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J. M. DE BELL, JR
MULTIPLEXING DEVICE

2,909,774

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2 Sheets-Sheet 1

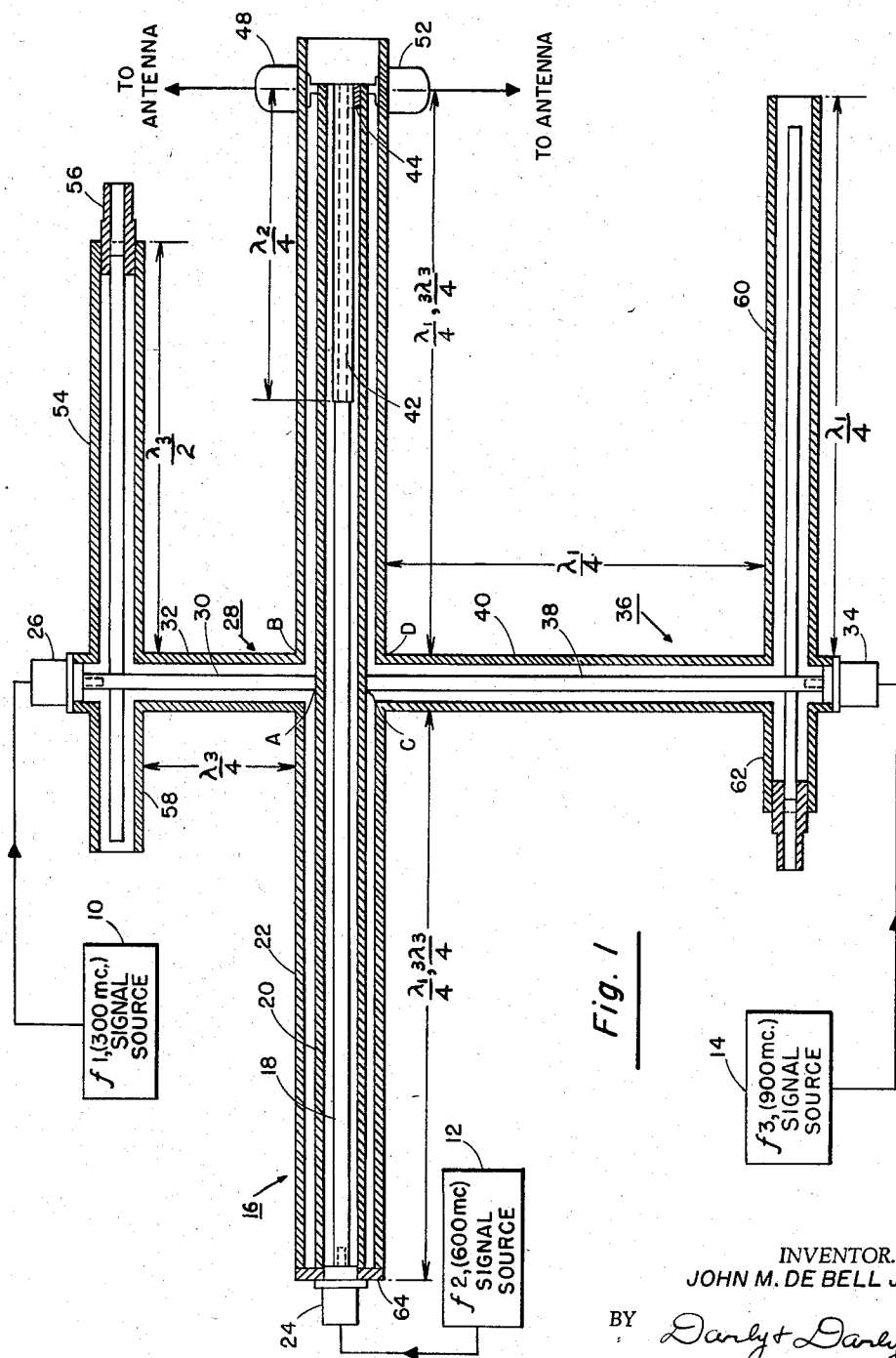


Fig. 1

INVENTOR.
JOHN M. DE BELL JR.

BY

Darby & Darby

ATTORNEYS

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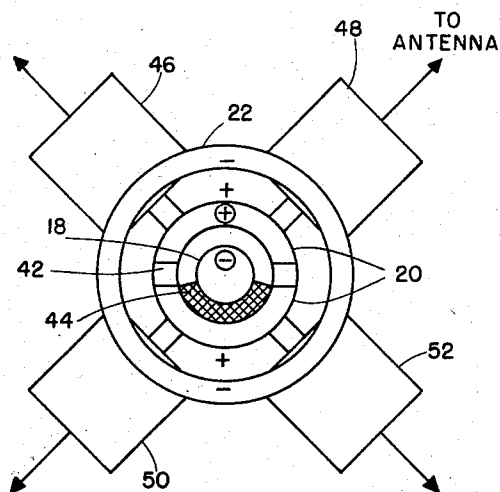


Fig. 2

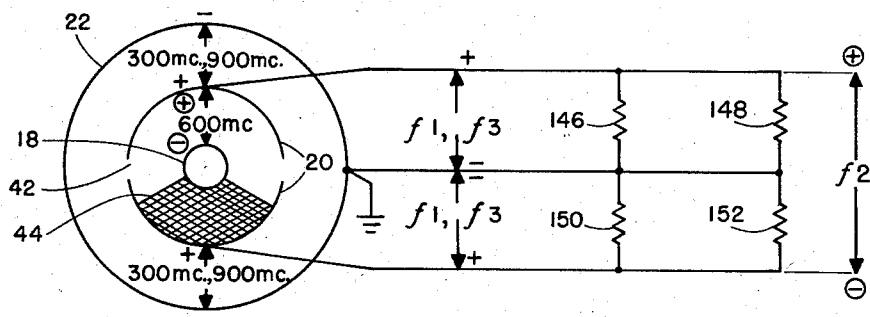


Fig. 3

INVENTOR.
JOHN M. DE BELL JR.

BY

Darby + Darby

ATTORNEYS

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MULTIPLEXING DEVICE

John M. de Bell, Jr., Passaic, N.J., assignor to Allen B. Du Mont Laboratories, Inc., Clifton, N.J., a corporation of Delaware

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17 Claims. (Cl. 343—176)

This invention relates to the multiplexing of electrical signals and particularly to a device permitting simultaneous application of several radio signals of different frequency to a single antenna or utilization device.

Existing diplexing devices have been utilized to permit combinations of two radio frequency signals. It has been difficult, however, to multiplex more than two different carrier frequencies for simultaneous operation without introducing interaction or cross coupling effects. Cross coupling may cause output distortion, loading, and possible damage to the transmitter, and to avoid such interaction in the transmission of multiple signals, separate antennas are generally used. The use of separate antennas, however, introduces other problems. If the antennas are placed one above the other, propagation data must be corrected for the relative height of the different antennas, while if the antennas are placed side by side, the radiation from each will not be omnidirectional, as each antenna will cause a shadow to appear in the other's radiation pattern.

As an alternative to the use of multiple antennas, a "brute force" method utilizes a single antenna and complex and inefficient filter networks. The filters in each signal path pass one frequency and reject others before the passed frequencies are combined at the antenna. The filters generally have the disadvantage of presenting a resistance which is not constant over the band-pass, and therefore introduce frequency transients and undesirable variations of voltage standing wave ratios. It is consequently difficult to obtain satisfactory wide band-pass characteristics.

It is therefore the principal object of the present invention to provide a novel multiple frequency multiplexing device.

It is another object of the invention to provide a simplified, compact and efficient multiplexing device which permits simultaneous transmission of at least three radio frequency signals.

An additional object of the invention is to provide a multiplexer without filters, which has minimum cross coupling and interaction between several different carrier frequencies combined for simultaneous operation.

A further object is to furnish a multiplexer having proper impedance matching and phasing to permit the combination of more than two separate signals for simultaneous application to an antenna array.

In the instant invention, three high frequency radio signals having a substantially 1:2:3 frequency ratio, are combined and transmitted simultaneously through a coaxial triplexer device which applies the energy to a single antenna array. The frequencies having the 1:3 ratio are fed into two branch coaxial lines which join a main line carrying the center frequency. The center frequency and branch frequencies are separated respectively into inner and outer concentric paths before being combined at the antenna or load. A split coaxial conductor section at the output end is utilized to provide proper impedance matching and phasing for propagation of the

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center frequency into the antenna and to isolate the inner and outer paths.

In addition, by utilizing open or shorted one-quarter, one-half and three-quarter wavelength coaxial sections and stubs, high impedances are reflected at proper junction points to further aid in isolating the various signal paths and frequencies and prevent cross-coupling. The integral relationship between frequencies permits use of the same main coaxial sections to provide impedance matching and isolation for more than one branch, and simplifies the problem of phasing and the design of feed lines to the antenna.

The detailed description and accompanying drawings which follow consider the multiplexing device in a particular triplexer configuration, for combining three different frequencies. It is to be understood that this arrangement represents but one embodiment chosen for purposes of explanation and illustration and is not to be construed as defining the limits of the invention.

Fig. 1 is a cross-sectional view of the triplexer structure;

Fig. 2 is an end view of the triplexer, showing the composite coaxial lines and the output connections thereof; and

Fig. 3 is a schematic representation of the output connections.

As indicated in Fig. 1, three signal sources or transmitters 10, 12 and 14 generate three radio frequency signals f_1 , f_2 and f_3 , respectively. The frequencies are preferably in a substantially integral relationship or 1:2:3 ratio, representative numerical values of 300 mc. for f_1 , 600 mc. for f_2 and 900 mc. for f_3 , being chosen to aid in the description. The main line 16 of the triplexer is made up of two coaxial transmission paths. The first, or inner, path is formed by a central or interior wire conductor 18, and circumjacent intermediate tubular conductor 20. The second, or outer, path is formed by intermediate tubular conductor 20, which is common to both inner and outer paths, and an additional circumjacent exterior conductor tube 22, which also acts as a housing for the structure.

The 600 mc. center or primary frequency f_2 is fed from source 12 to a coaxial input connector 24 which inserts the signal into the inner pair of conductors 18 and 20 of the main transmission line 16. The lower frequency signal f_1 , of 300 mc., is applied from source 10 through a second coaxial connector 26, into a first branch or side arm coaxial transmission line section 28, which is formed by an inner wire conductor 30 and an outer concentric or circumjacent tubular conductor 32. Inner conductor 30 is joined to the common tubular conductor 20 at the mid-section of main line 16, at an area designated as junction A, while outer conductor 32 forms junction B with outer tube 22 of the main line.

The higher frequency signal f_3 of 900 mc., from source 14, is inserted into coaxial connector 34 and a second side arm or branch 36. Branch 36 joins the main line symmetrically with branch 28, preferably from the opposite direction of the same plane. The branch arms may also join the mid-section of the main line at angles other than perpendicular and need not be coplanar. However, for simplicity of design they are arranged in the manner described. Arm 36, like arm 28, is formed of a single coaxial line having an inner wire conductor 38 and an outer concentric tubular conductor 40. Inner conductor 38 is joined at junction C with the common tubular conductor 20 of the main line on the side opposite to that of conductor 30 of arm 28, and outer conductor 40 joins outer tube 22 of the main line from the direction opposite to that of conductor 32, at junction D.

The three signal paths meet at a mid-section junction area of the main line, including junctions A, B, C and

D, and travel along the remaining half of the triplexer body toward the output end, to which is connected an antenna array or utilization device. The two branch frequencies f_1 and f_3 are propagated along the outer path provided by common tubular conductor 20 and outer concentric conductor 22, while the center or primary signal f_2 travels along the inner path between central wire conductor 18 and common conductor 20.

At a distance of one-quarter wavelength of f_2 from the triplexer's output end, the common tubular conductor 20 is split by a longitudinal coplanar slot 42, cutting the tubular cross section into two equal solid portions. A shorting plug 44 is placed at the extreme distal end of the inner path to short circuit the lower portion of central wire conductor 18 to the lower half of split tubular conductor 20. As shown in Fig. 2, the ends of the upper and lower halves of the slotted tubular conductor 20 are each connected to output couplings which pick up the several signals and apply them to the antenna leads. Optimum omnidirectional radiation has been achieved by the use of a four-bay discone antenna array, but other types of antennas may be employed. Since the instant antenna array requires four antenna lead lines, four output coaxial connectors 46, 48, 50 and 52 are used. The upper half of the split line 20 feeds the central lead of connectors 46 and 48, while the lower half, shorted to conductor 18, feeds the central lead of connectors 50 and 52. The outer shells of the four connectors are all electrically connected to the outer conductor 22 of the triplexer body. Lead lines transfer the energy picked off by output connectors 46, 48, 50 and 52 to the antenna array, which is not shown.

The split portion of conductor 20 acts as a bridge network and a balancing section, transforming an unbalanced-to-ground 600 mc. voltage at the base or start of the slot to a balanced push-pull voltage at the output connections. In a manner well known in the art, the short circuited line termination established by plug 44 appears as an open circuit at the base of the lower split portion, one-quarter wavelength from the end. An odd multiple of a quarter wavelength may also be utilized. This property and its use in preventing interference between signals will be referred to and more fully discussed hereinafter. Due to this "apparent" open circuit, the 600 mc. signal is transmitted and developed between the central wire conductor 18 and the unshorted half of the split conductor or between the upper and lower split portions. Since the shorting plug 44 at the terminal point connects the conductor 18 to one half of the split conductor 20, instantaneous opposing positive and negative 600 mc. polarities are alternately established at the upper unshorted portion compared to that in the lower shorted portion.

The equivalent circuit and antenna connections are shown schematically in Fig. 3. Resistances 146, 148, 150 and 152 represent the load, either in the form of dummy loads or feed lines to the antenna load, to which connectors or pickup devices 46, 48, 50 and 52 of Fig. 2 lead. The instantaneous plus phase of the 600 mc. signal, shown enclosed in a circle, is connected by the upper portion of split line 20 to the inner wire of pickups 46 and 48. Similarly, the instantaneous minus phase of the 600 mc. signal, shown enclosed in a circle, is connected by the lower shorted portion of split line 20 to the inner wire of pickups 50 and 52. One half cycle later the polarities are reversed. As previously stated, the outer portions of pickup devices 46, 48, 50 and 52 are all connected to the outer tube or housing 22 of the main line which serves as a ground or reference potential. Thus, one pair of antenna feed lines or loads (146 and 148) are connected in parallel, while the second pair (150 and 152) are also in parallel. Hence, for the 600 mc. signal frequency, the split conductor arrangement effectively places each pair of antenna lines in series with each other pair, in a balanced push-pull configuration.

The push-pull balanced 600 mc. components are prevented from interfering with or feeding into the 300 and 900 mc. channels at the antenna connections, as the equal and opposing polarities cancel. Application of these opposing polarities to the feed lines would also result in a cancellation of the 600 mc. signal at the antenna. This undesirable effect is corrected by changing the length of one pair of feed lines, to give the proper in phase relationship at the antenna. Impedance matching between the 600 mc. signal path and the load is determined by the diameter of central conductor 18 within the quarter wave split section of tubular conductor 20. The diameter of the central conductor 18 is slightly increased to compensate for the area of common tubular conductor 20 taken away by the split.

The branch frequencies are applied to the antenna in a somewhat different manner. The 300 mc. signal from source 10 enters the main transmission line at the mid-section junction and travels toward the antenna along the outer path provided by common tubular conductor 20 and concentric outer conductor 22, none of its energy using central wire conductor 18. The energy is distributed evenly throughout this path including the output connectors or pickup devices 46, 48, 50, and 52. The 900 mc. signal from source 14 feeds into the same outer coaxial path and is likewise evenly distributed. Thus, as indicated in Fig. 3 for the 300 mc. frequency, the same instantaneous signal polarities appear at both upper and lower portions of the split conductor 20, and the outer conductor has the opposite instantaneous polarity uniformly around its periphery. One-half cycle later these polarities are reversed. Exactly the same situation exists for the 900 mc. frequency signal. Since these frequency components are developed equally and confined between the outer coaxial pair of conductors, no resultant potential appears in the inner or 600 mc. path and interference at the antenna connections is prevented. The split section therefore does not affect transmission of the branch frequencies, and their signal path remains unbalanced, with all four loads 146, 148, 150 and 152 being effectively connected in parallel. Thus, the arrangement of the various components and connections at the output end of the instant device permits the combination of several signals at the antenna without harmful interaction.

A more complete description of the theory of the slotted bridge as used in antenna diplexers may be found in an article entitled "Television Antenna Diplexers" by W. H. Sayer, Jr., and J. M. de Bell, Jr., appearing in the July 1950 issue of "Electronics." Further explanatory material on balanced to unbalanced transformation may be found in "Electronic and Radio Engineering," Fourth Edition, pp. 901-902, by Frederick E. Terman, and "Very High Frequency Techniques," vol. I, pp. 85-86, by the Radio Research Laboratory Staff of Harvard University.

For proper multiplexing of several frequencies and to prevent cross coupling and distortion, it is also necessary to maintain isolation between the various signal sources. This result is achieved by arranging the lengths and characteristics of the various sections of the device to reflect high impedances at junction areas. As previously mentioned, it is well known in the art that a coaxial transmission line which is terminated in a short or open circuit at its end will appear to have an opposite impedance at a point one-quarter wavelength away. This reversal effect continues and repeats at each quarter wave interval along the length of the line. Thus, at one-half wavelength, the impedance is again equal to that at the end, while at three-quarters wavelength the opposite condition re-occurs. This property is successfully employed in the present invention to isolate the 300, 600 and 900 mc. sources from one another. A more complete description of this impedance effect may be found in "Radio Engineers' Handbook" (1943 Edition, pp.

180-186) by Frederick E. Terman, and "Communication Engineering" (1937 Edition, pp. 140-145) by William L. Everitt.

To prevent the 900 mc. signal from entering the 300 mc. branch 28, an open circuit or high impedance to the former frequency is established at the junction with the main triplexer body. This is accomplished by use of an additional coaxial structure 54 (Fig. 1). Structure 54 is a coaxial line section preferably connected perpendicularly to side arm 28 and extending parallel to the main line 16 for a length equal to one-half wavelength at 900 mc. Like the branches, the angular position of the added structure is chosen for convenience of mechanical design. The inner wire conductor of structure 54 is joined with branch inner conductor 30 and the outer conductor to outer conductor 32. A shorting bar 56 at the end of structure 54 shorts the inner and outer conductors together. This short circuit impedance repeats at one-half wavelength of 900 mc., occurring at the 300 mc. input point, where line 54 joins side arm 28. The length of the 300 mc. arm 28, from this junction with the shorted line section 54 to the body of the main line, is one-quarter wavelength at 900 mc. Therefore, shorting bar 56 is at a distance equal to three-quarters wavelength of the 900 mc. frequency from the main junction, and an open circuit is presented to that frequency at the junction, preventing the 900 mc. signal components from entering the 300 mc. branch. The short circuit appearing at the 300 mc. source provides additional protection against any 900 mc. components getting by the high impedance at the junction. The remaining 900 mc. components are thus shunted around the 300 mc. source to ground. The lengths of the coaxial structure 54 and branch 28 may also be arranged in other multiples of open or shorted quarter wavelength sections to produce the same results. The instant dimensions are determined by practical design considerations. The shorting bar 56 may be adjusted for best rejection characteristics. Since coaxial structure 54 is a half wavelength at 900 mc., it is only about one-sixth wavelength at 300 mc. This presents some reactance at the latter frequency and introduces some impedance mismatch. To present a pure resistance, the line 54 should be a quarter wavelength or multiple thereof. To compensate for this reactance so as to match arm 28 at 300 mc., a small additional open stub 58 projecting from the opposite side of branch 28 is utilized as an adjustment.

Similarly, another coaxial line section 60 is utilized to present an open circuit to the 300 mc. signal appearing at the junction of the 900 mc. branch and the main line. Structure 60 is preferably positioned perpendicularly at the input to the 900 mc. branch 36 and parallel to the main line. In this instance, the structure is an open one-quarter wavelength line at 300 mc., adjusted to reflect a short circuit for that frequency at the junction with the 900 mc. input. The 900 mc. branch is one-quarter wavelength of 300 mc. from the main triplexer body, resulting in an open circuit at the main line junction and blocking 300 mc. frequency components from entering branch 36. The short circuit appearing at the 900 mc. source, also shunts out any remaining 300 mc. components. As before, other lengths and terminations of quarter wavelength multiples may be employed to achieve the same effect. The reactance of structure 60 at 900 mc. is balanced out by a small adjustable shorted stub 62 on the opposite sides of the branch. Other combinations and arrangements of stubs may be utilized to obtain good rejection. For example, a series of similar stubs, tuned to the same frequency, could be used in each branch.

The use of a shorting ring 64 at the 600 mc. input connection to the main line 16 effectively prevents the 300 mc. and 900 mc. source from being reactively loaded by the 600 mc. conductive path. The shorting ring connects the outer pair of conductors 20 and 22 together. The

coaxial line length from connector 24 to the mid-section junction with side arms 28 and 36, represents one-quarter wavelength at 300 mc. and at the same time is three-quarters wavelength at 900 mc., due to the integral relationship or 1:3 ratio of the latter two frequencies. Thus the 600 mc. source appears as an open circuit to both branch frequencies at the junction with the main line. It is of prime importance in the instant invention that the branch frequencies be maintained within this ratio, or an odd multiple of it which produces equivalent results. This permits use of the same coaxial line between source 12 and the mid-section junction to cause the open circuit impedance to appear for both frequencies at the junction and prevents interaction with the 600 mc. source. The shorting ring 64 at the 600 mc. source bypasses any remaining 300 or 900 mc. components to provide further protection against loading and cross coupling.

The length of outer coaxial line of the triplexer body, from the main line junction with branches 28 and 36, to the antenna feedpoint, is also approximately three-quarters wavelength long at 900 mc. and one-quarter wavelength at 300 mc. Maintenance of the 1:3 ratio of wavelengths in this portion is not critical as the section of line is utilized primarily for impedance matching between the four loads, which are in parallel for the outer coaxial lines, and the impedances of the 300 and 900 mc. transmitter inputs. However, the length of line should be close to a quarter wavelength or some multiple thereof in order to present a pure resistance. The more critical dimensions that are important for proper impedance matching are the diameters of the various sections, as the coaxial transmission line impedance is a function of the ratio of inner and outer diameters. Thus, the diameters of the various sections are designed to match the load impedances to the input impedances into which the several transmitter sources are applied.

As previously described, the 300 and 900 mc. signals are phased properly for satisfactory operation at the output end of the triplexer. However, the 600 mc. signals are phased into plus and minus components, which tend to cancel at the antenna connections. If equal feed line lengths were taken from the triplexer output to each of the four discones in the antenna array, no net 600 mc. radiation would occur. This effect is compensated for by selection of proper lengths of feed line to the antenna. It is necessary that the feed lines from one side of the split coaxial section be longer than the others by an integral number of wavelengths at 300 and 900 mc., to assure that these signals arrive in phase and have the same instantaneous polarity at each element of the antenna array. At the same time the longer feed lines must exceed the shorter ones by a length which is an integral number of half wavelengths at 600 mc. in order for the originally out-of-phase 600 mc. signals to arrive in phase. An exact relationship, while preferable, is not necessary however, and an approximation may be utilized to maintain transmission lines within a reasonable length. Having all three frequencies in an integral relationship minimizes complexity in providing proper antenna feedlines. Each frequency may be transmitted independently and/or simultaneously with each other frequency, and it is not necessary to have the several different carrier frequencies synchronized with one another. However, the instantaneous phase and polarity of a particular frequency must be the same at each element of the antenna array in order to insure a proper omnidirectional radiation pattern for that signal.

It is possible to utilize the present invention with a center frequency which is not in an integral relationship with the two branch frequencies, despite the attendant problem in antenna feedline design. This is due to the fact that the various line lengths in the 600 mc. path within the triplexer body are independent of the two branch frequency wavelengths. Only the length of the split coaxial section is determined by the center frequency,

and that dimension is not affected by the branch signals. The proper relationship between the latter two frequencies, however, remains important for impedance matching and isolation and to permit the same main line lengths to be used for both.

It is also possible to introduce additional integral branch signal frequencies into the instant coupling device, to permit propagation of a multiplicity of signals simultaneously. The several branch frequencies may be combined to travel together along the outer pair of concentric conductors of the main triplexer body. The requirements for prevention of cross coupling and for selection of antenna line lengths to provide efficient transmission are the same as previously explained.

It can thus be seen that the present invention provides a novel compact multiplexing device permitting the combination of at least three frequencies for simultaneous transmission over a single antenna without harmful interaction between signals. While only one embodiment of the invention has been illustrated, it is apparent that the invention is not limited to the exact form or use indicated and that many variations may be made in the particular design and configuration without departing from the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A multiplexer for combining a plurality of frequencies to be applied to a utilization device, comprising a first conductive path comprising a central wire and a circumjacent intermediate tubular conductor; a second conductive path comprising said intermediate conductor and a circumjacent tubular conductor; and a plurality of branch conductors connected to said second path, each individual branch conductor having a length which presents at its junction with said second path an apparent open circuit to all of said plurality of frequencies except the one which it is transmitting, whereby each frequency is prevented from affecting other branch conductors.

2. A multiplexer for combining a plurality of frequencies to be applied to a utilization device, comprising a first coaxial conductive path comprising a central wire and a surrounding intermediate tubular conductor; a second coaxial conductive path comprising said intermediate conductor and a surrounding tubular conductor; a plurality of branch conductors of the coaxial type connected to said second path, each individual branch conductor having a property which presents at its junction with said second path an apparent open circuit to all of said plurality of frequencies except the one which it is transmitting, whereby each frequency is prevented from entering other branch conductors; and means to combine the frequencies in said first path with the frequencies in said second path.

3. A multiplexer for combining a plurality of frequencies to be applied to a utilization device, comprising a first coaxial conductive path comprising a central wire and a surrounding intermediate tubular conductor; a second coaxial conductive path comprising said intermediate conductor and a surrounding tubular conductor; a plurality of branch conductors of the coaxial type connected to said second path, each individual branch conductor having a length which presents at its junction with said second path an apparent open circuit to all of said plurality of frequencies except the one which it is transmitting, whereby each frequency is prevented from entering other branch conductors; means to combine the frequencies in said first path with the frequencies in said second path, said means comprising coplanar slots at the end of said intermediate tubular conductor, said slots having a length equal to an odd multiple of a quarter wavelength of the frequency to be transmitted along said first coaxial conductive path; shorting means for connecting the end of said central wire with one portion of said intermediate conductor between said slots, where-

by a signal which is transmitted along said first path appears between the solid portions of said intermediate conductor formed by said slots.

4. A triplexer comprising a first input path comprising a central wire and an intermediate circumjacent tube; means to apply an input signal to said first path, said means comprising an input terminal; a second conductive path comprising said intermediate tube and an outer circumjacent tube, whereby said outer tube forms a housing; a pair of coplanar coaxial-type input branch paths, each said branch path having a central wire connected to said intermediate tube, and an outer tube connected to said housing, whereby said outer tubes of said branch paths and said housing form a junction; means to apply signals of different frequencies to each said branch paths, said means comprising input terminals; means causing each said branch path to present at said junction an apparent open circuit to said frequency transmitted by the other of said branch paths.

5. The device of claim 4 wherein said first input path presents at its input terminal a short circuit to all signals except the one transmitted thereby; and each said branch input path presents at its input terminal a short circuit to the signal transmitted by the other branch input path.

6. A triplexer for combining three frequencies to be transmitted to a utilization device, comprising a first coaxial conductor comprising an inner tube and a circumjacent outer tube; a second coaxial conductor consisting of an inner wire and a circumjacent outer tube, whereby a signal of a second given frequency may be transmitted therethrough; a third coaxial conductor consisting of an inner wire and a circumjacent outer tube, whereby a signal of a third given frequency may be transmitted therethrough; a fourth coaxial conductor consisting of an inner tube and an outer tube; means electrically connecting said inner tubes and said inner wires; means electrically connecting said outer tubes, whereby a junction is formed; said first conductor having a characteristic which presents at said junction an apparent open circuit to said second and third frequencies; said second conductor having a characteristic which presents at said junction an apparent open circuit to said third frequency; said third conductor having a characteristic which presents at said junction an apparent open circuit to said second frequency; first means, positioned at the distal end of said fourth conductor, for picking off signals of said second and third frequencies which exist between said inner and outer tubes; a central wire within said inner tubes of said first and fourth conductors, whereby a signal of a first frequency may be transmitted between said inner tubes and said central wire; and second means for picking off signals of said first frequency.

7. The device of claim 6 wherein said first pickup means comprises a device having separate terminals connected to said inner and outer tubes.

8. The device of claim 6 wherein the distal end of said inner tube of said fourth conductor is split into two portions for a length equal to an odd multiple of a quarter wavelength of said first frequency.

9. The device of claim 8 wherein one of said split portions is electrically connected to said central wire.

10. The device of claim 9 wherein said second pickup means comprises a device having separate terminals connected to each of said portions formed by said split.

11. A triplexer for combining three frequencies to be transmitted to a utilization device, comprising a first coaxial conductor comprising an inner tube and a surrounding outer tube; a second coaxial conductor consisting of an inner wire and a circumjacent outer tube, whereby a signal of a second given frequency may be introduced; a third coaxial conductor consisting of an inner wire and a circumjacent outer tube, whereby a signal of a third given frequency may be introduced; a fourth coaxial conductor consisting of an inner tube and an outer tube; means electrically connecting said inner

tubes and said inner wires; means electrically connecting said outer tubes, whereby a junction is formed and whereby signals of said second and third frequencies exist between said inner and outer tubes; said first conductor having a property which presents at said junction an apparent open circuit to said second and third frequencies; said second conductor having a property which presents at said junction an apparent open circuit to said third frequency; said third conductor having a property which presents at said junction an apparent open circuit to said second frequency, and a central wire within said inner tube of said first and fourth conductors, whereby a signal of said first frequency may be transmitted.

12. In a triplexer for combining three frequencies to be transmitted to a utilization device, said triplexer having a first output coaxial conductor consisting of an inner tube and a circumjacent outer tube, and a second output coaxial conductor comprising a central wire within said inner tube the distal end of said inner tube being slit to form two separate portions; first pickup means for picking off signals which exist between said inner and outer tubes, said means comprising a device having separate terminals connected to said inner and outer tubes; and second pickup means, said means comprising a device having separate terminals connected to said portions of said inner tube.

13. A multiplexing device comprising coaxial means for conducting a primary signal; coaxial means for conducting at least two branch signals; coaxial means for combining said primary signal and said branch signals in a common concentric path for simultaneous transmission into an antenna, said branch signals joining said common path at a common junction; isolating means for preventing interaction between conduction paths of said primary and branch signals, including coaxial means causing each said branch signal conduction path to appear as a high impedance at said common junction to each other said branch signals and causing said primary signal path to appear as a high impedance at said common junction to each said branch signal; means for impedance matching between each said conduction path and said antenna; means for connecting said conduction paths to said antenna; and means for phasing and balancing said signals for transmission into said antenna.

14. A multiplexer comprising a main coaxial transmission line having an inner pair and an outer pair of concentric conductors including an interior wire conductor, an intermediate concentric conductor common to both said inner and outer pairs, and an exterior concentric conductor; means comprising said inner pair of conductors, for providing a transmission path for a primary signal into an antenna load; means comprising at least two branch coaxial line signal paths, for transmitting toward said antenna load independent branch signals of frequencies having a predetermined integral relationship, said branch coaxial lines forming a junction with said outer pair of conductors for conduction of said branch signals; means for impedance matching phasing and balancing said primary signal for transmission into said antenna load without interacting with said branch signal paths; means for preventing said branch signals from interacting with said primary signal path at said antenna load; means for impedance matching between each said branch signal path and said antenna load, said means including a first section of said main coaxial line having a length common to each said branch signal path; means for isolating each signal path from each other signal path at said junction, said means including a second section of said main coaxial line having a length common to each said branch signal path; and means for combining said several signal paths for simultaneous conduction into said antenna load.

15. A triplexer device comprising a main coaxial transmission line having an inner and an outer pair of concentric conductors including an interior wire conductor,

an intermediate concentric conductor common to both said inner and outer pairs and an exterior concentric conductor, said inner pair of conductors providing a transmission path for a center frequency signal; two branch coaxial lines providing transmission paths for two independent branch signals, said branch lines forming a junction with said outer pair of conductors, said branch signals and said center signal having a predetermined substantially integral frequency relationship; means for impedance matching phasing and balancing said center signal for transmission into a load without interacting with said branch signal paths, said means including a split coaxial line formed by slotting the end of said intermediate common conductor for a length which is one quarter wavelength long at said center frequency and terminating at said load, whereby said split coaxial line comprises equal first and second portions, and a shorting plug connecting said first portion to said interior wire conductor at said load termination; means for preventing said branch signals from interacting with said center signal path at said load; means for impedance matching between each said branch signal path and said load, said means including a first section of said main coaxial line having a length common to each said branch signal path; means for isolating each signal path from each other signal path at said junction, said means including a second section of said main coaxial line having a length common to each said branch signal path; and means for combining said several signal paths for simultaneous conduction into said load.

16. An antenna coupling device for multiplexing signals arranged in a substantially integral frequency relationship, comprising a main coaxial transmission line having an inner and an outer pair of concentric conductors including an intermediate concentric conductor common to both said inner and outer pairs; an input connection for inserting a center frequency signal into said inner pair of conductors, said inner conductors providing a transmission path for said center frequency signal into an antenna load; two branch coaxial lines providing transmission paths for two independent branch signals into said antenna load, said branches forming a junction with said outer pair of conductors; means for impedance matching phasing and balancing said center signal for transmission into said antenna load without interacting with said branch signal paths; means for preventing said branch signals from interacting with said center signal path at said antenna load; means for impedance matching between each said branch signal path and said load, said means including a first section of said main coaxial line between said junction and said antenna load one-quarter wavelength at the lower frequency of said branch frequencies and at the same time an integral multiple of one quarter wavelength at the higher frequency of said branch frequencies; means for isolating each said branch signal path at said junction from said center signal path, said means including a second section of said main coaxial line between said junction and said input connection for said center signals, said second section having a length equal to one quarter wavelength at said lower branch frequency and at the same time three quarters wavelength at said higher branch frequency, and a shorting ring connecting said inner and outer coaxial paths at said input connection, whereby an open circuit is reflected at said junction to prevent said branch signals from entering said center signal path; means for isolating each branch signal path from each other branch signal path at said junction; and means for combining said several signal paths for simultaneous conduction into said antenna load.

17. An antenna coupling device for triplexing three signals having a substantially integral frequency relationship, comprising a main coaxial transmission line having an inner and an outer pair of concentric conductors including an intermediate concentric conductor common

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to, both said inner and outer pairs; an input connection for inserting a center frequency signal into said inner pair of conductors, said inner conductors providing a transmission path for said center frequency signal into an antenna load; a first and a second branch input connection for inserting two independent branch signals into a first and second branch coaxial line forming a junction with said outer pair of conductors of said main coaxial line, said outer pair of conductors providing a transmission path for said branch signals into said antenna load; means for impedance matching phasing and balancing said center signal for transmission into said antenna load without interacting with said branch signal paths; means for preventing said branch signals from interacting with said center signal path at said antenna load; means for impedance matching between each said branch signal path and said load; means for isolating said branch signal paths from said center signal path at said junction; means for isolating each branch signal path from each other branch signal path at said junction, said means including a first coaxial line section extending from said first branch an integral number of quarter wavelengths at said second branch frequency and terminated to reflect a short circuit for said second branch frequency at said first branch input connection, said first branch being one

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quarter wavelength long at said second branch frequency to cause an open circuit to appear to said second branch frequency at said junction, and a first coaxial stub extending from said first branch adjacent to said first input connection to compensate for reactance of said first branch at said first branch frequency, a second coaxial line section extending from said second branch an integral number of quarter wavelengths at said first branch frequency and terminated to reflect a short circuit for said first branch frequency at said second branch input connection, said second branch being one quarter wavelength long at said first branch frequency to cause an open circuit to appear to said first branch frequency at said junction, and a second coaxial stub extending from said second branch adjacent to said second input connection to compensate for reactance of said second branch at said second branch frequency; and means for combining said several signal paths for simultaneous conduction into said antenna load.

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