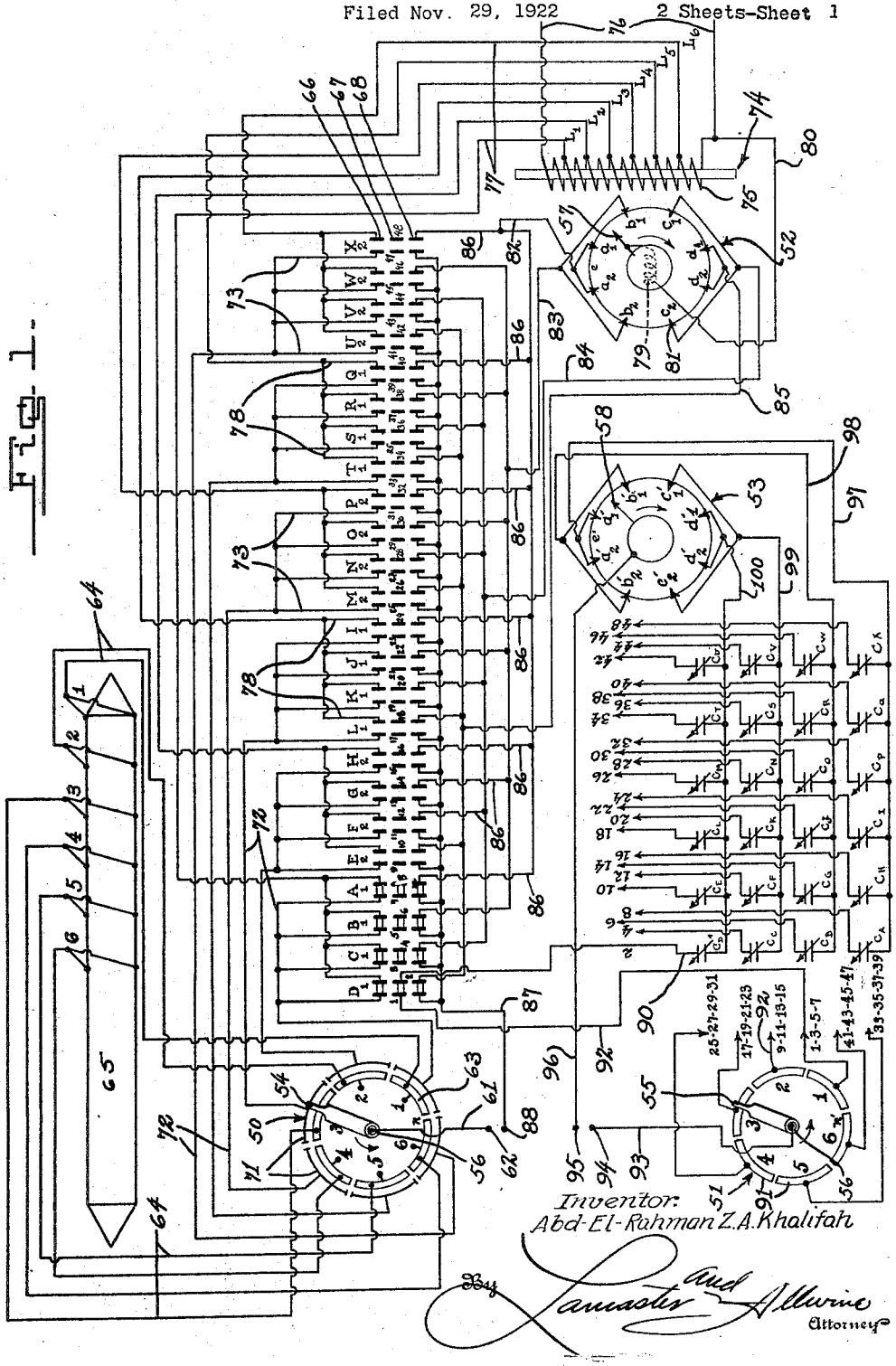
Nov. 29, 1927. 1,650,944

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APPARATUS FOR RADIO TRANSMISSION

Filed Nov. 29, 1922 2 Sheets-Sheet 1

Fig. 1.



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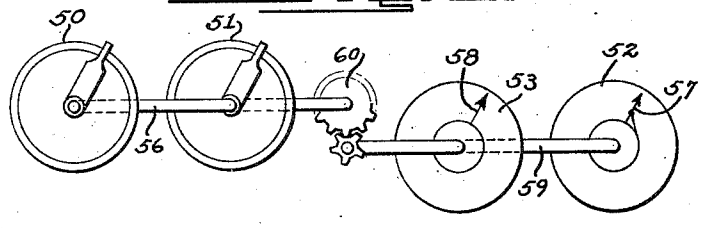
APPARATUS FOR RADIO TRANSMISSION

Filed Nov. 29, 1922 2 Sheets-Sheet 2

Fig. 2.

Position of switches A & B	Aerial point connected	Inductance connected when circuit closes on Switch C	Position of revolving coil on switches C & D		Circuit to be connected through plugs	Capacity	Stations
1	1	L_1	1	a_1	A_1	C_A	A
			2	b_1	B_1	C_B	B
			3	c_1	C_1	C_C	C
			4	d_1	D_1	C_D	D
2	2	L_2	5	d_2	E_2	C_E	E
			6	c_2	F_2	C_F	F
			7	b_2	G_2	C_G	G
			8	a_2	H_2	C_H	H
3	3	L_3	9	a_1	I_1	C_I	I
			10	b_1	J_1	C_J	J
			11	c_1	K_1	C_K	K
			12	d_1	L_1	C_L	L
4	4	L_4	13	d_2	M_2	C_M	M
			14	c_2	N_2	C_N	N
			15	b_2	O_2	C_O	O
			16	a_2	P_2	C_P	P
5	5	L_5	17	a_1	Q_1	C_Q	Q
			18	b_1	R_1	C_R	R
			19	c_1	S_1	C_S	S
			20	d_1	T_1	C_T	T
6	6	L_6	21	d_2	U_2	C_U	U
			22	c_2	V_2	C_V	V
			23	b_2	W_2	C_W	W
			24	a_2	X_2	C_X	X

Fig. 3.



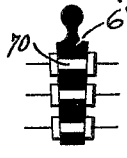


Fig. 4.

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR RADIOTRANSMISSION.

Application filed November 29, 1922. Serial No. 604,105.

The present invention relates to radio apparatus, and aims to provide a multiplex apparatus for the transmission of intelligence (either telegraphically or telephonically) wherein there is provision for multiple inductances and capacities, in order that, when used in a sending station, one or more (up to as many as provision is made for) receiving stations tuned or adjusted for different wave lengths can be simultaneously given the signals, message or other intelligence, the sending or broad-casting apparatus being capable of transmitting the information or intelligence in a number of different wave lengths at the same time; and the apparatus is also useful in a receiving station in order to enable quick tuning to be obtained by the provision of the multiple inductances and capacities, requiring no adjustments other than making circuit connections through a convenient switch board.

There are circumstances which render it highly desirable to enable signals, messages or other intelligence to be transmitted in different wave lengths simultaneously, for which the present apparatus is admirably suited. For example, a ship in distress at sea would be capable of sending out distress signals in a number of different wave lengths in order to assure of the signals or message being picked up by some receiving station, either on the land or other ship, to assure of assistance being received, whereas the sending out of a signal or message in a single wave length might not reach a station although there are receiving stations within range having other wave lengths of adjustment. In this way, by the transmission of a signal or message in a number of different wave lengths, assurance is had of the signal or message reaching any and all stations within range having the given wave lengths of adjustment. The principle is also useful for other purposes, inasmuch as information or entertainment of a public or general nature can be broad-casted in a number of different wave lengths so as to be simultaneously transmitted to receiving stations having different wave lengths, instead of requiring the adjustment of the receiving stations to a given wave length of transmission.

The underlying principle of the present apparatus resides in the inclusion in the sending circuit or device a series of different inductances and corresponding capacities in succession, and with sufficient rapidity or speed so as not to interfere with or break up the telephonic sound waves or telegraphic dots and dashes, whereby the message has each variation or wave thereof split or divided up into a number of different wave lengths so as to be capable of reception by receiving apparati tuned for such different wave lengths.

The apparatus is also of advantage in a receiving set for quick tuning, inasmuch as the different inductances and capacities are ready for instant use, it only being necessary to make suitable circuit connections to bring in the proper inductance and capacity for the particular wave length, instead of requiring careful and patient tuning adjustments.

The invention also involves a novel method of radio transmission in which the same message, signals or intelligence can be transmitted or broad-casted in different wave lengths at the same time.

A further object is the provision of such an apparatus including novel means for bringing into the sending or receiving circuit or device a series of different inductances and corresponding capacities in progressive succession, for the purpose of simultaneous transmission in different wave lengths, or for quick tuning in a receiving set.

With the foregoing and other objects in view, which will be apparent as the invention is more fully understood, the invention resides in the apparatus and method as hereinafter described and claimed, it being understood that changes and alterations can be made in the details of construction and arrangement of the parts, within the scope of what is claimed, without departing from the spirit of the invention.

The invention is illustrated in the accompanying drawings, wherein:

Figure 1 is a diagrammatical view of the apparatus.

Fig. 2 is a chart depicting the successive inductances, capacities and aerial connections in the different positions of the commutators.

Fig. 3 is a diagrammatical view showing the operating means of the commutators for controlling the inductances and capacities.

Fig. 4 is a detail view showing one of the plugs of the switch board.

In the embodiment of the appartus as shown, there is a primary inductance com-

mutator 50, a primary capacity commutator 51, a secondary inductance commutator 52, and a secondary capacity commutator 53, each of which is constructed for making a series of circuit connections in succession. As shown, the commutators 50 and 51 have the respective switch arms or brushes 54 and 55 secured on a shaft 56, while the secondary commutators 52 and 53 have the respective contact arms or brushes 57 and 58 secured on a shaft 59. These shafts 56 and 59 are geared together or operatively connected, as at 60 (see Fig. 3), whereby the secondary commutators are operated in synchronism or timed relation with the primary commutators. In the arrangement as shown, the contact arms of the secondary commutators make three revolutions to a single revolution of the contact arms 54 and 55 of the primary commutators, but the ratio depends on the number of contacts used in the commutators.

A conductor 61 connects the contact arm 54 with a binding post 62, for connecting the primary commutator 50 in the transmitting or receiving circuit or device, and the commutator 50 includes an annular series of contact segments 63 (there being six as shown). Said segments 63 are connected by the respective conductors 64 to the aerial or antenna 65 at different points numbered (from 1 to 6) according to the numbering of the segments 63 as shown, whereby when the contact arm 54 engages the several segments in succession, corresponding aerial connections or changes are obtained in succession, there being six changes in the aerial connections for twenty-four different inductances and corresponding capacities, the apparatus as shown being designed for twenty-four different wave lengths.

A switchboard is provided composed of a series of plug sockets, one for each wave length, so that there are twenty-four of such sockets as shown, which are designated A1, B1, C1, D1, E2, F2, G2, H2, I1, J1, K1, L1, M2, N2, O2, P2, Q1, R1, S1, T1, U2, V2, W2 and X2. Each socket has the pairs of spaced contacts 66, 67 and 68, and a plug 69 in insertable in each socket. The plug is of insulating material and has the bridging rings or portions 70 for bridging or connecting the contacts of the several pairs. These plugs can be readily inserted in the several sockets to make the proper circuit connections for the corresponding inductances and capacities, whereby the different wave lengths are selected by the insertion of the plugs in the corresponding sockets, it thus being possible to select the wave lengths for either sending or receiving messages.

The primary commutator 50 has an annular series of contact segments 71, one for each segment 63, to be engaged in succession by the contact arm 54, and a leader or conductor 72 is connected to each segment 71 to connect the commutator with the plug sockets of the switchboard. Each conductor 72 has branches 73, there being six conductors 72 in the arrangement as shown, and four branches 73 for each conductor, providing twenty-four branches, one for each plug socket. Each branch 73 is connected to one contact 66 of one pair, in order that the segments 71 of the commutator 50 are connected to the corresponding contacts 66 in groups. Thus, contacts 66 of the plug sockets A1, B1, C1 and D1 (first group) are connected to the first segment 71, contacts of the plug sockets E2, F2, G2 and H2 (second group) are connected to the second segment 71, and so on.

The other contacts 66 of the plug sockets are connected in similar groups to the variable inductance device 74, which includes an inductance coil 75 having the terminals 76 for connecting it in the sending or receiving set in the usual manner. The coil 75 has the taps L1, L2, L3, L4, L5, and L6 to which the conductors or leaders 77 are connected, and said conductors have the branches 78, corresponding with the branches 73 of the conductors 72, which are connected to those contacts 66 complementing the contacts of the pairs to which the branches 73 are connected, whereby the insertion of a plug in any socket of one group will connect the corresponding conductors 72 and 77, there being six groups of sockets and six pairs of conductors 72 and 77. In this way, the insertion of a plug in any socket of the first group (A1, B1, C1 and D1) will connect the first segment 71 of the commutator 50 with the first tap L1 of the coil 75, and the insertion of a socket in any one of the second group of sockets will connect the second segment 71 with the second tap L2, and so on.

The inductance device 74 includes a movable coil 79, which is mounted for rotation as shown, and which may be located within or in other inductive relation with the coil 75. As shown, the coil 79 rotates with the contact arm 57 of the secondary inductance commutator 52, and the coil 79 has one terminal connected to the contact arm 57 and its other terminal connected by the conductor or leader 80 with one terminal of the coil 75. The commutator 52 has the annular series of contacts 81 for the successive engagement of the contact arm 57 for connecting the coils 75 and 79 in the circuit in the different angular positions of the coil 79 in succession, the contacts 81 being designated *a*1, *b*1, *c*1, *d*1, *a*2, *b*2, c2 and *d*2.

The contacts of the commutator 52 are connected to contacts 68 of the plug sockets, with the contacts of the commutator connected in pairs, and each pair connected to one contact 68 of each group of plug sockets. Thus, a conductor 82 is connected to the contacts *a*1 and *a*2, a conductor 83 is connected

to the contacts $b1$ and $b2$, a conductor 84 is connected to the contacts $c1$ and $c2$, and a conductor 85 is connected to the contacts $d1$ and $d2$. These conductors 82, 83, 84 and 85 each have six branches 86, one for each group of plug sockets, and the branches of each conductor are connected to one contact 68 of each group of sockets. Thus, the branches of the conductor 82 are connected to one of the contacts 68 of each of the sockets A1, H2, I1, P2, Q1 and X2. The branches of the conductor 83 are connected to one contact 68 of each of the sockets B1, G2, J1, O2, R1 and W2. The branches of the conductor 84 are connected to contacts 68 of the sockets C1, F2, K1, N2, S1 and V2, while the branches of the conductor 85 are connected to the contacts 68 of the sockets D1, E2, L1, M2, T1 and U2. The coil 79 has four inductive positions with reference to the coil 75 determined by the engagement of the arm 57 with either of the contacts $a1$ and $a2$, with either of the contacts $b1$ or $b2$, with either of the contacts $c1$ or $c2$ and with either of the contacts $d1$ and $d2$, and in any inductive position of the coil 79 it is connected with one plug socket of each group, and the coil 79 and arm 57 in moving through one-half of a revolution will result in the coil 79 being connected with all four sockets of each group in succession. Inasmuch as the commutator 52 makes three revolutions for each revolution of the commutator 50, the arm 57 will make one half of a revolution while the arm 54 of the commutator 50 moves through an arc or step equivalent to the length of a segment 63 or 71. Thus, during the engagement of the contact arm 54 with any one segment 71, thereby connecting said contact arm with the plug sockets of one group, the commutator 52 will connect the inductance device with the sockets of such group in succession, as well as with the sockets of the other groups, and with the coil 79 in different inductive positions in succession. The other contacts 68 are all connected to a common conductor 87 leading to a binding post 88 complementing the binding post 62, whereby the multiple or parallel shunt inductance connections can be connected in the sending or receiving circuit as usual. The space between the binding posts 62 and 88 represents a variable inductance controlled by the commutators 50 and 52, which may be connected in the sending or receiving circuit in the usual manner of connecting in the inductance, and the binding post 62 is also used for connecting in the aerial 65 by way of the conductors 64, segments 63, contact arm 54, and conductor 61.

There is one condenser or capacity for each inductance, and with twenty-four plug sockets in the switchboard, there are a similar number of condensers or capacities 90, which are designated C_A, C_B, C_C, C_D, C_E, C_F, C_G, C_H, C_I, C_J, C_K, C_L, C_M, C_N, C_O, C_P, C_Q, C_R, C_S, C_T, C_U, C_V, C_W and C_X. These condensers or capacities are connected in succession with the corresponding plug sockets in a manner similar to the connections of the inductances with the plug sockets, using the contacts 67 of said sockets. The primary capacity commutator 51 has an annular set of contact segments 91, there being six to correspond with the segments of the commutator 50, and the switch arm 55 corresponds in position with the switch arm 54 to engage the segments 91 in succession in synchronism with the commutator 50. Each segment 91 has a conductor 92 connected thereto and the conductor is connected to one contact 67 of each pair of one group of plug sockets, similar to the connection of the conductors 72 with the contacts 66. The capacity connections are not shown as completed with the contacts 67, but are indicated by numerals. The contacts 67 are numbered from 1 to 48, and the conductor 92 of the first segment 91 is connected to the contacts 1, 3, 5 and 7, of the first group, thereby connecting it with one contact 67 of each of the sockets of the first group. Similarly, the conductor 92 of the second segment 91 is connected to the contacts 9, 11, 13 and 15 or to one contact 67 of each of the sockets of the second group, and so on. In other words, the conductors 92 are connected to the contacts 67 in precisely the same manner that the conductors 72 are connected to the contacts 66, the connections of the conductors 92 with the contacts 67 being indicated by numerals, although a complete connection with the plug socket D1 is shown. The contact arm 55 is connected by a conductor 93 with a binding post 94, and a companion binding post 95 is connected by a conductor 96 with the contact arm 58 of the secondary capacity commutator 53. This commutator 53 has the contacts $a'1$, $a'2$, $b'1$, $b'2$, $c'1$, $c'2$, $d'1$ and $d'2$, similar to the contacts of the commutator 52. The contact arm 58 is in the same position as the arm 57 and they rotate one with the other so that the contact engagements of the secondary commutators is the same. A conductor 97 is connected to the pair of contacts $a'1$ and $a'2$, a conductor 98 is connected to the pair of contacts $b'1$ and $b'2$, a conductor 99 is connected to the contacts $c'1$ and $c'2$ and a conductor 100 is connected to the pair of contacts $d'1$ and $d'2$, similar to the connections of the conductors 82, 83, 84 and 85 with the contacts of the commutator 52. The conductors 97, 98, 99 and 100 are connected to the capacities or condensers similar to the connections of the conductors 82, 83, 84 and 85 with the plug sockets. Thus, the conductor 97 is connected to one terminal of each of the capacities C_A, C_H, C_I, C_P, C_Q and C_X of the first row at the bottom. For convenience, the capacities or condensers are shown

in four horizontal rows, six in a row, to correspond with the four capacity positions of the contact arm 58 in each half revolution thereof, with one capacity or condenser in each row for each position of the arm 58. The conductors 98, 99 and 100 are similarly connected to the capacities or condensers of the second, third and fourth rows above, as clearly apparent by reference to Fig. 1. Thus, with the arm 58 engaging either the contact $a'1$ or $a'2$, the conductor 96 is connected to the capacities of the first row, and when the arm 58 engages either the contact $b'1$ and $b'2$ the conductor 96 is connected to the capacities of the second row, and so on. The capacities of each row are connected to one plug socket of each group. Thus, the first group of capacities of the several rows (C_A, B_B, C_C, and C_D) are connected to corresponding contacts 67 of the first group of plug sockets, the capacities C_E, C_F, C_G, and C_H of the second group are connected to contacts 67 of the second group of plug sockets, and so on. More specifically, as indicated by the numerals, the capacities are connected to those contacts 67 with the even numbers running from 2 to 48, while the conductors 92 leading from the commutator 51 are connected to the contacts 67 with the odd numbers. Thus, in each position of the contact arm 55 in engagement with one segment 91, such contact arm is connected to contacts 67 of the corresponding group of plug sockets, and the other contacts 67 of such group are connected to the corresponding group of capacities, one in each row, and such capacities are connected in succession by the commutator 53 with the conductor 96 and binding post 95.

The contact arm 58 makes one-half of a revolution, similar to the contact arm 57, for each step of movement of the arm 55 through an arc corresponding to the length of a segment 91. For example, when the arm 55 engages the first segment 91, the binding post 94 is connected through the arm 55 with the conductor 92 that is connected to the contacts 1, 3, 5 and 7 of the first group of plug sockets, and the other contacts 2, 4, 6 and 8 of said plug sockets are connected to the first capacities of the several rows, and the contact arm 58 in making one-half of a revolution will connect such first capacities of the rows in succession with the binding post 95. When the arm 55 engages the second segment 91, the binding post 94 is connected with the contacts 9, 11, 13 and 15 of the second group of plug sockets, and the other contacts 10, 12, 14 and 16 of said second group of sockets are connected to the corresponding second capacities of the four rows, and said second capacities are connected in succession by the contact arm 58 with the binding post 95. Thus, as the arm 55 moves from one segment to the other, the circuit is made through the groups of plug sockets with the groups of capacities in succession, divided into four rows or series, and the capacities in each group are connected in succession through the commutator 53 with the binding post 95, the arm 58 making one-half of a revolution while the arm 55 engages any one segment 91.

The binding posts 94 and 95 have the variable capacities connected between them in progressive succession through the commutators 51 and 53, and said binding posts are connected in the sending or receiving circuit in the usual manner. The capacities or condensers are adjusted to correspond with the different inductances, simultaneous inductance and capacity connections being made through the primary and secondary commutators.

The successive inductance and capacity changes are indicated in the chart (Fig. 2). Thus, in the first position of the commutators 50 and 51, with the contact arms 54 and 55 starting at n and n', respectively, the arms 54 and 55 engage the first segments 63 and 71 of the commutator 50 and the first segment 91 of the commutator 51, respectively. The first point of the aerial is thus connected in circuit through the first segment 63, and the first segment 71 is connected through the first group of plug sockets (with the plugs in place) to the first tap L1 of the inductance coil 75. Similarly, the arm 55 engaging the first segment 91 will connect said arm 55 through the first segment 91 with the contacts 1, 3, 5 and 7 of the first group of plug sockets, and through the plugs, with the first group of capacities C_A, C_B, C_C and C_D of the four rows or series. Now, with the point of aerial connection at 1 on the aerial and with the connection with the inductance device at the tap L1, starting with the contact arm 57 at e on the commutator 52, while the contact arm 54 is moving along the segments 63 and 71, the arm 57 will engage the contacts $a1$, $b1$, $c1$ and $d1$ in succession. Thus, with the arm 57 engaging the contact $a1$ and the coil 79 in one angular position, the inductance circuit extends from the binding post 62 through the conductor 61, arm 54, first segment 71, first conductor 72, first group of sockets, conductor 77, tap L1, coil 75, conductor 80, coil 79, arm 57, contact $a1$, conductor 82, socket A1 and plug therein, conductor 87 and binding post 88, which is the first inductance. Then, in the second inductance, the arm 57 engages the contact $b1$, and the circuit leads from the coil 79 in a different angular position thereof through contact $b1$, conductor 83, socket B1 and plug therein to the binding post 88. When the arm 57 engages the contact $c1$, the coil 79 is connected, with the same tap connection of the coil 75, in another position of the coil 79, with the socket C1, thereby providing a

third inductance, and when the arm 57 engages the contact $d1$ the connection through the coils 75 and 79, with the coil 79 in still another position, is made with the plug socket D1, thus providing four different inductances in succession for the four plug sockets of the first group, and with the aerial connection at the first point. Four corresponding capacities are brought into the circuit at the same time that the four inductances are established. Thus, with the arm 55 engaging the first segment 91, the binding post 94 is connected through the conductor 93, arm 55, first segment 91 and conductor 92 with the sockets of the first group, and through the plugs in said sockets with the first group of capacities C_A, C_B, C_C and C_D. The arm 58 engages the contact $a'1$ when the arm 57 engages the contact $a1$, said arms 57 and 58 engaging the corresponding contacts simultaneously. Thus, if a plug is in the socket A1, with the arm 58 engaging the contact $a'1$, the circuit includes the binding post 94, conductor 93, arm 55, first segment 91, conductor 92, contact 7 of socket A1, contact 8, first capacity C_A, contact $a'1$, arm 58, conductor 96 and binding post 95. When the arm 58 engages the contact $b'1$ then the second capacity C_B is connected through the plug in the corresponding socket B1. When the arm 58 engages the contact $c'1$ then the third capacity C_C is connected in the circuit, and when the arm engages the contact $d'1$ then the fourth capacity C_D is connected in the circuit. After such four inductances and capacities are established in succession for the first step of the commutators 50 and 51, the arms 54 and 55 pass to the second segments of said commutators. The second point of the aerial is now connected in the circuit through the second segment 63, and the binding post 62 is connected through the arm 54, second segment 63, the second group of plug sockets and plugs therein, and corresponding conductor 77 with the second tap L2 of the coil 75. Thus, in the second position of the commutators 50 and 51 the second point of connection with the aerial is used and the second tap of the coil 75. Also, the arm 55 engaging the second segment 91 of the commutator 51 will connect the binding post 94 with the contacts 9, 11, 13 and 15 of the second group of plug sockets, and through the plugs the connection is made with the second group of capacities C_E, C_F, C_G and C_H.

The operation is repeated for the second group of plug sockets with the second aerial, inductance and capacity connections. When the arm 57 engages the contact $d2$, the inductance circuit includes the binding post 62, conductor 61, arm 54, second segment 71, conductor 72, plug socket E2 and plug therein, conductor 77, tap L2, coil 75, conductor 80, coil 79 in its corresponding angular position, arm 57, contact $d2$, conductor 84, plug socket E2, conductor 87 and binding post 88. When the arm 57 moves into engagement with the contact $c2$, the position of the coil 79 is changed, and the connection is made through the socket F2, the second one of the second group. The connections are made through the other sockets G2 and H2 of the second group when the arm 57 engages the contacts $b2$ and $a2$. At the same time that the second group of inductances are established in succession, the second group of capacities are brought into the circuit in succession. Thus, with the arm 57 engaging the contact $d2$ and the arm 58 engaging the contact $d'2$, the capacity circuit includes the contact 94, conductor 93, arm 55, second segment 91, conductor 92, contact 9 of socket E2, plug in said socket, contact 10, capacity C_E, conductor 100, contact $d'2$, arm 58, conductor 96 and binding post 95. As the arm 58 engages the contacts $c'2$, $b'2$ and $a'2$ the other capacities C_F, C_G and C_H of the second group are connected in the capacity circuit in succession. Thus, as the arms 54 and 55 of the primary commutators advance along the segments the group changes, both in inductances and capacities, are made in succession, and for each group, the secondary commutators 52 and 53 establish the individual inductance and capacity circuit connections in succession for the individual plug sockets of the particular group, so that with a complete revolution of the primary commutators the entire series of inductances and corresponding capacities are established in progressive succession.

The commutators rotate at a high speed, and the velocity must be exceedingly high, especially for telephonic transmission so as not to destroy the continuity of the sound waves or vibrations superimposed on the radio oscillations. With telegraphic transmission the rotation of the commutators can be somewhat slower than with telephonic transmission, although the speed of rotation must be sufficiently high, so that the complete series of inductance and capacity changes is made in a fraction of a telegraphic interruption or interval. That is, for each dot, dash or space of a telegraphic code, the complete series of inductances and capacities must be established at least once, and preferably several times, and the complete series of changes, in inductances and capacities must also be established at least once for each fraction of a sound wave in telephonic transmission. Therefore, the speed of rotation of the commutators must be correspondingly high, depending on the nature of the signals, message or other intelligence being transmitted. Also, by using different velocities of rotation for the commutators in telegraphic and telephonic transmissions, interference between such transmissions is avoided.

When the improvements are used in a sending apparatus, by inserting the plugs in the different sockets of the switchboard, each socket representing a predetermined wave length, the signals or message will be sent out in the corresponding wave lengths, and one or more plugs can be inserted in the sockets. It is thus possible to transmit the same signals or messages in as many different wave lengths as there are plug sockets in the switchboard, or to select such desired wave lengths as within the range of the apparatus. When any one plug is inserted in a socket for a predetermined wave length, the corresponding inductance and capacity connections are made simultaneously through the same plug.

The apparatus is also useful in a receiving set by enabling quick tuning to be obtained, it only being necessary to insert a plug in the sockets in succession, and when the plug is inserted in the socket corresponding with the wave length being transmitted, the tuning is at once established without adjustments of inductance and capacity.

Having thus described the invention, what is claimed as new is:—

1. In a radio apparatus, a variable inductance device, a commutator for making different connections with said device in succession, and a secondary commutator for making different connections with said device in succession for each of the aforesaid connections, said device including a part movable with the secondary commutator for obtaining different inductive relations for the different second named connections.

2. In a radio apparatus, a variable inductance device including a circuit, coils in said circuit and having an inductive relation, means in said circuit for making different connections with one of said coils in succession, the other coil being movable, and means in said circuit movable with the last named coil for making other connections with said coils in succession during each connection made by the first named means.

3. In a radio apparatus, a variable inductance device including a circuit, coils in said circuit and having an inductive relation, a primary commutator in said circuit for making different connections with one coil in succession, and a secondary commutator in said circuit for making different connections in succession with the coils during each connection made by the primary commutator, the other coil of said device being movable with the secondary commutator.

4. In a radio apparatus, a variable inductance device having coils in inductive relation, a primary commutator, a switchboard having pairs of contacts arranged in groups, the commutator having segments each connected to one contact of each pair of one group, the other contacts of the several groups being connected to different points of one of said coils, and a secondary commutator for connecting said coils in a circuit in connection with the primary commutator, the secondary commutator having contacts, the switchboard having other pairs of contacts arranged in groups similar to the aforesaid contacts, each of the contacts of the secondary commutator being connected to one contact of one pair of each of the last named groups, and the secondary commutator being operated to make a series of changes in circuit connections for each connection through the primary commutator.

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