Oct. 31, 1950 H. A. WHEELER 2,527,664

WAVE SIGNAL TRANSLATING SYSTEM FOR SELECTED BAND OF WAVE SIGNAL FREQUENCIES

Filed Nov. 8, 1945

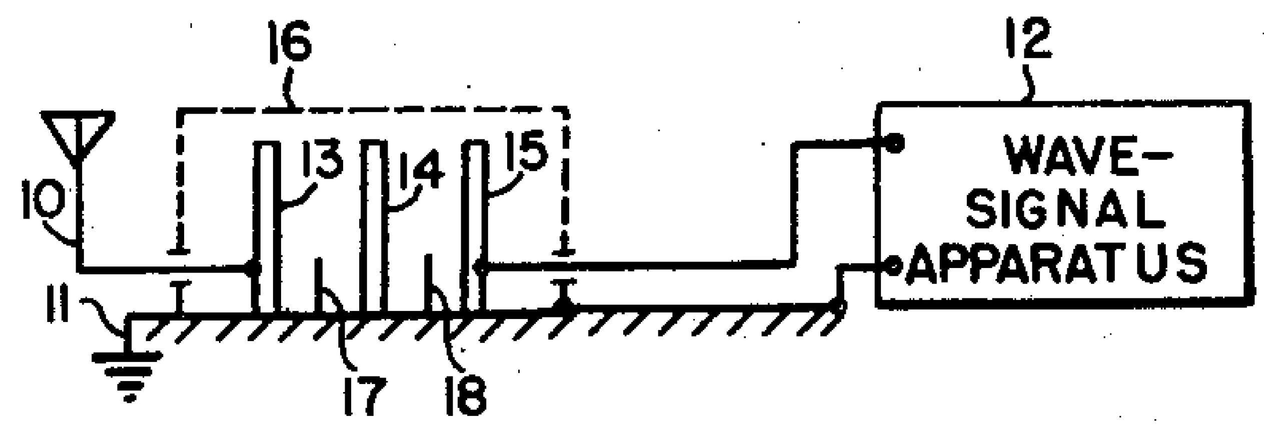

FIG. 1

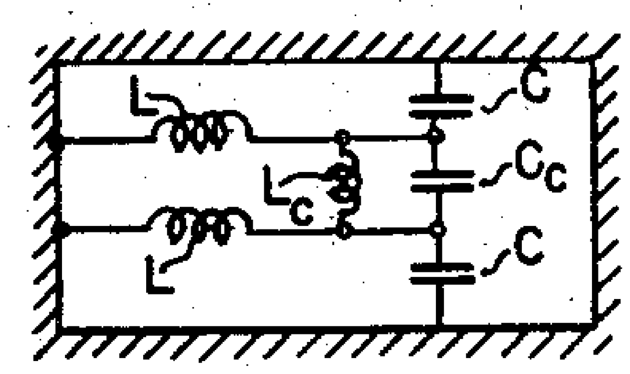

FIG. 1a

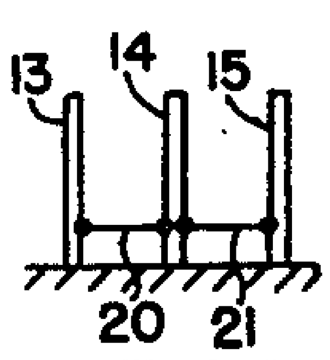

FIG. 2

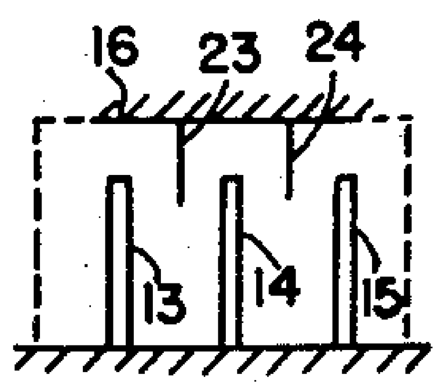

FIG. 3

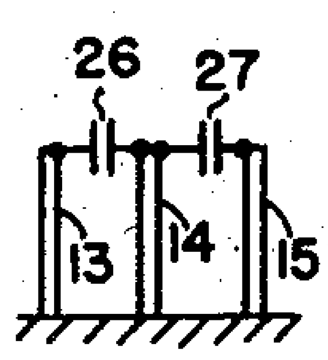

FIG. 4

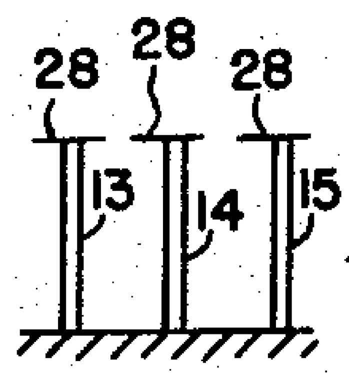

FIG. 5

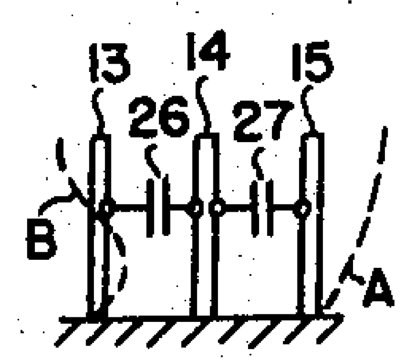

FIG. 6

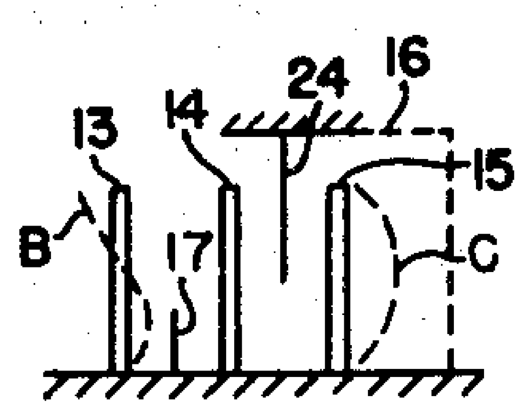

FIG. 7

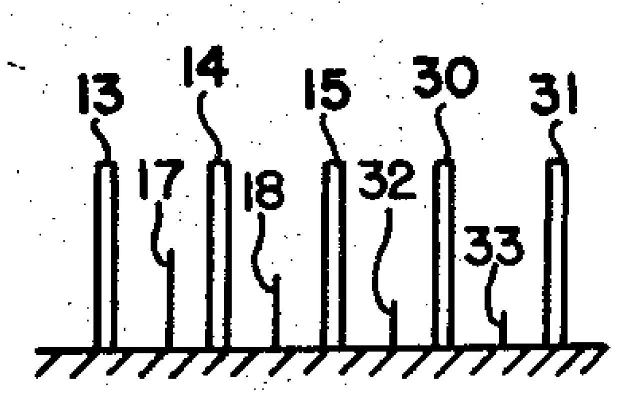

FIG. 8

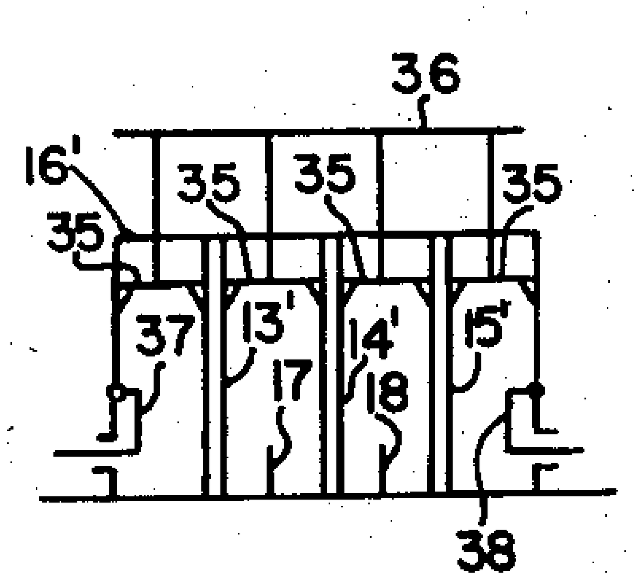

FIG. 9

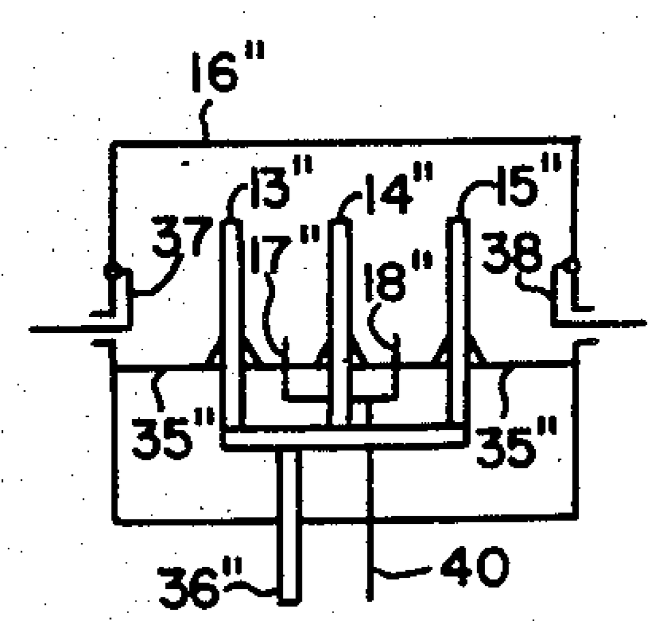

FIG. 10

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WAVE-SIGNAL TRANSLATING SYSTEM FOR SELECTED BAND OF WAVE-SIGNAL FREQUENCIES

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Application November 8, 1945, Serial No. 627,473

12 Claims. (Cl. 178—44)

1

The present invention relates to wave-signal translating systems and, particularly, to such systems of the resonant type which selectively translate wave signals lying within a predetermined band of wave-signal frequencies, the translation band being either narrow or wide as desired. In greater particularity, the invention relates to a translating system of the type described having a plurality of tandem-arranged coupled resonant circuits which in their tandem relationship provide a desired band-pass characteristic for the system.

It frequently is desirable in high-frequency wave-signal apparatus to provide a plurality of resonant wave-signal circuits each having relatively low resistance for high-frequency currents, a large ratio of inductive reactance to resistance, and good frequency stability. Wave-signal transmission lines of the correct length have resonant properties which render them suitable for this purpose. Such lines may be so constructed and arranged that they exhibit the desirable characteristics last mentioned. However, it heretofore has been considered essential that, to prevent undesirable intercoupling between the lines, each such transmission line be isolated from any other similar line, either by the use of adequate wave-signal shields between the lines or by the interposition between the lines of wave-signal repeater devices having unidirectional translating characteristics, or both. Where three, four, or even more such transmission lines must be utilized in tandem to provide a desired over-all band-pass characteristic, it is apparent that the use of individual isolating wave-signal shields for each line may easily lead to structural complications.

It is an object of the present invention, therefore, to provide a new and improved wave-signal translating system which avoids one or more of the disadvantages and limitations of such prior translating systems.

It is a further object of the invention to provide a new and improved wave-signal translating system which utilizes a plurality of tandem-coupled resonant elongated conductors or transmission lines and yet one of simple and inexpensive construction having minimum space requirements.

It is an additional object of the invention to provide a new and improved wave-signal translating system which selectively translates wave signals of desired fundamental frequencies while at the same time providing substantial attenuation to wave signals having one or more frequencies harmonically related to the first-mentioned wave signals.

2

In accordance with the invention, a wave-signal translating system comprises a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately the given wave length a standing wave along each such conductor thereof. These conductors have with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at the given wave length and are axially so positioned and at least partially exposed with relation to one another that the portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along the aforesaid portions have at adjacent points on the conductors approximately the same phase relationships. The translating system includes a coupling member disposed between the aforesaid portions of the conductors and proportioned unequally to disturb the opposing couplings over a distance less than one-half the length of the aforesaid portions, whereby the conductors are coupled by an excess of one kind of the inductive and capacitive coupling developed in the intervening space between the aforesaid portions thereof.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring now to the drawing, Fig. 1 is a circuit diagram, partly schematic, representing a complete wave-signal system embodying the present invention in a particular form; Fig. 1a represents the equivalent circuit diagram of a portion of the Fig. 1 system; Figs. 2–5, inclusive, schematically represent modified forms of the invention employing different coupling arrangements; Figs. 6–8, inclusive, schematically represent additionally modified forms of the invention adapted to attenuate the translation of undesired harmonically related wave signals; and Figs. 9 and 10 illustrate translating systems embodying the present invention in a form suitable for tuning the system over a predetermined range of wave-signal frequencies.

Referring now more particularly to Fig. 1 of the drawing, there is represented, partly schematically, a complete wave-signal system embodying the present invention in a particular form. This translating system is shown as being utilized to couple an antenna-ground system 10, 11 to a wave-signal apparatus 12 which may be a wave-signal transmitter or a wave-signal receiver. The translating system includes three tandem-arranged elongated conductors 13, 14 and 15, which may for example be of circular cross section spaced from each other less than one radian length at a given or operating wave length. This spacing of the conductors is such that the time of transit of electromagnetic energy moving from one conductor to the other is inappreciable. Expressed in another manner, the conductor spacing mentioned insures that the instantaneous values of current or voltage at corresponding points on adjacent pairs of conductors shall have no appreciable phase difference caused by virtue of the spacing. While the conductors are shown in Fig. 1 and in subsequent figures as linearly aligned, thus to provide an arrangement in which the conductors are coupled primarily in cascade, it is to be understood that the conductors may be arranged in nonlinear fashion where it is desired that coupling shall exist between each of three or more conductors to enable the attainment of a desired over-all band-pass characteristic. The conductors 13, 14 and 15 are electrically connected at one end to the ground conductor 11 and are enclosed within a wave-signal shield, indicated by the broken line 16, to minimize the direct pickup or radiation of wave-signal energy. Such a shield does not have to be an enclosure, but may be only a ground plane near the conductors and parallel to the axes thereof. The preferred shield, of course, is a rectangular box with its minimum dimension normal to a plane which includes the conductor axes. Each conductor has an electrical length equal to an odd number of quarter-wave lengths at the given operating wave length so that each is adapted to develop by resonance at approximately the given wave length a standing wave therealong.

As thus arranged, conductors 13, 14 and 15 have with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at the operating wave length and are axially so positioned and at least partially exposed with relation to one another that the portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along their parallel portions have at adjacent points on the conductors the same space-phase relationship. As is well known, the standing waves of current along these conductors have maximum values in the region of the ground conductor 11 so that the maximum magnetic fields developed in the intervening space between the conductors have maximum values in this region.

The translating system includes a conductive grounded electromagnetic-shielding member 17, which may comprise a sheet of conductive material, positioned in the region of the predominant magnetic field between the pair of conductors 13 and 14 and a similar conductive coupling member 18 positioned in the region of the predominant magnetic field of the pair of conductors 14 and 15. These coupling members are thus arranged unequally to disturb, over a distance less than one-half the length of the parallel portions of the conductors, the opposing coupling between the conductors caused by the electric and magnetic fields developed by the standing waves of current and potential therealong.

The antenna 10 is coupled to a point on the conductor 13 spaced from its grounded end while the wave-signal apparatus 12 is coupled to a point on the conductor 15 spaced from the grounded end of the latter.

Considering now the operation of the wave-signal translating system just described, the conductors 13, 14 and 15 operate as resonant circuits inductively coupled in pairs in tandem relationship and providing a selective band-pass filter which couples the antenna system 10, 11 and the wave-signal apparatus 12. Applicant has found that in the absence of the coupling members 17 and 18, conductors having the length and spacing specified above remain entirely uncoupled with relation to one another. This is because each pair of the conductors is inductively coupled by the magnetic fields developed by the standing waves of current along the conductors, but is also capacitively coupled by the electric fields developed along the conductors by the standing waves of potential. These inductive and capacitive couplings are equal, as will presently be explained in greater detail, and oppose one another so that the net coupling between the conductors is zero. The coupling members 17 and 18 unequally disturb the opposing couplings between the individual pairs of conductors to effect coupling thereof by an excess of one kind of inductive or capacitive coupling developed in the intervening space between the parallel portions of the conductors. Where the coupling members 17 and 18 are of conductive material completely to shield one conductor from the other over the length of the coupling member, and are located in a region of predominant inductive coupling, it will be apparent that the inductive coupling between the conductors is reduced without any material reduction of the capacitive coupling therebetween so that the conductors are coupled by a net excess of capacitive coupling. It will be apparent that the extent to which any pair of adjacent conductors is coupled is thus dependent upon the length of the intervening coupling member since this determines the extent to which the inductive coupling between the pair of conductors is reduced.

The character of the couplings between the conductors of the translating system will now be considered in greater detail with reference to Fig. 1*a* which, for simplicity, shows the equivalent circuit diagram of a wave-signal translating system utilizing only two conductors. The lumped inductors L represent the effective values of the distributed inductances of each conductor. The lumped inductor L_c represents the effective value of the distributed inductive coupling between the conductors. The condensers C and C_c represent respectively the effective values of the distributed capacitances of either conductor to the wave-signal shield and the distributed capacitive coupling between the conductors.

It will be apparent from this equivalent circuit diagram that each conductor essentially is a resonant circuit and that the two resonant circuits thus provided are coupled by inductive coupling L_c and capacitive coupling C_c. Where the two circuits are provided with parallel resonant lines as in Fig. 1 and where the coupling members 17 and 18 of Fig. 1 are omitted, it has been proven theoretically and verified experimentally that the inductive coupling L_c and the capacitive coupling C_c are equal but oppose one another so that the inductive and capacitive couplings between the circuits cancel out. This cancellation of the inductive and capacitive couplings is premised, of course, upon the particular arrangement of the resonant conductors previously described; namely, that the conductors are spaced from each other less than one radian length, are exposed to one another over approximately parallel portions of their length approximately equal to an integral number of quarter-wave lengths at the resonant wave length, and are axially so positioned with relation to one another that the standing waves developed along their exposed portions have at adjacent points on the conductors approximately the same space-phase relationships. However, anything that is done, as by the provision of the shielding members 17 and 18 of the Fig. 1 arrangement, unequally to disturb the opposing inductive and capacitive couplings between the conductors will result in a net coupling between them so that a wave-signal current on one conductor will then induce a wave-signal voltage on the other.

There are numerous ways in which the unequal disturbance of the inductive and capacitive couplings may be modified to effect the result last mentioned. There are two typical such ways. One resides in the use of a shield which obstructs both kinds of coupling between the conductors but is inserted at a position along the conductors where one kind of coupling predominates, thereby disturbing the balance of coupling. This is exemplified in Fig. 1 where the grounded shields 17 and 18 reduce both the inductive and capacitive couplings but are positioned at a position where the inductive coupling predominates. The second typical way of unequally disturbing the inductive and capacitive couplings between the conductors is by the use of a shield which modifies one kind of coupling more than the other and is positioned between the conductors at a region where it disturbs the balance of coupling.

Fig. 2 schematically represents an arrangement in which the balance of coupling is disturbed in the manner last mentioned. Here the inductive coupling between the conductors 13 and 14 is increased by a conductor 20 connected between the conductors 13 and 14 at a point near to but spaced from their grounded ends, the conductors 14 and 15 being similarly coupled by a conductor 21 similarly connected and arranged. By positioning the conductors 20 and 21 near the grounded ends of the conductors 13, 14 and 15, they are positioned in the regions of the predominant magnetic fields developed in the intervening spaces between the conductors and thus effect an increase of the inductive coupling between the conductors while at the same time having substantially no effect on the capacitive coupling.

Fig. 3 schematically represents a wave-signal translating system embodying a modified form of the invention wherein a pair of conductive grounded coupling members 23 and 24 are inserted between respective pairs 13, 14 and 14, 15 of the elongated conductors in the regions thereof where the predominant capacitive fields exist therebetween. That is, the standing waves of potential developed along the conductors 13, 14 and 15 have maximum amplitudes at the open ends of the conductors so that the capacitive couplings between the conductors are predominant in this region. The effect of the coupling members 23 and 24 is to reduce the capacitive couplings without appreciably changing the value of the inductive couplings primarily existing between the conductors near their grounded ends. This unequal disturbance of the opposing inductive and capacitive couplings consequently causes the conductors to be inductively coupled in tandem relationship. The coupling members 23 and 24 of the instant arrangement may comprise either solid sheets of conductive material or may comprise a Faraday shield, the latter being arranged to modify only the capacitive coupling and having no appreciable effect on any inductive coupling which may exist between the conductors near their open ends.

Fig. 4 represents a wave-signal translating system in which the capacitive couplings between the conductors 13, 14 and 15 are increased by the provision of coupling condensers 26 and 27 which are connected between the open ends of the respective pairs of conductors 13, 14 and 14, 15.

Fig. 5 schematically represents a similar arrangement in which the capacitive couplings between the conductors are increased by the provision of small conductive plates 28 electrically connected to the ends of the conductors.

In certain applications of a translating system embodying the present invention, the conductors may tend to develop along each thereof, in addition to a standing wave of the desired resonant wave length, undesirable standing waves harmonically related to the desired resonant standing waves. From what has been said before, it will be apparent that the conductors remain uncoupled for such harmonically related standing waves where the lengths of the conductors which are exposed to one another are an integral number of quarter-wave lengths at the harmonically related standing waves and where they have a spacing less than one radian length at the wave length of the latter. Advantage may be taken of this fact to provide a translating system which translates a wave signal of the resonant wave length but which attenuates wave signals having a harmonically related wave length.

Fig. 6 schematically represents a translating system of this type. Broken-line curve A represents a standing wave of potential of the desired resonant wave length developed along the conductors 13, 14 and 15 while broken-line curve B represents a third-harmonic standing wave of potential developed along the conductor 13. The conductors 13, 14 and 15 of the present arrangement preferably have a spacing less than one radian length of the third-harmonic standing wave although substantial attenuation of the third harmonic is effected even for somewhat larger spacings. Coupling condensers 26 and 27 are connected between the conductors at a point approximately two-thirds of their length as measured from their grounded ends. Since this point of coupling is a zero-potential point of the third-harmonic standing wave, the equal and opposing inductive and capacitive couplings between the conductors are not modified insofar as the third-harmonic standing wave is concerned so that the conductors remain uncoupled for this wave. This is true, for the same reason, also for harmonic standing waves which are multiples of the third-harmonic wave. At the same time, the coupling condensers 26 and 27 unequally disturb the inductive and capacitive couplings, namely by increasing the capacitive couplings, between the conductors insofar as the desired resonant standing wave is concerned. Wave-signal energy of the desired wave length is thus translated by the translating system while undesired wave-signal energy having a third-harmonic, or multiple of a third-harmonic, wave length is substantially attenuated by the system.

A modified form of wave-signal translating system which possesses the harmonic-suppression characteristic last described is schematically represented in Fig. 7. Here a conductive grounded coupling member 17 is positioned between the conductors 13 and 14 and extends over a distance thereof equal to a quarter-wave length of the undesired harmonically related standing wave represented by broken-line curve B. The conductors 13 and 14 have an exposed length equal to one-half wave length of the harmonically related standing wave and thus are not coupled for wave signals of this wave length or for wave signals which are multiples of this harmonic wave length. As in the arrangement of Fig. 1, however, these conductors are coupled for wave signals having the desired resonant wave length. By way of illustrating the flexibility and wide range of application of a translating system embodying the present invention, the conductors 14 and 15 are shown as being inductively coupled by a conductive grounded coupling member 24, as in the Fig. 3 arrangement, for a standing wave of the resonant wave length. They remain uncoupled, however, for a second-harmonic standing wave, represented by the broken-line curve C, by virtue of the fact that the coupling member 24 extends between the conductors 14 and 15 for a distance equal to one quarter-wave length of the second-harmonic wave thus to leave these conductors exposed to one another only over a quarter-wave length of the second-harmonic wave. Here again the harmonic attenuation is effective for harmonic wave lengths, such as the fourth, sixth or eighth harmonic, which are multiples of the second-harmonic wave. A wave signal having the desired resonant wave length is thus translated by the system while wave signals having an undesired third-harmonic wave length are substantially attenuated by the coupled conductors 13 and 14 and wave signals having an undesired second-harmonic wave length are substantially attenuated by the coupled conductors 14 and 15.

It will be apparent that a large number of such undesired harmonically related wave signals may be attenuated by the provision of sufficient pairs of resonant conductors. A wave-signal translating system adapted to suppress four such harmonically related wave signals is shown in Fig. 8 which includes five tandem-arranged elongated conductors 13, 14, 15, 30 and 31 with four intervening conductive coupling members 17, 18, 32 and 33. Each of the coupling members has a length equal to a quarter-wave length of an individual undesirable harmonically related standing wave to be attenuated. Thus, for example, the conductors 13 and 14 with their intervening coupling member 17 may attenuate a second-harmonic and multiples of a second-harmonic standing wave, the conductors 14 and 15 may attenuate a third-harmonic and multiples of a third-harmonic standing wave, the conductors 15 and 30 a fifth-harmonic and multiples of a fifth-harmonic standing wave, and the conductors 30 and 31 a seventh-harmonic and multiples of a seventh-harmonic standing wave. All of the conductors are capacitively coupled, however, for the desired wave signal of resonant wave length so that such wave signals are freely translated by the translating system.

Fig. 9 illustrates a wave-signal translating system embodying the present invention in a modified form adapted to be tuned over a range of wave-signal wave lengths. The instant arrangement is essentially similar to that of Fig. 1, similar elements being designated by similar reference numerals and analogous elements by similar reference numerals primed, except that the elongated conductors 13′, 14′ and 15′ have an electrical length equal to slightly more than one-half wave length at the longest wave length of any wave signal to be translated by the system. Further, the conductors are electrically connected at both of their ends to the wave-signal shield 16′. An apertured diaphragm 35 of conductive material conductively but slidably engages around its periphery the inner walls of the wave-signal shield 16′ and is provided with apertures having resilient inturned serrated edges which conductively but slidably engage the conductors 13′, 14′ and 15′. A manually adjustable member 36 is mechanically connected to the diaphragm 35 to move the latter within the wave-signal shield 16′ for purposes of adjusting, in well-known manner, the resonant lengths of the conductors 13′, 14′ and 15′. A coupling loop 37 is provided by which to couple the conductor 13′ to a first external wave-signal translating circuit and a similar coupling loop 38 is provided to couple the conductor 15′ to another external wave-signal translating circuit. Except for the adjustable tuning feature, itself well known in the art, the operation of this modified form of the invention is essentially similar to that of Fig. 1 and will not be repeated.

A somewhat similar tunable translating system embodying an additionally modified form of the invention is shown in Fig. 10. The present arrangement is essentially similar to that of Fig. 9, similar elements being designated by similar reference numerals and analogous elements by similar reference numerals double primed. The conductive diaphragm 35″ of the present arrangement is fixedly positioned within the wave-signal shield 16″ and the elongated conductors 13″, 14″ and 15″ are mechanically connected to a manually adjustable member 36″ for movement in unison through the apertures of the diaphragm to tune the conductors to resonance in well-known manner. The conductive coupling members 17″ and 18″ also movably extend through apertures in the diaphragm 35″, in conductive engagement therewith, and are mechanically connected to a second manually adjustable control 40 for movement in unison to adjust the extended lengths of the coupling members between the conductors 13″, 14″ and 15″. Adjustment of the coupling members 17″ and 18″ may be desirable in some applications in order that the extent of coupling between the conductors 13″, 14″ and 15″ may be varied at will or in order selectively to effect the attenuation of one or more undesirable harmonically related wave signals. The operation of this modified form of the invention is otherwise essentially similar to that of Fig. 1 and will not be repeated.

It will be apparent from the foregoing description of the invention that a wave-signal translating system embodying the invention involves only a very simplified and inexpensive construction and may readily be designed or adjusted to have any desired band-pass translation characteristic, as by suitable choice of the number of coupled stages thereof and the extent to which the stages are coupled. Additionally, a translating system embodying the invention has the advantage that one or more undesirable harmonically related wave signals may be substantially attenuated. There is the further advantage that the translating system of the present invention may readily be constructed either of the fixed-tuned or adjustably tuned type and, when of the latter type, may have a band-pass characteristic which may be maintained substantially constant over its tuning range.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a coupling member disposed between said portions of said conductors and proportioned unequally to disturb said opposing couplings over a distance less than one-half the length of said portions, whereby said conductors are coupled by an excess of one kind of the inductive and capacitive coupling developed in the intervening space between said portions thereof.

2. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a conductive coupling member disposed between said portions of said conductors and proportioned unequally to disturb said opposing couplings over a distance less than one-half the length of said portions, whereby said conductors are coupled by an excess of one kind of inductive and capacitive coupling developed in the intervening space between said portions thereof.

3. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space phase relationships, and a conductive grounded shielding member disposed between said portions of said conductors and proportioned unequally to disturb said opposing couplings over a distance less than one-half the length of said portions, whereby said conductors are coupled by an excess of one kind of inductive and capacitive coupling developed in the intervening space between said portions thereof.

4. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a conductive coupling member disposed between said portions of said conductors in the region of predominately magnetic fields thereof and proportioned unequally to disturb said opposing couplings over a distance less than one-half the length of said portions, whereby said conductors are coupled by an excess of one kind of inductive and capacitive coupling developed in the intervening space between said portions thereof.

5. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a conductive coupling member disposed between said portions of said conductors in the region of the predominant magnetic fields thereof and proportioned to reduce over a distance less than one-half the length of said portions the inductive component of the opposing coupling therebetween, whereby said conductors are coupled by an excess of capacitive coupling developed in the intervening space between said portions thereof.

6. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approxi-

mately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a conductive coupling member disposed between said portions of said conductors in the region of the predominant magnetic fields thereof and proportioned to increase over a distance less than one-half the length of said portions the inductive component of said opposing coupling, whereby said conductors are coupled by an excess of inductive coupling developed in the intervening space between said portions thereof.

7. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a capacitive coupling member disposed between said portions of said conductors in the region of the predominant electric fields thereof and proportioned to increase over a distance less than one-half the length of said portions the capacitive component of said opposing coupling between said portions, whereby said conductors are coupled by an excess of the capacitive coupling developed in the intervening space between said portions thereof.

8. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof but tending also to develop along each thereof an undesirable standing wave harmonically related to said first-mentioned standing waves, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a coupling member disposed between said portions of said conductors and proportioned unequally to disturb over a predetermined length of said conductors said opposing coupling between said portions, said length being selected to disturb substantially equally the opposing coupling between said portions caused by the electric and magnetic fields developed by said harmonically related standing waves, whereby said conductors are coupled for said given wave length by an excess of one kind of inductive and capacitive coupling developed by said first-mentioned standing waves in the intervening space between said portions thereof but are substantially uncoupled for said harmonically related standing waves.

9. A wave-signal translating system comprising, at least three tandem-related elongated conductors spaced from each other less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof but tending also to develop along each thereof a plurality of undesirable standing waves harmonically related to said first-mentioned standing waves, pairs of said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said given wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, and a coupling member disposed between said portions of each said pair of said conductors and proportioned unequally to disturb over a predetermined length of said conductors of said each pair the opposing coupling between said portions, said length for each said pairs of conductors being individually selected to disturb substantially equally the opposing coupling between said conductor portions caused by the electric and magnetic fields developed by an individual one of said harmonically related standing waves, whereby said conductors are coupled in tandem for said given wave length by an excess of one kind of inductive and capacitive coupling developed by said first-mentioned standing waves in the intervening space between said portions thereof but are substantially uncoupled in said tandem relationship for said harmonically related standing waves.

10. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, a coupling member disposed between said portions of said conductors and proportioned unequally to disturb over a distance less than one-half the length of said portions the opposing coupling between said portions, whereby said conductors are coupled by an excess of one kind of the inductive and capacitive coupling developed in the intervening space between said portions thereof, and wave-signal shielding means for substantially reducing the ra-

diation of wave-signal energy from said conductors to space.

11. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of length approximately equal to an integral number of quarter-wave lengths at said wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, a coupling member disposed between said portions of said conductors and proportioned unequally to disturb over a distance less than one-half the length of said portions the opposing coupling between said portions, whereby said conductors are coupled by an excess of one kind of the inductive and capacitive coupling developed in the intervening space between said portions thereof, and wave-signal shielding means providing at least one conductive surface relatively closely spaced from said conductors and approximately parallel to a plane which includes the axes thereof.

12. A wave-signal translating system comprising, a pair of elongated conductors spaced less than one radian length at a given wave length and adapted to develop by resonance at approximately said given wave length a standing wave along each thereof, said conductors having with one another approximately parallel portions of

length approximately equal to an integral number of quarter-wave lengths at said wave length and being axially so positioned and at least partially exposed with relation to one another that said portions have opposing coupling therebetween caused by the electric and magnetic fields developed thereby and the standing waves developed along said portions have at adjacent points on said conductors approximately the same space-phase relationships, a coupling member disposed between said portions of said conductors and proportioned unequally to disturb over a distance less than one-half the length of said portions the opposing coupling between said portions, whereby said conductors are coupled by an excess of one kind of the inductive and capacitive coupling developed in the intervening space between said portions thereof, and wave-signal shielding means enclosing said conductors and including conductive surfaces relatively closely spaced from said conductors and positioned on either side of a plane which includes the axes thereof.

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