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Radio frequency network.

A radio frequency network, comprises a first common node (2) connected to a common input or output port (8), a second common node (3), and at least three identical branches (1) therebetween, each branch (1) comprising a first branch node (4), to which is connected a balance load (6), and a second branch node (5) spaced therefrom and connected to a branch output or input port (7), the network being dimensioned and arranged such that an r.f. signal of a specific frequency input at the common input port (8) is divided equally between all the branch output ports (7), and a plurality of identical r.f. signals of the specific frequency applied in phase to all the branch input ports (7) appear combined at the common output port (8).

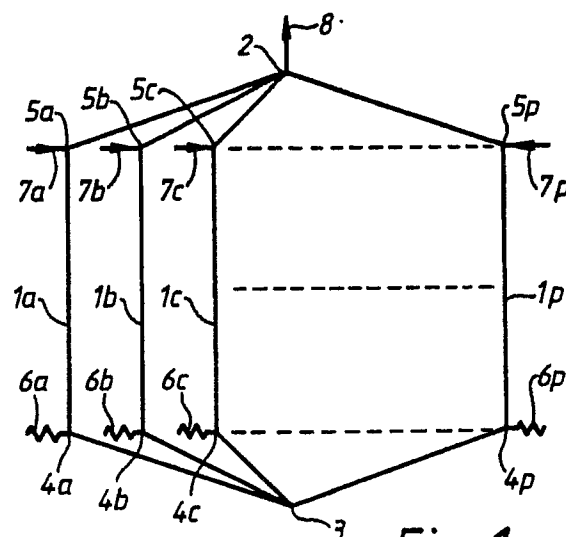


Fig.1.

RADIO FREQUENCY NETWORK

This invention relates to a radio frequency network usable for splitting an r.f. signal or for combining a plurality of r.f. signals.

A particular application for a combiner is in transmitters, for example television transmitters. Conventionally, a television transmitter uses a klystron in the r.f. output stage to amplify the signal to be passed to the antenna. While klystrons generally perform this function satisfactorily and reliably, they require complex cooling arrangements, usually employing circulating water, and these require regular maintenance. In addition, failure of the klystron renders the transmitter inoperative.

For these reasons, there has been a move towards the use of arrays of solid state r.f. amplifiers operating in parallel in place of the klystron. With an array of parallel solid state amplifiers, it is necessary to combine the output signals in phase in such a way that failure of individual amplifiers does not jeopardize the total output.

The present invention provides a radio frequency network, comprising a first common node connected to a common input or output port, a second common node, and at least three identical branches therebetween, each branch comprising a first branch node, to which is connected a balance load, and a second branch node spaced therefrom and connected to a branch output or input port, the network being dimensioned and arranged such that an r.f. signal of a specific frequency input at the common input port is divided equally between all the branch output ports, and a plurality of identical r.f. signals of the specific frequency applied in phase to all the branch input ports appear combined at the common output port.

All the inter-nodal distances are preferably equal to one quarter of the operating wavelength of the input signal or signals. However, for many applications, a narrow network bandwidth is unsatisfactory. It has been found that the values of the impedances of the portions of the branches between the second common nodes and each first branch node have some influence on the bandwidth of the network. By selection of suitable impedances for these portions, the bandwidth may be increased. The impedance is preferably low relative to the other portions of the network.

A greater increase in bandwidth may be achieved by providing a quarter wavelength transformer between the first common node and the common input/output port, the length of the line added being a quarter of the wavelength at the centre of the bandwidth. Still further improvement of the bandwidth may be obtained by connecting to the first common node a short circuited stub, pref-

erably having a length equal to a quarter wavelength. By way of example, using this construction, a twenty way combiner with a bandwidth of 88 to 108 MHz for an input VSWR of less than 1.02:1 can be achieved.

When the network is used as a splitter, as each output load fails, the input match deteriorates, but all the other inputs stay at the same amplitude and phase. This input deterioration could be cleaned up by, for example, using a circulator.

When the network is used as a combiner, as each input fails, the output power drops by somewhat more than this input amount, depending on the number of already failed inputs. Most of the surplus power appears in the load adjacent to the failed input, with the remainder spread evenly around the other loads.

The network of the invention may be formed of coaxial cable, multi-wire cable, waveguide, or even LC circuits to give a 90° phase shift. The quarter wavelength lines may conveniently be any odd multiple of quarter wavelengths where this makes the network physically easier to realise. The use of greater lengths carries the disadvantage, however, that the operating bandwidth becomes narrower.

Reference is made to the drawings, in which :

Figure 1 is a diagrammatic representation of a sixteen-way combiner in accordance with one embodiment of the invention;

Figure 2 is a diagram of a modified form of the combiner illustrated in Figure 1; and

Figures 3, 4 and 5 are graphs of insertion loss and VSWR against frequency respectively for the network as shown in Figure 1, the network shown in Figure 2, but without the stub, and the network shown in Figure 2 with the stub.

Referring to Figure 1 the network comprises sixteen identical branches 1a to 1p extending between a first common node 2 and a second common node 3. Each branch 1 comprises three equal lengths of coaxial cable joined at a first branch node 4 and at a second branch node 5. A balance load 6 is connected to the first branch node 4, while a branch input port 7 is connected to the second branch node 5. The inter-nodal length is in each case one quarter of the wavelength at the centre of the operating bandwidth for the network, thus giving a 90° phase shift in each portion of the network for that wavelength. The first common node 2 is connected to an output port 8.

In use, sixteen identical r.f. signals are applied in phase to the branch input ports 7a to 7p. The signal appearing at the output port 8 is substantially the sum of the input signals.

Referring now to Figure 2, the bandwidth of the

network may be increased by connecting a quarter wavelength transformer 9 between the first common node 2 of the network illustrated in Figure 1, and the output port 8. A further improvement may be achieved by connecting a short circuited quarter wavelength stub 10 to the first common node 2. Adjustment of the impedances of the lines extending between the second common node 3 and each of the first branch nodes 4a to 4p can also improve the bandwidth. The effects of these modifications are illustrated by Figures 3, 4 and 5.

Figure 3 illustrates insertion loss and input VSWR against frequency for the network illustrated in Figure 1, where, in each branch, the impedance of the line from the second common node 3 to the first branch node 4 is 280 ohms, the impedance of the line between the two branch nodes 4 and 5 is 50 ohms, and the impedance of the third line is 12.5 ohms. It will be seen that, moving away from the central frequency of approximately 670 MHz, one encounters rapidly increasing loss and VSWR.

Figure 4 shows the effect of a circuit in accordance with Figure 2, but without the short circuited stub. The impedances are set in each branch, from the second common node 3 to the first common node 2 as 5 ohms, 50 ohms and 100 ohms respectively. The quarter wavelength transformer has an impedance of 25 ohms. It will be seen that the bandwidth over which very low loss is experienced is very much greater, extending from about 470 MHz to about 860 MHz the VSWR over this range is also substantially reduced.

Figure 5 shows the effect of adding a short-circuit stub, having an impedance of 49 ohms. The impedance of the line in each branch extending from the second common node to the first branch node is increased to 50 ohms, with all other impedances remaining the same. It will be seen that, while the loss is very slightly increased over the bandwidth of 470 to 860 MHz, the VSWR is significantly reduced further.

While the networks described with reference to the drawings are symmetrically arranged with respect to impedance, it has been found that by varying the ratio of the impedances in one branch to those in any of the remaining branches, the power in that branch will vary relative to that in each of the other branches. This is of particular application in a splitter, if an uneven distribution of output power is desired.

It should be noted that the network of the application, although particularly described with reference to television transmitters, will find application in many other types of transmitter, and generally where a plurality of r.f. signals are to be combined together or produced from a single such signal.

Claims

1. A radio frequency network, comprising a first common node connected to a common input or output port, a second common node, and at least three identical branches therebetween, each branch comprising a first branch node, to which is connected a balance load, and a second branch node spaced therefrom and connected to a branch output or input port, the network being dimensioned and arranged such that an r.f. signal of a specific frequency input at the first common node is divided equally between all the branch output ports, and a plurality of identical r.f. signals of the specific frequency applied in phase to all the branch input ports appear combined at the first common node.

2. A radio frequency network according to Claim 1, wherein the impedances of the portions of the branches between the second common node and each first branch node are such that substantially all of an r.f. signal having any one of a range of frequencies input at the common input port is divided equally between all the branch output ports, and a plurality of identical r.f. signals, all of any one of a range of frequencies, applied in phase to all the branch input ports appear substantially combined at the common output port.

3. A radio frequency network according to Claim 2, wherein the impedance of the portion of each branch between the second common node and the first branch node is substantially lower than that of either of the other two portions thereof.

4. A radio frequency network according to Claim 2 or 3, wherein a short circuited stub is connected to the first common node.

5. A radio frequency network according to Claim 4, wherein the stub is equal in length to the portion of any of the branches between first common node and the second branch node.

6. A radio frequency network according to any of Claims 2 to 5, wherein a quarter-wavelength transformer is connected between the first common node and the common input/output port, the length of the transformer being a quarter of the centre wavelength of the said range.

7. A radio frequency network according to any preceding claim, wherein each portion of each branch has a length equivalent to one quarter of the specific wavelength or of the centre wavelength of the said range.

8. A television transmitter, comprising a vision modulated r.f. signal amplification stage having a plurality of parallel solid state amplifiers, the output of each of which is connected to a respective branch input node in a network according to any preceding claim, the common output port being connected to signal mixing stage for mixing the vision and sound-modulated signals.

9. A television transmitter according to Claim 8, comprising a signal splitter for splitting the vision modulated r.f. signal into a plurality of parallel signals which are input to the amplifiers.

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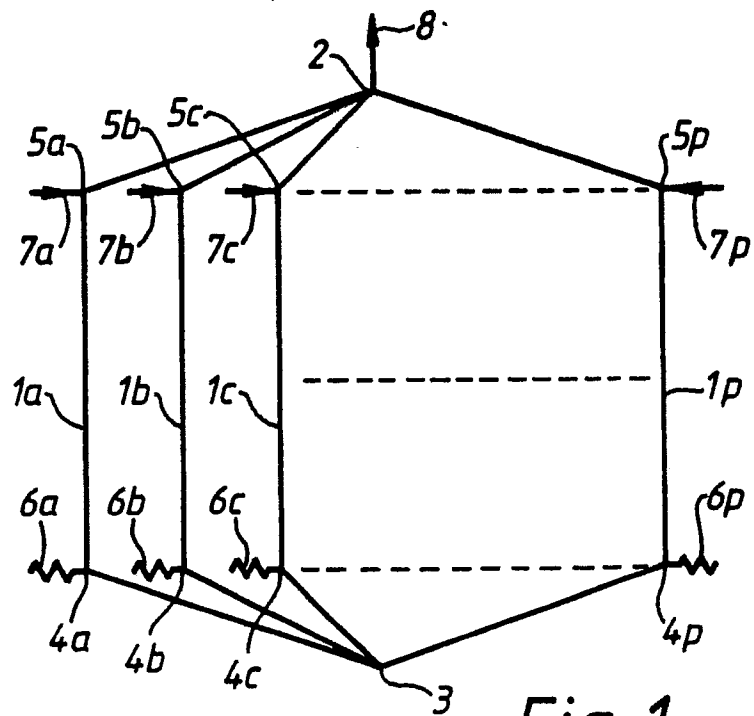


Fig.1.

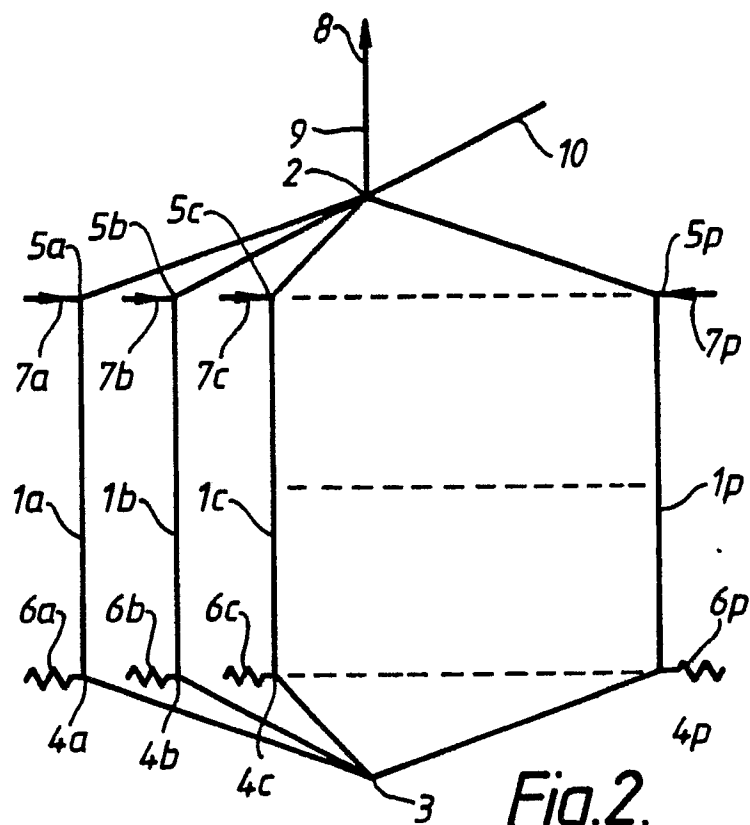


Fig.2.

NOUVEAU DÉPOSÉ
Nouvellement déposé

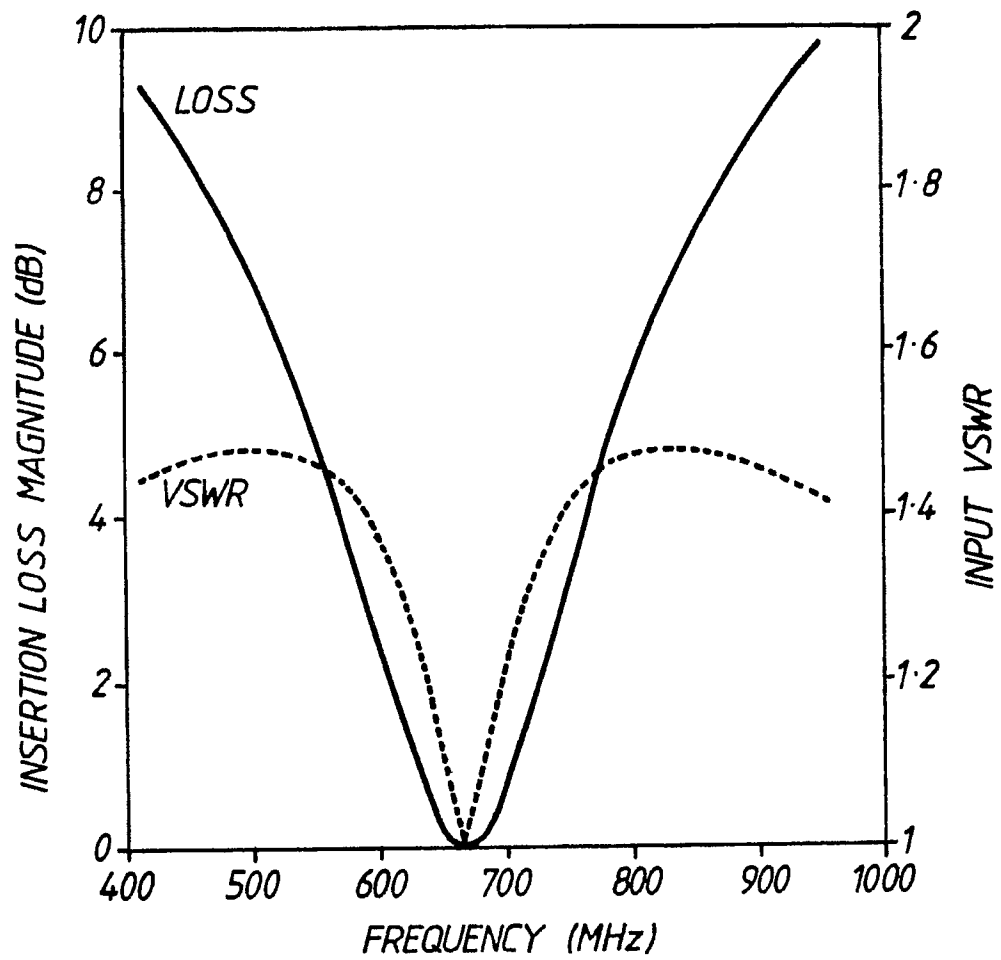
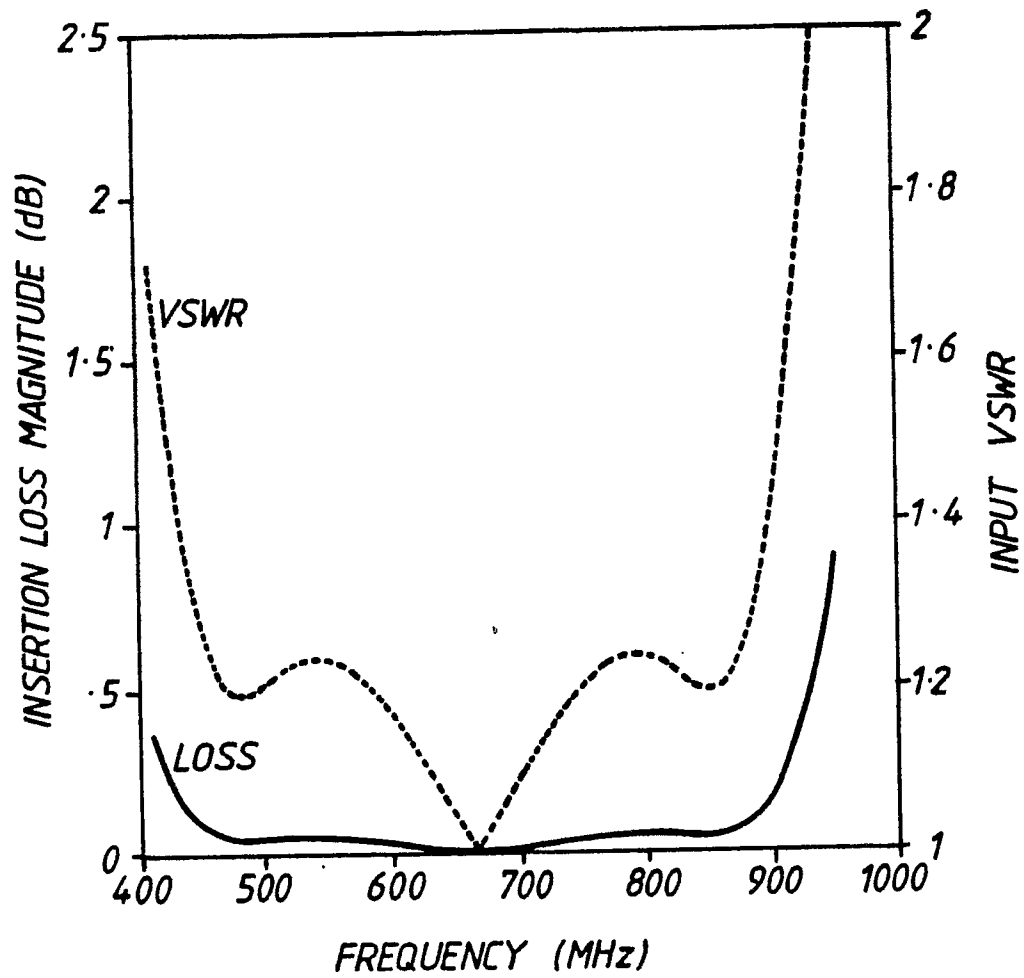
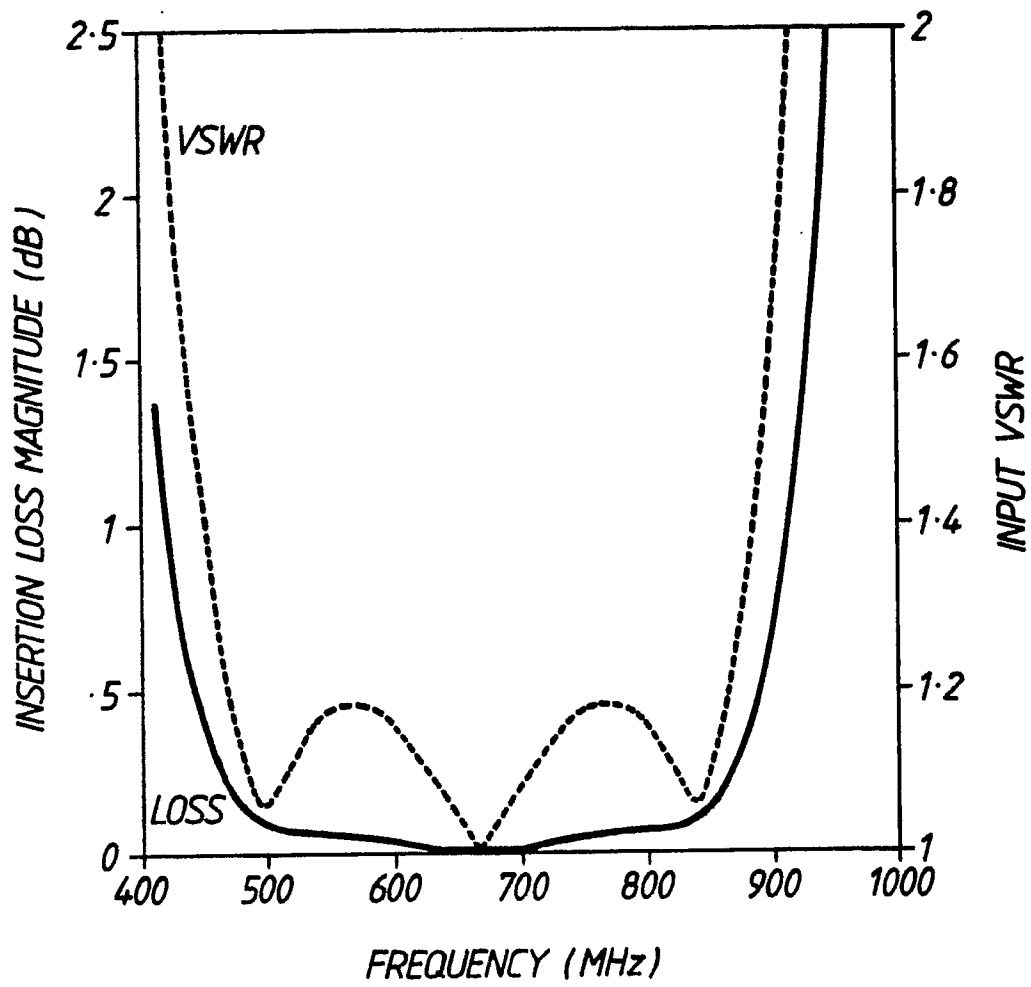


Fig.3.

*Fig. 4.*

*Fig. 5.*