

Sept. 8, 1942.

E. L. HOFFMANN ET AL

2,295,173

STEP-WISE TUNING OF ELECTRICAL CIRCUITS

Filed June 20, 1940

5 Sheets-Sheet 1

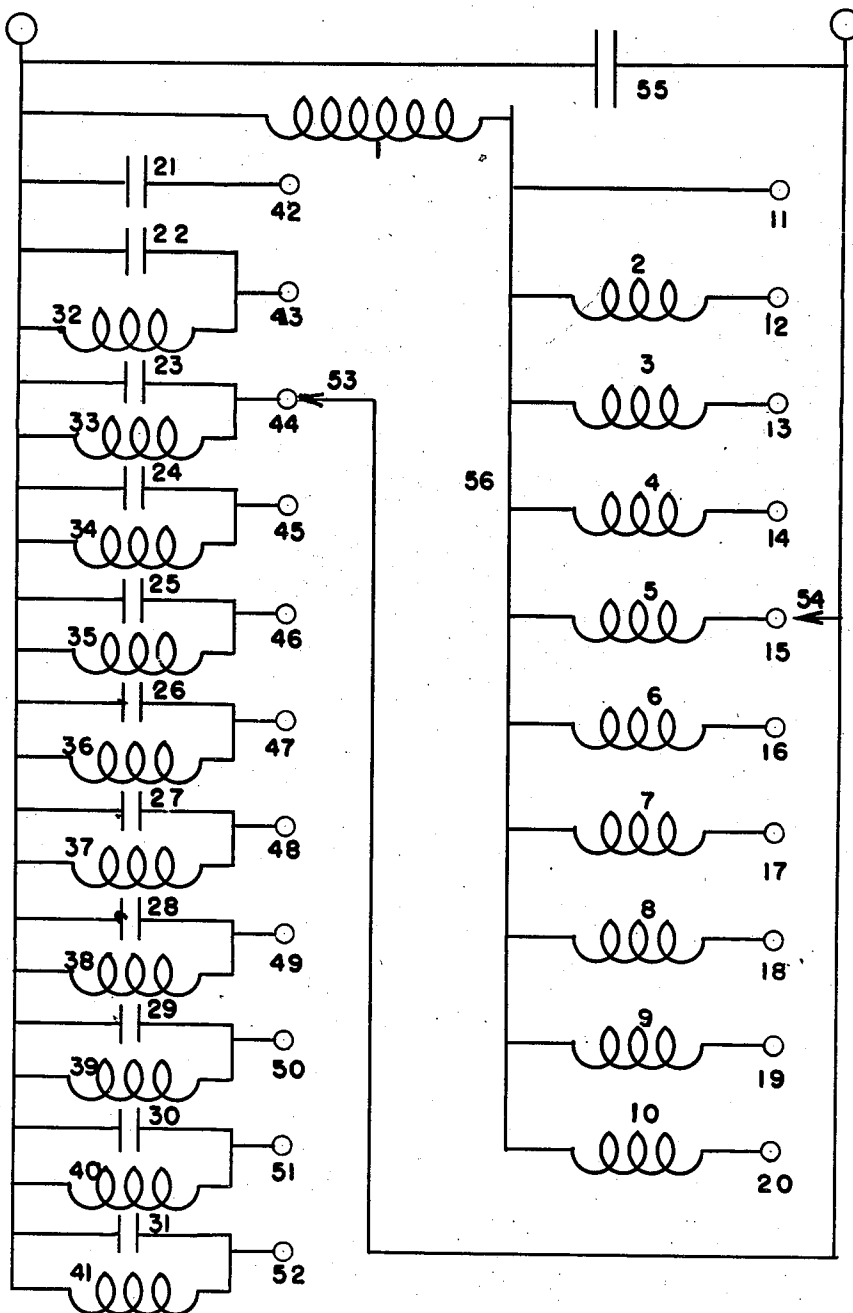


FIG. 1

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5 Sheets-Sheet 2

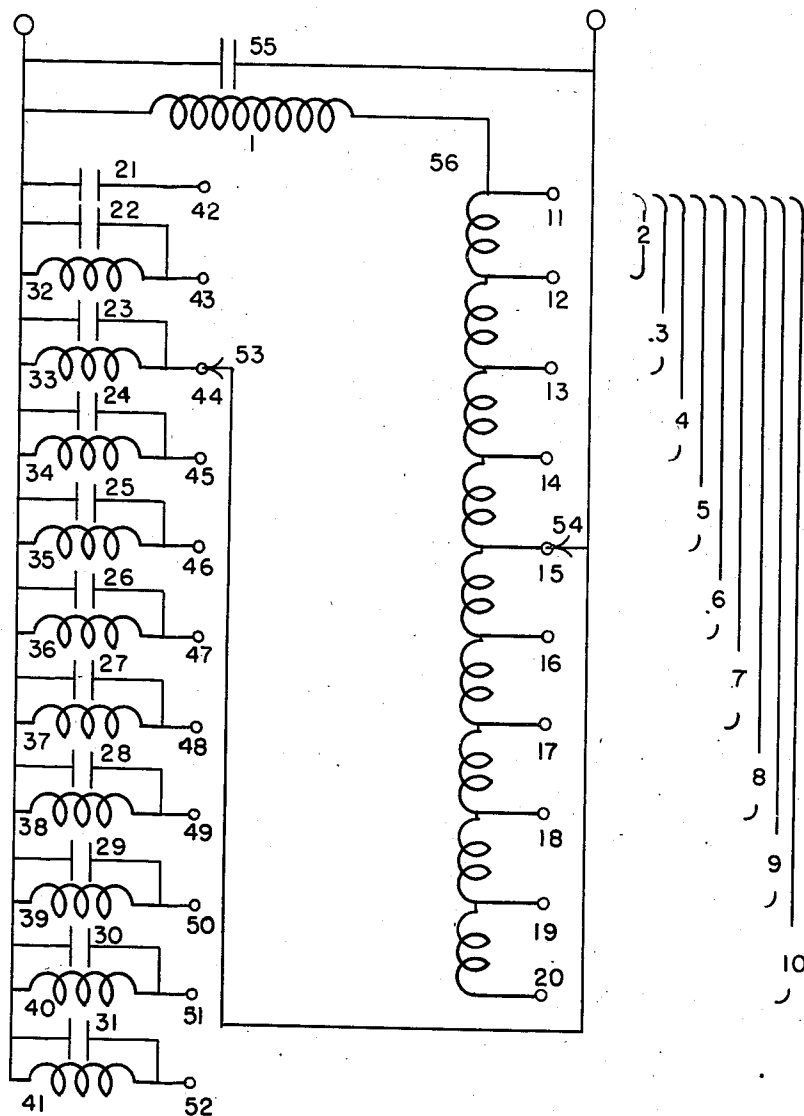


FIG. 2

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5 Sheets-Sheet 3

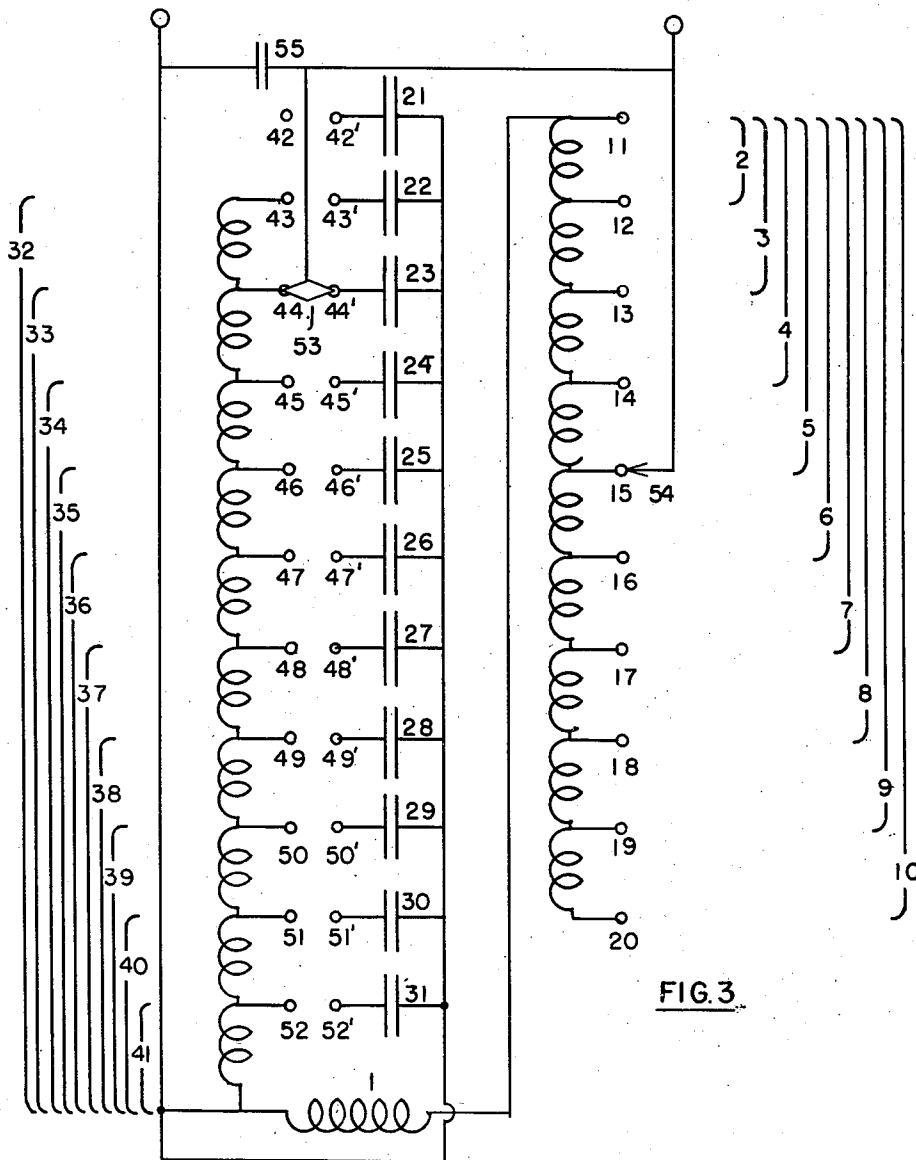
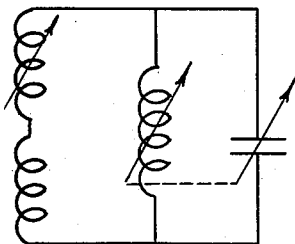


FIG. 3

FIG. 4



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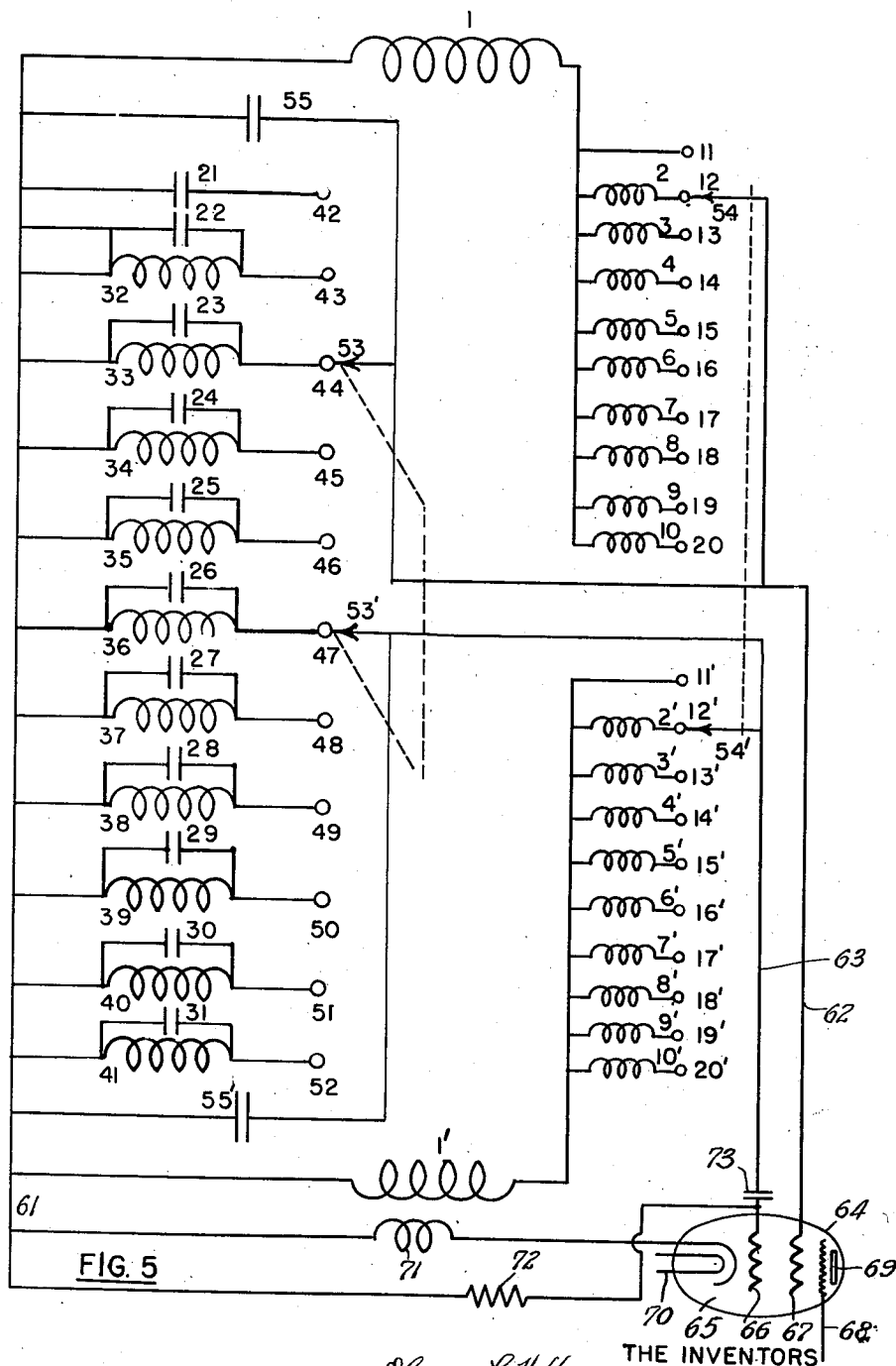
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Filed June 20, 1940

5 Sheets-Sheet 4



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5 Sheets-Sheet 5

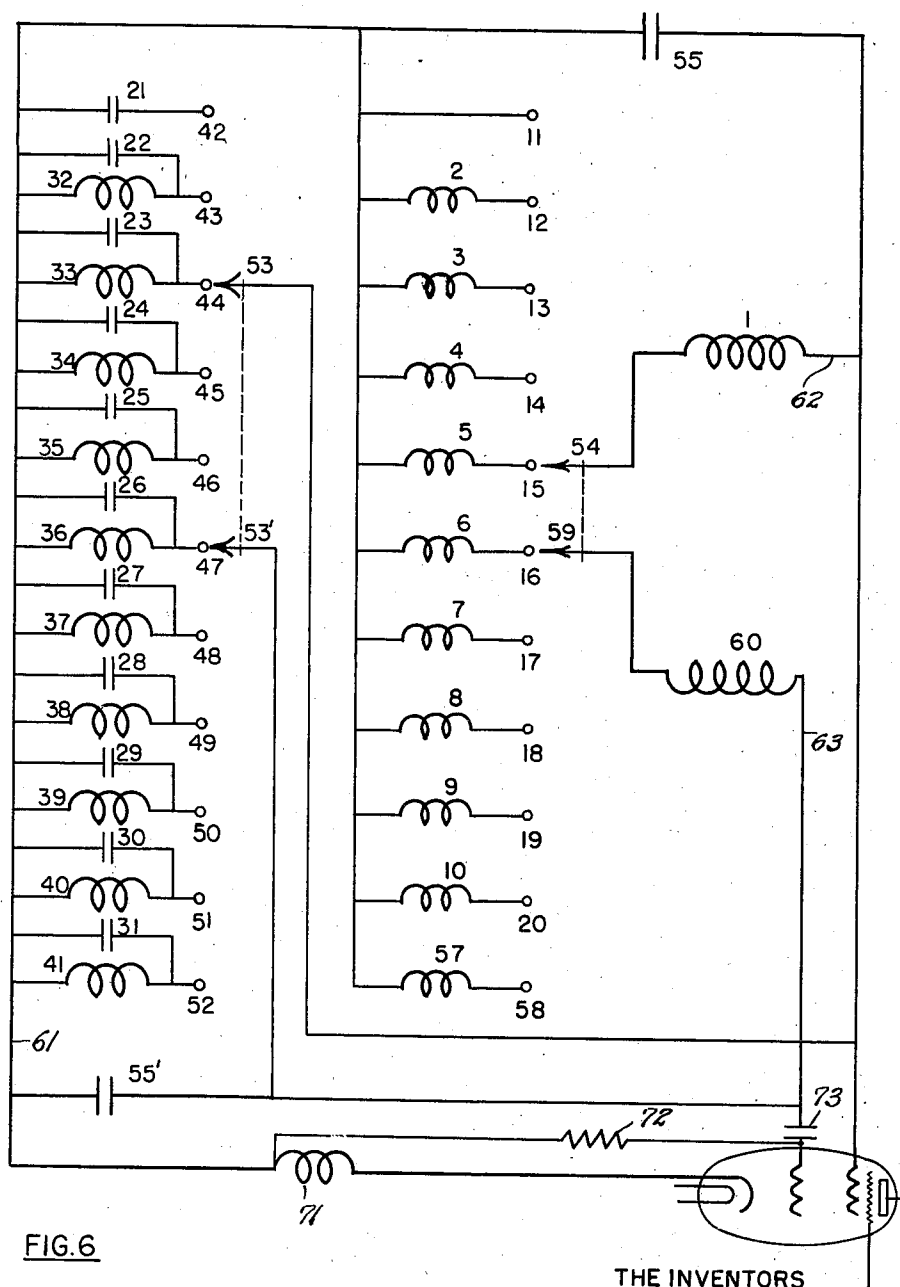


FIG. 6

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2,295,173

STEP-WISE TUNING OF ELECTRICAL CIRCUITS

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Application June 20, 1940, Serial No. 341,418

6 Claims. (Cl. 250—40)

This invention relates to the step-wise or decrement method of tuning electrical circuits and it is particularly concerned with the methods applicable to radio receiving circuits and circuits of similar devices.

At the present time the greater percentage of programs presented on the radio for entertainment purposes are broadcast on frequencies in one band. Stations in this band, known as the broadcast band, are assigned to frequencies which are evenly divisible by ten. Consequently, stations broadcasting on adjacent channels within this band are separated from each other by ten kilocycles.

In an attempt to provide a simpler means for selecting stations in this band which is less critical than the common tuning means, industry has provided preferred station selectors. By means of these devices, a limited number of channels to which they have been previously adjusted may be selected. In addition to this limitation, such devices are subject to inaccurate tuning, especially in view of the wide adjustment variation required by the various component parts in order to cover the entire band. Still further objections have been raised to the pre-setting adjustment which must be made by the owner of the receiver or by one more skilled in the art.

In view of these facts, there has been a constant search for devices which are free from the above limitations, by means of which tuning to the desired channel may be easily and accurately accomplished and adjustment between these channels or to side bands thereof is made difficult or impossible.

It is the primary object of this invention to provide a step-wise tuning means which can be constructed economically, which is accurate and simple to operate, which is free from the well known limitations of so called preferred station selectors, and which is less critical to adjust than common tuning devices.

A further object of this invention is a method of incorporating this step-wise tuning means in a superheterodyne type of receiver in a manner such that the various component parts will be employed alternately for both the oscillator and signal circuit, thereby reducing the required number of parts to a minimum.

Other objects of this invention will be obvious to persons skilled in the art upon an understanding of the embodiment thereof herein described or illustrated.

It is to be understood that the forms of this

invention herein given are for illustrative purposes for demonstrating the principle and mode of operation, and are not to be construed as unnecessarily limiting the scope of this invention as defined in the claims.

In order to demonstrate an embodiment of the principles herein described and to further simplify the descriptive material, six figures are given:

Fig. 1 is a schematic diagram showing one form of the invention as applied to a single tuning circuit;

Fig. 2 is a schematic diagram showing a modified form of circuit shown in Fig. 1;

Fig. 3 is a schematic diagram showing a further modification;

Fig. 4 is a schematic diagram showing one form of the basic circuit employed in this invention; and

Figs. 5 and 6 are schematic diagrams showing a form of this invention as incorporated in a superheterodyne circuit.

Basically, all electric tuning circuits consist of an inductance L, a capacitance C, and a resistance R. The value of R is usually kept small so that the resonance frequency of the tuned circuit does not differ within practical limits from that given in the defining equation:

$$(2\pi f)^2 = 1/LC \text{----- I}$$

The difference between all tuning circuits is to be found in the manner in which the size of the reactive constants of L and C are varied to bring the circuit to resonance. Some devices provide for the mechanical shifting of elements of a constantly variable reactor. Others electrically switch into or out of the circuit reactive components which have been previously adjusted.

In actual practice it makes little difference whether the value of L or C is altered to obtain the desired effect. However, certain practical advantages are to be found in one method over the other. Certain problems arise when precise tuning in steps of ten k. c. is attempted. These difficulties may be seen at once by a study of the equations formed by taking the first derivative of I with respect to L as in II or with respect to C as in III.

$$2df/f = -dL/L \text{----- II}$$

$$2df/f = -dC/C \text{----- III}$$

It will be noted from these equations that the percentage of shift in frequency is proportional to the percent of change of reactive element. Equal increments of reactive element cannot be arranged to cause proportionally equal changes

of frequency. Various circuits have been devised wherein substantially equal increments of frequency can be obtained. Up to this time few of these devices have been practical.

For the purpose of providing a mathematical analysis of this invention and furthermore to demonstrate a simple method for its operation, the desired band of frequencies is divided up into groups each having a predetermined number of channels. In the United States since the channels are ten k. c. wide, it is convenient to place ten of them in a group. In addition, greater simplification will result in dividing this band according to the plan suggested in table A. The tables referred to throughout the specification will be found at the end thereof. In table A adjacent figures in horizontal rows differ by ten k. c. or the width of one channel. Adjacent figures in vertical columns represent a difference of one hundred k. c. Table A discloses all the frequencies that the present embodiment of the device will tune to and actually shows all the combinations obtainable by the two controls suggested. This table includes all channels to which stations are assigned in the broadcast band. Thus, it is convenient to have a tuning device whereby the desired channel may be selected by two adjustments; a coarse adjustment and a fine adjustment within said coarse adjustment. To simplify the calculations, a table B of circuit constants has been compiled. Table B shows the circuit constants for frequencies shown in table A.

Fig. 1 shows a schematic diagram of the step-wise tuning circuit. It consists of an inductor 1 which by means of contacts 11 to 20, and contactor 54, may be connected directly across capacitor 55 or may be connected in series with any of the inductors 2 to 10. This series combination made up of inductor 1 and inductors 2 to 10, is always in shunted relationship to capacitor 55. The adjustment which may be made by contactor 54, contacts 11 to 20 and the associated equipment, constitute the fine step adjustments by means of which the coarse steps made by contactor 53, contacts 42 to 52 and the associated equipment, are subdivided into substantially equal steps of ten k. c. Connected to contacts 42 to 52 are capacitors 21 to 31, each of which, except for 21, is shunted with one of the inductors 32 to 41. The values of these inductors and capacitors are chosen so that when they are placed in shunt with capacitor 55 and neighboring equipment they will alter the resonating characteristics of the circuit in substantially equal steps of 100 k. c., and further to so alter the resonance characteristics of the circuit that each of these coarse steps will be subdivided in steps substantially equal to ten k. c. Thus, by independent switching of the contactors 53 and 54 the resonance characteristics of the circuit may be shifted in steps substantially equal to ten k. c. throughout the entire band.

Calculations for the various circuit components have been made so that when contactor 53 makes with contact 42, the circuit will resonate at a frequency between 500 and 590 k. c., depending upon the position of contactor 54 in relationship to contacts 11 to 20.

An inductance to shunt capacitor 21 has been omitted for reasons of economy. It is apparent, therefore, that a value of the inductor 1 must be chosen in such relationship to capacitors 55 and 21, that when it is placed in series with in-

ductance 3, for example, the circuit will resonate at 570 k. c.; when placed in series with 8, at 530 k. c. Likewise, when contactor 54 makes with contact 11, and no inductor is included in the circuit between 54 and connection 56, the circuit will resonate at 590 k. c.

If an inductance is included in the branch containing contact 11 then the value of inductance 1 must be reduced and inductors 2 to 10 increased by an equivalent amount. It is also possible to remove either capacitor 31 or 55 from the circuit with the proper alteration of the sizes of the various remaining capacitors. Furthermore, inductor 1 may be eliminated from the circuit by the addition of sufficient inductance to each branch circuit including contacts 11 to 20.

For reasons obvious to persons skilled in the art, precise tuning cannot be obtained for all frequencies. Certain choices must be made in order to obtain the minimum deviation from the desired frequency. These deviations from the ideal will be given in table C.

In order to keep these deviations to a minimum, certain choices may be made in the method of making the calculations. The calculations will be started from the 520 k. c. point instead of the 590 k. c. point, where only one inductor is in the circuit. We will assume the inductance made up of 1 and 8 to be 300 microhenries. The choice of this value is quite arbitrary but a value should be chosen so as to maintain a consistently good L/C ratio throughout the entire band. There are no other rules governing the choice of this value, but the practical limitations set upon the remaining parts will aid in making the choice. Having this value, the inductance at 570 k. c. made up of 1 and 3 may be calculated by using Equation IV, wherein 1_{c_a} is the circuit constant at 570 k. c. 1_{c_b} is the circuit constant at 520 k. c., L is the value of the inductance at 520 k. c. and L_a is the value to be determined.

$$L_a = 1_{c_b} L / 1_{c_a} \text{-----IV}$$

The value thus computed for L_a is 249.66 mh. having these two inductance values, the size of the various shunting inductors (L_s) 32 to 41 may be calculated by Equation V.

$$L_s = L_a L (1_{c_b} - 1_{c_a}) / (L 1_{c_a} - L_a 1_{c_b}) \text{-----V}$$

In this equation 1_{c_a} represents the circuit constant at the frequency in k. c. in the desired coarse step, whose ten's column bear the number two, e. g. 620. 1_{c_b} the circuit constant for the frequency within the same coarse step, whose ten's column bears the number 7, e. g. 670. The values for L_s , thus obtained being the values of 32 to 41 in microhenries are:

32=1487.94	37=236.39
33= 744.47	38=212.70
34= 496.36	39=186.03
35= 372.26	40=165.49
36= 297.70	41=148.88

The values of the shunting condensers (C_s) 55+21 may now be computed from Equation VI.

$$C_s = 1_{c_a} (L_s + L) / L_s L \text{-----VI}$$

Where the value of 1_{c_a} are as defined above, the size of these capacitors in micromicrofarads are:

21+55=312.28	27+55=152.74
22+55=263.94	28+55=136.74
23+55=228.51	29+55=126.57
24+55=201.47	30+55=117.78
25+55=180.15	31+55=110.19
26+55=162.94	

The remaining values of the fine step inductors 2 to 10, plus the inductor 1 are calculated at 1000 to 1090 k. c., since this represents most nearly the middle of the band. In the equation, the value of the fine step inductor in question and the inductance 1, will be represented by L_c ; the circuit constant for the frequency in question as $1c$.

$$Lc = 1cL_s / (L_s C_s - 1c) \text{----- VII}$$

The various values for the circuit constant between 1000 and 1090 can be obtained from table II, the value for C_s is capacitor 25 plus capacitor 55. L_s is inductor 35. It is therefore only necessary to substitute these values into the above Equation VII to obtain the values for the inductance. These values in microhenries are:

1+0=233.47	1+6=278.34
1+2=241.33	1+7=288.59
1+3=249.66	1+8=300.00
1+4=258.50	1+9=312.24
1+5=267.90	1+10=325.98

However, according to Fig. 1, the fine step inductor for the 90 k. c. step equals zero, hence the value of inductor 1 is 233.47 mh. Subtracting this value from the others above, we have in microhenries:

2= 7.86	7=55.12
3=16.19	8=66.53
4=25.03	9=78.77
5=34.43	10=92.51
6=44.87	

The values calculated according to the above reasoning have been substituted into equations from which the resulting resonating frequencies have been computed for the entire band. The difference between these frequencies and the desired or ideal frequency is listed in table C, and this table shows the amount of frequency variation in cycles per second from the ideal value shown in table A through the use of components having values suggested in the specification.

Basically all circuits are made up according to the circuit suggested in Fig. 4. They consist of an inductor, a portion of which is adjustable in defined steps through the range of 0 to 92.51 mh.—a second shunting inductor variable in definite steps between infinity and 148.88 mh. and a capacitor which is variable in defined steps between 110.19 to 312.28 mmfds. It is obvious, therefore, that the fine step inductors may be arranged as a sectionalized inductance (Fig. 2). In this fashion, the inductance given would not represent the individual inductances, but the value from a common end to a tap on the inductor. It is further obvious that the coarse step inductor may be constructed as a sectionalized inductor as in Fig. 3.

The various components as calculated and assembled in Fig. 1, 2 or 3 may be employed in tuning a single circuit. In the case of receivers which require two or more variable circuits attuned to the same frequency, a complete duplication of parts is necessary. In superheterodyne receivers, such duplication is avoided through the proper choice of the intermediate or difference frequency which makes possible a unique method of obtaining this frequency.

As it is well known, the most simple type of superheterodyne receiver now used in standard practice for reception in the broadcast band, requires two tuning circuits. The resonating frequencies of these two circuits differ constantly

by an amount equal to the intermediate frequency. In such circuits it is possible to employ certain of the reactive components alternately for the signal and oscillator circuits throughout the band of selectable frequencies. Furthermore, certain advantages are to be found in reducing the required oscillator range. For example, the oscillator during the higher frequency portion of the band may be made to operate at a lower frequency than the selected signal. In the lower frequency portion, the oscillator may be made to operate at a higher frequency than the selected signal. Thus, by means of the proper intermediate frequency, the oscillator range may be made approximately equal to one-half the signal frequency range.

In the circuit shown in Fig. 5, the intermediate frequency was chosen as 300 k. c. In this circuit the switching combinations are such that the oscillator frequency differs from the resonating frequency of the signal circuit by that amount. For the range between 500 to 990 k. c., the oscillator covers the range of 800 to 1290 k. c. In the range from 1100 to 1590, the oscillator range extends from 700 to 1290 k. c. In superheterodyne receivers, of the single band type, the oscillator frequency is more critical than the resonance frequency of the signal selecting circuit. It is possible to receive a signal without an appreciable loss of quality if the selecting circuit is a slight amount off resonance. For this reason, the method of reducing the oscillator range to one-half of the signal selecting range has considerable merit, especially in view of the number of critical components required in this type of device. In using such a system still other advantages may be realized, due to the fact that the oscillator does not cover the entire range and is not required to operate at the higher frequencies, it is less subject to drift than is a conventional type oscillator. In order to have the oscillator operating at its lowest possible frequency in the required range, the choice was made for a range between 700 and 1290 k. c. over a range of 800 to 1390 k. c., which would be equally effective for receivers using 300 k. c. I. F. from the standpoint of receiving signals.

By referring to table C, the reasons for calculating the shunting inductors (32 to 41) at the 30 and 70 k. c. points within the coarse step is obvious for in this way the difference between the desired and the ideal frequency is kept at a minimum. The plus sign indicates that the circuit is attuned to a higher frequency.

For example, in Fig. 5, coil 1 is the antenna inductor and 1' the oscillator inductor. All unprimed numbers from 1 to 20 refer to those components which are to be associated with the antenna circuit, the primed numbers 1' to 20' with the oscillator circuit. Some of the elements 21 to 41 inclusive are used both for the oscillator circuit and the input circuit. Elements 11 to 21 inclusive, 1 and 55 are used for the input circuit only. Elements 11' to 20' inclusive, 1' and 55', are used for the oscillator circuit only. The values of these various parts are identical. In the case of 55 and 55' these two values differ only by the different circuit and distributed capacities in their associated circuits. Capacitors 21 to 31 will likewise differ from the calculated values by the distributed capacities in the associated coil and connective wiring.

For simplicity in illustration, the coarse step contactor 53' is shown in Fig. 5 as operating syn-

chronously with 53. In actual practice these switch parts make the following combinations:

When 53 contacts 42, 53' contacts 45
 When 53 contacts 43, 53' contacts 46
 When 53 contacts 44, 53' contacts 47
 When 53 contacts 45, 53' contacts 48
 When 53 contacts 46, 53' contacts 49
 When 53 contacts 47, 53' contacts 44
 When 53 contacts 48, 53' contacts 45
 When 53 contacts 49, 53' contacts 46
 When 53 contacts 50, 53' contacts 47
 When 53 contacts 51, 53' contacts 48
 When 53 contacts 52, 53' contacts 49

A switch to make such connections may be of various designs which are well known in the art.

An oscillator mixer tube 64 is shown in both Figs. 5 and 6 which is next to be discussed. This tube has a cathode 65, an oscillator grid 66, an input or signal grid 67, an auxiliary grid 68, a plate 69, and a heater 70. Likewise in both of these figures there appears a coil 71 which is a tickler coil for the oscillator coil 18, a grid leak 72 and a grid condenser 73. It is not essential that mixer circuits or tubes of the particular type shown and described be employed in practicing the invention.

In order to reduce the total number of component parts, a modification of the system suggested in Fig. 5 may be made. This modification, an example of which is shown in Fig. 6, consists simply of a method by which most of the fine step inductors are employed for both the oscillator and signal selecting circuits. Referring to Fig. 6, capacitors 55, 55', 21 to 31, inductors 1 to 10 and 32 to 41 are of the same values as those shown in Fig. 5. An inductor 57, a contact 58 and a contactor have been added. The inductors 2' to 10', together with associated contacts and contactor, have been eliminated. Inductor 1' of Fig. 5 is replaced by inductor 60 which is smaller than 1' by an amount of inductance approximately equal to inductor 2. Contactors 54 and 59 are mechanically connected to operate simultaneously in a manner so that they are always connected to adjacent contacts

58, and since the value of inductor 1 is larger than inductor 60 by an amount equal to 2, the inductance between the points 61-62 and 61-63 would be substantially equal, (assuming for the moment that contactors 53 and 53' are disengaged from their respective contacts).

The above condition is similar to that met in Fig. 5. Hence, all the values for the inductors except 57 and 60 may be obtained from calculations heretofore given. Inductors 57 and 60 may likewise be obtained from these calculations by applying the above reasoning.

By calculating the fine steps for the oscillator circuit instead of the signal selecting circuit, the oscillator frequency may be more accurately adjusted to the desired frequency than the signal selecting circuit. The off resonance differences between the signal frequency and the resonance frequency of this circuit are not appreciable.

Although this invention was described in connection with a certain frequency range, the invention is applicable in other bands where stations are assigned to channels of uniform width.

Inasmuch as many changes in values of the various components could be made as well as many different methods of switching and altering the size of the variable components and many different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description, as well as in accompanying figures, shall be interpreted as illustrative and not a limitation of the sense of the invention as defined in the claims.

Table A

Fine steps— Coarse steps	00	10	20	30	40	50	60	70	80	90
5.....	500	510	520	530	540	550	560	570	580	590
6.....	600	610	620	630	640	650	660	670	680	690
7.....	700	710	720	730	740	750	760	770	780	790
8.....	800	810	820	830	840	850	860	870	880	890
9.....	900	910	920	930	940	950	960	970	980	990
10.....	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090
11.....	1100	1110	1120	1130	1140	1150	1160	1170	1180	1190
12.....	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290
13.....	1300	1310	1320	1330	1340	1350	1360	1370	1380	1390
14.....	1400	1410	1420	1430	1440	1450	1460	1470	1480	1490
15.....	1500	1510	1520	1530	1540	1550	1560	1570	1580	1590

Table B

Fine steps— Coarse steps	00	10	20	30	40	50	60	70	80	90
5.....	10132.12	97386.75	93682.64	90175.53	86866.60	83736.50	80772.60	77963.36	75298.10	72767.33
6.....	70361.97	68073.87	65895.66	63819.85	61841.54	59953.33	58150.38	56427.48	54780.06	53203.71
7.....	51694.43	50248.56	48862.48	47532.94	46256.95	45036.14	43854.39	42722.70	41634.28	40586.94
8.....	38578.60	38607.38	37671.47	36769.17	35898.96	35059.23	34248.65	33465.84	32709.58	31978.67
9.....	31271.96	30588.44	29927.10	29286.98	28667.16	28066.80	27485.13	26921.36	26374.73	25844.61
10.....	25330.28	24831.17	24346.30	23876.24	23419.28	22975.31	22543.88	22124.45	21716.65	21320.00
11.....	20934.13	20558.63	20193.15	19837.34	19490.84	19153.34	18824.58	18504.13	18191.83	17887.35
12.....	17590.48	17300.93	17018.48	16742.88	16473.93	16211.38	15955.10	15704.83	15460.39	15221.61
13.....	14988.35	14762.44	14537.58	14319.81	14095.25	13898.67	13695.01	13495.82	13300.94	13110.23
14.....	12923.62	12740.95	12562.13	12387.07	12215.62	12047.70	11883.23	11722.11	11564.23	11409.53
15.....	11257.91	11109.29	10963.60	10820.74	10680.69	10543.31	10408.57	10276.40	10146.73	10019.49

Table C

Fine steps— Coarse steps	00	10	20	30	40	50	60	70	80	90
5.....	+1250	+320	0	-160	-260	-270	-170	0	+250	+570
6.....	+1000	+200	0	-115	-175	-180	-120	0	+160	+400
7.....	+750	+130	0	-75	-150	-150	-70	0	+100	+257
8.....	+550	+75	0	-60	-100	-100	-45	0	+60	+150
9.....	+400	+35	0	-20	-75	-75	-20	0	+50	+50
10.....	0	0	0	0	0	0	0	0	0	0
11.....	-150	-75	0	+30	+80	+80	+30	0	-60	-70
12.....	-200	-100	0	+60	+100	+100	+60	0	-100	-200
13.....	-300	-150	0	+80	+200	+200	+80	0	-150	-300
14.....	-400	-250	0	+100	+250	+250	+100	0	-250	-500
15.....	-500	-350	0	+120	+300	+300	+120	0	-350	-700

in the order shown. Some of the elements 21 to 60 41 are used for both the oscillator and input circuits. Elements 2 to 10 inclusive and 57 are used for the oscillator circuit and elements 2 to 10 inclusive are used for the input circuit. Elements 1 and 55 are used for input and elements 60 and 55' are used for the oscillator.

The coil in the cathode lead is a tickler coil and may be inductively coupled to element 60.

Since the fine step inductance included in the circuit by means of contactor 54 and contacts 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20 is always smaller by an amount of inductance approximately equal to 2 than the fine step inductance included in the circuit by means of contactor 59 and contacts 12, 13, 14, 15, 16, 17, 18, 19, 20 and

We claim:

1. In a single band radio receiver, means for step-wise tuning of electrical circuits at substantially uniform frequency intervals compris-

ing a two branched circuit both branches starting at one common point and terminating at a second common point, one branch being made up of inductance, means for adjusting said inductance in predetermined steps consisting of fine steps, the second branch of said circuit consisting of capacity and inductance, means for adjusting said capacity and said second mentioned inductance in predetermined steps constituting coarse steps, the combined values of the inductance and capacitance in the individual steps of the second branch being selected to divide the band of frequencies into uniform coarse steps and said values being such in relation to the inductance in the first branch that adjustment of the same will divide the coarse steps into substantially equal fine steps.

2. In a single band radio receiver, means for step-wise tuning of electrical circuits at substantially uniform frequency intervals comprising a two branched circuit both branches starting at a common point and terminating at a second common point, one branch being made up of inductance and means for adjusting said inductance in predetermined steps, the effective value of the inductance for the branch for each step being substantially equal to $1cL_s/(L_sC_s-1c)$ in which $1c$ is a circuit constant for the frequency to which the circuit is to resonate, L_s is the value of the inductance in the second branch, C_s is the total value of the capacity in the circuit, the second branch of said circuit consisting of capacity and inductance and means for adjusting the values of said capacity and inductance in relation to each other, the value of the inductance in the second branch being substantially equal to

$$L_a L (1c_b - 1c_a) / (L 1c_a - L_a 1c_b)$$

in which L_a is the value of the inductance in a selected step of the first branch, L is the value of the inductance of a second selected step of the first branch, $1c_a$ is a circuit constant for the frequency desired for the value of L_a in combination with the values L_s and $1c_b$ is a circuit constant for the frequency desired for the value 1 in combination with the value L_s , and the total circuit capacity of the second branch being such as to resonate the entire circuit at the frequency for which $1c$ values were chosen.

3. In a radio receiver, means for step-wise tuning of electrical circuits at substantially uniform frequency intervals in a single band comprising a plurality of inductors of predetermined sizes having one end connected in common relationship to each other and to an additional inductor, a switch means for connecting the circuit to any of the terminal points of said first mentioned inductor thereby rendering the values of inductance taken between the end of the second mentioned inductor and the selecting switch adjustable in predetermined steps constituting fine steps, a plurality of impedances made up of shuntly connected capacitors and inductors, a second switch means for placing into the circuit any of said impedances, the values of said impedances bearing such relationship to one another to subdivide the band into uniform coarse steps of frequencies, said capacitors and said inductors having such relationship to one another and to the first mentioned fine step inductor that said fine steps

in operation therewith subdivide the desired band of frequencies into substantially equal fine step intervals.

4. In a radio receiver, means for step-wise tuning of electrical circuits at substantially uniform frequency intervals in a single band comprising a plurality of inductors of predetermined sizes having one end connected in common relationship to each other and to an additional inductor, a switch means for connecting the circuit to any of the terminal points of said first mentioned inductor thereby rendering the values of inductance taken between the end of the second mentioned inductor and the selecting switch adjustable in predetermined steps constituting fine steps, a capacitor connected between the end of the second mentioned inductor and the selecting switch contactor, a plurality of impedances made up of shuntly connected capacitors and inductors, a second switch means for placing into the circuit any of said impedances, the values of said impedances bearing such relationship to one another to subdivide the band into uniform coarse steps of frequencies, said capacitors and said inductors having such relationship to one another and to the first mentioned fine step inductor that said fine steps in operation therewith subdivide the desired band of frequencies into substantially equal fine step intervals.

5. In a radio receiver, means for the step-wise tuning of electrical circuits at substantially uniform frequency intervals of frequencies in a single band comprising an inductor at least a portion of which is adjustable in predetermined steps constituting the fine steps, a sectionalized inductor and a plurality of capacitors, switching means for simultaneously connecting various sections of said sectionalized inductor in shunted relationship to the inductor and to simultaneously vary certain of said capacitors, said switching arm constituting the coarse step adjustment, said capacitors having such relationship to the sections of said sectionalized inductor and said adjustable inductor that said fine steps will equally subdivide said coarse steps and thereby uniformly subdivide the band of electrical frequencies into substantially uniform fine step intervals.

6. In a radio receiver, a means for the step-wise tuning of electrical circuits at substantially uniform intervals of frequency in a single band, comprising an inductor at least a portion of which is adjustable in predetermined steps constituting the fine steps, a capacitance being connected in shunt to said inductor, a sectionalized inductor and a plurality of capacitors, a switching means for connecting said sections of second inductor in shunted relationship to said first mentioned inductor, first mentioned capacitor, and to the various capacitors of said plurality of capacitors, said switching arrangement constituting the coarse step adjustment and said second capacitors having such a relationship to the sections of said sectionalized inductor and said adjustable inductor that said fine steps will equally subdivide said coarse steps and thereby uniformly subdivide the band of selectable frequencies into substantially uniform fine step intervals.

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