April 28, 1925. 1,535,189

R. E. THOMPSON

RADIO COMMUNICATION APPARATUS

Filed March 7, 1919 6 Sheets-Sheet 1

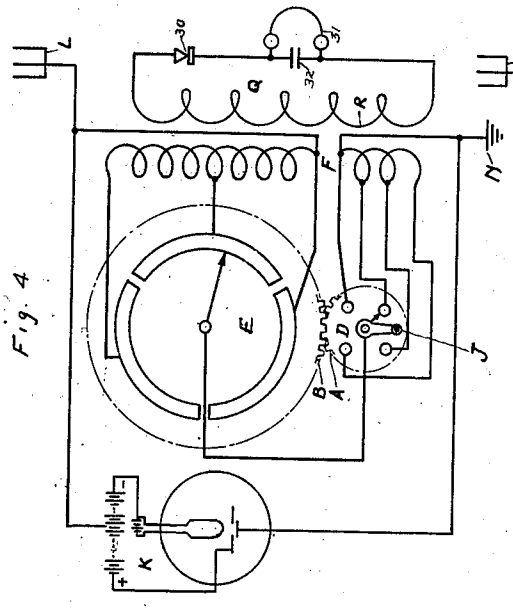


Fig. 4

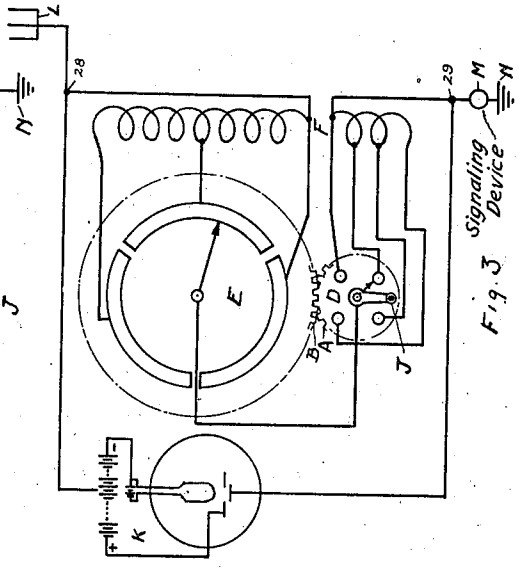


Fig. 3

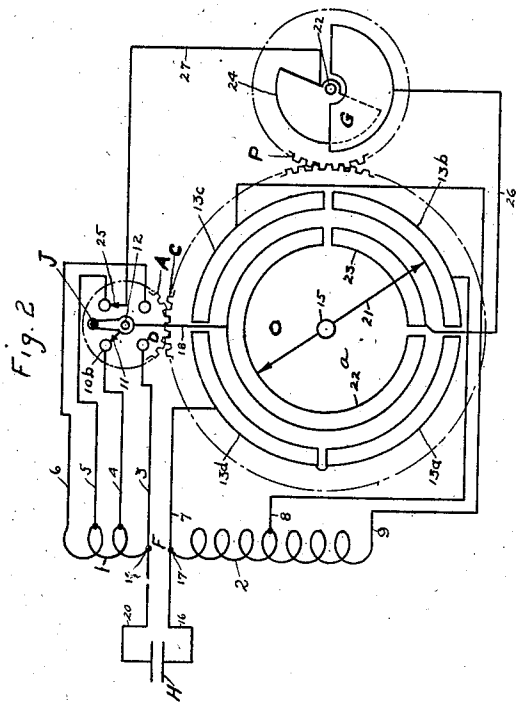


Fig. 2

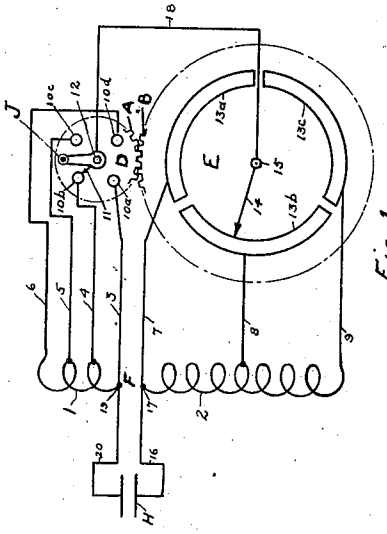


Fig. 1

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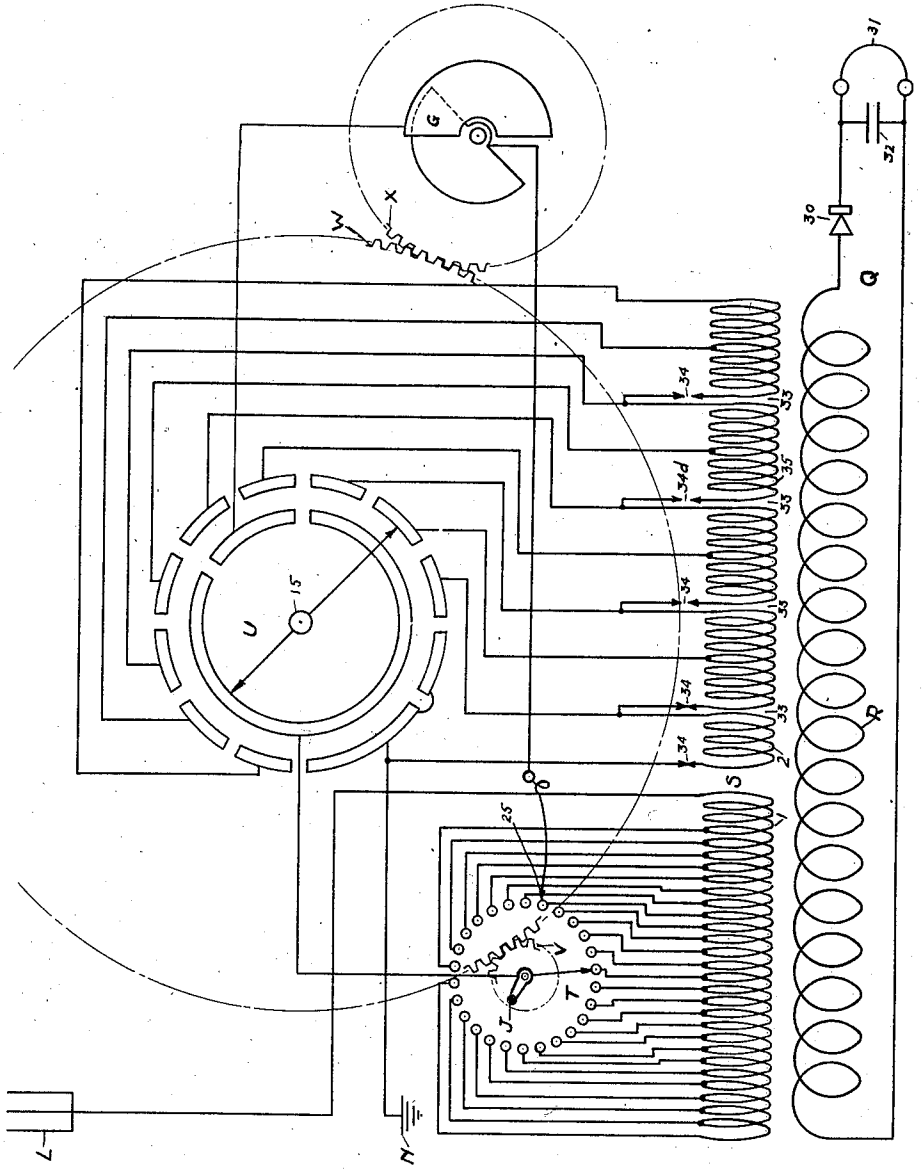


Fig. 5

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Filed March 7, 1919 6 Sheets-Sheet 3

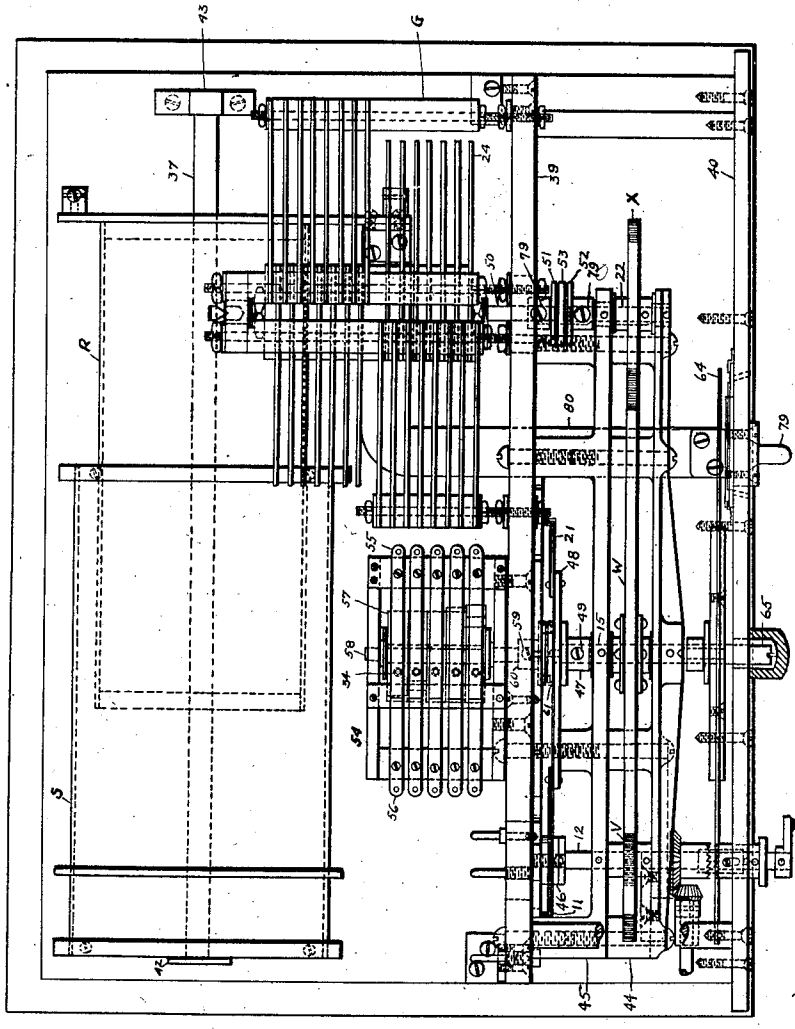


Fig. 6

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RADIO COMMUNICATION APPARATUS

Filed March 7, 1919 6 Sheets-Sheet 4

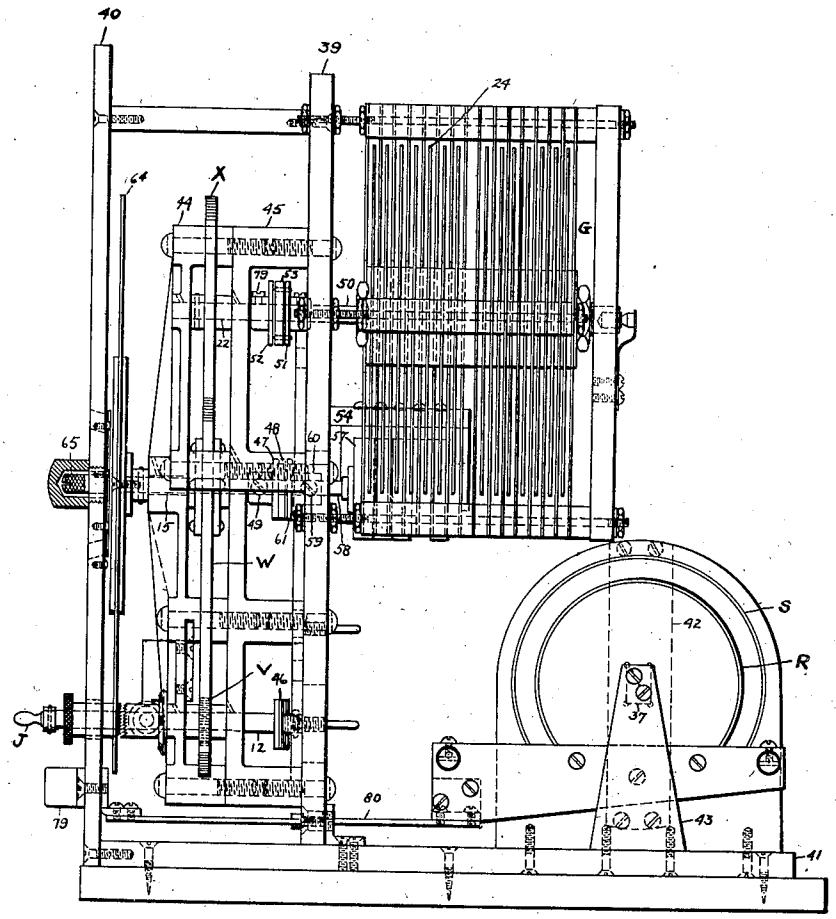


Fig. 7

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RADIO COMMUNICATION APPARATUS

Filed March 7, 1919 6 Sheets-Sheet 5

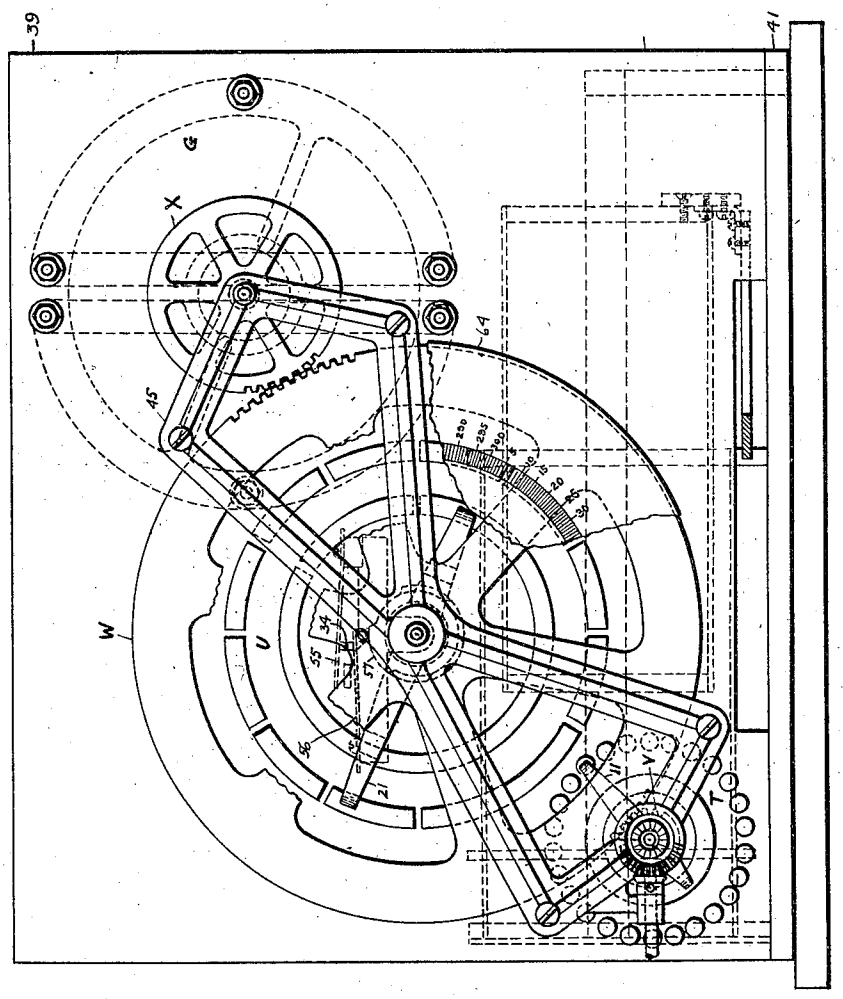


Fig. 8

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April 28, 1925. 1,535,189

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RADIO COMMUNICATION APPARATUS

Filed March 7, 1919 6 Sheets-Sheet 6

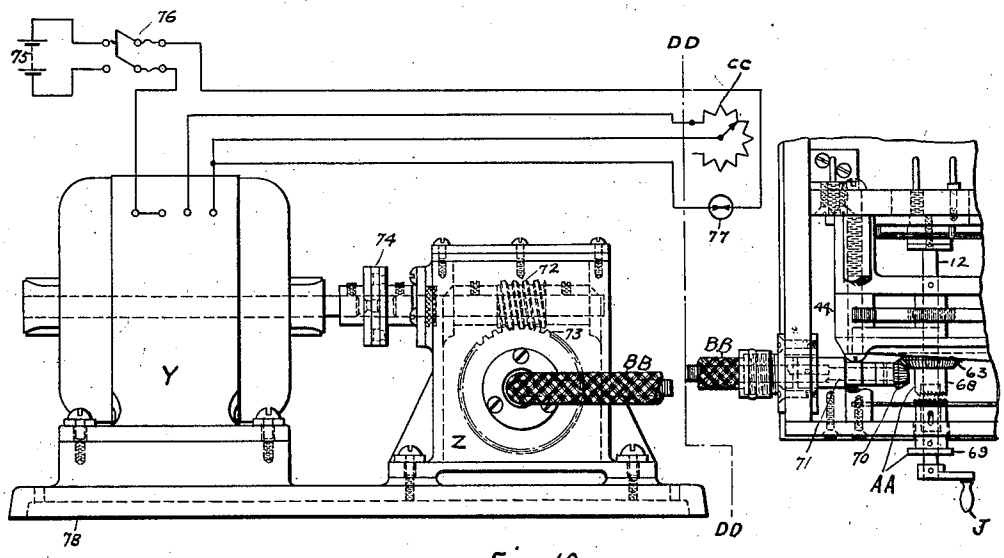


Fig. 10

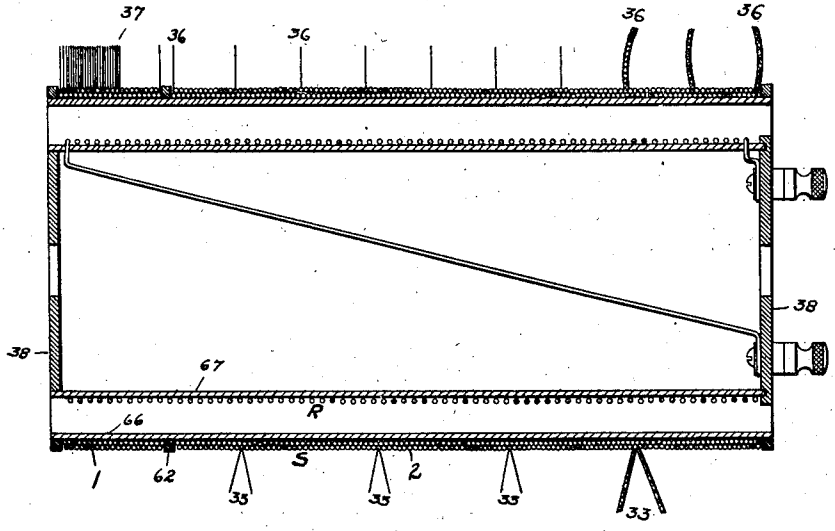


Fig. 9

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BY Roy E. Thompson
Philip Farnsworth
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Patented Apr. 28, 1925. 1,535,189

UNITED STATES PATENT OFFICE.

ROY E. THOMPSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO WIRELESS IMPROVEMENT COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW YORK.

RADIO COMMUNICATION APPARATUS.

Application filed March 7, 1919. Serial No. 281,113.

To all whom it may concern:

Be it known that I, ROY E. THOMPSON, a citizen of the United States, residing in the city of New York, borough of Manhattan, county and State of New York, have invented new and useful Radio Communication Apparatus, the principles of which are set forth in the following description and accompanying drawings, wherein is disclosed the form of the invention which I now consider to be the best of the various forms in which said principles of the invention may be embodied.

My invention relates to improvements in electrical circuits or systems, for example, such as are employed in radio communication; and the same has for its object more particularly to provide a simple, efficient and reliable system which may be readily tuned.

Further, said invention has for its object to provide a system of the character specified which may be tuned by a single operation without coupling affecting the efficiency of said operation and requiring adjusting.

Further, said invention has for its object to provide a system of the character specified in which the tuning elements thereof are disposed therein in non-coupled relation to each other to permit of the joint operation of said elements to tune the system without coupling affecting said operation and requiring adjustment.

Further, said invention has for its object to provide a system of the character specified in which one of a pair of coupled circuits thereof is constructed to be substantially non-cumulative and efficiently operative to receive without tuning adjustment therein oscillations from the other of said circuits over a range of wave-lengths, and in which the tuning elements of the system are disposed in the said other of the coupled circuits, and are interconnected to permit of the actuation thereof by a single operation to tune the system.

Further, said invention has for its object to provide a system of the character specified in which the tuning elements thereof are interconnected to permit of the operation thereof at will by hand or motor to tune said system over a range of wave-lengths.

Further, said invention has for its object to provide a system of the character specified in which the tuning elements thereof are rendered successively effective in the system to vary the wave length over a wide range by a single operation.

Further, said invention has for its object to provide a system of the character specified including a variable inductance for the longer wave lengths of a range of wave lengths and a variable condenser for the shorter wave lengths of said range, in which said inductance and said condenser are rendered successively effective in said system to vary the wave length thereof by the continuous operation of a single control or instrumentality.

Other objects will in part be obvious and in part be pointed out hereinafter.

To the attainment of the aforesaid objects and ends, my invention consists in the novel details of construction, and in the combination, connection and arrangement of parts hereinafter more fully described and then pointed out in the claims.

In the accompanying drawings forming part of this specification, wherein like numerals of reference indicate like parts,

Fig. 1 represents diagrammatically, a means for continuously and continually varying the inductance of an electrical circuit.

Fig. 2 represents diagrammatically, a means for continuously varying the inductance of an electrical circuit over a certain period of time, then continuously varying the capacity of the circuit over another period of time, and continually repeating this cycle of continuous variation of inductance and of capacity.

Fig. 3 represents diagrammatically the application of arrangement of Fig. 1 to a transmitter of radio signals.

Fig. 4 represents diagrammatically the application of the arrangement of Fig. 1 to a combined generator and receiver of radio signals, the generator acting as a source of energy for receiving incoming signals by the well known heterodyne or "beat" method.

Fig. 5 represents diagrammatically the application of the arrangement of Fig. 2 to a receiver of radio signals and is the wiring diagram of a receiver suitable for general commercial purposes in radio communication.

Figs. 6, 7, 8, 9, and 10 represent a receiver for use in radio communication and designed to physically embody various diagrammatic disclosures of Figs. 1–5.

Referring to Fig. 1, F is an inductance coil broken into two adjacent sections, 1 and 2. Section 1 is provided with taps 3, 4, 5 and 6, the number of turns included between taps being one. Section 2 is provided with taps 7, 8, 9 and contains between taps four turns, which is equivalent in turns to all the turns in section 1 plus the turns included between two adjacent taps of section 1. D is a switch for bringing into circuit any tap of section 1. The switch has four contact points 10, the number of contact points being sufficient to connect to all taps of section 1, including the initial and final taps. 11 is the contact arm of switch D and is fixed on a shaft 12. E is a switch for bringing into circuit any tap of section 2. The switch has three contact segments 13, the number of segments being sufficient to connect to all taps of section 2, including the initial and final taps. 14 is the contact arm of switch E and is fixed to a shaft 15. Shafts 12 and 15 are mechanically connected by gears A and B, the gears having a ratio of one to three, three being the number of segments of switch E. J is a crank attached to shaft 12 for producing continuous rotation of switch arm 11 and consequently of switch arm 14 thru the action of the gears A and B. H is a condenser connected in series with as much of inductance coil F as happens to be tapped in at any time. With the gears A and B as described, contact arm 11 makes a complete revolution clockwise during the time that the contact arm 14 completes its travel over one segment counter-clockwise. Switch arm 14 must be set on shaft 15 in such angular position that it will always start its travel over a segment of switch E just when switch arm 11 of switch D starts its cycle of rotation, i. e., when switch arm 11 starts traveling over contact point 10^a which is connected to the initial tap 3 of section 1 of coil F. When switch arm 11 completes its travel over contact 10^d which is connected to the last tap of section 1, it begins its cycle over again, passing on to switch contact point 10^a, and when switch arm 14 has passed over segment 13^c, which is the final tap of section 2, it begins its cycle of operation over again, passing on to segment 13^a which is the initial tap of section 2. The electrical circuit for the position of the switches, as shown in Fig. 1 follows: Condenser H connecting wire 16, initial point 17 of section 2 of inductance coil F, tap 8, segment 13^b, switch arm 14, connecting wire 18, switch arm 11, switch point 10^b, tap 4, section 1 of inductance coil F, initial point 19 of section 1, connecting wire 20, back to condenser H.

Referring to Fig. 2, inductance F, condenser H switch D and crank J are parts similar to corresponding parts in Fig. 1. G is a rotary variable plate condenser, the rotary plates 24 of which are mechanically connected to shaft 22. O is a switch for doing two things. During a period of time it connects successively with the taps on section 2 of inductance F, and during a subsequent period of time it brings condenser G into circuit. The former occurs when switch arm 21 is in contact with switch segments 13^a, 13^b or 13^c, and the latter when it is in contact with segment 13^d. Segment 22^a is a common segment for connecting with segments 13^a, 13^b and 13^c which tap off from section 2 of inductance F. Segment 23 in conjunction with segment 13^d brings condenser G into circuit. The number of segments of switch O and the angles subtended by each are determined in the following way. One segment 13^d and its corresponding connecting segment 23 are used for bringing condenser G into circuit, and the fraction of a circle which segment 13^d is to occupy is determined by the length of the time condenser G is to be in circuit as compared with the entire time required for a complete cycle of variation of both inductance and capacity. In addition to the condenser segment 13^d, there is one segment for each tap of section 2, including the initial and final tap, and the fraction of a circle which each takes up is the angular space unoccupied by the condenser segment divided by the number of inductance taps. Switch arm 21 is fixed to shaft 15. Shaft 12, shaft 15 and shaft 22 are mechanically connected by gears A, C and P. The ratio of the gears is determined in the following way. Switch arm 11 must make a complete revolution while switch arm 21 travels over one inductance tap segment. The rotary plates 24 of condenser G must make one-half revolution, while switch arm 21 travels over condenser segment 13^d. For the specific case shown in Fig. 2 the ratio of gears A, C and P is one to four to two. Connected with one set of plates of condenser G is plug 25 for connecting with any tap of section 1, the tap to be determined by the quantity of fixed inductance desired in circuit during that part of the cycle of operation in which the capacity of the circuit is being varied. For the position of the moving parts as shown in Fig. 2, that part of the cycle of operation in which the inductance F is varied is taking place, and the electrical circuit is as follows: Condenser H, connecting wire

16, initial point 17 of section 2, tap 8, segment 13^b, switch arm 21, segment 22^a, connecting wire 18, switch arm 11, contact point 10^b, tap 4 section 1, initial point 19 of section 1, connecting wire 20, back to condenser H. If the moving parts were in such position that switch arm 21 were connecting segments 13^d and 23, (the moving parts other than switch arm 21 being as shown in the figure), the electrical circuit would then be condenser H, connecting wire 16, connecting wire 7, segment 13^d, switch arm 21, segment 23, connecting wire 26, thru condenser G, connecting wire 27, plug 25, tap 5, section 1, initial point 19 of section 1, connecting wire 20 back to condenser H.

Referring to Fig. 3; inductance F, switch D, switch E, gear A, gear B and crank J are parts similar to corresponding parts in Fig. 1. L is an antenna, M is a signaling device such as a telephone microphone or a telegraph key, and N is the ground. K is a means of producing high frequency oscillations of a frequency determined by the constants in the circuit in which it is placed. In this case it is the well known evacuated bulb type, commonly known as the oscillion, pliotron, dynatron or the like, and is placed across the antenna end 28 and the ground end 29 of inductance F. Fig. 3 is the exact counterpart of Fig. 1, except that condenser H has been replaced by the capacity of antenna L to the ground N, with the addition of the signalling device M and the source of energy K.

Referring to Fig. 4, this duplicates all parts shown in Fig. 3, except the signaling device M which is omitted. In addition, Fig. 4 contains a secondary circuit Q which may be of the type shown in my U. S. Patent, No. 1,328,932, filed August 21, 1917. This circuit Q consists of inductance coil R of negligibly small distributed capacity, detector 30 which in this case is shown diagrammatically, telephones 31 and bridging condenser 32. The incoming signal comes down aerial L thru inductance coil F to ground N. The local source of energy K impresses on the same circuit a frequency just slightly different from the incoming frequency, heterodyning the incoming frequency which is then received in the secondary circuit Q.

Referring to Fig. 5, aside from the secondary circuit Q, the rest of the figure has its counterpart in Fig. 2, save that the condenser H of Fig. 2 is replaced in Fig. 5 by the capacity of antenna L to ground N, and inductance coil F of Fig. 2 is replaced by inductance coil S, similar to it, except that it is shown in Fig. 5 with more turns in section 1 and section 2, and section 2 is broken up at points 33 to get rid of the so-called "dead end" effect. Switch D of Fig. 2 is replaced in Fig. 5 by switch T shown with more contact points, viz., twenty-six in number. Switch E of Fig 2 is replaced in Fig. 5 by switch U with more segments, viz., 10 inductance tap segments and one double length condenser segment. Gears A, C and P of Fig. 2 are replaced in Fig. 5 by gears V, W and X, with ratios of one to twelve to four. Operated from shaft 15 is a secondary switching mechanism which closes switch points 34 successively just before that division of section 2 to which the particular point in question is attached, is brought into circuit; thus point 34^d is closed just before division 35 is brought into circuit. Whenever a division of section 2 is in circuit, all of the points 34 preceding that division are closed and all those following are open. The detector circuit Q is a duplicate of detector circuit Q as shown in Fig. 4, in accordance with my said patent.

Referring to Figs. 6, 7, 8, 9 and 10, illustrating radio receiving apparatus termed a "receiver," the parts already described in previous figures are designated with like letters and numbers, and unless such parts contain additional unusual electrical or mechanical features they will not be further described. All of these figures, except Fig. 9 are drawn to approximately the same scale. The overall dimensions of panel 40 are fifteen inches wide, twelve and three-fourths inches high, one-fourth inch thick. All other dimensions can be approximately scaled from these. 39 is an insulating panel which serves as a support for all of the gears, and switching and indicating mechanism and the condenser G. 40 is an insulating panel which forms the front of the receiver and which supports some of the auxiliary parts of the receiver, such as binding posts, etc. 41 is an insulating panel which supports panels 39 and 40, primary coil S, secondary coil R with its accompanying sliding track 37 and sliding track supports 42 and 43. 44 and 45 are castings for supporting the gear and switching mechanisms. Switch arm 11 is mechanically connected to shaft 12, thru insulator 46. Switch arm 21 is mechanically connected with coupling 47 by means of an insulator 48. Coupling 47 is attached to shaft 15 by means of set screw 49, which enables switch arm 21 to be turned on shaft 15 independently of gear W, thus enabling switch arm 21 to be set and locked in proper angular position relative to switch arm 11. Rotary plates 24 of condenser G are attached to shaft 50 which is attached to coupling 51, which in turn is attached to coupling 52 thru an insulator 53, and coupling 52 is attached to shaft 22 by means of set screw 79 which permits of the setting of rotary plates 24 in the proper angular position relative to switch arm 11. 54 is the secondary switching mechanism for making

contact at points 33 of section 2 of inductance S described in Fig. 5. It consists of five single-pole switches 55 and 56, which are made to open or close by action of an insulating cam 57 attached to shaft 58, which is attached by means of set screw 59 to coupling 60. Coupling 60 is attached thru insulator 61 to coupling 47, to which switch arm 21 is also attached but from which it is insulated. Set screw 59 enables switching mechanism 54 to operate in its proper angular relation to switch arm 21. 64 is an indicating card with a fixed reference scale on it. 65 is a bolt for attaching indicating card 64 to shaft 15. The indicating card has a space on it outside of the fixed scale for a second scale to be put on the card after the receiver is installed in conjunction with the antenna with which it is to be used. The receiver is calibrated in connection with a particular antenna, and the second or wave-length scale is then marked on the card. The primary coil S and the secondary coil R are shown in detail in Fig. 9, for it is only by proper construction of these coils to be described that the above described construction of gear and switching mechanism can be applied to a radio receiver in the most practical and efficient manner. Primary coil S of this particular receiver is wound on an insulating form 66 seven and five-eighths inches long by four and one-eighth inches diameter. Section 1 is wound (starting from collar 62) with a double layer banked winding for fifteen turns, and tap 37 is made. Taps are then made every single turn until forty turns are completed, making twenty-five variable turns. Section 2 is wound starting from collar 62, and has a double layer banked winding, and taps are taken every twenty-sixth turn for 9 divisions, making two hundred thirty-four turns in section 2. In addition, the coil is broken at points 33, which occur at the end of the first, third, fifth and seventh divisions. The wire used in both sections 1 and 2 is number eighteen B & S gauge double silk covered copper wire. Secondary coil R is wound on an insulating form 67, seven and five-eighths inches long by three and five-sixteenths inches diameter. It is wound with number eighteen B & S gauge double silk covered copper wire, spaced its own diameter by means of twine (not shown) which is bound between turns. There are seventy turns in the coil. The secondary coil can be slid along its own axis in and out of the primary S by means of handle 79, arm 80 and track 37. The purpose is merely to strengthen or weaken signals, when this is desirable as in the crowded harbors. The mechanism for driving the gears is best seen in Fig. 10. J is a hand crank for driving shaft 12. 63 is a beveled gear attached to 68 which is the rear half of clutch AA. The combination of 63 and 68 can run free on shaft 12. 69 is the other half of clutch AA, and is keyed to shaft 12 so that it can slide along the axis of the shaft but must turn with said shaft 12. A pushing in of clutch-half 69 causes it to engage with 68, so that if 68 is revolving it causes 69 to revolve and hence turns shaft 12 with it. Beveled gear 63 is continually meshed with beveled gear 70 which turns on shaft 71 which is supported by casting 44. The gear ratio of gear 70 to gear 63 is one to two. Shaft 71 is connected with flexible shaft BB, which is driven by worm 72 and gear 73 within gear box Z, the ratio of worm 72 to gear 73 being one to ten. The gears are driven thru coupling 74 by an electric motor Y, the speed of which is eighteen hundred R. P. M. and which is run from current supply 75 thru switch 76 and push button 77. The speed of motor Y is controlled by rheostat CC. With the motor and gears described, shaft 12 turns at the rate of ninety R. P. M. Motor Y and gear box Z are mounted on a common base 78. The dot and dash line DD, DD represents a table edge. The parts to the left are those things which can be placed under the table or at a convenient distance, and the parts to the right are those things which are necessary for control and should be near the operator.

By my invention I am able continuously and uniformly to vary the wave-lengths and therefore the "tune" of a receiving antenna circuit thru its entire range over and over again by the manual or mechanical turning of a single control. In this manner a radio operator may literally "sweep the ether" for radio signals which may be transmitted on any known wave-length, and he may immediately stop at the "tune" upon which he hears a signal which he desires to receive. The same is true of a transmitting station equipped with my improved device. Signals of wave-length continually changing from the shortest to the longest generally used may be sent out for the purpose of attracting the attention of other stations having ordinary receivers or having receivers embodying my said invention. By my said invention the unskilled operator may adjust for the transmission or reception of any wave-length or tune which he may do slowly or quickly and to any extent by the manual operation of the uni-control, or he may cause his apparatus to travel automatically over and over its entire range.

With my apparatus or system the operator may send or receive all wave-lengths or tunes when and so long as this is desirable and he may instantly stop at any desired tune and exclude all others when this latter is desirable. The advantages will be apparent to those familiar with the radio art.

The feature shown in Figs. 6, 7 and 8

which permits of the adjustment of the relative position of the detector coil, or as it is generally known "the variable coupling" is not essential or even desirable in a device embodying my invention and is shown herein merely because it is a part of the particular receiver to which I have applied my invention in the apparatus used herein as illustrating same.

It is desirable that there be no necessity for varying the coupling between the antenna and detector coils in such receivers as my invention may be applied to, and Fig. 9 illustrates an antenna coil and a detector coil so proportioned as to diameter, length and distribution of wire that highly efficient transfer of energy from antenna coils S to detector coil R and thence to detector and indicating device is accomplished at all wave-lengths when the antenna coil is varied from its minimum to its maximum inductance, without changing the fixed position of coil R or any of the constants in circuit therewith. The antenna coil S is designed when connected with an antenna having approximately 1000 micro farads capacity to give the antenna circuit a range of from 300 to 3500 meters, and the detector coil R will transfer the energy at any of these wave-lengths with substantially equal and maximum efficiency. Coils for accomplishing this result for any range of wave-lengths in the antenna circuit may be designed or worked out by referring to the information given in the specifications forming part of my said Patent 1,328,933, filed August 21, 1917.

The "dead end" cut out switches 56—57 of Fig. 6 for opening the coil S at the points 34 in Fig. 5 do not form any essential part of my invention—these switches being commonly used in many known receivers and being shown and described here only because they happen to be attached to the particular receiver—a description of which is being used herein to illustrate one specific application of my invention.

It will be obvious to any one skilled in the art that many variations in the mechanical or electrical construction of apparatus embodying the uni-control features of my invention may be worked out without departing from the scope thereof.

Other useful purposes to which my invention may be put will occur to one from time to time as for instance in synchronous radio telegraphy where both transmitter and receiver may have their wave-lengths constantly varied but still be kept substantially in tune by driving their respective uni-control shafts at substantially the same average speed.

Another very desirable use to which my invention may be put is made possible by the uni-control feature when used in connection with the motor driving device shown in Fig. 10 and described hereinbefore. This motor device will permit an operator to "listen in" in effect upon all wave lengths. In the embodiment of my said invention illustrated the entire wave-length range is covered by operation of the motor in about eight seconds, the operation being continuously repeated. A transmitter sending on a wave-length within this range will be quickly noted by the operator using my apparatus at some point during the said period of operation of the same. When the transmitted signal is noted the receiving operator will of course disengage the clutch 69 Fig. 10 stopping immediately at or near the point where the signal is heard and make any backward or forward adjustment necessary to secure the best effect by the manual operation of crank J (Fig. 10). This feature will be found of great importance in that it makes possible the partial or entire removal of the present wave-length restriction imposed by law upon transmitting stations. For instance the act of August 13, 1912, regulating radio communication requires certain stations to send and receive on the normal wave-lengths of 300 and 600 meters to insure the reception of distress signals and to insure the proper handling of commercial business. This regulation causes congestion on these two wave-lengths. My said invention obviates the necessity for such a regulation because the use thereof insures that the signal will be duly received or noted irrespective of the wave-length thereof.

By my invention I therefore hope and expect to make possible the removal of the present national, as well as international restrictions placed upon the use by transmitting stations for general public service of more than two wave-lengths, (one of which two wave-lengths must also under the present law be used for all distress messages or messages relating thereto,) and thru this removal I expect to see the number of messages which may be sent and received simultaneously in the same section or radius, without undue interference, increased at least twofold and probably more than tenfold.

I claim:—

1. A system of the character described comprising an oscillation circuit, a plurality of frequency determining elements therefor, manually operable means mechanically interconnecting said elements to permit of the joint mechanical operation thereof to cause a progressive change in the wave length of said circuit, a motor drive for said means, and means interposed between said manually operable means and said motor drive to permit of the operation at will by the manual or motor driven means.

2. A system of the character described comprising an oscillation circuit, a plurality of elements controlling the frequency of said

circuit, and mechanically and electrically interconnected to permit of the joint mechanical operation thereof to cause a progressive change in the wave length of said circuit, manually operable means for effecting said joint operation, a motor drive for the same, and a clutch arranged to permit of the operation at will by the manual or motor driven means.

3. A system of the character described comprising an oscillation circuit, frequency determining elements therein, rotatable controls for said elements mechanically and electrically interconnected, a rotatable shaft for jointly operating said controls to cause a progressive change in the wave length of said circuit, a gear loosely mounted on said shaft, power driven means permanently meshing with said gear, a member on said shaft for manually rotating the same, and a clutch for connecting said shaft and said gear together to permit of the operation of said shaft by said power driven means.

4. A system of the character described comprising an oscillation circuit, an inductance therein, a variable condenser in said circuit, mechanically and electrically interconnected switches respectively tapped to unit sections of a part of said inductance and to multiple section of another part of said inductance, and coordinated to permit of the cycle of operation of the unit switch to be repeated for each stage of operation of the multiple switch, means actuated jointly with said switches to progressively vary the capacity of said condenser effective in said circuit, and means controlled by the operation of certain of said switches to cut said condenser out of said circuit; all whereby the operation of said system progressively varies the wave length of said circuit over a wide range.

5. A system of the character described comprising an oscillation circuit, a variable inductance for said circuit, a variable condenser for said circuit, means for actuating said inductance and said condenser to vary the wave length of said circuit over a wide range by a single operation, and means operated by said first named means to render said inductance and said condenser successively effective in said circuit to vary the wave length of said circuit over said range.

6. A system of the character described comprising an oscillation circuit, frequency determining elements therefor including a variable inductance and a variable condenser, a control for actuating said elements to vary the wave length of said circuit over a wide range by a single operation, and means operated by said control to render one element ineffective in said circuit to vary the wave length during the effective operation of the other element to vary said wave length.

7. A system of the character described comprising an oscillation circuit, inductances therein to permit of the variation of the wave length of said circuit by small degrees over a part of the range thereof, a variable condenser in said circuit to permit of the progressive variation of the wave length of said circuit over the remaining part of said range, switches controlling said inductances, means mechanically interconnecting said switches and said condenser to permit of the variation of the wave length of said circuit throughout said range by a single operation, and means controlled by certain of said switches to render said inductances and said condenser successively effective in said circuit to vary the wave length thereof.

8. A system of the character described comprising an oscillation circuit, a variable inductance therefor, a variable condenser for said circuit, means mechanically interconnecting said inductance and said condenser to permit of the variation of the wave length of said circuit over a wide range by a single operation, and means controlled by said first named means to disconnect said condenser from the circuit during the effective variation of said inductance in said circuit, and to prevent the variation of said inductance during the effective operation of said condenser to vary the wave length of said circuit.

9. A system of the character described comprising an oscillation circuit, a variable element therein to permit of the variation of the wave length of said circuit by small degrees over a part of the wave length range thereof, a variable element therein to permit of the progressive variation of the wave length of said circuit over the remaining part of said range, means mechanically interconnecting said elements to permit of the variation of said wave length over said range by a single operation, and means operated by said first named means to render one element ineffective in said circuit to vary the wave length during the effective operation of the other element to vary said wave length.

10. A system of the character described comprising an aerial circuit, a plurality of adjustable frequency determining elements therein including relatively movable parts, a single control mechanically interconnecting said several movable parts to permit of the variation of the wave length of said circuit over a range by a single operation, and a secondary circuit coupled to said aerial circuit, and constructed to be substantially non-cumulative and efficiently operative to receive without tuning adjustment therein and at definite coupling the oscillations from said aerial circuit of the several wave lengths of said range.

11. A system of the character described comprising a plurality of circuits, interlinking means connecting said circuits in operative relation; said interlinking means being arranged to permit of the disposition in said circuits of adjustable frequency determining elements in non-coupled relation to each other to vary the wave length for the system as a whole by the joint operation of said elements without coupling affecting the efficiency of said operation and requiring adjustment, a plurality of adjustable frequency determining elements for said circuits including relatively movable parts to permit of the variation of the wave length for the system as a whole by the joint operation of said elements; all of said jointly operable elements being so arranged relatively to said interlinking means as to dispose said elements in non-coupled relation to each other in said circuits to permit of the said joint operation of said elements without coupling affecting the efficiency of said operation and requiring adjustment, and a single control mechanically interconnecting said several movable parts for affecting said joint operation of said elements to vary the wave-length for the system as a whole.

12. A system of the character described comprising an aerial circuit, an adjustable inductance therein, an adjustable condenser in said circuit, a control mechanically interconnecting said inductance and said condenser to permit of the variation of the wave length of said circuit over a wide range by a single operation, means operated by said control to render said inductance and said condenser successively effective in said circuit to vary said wave length, and a secondary circuit coupled to said aerial circuit, and constructed to be substantially non-cumulative and efficiently operative to receive without tuning adjustment therein the oscillations from said aerial circuit of the several wave lengths of said range.

13. A system of the character described comprising an aerial circuit, a plurality of inductances therein to permit of the variation of the wave length of said circuit by small degrees over a part of the range thereof, a variable condenser therein to permit of the progressive variation of the wave length of said circuit over the remaining part of said range, means mechanically interconnecting said inductances and said condenser to permit of the joint mechanical operation thereof to vary the wave length of said circuit over said range by a single operation, means operated by said first named means to render said inductances and said condenser successively effective in said circuit to vary the wave length over said range, and a secondary circuit coupled to said aerial circuit, and constructed to be substantially non-cumulative and efficiently operative to receive without tuning adjustment therein the oscillations from said aerial circuit of the several wave lengths of said range.

14. A system of the character described comprising an oscillation circuit, a variable inductance for said circuit, a variable condenser for said circuit, manually operable means for actuating said inductance and said condenser to vary the wave length of said circuit over a wide range by a single operation, means controlled by said manually operable means to render said inductance and said condenser successively effective in said circuit to vary the said wave length over said range, a motor drive for said manually operable means, and means to permit of the operation at will by the manual or motor driven means.

15. A system of the character described comprising an oscillation circuit, a plurality of variable inductances therein to permit of the variation of the wave length of said circuit by small degrees over a part of the range thereof, a variable condenser therein to permit of the variation of the wave length of said circuit over the remaining part of said range, manually operable rotatable means mechanically interconnecting said inductances and said condenser to permit of the variation of the wave length of said circuit over said range by a single operation, means controlled by said manually operable means to render said inductances and said condenser successively effective in said circuit to vary the said wave length over said range, a motor drive for said manually operable means, and means to permit of the operation at will by the manual or motor driven means.

16. A system of the character described comprising an oscillation circuit, a variable inductance therein, a variable condenser in said circuit, manually operable means for actuating said inductance and said condenser to vary the wave length of said circuit over a wide range by a single operation, means controlled by said manually operable means for disconnecting said condenser from said circuit during the variation of said inductance, a motor drive for said manually operable means, and means to permit of the operation at will by the manual or motor driven means.

17. A system of the character described comprising an aerial circuit, a plurality of frequency determining elements therein having relatively movable parts, manually operable means mechanically interconnecting said several movable parts to permit of the variation of the wave length of said circuit progressively over a range by a single operation, a secondary circuit coupled to said aerial circuit, and constructed to be substan-

tially non-cumulative and efficiently operative to receive without tuning adjustment therein and at definite coupling the oscillations from said aerial circuit of the several wave lengths of said range, a motor drive for said manually operable means, and means to permit of operation at will by the manual or motor driven means.

18. A system of the character described comprising an aerial circuit, a variable inductance therein, a variable condenser therein, manually operable rotatable means mechanically interconnecting said inductance and said condenser to permit of the joint mechanical operation thereof to vary the wave length of said circuit over a wide range, means controlled by said manually operable means to render said inductance and said condenser successively effective in said circuit to vary the wave length over said range, a secondary circuit coupled to said aerial circuit, and constructed to be substantially non-cumulative and efficiently operative to receive without tuning adjustment therein the oscillations from said aerial circuit of the several wave lengths of said range, a motor drive for said manually operable means, and means to permit of the operation at will by the manual or motor driven means.

ROY E. THOMPSON.

Witnesses:
OTTO A. MARTINI,
JULIAN BARTH.