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A. ALFORD
COAXIAL BRIDGE

2,769,146

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2 Sheets-Sheet 2

FIG. 2

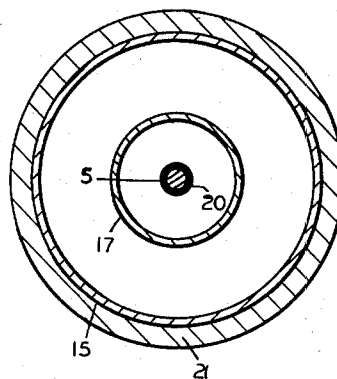


FIG. 3

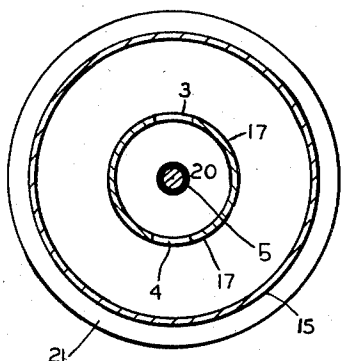


FIG. 4

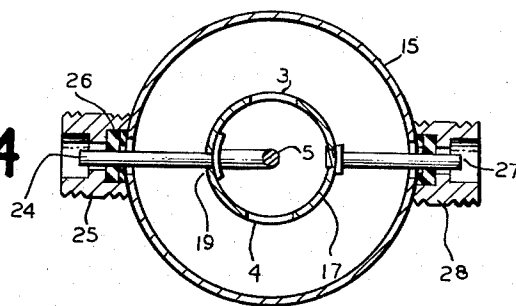


FIG. 5

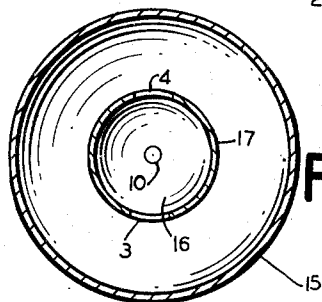
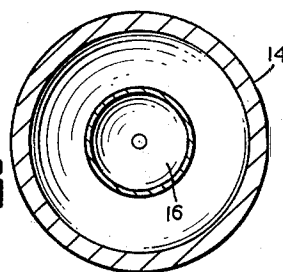


FIG. 6



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COAXIAL BRIDGE

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8 Claims. (Cl. 333-11)

The present invention relates to what may be called a coaxial bridge which may be more conveniently used as a circuit arrangement than the known transmission line bridge which becomes complex and relatively expensive to manufacture when used in connection with coaxial lines for feeders and loads.

The coaxial bridge circuit of the present invention is a simpler and better arrangement than other types of feeder systems and provides the same or more freedom in circuit operation. In accordance with the present invention the coaxial bridge may provide two input ends and two output ends and when the loads in the input ends are balanced, no energy from one input end will be delivered at the opposite output end. The input from one end feeds the two loads in the same phase, while the input from the opposite ends feeds the loads in opposite phase.

The coaxial bridge of the present invention is applicable to many types of feeder systems and is particularly applicable to a localizer antenna system used for instrument landing where the main array is intended to produce the principal localizer course along the runway and the subsidiary array is used to provide the background course. The present invention may also be used as a measuring bridge since an unknown impedance may be connected at one load terminal and this will be exactly balanced when no energy appears at the opposite input end from where the energy is impressed. When used for an array with principal localizer for the runway and subsidiary array for the background course, the load must be fed in the same phase for one type of pattern and in the opposite phase for the other type of pattern for energizing this system. The present invention of a coaxial bridge circuit readily provides operation of this system.

Further advantages and features of the present invention will be more readily appreciated from the description in the specification set forth below when taken in connection with the drawings illustrating an embodiment of the same, in which:

Figure 1 shows a longitudinal section through the coaxial bridge assembly of the present invention.

Figure 2 shows a cross section taken substantially along the line 2-2 of Figure 1.

Figure 3 shows a cross section taken on the line 3-3 of Figure 1.

Figure 4 shows a cross section taken along the line 4-4 of Figure 1.

Figure 5 shows a cross section taken along the line 5-5 of Figure 1, and

Figure 6 shows a cross section taken along the line 6-6 of Figure 1.

In the arrangement indicated in the drawings, the coaxial bridge comprises two input ends A and B and two load ends I and II. The input end A comprises a terminal 10 of an inner conductor surrounded by a coaxial tube 11 which comprises the outer conductor. The inner conductor 10 at the end A may be supported by an

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insulating collar 12 spacing it from the outer conductor. The outer conductor 11 is threaded into a shoulder 13 which has an outwardly tapering wall 14 fitting into an outer cylinder conductor 15 to which it is rigidly joined or integral therewith. The inner conductor 10 within the conical wall 14 is also flared outward forming a conical end 16 which is joined at the end of a tube 17 and made an integral element with it. The tubes 15 and 17, the conical members 14 and 16 and the inner conductor 10 and outer conducting element 11 are all coaxially positioned. The tube 17 is provided with two diametrically opposed slots 3 and 4 extending substantially the length of the tube 17 but not into the very end of the tube so that the slots are completely surrounded by metal. At the input end B the outer conductor comprises the threaded collar or tube 18, while the inner conductor 5 coaxially positioned with it is insulated therefrom by a suitable insulating ring 20. The member 18 is threaded securely or secured in some other way to an end plate 21 which is conductive and which holds securely the end of the tube 15 in a shoulder 22 forming a good conductive joint. The tube 17 is also securely held in a shoulder or recess in the plate 21 in a good conductive joint.

All of the elements in the present invention are conductive with the exception of the insulating members used as spacers or insulators between the various inner or outer conductors as indicated by the sectioning. It should be noted that the slots 3 and 4 terminate just short of the upper end of the tube 17 so that the end of the tube 17 fitting into the recess 23 in the plate 21 provides a secure short circuit at the end of the slots 3 and 4. The slots 3 and 4 are also short circuited by the conical elements 16 at the left end of the tube 17. Other suitable methods of short circuiting the ends of the slots may of course be used. At the upper end of the coaxial bridge as shown in Figure 1, the inner conductor 5 which is preferably positioned coaxially with the tubes 17 and 15 extends substantially to a mid-position of the length of the slot and is then turned at a right angle and connected to the wall of the tube 17 in a position substantially mid-way between the slots 3 and 4 as indicated at 19. From this point of connection a conductor 24 extends outward through a hole in the tube 15 forming the inner conductor for the load I. The outer conductor for the load I is formed by the element 25 which is conductively united with the outer wall of the tube 15. The element 25 acts as the outer conductor for the inner conductor 24 and forms the coaxial load terminal for the load I. An insulating ring 26 spaces and supports the inner conductor 24 from the outer conductor 25. Extending from a diametrically opposite position with reference to the right angle bend in the conductor 5, a conductive connection 27 is made to the wall of the tube 17 in a position mid-way between the slots 3 and 4. This conductor 27 extends outward through a hole in the tube 15, is insulated from it and forms the inner conductor for the load II. The outer conductor for the load II is formed by the element 28 which surrounds and is coaxial with the conductor 27 and is conductively secured to the outer wall of the tube 15.

When current is fed into the input end A, the coaxial feed comprises the tube 17 forming the inner conductor and the tube 15 forming the outer conductor. Therefore the load at I is energized with the outer conductor 25 connected to the outer conductor 15 and the inner conductor 24 connected to the inner conductor 17. The same phase of energization is also provided for the load II since the outer conductor 28 is connected to the outer conductor 15 and the inner conductor 27 is connected to the inner conductor 17. The outputs of the loads are therefore in the same phase with each other. From the

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symmetry of the arrangements and the connections, it will be seen that no power comes out of B when the loads I and II are the same. Both outer and inner conductors are at the end B under these conditions effectively short-circuited by the conductive end plate 21. The distance between the end plate 21 and the mid-position of the slot where the inner conductors of the loads I and II are connected should not be a half wave length or a whole multiple of a half wave length. This distance is preferably but not necessarily made equal to $\lambda/4$ where $\lambda/4$ is the average operating frequency or a frequency within the operating range.

When power is fed into the end B with equal loads at I and II, equal and opposite potentials are set up across the gaps in the slots 3 and 4 with the potential at the ends of the slots equal to zero because of effective short circuit by the conduction material around the end of the gap. The conductors 24 and 27 assume equal and opposite potentials and the outer conductors 25 and 28 equal and opposite potentials from that of the conductors 24 and 27. It is difficult if not impossible to provide an accurate corresponding circuit diagram but the physical analysis appears to be plain.

Assume the presence of two charges of positive potential travelling down the conductor 5 and two corresponding negative charges travelling down the conductor 17 each attracting their opposites. The slots 3 and 4 will, if symmetrically placed, distribute half the negative charge in the part of the tube 17 on the right of conductor 5 and half in the tube 17 on the left of conductor 5. At the mid-connecting point where the conductor 5 connects to the inner side of tube 17, the charge there on tube 17 becomes neutralized but only to the extent of half or a portion of the charge on conductor 5. In fact at the connecting point 19 the course of the charge can be in three directions; down the tube 17, up the tube 17 and outward through the conductor 24. Where the system is balanced and the loads are equal and where the lengths from the point 19 to the ends of the slot are substantially an effective one quarter of a wave length of the operating frequency of propagation all the remaining charge may flow out through the conductor 24. Since the other negative charge on the opposite (right referred to Figure 1) half of the tube 17 is released at the junction of the conductor 5 to the tube 17, this charge flows out through conductor 27.

The corresponding opposite charges are built up on the tube 15 to offset the charges on the inner conductors 24 and 27 and establish the electric field for the pair of coaxial cable terminals of loads I and II. For the power fed in at the end B the two halves of the tube 17 below the bend where the junction 19 is made form a shunt impedance between the conductors 19 and 27. It will be noted also that the tube 15 even though conductive has built up in it opposite potentials at the outer conductor elements 25 and 28.

When the coaxial bridge is used as a measuring circuit, an unknown impedance may be placed at load I and power may be impressed at A or B. A known impedance is adjusted at load II until the power opposite to the input end is zero. The loads then will be balanced.

While the embodiment shown in the drawings show cylindrical elements, it is to be understood that other cross sectional forms may be used for the coaxial conductors without departing from the scope of the invention providing the effects and results as herein may be obtained.

Having now described my invention, I claim:

1. A four terminal network comprising four coaxial transmission lines, the outer conductors of the four lines being electrically connected to a cylindrical shell forming a cylindrical cavity, the inner conductor of the first coaxial line entering through one end of the cylindrical cavity and divided into two substantially spaced parallel parts of the same conductor for the length of the cavity

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and short circuited at the opposite end of the cavity, the inner conductor of the second coaxial line entering at the other end of the cylindrical cavity and extending between and parallel to the parts of the first conductor and electrically coupled to said first conductor between its ends within said cylindrical cavity and said third and fourth inner conductors being electrically coupled to the external side of said spaced parts of said first inner conductor at equal distances from the short circuited end of said first inner conductor.

2. A four terminal network comprising four coaxial transmission lines, the outer conductors of the four lines being electrically connected to a cylindrical shell forming a cylindrical cavity, the inner conductor of the first coaxial line entering through one end of the cylindrical cavity and divided into two substantially spaced parallel parts of the same conductor providing a pair of substantially opposed slots extending substantially the length of the cavity and said parts being electrically connected at the opposite end of the cavity, the inner conductor of the second coaxial line entering at the other end of the cylindrical cavity and extending between and parallel to the parts of the first inner conductor and connected to said first inner conductor between its ends within said cylindrical cavity and said inner conductors of the third and fourth coaxial line being connected to diametrically opposed sides of the first inner conductor.

3. A four terminal network comprising four coaxial transmission lines, the outer conductors of the four lines being electrically connected to a cylindrical shell forming a cylindrical cavity, the inner conductor of the first line entering through one end of the cylindrical cavity and forming a hollow cylindrical conductor with slots on opposite sides of the conductor extending substantially for the length of the conductor within the cavity and said inner conductor being electrically connected to the opposite end of the cavity, the inner conductor of the second coaxial line entering at the other end of the cylindrical cavity and extending between and parallel to the parts of the first inner conductor and connected to said first inner conductor between its ends to a side of the inner conductor between said slots and the inner conductor of said third and fourth coaxial lines being connected to diametrically opposed sides of said first inner conductor at equal distances from said opposite end of said cavity and the end of the slot most remote from said opposite end.

4. A four terminal network comprising four coaxial transmission lines, the outer conductors of the four lines being electrically connected to a cylindrical shell forming a cylindrical cavity, the inner conductor of said first coaxial line entering through one end of the cylindrical cavity and dividing into two substantially spaced parallel parts of the same conductor for the length of the cavity and being short circuited at the opposite end of said cavity and connected to said shell, the inner conductor of the second coaxial line entering at the other end of the cylindrical cavity and extending between and parallel to the spaced parts of the same first inner conductor and connected to said first inner conductor between its ends within the cylindrical cavity, the distance between said short circuited end and the point of connection of said second inner conductor to the first being an odd multiple of a quarter wave length of the frequency at which said network is to be operated, and said third and fourth inner conductors being electrically connected to the diametrically opposed sides of said first inner conductor at equal distances from the short circuited end of said first inner conductor.

5. A four terminal network comprising four coaxial transmission lines, the outer conductors of the four lines being electrically connected to a cylindrical shell forming a cylindrical cavity, the inner conductor of the first coaxial line entering through one end of the cylindrical cavity and divided into two substantially spaced parallel

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parts of the same conductor for the length of the cavity and short circuited at the opposite end of the cavity and connected to said shell at said short circuited end, the inner conductor of the second coaxial line entering at the other end of the cylindrical cavity and extending between and parallel to the spaced parts of the same first inner conductor and connected to said first inner conductor substantially mid-way between its ends within said cylindrical cavity and said third and fourth inner conductors being electrically connected to the diametrically opposed sides of the first inner conductor at equal distances from the short circuited end of said first inner conductor.

6. An arrangement as set forth in claim 5 in which the connection of said second inner conductor to the first inner conductor is at a point substantially one-quarter wave length of the operating frequency of said network from the point of entrance of the second conductor into the cavity.

7. An arrangement as set forth in claim 5 in which said third and fourth inner conductors are connected

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to said first conductor at a point opposite to the connection of said second inner conductor to said first inner conductor.

8. A system as set forth in claim 3 in which the slot in said first inner conductor is substantially one half wave length long referred to the operating frequency of the network.

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