

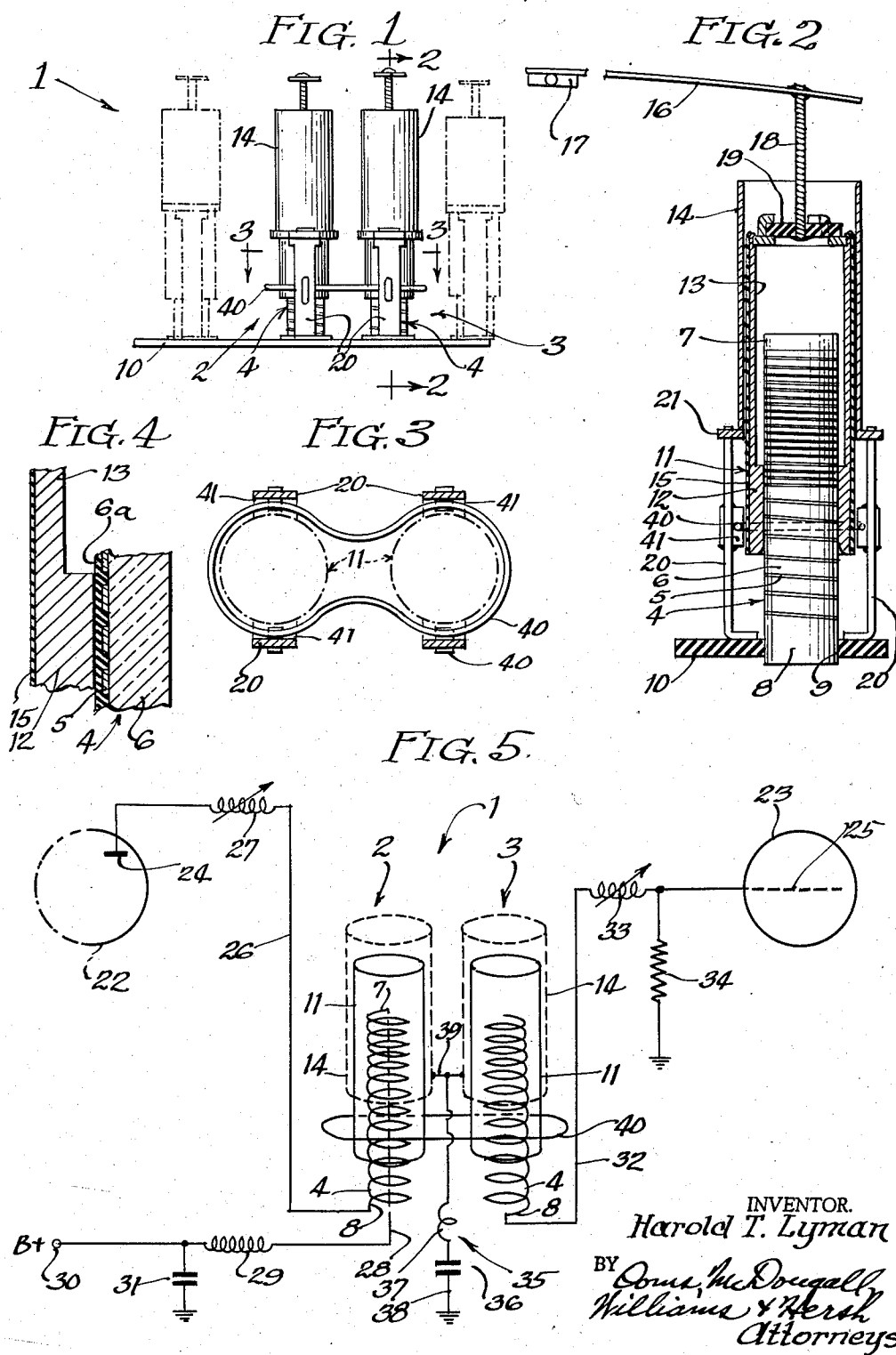
Nov. 17, 1959

H. T. LYMAN

2,913,681

SLEEVE-TUNED BAND-PASS TUNER WITH VARIABLE COUPLING

Filed June 12, 1957



INVENTOR.
Harold T. Lyman
BY *Donna McDougall*
Williams & Hersh
Attorneys

1

2,913,681

SLEEVE-TUNED BAND-PASS TUNER WITH VARIABLE COUPLING

Harold T. Lyman, Milford, Conn., assignor to Aladdin Industries, Incorporated, Nashville, Tenn., a corporation of Illinois

Application June 12, 1957, Serial No. 665,262

5 Claims. (Cl. 333—70)

This invention relates to tuners for use at high radio or television frequencies.

One object of the present invention is to provide a new and improved band-pass tuner which affords substantially uniform band width throughout an extremely wide tuning range.

A further object is to provide a new and improved coupler which is tunable by sleeve means adapted to envelop the coil of the coupler, and which provides for automatic variation of the degree of coupling in response to movement of the sleeve means.

Another object is to provide a new and improved band-pass tuner in which substantially constant band width is achieved over a wide tuning range in a relatively simple, low cost arrangement.

Further objects and advantages of the present invention will appear from the following description, taken with the accompanying drawings, in which:

Fig. 1 is a somewhat diagrammatic elevational view of a tuner to be described as an illustrative embodiment of the present invention.

Fig. 2 is an enlarged longitudinal sectional view of one element of the tuner, taken generally along a line 2—2 in Fig. 1.

Fig. 3 is a somewhat diagrammatic, transverse sectional view, taken along a line 3—3 in Fig. 1.

Fig. 4 is a greatly enlarged fragmentary longitudinal sectional view with parts broken away.

Fig. 5 is a circuit diagram showing one application of the illustrative tuner.

As already indicated, Fig. 1 illustrates a tuner 1, which in this case is adapted to be employed as a tunable band pass coupler at high radio or television frequencies. Thus, for example, the tuner 1 may be employed as a coupling device in a television receiver adapted to cover the VHF (very high frequency) television channels in the band from 54 to 216 megacycles.

Thus, the tuner 1 has two tuned circuits, an input circuit 2 and an output circuit 3. The circuits 2 and 3 are substantially identical, and a single description will serve for both. Thus, each of the tuned circuits 2 and 3 comprises a generally helical inductance coil 4, which in this case, is substantially cylindrical in shape. As shown to best advantage in Figs. 2 and 4, each coil 4 comprises a flat ribbon-like conductor 5 which is suitably formed or mounted on an insulating tubular support or coil form 6. Thus, the coil conductor 5 may be formed on the support 6 by suitable circuit printing techniques. A dielectric coating or covering 6a is applied to the coil 4 to insulate the coil conductor 5, for a purpose to be discussed in detail shortly. It will be noted that the coil conductor 5 varies in width along the length of the coil. Thus, in Fig. 2, the coil conductor 5 is relatively narrow along the upper end of the coil 4, and is relatively wide along the lower end of the coil. The coil 4 has first and second end terminal portions 7 and 8 at the upper and lower ends thereof. Due to the varia-

2

tion in the width of the coil conductor 5, the inductance for unit length of the coil 4 is greater adjacent the end portion 7 than it is adjacent the end portion 8. This is desirable to provide proper spreading of the television band, but is not actually necessary to the present invention, as will appear shortly. The lower end portion 8 of the coil 4 is mounted in an opening 9 formed in an insulating plate or other support 10.

As disclosed and claimed in the copending application of Harold T. Lyman, Serial No. 438,043, filed June 21, 1954, each coil 4 is adapted to be tuned by a sleeve 11 which is slidably received around the coil and is movable over the coil from one end to the other thereof in enveloping relation thereto. Thus, the sleeve 11 is movable over the coil 4 between the upper and lower ends 7 and 8. The effect of the moving sleeve 11 is to vary the effective inductance of the coil 4 between the sleeve 11 and the lower end terminal portion 8. Thus, the sleeve 11 and the coil 4 provide a two-terminal tuned circuit, with the sleeve as one terminal and the end 8 of the coil as the other terminal. It will be understood that the coil 4 is resonated by its own inherent or distributed capacitance, usually augmented by capacitances associated with the circuit connected to the tuner, such circuit capacitances including interelectrode capacitances of vacuum tubes or the like, for example.

The illustrated sleeve 11 has an internally reduced lower or head end portion 12 which is received around the coil 4 in closely fitting slidable relation thereto. Although this closely fitting portion 12 of the sleeve could be in direct conductive engagement with the coil conductor 5, it is more advantageous to provide dielectric means between the sleeve portion 12 and the coil 4, so that the coupling therebetween will be capacitive. In the illustrated embodiment, the insulating coating 6a provides the dielectric between the closely fitting sleeve portion 12 and the coil 4. The provision of this dielectric eliminates electrical noise that might otherwise be produced by the sliding movement of the sleeve 11 along the coil 4.

The illustrated sleeve 11 has an upper or tail end portion 13 which is of substantially greater inside diameter than the head end portion 12 and thus is spaced outwardly from the coil 4 to a substantial extent. The tail end portion 13 encloses or envelops the inactive portion of the coil 4 above the closely fitting sleeve portion 12. It has been found that the stepped construction of the sleeve 11, with the closely fitting head end portion 12 and the outwardly spaced tail portion 13, greatly improves the figure of merit or Q of the coil, as compared with an arrangement employing a tuning sleeve having a single, substantially uniform inside diameter. Thus, the stepped construction localizes the capacitive energy exchange at the closely fitting portion 12 and largely prevents the passage of radio frequency currents along the inactive portion of the coil 4 within the tail portion 13 of the sleeve. The sleeve 11 has the effect of greatly reducing the effective inductance of the inactive portion of the coil 4 within the sleeve, so as to eliminate any troublesome spurious resonances which might otherwise be caused by the inactive coil portion. The tail portion 13 of the sleeve is spaced closely enough to the coil to suppress spurious resonances, while maintaining the Q of the active portion of the coil between the sleeve and the lower end portion 8.

It would be possible to make a circuit connection to the sleeve 11 by various means, such as a flexible conductor, for example, but it is more advantageous to establish capacitive coupling or energy exchange with the sleeve. In the illustrated embodiment, this is brought about by providing a stationary annular coupling electrode

3

or second sleeve 14 around the first sleeve 11. To provide a dielectric between the sleeve 11 and the coupling electrode 14, an insulating coating or covering 15 is provided on the outside of the sleeve 11. The length and position of the coupling sleeve 14 are such that at least a portion of the tuning sleeve 11 is within the coupling sleeve 14 throughout the range of movement of the tuning sleeve 11 along the coil 4. In this case, the coupling sleeve 14 is quite elongated, although it might be relatively short. The coupling sleeve 14 is positioned so that its lower portion is around the upper portion of the coil 4. Even when the tuning sleeve 11 is moved downwardly as far as possible toward the lower end 8 of the coil 4, the upper end of the sleeve 11 is within the coupling sleeve 14. On the other hand, when the tuning sleeve 11 is retracted to the upper end 7 of the coil 4, the lower portion of the sleeve 11 is within the coupling sleeve 14. Thus, substantial capacitive coupling is always produced between the coupling sleeve 14 and the tuning sleeve 11. Various mechanical arrangements may be provided for moving the tuning sleeve 11 along the coil 4. Thus, in the illustrated arrangement, each tuning sleeve 11 is adapted to be operated by an arm 16 mounted on a swingable or rockable member 17 which supports all of the arms 16. A flexible resilient rod-like member 18 is employed to establish a connection between the arm 16 and the sleeve 11. It will be seen that the upper end of the rod 18 is soldered or otherwise connected to the arm 16, while the lower end of the rod 18 is suitably secured to an insulating disk 19 mounted on the upper end of the tuning sleeve 11.

The illustrated coupling sleeve 14 is supported by a pair of legs 20 extending between the lower end of the sleeve and the insulating plate 10. It will be seen that the legs 20 are connected to an outwardly projecting flange 21 at the lower end of the sleeve 14 and are spaced outwardly a substantial distance from the tuning sleeve 11.

In the illustrated arrangement, the two coils 4 of the input and output tuned circuits 2 and 3 are parallel to each other and are spaced apart a short distance. Thus, inherent inductive and capacitive coupling exists between the two coils. Thus, the tuner 1 may be employed as a tunable band pass coupler, as illustrated by the circuit diagram of Fig. 5. This circuit illustrates an application of the tuner 1 in which the tuner is employed as an interstage coupler in a television receiver or the like. In this case, the tuner 1 provides band pass coupling between the output of a radio frequency amplifier 22 and the input of a superheterodyne mixer 23. It will be seen that the amplifier 22 takes the form of a vacuum tube or an equivalent amplifying device having an output electrode in the form of a plate or anode 24. The mixer 23 likewise comprises a vacuum tube or equivalent device having an input electrode, shown as a control grid 25.

Various circuit connections may be employed to and from the tuner 1. In this case, the two terminals of the input tuned circuit 2 are provided by the end portion 8 of the coil 4, and the coupling sleeve 14, which, in turn, is capacitively coupled to the tuning sleeve 11. The terminal portion 8 of the coil 4 is connected to the plate or output electrode 24 by a lead 26 with a trimming inductance 27 connected in series therewith. The trimmer coil 27 may be variously constructed, but may, for example, take the form of a few turns of wire which may be compressed or stretched to provide a variable trimming inductance. Power supply voltage may be fed to the anode 24 by a lead 28 connected to the upper end 7 of the coil 4 in the tuned circuit 2. The lead 28 may be extended through the inside of the hollow tubular coil form 6 as indicated in Fig. 5. A radio frequency choke coil 29 may be connected between the lead 28 and a power supply terminal 30, which may be bypassed to ground by a capacitor 31.

4

As in the case of the input tuned circuit 2, the two terminals of the output tuned circuit 3 are provided by the end portion 8 of the coil and the coupling sleeve 14. The input electrode 25 of the mixer 23 is connected to the terminal portion 8 of the coil 4 by a lead 32 with a trimmer coil 33 in series therewith. The trimmer coil 33 may be similar to the trimmer coil 27. A return resistor 34 is conventionally connected to provide a direct current path between the grid 25 and ground.

The inherent coupling between the coils 4 of the tuned circuits 2 and 3 may be enhanced by the provision of a coupling circuit 35 between the terminal sleeves 14 of the input and output tuned circuits 2 and 3. In this case, the coupling circuit 35 simply comprises a capacitor 36 and a small inductance 37 which are connected in series between the coupling sleeves 14 and a ground lead 38, the sleeves 14 being connected together by a lead 39. Thus, the capacitor 36 and the inductance 37 are common to the input and output circuits 2 and 3. The values of the capacitance 36 and the inductance 37 may be such as to provide a suitable degree of coupling and a suitable variation in the degree of coupling due to the changing impedance of the elements 36 and 37 with frequency. For example, a value of approximately fifty micro-microfarads has been employed successfully for the capacitor 36. The inductance 37 may consist merely of the inherent inductance of the leads to the capacitor 36, or may be augmented by a coil of a few turns. It is advantageous to proportion the capacitor 36 and the inductance 37 so that the series resonant frequency thereof is somewhat above the highest frequency to be covered.

The inherent coupling between the input and output circuits 2 and 3, and the additional coupling provided by the common coupling circuit 35, do not afford uniform band width throughout the frequency range covered by the tuner 1. Sufficient coupling for the desired band width may be provided in the upper portion of the frequency range, but the coupling will be insufficient to provide similar band width at the lower end of the range. If the circuit 35 is adjusted to provide sufficient coupling at the lower end of the frequency range, the coupling and the band width will be excessive at the upper end of the range.

To provide additional coupling between the tuned circuits 2 and 3 for the lower part of the tuning range, an inductive coupling link 40 is provided around the two coils 4 of the tuned circuits 2 and 3. In this case, the link 40 comprises a single turn of wire, or other conductor, looped around both coils, although the link might have multiple turns. The link 40 is supported by insulating members 41 mounted on the legs 20. It will be seen that the link 40 is spaced outwardly from the coils 4 so as to afford clearance for passage of the tuning sleeves 11. The link 40 is disposed in intermediate relation to the ends 7 and 8 of the coils 4, so that the sleeves 11 will pass into the link 40 at an intermediate point in the range of movement of the sleeves.

When the sleeves 11 are withdrawn from the link 40, the coils 4 will be tuned to the lower portion of the frequency range. This portion may correspond to the lower portion of the VHF television band, comprising channels 2-6. For this lower portion of the frequency range, the link 40 provides additional coupling between the coils 4 of the tuned circuits 2 and 3, so as to afford adequate coupling and suitably wide band width.

When the sleeves 11 are moved over the coil so as to enter the link 40, the coils will be tuned to the upper portion of the frequency range, which may correspond to the upper portion of the VHF television band, comprising channels 7-13. With the sleeves 11 within the link 40, the sleeves shade the link from the coils 4 with the result that the inductive coupling action of the link is largely nullified. Thus, the degree of coupling between the tuned circuits 2 and 3 is reduced when the sleeves

5

enter the link in tuning the coils toward the upper portion of the frequency range. In this way, excessive band width in the upper end of the range is avoided.

The link 40 also acts as a pair of interconnected electrodes to provide additional capacitive coupling between the coils 4 of the tuned circuits 2 and 3 for the lower portion of the frequency range. This capacitive coupling is also largely nullified when the sleeves 11 enter the link, because of the relatively low impedance between the sleeves and ground.

Thus, the co-operative arrangement of the link and the tuning sleeves is such that the degree of coupling between the tuned circuits is automatically varied by the movement of the sleeves, to provide substantially uniform band width throughout the tuning range. This highly advantageous result is achieved with a minimum of complexity, and at extremely low cost.

Various modifications, alternative constructions and equivalents may be employed without departing from the true spirit and scope of the invention as exemplified in the foregoing description and defined in the following claims.

I claim:

1. In a tuner, the combination comprising first and second similar generally helical coils disposed in generally parallel spaced-apart relation, first and second conductive tuning sleeves movable telescopically over said respective first and second coils from one end thereof toward the opposite end thereof for varying the effective inductance of each of said coils between the corresponding sleeve and said opposite end of said coil, each of said sleeves having an internally reduced end portion received over the corresponding coil in closely fitting slidable relation thereto, each of said coils having a dielectric covering thereon to provide for capacitive coupling between said coil and the corresponding sleeve, each of said sleeves having a portion stepped outwardly internally from the corresponding coil and extending longitudinally from said internally reduced end portion of said sleeve, first and second annular coupling electrodes disposed around said respective first and second sleeves with dielectric means between each of said electrodes and the corresponding sleeve to provide for capacitive coupling therebetween, at least a portion of each of said sleeves being within the corresponding electrode throughout the range of movement of said sleeve, an input terminal connected to said opposite end of said first coil, an output terminal connected to said opposite end of said second coil, a common return input and output terminal, a conductor connected between said first and second coupling electrodes, an inductor and a capacitor connected in series between said conductor and said return terminal, and a continuous inductive link coil looped around both of said first and second coils to establish inductive coupling therebetween, said link coil being disposed along said first and second coils at an intermediate point between the ends thereof and being spaced outwardly from said coils to afford passage for said sleeves through said link coil, said sleeves upon passing through said link coil being effective substantially to nullify the inductive coupling action thereof.

2. In a tuner, the combination comprising first and second generally helical coils having first and second ends, first and second conductive tuning sleeves received around said respective coils and movable telescopically therealong in enveloping relation thereto between said first and second ends for varying the effective inductance of each of said coils between the second end thereof and the corresponding sleeve, an input terminal connected to said second end of said first coil, an output terminal connected to said second end of said second coil, a common return input and output terminal, coupling means interconnecting said sleeves and including common coupling impedance means mutually connecting said sleeves to said return terminal to establish coupling between said coils

6

for all positions of said sleeves, and a link coil looped in common around said first and second coils intermediate the ends thereof and spaced outwardly therefrom for receiving said sleeves, said link coil affording inductive coupling between said first and second coils, said sleeves being movable into said link coil at an intermediate point in the range of movement of said sleeves and thereupon being effective largely to nullify the inductive coupling action of said link coil.

3. In a tuner, the combination comprising first and second generally helical coils having first and second ends, first and second conductive tuning sleeves movable telescopically over said respective first and second coils between said ends thereof for varying the effective inductance of each of said coils between the corresponding sleeve and said second end of said coil, dielectric means between each of said coils and the corresponding sleeve to provide for capacitive coupling therebetween, first and second coupling electrodes disposed adjacent said respective first and second sleeves with dielectric means between each of said electrodes and the corresponding sleeve to provide for capacitive coupling therebetween, at least a portion of each of said sleeves being opposite the corresponding electrode throughout the range of movement of said sleeve, an input terminal connected to said second end of said first coil, an output terminal connected to said second end of said second coil, a common return input and output terminal, a conductor connected between said first and second coupling electrodes, a capacitor connected between said conductor and said return terminal to provide coupling between said coils for all positions of said sleeves, and a continuous inductive link coil looped around both of said first and second coils to establish inductive coupling therebetween, said link coil being disposed along said coils at an intermediate point between the ends thereof and being spaced outwardly from said coils to afford passage for said sleeves through said link coil, said sleeves upon passing through said link coil being effective substantially to reduce the inductive coupling action thereof.

4. In a tuner, the combination comprising first and second generally helical coils having first and second ends, first and second conductive tuning sleeves movable telescopically over said respective first and second coils between said ends thereof for varying the effective inductance of each of said coils between the corresponding sleeve and said second end of said coil, dielectric means between each of said coils and the corresponding sleeve to provide for capacitive coupling therebetween, first and second coupling electrodes disposed adjacent said respective first and second sleeves with dielectric means between each of said electrodes and the corresponding sleeve to provide for capacitive coupling therebetween, at least a portion of each of said sleeves being opposite the corresponding electrode throughout the range of movement of said sleeve, an input terminal connected to said second end of said first coil, an output terminal connected to said second end of said second coil, a common return input and output terminal, coupling impedance means mutually interconnecting said common terminal and said coupling electrodes to provide coupling between said coils for all positions of said sleeves, and a coupling element adjacent both of said first and second coils to establish coupling therebetween, said coupling element being disposed along said coils at an intermediate point between the ends thereof and being spaced outwardly from said coils to afford passage for said sleeves between said element and said coils, said sleeves upon passing therebetween being effective substantially to reduce the coupling action of said element.

5. In a tuner, the combination comprising first and second generally helical coils having first and second ends, first and second conductive tuning sleeves movable telescopically over said respective first and second coils between said ends thereof for varying the effective in-

7

ductance of each of said coils between the corresponding sleeve and said second end of said coil, dielectric means between each of said coils and the corresponding sleeve to provide for capacitive coupling therebetween, first and second coupling electrodes disposed adjacent said respective first and second sleeves with dielectric means between each of said electrodes and the corresponding sleeve to provide for capacitive coupling therebetween, at least a portion of each of said sleeves being opposite the corresponding electrode throughout the range of movement of said sleeve, an input terminal connected to said second end of said first coil, an output terminal connected to said second end of said second coil, a common return input and output terminal, coupling impedance means mutually interconnecting said coupling electrodes and said common terminal to provide coupling between said coils for all positions of said sleeves, and a continuous inductive link coil looped around both of said first and second coils to establish inductive coupling therebetween, said link coil being disposed along said first and second coils at an in-

8

intermediate point between the ends thereof and being spaced outwardly from said first and second coils to afford passage for said sleeves through said link coil, said sleeves upon passing through said link coil being effective substantially to reduce the inductive coupling action thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

1,798,012	Cohen et al. -----	Mar. 24, 1931
2,250,366	Frisbee -----	July 22, 1941
2,477,693	Guanella -----	Aug. 2, 1949
2,511,185	Ware -----	June 13, 1950
2,641,708	Carlson -----	June 9, 1953
2,645,718	Keizer -----	July 14, 1953
2,753,530	Horvath -----	July 3, 1956
2,786,945	Lyman -----	Mar. 26, 1957

OTHER REFERENCES

Radiotron Designer's Handbook, by Langford-Smith, 4th ed., pub. by Wireless Press, page 418.