in front of the rear bearing **22**, I provide a tuning cam **27**. Cam **27** is provided around its periphery with a number of lobes **27*a***, preferably spaced equi-angularly

and designed with progressively greater radial dimensions. This construction is shown clearly in Figs. 4 and 5.

Each of the lobes **27*a*** is formed with a reentrant slot **27*b*** having a circumferential portion and a radial portion. By manual insertion of a screw driver into either the circumferential or radial parts of the slots **27*b***, the individual lobes **27*a*** can be bent so as to vary slightly the effective radial dimensions of the various lobes.

As may be seen from Figs. 4 and 5, the lobes of the cam **27** are positioned closely adjacent one another, and each lobe has a central portion of greater radial dimension than the parts of the lobe immediately adjacent thereto, so that the lobes define a group of recessed portions or "lows," respectively separated by curved raised zones or "highs."

For cooperation with the cam **27**, I provide a cylindrical cam follower **28** which is mounted on the rearward one of a pair of rocker arms **29**. Rocker arms **29** are journaled for rotation on a shaft **30** situated adjacent side frame member **14** and held in frame-carried bearings **31**. Joining the two rocker arms **29** together and insuring their motion as a unit is a U-shaped link **32** which is secured to each of the arms **29** by means of rivets **33**. The rocker arms **29** and the cam follower **28** are spring-biased against the cam **27** by means of a pair of torsion springs **34** carried on shafts **30** and having their respective ends seated against the rocker arms **29** and the frame member **14**.

The outer ends of the rocker arms **29** are joined together by a rod **35**. Rod **35** carries, spaced along its length, a group of insulating support members **36**, preferably made of nylon or other similar material, over which the control rods **37** for slide members **19** are secured.

The rods **37** are required, during tuning movement, to undergo a small amount of flexure, and it is desirable that they have freedom to rotate slightly relative to the rod **35**. For that reason, the rods **37** are preferably modified at their upper ends, as shown in Fig. 5, to form spring clamp terminals **37*a*** which are snapped over the sleeves **36**, the sleeves being free to rotate on the rod **35**.

At their respective lower ends, the control rods **37** are soldered or otherwise securely held to clamp members **38**, which respectively are snapped over the tuning sliders **19**. One of the clamp members **38** is shown in perspective in Fig. 6.

The arrangement just described affords freedom of adjustment with respect to the positions of the slide elements **19** and the control rods **37**. This adjustability is a valuable feature of my invention. Normally the optimum positions of the slide members **19** on the respective coils **15** will be about the same for any given channel, since the three coils **15** are normally tuned to the same frequency for each channel. Small differences in the circuit capacitance associated with the various coils **15** may require, however, that the tuning sliders **19** be slightly staggered relative to one another. Such staggering is made possible by the control arrangement just described, comprising the clamps **38**. As indicated in Fig. 2, the optimum positions of the respective slide members **19** can be determined experimentally during the factory adjustment of the tuner, and the clamps **38** positioned thereon accordingly. After the optimum relative positions of the clamp members **38** on the respective slide members **19** have been determined, the clamps can then be soldered, cemented, or otherwise secured permanently in position.

From the foregoing description, and from a study of Figs. 2 and 5, it will be seen that rotation of shaft **25** will successively bring the cam follower **28** into a series of stable positions whereat it is seated between adjacent lobes **27*a***. As the shaft **25** is rotated, the rocker arms **29** will move in position and cause the tuning sliders **19** to move along the coils **15**. By its design, the cam **27** will give the tuner an inherent detent action, since the cam follower **28** will find a stable position in each of the "lows" between the respective lobes **27a**. Adjustment of the tuning-slide positions for each channel setting may be made by insertion of a screw driver into either the radial or circumferential portions of the respective slots **27b**. Additional individual circuit adjustments, to achieve optimum "tracking" of the various tuned circuits may be achieved by screw-driver adjustment of the movable cores **15a** with which the coils **15** will normally be provided.

I shall now describe the manner in which I provide for individual channel-by-channel adjustment of the oscillator coil **16**.

Control rod **21**, which is secured at its lower end to the tuning slider **20**, is mounted at its upper end, through an insulating sleeve **39**, to an auxiliary rocker arm **40**, the rear end of which is journaled on shaft **30** previously mentioned. A torsion spring **41**, encircling the shaft **30**, has its respective ends seated on the frame member **14** and the rocker arm **40**, biasing the rocker arm **40** downward.

As may be seen from Fig. 1, rocker arm **40** has a right-angle bend in it near its front end, so that the arm crosses over one of the rocker arms **29** and terminates over oscillator coil **16**.

Intermediate its ends and substantially directly over the shaft **25**, rocker arm **40** has integrally formed therein a laterally extending boss **42**, the lower surface of which is canted upward at a slight angle. Boss **42** is positioned for cooperation with a disc-shaped cam element **43**, mounted on and keyed to shaft **25** immediately behind the front end plate **12**. Spirally disposed around the center of cam disc **43**, at angular positions corresponding to the various "lows" of cam **28**, are a plurality of screws **44**, positioned with their heads on the side of cam **43** adjacent end plate **12** and with their shanks extending into the space behind cam **43**. The radial disposition of the various screws **44** is such that, in each channel position defined by a "low" on cam **28**, one of the screws **44** is directly under the boss **42** carried by rocker arm **40**. In each channel position of the tuner, therefore, it is possible to adjust the position of rocker arm **40**, and hence of slide member **20**, with great precision, merely by turning the particular screw **44** which is then in abutment with boss **42**. Since the under surface of the boss **42** is slightly canted upward, the rocker arm **40** is raised when the screw **44** in abutment with boss **42** is screwed inward, and the arm **40** is correspondingly lowered, under the urging of spring **41**, when the screw **44** in abutment with boss **42** is screwed outward.

When shaft **25** is rotated to select a new channel, the particular screw **44** formerly in abutment with boss **42** rotates out of engagement therewith, the rocker arm **29** engages arm **40**, and sliders **19** and **20** thereupon move together to the position appropriate to the newly selected channel. When cam follower **28** stops in the "low" of cam **27** corresponding to the newly selected channel, a new screw **44** takes its place under the boss **42**, and hence governs the position of the oscillator slide **20** for that channel.

It will of course be understood that the arm **40**, the boss **42**, and the screws **44** are so positioned that in each channel setting the particular screw **44** then in engagement with the boss **42** holds the arm **40** above and free of the rocker arm **29**, thus leaving the oscillator slider **20** free for control by the position of screw **44**.

From the foregoing description, it will be apparent that, in the initial adjustment of my tuner at the factory, the optimum oscillator frequency for each channel can be set with very great precision by adjustment of the respective screws **44**, independently of the tuning of the various coils **15**. Once the screws **44** have been correctly adjusted, they can then be held against undesired rotation by cementing or in any other suitable fashion, thus insuring that the adjustment will remain correct during the normal use of the tuner.

From the previous description of the fine-tuning mechanism, it will be realized that rotation of shaft **24**, by rocking slightly the shaft **25**, will produce a very slight upward and downward movement of the particular screw **44** which is then bearing against the boss **42**, thus providing a vernier control of the oscillator frequency.

In the television-tuner application of my invention, the oscillator circuit is the only one whose tuning is sufficiently critical to require an individual channel-by-channel adjusting means such as is exemplified by the rocker arm **40**, cam **43**, and screws **44**. In other applications, the use of such individual-channel adjusting means might be required for more than one tuned circuit, and my invention embraces the use of as many such means as the particular application may justify.

While the foregoing description of a typical embodiment of my invention has recited many of the structural features in considerable detail, it should be understood that it is intended to be illustrative only rather than limiting. Persons skilled in the art will be able to make many variations in the structure described without departing from the true spirit and scope of the invention as exemplified in the foregoing description and defined in the appended claims.

I claim:

1. In a radio-frequency tuner having a first tuned circuit tunable by movement of a first tuning element and a second tuned circuit tunable by movement of a second tuning element, the combination comprising a tuning cam mounted for movement in a predetermined locus and having a plurality of distinct positions representative of frequency channels to be tuned, means for moving said cam into any selected one of said positions, cam-follower means connected to said first tuning element and operative responsively to engagement with said cam to move said first tuning element and thereby to tune said first circuit to a frequency channel corresponding to said selected position, means for moving said second tuning element, said moving means being mounted in a lost-motion relation with said follower means operative to move said second tuning element responsively to rotation of said cam while leaving to said moving means in each cam position a limited range of movement independently of said follower means, a second cam operatively connected to said cam-moving means for movement thereby in step with said first cam, said second cam being provided with a plurality of individually adjustable elements spatially disposed thereon to correspond with said distinct positions of said first cam and means operatively associating said second cam and said means for moving said second tuning element for causing said second tuning element to move within said limited range responsively to engagement with a particular one of said adjustable elements when said first cam is moved into a selected one of said positions, whereby optimum tuning of said second circuit for each of said channels may be achieved by adjustment of said adjustable elements.

2. In a radio-frequency tuner having a first tuned circuit tunable by movement of a first tuning element and a second tuned circuit tunable by movement of a second tuning element, the combination which comprises a rotary tuning cam having a plurality of distinct positions representative of frequency channels to be tuned, cam-rotating means operable to move said cam into any selected one of said positions, cam-follower means connected to said first tuning element and operative responsively to engagement with said cam to move said first tuning element and thereby to tune said first circuit to a frequency channel corresponding to the position of said cam, means for moving said second tuning element, said moving means being mounted in a lost-motion relation with said follower means operative to move said second tuning element when said cam is rotated from one position to another while leaving to said moving means in each cam position a limited range

of movement independently of said follower means, a second cam operatively connected to said cam-rotating means for rotation thereby in step with said first cam, said second cam having a plurality of individually adjustable elements, one for each of said distinct positions of said first cam and spaced on said second cam in a pattern corresponding with said positions of said first cam, and means operatively associating said second cam with said moving means for causing said second tuning element to move slightly within said limited range responsively to engagement between said moving means and a particular one of said adjustable elements when said first cam is rotated into any selected one of said positions, whereby the optimum tuning of said second circuit for each of said frequency channels may be achieved by adjustment of said adjustable elements.

3. The apparatus defined in claim 2 wherein said second cam comprises a flat plate mounted for rotation, and wherein said adjustable elements comprise screws spirally

distributed on the face of said plate and threadedly carried thereby.

4. The apparatus defined in claim 3 wherein said means associating said second cam and said means for moving said second tuning element consists of an inclined projection connected to said moving means and positioned adjacent said second cam.

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